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City of Port Phillip

Section 53V Environmental Audit - Interim Report

Gasworks Site, Albert Park

December 2008

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction

This report outlines the results of a preliminary assessment of risk as part of an audit carried out under Section 53V of the Environment Protection Act 1970, for the South Melbourne Gasworks site. The purpose of this report is to provide an initial outline of findings related to risk for discussion with the EPA, in order to confirm that the methodology and nature of findings are consistent with the requirements of the EPA.

The audit is being undertaken in two stages. This report relates to the first stage of the audit, and involves a preliminary assessment of the currently available information to indicate what further works are required to complete the audit. This initial assessment considers the risks associated with groundwater and soil contamination with a view to determining what further investigation and remediation work may be required. The second stage of the audit will consider the condition of the site following the necessary works.

The City of Port Phillip advises that it intends to address longer-term issues at the Site though the development of a final master plan for the Site. These plans are yet to be finalised, and are unlikely to be decided upon until at least this stage of the audit has been completed.

This first stage of the audit includes consideration of Interim Contaminations Management Plans for the Site and whether the Site can continue to be managed in an appropriate manner until the additional separation layer works and/or other cleanup works, revised management plans and/or master plans are designed and implemented.

The information contained in this report represents part of the first stage of the audit, including:

- A summary of the findings of a first screening risk assessment workshop that was held with Golder Associates and DLA Phillips Fox on 1 May 2008 and provided general agreement on the risk assessment matrix and beneficial used to be protected.
- A preliminary review of the information that has been provided to GHD (ie. Golder Associates reports) and that have been used as the basis for the screening risk assessment;
- The results of the screening risk assessment;
- The results of a second screening risk assessment workshop held with Golder Associates, CoPP and DLA Phillips Fox on 27 June 2008; this workshop considered the results of the screening risk assessment and provided a common view of the available information and ranking of risks;
- Preparation of an “In-Principle Land Management Strategy” by Golder Associates, which outlines in simple form the key elements of a land management strategy for the site that will provide for control of the risks that have been identified in the screening risk assessment; and
- Preparation of this interim report that summarises the findings of the work to date. Note that this report was finalised on July 24th, 2008, with information available at that time. This report has not considered information which has become available after that time.

In the development of the scope it was agreed that the auditor would prepare advice to the City of Port Phillip in the form of an interim findings/report outlining preliminary recommendations regarding the need for further clean up and/or management of the site to provide an adequate level of control of the risks resulting from the contamination. This report provides this advice.

The next stage of the work is expected to involve:

- A meeting with EPA to discuss the screening risk assessment approach, to calibrate the risk descriptors, to present the screening risk assessment findings including the in-principle land management strategy to control the risks, and to seek in-principle agreement that the land management strategy is consistent with EPA's requirements, and to identify any additional requirements of EPA.
- Revision of this Interim Report to reflect the outcome of the meeting with EPA.

Assuming approach and works and land management controls are consistent with EPA's requirements for this Site, the further work might then involve:

- GHD and/or Golder Associates completing the detailed risk assessment and advising on any further requirements for investigation, remediation and management;
- Golder Associates preparing detailed work plans to address key risks identified, and GHD to review;
- Golder Associates carrying out any further investigation that is required and developing a plan for improving containment and a long term management strategy;
- GHD auditing this work and preparing an audit report that can be used to assist in gaining agreement with EPA on the proposed long term management strategy and accompanying works; and
- GHD then completing the final audit after the works have been completed and the management plan is in place.

The overall product of the environmental audit will be the issue of an environmental audit report on the risk of any possible harm or detriment to the land and groundwater condition (among other beneficial uses) at the Site, and in the area just beyond the boundary of the Site.

2. Scope of the Audit

2.1 Background

The scope for the environmental audit was completed in accordance with the environmental auditor guidelines issued by the Environment Protection Authority (EPA) for the preparation of an environmental audit in relation to the risk of any possible harm or detriment to the environment (EPA Publication 952). Definition of the scope of the environmental audit is a important step in the process for undertaking a statutory environmental audit conducted in accordance with Part IXD of the *Environment Protection Act 1970*.

The auditor was engaged by the City of Port Phillip (CoPP) and DLA Phillips Fox (DLA) to undertake an audit of the site that was formerly used as the South Melbourne Gasworks (Gasworks Site). At the time of engaging the auditor, and to this date, the site is used as an open space recreational area named "Gasworks Park", and the Southport Community Nursing Home Site ("Southport Site").

CoPP has advised the auditor that the future use of both Gasworks Park and the Southport Site is likely remain parkland, and the Southport Site may remain a nursing home or may be developed into another community use.

Table 1 below summarises the appointment details of the auditor and information on the audit.

Table 1 Detail on the Appointment of the Auditor and Site Background

Name of Auditor	Peter Nadebaum
Term of appointment of Auditor	16 May 1990 to 29 November 2011
Name of premises/location	The "Gasworks Site" comprising Gasworks Park and the Southport Community Nursing Home (Southport Site).
Premises/location address	The site is bound by Graham Street to the south, Pickles Street to the west, and Richardson Street to the north and Foote Street/Bridport Street to the east (refer to attached map) in Albert Park. The South Melbourne Gas Regulator Site (Alinta Site) in the northern corner of this parcel is not included in the audit. See Figure 1 and Figure 2.
Owner	Gasworks Park is partially owned by the City of Port Phillip and partially owned by the State of Victoria. The City of Port Phillip is currently the Committee of Management for Gasworks Park. The City of Port Phillip owns Southport Community Nursing Home.
Municipality	City of Port Phillip
Person/Organisation requesting audit	Audit Client: City of Port Phillip and DLA Phillips Fox. Louise Hicks, Partner of DLA Phillips Fox, on behalf of Kathy Dillon of the City of Port Phillip.
Reason for request	The audit is voluntary and the auditor was engaged by direct request.
Date of request	18 June 2007
Notification to EPA	18 June 2007
Proposed completion date of audit	April 2009

2.2 Description of the Premises

The audit area, referred to herein as the Gasworks Site, covers an area of 3.43 hectares within Albert Park (see **Figure 1**).

Gasworks Park is 2.67 hectares in area and consists of grassed and landscaped areas, seating areas, a playground, a small wetland and gravel tracks. There are 11 buildings on Gasworks Park, some of which were former gasworks buildings that were retained as part of the redevelopment. It is understood that the buildings are now used for arts related activities (i.e. sculpture, ceramics, a bookshop, and a theatre). Appendix A lists the various buildings, occupiers and activities as of September 2007.[1]

The Southport Site covers an area of 0.54 hectares and was established on the northeast corner of the greater Gasworks Site in the 1980s. A brick building covers most of the Southport Site, and some grassed and landscaped areas have been established on the site as well.

Neighbouring land uses include:

- Low density residential houses over Richardson and Foote Streets to the north and east respectively;
- An Alinta-owned site located near the corner of Richardson and Pickles Streets, and forms the northeastern boundary of the audit area. This site is used as a gas and fuel workshop;
- High-density apartments on the eastern side of Pickles Street;
- A retirement village has been proposed for the southern side of Graham Street, although the plan is not final; and
- It is understood that a new college is proposed at the former Albert Park College site bounded by Graham, Foote, Danks and Withers Streets.

2.2.1 History of the Site

The Gasworks Site was used for gas manufacturing from 1873 until decommissioning in 1955[2]. The Southport Site was established in 1981. It is understood that in 1982 the northern two thirds of the site was landscaped and grass cover was established forming Gasworks Park, with no additional remediation being undertaken. The landscaping appears to have comprised the placement of clay and topsoil; however, there does not appear to be records of the constructed depths and extent of this cover layer over the site.

The presence of tars has been noted in the southeast corner of the site. This area remained fenced off from the park awaiting EPA approval of an appropriate remediation proposal. Subsequently EPA advised the City on 28 November 1991 of the following requirements for landscaping of Foote/Graham Street area:

- Soil is removed to a nominal depth of 0.5 m and disposed to an EPA licensed landfill;
- Agriculture drainage is installed to prevent pondage of water and minimise the migration of contaminants from this area;

[1] Information provided by Kathy Dillon via email dated 11 October 2007.

[2] Golder Associates, *Interim Contamination Management plan for Current Site Use, Gasworks Park, Graham Street, Albert Park, City of Port Phillip*, 18 May 2004.

- The excavation is backfilled with clean fill (this need not be impervious clay); and
- Vegetation needs to be selected that will ensure root growth will not penetrate the base of the old purifiers.

It is understood that the top 0.5 m of fill was removed from the Graham/Foote Street area by February 1992 and disposed offsite. Minutes of the last Gasworks Site Contamination Steering Committee on 11 February 1992 indicate that the remediation works were scheduled for completion in July 1992. It is assumed that the works were completed as proposed by EPA. Further site history is provided in Section 3.

2.3 How the Scope was Defined

EPA Publication 952 "*Environmental Auditor Guidelines for the Preparation of Environmental Audit Reports on Risk to the Environment"* (October 2007) (Section 53V Guidelines) provide guidance to environmental auditors undertaking an environmental audit pursuant to section 53V of the *Environment Protection Act* 1970. The auditor has referred to the Section 53V Guidelines to address the requirements for the scope of the audit.

The outline for the scope for the audit was based on:

- The initial Project Brief prepared by DLA and provided to GHD prior to engaging the auditor;
- Discussions with CoPP, DLA and Golder Associates. Golder Associates are the assessment consultant for the site, and have undertaken environmental investigations at the site since 2004;
- A meeting with EPA personnel on 9 June 2007, at which the scope for the audit had been discussed; and
- A meeting with EPA on 15 January 2008 to discuss a draft of the audit scope that had been provided to EPA in November 2007. EPA subsequently provided written feedback on the draft scope to CoPP dated 7 February 2008; this was considered in the final review of the audit scope.

A final scope was prepared that considered the feedback from EPA, CoPP, DLA and Golder Associates, and this was provided to CoPP on 8 April 2-08. The final audit scope is reflected in the following sections.

2.4 The Activities and Components of the Activities to be Considered

In broad terms, Section 53V audits provide an auditor's assessment 'in relation to the risk of any possible harm or detriment to a segment of the environment caused by any industrial process or activity, waste, substance or noise'. In the case of the Gasworks Site, a number of activities are subject to audit; these are:

- The former use of the site for gas-making, and the associated land and groundwater contamination that has resulted from this activity at the site;
- The current site contamination management arrangements; and
- The management arrangements that will be proposed for the ongoing use of the site.

2.5 The Objectives of the Audit

The audit will provide a staged approach to the assessment of risk posed by the Gasworks Site.

2.5.1 Summary of the Expected First Stage of the Audit

The first stage of the audit will consider the risk of possible harm or detriment to groundwater and land caused by past industrial processes and activities at the site.

With respect to groundwater, groundwater assessment has been undertaken at the Gasworks Site commencing December 2003, and additional information may be sought to meet the requirements of the audit. The first stage will include consideration of the groundwater beneath the site and also whether groundwater migrating from the site is posing a risk to off-site and down-gradient receptors.

In particular the scope for the first stage will consider:

- Whether or not groundwater quality objectives are being protected at and beyond the boundary of the Site; and
- The likelihood of groundwater beneficial uses being realised at and beyond the Site.

Included in the first stage of the audit will be an assessment of the existing separation layers at the Gasworks Site, and the Interim Contamination Management Plans (ICMPs) for the Site. Essentially, this will consider:

- Whether of not the beneficial uses of the land *with respect to the existing land use* are protected at the Site.

Therefore, included in the first stage objectives would be an assessment of whether the site can continue to be managed in a responsible manner until the additional separation layer works are designed and a revised management plan can be implemented for the whole Gasworks Site.

In this way, the approach has the advantage of gaining a full appreciation of the issues relating to both land and groundwater, and avoids the possible problem where the later stage of the audit that relates primarily to the land, might give rise to considerations that should have been considered earlier.

The first stage of the audit will also consider the risk of any possible harm or detriment to land caused by past gasworks operations and activities at the site. In particular, the environmental audit will consider:

- Whether or not the beneficial uses of the land *with respect to the existing and proposed land use* are protected at the site; and
- Whether or not the land contamination poses a risk to other environmental media and their associated beneficial uses, including the use of groundwater at and beyond the site.

The Gasworks Site is currently managed in accordance with two management plans, as follows:

- “Interim Contamination Management Plan for Current Site Use, Southport Nursing Home, Richardson Street, Albert Park, Report 04613504/014” (Golder Associates, dated 18 May 2004); and
- “Interim Contamination Management Plan for Current Site Use, Gasworks Park, Graham Street, Albert Park, Report 04613504/025” (Golder Associates, dated 18 May 2004).

An assessment of the adequacy of existing separation layers at the Gasworks Site and the associated Interim Site Management Plans will be undertaken as part of the first stage of the audit.

The auditor understands that any further development of the separation layer that might be required can be expected to take place as part of the second stage.

It is expected that the second stage of the audit will require some time to complete as the plans for the Site's redevelopment are not yet finalised and would require consultation with the CoPP community and other stakeholders.

Some soil, vapour and groundwater testing of the Southport Community Nursing Home has occurred with residents in place. Golder Associates advises that more testing can be done if necessary but some areas of the site will be constrained and further testing may not be able to be undertaken while residents remain. Alternative accommodation may take some time to source. The approach that Golder Associates proposes is to take the assessment as far as possible with residents in place. If a constraint on information occurs due to the occupation of the site that cannot be overcome, then the Audit may be delayed or may need to be qualified in that area of the site.

Golder Associates also advises that remediation of the Southport Site if required would be more problematic with residents in place, although some limited remediation may be able to be undertaken. In addition, further testing and remedial works, if required, might not be able to be undertaken in some areas of the Gasworks Site such as the residential areas of the Southport Site, and may take some time to resolve.

In undertaking the assessment of the risk posed to the land and groundwater segments at the Site, the audit will consider information that is available regarding the quality of the land at the site, and the quality of groundwater at, and potentially migrating from the site. The auditor will also identify data gaps, and, if necessary, request or conduct sampling and analysis to address the gap.

A summary of the audit considerations is provided in Table 2.

Table 2 Summary of Audit Inclusions

	First Stage	Second Stage
Indicative Timing	Completion within 6 months of agreement on scope.	Completion within 12 months of agreement on scope.
Focus	Immediate issues addressed through assessment of the Interim Site Contamination Management Plans, including existing separation layers across the site.	Focus of the audit will include the outcomes of any clean up and/or management works, including those that may arise from the groundwater audit.
	Short to longer-term issues addressed through the assessment of higher ranked groundwater risks at and beyond the Gasworks Site.	Longer term issues for the gasworks Site will be addressed through an assessment of the risk posed by the site in its final condition, or as proposed by the final capping designs and management plans for the site.
Reporting	Interim findings to be reported at an appropriate stage of the audit, or at completion of the 1st stage.	Findings reported in an environmental audit report.

Further details on the staging and timing of the audit is discussed in Section 2.10.

2.6 The Segment of the Environment to be Audited

The geographical extent of the segment of the environment to which the former gasworks activities may pose a risk is essentially the boundary of the Gasworks Site, as this is the site on which the activity was conducted, and for which the Interim Contamination Management Plans relate. This area is described in Table 1 and is represented on Figure 2.

In assessing the risk that the contamination at the site may pose, the auditor will consider the risk at the site as well as the portion of the surrounding environment beyond the site to which the activities may pose a risk. This will include consideration of the potential receiving environment for groundwater leaving the site, and receptors associated with this environment. Based on a preliminary review of the site assessment information, it appears that important receptors include those associated with land and groundwater uses adjacent to the site (and particularly downgradient of the site), and the local sewer system that runs beneath the streets that bound the Gasworks Site that appears to be acting as a sink for groundwater and groundwater flow, by and large, appears to be contained by this sewer network.

2.7 The Elements of the Environment to be Considered

The quality of the land and groundwater has the potential to affect the following elements of the environment:

- Air, including odour in both indoor and outdoor environments;
- Land, including aesthetics; and
- Groundwater and surface water.

These elements apply at the Gasworks Site on which the gasworks activities had been undertaken, and the elements also apply off-site where a potential exposure pathway and receptor is identified, and therefore a risk to the element would exist.

2.8 Beneficial Uses of the Segment

The existing and potential beneficial uses of the segment(s) of the environment need to be identified before any risk of possible harm or detriment to them can be assessed.

The beneficial uses to be protected for particular segments of the environment are declared in State environment protection policies (SEPP).

Land and groundwater are the primary segments of interest, however as they can impact air and surface water segments, the audit has an interest in all four segments. The beneficial uses of each segment are summarised below, and further detail is provided in Section 5.

2.8.1 Beneficial Uses of the Land Segment

The State Environment Protection Policy (Prevention and Management of Contamination of Land) No. S95, Gazette 4/6/2002 (Land SEPP) identifies a number of land use categories and protected beneficial uses for each land use category. Those that are relevant for to the Gasworks Site include:

- Sensitive land, such as residential for the area covered by the Southport Site; and
- Recreational and open space use of the land.

The beneficial uses applicable to these land use categories are summarised in Table 3.

Table 3 Protected Beneficial Uses of Land Relevant to this Audit

Beneficial Use	Sensitive Use (Other)[3]	Recreation/Open Space
Maintenance of Ecosystems		
Natural Ecosystems		
Modified Ecosystems	✓	
Highly Modified Ecosystems	✓	✓
Human Health	✓	✓
Buildings & Structures	✓	✓
Aesthetics	✓	✓
Production of Food, Flora & Fibre	✓	

2.8.2 Beneficial Uses of the Air Segment

The State Environment Protection Policy (Air Quality Management) No. S240, Gazette 21/12/2001 (Air SEPP) identifies the beneficial uses of the air segment, and these will be considered with respect to the whether the subsurface contamination at the Gasworks Site poses a risk to recreational users of the site and residents/workers at the Southport Site. It is anticipated that air issues for the site might include:

- Odorous pollutants, such as in the case that intrusive remediation were to be undertaken and that might liberate odours into the local atmosphere; and
- Volatile chemicals (carcinogens and non-carcinogens) might pose a vapour risk to on-site users and near-by sites, as a result of residual contamination remaining at depth.

2.8.3 Beneficial Uses of the Groundwater Segment

The State Environment Protection Policy (Groundwaters of Victoria), No. S160, (Gazette 17/12/1997 as varied 19/3/2002, No. G12, Gazette 21/3/2002) (Groundwater SEPP) classifies groundwater into a number of segments based on the total dissolved solids (TDS) concentration of the groundwater. The beneficial uses to be protected for each of the groundwater segments are defined in the Groundwater SEPP, and reproduced in Table 4. The relevant groundwater segment for the Gasworks Site is understood to be Segment A1 based on background salinity as reported by Golder Associates[4], and the beneficial uses protected for this segment will be considered when assessing the risk posed to groundwater. All protected beneficial uses of Segment A1, and the relevance of the use (i.e. whether the

[3] The Land SEPP separates Sensitive Land Use into “High Density” and “Other”. The Southport Community Nursing Home is considered to lie within “Other” as it is a more sensitive land use than high-density, defined as “a density greater than one dwelling per 200 m^3 or a residential building greater than 4 storeys” (EPA Environmental Auditor (Contaminated Land), Guidelines for Issue of Certificates and Statements of Environmental Audit, Publication 759b, June 2002).

[4] Further Groundwater Investigation, 29 November 2006.

use is existing or likely at and beyond the boundary of the site) will be considered in undertaking the risk assessment.

In addition to the beneficial uses defined in Table 4, consideration will also be given to the potential for groundwater contamination to adversely affect human health and aesthetics through volatilisation of contaminants, and to adversely affect the operation of sewerage systems and receiving waters through leakage into subsurface sewerage and stormwater systems.

Table 4 Protected Beneficial Uses of Groundwater

Beneficial Uses	Segments (mg/L TDS)				
	A1 (0-500)	**A2 (501-1,000)**	**B (1,001-3,500)**	**C (3,501-13,000)**	**D (> 13,000)**
Maintenance of Ecosystems	✓	✓	✓	✓	✓
Potable Water Supply					
Desirable	✓				
Acceptable		✓			
Potable Mineral Water Supply	✓	✓	✓		
Agriculture, Parks & Gardens	✓	✓	✓		
Stock Watering	✓	✓	✓	✓	
Industrial Water Use	✓	✓	✓	✓	✓
Primary Contact Recreation (eg. Bathing, Swimming)	✓	✓	✓	✓	
Buildings and Structures	✓	✓	✓	✓	✓

2.8.4 Beneficial Uses of the Surface Water Segment

The Groundwater SEPP prescribes that the beneficial use *maintenance of* ecosystems must be protected and that groundwater shall not cause receiving waters to be affected to the extent that the level of any water quality indicator specified in the relevant SEPP for surface waters is exceeded.

The State Environment Protection Policy (Waters of Victoria), initally dated 23/2/1988, Gazette 26/2/1988, and as varied 5/10/2004, No. S210, Gazette 5/10/2004) (WoV SEPP) identifies the beneficial uses of the surface waters within Victoria.

The closest surface water discharge point for groundwater leaving the Gasworks Site is likely to be Port Phillip Bay, which is covered by a variation to the WoV SEPP, Schedule F6 (Waters of the Port Phillip Bay) No. S101, Gazette 27/8/1997, herein referred to as Schedule F6 Waters of Port Phillip Bay. It has not yet been fully established whether groundwater actually discharges to Port Phillip Bay, however, theoretically this would appear to be the natural discharge point for groundwater leaving the site.

The aquatic ecosystems that are to be protected lie within the “general” segment of Schedule F6 and the beneficial uses protected for the “general” segment are listed as:

- Substantially natural ecosystems with some modification (i.e. 95% level of protection might be applied, consistent with ANZECC/ARMCANZ 2000);
- Water based recreation:
  - Primary contact recreation (eg. swimming, water-skiing);
  - Secondary contact recreation (eg. boating, fishing);
  - Aesthetic enjoyment (eg. walking by the water);
- Production of molluscs for human consumption:
  - Natural populations (the consumption of naturally occurring molluscs);
  - Aquaculture (the consumption of molluscs from declared aquaculture zones included in a shellfish sanitisation program by the Responsible Authority);
- Commercial and recreation use of edible fish and crustacea;
- Navigation and shipping; and
- Industrial water use.

Similar to the Groundwater SEPP, all protected beneficial uses of Schedule F6 “general” segment, and the relevance of the use (i.e. whether the use is existing or likely, and whether a contamination pathway exists) will be considered in undertaking the risk assessment.

2.9 Relevant Audit Criteria

The audit criteria will be derived from a number of sources. These will include:

- Environmental quality objectives prescribed by the relevant SEPPs (above);
- Requirements of the Interim Contamination Management Plans for the Gasworks Site;
- Requirements of any proposed Contamination Management Plans for future and on-going management of the Gasworks Site; and
- Criteria for the assignment of risk developed in conjunction with CoPP and EPA.

Other criteria may be included in the audit as the review of information on the site is progressed.

2.10 Sources of Information

The environmental audit will be largely based on the environmental assessment and reporting undertaken by Golder Associates since 2004 (ongoing), review of the Interim Site Contamination Management Plans, and supporting information. It has been agreed that initially the auditor will begin the first stage of the audit on the existing reports, and it will be decided at a later stage what extra work may need to be undertaken by Golder Associates.

Information that becomes available for the final capping design of the site will be considered.

The auditor will also collect any relevant on-site operations records, measurements, observations or other information as required.

2.11 Period of Time Over Which the Audit is to be Conducted

As the audit has been initiated by CoPP and DLA there is no statutory deadline for completion and delivery of the audit report. It was expected that the first stage of the audit may take six months from the time the audit scope is agreed, and the second stage may take a further six months to complete, although this will depend on the time taken to carry out the further investigations and work identified in the first stage.

The first stage of the audit will include an assessment of any short to medium term risks to people and the environment. It is anticipated that a set of interim findings would be reported at this stage of the audit. If warranted, measures could then be considered as part of the final capping design for the site, and be incorporated into the second stage of the audit.

2.12 Considerations and Exclusions in the Development of the Scope for the Audits

The audit is restricted to the activities conducted at the site, such as described in Sections 2.4 and 2.5. The audit does not consider activities conducted at near-by premises, such as operations on the Alinta Site, and neighbouring uses.

The audit assesses the risk posed by former gasworks activities and associated residual contamination at the Gasworks Site to the existing and longer-term land uses at the site, and well as the portion of the surrounding environment beyond the site boundary to which the activities may pose a risk.

It is noted that the Gasworks Site is expected to be a source of groundwater pollution and any decision on the necessity of remediation is expected to require consideration of EPA guidance relating to *Clean Up to the Extent Practicable* (CUTEP). While the CUTEP process is invoked during a Section 53X audit, it is understood that a CUTEP submission by the auditor and determination by EPA might be able to be made during a Section 53V audit or, if necessary, the audit can transition to a Section 53X audit from which a CUTEP submission may be an outcome.

Because of the uncertainty in the process, for the purposes of this definition of scope, the CUTEP process has not been included as a step in the Section 53V audit of the Gasworks Site.

2.13 Use of Risk Assessment

The significance of the risks is assessed using a semi-quantitative methodology based on the Australian Standard for Risk Management (AS4360: 2000). Any requirements and recommendations for improvement will focus on the higher risks.

Descriptors for the assignment of “Likelihood” (of a hazardous event occurring), “Consequence” (i.e. the impact if the hazardous event occurs) and a matrix for assigning “Risk” in terms of the Likelihood and Consequence are to be agreed during the first stage of the audit as part of the screening risk assessment.

The result of the screening risk assessment will express the auditor’s opinion on the risks posed to the relevant beneficial uses, for instance *the site poses a low/medium/high risk to recreation and open space use of the park*. Note that this assessment reflects the auditor’s assessment of risk and is limited to the risk to beneficial uses, and does not consider other effects such as risk to reputation. Further, the ranking of risk may not reflect the ranking that other stakeholders such as the City and the community may place on the issues.

Recommendations will be provided on how the risk may be reduced, and priorities will be assigned to recommendations. This is discussed further in Section 6.

2.14 Level of Stakeholder Involvement in the Environmental Audit

The audit has involved liaison with the audit clients CoPP and DLA, and their assessment consultant Golder Associates. Consultation may include other Gasworks Parks stakeholders such as the State, residents/staff of the Southport Community Nursing Home, the Dogs Group, Gasworks Arts community, Alinta and the surrounding community, however the need for this will be determined by CoPP.

EPA has been identified as a relevant stakeholder to the process, as administrators of the environmental audit system and considering their involvement with the site's development into a Nursing Home and park in the early 1980s. EPA personnel were involved in the development of the scope for this audit.

As part of the first stage of the audit it is proposed that a workshop with EPA be held to allow EPA to understand the process of risk assessment and to confirm that the proposed approach and expected outcome should be acceptable to EPA.

2.15 Environmental Audit Report

The first stage of the audit will produce an interim report on the findings of the screening risk assessment. This will include preliminary findings regarding the need for further clean up and/or management of the site to provide an adequate level of control of the risks resulting from the contamination. It is proposed that a summary of the findings of the workshops and the preliminary assessment will be provided; this will not be final and will depend on the findings of the further more detailed assessment of the available information.

The second stage of the audit will consider the condition of the site following the necessary works. Following these works, a draft environmental audit report will be prepared for discussion with CoPP and DLA. A final draft report will be submitted to EPA for discussion to ensure that recommendations are not inconsistent with the requirements of EPA.

A final report will be prepared and forwarded to CoPP, DLA and EPA. The contents of this report will include information listed in the Act and the Guidelines relating to Section 53V audits, and will outline the findings of the environmental audit with respect to objectives listed in Section 2.5.

In particular, the audit report is expected to include recommendations relating to:

- Where the risk of any possible harm or detriment to a segment or an element of the environment has been determined, recommendations for the measures necessary to reduce the risk to an acceptable level;
- Where the risk of any possible harm or detriment to a segment or an element of the environment cannot be determined, the measures necessary to ensure that risk to a segment will be able to be determined in the future;
- Monitoring or modelling of data as may be necessary; and
- Improving environmental performance, management systems and monitoring programs as may be necessary.

Audit recommendations will be prioritised and a timeframe suggested for their implementation will be provided in the report.

3. Background

3.1 Review of Site History

Golder Associates undertook a site history review of Gasworks Park site. The Site was formerly the manufacturing area of the South Melbourne Gasworks but was redeveloped and has been used as a park since the 1980's.

The Golder Associates *Site History Review* (2004) review provides factual information on the site conditions, based on the status of the Site and information available to them in January 2004. The *Site History Review* (2004) focussed on identifying the past gasworks activities that occurred on the site and the actions that had been undertaken on the Site since cessation of gas manufacturing. The review included information about the processes that occurred on the Site during the operation of the gasworks facility, and a description of the redevelopment and remediation of the Site that was undertaken to form the Park. Sources of information included aerial photographs (1945, 1951, 1961 and 1970), as well as reports and files that were provided by CoPP, including Gas and Fuel Corporation reports and previous environmental site assessment reports by Maunsell (1987, 2003) and Kilpatricks (2002, 2003).

A summary of the findings of the Golder Associates report is provided in Table 5, and further information can be found in the report *Site History Review* (January 2004).

Table 5 Summary of History of Site Operations and Environmental Site Investigations (1871 – 2004)

Year	Site History
1871	The South Melbourne Gas Company was formed in 1871. The company initially leased 2.43 ha of land (No. 2 Holder site and southern part of the Gas Manufacturing Plant) on Pickles Street on the boundary of what is now the suburbs of Albert Park and Port Melbourne.
1873	The gas manufacturing plant was built in 1873. Within a few years of the plant being built the gas company merged with the Melbourne and Collingwood Gas Companies to form the Metropolitan Gas Company. The plant operated from 1873 to 1955, with some aspects remaining functional until 1977.
1878	The Metropolitan Gas Company received a Crown Grant in 1878 with respect to the leased site. An additional piece of land was purchased to the north of the site on the east side of Pickles Street to create a combined area of 3.46 ha which is now the site of Gasworks Park. This was developed into the main manufacturing plant for the gasworks. Further land purchases occurred over the following years of the meter shop site (1885), No. 1 Holder site (1888) and oil store and laboratory site (1913).
1951	The Metropolitan Gas Company and Brighton Gas Company were merged, and the Gas and Fuel Corporation of Victoria became the registered proprietor of all the properties.
1955	The Site manufactured gas until 1955 with the exception of a temporary closure during the Depression. Some parts of the site never reopened after the closure in the Depression but other areas continued some form of operation until 1971.
1979	Gas manufacturing plant was sold to City of South Melbourne and the Government of Victoria, and subsequently developed into the Park that it is today.

Year	Site History
	The Gas and Fuel Corporation retained a small portion in the northern corner of the site for depot use. Golder Associates report that aerial photos from 1971 show that much of the site had already been demolished with the exception of the buildings that remain at the park today, and the coke bunker in the north of the site.
1981	The Southport Nursing Home established on part of the City owned land at gasworks site by 1981.
1982	A City report indicates that grass cover was established on the remainder of the site by 1982. The City of South Melbourne was appointed the Committee of Management for the Crown land at the site.
1985	The City engaged the State Chemistry Laboratory in mid-1985 to assess the soils on the site and provide recommendations for improving grass growth, as there was reported difficulty with maintaining grass growth. The laboratory reported recommended that the underlying clay be ripped and gypsum added but it is not known whether the City adopted the recommendation. The laboratory investigations reported loam (up to 0.3 m thick), underlain by heavy clay (to a maximum depth of 0.7 m) and underlain predominantly by coke and gravel. The total depth of soil cover over the coke/gravel layer was reported to be about 0.25 to 0.45 m.
1986	A Master Plan for the site was developed and a Planning permit issued for landscaping works in 1986. Stage 1 of the redevelopment focussed on the northern two thirds of the site. This involved the removal of obsolete footings and basement structures and the installation of a drainage and sprinkler system. Fill material appears to have been imported onto the site to attain the required topography, but the source of the fill is not known.
1987	Stage 2 of the landscaping works was to commence in 1987. These were to concentrate on the southeast corner of the site. However there was disruption to the plans due to concern regarding the contamination and clean up of former gas works sites (in general), and from an inspection of a test pit dug in the are of the former purifier beds where coal tars had been previously observed. Maunsell prepared a proposal for undertaking further investigations and remediation at the site. Works on Stage 2 were suspended at about this time.
1988	A proposal was put to Council recommending capping of the southeast corner of the site. The City engaged EPA and the Gas and Fuel Corporation to assist with resolving the contamination issues at the site. In May 1988 the Gas and Fuel Corporation commenced site assessment, involving trench excavations. One trench in the southeastern corner reported “significant amounts of free tar”, and other reported tarry contamination. On 1 September 2008 EPA issued a Clean Up Notice on the Gas and Fuel Corporation of Victoria requiring assessment and remediation of soil and groundwater on all of the sites formerly associated with the South Melbourne Gasworks. There was some documentation reported by Golder Associates dated October 1990 that indicated that the Notice would be held in abeyance pending further discussion with the gas and Fuel Corporation, and that in other documents, information reporting that the Notice would be withdrawn. Initial groundwater investigations were commissioned by the gas and Fuel Corporation (ie. wells SM88-BH1 to SM88-BH7).
1990 – 1991	The Gasworks Site Contamination Steering committee was formed, comprising representatives form the City of South Melbourne EPA, Gas and Fuel Corporation, and Department of Conservation. The objective was to monitor and coordinate the testing program and report back to their organisations. The Steering committee met 16 times until February 1992 when

Year	Site History
	their objectives were considered to have been achieved. The Gas and Fuel Corporation conducted further testing in 1990, and the results were provided to EPA for review. The EPA required a clean up strategy to be developed for the Graham/Foote Street corner of the site, and Near Buildings 3, 4 and 9. Following this Golder Associates report that further testing appears to have been undertaken, and reported that the purifier beds in the south east corner of the site had solid bases, thereby reducing the risk of tar migration. In 1990 further groundwater investigations were commissioned by the Gas and Fuel Corporation (ie. SM90-BH1 to SM90-BH15). Golder Associates cite a letter from EPA to the City dated 26 September 1990, that states that "…as it (the site) has currently been remediated, we have no fear for either the short or long term health of visitors, occupants of the proposed artist's studio, nursing home residents or gardener". Redevelopment and use of the site buildings proceeded. Later in 1991, following another series of soil tests commissioned by the gas and Fuel Corporation (in 1990), EPA wrote to the Gas and Fuel Corporation that "…while the site usage remains public open space and the soil continues to bear a healthy grass cover, the PAH levels found are not considered to adversely affect either public or environmental health at the site. However the elevated levels encountered do reinforce the need to ensure that staff and contractors working at the site are advised of the contamination and that they take adequate hygienic precautions when disturbing the soil on the site". Golder Associates cite a letter from the Health Department to the Gas and Fuel Corporation, dated 12 April 1991, stating that "…from the perspective of the Department there is certainly no risk to public health through the community using this area as parklands/open space. For occupational health reasons, workers in regular contact with the contaminated areas of soil should observe normal hygiene precautions."
1992	The requirements of the landscaping/remedial works for the south eastern corner of the site, where tars had been observed, are likely to have been undertaken sometime between February and July 1992. This involved some remediation in southeast corner of site comprising excavation of 0.5m of contaminated fill and replacement with "clean soil". A record of the origin of soils used and the depth to which it was placed was not found. The Site was 'declared' suitable for use as a park by EPA following a series of soil and groundwater assessments up to 1992.
2002 & 2003	Kilpatrick and Associates Pty Ltd undertook a preliminary contamination assessment for the new administration building and landscaping in the south of the park adjacent Building 9 (2002). The soil assessment found PAHs in the fill in the area. Meinhardt undertook a human health risk assessment using the Kilpatrick soil data (2003), concluding that there was a "significant risk" to construction workers and to onsite commercial occupants of the buildings following redevelopment. The report recommended that an Occupation Health and Safety Plan be developed, and that an additional layer of 0.5 m of clean fill be placed over landscaped areas as part of the development. Kilpatrick and Associates Pty Ltd developed a Site Contamination Health and Safety Plan (2002). Kilpatrick and Associates Pty Ltd reported on the assessment of three areas of Gasworks Park for a playground.
2004	Golder Associates prepared the *Site History Review* (2004) that recommended that CoPP consider further assessment and management of the site to reduce potential risks.
Reference: Information reported in this Table has been sourced from the *Site History Review* (2004).	

Gasworks Park site is currently zoned as a Public Park and Recreation Zone under the Port Phillip Planning Scheme.

Golder Associates note that other areas of the Gasworks were sold and redeveloped for residential use in the 1990's, and that this occurred after significant remedial works and completion of statutory Environmental Audits for the sites. These other areas were not discussed further in the older site history review. The Southport Community Nursing Home Site was also not included within the scope of the Golder Associates review.

Golder Associates identified three gas-manufacturing processes that were believed to have been active on this site:

Coal Carbonisation Plant: The Coal Carbonisation Plant process appears to have been undertaken in the west and centre of the site in the zone primarily containing the coke plant, retort houses and the coal store. It is likely that the coke plant was used for:

- Generation of low calorific producer gas for use in the retort.
- Manufacture of high-grade coke for metallurgical uses and recover other marketable by-products.

Carburetted Water Gas Plant: The Compete Gasification Plant was located in the southwest corner of the site. The plant at the site used brown coal as the fuel source. Golder Associates surmised that the plant would be likely to have the following main features:

- Carburetted Water Gas Plant; and
- Quenching and By Product Treatment Equipment.
- The plant produced gas, as well as a tar/oil/water (naphtha to crude oil) emulsion as a waste, and ash/clinker.

Oil Gas Plant: The Oil Gas Plant was located in the north west of the site. The oil was supplied via a pipeline form the oil store across Pickles Street to the north west of the site. The Oil Gas Plant had similar wastes to the Carburetted Water Gas Plant, ie. oil/tar/water emulsion, however, lampblack rather than coal tars were generally produced.

Gas Purification Process: This involved the following components:

- Condensers: located on the east of the site, these were used to remove water and tars from the coal gas. Golder Associates report that the resulting tar was likely to have been stored in the adjacent tar tank and possibly pumped to the tar tank in the north west of the site for storage prior to sale;
- Washers: located in the east of the site. Likely to have been used to remove naphthalene and ammonia from the gas as well as removing phenol and tar acids from the ammonia waste. The scrubbing and washing processes may have used oils, water, sulphuric acid benzene and sodium hydroxide. The process would have resulted in various wastes.
- Purifiers: Four purifier boxes were located in the north east of the site, and a set of underground purifiers in the south of the site. Golder Associates report that it is likely that the underground purifiers were built with the existing plant in the early years of the plant and the larger purifier to the north were built upon plant expansion. The purifiers were used for the removal of sulphur from the gas. The purifier wastes are referred to as "spent oxides" or "spent lime" and are expected to have concentrated levels of complexed cyanides, sulphur or sulphates (if oxidised over time) as well as

more volatile PAHs and other light end hydrocarbons. “Spend oxides” are identified by their Prussian blue, turquoise and purple colouring.

- Liquor Well and Tanks: There was a liquor well in the east of the site and a tank in the north east of unknown volume and contents. The different liquor products known to be generated at gas plants include tar oils, ammoniacal liquors produced by the carbonisation process, tar distillates, various waste light to heavy oils used in the Carburetted Water Gas and Oil Gas processes, and liquid blow downs from aqueous sulphur removal systems.

Other buildings that were noted in the *Site History Review* (2004) included:

- Boiler Room: presumably for gas manufacturing steam, but maybe also for the generation of clinker for commercial sale.
- Meter Room: for metering gas flow.
- Sub Station: a number of electrical sub stations have been identified around the site.
- Workshop and Amenities: These were located in the south north and west of the site and were likely to have been used for various activities to maintain and support the gasworks.
- Ferro-Cyanide Plant: Possibly used for the post processing of ferro-cyanide waste products for reuse or sale.
- Sulphate Store: Possibly used for the post-processing of sulphate from the waste products for reuse or sale.
- Laboratory: Likely to have been used for testing of products and the ongoing development of the site.

The auditor considers that the site history review undertaken by Golder Associates is consistent with good practice for such reviews, and provides useful information on the history of prior activities that are relevant to assessing the existence and significance of historical contamination. The auditor notes that there is considerable uncertainty with any such review, and it should not be assumed that the location, extent and significance of contamination can be identified and delineated with any degree of certainty.

3.2 Possible Contaminants of Interest based on the Site History

Golder Associates identified a list of contaminants of interest for the site, based on their site history review. These included:

- PAHs from tar and oil wastes;
- General hydrocarbons (ie. TRHs) from tar and oil wastes and storages;
- Various metals including arsenic from concentrations of coal minerals;
- Cyanide, sulphates and sulphides from gas purification and waste water treatment;
- Phenols from tar wastes;
- Monocyclic aromatic hydrocarbons (MAHs) including but not limited to benzene, toluene, ethylbenzene and xylenes;
- PCBs associated with the substations;
- Solvents associated with maintenance.

The auditor considers this to be an appropriate listing of contaminants of interest and, if the assessment is directed towards dealing with these contaminants, it can be reasonably expected that other contaminants that might be present will also be dealt with.

4. Information Reviewed

4.1 Listing of Documents

The documents reviewed for the purposes of this audit are provided in Table 6 and summarised below in Section 4.2.

Table 6: Documents Reviewed

Author	Date	Document Title	Reference used throughout this Report
Golder Associates	28 January 2004	Site History Review, Gasworks Park, Richardson Street, Albert Park, Report 04613504/003	*Site History Review* (January 2004)
Golder Associates	3 February 2004	Further Recommendations for Action, Gasworks Park, Albert Park, Document No. 04613504/006	*Further Recommendations for Action Letter* (February 2004)
Golder Associates	18 May 2004	Interim Contamination Management Plan for Current Site Use, Southport Nursing Home, Richardson Street, Albert Park, Report 04613504/026	*Southport Nursing Home ICMP* (May 2004)
Golder Associates	18 May 2004	Interim Contamination Management Plan for Current Site Use, Gasworks Park, Graham Street, Albert Park, Report 04613504/025	*Gasworks Park ICMP* (May 2004)
Golder Associates	July 2004	Vapour And Edible Vegetation Risk Assessment, Gasworks Park and Southport Nursing Home, Albert Park, Report 04613504/010	*Vapour and Edible Vegetation Risk Assessment* (July 2004)
Golder Associates	28 July 2006	Review of Contamination Status, Southport Nursing Home, Richardson Street, Albert Park, Victoria, Report 05613732/022	*Review of Contamination Status, Southport Nursing Home* (July 2006)
Golder Associates	28 July 2006	Installation and Sampling of Additional Groundwater Wells, Gasworks Park Precinct, Former South Melbourne Gasworks, Graham Street, Albert Park, Victoria, Report 05613732/021	*Installation and Sampling of Additional Groundwater Wells, Gasworks Park Precinct* (July 2006)
Golder Associates	28 July 2006	Assessment of Groundwater Risks, Gasworks Park Precinct, Former South Melbourne Gasworks, Graham Street, Albert Park, Victoria, Report 05613732/019	*Assessment of Groundwater Risks, Gasworks Park Precinct* (July 2006)
Golder Associates	28 July 2006	Hydrogeological Conceptual Model, Gasworks Park Precinct, Former South Melbourne Gasworks, Graham	*Hydrogeological Conceptual Model, Gasworks Park Precinct* (July 2006)

Author	Date	Document Title	Reference used throughout this Report
		Street, Albert Park, Victoria, Report 05613732/018	
Golder Associates	29 November 2006	Further Groundwater Investigation, North East of the Former South Melbourne Gasworks, Gasworks Precinct, Graham Street, Albert Park, Victoria, Report 05613732/039	*Further Groundwater Investigation, North East of the Former South Melbourne Gasworks, Gasworks Precinct* (November 2006)
Golder Associates	17 October 2007	Further Groundwater Investigation, Pickle Street Sewer, West of the Former South Melbourne Gasworks, Gasworks Precinct, Graham Street, Albert Park, Victoria, Report 05613732/059	*Further Groundwater Investigation, Pickle Street Sewer, West of the Former South Melbourne Gasworks, Gasworks Precinct* (October 2007)

4.2 Summary of Golder Associates Reports – Objectives and Findings

4.2.1 *Site History Review* (January 2004)

In January 2004 Golder Associates reported on the findings of their review of available historical records for the South Melbourne gasworks site. An abridged version of their review was provided in Section 3 above.

The *Site History Review* (2004) reported that the site assessment and remediation of the site soils would be considered to fall short of the requirements and standards for site assessment of today (being 2004 at that time).

4.2.2 *Further Recommendations for Action Letter* (February 2004)

Golder Associates prepared a letter report for CoPP regarding whether short term risks were acceptable for the on-going use of the park, while acknowledging that CoPP's intention was to implement additional management requirements the near future.

Included in the Golder Associates work was a site inspection, collection of 10 surface soil samples in locations that had not been previously sampled by Kilpatrick and Associates (2003), and laboratory analysis of the 10 samples for arsenic, lead, cyanide and PAHs, being the main contaminants of concern previously identified by Kilpatrick and Associates.

Golder Associates found that the analytical data indicated that further investigation and potential remediation or management action would be required for continued use of the site as a park, and that maintaining the separation layer between the soil and site users would reduce potential risks to health.

Golder Associates recommended a short-term management strategy, outlined below:

a) Due to the presence of visible coke on the woodchips within the playground area and due also to the thin separation the woodchips currently provide, Golder Associates recommended that the playground area be topped up with at least 150 mm to 200 mm of woodchips.

b) Golder Associates recommended that a mound of excavated soil present on the south side of the park which appeared to have been formed by recent maintenance on a light pole, be disposed to an

appropriate landfill as soon as possible and that future maintenance involving excavation is limited until management procedures (that include procedures for handling and disposal of excess soil) be implemented.

c) Golder Associates recommended that all areas of exposed soil on the site be covered in topsoil or reseeded.

d) Golder Associates recommended suspension of non-essential maintenance of the Park that requires excavation below the surface soils. If deep excavations are required, then site-specific management procedures are to be adopted that may include an assessment of soil to be excavated prior to excavation, a strategy for the health and safety of the workers and a strategy for the removal of excess soil.

e) Golder Associates recommended that garden and maintenance procedures within Gasworks Park be reviewed to make sure that all workers are made aware of the potential contamination issues, are aware of the need to wear gloves, the need to wash their hands and not eat within works areas.

f) Golder Associates recommended implementation of a strategy for further assessment, management and remediation as necessary to reduce health and environmental risk associated with the site in accordance with the requirements of the City of Port Phillip Soil Contamination Management Policy.

4.2.3 *Southport Nursing Home ICMP* (May 2004) and *Gasworks Park ICMP* (May 2004)

The Interim Contamination Management Plans (ICMPs) were developed to cover the use of the Southport Site and Gasworks Park by addressing the soil contamination.

A medium to long-term management strategy was being developed at that time for the CoPP to address this issue, and the ICMPs were prepared for CoPP for use in the interim period prior to a long-term strategy being put in place. It was envisaged that they would be replaced by the longer-term strategy within one to two years.

The objective of the ICMPs was to reduce the risk of exposure to site soils and their associated contamination. The site uses that were addressed included building occupation, recreational use of the park and open space areas, gardening and routine maintenance of the grounds, and residential uses at the Southport Site.

The ICMPs did not provide specific management advice for activities that require excavation greater than 300 mm into the underlying soils, rather a job specific contamination management plan was required for these activities.

From recent discussions with Golder Associates and the clients, it is understood that the 2004 ICMPs continue to be used as the basis for managing the risks posed by the site soil contamination.

4.2.4 *Vapour and Edible Vegetation Risk Assessment* (July 2004)

The findings of previous investigations by Kilpatrick and Associates, and Golder Associates had indicated that while some of the potential risks associated with exposure to the contaminated soils and wastes at the site could be managed through controls such as maintaining the separation layer and grass, the previous investigations had found that there were two main exposure pathways to gasworks waste for which there were no data on the site. These were:

- indoor and outdoor park users exposed to vapours arising from the waste; and

- park users ingesting edible vegetation grown on the site.

It was identified that short- and longer-term management requirements for both of these exposure pathways could not be derived without additional information. Therefore Golder Associates undertook a vapour and edible vegetation risk assessment that aimed to:

a) Assess whether there was a 'current' potential unacceptable risk to the occupiers of the site buildings posed by vapours from the former gasworks use of the site;

b) Assess whether there was a potential for gas generation from the soils on the site and therefore potential 'current' risks to adults and children involved in recreational activities and adult maintenance workers on the Park; and

c) Assess the potential for unacceptable health risks from the consumption of edible vegetation from the site.

To meet these objectives, Golder Associates undertook the following work and derived the following conclusions:

a) Golder Associates collected air samples from within four buildings at the Site to assess the risk posed by indoor air quality. The samples were tested for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) and cyanide. Four chemicals were detected, being phenol, ethylbenzene, toluene and xylenes. Not all these chemicals were detected at all of the indoor air sampling locations. Golder Associates undertook a quantitative risk assessment of the highest measured concentrations but did not find unacceptable risks to workers on the site or residents of the Southport Site. It was therefore concluded that, based on the data collected, that the gasworks waste on the site was not posing unacceptable vapour risks to workers and residents on the site.

b) To assess outdoor vapour risks, Golder Associates collected samples from four soil gas bores that were installed at various locations around the Park. The approach for the outdoor air soil vapour assessment was to focus on the areas of the Park with the highest potential for vapour generation. Twenty contaminants of concern were detected, but not all contaminants were detected at all of the soil gas bore locations. Golder Associates indicated that the soil gas concentrations varied significantly between locations. A quantitative risk assessment of the highest measured concentrations did not find unacceptable risks to child and adult recreational users of the Park or outdoor maintenance workers on the Park. Therefore, Golder Associates concluded that based on the data collected, the gasworks waste on the site did not appear to be posing vapour risks to recreational users of, or workers on, the Park.

Some limitations of the vapour risk assessment have been noted. These include that the risk assessment used measurement data collected from soil gas bores and indoor air that were sampled on one occasion only. The sampling program was designed to collect data that would result in conservative estimates of risk (i.e., over-estimate risks). However time-series data is really required to provide greater certainty of the sapling results, such as whether the sampling program actually captured vapour concentrations at the high end of the range for the site. As acknowledged by Golder Associates, the 2004 study could not determine what future vapour risks may be for the site, and that it should be considered a point-in-time assessment. Nonetheless, this assessment is the most detailed study of this vapour risk posed by the site to date.

The edible vegetation assessment involved a qualitative assessment of risks posed by consumption of the edible portions of vegetation grown on the site. It was noted that some site vegetation may be

growing in soil containing gasworks waste, and that contaminants may be taken up into the edible portions of the plants. The assessment considered that the consumption of vegetation on the site is very infrequent for both recreational park users and workers on the site, and that uptake of PAHs (the main soil contaminants on the site) into plant tissues is low. Overall, the assessment found that risks posed by consumption of edible vegetation on the site are likely to be negligible to very low.

4.2.5 *Review of Contamination Status, Southport Nursing Home* (July 2006)

The report provided a review of the contamination status of soil and groundwater at the Southport site, and the associated risks as they relate to the possible redevelopment of the site for medium or high density residential, aged care or public open space use, or to it's current use as a nursing home.

The Southport site was built over the portions of the former gas manufacturing plant. The gas manufacturing processes located within the footprint the Southport site included purifiers, a liquor well and tanks, and concentration plant and sulfate stores.

The scope of work included:

- A review of historical information from past reports on the site;
- Sampling and analysis of fill and natural materials in seven soil bores (BH5 to BH11) to a depth of 6 m below ground level.
- Sampling and analysis of fill and natural materials at two hand auger locations (HA1 to HA2) between ground level and 1.6 m below ground level.
- Installation of four monitoring wells (GW2 to GW5) at the sit, and one round of groundwater sampling of the wells;
- A vapour survey in the new monitoring wells, historical wells and previously installed vapour probes using a photoionisation detector;
- As assessment of the data and reporting of results, and a qualitative assessment to risks at the site; and
- An outline of the assessment and remediation strategy for areas identified requiring remediation.

The major findings included:

- The condition of the soil profile was found to be not suitable for redevelopment. Further management or remediation was recommended for the site to be considered suitable for redevelopment. The main issues related to:
  - Exceedences of lead, BaP, total PAH, TPH fraction >C9, benzene and total cyanide detected in soil across site.
  - Possible impacts to beneficial uses of the land and aesthetics, due to waste such as coke, ash, bricks, concrete and building rubble. In places, some aesthetic impact noted also in natural soils.
  - Soil pH ranged from 2.7-8.5, suggesting an aggressive soil in some areas in regards to buildings and structures.
- Golder Associates indicated that the fill material still required some remediation or management to be suitable for continued use as an aged care facility.
- Groundwater impacts from past use of the area as gasworks were reported, and the most significant impacts relate to ammonia, with the likely source being the former purifier beds located on both the

site and Gasworks Park, also representing a potential ongoing source of groundwater pollution. Further assessment of the potential ammonia plume to the north and east was recommended.

- Golder Associates made an assessment as to the minimum works required to be undertaken to get the site to a an appropriate state for redevelopment or for maintaining current use. Golder Associates also outlined the key risks to the client that related to cost of further works, the uncertainty in the amount of remediation required, and that the potential presence of old gasworks infrastructure could trigger overall environmental consideration of both soil and groundwater of the whole former gasworks precinct, and the environmental management issues and potential adverse publicity that may be incurred.
- Given the shared environmental issues to both Southport and Gasworks Park and the likely impact that redevelopment of one would have on the other, Golder Associates recommended that CoPP consider a coordinated approach to remediation and redevelopment of these sites.

4.2.6 *Installation and Sampling of Additional Groundwater Wells, Gasworks Park Precinct* **(July 2006)**

Golder Associates prepared a factual report on the additional groundwater wells that were installed to provide further information for the groundwater assessment of likely onsite and offsite risks posed by contaminated groundwater originating from the Gasworks Park Precinct. The scope of work included:

- Installation of 19 monitoring well, including seven onsite wells in gasworks park (GW18 to GW22, GW23A and GW24, and twelve offsite bores within nature strip that included four on Richardson Street (GW6 to GW9), two on Barrett Street (GW10, GW11), one on each of Foote Lane (GW12), Foote Street (GW15) and Graham Street (GW16) and three within road surface on Little Graham Street (GW13, GW14 and GW25). Two boreholes drilled onsite at gasworks park that couldn't be installed as groundwater wells due to auger refusal on buried waste (GW17, GW23)
- Soil samples were collected during drilling;
- And one round of groundwater sampling of 23 monitoring wells (included four existing groundwater wells – GW2 to GW5).
- Laboratory analysis of the soil and groundwater samples.

The major findings included:

- Soil results
  - Fill extends to 3.2 m depth within Gasworks Park.
  - Near surface fill comprised black sands with coke, brick and glass fragments.
  - The southern corner of the site reported the thickest layer of fill.
  - Analytical results were presented but as this was a factual report, results were not compared to criteria or discussed.
- Groundwater analytical results were presented but as this was a factual report the results were not discussed.
- Hydrocarbon odour was noted during groundwater sampling at locations GW03, GW04, GW19 (strong), GW23A and GW24, and hydrocarbon sheen was noted during groundwater sampling at locations GW03, GW04, GW05, GW11, GW19, GW21, GW23A, GW24 and GW25.

4.2.7 *Assessment of Groundwater Risks, Gasworks Park Precinct* (July 2006)

Golder Associates provided an assessment of the likely onsite and offsite risks posed by contaminated groundwater emanating from the site. The qualitative risk assessment for groundwater at and in the vicinity of the site involved:

- An assessment of current groundwater contamination condition;
- An assessment of potential beneficial uses of groundwater;
- An assessment of hydrogeological mechanisms responsible for current status of groundwater flow;
- Review of potential risks to both human health and ecological environment; and
- Recommendation of steps to move forward in assessment and remediation.

The major findings included:

- The groundwater TDS indicated that the groundwater was within Segment A1.
- Contamination in some 'background' wells was noted to exceed levels protective of some Segment A1 beneficial uses, thus indicating background quality may not support some of the protected beneficial uses. Golder Associates also indicted that the likely low yield of the Brighton Group aquifer would result in a low likelihood that groundwater would be abstracted for domestic or commercial use.
- Groundwater at site was found to be contaminated with common gasworks contaminants including heavy metals, ammonia, cyanide, sulphate, TDS, PAHs and MAHs. The main sources of ammonia, TDS and sulphate appear to be in the northeast of the site, whilst the main PAH and MAH sources appear to be in southeast and north east of the site. Other contaminants generally showed less of a pattern.
- The hydrogeological conceptual model for the site shows that groundwater from park will discharge into the Melbourne Water Sewer System of which the point of discharge is thought to be Werribee Treatment Plant. Golder Associates noted that 'the extremely small contribution of contaminated water from the Gasworks Park Precinct is considered unlikely to represent unacceptable risk to the environment at Werribee'.
- The groundwater assessment indicated some protected beneficial uses might be precluded by onsite groundwater contamination.
- The groundwater assessment indicated that there may be three possible area of offsite impact from Gasworks park and Southport, being:
  - The Alinta site - The model indicated that the Alinta site is generally upgradient of the main sources of contamination.
  - The area between the site and South Yarra main and Hobsons bay main sewer - The distance between the site and the south Yarra main and Hobsons bay main sewers is approximately 10 to 20 m, of which the land is entirely council roads; and
  - The residential area north of Richardson Street and northeast of Southport nursing home between the site and point of discharge into the sewer – delineation of the likely extent of the plume in the area was recommended.
- Golder Associates indicated that groundwater was expected to continue to discharge to the sewer system, as Melbourne Water was unlikely to undertake sewer repair works. It was noted that should pre-sewer groundwater flows be restored then it might take between 35,000 and 175,000 years for

groundwater to reach Port Phillip Bay. Significant dilution of contaminants would be expected to occur, resulting in negligible impact to both human health and ecological species.

- Golder provided some recommendations that:
  - Further offsite groundwater investigations to the northeast be undertaken;
  - That Melbourne Water be advised regarding seepage into sewers; and
  - Negotiations with EPA be continued regarding potential management and remediation options of the Gasworks Precinct.

4.2.8 *Hydrogeological Conceptual Model, Gasworks Park Precinct* (July 2006)

Golder Associates developed a Hydrogeological Conceptual Model for the Gasworks Precinct using the most recent and past hydrogeological and geological information on the area. The aim was to use the model to guide assessment of groundwater risks posed by groundwater contamination on and offsite from the Gasworks Precinct. The scope of work included:

- Review of existing hydrogeological information, and integrating sewer construction information;
- Development of a conceptual model of groundwater flow in the Gasworks Precinct considering the potential groundwater interaction between groundwater and the sewer system; and
- Developing a model for groundwater flow that considered the potential interactions between the groundwater and the sewer system.

The major findings of the model included:

- Significant draw down of groundwater levels is apparent in the area of Gasworks Park precinct caused by the South Yarra main sewer on Bridport Street;
- Significant draw down of groundwater levels by Hobsons Bay Main sewer on Graham Street in the area of the site is also apparent. Draw down does not appear to be a local effect as draw downs have been observed away from the site in areas west of Bay Street;
- Some potential draw down of groundwater levels caused by Pickles Street sewer particularly in north west corner of site;
- Golder Associates attribute the draw down effect of the two main sewers adjacent to the gasworks area is likely to have commenced after construction and have been present for over 100 years, and that evidence suggests that it has existed for at least 20 years;
- Groundwater from Gasworks Park discharges primarily into sewer network and is unlikely to migrate past the location of the sewers. Golder Associates comment that the risks of contaminated groundwater flowing beneath houses to the south east of the park to be very low;
- Golder Associates identified the main likely area of offsite groundwater flow from Gasworks Park that may continue beneath houses prior to discharging into the sewer network as the north east corner of the site opposite the nursing home near GW2 and GW8;
- Groundwater modelling of draw down indicated likely flows into the sewers of the order of 10L/m/day for an assumed sewer pipe average hydraulic conductivity of around $4x10^{-9}$ m/s over its 0.4 m thickness;
- The seepage contributed by the Gasworks Precinct sites along the 450 m sewer along Bridport and Graham Streets (to Pickles Street) was estimated by Golder Associates to be about 2300 L per day

flowing into the sewer. Estimated contribution from Gasworks Park to the sewer came to 0.001% of the typical daily flow rate in the sewer in this area as understood and reported by Golder Associates from discussions with Melbourne Water;

- Golder Associates reported that even in the event of sewer wall repair, blockage or upgraded, the a hydraulic conductivity of around $4x10^{-9}$ m/s is unlikely to be further reduced, and hence nor would there be any significant change in the draw down.
- Golder Associates reinforced a conclusion of their previous report, *Assessment of Groundwater Risks, Gasworks Park Precinct* (July 2006), that the flat topography of the region suggests that the "restored" hydraulic gradient would be in order of 0.001 to 0.002 m/m towards the bay, and that based on the range of permeability for the Brighton Group the groundwater was estimated to move from the site toward Port Phillip by at very low rates of between 0.001 to 0.002 metres per year.

Supporting information for the discharge modelling described in the *Assessment of Groundwater Risks, Gasworks Park Precinct* (July 2006) and *Hydrogeological Conceptual Model, Gasworks Park Precinct* reports (July 2006) was provided to the auditor via email in 11 July 2008. It was estimated by Golder Associates that the seepage contributed by the Gasworks Site to the 450 m length of sewer along Bridport and Graham Streets (to Pickles Street) to be about 2,300 L per day. Golder Associates reported that Melbourne Water had indicated that flows of up to 4,000 L/second could be recorded within the main sewers around the site, and hence Golder Associates estimated that groundwater at the site contributed some 0.001% of Melbourne Water's estimated flow in the sewers. The auditor has prepared some correspondence to Golder Associates seeking clarification on certain matters, and is awaiting feedback, however it would appear *prima facie* that the groundwater inflow from the Site is not likely to present a significant issue for the Western Treatment Plant that receives the inflow.

4.2.9 *Further Groundwater Investigation, North East of the Former South Melbourne Gasworks, Gasworks Precinct* (November 2006)

Golder Associates conducted a further assessment of the potential offsite impacts and associated risks of groundwater contamination that may be migrating to the north east of Gasworks Park and the Southport Site. The further work came out of the recommendations of a prior reportt, *Assessment of Groundwater Risks, Gasworks Park Precinct* (July 2006). That report has identified some uncertainty in the groundwater behaviour and quality in this area off site. Greig Street, Little Greig Street, Bridport Street and Durham Street bound the area.

The scope of work included:

- Installation of five monitoring wells (GW26 to GW30) north east of the Site, in the area bounded by Greig Street, Little Greig Street, Bridport Street and Durham Street;
- One round of gauging and groundwater sampling of the five monitoring wells;
- Gauging of all monitoring wells installed within, and in the vicinity of, Gasworks Park; and
- As assessment of groundwater data, including updating of hydrogeological model and associated groundwater risk assessment.

Based on the findings of the additional monitoring well installations to the north east and the associated sampling results, Golder Associates made the following conclusions:

- Groundwater elevations were generally similar between the June 2006 and September 2006 gauging events;

- The additional wells confirmed the influence of the South Yarra Main sewer on groundwater flow in the northeast region of the Site. The inferred groundwater flow in this are is towards the South Yarra Main sewer located along Bridport Street.
- The laterally extensive nature of observed length of groundwater depression suggests that leakage into the South Yarra main sewer and Hobsons Bay Main occurs regularly along the sewer rather than in discrete zones. As a result, groundwater is unable to migrate across the depression but rather discharges to the sewer.
- TDS varied between 710 mg/L (GW28) to 3,600 mg/l (GW27). The distribution of the concentrations suggests that groundwater does not migrate past the South Yarra Main Sewer. This observation conforms to the conceptual model.
- Groundwater to the north east of the Site was found to be contaminated with some heavy metals (arsenic, cobalt, copper, lead, nickel, zinc and selenium) and total cyanide. Consistent concentrations were recorded across the five monitoring wells, potentially indicated background concentrations for the area.
- The main contaminant of concern from the September 2006 monitoring round was ammonia. GW28 exceeded the odour threshold of 1.5 mg/L by over 20 times. For a number of reasons, such as the depth of groundwater, likely low yield, the potential regional background quality issues and the presence of reticulated water, Golder Associates reported that it was unlikely that groundwater in the area would be used drinking purposes, irrigation or to fill a swimming pool, or for stock watering. They concluded that there was a low risk posed by the elevated ammonia in groundwater.
- It was recommended that further assessment of the potential issues related to ammonia in the north east area would be required as part of the regulatory process, such as a Section 53V audit, to formalise the risk assessment works undertaken to date. It was acknowledged that the outcome of such a process might still be the need for remediation of the potential ammonia sources on the Southport and Gasworks Park sites and/or the need to prevent extraction and use of groundwater in the affected area in the northeast.
- Other issues of note include that groundwater, based on the sulfate and pH in the offsite northeast wells can be classified as being non-aggressive.

4.2.10 *Further Groundwater Investigation, Pickle Street Sewer, West of the Former South Melbourne Gasworks, Gasworks Precinct* (October 2007)

Golder Associates assessed the potential influence of the Pickles Street sewer on groundwater flow direction in the area between Gasworks Park and the Pickles Street sewer. The Pickles Street sewer is located west of the Gasworks Site.

The further work in this area came out of previous work undertaken by Golder Associates and reported in the *Hydrogeological Conceptual Model, Gasworks Park Precinct* report (July 2006). The hydrogeological conceptual report had indicated some potential draw down of groundwater levels caused by the Pickles Street sewer particularly in the northwest corner of the site.

A scope of work was developed comprising the installation and sampling of six groundwater monitoring wells west and north west of the Gasworks Site (GM31 to GM36). All monitoring wells installed to the west of the South Yarra Main Sewer on Bridport Street were also gauged, and the hydrogeological model and associated groundwater risk assessment were updated.

Based on the findings of the additional groundwater investigation works, Golder Associates made the following conclusions:

- Groundwater levels suggest that the Pickles Street sewer is locally influencing groundwater as groundwater is moving toward the west rather than toward southeast across the park.
- It was also noted that from the additional wells it appears Pickles Street sewer is leaking in area of Richardson Street (well GW34) where the groundwater level is deeper than it is closer to Graham Street. It is possible that in this area the sewer may be leaky and that groundwater is leaking into the Pickles Street sewer, or groundwater may be flowing though the backfill material around the sewer and into the Hobsons Bay Main;
- Golder Associates indicate there are a variety of potential sources of groundwater contamination are apparent in the north west of Gasworks Park, including Gasworks Park, the Alinta site, the former gasholder yard, and laboratory site to the west of Pickles Street among others;
- Groundwaters to the west and north west of Gasworks Park are found to be contaminated with heavy metals (arsenic, selenium, boron and manganese), sodium, sulphate, chloride, bicarbonate and total cyanide. Concentrations were reported to be generally consistent across the offsite wells to the east and north of the park, and perhaps indicating background concentrations in the area;
- Similar to the NE offsite investigation, ammonia was found to be the main contaminant of concern. Golder Associates assess that the risk associated with ammonia concentrations in the area offsite as low;
- Golder Associates indicate that the potential impact of groundwater conditions on the Alinta site may need further consideration as part of any 53V audit that may be undertaken at the Site;
- Golder Associates indicate that the potential impact of vapours on human health in the area is expected to be low based on contaminant of interest being ammonia;
- Groundwater in the offsite area can be classified as non-aggressive based on sulphate and pH concentrations.
- The additional groundwater data gathered as part of this assessment work supported a model that indicated groundwater flow form the Site would be to the Pickles Street sewer, South Yarra main sewer or Hobson Bay sewer, and ultimately discharge to the Werribee Treatment Plant for treatment;
- Potential risk to workers on the sewer system was considered to be low for the Pickles Street sewer as the sewer was regarded as too small to be entered, and likely to be receive less water at a lower infiltration that the other previously mentioned sewers.
- Golder Associates commented that their primary laboratory might be underestimating cyanide concentrations.

The recommendations that were derived form this scope of work included:

- That the report be provided to the Environmental Auditor for the site to assist in the undertaking of a S53V Environmental Audit for the groundwater at the site;
- A similar agreement to that proposed with Melbourne Water be sought with South East Water to inform workers of the potential contamination status of the sewer due to the ingress of contaminated groundwater; and

- Further assessment of cyanide concentrations be undertaken in MW35 as part of future monitoring as well as additional assessment of cyanide concentrations.

To the best of the auditor's knowledge, this report represents the most recent assessment report related to the Site that has been prepared by Golder Associates for CoPP and DLA.

5. Beneficial Uses Requiring Protection

5.1 Introduction

As described in Section 2.8, the existing and potential beneficial uses of the land, groundwater, air and potentially surface water segment(s) of the environment need to be identified before any risk of possible harm or detriment to them can be assessed. While land and groundwater are the primary segments of interest, contamination of these segments can impact air and surface water segments, and therefore the audit has an interest in all four segments.

The beneficial uses to be protected for particular segments of the environment are declared in State environment protection policies (SEPP), and the beneficial uses of each of these segments were provided in Section 2.8.

A site-specific assessment of the beneficial uses and the relevant receptors of any impact to these beneficial uses have been provided below.

In providing a more detailed listing of the beneficial uses that are to be protected, consideration has been given to the various pathways and receptors that can be impacted; these are summarised in the following sections. In this analysis, consideration has been given to those beneficial uses that are relevant and existing, and those that are only "potential" and are unlikely to be realised. This distinction has been made by using filled and unfilled circles in the various Tables. It can be expected that those that are indicated as only having "potential" to be realised will have a lower probability of effect in the risk assessment.

5.2 Beneficial Uses of the Land Segment

The State Environment Protection Policy (Prevention and Management of Contamination of Land) No. S95, Gazette 4/6/2002 (Land SEPP) identifies the protected beneficial uses for each land use category.

The categories that are relevant to the Gasworks Site include:

- Sensitive Use: consisting of land used for residential use, such as the aged-care facility at the Southport Site; and
- Recreational and open space use: consisting of general open space and public recreation areas;
- Commercial: consisting of a range of commercial and business activities. There are 11 buildings on the Site used for arts related activities (i.e. sculpture, ceramics, a bookshop, and a theatre), as well as buildings at the Southport site. Maintenance and other park workers are included in this category.

The scope of the audit also considers the impact that may be posed by the Site beyond the Site boundary. The offsite land use categories that have been identified include:

- Sensitive Use: residential land;
- Recreational and open space uses;
- Commercial uses; and
- Industrial uses, such as Alinta adjacent to the Site.

The beneficial uses applicable to these land use categories are summarised in Table 7 and Table 8.

With respect to the beneficial use “human health”, the receptors that will be considered include:

- Park users – adults and children;
- Workers – surface (ie. within buildings and maintenance workers/gardeners) and subsurface workers;
- Residents – ie Southport Site and residential off-site.

Table 7 Onsite - Beneficial Uses of Land

		Sensitive Use (Other)	Recreation and Open Space	Commercial
Maintenance of Ecosystems	Natural			
	Modified	●	●	
	Highly Modified	●	●	●
Human Health		●	●	●
Buildings & Structures		●	●	●
Aesthetics		●	●	●
Production of Food Flora and Fibre		●		

Empty cell	Land SEPP does not require the beneficial use to be protected
○	Land SEPP nominates the beneficial use to be protected – the beneficial use is not likely to be realised
●	Land SEPP nominates the beneficial use to be protected – the use is either existing or likely to be realised, i.e. potential use

Table 8 Offsite - Beneficial Uses of Land

		Sensitive Use (Other)	Recreation and Open Space	Commercial	Industrial
Maintenance of Ecosystems	Natural				
	Modified	●	●		
	Highly Modified	●	●	●	●
Human Health		●	●	●	●
Buildings & Structures		●	●	●	●

Aesthetics	●	●	●
Production of Food Flora and Fibre	●		

Empty cell	Land SEPP does not require the beneficial use to be protected
○	Land SEPP nominates the beneficial use to be protected – the beneficial use is not likely to be realised
●	Land SEPP nominates the beneficial use to be protected – the use is either existing or likely to be realised, i.e. potential use

5.3 Beneficial Uses of the Air Segment

The State environment Protection Policy (Air Quality Management) No. S240, Gazette 21/12/2001 (Ait SEPP) identifies the beneficial uses of the air segment, and these will be considered with respect to whether the subsurface contamination at the Gasworks Site poses a risk to recreational users of the site and residents/workers at the Southport Site.

The air issues under consideration in the screening risk assessment have included:

- Odorous pollutants, such as in the case that intrusive remediation were to be undertaken and that might liberate odours into the local atmosphere; and
- Volatile chemicals (carcinogens and non-carcinogens) might pose a vapour risk to on-sire users and near-by sites, as a result of residual contamination remaining at depth.

The impact of these issues on human heath and aesthetic enjoyment has been considered within the broader context land-based uses of the Site and offsite.

5.4 Beneficial Uses of Groundwater

The Groundwater SEPP classifies groundwater into a number of segments based on the total dissolved solids (TDS) concentration of the groundwater. The beneficial uses to be protected for each of the segments of groundwater are defined in the Groundwater SEPP, and are reproduced as Table 9.

The relevant groundwater segment for the Gasworks Site is understood to be Segment A1 based on background salinity[5] and the beneficial uses protected for this segment have been considered when assessing the risk posed to groundwater.

All protected beneficial uses of Segment A1, and the relevance of the use (i.e. whether the use is existing or likely at and beyond the boundary of the site) have been considered in undertaking the screening risk assessment.

Table 9 presents a summary of the beneficial uses of groundwater that are identified for:

- Onsite – at Gasworks Par and the Southport Site;

[5] Golder Associates, Further Groundwater Investigation, 29 November 2006.

- Offsite – and near to the site, i.e. the area just beyond the boundary of the site, as specified in the audit scope; and
- Offsite – and far from the site, Western Treatment Plan and Port Phillip Bay, as both are potential receivers of groundwater emitting from the site.

Groundwater from the site can discharge into sewers that surround the site. Under the terms of the SEPPs, these sewers do not pose a beneficial use that is to be protected. However, for the purposes of this audit, the potential for contaminated groundwater to enter the sewers and to affect the use of the sewers and sewerage system will be included within the audit risk assessment, as it can be expected that this will be of importance to some stakeholders and will practically need to be considered in any final assessment of the site.

In assessing impact on the sewerage system, consideration will be given to the operation and maintenance of the sewerage system, the operation of the sewage treatment plant, and the discharge and disposal or possible use of treated effluent from the treatment plant.

Table 9 Beneficial Uses of Groundwater Onsite and Immediate Surrounds

		On-Site	Off-Site Near the Site	Off-Site Far from the Site
Maintenance of Ecosystems		○	○ (1)	● (2)
Potable Water Supply	Desirable	○	●	●
	Acceptable	○	●	●
Potable Mineral Water Supply		Not a mineral water zone	Not a mineral water zone	Not a mineral water zone
Agriculture, Parks and Gardens		○	●	●
Stock Watering		○	●	●
Industrial Water Use		○	●	●
Primary Contact Recreation		○	●	●
Buildings and Structures		○	●	●

(1) No near-by watercourses have been identified.

(2) Waters of Port Phillip Bay – See Section 5.4

Empty cell	Groundwater SEPP does not require the beneficial use to be protected
○	Groundwater SEPP nominates the beneficial use to be protected – the beneficial use is not likely to be realised
●	Groundwater SEPP nominates the beneficial use to be protected – the use is either existing or likely to be realised, i.e. potential use

5.5 Beneficial Uses of Surface Water to be Protected

The Groundwater SEPP prescribes that the beneficial use *maintenance of ecosystems* must be protected and that groundwater shall not cause receiving waters to be affected to the extent that the level of any water quality indicator specified in the relevant SEPP for surface waters is exceeded. It has not yet been fully established whether groundwater actually discharges to Port Phillip Bay, however, theoretically this would appear to be the natural discharge point for groundwater leaving the site. It is for this reason that nearby Port Phillip Bay has been explicitly considered in the screening risk assessment.

Port Phillip Bay is covered by a variation to the WoV SEPP, Schedule F6 (Waters of the Port Phillip Bay) No. S101, Gazette 27/08/1997, herein referred to as Schedule F6 Waters of Port Philip Bay.

The aquatic ecosystems that are to be protected lie within the "general" segment of Schedule F6 and the beneficial uses protected for the "general" segment are listed in Schedule F6.

Similar to Groundwater SEPP, all protected beneficial uses of Schedule F6 "general" segment, and the relevance of the use (i.e. whether the user is existing or likely, and whether a contamination pathway exists) are considered below.

Table 10 Beneficial Uses of the General Segment of Port Phillip Bay

Beneficial Uses		General Segment
Maintenance of aquatic ecosystems and associated wildlife	Natural ecosystems	
	Substantially natural ecosystems with some modification	● (1)
	Highly modified ecosystems with some habitat values	● (1)
Water based recreation	Primary contact e.g. swimming, water-skiing	●
	Secondary contact e.g. boating, fishing	●
	Aesthetics enjoyment e.g. walking by the water	●
Production of molluscs for human consumption	Natural populations e.g. the consumption of natural molluscs	●
	Aquaculture e.g. the consumption of molluscs from declared aquaculture zones included in a shellfish sanitation program by the Responsible Authority	○
Commercial and recreational use of edible fish and crustacean		●
Navigation and shipping		●
Industrial water use		●
(1) 90% level of protection to be applied, ANZECC/ARMCANZ (2000)		

Empty cell	WoV Schedule F6 does not require the beneficial use to be protected
○	WoV Schedule nominates the beneficial use to be protected – the beneficial use is not likely to be realised

Beneficial Uses	General Segment
●	WoV Schedule F6 nominates the beneficial use to be protected – the use is either existing or likely to be realised, i.e. potential use

6. Assessment of Risk to Beneficial Uses

6.1 Methodology for the Assessment of Risk

The approach taken for assessing the risk to beneficial uses involved the following:

- Identification of the various exposure paths by which contamination might affect the various beneficial uses;
- Consideration of the potential for impact by the contaminants identified in the site history and typically associated with former gasworks operations and gasworks wastes, such as PAHs, petroleum hydrocarbons including BTEX, phenols, complex and free cyanides, ammonia, nitrates, sulphates and sulphides, metals, asbestos, salts, and pH.
- Identification and consideration of exposure scenarios which can be expected to be the higher risk scenarios; typically this involved selecting the worst case consequence which was deemed to be plausible. The scenarios were based on a review of the available Golder Associate's reports, as well as judgement of the auditor and his team.
- Assessment of the likelihood of each scenario occurring in which contamination would give rise to a significant effect on the beneficial uses, and the magnitude of the effect. This considered the existing controls that are in place (eg the Interim Contamination Site Management Plan). The descriptors defining the likelihood of a scenario occurring and the severity of effect, and the resulting level of risk are defined in the risk assessment matrix shown in Table 11. These descriptors were based on the Australian Standard *Risk Management* (AS 4360: 2004) and the ranking of risk for various combinations of likelihood and severity was based on the judgment of the auditor.

The approach is outlined in more detail together with the findings in the following sections.

6.2 Exposure Pathway Analysis

This section discusses the pathways by which the beneficial uses nominated by the SEPPs could be impacted. The analysis considered various water, soil and vapour mediums, as well as chemical release and transport mechanisms.

The exposure pathways were examined at a high level. Each pathway was compared to the SEPP relevant to the receptor. In this way, all beneficial uses were systematically considered to ensure that all uses were included and that the boundaries between SEPP jurisdictions were clearly defined.

The analysis considered the exposure pathways, such as how contamination of land and groundwater at the Site may impact protected uses at the Site and offsite. In carrying out this analysis, all protected beneficial uses within the audit area have been considered, however those uses that are likely to be realised have formed the focus for further assessment. Exposure flowcharts were developed for the following scenarios:

1. Risk posed by contaminated soil to onsite land beneficial uses;
2. Risk posed by contaminated soil/groundwater to onsite groundwater beneficial uses;
3. Risk posed by contaminated soil/groundwater to offsite groundwater beneficial uses (uses close to the Site);

4. Risk posed by contaminated soil/groundwater to offsite groundwater beneficial uses (uses far from the Site)[6];
5. Risk posed by contaminated soil/groundwater to offsite land beneficial uses (uses close to the Site);
6. Risk posed by NAPL to onsite land beneficial uses;
7. Risk posed by NAPL to onsite groundwater beneficial uses;
8. Risk posed by NAPL to offsite land beneficial uses (near the Site);
9. Risk posed by NAPL to offsite groundwater beneficial uses (uses close to the Site);
10. Risk posed by NAPL to offsite groundwater beneficial uses offsite (uses far from the Site).[7]

In carrying out the assessment, it was recognised that the impacts associated with NAPL can be similar to those associated with contaminated groundwater. While the investigation work has not clearly shown the presence of NAPL, it can be inferred to be present from the knowledge of the gasworks site, the limited clean up that has occurred, and from indirect soil and groundwater data. Because of the similarity of impacts by NAPL and other soil and groundwater contamination, there is potential to simplify the exposure flowcharts by combining contaminated soil/groundwater with the NAPL scenarios. However, for the purposes of this initial screening work, it was decided to keep NAPL separate, as it would then allow a more transparent understanding of the issues that are specifically associated with NAPL and the requirements for dealing with NAPL (which incurs a specific reference in the Groundwater SEPP and requirements for clean up).

The flowcharts are included in Appendix B.

The analysis yielded more than 260 combinations of receptors, general exposure pathways and relevant beneficial uses to be protected. The risk associated with each of these was assessed and the summary of these assessments is discussed in Section 6.5.

6.3 Nature and Severity of Exposure to Contaminants

For the purposes of this screening risk assessment, and to focus on the higher risk scenarios, an assessment of the consequence (severity) of exposure to the contamination was based on preliminary review of the available Golder Associate's reports, as well as judgement of the auditor and his team.

In general, the limiting contaminants were those typically associated with former gasworks operations and gasworks wastes, such as PAHs, petroleum hydrocarbons including BTEX, phenols, complex and free cyanides, ammonia, nitrates, sulphates and sulphides, metals, asbestos, salts, and pH.

6.4 Interim Management at the Southport Site for Current Use

The Southport Site and Gasworks Park are currently being managed under the *Southport Nursing Home ICMP* (May 2004) and the *Gasworks Park ICMP* (May 2004) respectively. The management plans

[6] Potential impacts far from the site boundary are not strictly included within the agreed audit scope, however they have been considered for completeness of the risk assessment.

[7] Potential impacts far from the site boundary are not strictly included within the agreed audit scope, however they have been considered for completeness of the risk assessment.

specify interim measures to reduce exposure to potential risks posed to park users and residents, maintenance and other workers by the identified soil contamination.

The management plans were to be revised within one to two years after implementation (i.e. by 2006), and the revision would appear to be overdue.

Nonetheless, it is understood that the management plans continue to be implemented at the Site and the screening risk assessment has considered the controls on the site that are embodied by the 2004 management plans.

6.5 Likelihood and Severity of Effect on the Segments of the Environment/Beneficial Uses

6.5.1 Initial Assessment by GHD

As a first stage in assessing the risk to beneficial uses, GHD carried out an initial assessment of the likelihood of a scenario occurring in which contamination would give rise to a significant effect on the beneficial uses.

In each case, a particular scenario and level of effect was considered, and the likelihood of this scenario occurring was then determined based on information obtained from the preliminary review of information pertaining to this site and consultation with stakeholders.

The descriptors defining the likelihood of a scenario occurring and the severity of effect, and the resulting level of risk are defined in the risk assessment matrix shown in Table 11. These descriptors were based on the Australian Standard *Risk Management* (AS 4360: 2004) and the ranking of risk for various combinations of likelihood and severity was based on the judgment of the auditor. This was considered to be an adequate approach for the audit where only a relative ranking is required to focus further assessment. It is possible that other risk rankings could be adopted.

Severity of effect considered the following:

- People (mainly human health);
- Financial impact of damage to assets and heritage; and
- Environment (actual impact on ecosystems, as distinct from regulatory compliance).

The descriptors for ranking likelihood and severity are provided in Table 11.

Table 11 Risk Assessment Matrix

Consequences				Probability				
	People	Assets & Heritage	Environment	A	B	C	D	E
				Improbable	Unlikely	Possible	Likely	High
0	No health effect/injury: - non detect or < limit	No damage	No effect: - non detect or < limit	Negligible	Negligible	Negligible	Negligible	Negligible
1	Slight health effect: - possible occasional exceedence	Slight damage <$10 000	Slight effect: possible occasional exceedence	Negligible	Negligible	Low	Low	Low
2	Minor health effect - = 0 - 10 x limit and relevant extractive use	Minor damage <$100 000	Minor effect, single complaint, minor breach: =0 -10 x limit and relevant beneficial use	Low	Low	Low	Medium	Medium
3	Major health effect -- = 10-100 x limit and relevant extractive use	Localised damage <$1 000 000	Localised effect, multiple complaints, substantial breach: - >10 - 100 x limit and relevant beneficial use	Low	Low	Medium	Medium	High
4	Major health effect -- >100 x limit and relevant extractive use	Major damage <$10 000 000	Major effect, widespread nuisance, persistent breach or impact: >100 x limit and relevant beneficial use	Low	Medium	Medium	High	High
5	Acute health effect -- *>>100 x limit and relevant extractive use*	Extensive damage >$10 000 000	Massive effect, persistent severe damage: *>>100 x limit and relevant beneficial use*	Medium	Medium	High	High	High

6.5.2 Input to the Assessment by Golder Associates, CoPP and DLA

The draft of the screening risk assessment was provided to Golder Associates, CoPP and DLA on 19 June 2008, and a second workshop to review the risk scenarios and the rankings with Golder Associates, CoPP and DLA was held at the DLA office on 27 June 2008. At the workshop there was general agreement on the outcomes of the draft screening risk assessment, and some minor revisions were identified.

6.5.3 Findings of the Screening Risk Assessment

The findings of the screening risk assessment process, taking into account the relevant controls, are summarised in Table 12. The screening risk assessment identified:

- 50 medium risk scenarios;
- 99 low risk scenarios; and
- 115 negligible risk scenarios.

Note that the number of scenarios considered, and therefore the number of risks identified, relates to the environmental media, receptors and beneficial uses as identified from the audit scope process.

A summary of the higher ranked risks (medium risks) is provided in Table 13 for on-site risks, and Table 14 for off-site risks. The complete tables of the risk ranking process are Appendix C, and these contain further information on the low and negligible ranked risks.

Table 12 Findings of the Screening Risk Assessment

Exposure Pathway	No. scenarios assessed	No. of 'high' risk scenarios	No. of 'medium' risk scenarios	No. yielding high 'low' scenarios	No. yielding 'negligible' scenarios
Flowchart 1 Contaminated Soil –> Risk to Onsite Land Beneficial Uses	46	0	19	21	6
Flowchart 2 Contaminated Soil/Groundwater –> Risk to Onsite Groundwater Beneficial Uses	14	0	2	10	2
Flowchart 3 Contaminated Soil/Groundwater –> Risk to Offsite Groundwater Beneficial Uses (near the site)	14	0	6	3	5
Flowchart 4 Contaminated Soil/Groundwater –> Risk to Offsite Groundwater/Surface Water Beneficial Uses (far from the site)	43	0	0	11	32

Exposure Pathway	No. scenarios assessed	No. of 'high' risk scenarios	No. of 'medium' risk scenarios	No. yielding high 'low' scenarios	No. yielding 'negligible' scenarios
Flowchart 5 Contaminated Soil/Groundwater –> Risk to Offsite Land Beneficial Uses (near the site)	15	0	3	7	5
Flowchart 6 NAPL –> Risk to Onsite Land Beneficial Uses	33	0	8	20	5
Flowchart 7 NAPL –> Risk to Onsite Groundwater Beneficial Uses	13	0	2	9	2
Flowchart 8 NAPL –> Risk to Offsite Land Beneficial Uses (near the site)	15	0	2	8	5
Flowchart 9 NAPL –> Risk to Offsite Groundwater Beneficial Uses (near the site)	28	0	8	10	10
Flowchart 10 NAPL –> Risk to Offsite Groundwater/Surface Water Beneficial Uses (far from the site)	43	0	0	0	43
Total	**264**	**0**	**50**	**99**	**115**

Table 13 Summary of the On-Site Higher Risk Scenarios

Pathway Description	Beneficial Use - Receptors	Limiting Contaminants	Commentary	Existing Risk Treatment and/or Management Measures
Diffusion of gases into onsite buildings (including the residential buildings) arising from onsite contamination (i.e. soil, groundwater, NAPL)	Land: Human health (Park users, workers in buildings), aesthetics	Phenol, ethyl benzene, toluene, xylene NAPL such as coal tars and oils containing PAHs, BTEX, phenols VOCs and SVOCs	The 2004 Golder indoor air vapour risk assessment involved sampling the air in buildings at four locations on the site. Golder tested for VOCs, SVOCs and CN. Four chemicals of interest (COIs) were identified. These were: phenol, ethylbenzene, toluene and xylenes. The risk assessment of the COIs detected in indoor air used the highest concentrations of each chemical measured at any of the indoor monitoring locations. Based on the data collected for the indoor air vapour risk assessment, Golder concluded that the gasworks waste on the site did not appear to be posing vapour risks to workers and residents on the site. However, there is uncertainty about the representativeness of the study (the vapour risk assessment used measurement data collected from soil gas bores that were sampled on only one occasion, and indoor air that was also sampled on only one occasion. Although the sampling design had the objective of collecting data that would result in conservative estimates of risk (i.e. targeting areas closest to potential sources), without time-series data it cannot be determined whether the sampling programme actually captured representative vapour concentrations (Golder discusses this in their report). Nor can it be determined what future vapour risks may be for the site. Therefore, the vapour risk assessment can only be considered a point-in-time assessment only).	The ICMPs specify that potential vapour exposure within buildings be minimised through the continual use of air conditioning systems and adequate ventilation. It further states that time spent in poorly ventilated locations be minimised pending further measurements and recommendations (being the 2004 vapour survey that was yet to be undertaken at the time of preparing the ICMPs). <u>Uncertainty:</u> The presence of NAPL and the associated volatiles on the site remains an area of uncertainty. It is expected that NAPL will be present in the southeast area of the site but the extent of it and whether NAPL has migrated beyond the site boundary remains uncertain.

Pathway Description	Beneficial Use - Receptors	Limiting Contaminants	Commentary	Existing Risk Treatment and/or Management Measures
Diffusion of gases into excavations arising from onsite contamination (i.e. soil, groundwater, NAPL)	Land: Human health (workers undertaking sub-surface works)	VOCs and SVOCs	The Golder 2004 soil gas study did not explicitly address risks to subsurface workers, however tar residues and odours were observed in fill in some locations and soil gas bores detected a number of VOCs and SVOCs, and it appears likely that these can be present in deeper excavations that might be undertaken.	
Direct contact as well as possible ingestion of contaminated soil	Land: Human health (park users, workers in buildings, workers undertaking sub-surface works)	PAHs, TPHs, benzene, cyanide	Overall the soil contamination reported in the fill on site is not considered to pose an unacceptable risk to human health providing controls are put in place to reduce exposure to the soil and promote safety for maintenance workers. In the longer term, a more robust management system will need to be implemented.	ICMPs require that the separation layer be maintained over the non-building areas of the site. In the ICMPs, it was recommended that workers or people who spend more than two days/week at the site be briefed by the Health and Safety Coordinator (presumably a member of CoPP staff) regarding site issues, including the need to minimise exposure to soils and adopt standard hygiene practices. The ICMPs do not explicitly deal with any intrusive works greater than 0.3 m bgl – for these the ICMP requires that a task-specific contamination management plan be prepared, in consultation with the CoPP Health and Safety Coordinator. A suggested pro-forma for the task specific contamination management plan was attached to the ICMPs.
	Aesthetics	Surface waste	Near the surface fill has been reported as generally comprised of black sands with fragments of coke, bricks, glass and other gasworks related wastes.	Aesthetic issues are partially addressed by the on-site management actions. For instance, the ICMPs specify that most areas of the site outside of the buildings be covered by a separation layer that consists of paved areas including gravel paths, grass and wood chips.

Pathway Description	Beneficial Use - Receptors	Limiting Contaminants	Commentary	Existing Risk Treatment and/or Management Measures
Onsite extraction of contaminated groundwater onsite	Groundwater: Agriculture, parks and gardens (irrigation)	TDS, boron, arsenic, manganese	Contaminant concentrations in the shallow aquifer were noted to be up to 100 times greater than irrigation guidelines in some instances (ie. severity rating of 4 to 5), and assuming that the use of the groundwater for irrigation is 'unlikely' (rather than 'improbable') results in a medium risk ranking. Other uses of groundwater such as potable and recreational uses were determined to have a lower level of risk, in that these uses were considered to be 'improbable'. There is no data on the deeper groundwater, and the risk has been determined to be medium, similar to the shallow groundwater, based on conservative assumptions.	The ICMPs do not address groundwater use on site, but it is understood that CoPP would not allow extractive use of groundwater at the site (CoPP being the Committee of Management for the site), and it is unlikely that approval could be mistakenly given.

Table 14 Summary of the Off-Site Higher Risk Scenarios

Pathway Description	Beneficial Use - Receptors	Limiting Contaminants	Commentary	Existing Risk Treatment and/or Management Measures
Offsite extraction of contaminated groundwater that has arisen from onsite contamination	Groundwater: Potable water use	TDS, ammonia, Ni, Mn, sulphate NAPL such as coal tars and oils containing PAHs, BTEX, phenols	Groundwater contaminant concentrations off site exceed the potable water guideline concentrations for ammonia (aesthetics), As, Ni, Mn, sulphate (health and aesthetics). Ammonia concentrations in particular, are orders of magnitude above the potable use aesthetic guidelines (ie. in the wells immediately adjacent to the eastern and north eastern boundaries of the site). An ammonia plume that is extending beneath the residential area beyond Richardson Street contains groundwater with elevated salinity above Segment A background levels, accompanied by increases in sulphate, BTEX, CN and ammonia. While groundwater is unlikely to be used as a source of domestic/potable water in this region of Melbourne as reticulated water supplies this area, the concentrations exceedences are high enough to result in a medium level risk allocation.	Deep sewers close to the site boundary intercept groundwater flow from the site to beneath residential areas in most areas out side the site, but not in all areas. There are no known groundwater extraction wells in the vicinity of the site. The area is understood to not be within a declared Groundwater Quality Restricted Use Zone. Use of groundwater might occur by residents in the area. Delineation of elevated concentrations in offsite areas is an area of uncertainty. It would be possible for use to be controlled by the bore licensing Authority (Southern Rural Water) if advised/consulted by the responsible Authority (ie. CoPP or EPA). The likely low yield of the Brighton Group

Pathway Description	Beneficial Use - Receptors	Limiting Contaminants	Commentary	Existing Risk Treatment and/or Management Measures
	Groundwater: Agriculture, parks and gardens (irrigation)	TDS	TDS is up to 3,600 mg/L in the area bound by Richardson, Grieg and Bridport Streets, well above the desirable concentrations for watering of gardens, and is the limiting contaminant. B and Mn are elevated and can also exceed guideline levels for irrigation use. The risk assessment assumes that there is potential for groundwater in the residential area adjacent to the site to be used for irrigation, as there are no explicit controls preventing use in this area.	
	Groundwater: Primary contact recreation (eg. filling swimming pools)	Ammonia	Groundwater contaminant concentrations exceed the guideline concentrations for primary contact recreation for ammonia by several orders of magnitude in the NE corner around Richardson St as well as elevated As, CN, Bo and Mn. It is possible that groundwater could be used by residents for topping up swimming pools, and this acknowledgement has contributed to the medium level risk allocation for this scenario.	
Diffusion of gases into offsite excavations that has arisen from contaminated groundwater leaving the site.	Land: Human health (workers undertaking subsurface works)	Ammonia	An ammonia plume has been identified offsite (NE & W) and this would present an odour issue rather than a health issue. Groundwater is typically below the likely depth of most buildings in the vicinity the site. However	The auditor understands that Melbourne Water has been informed of the contamination that may be entering the sewer from the site. Golder Associates recommended that a similar agreement to that proposed with Melbourne Water be sought with South East Water to

Pathway Description	Beneficial Use - Receptors	Limiting Contaminants	Commentary	Existing Risk Treatment and/or Management Measures
Diffusion of gases into the sewers that has arisen from contaminated groundwater and NAPL leaving the site	Land: Human health (workers undertaking subsurface works)	Ammonia		

6.5.4 Medium Risk Scenarios posed Onsite

The scenarios that yielded the highest risks at the Site related to:

- Migration of volatile emissions into onsite buildings and structures, including residential buildings, as well as excavations;
- Contact by persons with contaminated and soil and gasworks waste that may be on the surface of the Site; and
- Contaminated groundwater being extracted for irrigating the Site.

6.5.5 Medium Risk Scenarios posed Off-Site

The scenarios that yielded the highest risks offsite related to:

- Contaminated groundwater leaving Gasworks Site and being extracted offsite for domestic, irrigation and recreational uses;
- Contaminated groundwater (and NAPL) entering the sewers and potentially giving rise to emissions and direct contact risks for workers;

6.5.6 Scenarios that did not pose any Medium Risks

Two of the 10 flowcharts yielded only low and negligible risks scenarios. These flowcharts assessed the scenarios whereby contaminated groundwater might:

- Enter the sewer system and be received at the Western Treatment Plant and ultimately discharge to Port Phillip Bay;
- Underflow the sewer system and discharge at the Bay; and
- Underflow the sewer system and be extracted for use some distance from the Site.

Deep sewers intercept groundwater and restrict flow leaving the Site, although it is recognised that this is not the case in all areas such as the northeast and west regions of the Site. Recognising that underflow of deep groundwater could occur was the basis for including these exposure pathways in the screening risk assessment. Also, while it has not yet been fully established whether groundwater actually discharges to Port Phillip Bay, theoretically this would appear to be the natural discharge point for groundwater leaving the site.

Nonetheless, the scenarios yielded either low or negligible risks. Considerations leading to this included:

- The extent of elevated concentrations in offsite areas is an area of uncertainty; however, contaminant concentrations in immediate offsite wells have reported contaminant concentrations above guidelines for Segment A beneficial uses, particularly related to ammonia in groundwater.
- Dispersion and attenuation of contaminants is expected to occur in the sewer, at the treatment plant, or along the pathway to the Bay and significantly reduce concentrations prior to discharge. In particular, ammonia is present at high concentrations in groundwater and is likely to be a contaminant that enters the sewer; however, ammonia is naturally occurring in sewage and in small quantities is

unlikely to be of concern.

- The likely low yield of the Brighton Group aquifer could be a restriction on the abstraction of deep groundwater for extractive uses. It is uncertain whether groundwater is actually being used by residents in the vicinity of the site, and the use of groundwater for stock and as drinking water is particularly unlikely to be realised in the Albert Park area. Notwithstanding this, these beneficial uses remain relevant for the purposes of the screening risk assessment.

6.5.7 Limiting Contaminants

In the context of this report, “limiting contaminant” refers to the contaminant that can be expected to determine the requirements for control; this will generally be the contaminant with the greatest exceedence of criteria.

The risk assessment process indicated that the limiting contaminants were:

Fill and Soils:

- Lead;
- Benzo(a)pyrene;
- Total PAHs;
- TPHs;
- Fraction >C9;
- Benzene;
- Total cyanide; and
- Possible presence of tars/NAPL.

Groundwater:

- Low pH
- Ammonia
- Possible presence of tars/NAPL
- BTEX.

6.6 Issues Requiring Resolution

The issues identified as requiring further assessment to resolve uncertainty and to better understand the level of risk included:

- The extent of contamination in soil and shallow fill, and the performance requirements for capping and control of future activities;
- NAPL, particularly its presence and extent on site, and its significance as an ongoing source of vapours and groundwater contamination;

- Vapours, particularly the potential for these to enter buildings;
- The migration of dissolved phase groundwater contamination off site, and the potential for use of this groundwater;
- The extent to which deeper groundwater might be contaminated and result in groundwater contamination migrating from the site.

In addition, it was determined that there was a need to update the Interim Contamination Management Plans to address longer-term issues and ensure robustness of the administrative controls.

7. Proposed Further Work to Address the Higher Risk Issues

7.1 Requirement for Further Works

For the purposes of determining the further works that will be required, it was assumed that the 50 higher (i.e. medium) risk scenarios require further work to reduce the risk to a low or negligible risk, and that risk scenarios ranked as low or negligible would not require clean up, management or investigative work at this time. Notwithstanding this, the auditor assumes that the assumptions underlying the negligible and low risk scenarios will be reviewed in the later stages of the audit to confirm that this assumption is appropriate in view of the additional information that will have become available.

In terms of determining what further work would be required to address the higher ranked risks, Golder Associates reviewed the results of the screening risk assessment carried out by the auditor and that was discussed at the workshop on 27 June 2008, and prepared a scope for further works to address issues that have been found to be either of high uncertainty or present a medium risk to human health or the environment.

The auditor assumes that if the risk is not able to be entirely removed (such as through removing the source) then the objective should be to reduce the higher risk scenarios to at least low or negligible risk. These considerations were formalised in a letter from Golder Associates to DLA titled *'Summary of Assessment Scope of Works'* dated 10 July 2008, and the contents of this letter are described below.

7.2 Further Assessment of Groundwater/NAPL Issues

Golder Associates outlined a process to resolve the issues associated with NAPL at the site. The elements of this further assessment include:

a) Review potential sources of NAPL based on available site history and analytical data.

b) Review background groundwater information for Gasworks Park and surrounding area (via other audits if possible) to assess typical background information for ammonia, cyanide and metals.

c) Review basis for critical criteria for contaminants such as ammonia and cyanide to confirm their applicability to Gasworks Park and its surrounds.

d) Undertake further site investigations to:

- Assess the presence of NAPL in the soil and groundwater.
- Further characterise groundwater pollution off site to the north east and, in particular, the potential sources of the off site groundwater pollution.
- Assess whether Gasworks Park is a source of groundwater pollution offsite towards Alinta site in the northwest.
- Assess the potential for contamination of the deeper aquifer on and off the site due to onsite pollution.

e) Provide a risk assessment and remedial options report for issues relating to NAPL and off site

groundwater pollution including an assessment of potential costs and risks.

f) Recommend a preferred action plan to address groundwater risks at the site. In the case of any off site groundwater pollution, the action plan must include a strategy for dealing with existing off site pollution should this be present.

g) Report on assessment, discuss and agree actions with the stakeholders including the auditor and revise as necessary.

Comment by the Auditor:

Overall, the stated objectives of the further assessment work proposed by Golder Associates are appropriate. However, note that the proposed investigations may be challenging to complete and the proposal does not indicate the expected outcome of the work and the nature and cost of the measures that may be necessary to reduce the risk to a low level. For example, issues which may be particularly difficult to obtain closure on include:

- ***"assess the presence of NAPL in the soil and groundwater"; and***
- ***"dealing with existing off site pollution should this be present" (note that it is already known that off site pollution is present and the key issue is whether measures will or will not be necessary to avoid contamination continuing to migrate from the site and affect the use of groundwater offsite).***

Other notes on the proposed further work include:

- ***Timing of the further works has not been provided.***
- ***It is uncertain whether further review of potential sources of NAPL based on available site history and analytical data will yield new information, and information that might alter the conceptual model. Progressing direct investigation works should be a priority for identifying NAPL sources.***
- ***The higher risk assigned to contaminated groundwater potentially leaving the Site and being extracted offsite related not only to the severity of the contamination, but also to the possibility that groundwater might be used for irrigating gardens or filling swimming pools. Establishing whether groundwater is being used, or advising of the risk posed by groundwater in the vicinity of the Site is not addressed in the scope described above.***
- ***Several of the higher risks related to deeper groundwater being extracted for use. In the absence of deeper groundwater quality information, the shallow groundwater information was adopted by the auditor as the basis for the severity ranking for the deeper groundwater scenarios. Golder Associates have not explicitly stated that there will be any investigation of the deeper groundwater quality, and it is noted here that this was considered a key uncertainty in the screening risk assessment.***

7.3 Further Assessment of Vapour Issues

Golder Associates have outlined a scope for the further assessment of vapour issues posed at the Site. The elements of this further assessment include:

a) Design and implementation of further investigation to provide more information on the occurrence of volatile compounds in ambient air within buildings and in the soil and groundwater in the wider site area. This should include the potential current risk and future risk posed by the presence of potential NAPL at the site.

b) Undertake a vapour health risk assessment as necessary to assess risks posed by the identified volatile compounds.

c) Prepare an options assessment of potential remediation or monitoring and management actions including assessment of potential; costs and risks.

d) Recommend a preferred action plan to address vapour risks at the site.

e) Report on assessment, discuss and agree actions with the stakeholders including the Environmental Auditor and revise as necessary.

Comment by the Auditor:

The stated objectives of the further assessment work proposed by Golder Associates are appropriate. The proposed assessment of vapour is linked with the work proposed in the previous section on assessment of NAPL. Note that NAPL under buildings would be likely to pose the greatest risk to indoor air, and would be difficult to identify and characterise. Similar to the previous point, it should be noted that the proposal does not indicate the expected outcome of the work and the cost of the measures that may be necessary to reduce the risk to a low level.

Other notes on the proposed further work include:

- ***Timing of the further works has not been provided.***

7.4 Site Capping

Golder Associates has outlined a scope for the site capping that includes:

a) Develop performance requirements for the capping of the site based on the risk assessment prepared by the Auditor and other site information.

b) Develop capping options to achieve the performance requirements. The assessment will consider costs, risks, site constraints and performance.

c) Recommend a preferred capping option with supporting modelling and documentation as required as well as the requirements for implementation such as staging of the capping and environmental management.

d) Report on assessment, discuss and agree actions with the stakeholders including the Auditor and revise as necessary.

Comment by the Auditor:

The stated objectives of the further assessment work proposed by Golder Associates are appropriate. It is noted that the performance requirements must consider measures for the protection of beneficial uses of land associated with recreational use of the park, residential use at the Southport Site, and commercial uses of the Site (i.e. workers at the Site).

7.5 Site Management

Golder Associates have outlined a scope for ongoing Site management that includes:

a) Update the existing Interim Contamination Management Plan (CMP) to address the long-term management of the site for the adopted remedial actions. The CMP should include management procedures, trigger conditions and contingency plans should triggers be met.

b) Report on assessment, discuss and agree actions with the stakeholders including the auditor and revise as necessary.

Comment by the Auditor:

The stated objectives of the further assessment work proposed by Golder Associates are appropriate. It is noted that the updated management plans must consider both the Park and Southport Sites.

7.6 Conclusions

The objective of the further work proposed by Golder Associates has the objective of providing more information to address issues that have been found through the initial risk assessment to be of either high uncertainty or present a medium risk to human health or the environment.

The auditor has assessed the proposed scope of the further work, and concludes that it is consistent with providing necessary further information on key areas of risk and uncertainty.

However, a key objective of the further work is to provide confidence that the risks will be reduced to a low or negligible level. While the proposals by Golder Associates infer that this will be the outcome and can be accepted and proposed to the EPA as such, caution is required as there is no indication in the proposals as to the likely outcome in terms of the extent and nature of the investigation and remedial work necessary to deal with some of the more difficult issues. This may be able to be resolved by Golder including a more definitive statement on what the outcome will be for each portion of the proposed work (eg reduce the risk to a low level); however, this would not indicate what works would ultimately need to be carried out.

Timing of the further works has not been provided; this may be of importance to CoPP and EPA.

8. Limitations

The risk assessment has assessed the risk posed by former gasworks activities and associated residual contamination at the Gasworks Site to the existing beneficial uses of the land and groundwater at the Site and in the surrounding environment. The audit has not considered activities conducted at nearby premises, such as operations on the Alinta Site, and their effect on neighbouring uses. This is consistent with the agreed audit scope (dated April 2008).

The results of the screening risk assessment risk assessment have, amongst other things, expressed the auditor's opinion on the risks posed to the relevant beneficial uses, for instance *the site poses a low/medium/high risk to recreation and open space use of the park*. The results of the screening risk assessment to date have been subject to further consultation and refinement with Golder Associates, CoPP and DLA. It is expected that in order to complete the first stage of the audit, that the information provided in this interim report would form the basis for further discussion with the clients, Golder Associates, and EPA.

In this interim report recommendations have been provided on how the risk may be reduced, and these are mainly in the form of further assessment and other works as proposed by Golder Associates to address the risk assessment outcomes. Priorities will be assigned to the recommendations that arise after this further work and in the final audit report.

In carrying out this assessment, the auditor assumes that CoPP has determined that the product of the risk assessment process will provide a suitable outcome and that the findings on the level of risk will provide a sufficient basis for making decisions on the need for additional clean up, the level of management that might be required, and on the future use of the site. In this respect, the audit will not provide a statement as to the suitability of the land for it's current or intended use. If such a statement were to be required, the auditor could probably only make such a statement through undertaking a Section 53X audit, which is a well established system for making statements on land suitability.

It is noted that the Gasworks Site is expected to be a source of groundwater pollution and the outcome of the proposed audit process is a conclusion by the auditor on the level of risk that the pollution poses to beneficial uses of the land and groundwater. While the auditor may consider guidance and practice relating to the *Clean Up to the Extent Practicable* (CUTEP) of polluted groundwater, this audit is not expected to formally consider whether CUTEP has been achieved at the Site.

FIGURES

LEGEND

Location of Gasworks Site Audit Area

N
W E
S

0 250 500
Metres

DATA SOURCE: Melways Edition 35, Copyright Ausway 2007

Prepared.	CJI	22/08/2007	Workspace	001_LocalityPlan.WOR
Checked.	VMS	22/08/2007	Location	G:\31\21452\CADD\GIS\Projects
Approved.	VMS	22/08/2007	Map Grid	GDA 94 (MGA Zone 55)

GHD
180 Lonsdale Steet
Melbourne Vic 3000
Tel: 61 3 8687 8000
Fax: 61 3 8687 8111

Project: **Gasworks Site, Pickles & Graham St, Albert Pk**

Title: **Figure 1 - Locality Plan**

Project No:	Date:		Scale:	Sh of	Rev.
31/21452	22/08/2007	A4	1:15,000	1 of 1	0

LEGEND

Gasworks Site
Audit Area

N
W E
S

0 50 100

Metres

DATA SOURCE: Golder Associates (2006), Hydrological Conceptual Model, p. 24

Prepared.	CJI	23/08/2007	Workspace	002_SiteLayoutPlan.WOR
Checked.	VMS	23/08/2007	Location	G:\31\21452\CADD\GIS\Projects
Approved.	VMS	23/08/2007	Map Grid	GDA 94 (MGA Zone 55)

GHD

180 Lonsdale Steet
Melbourne Vic 3000

Tel: 61 3 8687 8000
Fax: 61 3 8687 8111

Project: **Gasworks Site, Pickles & Graham St, Albert Pk**

Title: **Figure 2 - Site Layout Plan**

Project No:	Date:		Scale:		
31/21452	23/08/2007	A4	1:2,000	Sh 1 of 1	Rev. 0

Appendix A

Gasworks Arts Park – Buildings, Occupiers, Activities (September 2007)

GASWORKS ARTS PARK

Outlined below is a list of current buildings, most occupiers and activities on site at the Gasworks Arts Park.

Gasworks Arts Park Building 1 – Sculpture Studio
Occupiers: Jamieson Miller, Julie Squires, Craig Barrett, Matthew Harding, Michael Sibel
Activities: Used as a professional work space by several sculptors.

Gasworks Arts Park Building 2 – Arts and Crafts Studio
Occupiers include: Various occupants on a sessional basis over each term and holidays
Activities include: Painting classes, art & craft classes, modelling and animation workshops, life drawing classes, children's activities,

Gasworks Arts Park Building 3 – Ceramics Studio
Occupiers: Anne Ronjat, Ursula Dutkiewicz, Kris Coad, Sophia Legoe
Activities: Used as a professional work space by several ceramic artists. Also used for holiday workshops and teaching.

Gasworks Arts Park Building 4 – Visual Arts Studio 1 and 2
Occupiers: Tricia Sabey, Lisa Roet, Ted Powell, Oleh Witer
Activities: Used as a professional work space by several visual artists.

Gasworks Arts Park Building 4 – Visual Arts Garden Studio 3
Occupiers include: Various occupants on a sessional basis over each term and holidays
Activities include: Drama rehersals, yoga classes, childrens activities, workshops, holiday programs, music and singing classes, writing workshops, auditions, clowning, story-telling

Gasworks Arts Park Building 5 – Gatehouse Building – Bookshop
Occupiers: Books Illustrated shop and gallery; illustrator Ann James
Activities: Bookshop and gallery, children's activities, gallery tours, workshops

Gasworks Arts Park Building 6 – Café and Angela Robarts-Bird Gallery
Occupiers: Café - Biggins Bar Solutions P/L; Gallery - various artist exhibitiors
Activities: Café – light meals, coffee, functions; Gallery – various exhibitions on a weekly or fortnightly basis

Gasworks Arts Park Building 7 – Main Theatre, Foyer and Dressing Room
Occupiers include: Various occupants for performances on a weekly or fortnightly basis
Activities: Theatre – performances, drama, musical theatre, dance, music, community events, forums, school concerts, performance recording; Foyer – used as gallery space for various exhibitions on a weekly or fortnightly basis

Gasworks Arts Park Building 8 – Electricty Sub-station
Occupiers: CitiPower
Activities: Electricity sub-station

Gasworks Arts Park Building 9 – Gasworks Admin Offices
Occupiers: Gasworks Arts Inc, staff, contractors, volunteers
Activities: Organisation and administration of various activities on an on-going basis

Gasworks Arts Park Building 10 – Darkroom
Occupiers include: Various occupants on a useage basis over days, nights, weekends
Activities include: Development and printing of photographs

Gasworks Arts Park Building 11 – Studio Theatre – Workshop
Occupiers include: Various occupants for performances on a daily or weekly basis
Activities include: Rehersals, drama, dance, community events, music, forums, workshops, yoga, holiday program activities, physical theatre & movement classes, professional development workshops

Other activities in the general park site at Gasworks Arts Park
Activities: Monthly Farmer's Market (approx 60 stall-holders), dog traing classes, family events, 'Once Upon A Story" children's literacy event, holiday program activities, various functions.

Appendix B

Exposure Flowcharts

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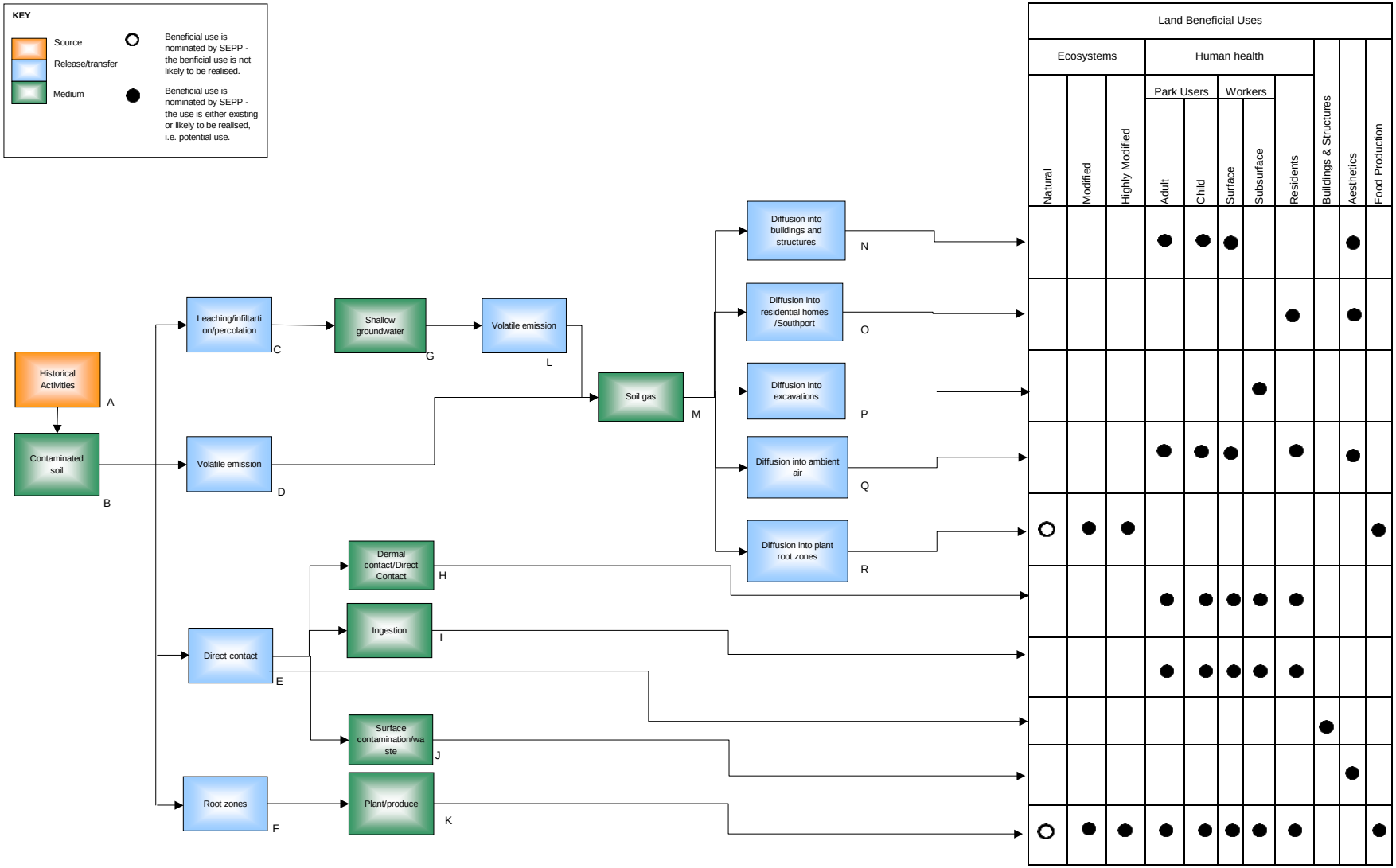
FLOWCHART 1 - Exposure Pathway Analysis – Land Segment, Onsite Receptors



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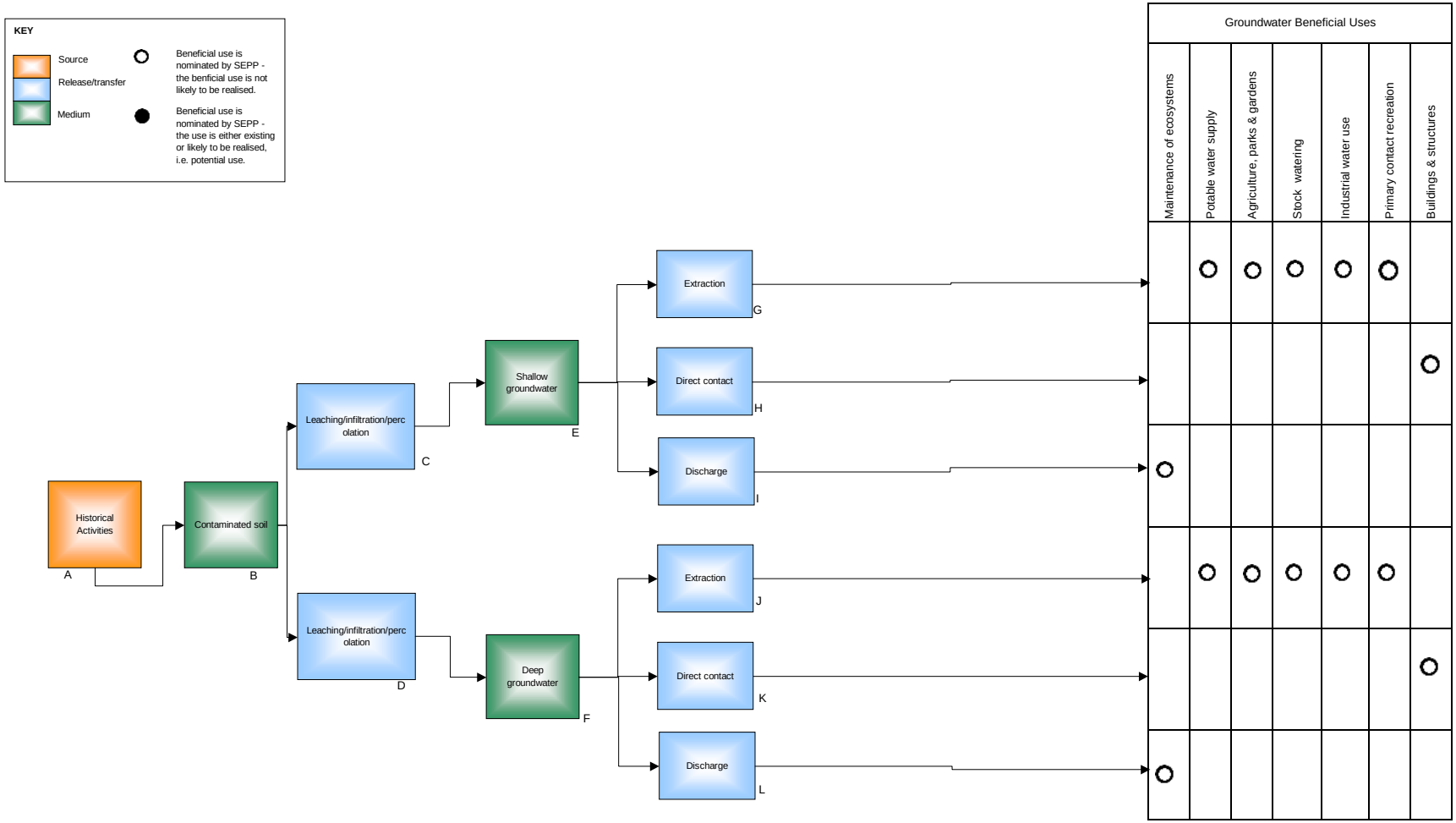
FLOWCHART 2 - Exposure Pathway Analysis – Groundwater, Onsite Receptors



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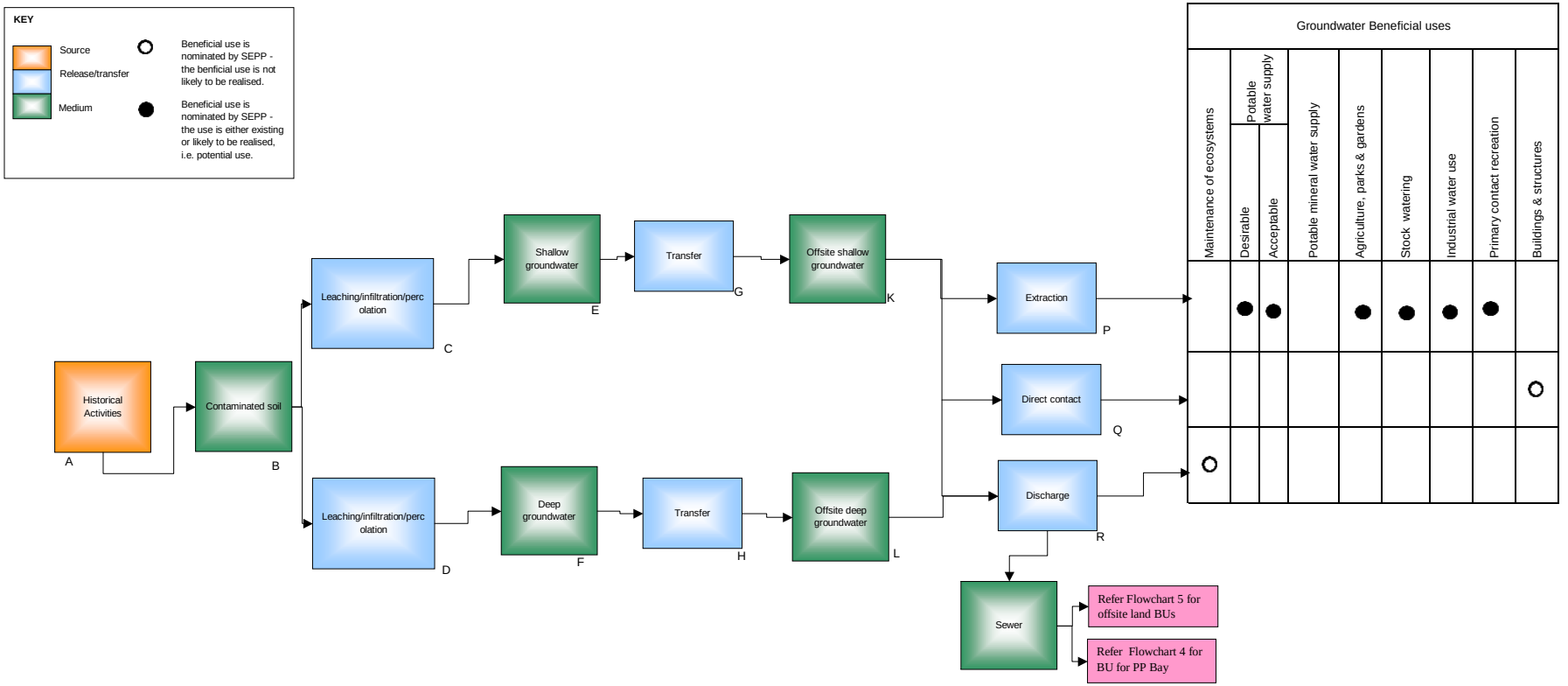
FLOWCHART 3 - Exposure Pathway Analysis – Groundwater Segment, Offsite (near the site)



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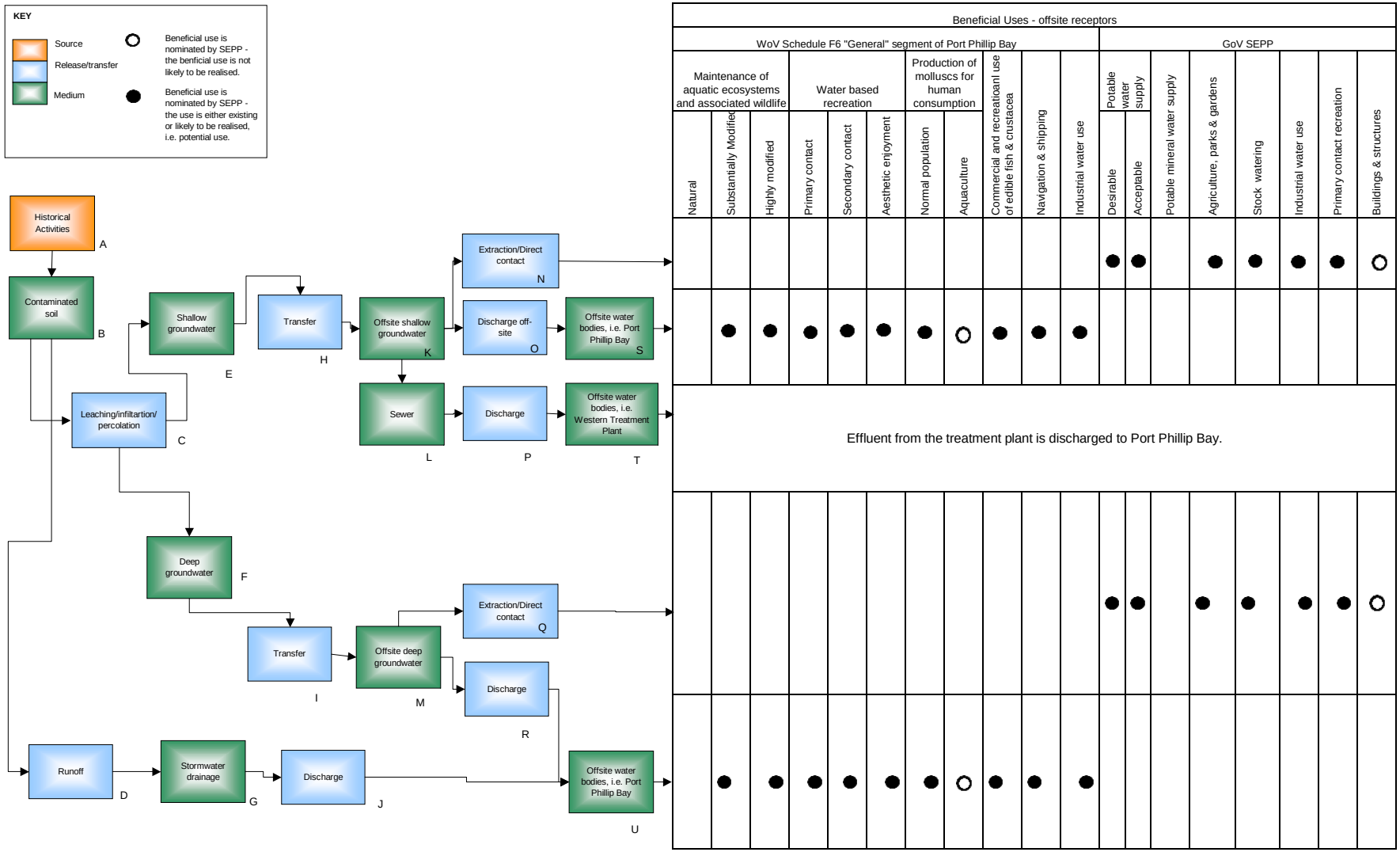
Flowchart 4: Exposure Pathway Analysis – Groundwater and Surface Water Segment, Offsite Receptors (far from the site)



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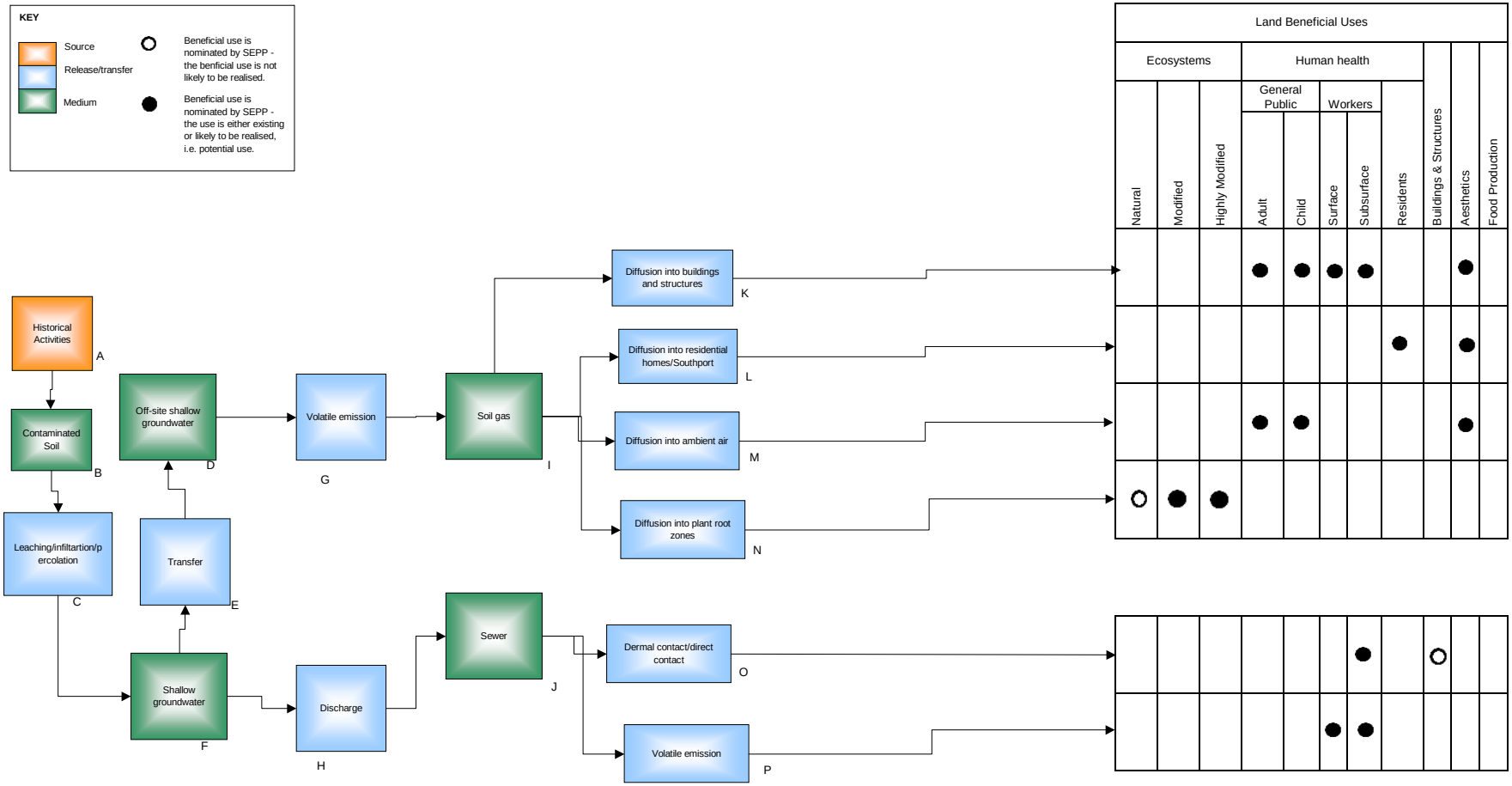
Flowchart 5: Exposure Pathway Analysis – Land Segment, Offsite Receptors (near the site)



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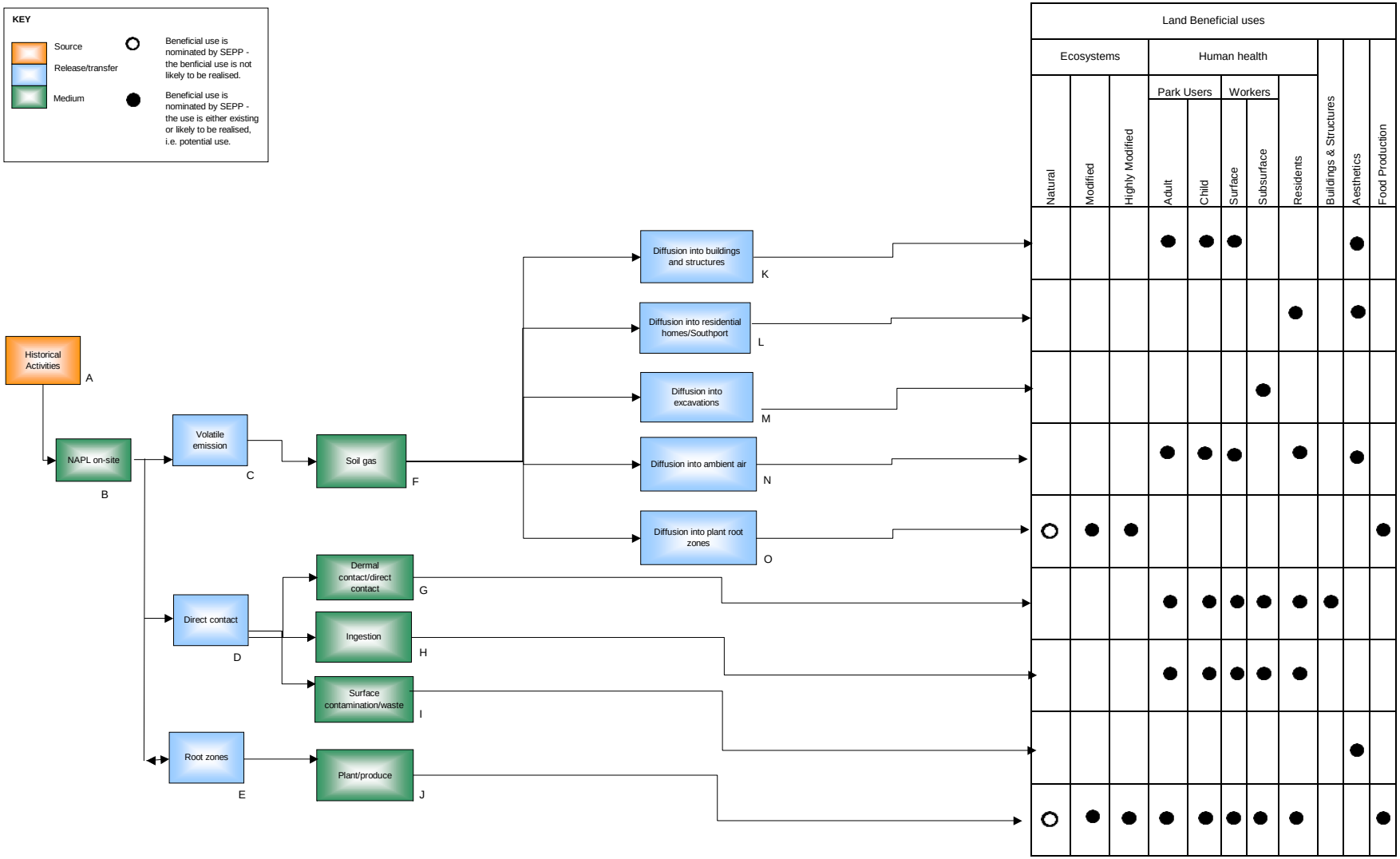
FLOWCHART 6 - Exposure Pathway Analysis – NAPL, Land Segment, Onsite Receptors



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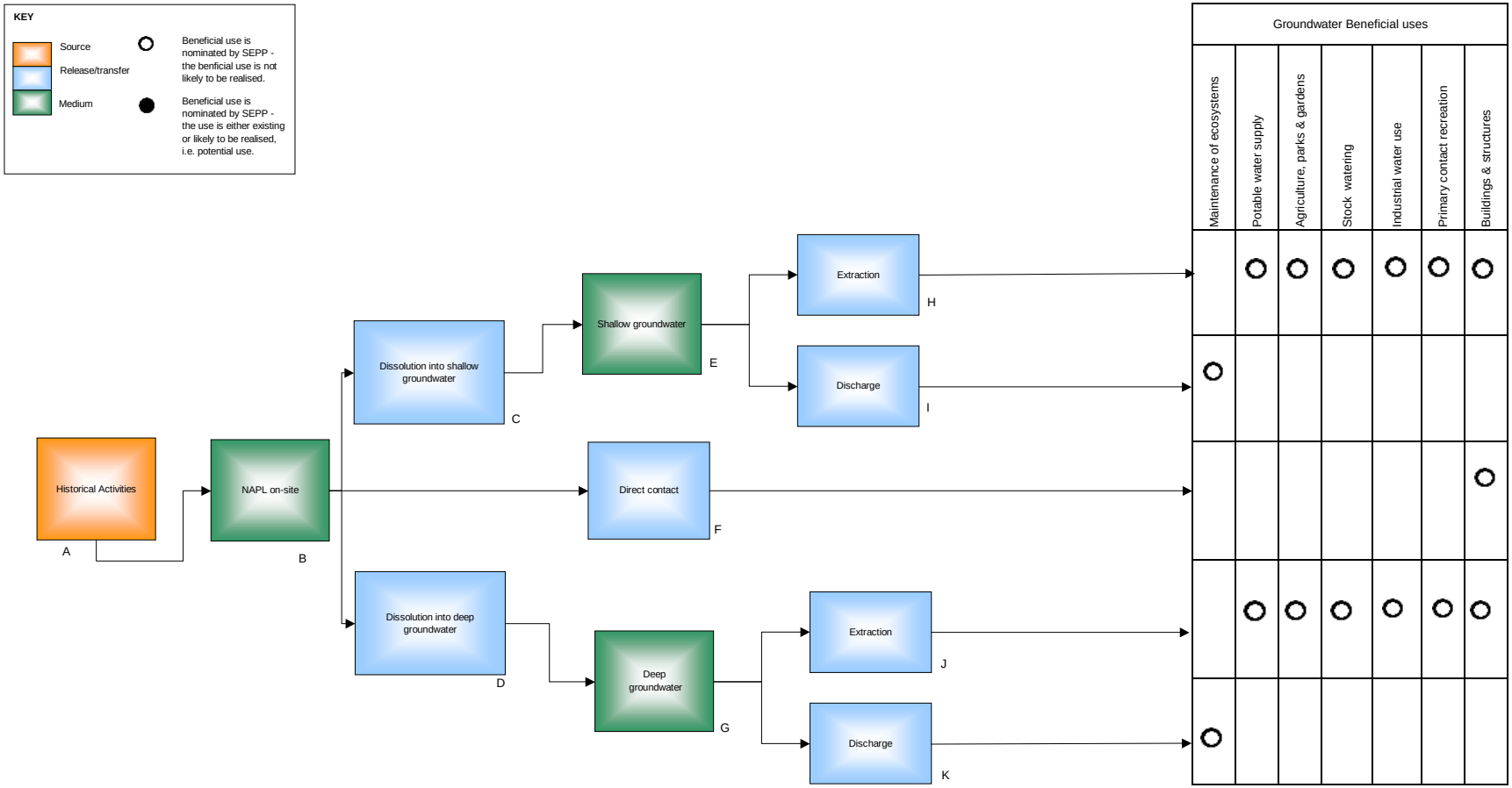
FLOWCHART 7 - Exposure Pathway Analysis – NAPL, Groundwater Segment, Onsite Receptors



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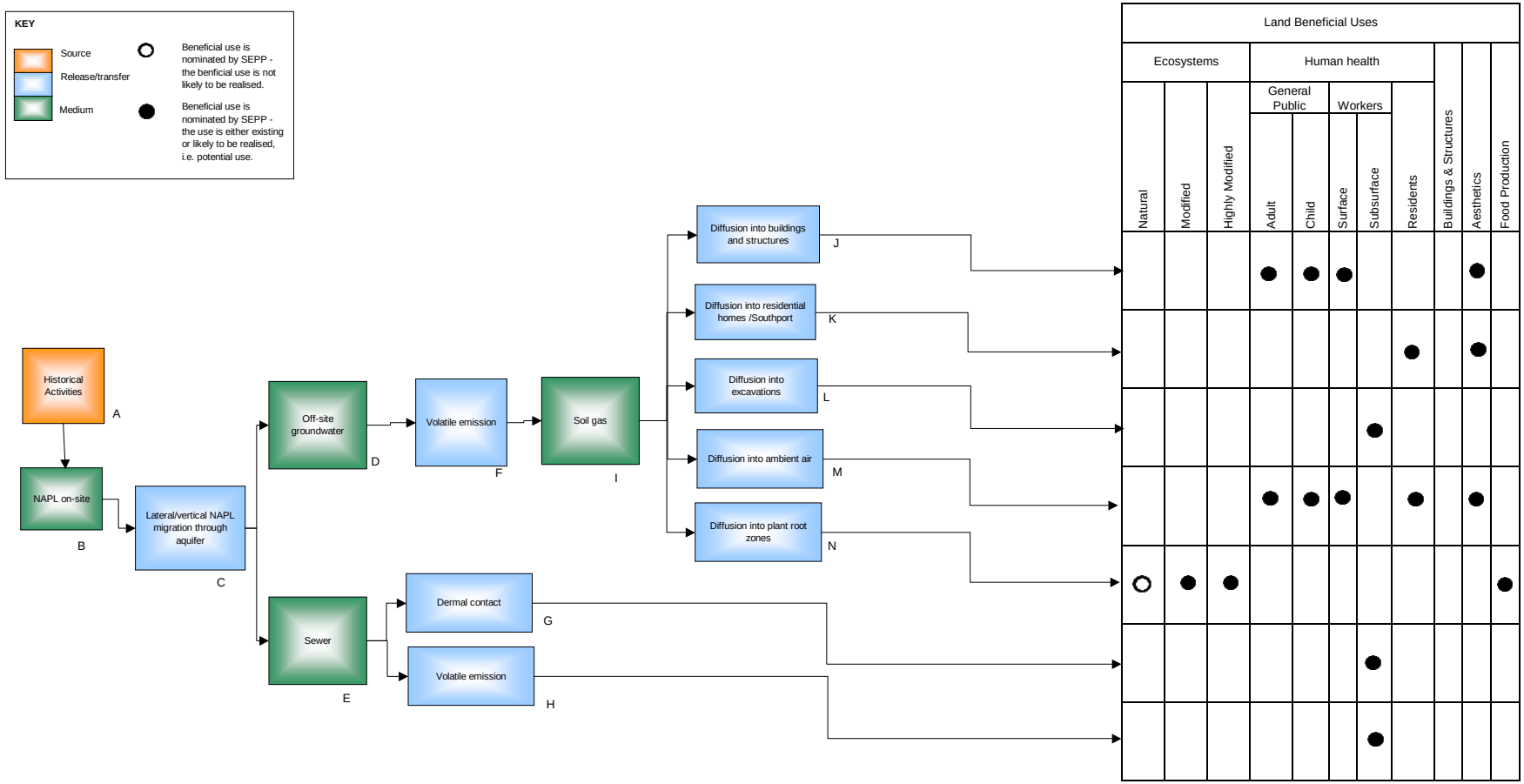
FLOWCHART 8 - Exposure Pathway Analysis – NAPL, Land Segment, Offsite Receptors (near to site)



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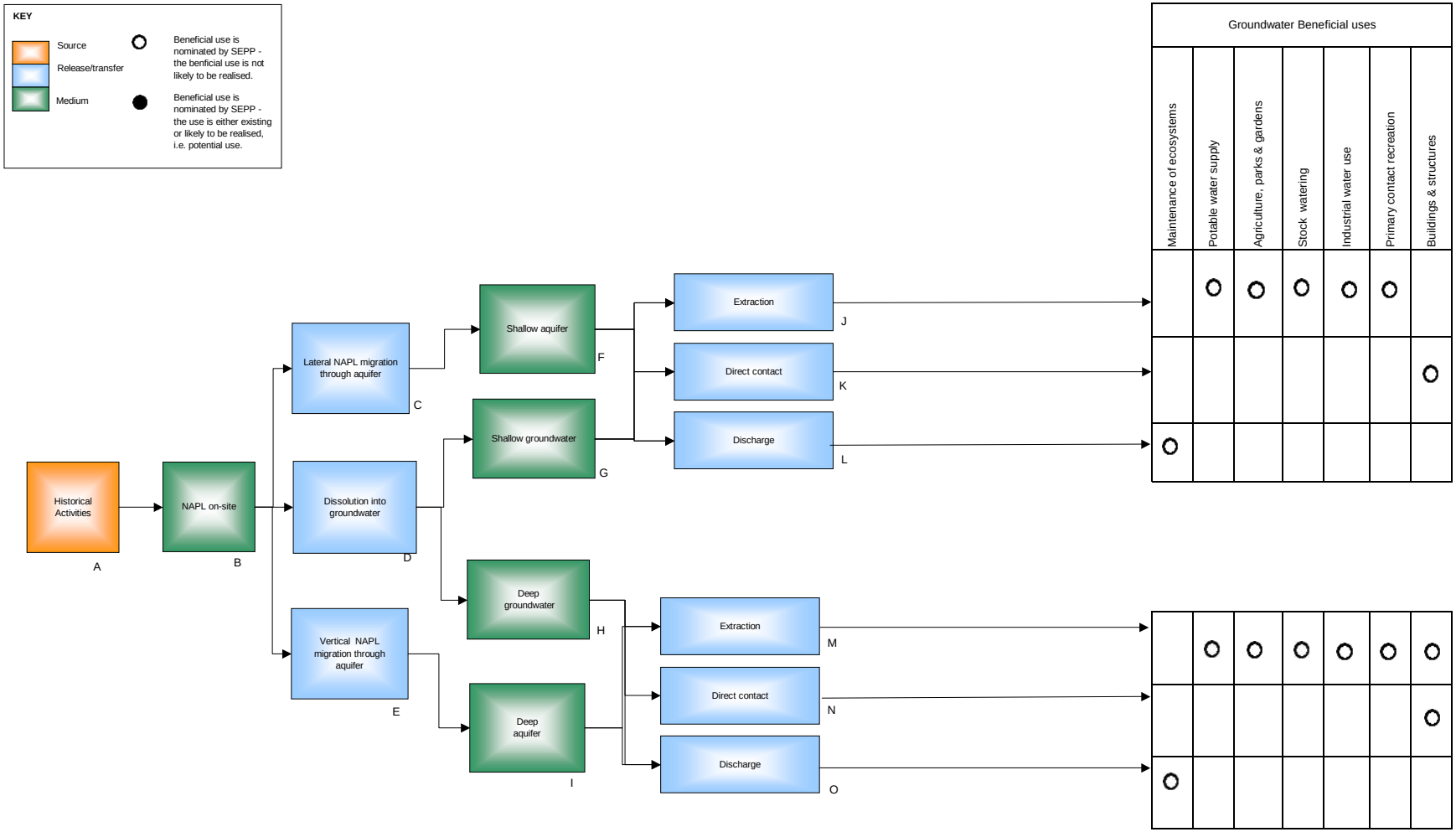
FLOWCHART 9 - Exposure Pathway Analysis – NAPL, Groundwater Segment, Offsite Receptors (near to the site)



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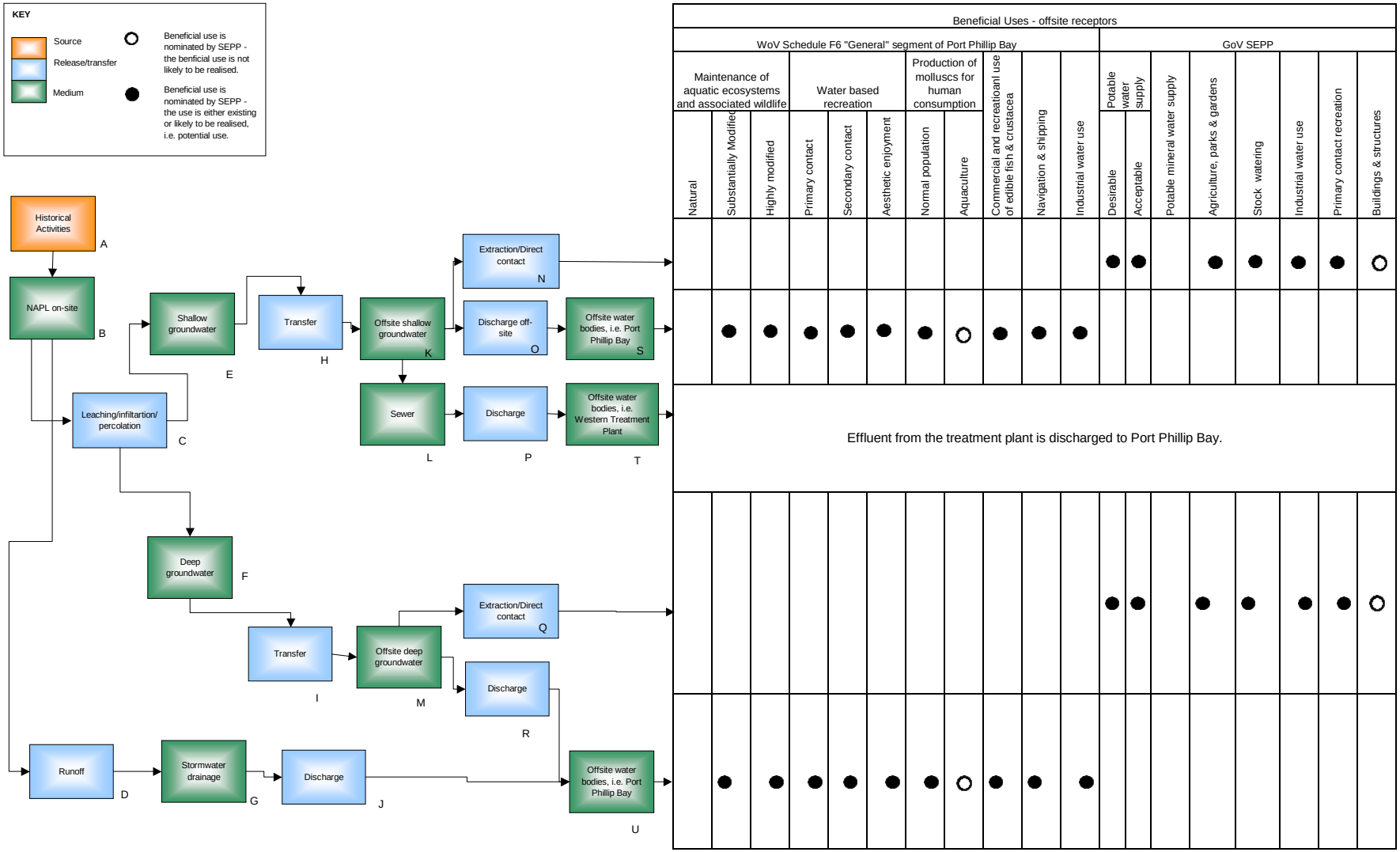
Flowchart 10: Exposure Pathway Analysis – NAPL, Groundwater and Surface Water Segment, Offsite Receptors (far from the site)



Appendix C

Screening Risk Rankings

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Exposure path no.	Exposure path description	Beneficial use	Limiting contaminant	Severity	Likelihood	Risk	Controls	Comment	UNCERTAINTY
Flowchart 1	**GASWORKS SITE, Land Segment: On-site beneficial uses**								
1ABCGLMN	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Volatile emission -> Soil gas -> Diffusion into buildings & structures	Human health: Park users - Adult	phenol, ethyl benzene, toluene, xylene	2	D	Medium	Controls as per ICMPs - Potential vapour exposure within the buildings to be minimised through the continual use of air conditioning systems and adequate ventilation. Time spent in poorly ventilated locations should be minimised pending further measurements and recommendations.	Vapour and Edible Vegetation Risk Assessment (July 2004) - The 2004 Golder indoor air vapour risk assessment involved sampling the air in buildings at four locations on the site. Golder tested for VOCs, SVOCs and CN. Four chemicals of interest (COIs) were identified. These were: phenol, ethylbenzene, toluene and xylenes. The risk assessment of the COIs detected in indoor air used the highest concentrations of each chemical measured at any of the indoor monitoring locations. Based on the data collected for the indoor air vapour risk assessment, Golder concluded that the gasworks waste on the site did not appear to be posing vapour risks to workers and residents on the site.	Uncertainty about the representativeness of the study (the vapour risk assessment used measurement data collected from soil gas bores (sampled on one occasion) and indoor air (also sampled on one occasion). Although the sampling design tried to collect data that would result in conservative estimates of risk (i.e. targeting areas closest to potential sources) without time-series data it cannot be determined whether the sampling programme actually captured vapour concentrations at the high end of the range for the site (Golder discusses this in their report). Nor can it be determined what future vapour risks may be for the site. Therefore, the vapour risk assessment can only be considered a point-in-time assessment only. Uncertainty regarding the robustness of the ventilation systems ie. could they shut off?
		Human health: Park users - Child	As above.	2	D	Medium	As above.	As above.	As above.
		Human health: Workers - Surface	phenol, ethyl benzene, toluene, xylene	2	D	Medium	Controls as per ICMPs - Potential vapour exposure within the buildings to be minimised through the continual use of air conditioning systems and adequate ventilation. Time spent in poorly ventilated locations should be minimised pending further measurements and recommendations.	Vapour and Edible Vegetation Risk Assessment (July 2004)- In addition to the above information, it is noted that the 2004 Golder sampling was undertaken on a Monday morning to be conservative as it was considered that any vapours inside the buildings may be at higher concentrations after the buildings were closed/less frequently used over the weekend. Two park based buildings were selected based on the site history to be as close as practical to the worst potential areas for vapours, i.e. one location was in the bookshop in the administration area of the site (west of the former coal gasification plant); and the other in the dressing room of the theatre (in the administration building area of the site, and east of the former underground purifiers).	Uncertainty of vapour ingress at other buildings on the site (there are actually 11 buildings on the site and the 2004 study only sampled within two buildings - albeit targeted as close to potential sources).
		Aesthetics	VOCs and SVOCs	2	D	Medium	Not explicitly addressed in the ICMPs, but odours can be expected to be managed by use of the ventilation systems.	Reports of objectionable odours within buildings have not been seen by the auditor, however the contaminants of concern at the site are known to be odorous. Odours have been observed during the soil and groundwater investigations and noted on logs.	As above.
1ABCGLMO	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Volatile emission -> Soil gas -> Diffusion into residential homes/Southport	Human health: Residents	phenol, ethyl benzene, toluene, xylene	2	D	Medium	Southport ICMP states that potential vapour exposure within the buildings should be minimised through the continual use of air conditioning systems and adequate ventilation. Time spent in poorly ventilated locations should be minimised pending further measurements and recommendations.	Vapour and Edible Vegetation Risk Assessment (July 2004) - Four non-carcinogenic COIs were detected within some of the four buildings sampled at the site (2004). Two of the sampling locations were within the Southport Site. A quantitative RA based on the highest concentrations was conducted and concluded that based on the data collected there did not appear to be a risk to workers or residents.	Uncertainty about the representativeness of the Golder Vapour and Edible Vegetation Risk Assessment (July 2004) study (i.e. vapour samples were collected on one occasion and may not be representative of the high-end of the vapour that may be emitted, or what may be emitted in the future. The 2004 study represents a point in time and is not substantial enough to understand current risk or future risks. At the time of preparing the ICMP, Golder was about to commence indoor vapour testing to provide further information for guidance on this issue. The ICMP was to be updated should the testing indicate additional actions are required. ICMPs were not updated. Uncertainty regarding the robustness of the ventilation systems ie. could they shut off?
		Aesthetics	VOCs and SVOCs	2	D	Medium	Not explicitly addressed in the ICMPs, but odours can be expected to be managed by use of the ventilation systems.	Reports of objectionable odours within buildings have not been seen by the auditor, however the contaminants of concern at the site are known to be odorous. Odours have been observed during the soil and groundwater investigations and noted on logs.	As above.
1ABCGLMP	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Volatile emission -> Soil gas -> Diffusion into excavations	Human health: Workers - Subsurface	VOCs and SVOCs	3	D	Medium	ICMP - All intrusive maintenance works (>30cm bgl) must prepare a task specific contamination management plan in consultation with a CoPP Health and Safety Coordinator. Considerations to be included: dust management, what to do is coloured or odorous soils are encountered, hygiene practices such as washing hands after working at the site.	Risks from vapours to subsurface works was not included in the Golder 2004 study.	The Golder 2004 soil gas study did not explicitly address risks to subsurface worke4rs, however soil gas bores detected a number of VOCs and SVOCs, and it can be assumed that these would be present in deeper excavations that might be undertaken.
1ABCGLMQ	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Volatile emission -> Soil gas -> Diffusion into ambient air	Human health: Park users - Adult	VOCs and SVOCs	1	C	Low	ICMPs - do not address this exposure pathway, likely because the risks were considered to be low.	Vapour and Edible Vegetation Risk Assessment (July 2004) - The outdoor air vapour risk assessment involved sampling four soil gas bores installed at various locations around the Park. Twenty COIs were identified. Not all COIs were detected at all of the soil gas bore locations, and soil gas concentrations varied significantly between locations. A quantitative risk assessment of the highest measured concentrations of the COIs did not find unacceptable risks to child and adult recreational users of the Park or outdoor maintenance workers on the Park. Therefore, based on the data collected for the outdoor air vapour risk assessment, Golder concluded that gasworks waste on the site did not appear to be posing vapour risks to recreational users of, or workers on, the Park. The assessment of risks to both child and adult recreational park users found that risks from all noncarcinogenic COIs to be less than a value of 0.2, and carcinogenic risks from benzene to child and adult recreational park users were found to be less than 1 x 10-5 and therefore also acceptable.	Uncertainty about representativeness of study (ie. study was limited in scope and conclusions based on a single sampling event at 4 soil gas bore locations).
		Human health: Park users - Child	VOCs and SVOCs	1	C	Low	As above.	As above.	As above.
		Human health: Workers - Surface	VOCs and SVOCs	1	C	Low	Park ICMP includes measures to minimise risk w.r.t. standard maintenance activates related to direct contact with soils/waste.	As above. for park users.	
		Human health: Residents	VOCs and SVOCs	1	C	Low	ICMPs - do not address this exposure pathway, likely because the risks were considered to be low.	As above for park users.	
		Aesthetics	VOCs and SVOCs	1	C	Low	ICMPs - do not address this exposure pathway, likely because the risks were considered to be low.	Reports of objectionable odours have not been seen by the auditor, although hydrocarbon odours and staining was noted in soil bore locations BH6, BH7, BH8, BH10 and BH11 and groundwater monitoring wells GW2 to GW4.	

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Exposure path no.	Exposure path description	Beneficial use	Limiting contaminant	Severity	Likelihood	Risk	Controls	Comment	UNCERTAINTY
1ABCGLMR	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Volatile emission -> Soil gas -> Diffusion into plant root zones	Ecosystems: Natural/Modified/Highly Modified		1	D	Low	No controls, although plants grow throughout the site, in many areas the plants are established on some form of capping rather than directly on waste/contaminated soil.	Some gases may kill or harm plants but are generally not bioaccumulative . The other bioaccumulative chemicals tend to solid liquid such as PAHs, PCBs, pesticides.	
		Food production		1	D	Low	Edible vegetables are not being proactively grown at the site, ie. bush tucker trail and fruit trees. Golder identified that some part of plants that grow at the site could be eaten (see Report 5) but that it is unlikely this would occur.	Some gases may kill or harm plants but are generally not bioaccumulative. The other bioaccumulative chemicals tend to solid liquid such as PAHs, PCBs, pesticides.	
1ABDMN	Historical activities -> Contaminated soil -> Volatile emission -> Soil gas -> Diffusion into buildings & structures	Human health: Park users - Adult	phenol, ethyl benzene, toluene, xylene	2	D	Medium	Controls as per ICMPs - Potential vapour exposure within the buildings to be minimised through the continual use of air conditioning systems and adequate ventilation. Time spent in poorly ventilated locations should be minimised pending further measurements and recommendations.	The 2004 Golder indoor air vapour risk assessment involved sampling the air in buildings at four locations on the site. Golder tested for VOCs, SVOCs and CN. Four chemicals of interest (COIs) were identified. These were: phenol, ethylbenzene, toluene and xylenes. The risk assessment of the COIs detected in indoor air used the highest concentrations of each chemical measured at any of the indoor monitoring locations. Based on the data collected for the indoor air vapour risk assessment, Golder concluded that the gasworks waste on the site did not appear to be posing vapour risks to workers and residents on the site.	The vapour risk assessment used measurement data collected from soil gas bores (sampled on one occasion) and indoor air (also sampled on one occasion). Although the sampling design tried to collect data that would result in conservative estimates of risk (i.e. targeting areas closest to potential sources) without time-series data it cannot be determined whether the sampling programme actually captured vapour concentrations at the high end of the range for the site (Golder discusses this in their report). Nor can it be determined what future vapour risks may be for the site. Therefore, the vapour risk assessment can only be considered a point-in-time assessment only.
		Human health: Park users - Child	As above.	2	D	Medium	As above for adult users.	As above.	As above.
		Human health: Workers - Surface	phenol, ethyl benzene, toluene, xylene	2	D	Medium	Workers/resident artists at the site.	Vapour and Edible Vegetation Risk Assessment (July 2004) - In addition to the above information, it is noted that the 2004 Golder sampling was undertaken on a Monday morning to be conservative as it was considered that any vapours inside the buildings may be at higher concentrations after the buildings were closed/less frequently used over the weekend. Two park based buildings were selected based on the site history to be as close as practical to the worst potential areas for vapours, i.e. one location was in the bookshop in the administration area of the site (west of the former coal gasification plant); and the other in the dressing room of the theatre (in the administration building area of the site, and east of the former underground purifiers).	There are actually 11 buildings on the site and the 2004 study sampled within two buildings - albeit targeted as close to potential sources.
1ABDMO	Historical activities -> Contaminated soil -> Volatile emission -> Soil gas -> Diffusion into residential homes/Southport	Human health: Residents	phenol, ethyl benzene, toluene, xylene	2	D	Medium	Southport ICMP - Potential vapour exposure within the buildings to be minimised through the continual use of air conditioning systems and adequate ventilation. Time spent in poorly ventilated locations should be minimised pending further measurements and recommendations.	Vapour and Edible Vegetation Risk Assessment (July 2004) - Four non-carcinogenic COIs were detected within some of the four buildings sampled at the site (2004). Two locations were within the Southport site. A quantitative RA based on the highest concentrations was conducted and concluded that based on the data collected there did not appear to be a risk to workers or residents.	Vapour samples were collected on one occasion and may not be representative of the high-end of the vapour that may be emitted, or what may be emitted in the future. Report 5 represents a point in time and is not substantial enough to understand current risk or future risks. At the time of preparing the ICMP indoor vapour testing was about to be commenced to provide further information for guidance on this issue. The ICMP was to be updated should the testing indicate additional actions are required.
		Aesthetics	VOCs and SVOCs	2	D	Medium		Reports of objectionable odours have not been seen by the auditor, though it is possible that the contamination could give rise to odours within buildings.	
1ABDMP	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Volatile emission -> Soil gas -> Diffusion into excavations	Human health: Workers - Subsurface	VOCs and SVOCs	3	D	Medium	Park ICMP - task specific management for any works > 30cm bgl.	Risks from vapours to subsurface works was not included in the Golder 2004 study.	Uncertain whether the results from the soil gas sampling by Golder in 2004 can be applied to assess risk to subsurface workers.
1ABDMQ	Historical activities -> Contaminated soil -> Volatile emission -> Soil gas -> Diffusion into ambient air	Human health: Park users - Adult	VOCs and SVOCs	1	C	Low	No controls on this exposure pathway.	Vapour and Edible Vegetation Risk Assessment (July 2004) - The outdoor air vapour risk assessment involved sampling four soil gas bores installed at various locations around the Park. Twenty COIs were identified, and not all COIs were detected at all of the soil gas bore locations. Soil gas concentrations varied significantly between locations. A quantitative risk assessment of the highest measured concentrations of the COIs did not find unacceptable risks to child and adult recreational users of the Park or outdoor maintenance workers on the Park. Therefore, based on the data collected for the outdoor air vapour risk assessment, Golder concluded that gasworks waste on the site did not appear to be posing vapour risks to recreational users of, or workers on, the Park. The assessment of risks to both child and adult recreational park users found that risks from all noncarcinogenic COIs to be less than a value of 0.2 and carcinogenic risks from benzene to child and adult recreational park users to be less than 1 x 10-5, and therefore acceptable.	Again, the 2004 vapour study was limited in scope and conclusions based on a single sampling event at four soil gas bore locations.
		Human health: Park users - Child	VOCs and SVOCs	1	C	Low	As above.	As above.	
		Human health: Workers - Surface	VOCs and SVOCs	1	C	Low	As above.	As above for park users.	
		Human health: Residents	VOCs and SVOCs	1	C	Low	As above.	As above for park users.	
		Aesthetics	VOCs and SVOCs	1	C	Low	As above.	Objectionable odours in the parkland do not appear to be a significant issue, however hydrocarbon odours and staining have been noted in several soil and groundwater borehole locations.	
1ABDMR	Historical activities -> Contaminated soil -> Volatile emission -> Soil gas -> Diffusion into plant root zones	Ecosystems: Natural/Modified/Highly Modified		1	D	Low	No controls - plants grow through the site, in many areas established on capping rather than directly on waste/contaminated soil.	Some gases may kill or harm plants but are generally not bioaccumulative . The other bioaccumulative chemicals tend to solid liquid such as PAHs, PCBs, pesticides.	

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Exposure path no.	Exposure path description	Beneficial use	Limiting contaminant	Severity	Likelihood	Risk	Controls	Comment	UNCERTAINTY
		Food production		1	D	Low	Edible vegetables are not being proactively grown at the site, ie. bush tucker trail and fruit trees. Golder identified that some part of plants that grow at the site could be eaten but that it is unlikely this would occur.	Some gases may kill or harm plants but are generally not bioaccumulative . The other bioaccumulative chemicals tend to solid liquid such as PAHs, PCBs, pesticides.	
1ABE	Historical activities -> Contaminated soil -> Direct contact	Buildings and structures	pH, sulphates	3	A	Low	No explicit controls, however new buildings would need to be approved by CoPP, and CoPP is likely to consider the requirements for building design (eg low pH and sulphate impact on buildings and structures).	Review of Contamination Status, Southport Nursing Home (July 2006) have indicated a potential for site soils to impact upon buildings and structures built on the site, ie. soil data collected during the various assessments reported pH range between 2.7-8.5 pH units, in both the fill and natural soils. Golder recommended remediation or management of the issue, and that the site can be considered suitable for the proposed uses (being medium/high density residential and/or open space uses). The Australian Standard for Piling Design and Installation (AS 2159-1995) indicates that for concrete piles the site soil pH would be considered very severe to non-aggressive. Golder advised that soil condition on the site can be variable and caution should be taken when designing new buildings and structures. Sulphate was of less significance, and Golder found that two samples out of 38 analysed were above the adopted criterion and therefore the risk of impacts to buildings and structures represented by the sulphate in soils was considered to be low. It is noted that Golder used the NEPM EIL for sulphate of 2000 mg/kg to assess impact to this beneficial use; this is conservativ	The available information relates mostly to the Southport Site and, while it is probably indicative of the situation elsewhere, there is some uncertainty in this.
1ABEH	Historical activities -> Contaminated soil -> Direct contact -> Dermal contact	Human health: Park users - Adult	PAHs, TPHs, Benzene, cyanide	2	B	Low	ICMP requires that the separation layer be maintained over the non-building areas of the site.	Soils on Gasworks Park and Southport are contaminated with gasworks waste. A number of contaminant concentrations were found to exceed the criteria adopted for the protection of human health and the environment the current site usage. Elevated concentrations were found for lead and some organic compounds such as total recoverable hydrocarbons and polycyclic aromatic hydrocarbons, including benzo(a)pyrene, consistent with material originating from gasworks sites. Golder Associates collected surface samples from across the Park in 2004. Results were compared to NEPM E HIL criteria to assess the severity. The low severity ranking is based on the measurement of PAHs at the surface at up to 120 ppm (see Further Recommendations for Action Letter, February 2004), which is only slightly greater than the NEPM D threshold value (80 mg/kg) for commercial land use.	There is uncertainty regarding the extent of the capping at the site and the concentrations of contaminants that might occur at the surface of the site.
		Human health: Park users - Child	PAHs, TPHs, Benzene, cyanide	2	B	Low	As above.	As above.	As above.
		Human health: Workers - Surface	PAHs, TPHs, Benzene, cyanide	2	B	Low	ICMP - Golder recommended that workers or people who spend more than two days a week at the site be briefed by the Health and Safety Coordinator regarding site issues, the need to minimise exposure to soil at the site and the need to adopt standard hygiene practices following contact with the surrounding soils.	This exposure pathway considers commercial building workers and resident artists etc within this category. Elevated concentrations were found for lead and some organic compounds consistent with material originating from gasworks sites, such as total recoverable hydrocarbons and polycyclic aromatic hydrocarbons, including benzo(a)pyrene. Golder Associates collected surface samples from across the Park in 2004. Results were compared to NEPM E HIL criteria to assess the severity. The low severity ranking is based on concentrations of PAHs at the surface at up to 120 ppm (refer to comment above for significance).	
		Human health: Workers - Subsurface	PAHs, TPHs, Benzene, cyanide	4	B	Medium	ICMP - All intrusive maintenance works (>30cm bgl) must prepare a task specific contamination management plan in consultation with a CoPP Health and Safety Coordinator. Considerations to be included: dust management, what to do is coloured or odorous soils are encountered, hygiene practices such as washing hands after working at the site.	Elevated concentrations were found for lead and some organic compounds consistent with material originating from gasworks sites, such as total recoverable hydrocarbons and polycyclic aromatic hydrocarbons, including benzo(a)pyrene. Severity is based on the measured results for soils from surface to maximum investigation depth. Results were compared to NEPM F HIL criteria to assess the severity. Severity is based on the maximum measured benzene concentration, at a depth of 2.3 - 2.4 m. However, there are reports of tar and tarry odour (eg Report 7), and this suggests that the investigations to date have not identified the highest concentrations.	There is uncertainty regarding the extent of the capping at the site and the concentrations of contaminants that might occur at shallow depths on the site.
		Human health: Residents	PAHs	3	B	Low	Southport ICMP has specified control w.r.t. access to fill/natural soils underlying the separation layers, and that capping be maintained over non-building areas of the site.	Soils on Gasworks Park and Southport are contaminated to various degrees with gasworks waste. A number of contaminant concentrations were found to exceed the criteria generally adopted for the protection of human health and the environment for a site used for the current purposes. The elevated concentrations were generally found for lead and some organic compounds consistent with material originating from gasworks sites, such as total recoverable hydrocarbons and polycyclic aromatic hydrocarbons, including benzo(a)pyrene. Severity is based on the measured concentrations of PAHs and B(a)P in surface soils.	There is uncertainty regarding the extent of the capping at the site and the concentrations of contaminants that might occur at the surface of the site.
1ABEI	Historical activities -> Contaminated soil -> Direct contact -> Ingestion	Human health: Park users - Adult	PAHs, TPHs, Benzene, cyanide	4	B	Medium	ICMP requires that the separation layer be maintained over the non-building areas of the site.	Soils on Gasworks Park and Southport are contaminated to various degrees with gasworks waste. A number of contaminant concentrations were found to exceed the criteria generally adopted for the protection of human health and the environment for a site used for the current purposes. The elevated concentrations were generally found for lead and some organic compounds consistent with material originating from gasworks sites, such as total recoverable hydrocarbons and polycyclic aromatic hydrocarbons, including benzo(a)pyrene. Analytical data provided by Golder commences at a depth of 0.5 m below surface. Results were compared to NEPM F HIL criteria to assess the severity. Severity is based on the measured benzene concentration at a depth of 2.3 -2.4 m.	There is uncertainty regarding the extent of the capping at the site and the concentrations of contaminants that might occur at the surface of the site.
		Human health: Park users - Child	PAHs, TPHs, Benzene, cyanide	4	B	Medium	As above.	As above.	As above.
		Human health: Workers - Surface	PAHs, TPHs, Benzene, cyanide	4	B	Medium	ICMP - Golder recommended that workers or people who spend more than two days a week at the site be briefed by the Health and Safety Coordinator regarding site issues, the need to minimise exposure to soil at the site and the need to adopt standard hygiene practices following contact with the surrounding soils.	This exposure pathway considers commercial building workers and resident artists etc within this category. Analytical data provided by Golder commences at a depth of 0.5 m below surface. Results were compared to NEPM F HIL criteria to assess the severity. Severity is based on a benzene concentration at a depth of 2.3 -2.4 m.	As above.

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Exposure path no.	Exposure path description	Beneficial use	Limiting contaminant	Severity	Likelihood	Risk	Controls	Comment	UNCERTAINTY
		Human health: Workers - Subsurface	PAHs, TPHs, Benzene, cyanide	4	B	Medium	ICMP - All intrusive maintenance works (>30cm bgl) must prepare a task specific contamination management plan in consultation with a CoPP Health and Safety Coordinator. Considerations to be included: dust management, what to do is coloured or odorous soils are encountered, hygiene practices such as washing hands after working at the site.	Severity is based on soils from surface to maximum investigations depth. Results were compared to NEPM F HIL criteria to assess the severity. Severity is based on the measured benzene concentration at a depth of 2.3 - 2.4 m. However, there are reports of tar and tarry odour (eg Report 7), and this suggests that the investigations to date have not identified the highest concentrations.	There is uncertainty regarding the extent of the capping at the site and the concentrations of contaminants that might occur at shallow depths on the site.
		Human health: Residents	PAHs	1	B	Negligible	Southport ICMP puts controls over access to fill/natural soils underlying the separation layers.	Soils on Gasworks Park and Southport are contaminated to various degrees with gasworks waste. A number of contaminant concentrations were found to exceed the criteria generally adopted for the protection of human health and the environment for a site used for the current purposes. The elevated concentrations were generally found for lead and some organic compounds consistent with material originating from gasworks sites, such as total recoverable hydrocarbons and polycyclic aromatic hydrocarbons, including benzo(a)pyrene. Severity is based on the measured concentrations of BaP in soils less than 0.4m below surface level. One of four samples between surface and 0.4 m recorded a B(a)P concentration exceeding NEPM D HIL criteria. However, it should be noted that the highest severity recorded on the site is 4, based on the B(a)P concentration at a depth of 0.5 - 0.6 m. However, there is uncertainty as to whether the highest concentrations have been identified.	There is uncertainty regarding the extent of the capping at the site and the concentrations of contaminants that might occur at the surface of the site.
1ABEJ	Historical activities -> Contaminated soil -> Direct contact -> Surface contamination/ waste	Aesthetics	Surface waste	2	D	Medium	Aesthetic issues partially addressed by site management actions. The site ICMPs specify that most areas of the site outside of the buildings are covered by a separation layer that consists of paved areas including gravel paths, grassed areas with a dense healthy cover and landscaped gardens with woodchip cover.	Report 7 – At the site fill material varies from 0.5 m and 3.2 m in thickness. Near the surface, fill material has been reported as generally comprised of black sands with fragments of coke, bricks and glass. In addition, the fill has also been reported to include tar and large sections of steel and other metallic waste. A strong tarry odour has been associated with the fill material at the locations reporting tar. Hydrocarbon odours and staining have been identified within the fill and natural material on the site.	A basis for the controls in the ICMPs was generally that activities undertaken at the site by site occupiers and the general public are not considered to pose a significant human health risk in the short term due to the infrequent exposure to the soil. However, there is some uncertainty regarding the extent of the capping at the site.
1ABFK	Historical activities -> Contaminated soil -> Root zones -> Plants/Produce	Ecosystems: Natural/modified/highly modified	PAHs, metals	2	B	Low	No controls - plants grow through the site, in many areas established on capping rather than directly on waste/contaminated soil.	The major contaminants in soil have been found to be PAHs, including benzo(a)pyrene) and TPHs (>C9). The PAHs are considered to have potential to be in two forms in soils on the site – a liquid form (e.g., tars, liquors in and near tanks and pits) and in solid form (e.g., ash, coke, coal in and near hoppers and bunkers). The potential for the VOCs and SVOCs to impact on the terrestrial ecosystems (eg plants has not been well characterised in the assessment reports. Metals have been found above NEPM EILs, and other contaminants such as low pH and sulphate may impact the beneficial use of maintenance of ecosystems. In practice, park management practices have been able to select plants that will grow in the soils at the site, and contaminant concentrations in surface soils do not appear to be a limiting consideration.	The effect of the contamination on plants has not been well characterised.
		Human health: Park users - Adult	PAHs, metals	1	B	Negligible	The bush tucker trail is understood to have been removed from the site. Not sure about the fruit trees.	To derive an overall risk ranking for contaminant uptake and potential consumption, Golder identified site plants, and assessed the expected root depth, the edible portion of the plant, the likelihood of consumption, and the expected form of the PAHs contamination. The risks associated with consumption of other edible vegetation on Gasworks Park were expected ranked as negligible to nil - as uptake was expected to be low and consumption of vegetation expected to be infrequent.	The contamination in soil and fill has not been well characterised, and the potential for uptake by plants is not well characterised; prediction of uptake is highly uncertain. Analysis of plant material would provide a more direct measure of plant uptake.
		Human health: Park users - Child	PAHs, metals	1	B	Negligible	The bush tucker trail is understood to have been removed from the site. Not sure about the fruit trees.	As above for adult park users.	
		Human health: Workers - Surface	PAHs, metals	1	B	Negligible	The bush tucker trail is understood to have been removed from the site. Not sure about the fruit trees.	As above for park users, but considering that frequency at the park is expected to be less than park users.	
		Human health: Workers - Subsurface	PAHs, metals	1	B	Negligible	Edible vegetables are not being proactively grown at the site, ie. bush tucker trail and fruit trees. Golder identified that some part of plants that grow at the site could be eaten (see Report 5) but that it is unlikely this would occur.	As above for park users, but considering that frequency at the park is expected to be less than park users.	
		Human health: Residents	PAHs, metals	1	B	Negligible	The bush tucker trail is understood to have been removed from the site. Not sure about the fruit trees.	As above for adult park users.	
		Food production	PAHs, metals	2	B	Low		The major contaminants in soil have been found to be PAHs, including benzo(a)pyrene) and TPHs (>C9). The PAHs have potential to be in two forms in soils on the site – a liquid form (e.g., tars, liquors in and near tanks and pits) and in solid form (e.g., ash, coke, coal in and near hoppers and bunkers). PAHs in solid form are expected to have a lower potential for uptake by plant roots. PAHs in liquid form are expected to have a higher potential for uptake by plant roots, and effect on plant growth. Metals have been found above NEPM EILs, and also could give rise to plant uptake and effects on plant growth. Because of the controls on the use of plants for food, the relevance of this beneficial use is reduced.	The significance of the contamination with respect to plant uptake and effects on plants and plant growth is uncertain and not well characterised.

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Exposure path no.	Exposure path description	Beneficial use	Limiting contaminant	Severity	Likelihood	Risk	Controls	Comment	UNCERTAINTY
Flowchart 2	**GASWORKS SITE, Groundwater Segment: On-site beneficial uses**								
2ABCEG	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Extraction	Potable water - Desirable/acceptable	TDS, arsenic, manganese, ammonia and cyanide nickel exceed the drinking water criteria.	4	A	Low	Extractive uses of groundwater are not addressed in the ICMPs, but unlikely to occur given CoPP management/control over activities at the site.	Groundwater contaminant concentrations on site exceed the potable water guideline concentrations for As, Ni, Mn, NH3 (health and aesthetics), SO4 (health and aesthetics) . NH3 especially is orders of magnitude above the potable use aesthetic guideline concentrations. In addition, the salinity has been elevated in the aquifer above Segment A background levels in 5 bores within the site boundaries. Potable use on site is unlikely to be realised because of the CoPP controls, the reticulated water supply to the area and expected on-going use of the park as public space.	
		Agriculture, parks & gardens	TDS, boron, arsenic, manganese	4	B	Medium	CoPP controls on use. Use of groundwater for irrigation onsite is unlikely.	Concentrations of arsenic and boron exceed the adopted irrigation criterion in GW2 and GW4. The source of arsenic may be associated with the naturally occurring arsenic in the Brighton Group soils mobilised by low pH conditions on the site. It is possible that the boron concentration is associated with background concentrations. The salinity of the groundwater on parts of the site has been elevated by contamination and this will have altered the potential for use of the groundwater for irrigation. Even in parts of the site in which the groundwater has salinity less than 1500mg/L, contaminants (eg boron and CN) are present that could affect the use of the groundwater for irrigation. A medium level risk has been assigned based on the low likelihood of extractive use of groundwater at the site (that is, irrigation is unlikely ('B'), but not improbable ('A')	
		Stock animals		4	A	Low	CoPP controls on use. Use of groundwater for stock watering onsite is improbable.	Molybdenum in monitoring well GW4 (0.012 mg/L) and As in MW3 marginally exceeds the adopted stock watering guideline (0.01 mg/L for Mo).	
		Industrial use	SO4, pH	2	A	Low	CoPP controls on use. Use of groundwater for industrial purposes onsite is improbable.	Groundwater unlikely to be suitable for industrial uses without some treatment prior to use.	
		Primary contact recreation	NH3, As, B, Mn,	4	A	Low	CoPP controls on use. As above for potable water use.	Groundwater contaminant concentrations on parts of the site exceed the guideline concentrations for primary contact recreation for NH3 by several orders of magnitude as well as being slightly above guideline concentrations for As, CN, boron and manganese.	
2ABCEH	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Direct contact	Buildings & structures	low pH, sulphates	2	B	Low	Groundwater is currently below the likely depth of most structures at the site.	Review of Contamination Status, Southport Nursing Home report (July 2006) - Sulphate concentrations in groundwater at the site were recorded between 220 mg/L and 2,400 mg/L; pH between 6.2 and 8.1 pH units. The soil assessment indicated that pH conditions (and to a lesser extent sulphate conditions) may impact upon the beneficial use of the land for buildings and structures. The groundwater concentrations indicated impact from sulphate but less of an impact from the low pH soils. The Australian Standard for Piling Design and Installation (AS2159-1995) considers buried concrete, and groundwater at the site can be classified as being between mild and non-aggressive; current information indicating that the groundwater condition at the site is not likely to present an unacceptable risk to the beneficial use of buildings and structures.	There is uncertainty as to whether the sewers might be repaired in the future, and in which case the groundwater might rise and affect high rise apartments with potentially deep foundations and basements.
2ABCEI	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Discharge	Maintenance of ecosystems	NH3, As	5	No surface water body onsite	Negligible	No surface water body onsite.	On the site, the concentration of NH3 and CN exceed the ecosystem criteria by several orders of magnitude. As and Mn are also elevated above what could be background concentrations. There is no surface water body on site to which groundwater would discharge.	
2ABDFJ	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Deep groundwater -> Extraction	Potable water	TDS, arsenic, manganese, NH3 and cyanide nickel exceed the drinking water criteria.	4	A	Low	Extractive uses of groundwater are not addressed in the ICMPs, but unlikely to occur given CoPP management/control over activities at the site.	It is not expected that dissolved phase groundwater contamination at the site will migrate vertically downward to deeper aquifers (unless via DNAPL - covered later in Flowchart 7).	There are no data on the groundwater conditions beneath the Brighton Group aquifer
		Agriculture, parks & gardens	TDS, boron, arsenic, manganese	4	B	Medium	As above.	As above. A medium level risk has been assigned on the basis of the possibility of extractive use of groundwater at the site (that is, irrigation is unlikely ("B'), but not improbable ('A'))	
		Stock animals		4	A	Low	As above.	As above. A low level risk has been assigned on the basis of the possibility of the extractive use of groundwater at the site (that is, this use is improbable ('A'))	
		Industrial use	SO4, pH	2	A	Low	As above.	As above. Use is improbable.	
		Primary contact recreation	NH3, As, B, Mn,	4	A	Low	As above.	As above. Use is improbable.	
2ABDFK	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Deep groundwater -> Direct contact	Buildings & structures	Sulphates	2	B	Low	Groundwater is currently below the likely depth of most structures at the site.	As above.	
2ABDFL	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Deep groundwater -> Discharge	Maintenance of ecosystems	NH3, As	5	No surface water body onsite	Negligible	No surface water body onsite.	As above.	

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Exposure path no.	Exposure path description	Beneficial use	Limiting contaminant	Severity	Likelihood	Risk	Controls	Comment	UNCERTAINTY
Flowchart 3	**GASWORKS SITE, Groundwater Segment: Offsite beneficial uses (near the site)**								
3ABCEGKP	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater -> Extraction	Potable water supply: Desirable/Acceptable	TDS, NH3	4	B	Medium	Deep sewers intercept groundwater and restrict flow under most residential areas surrounding the site, although not in all areas. The likely low yield of the Brighton Group aquifer could be a restriction on the abstraction of groundwater for extractive uses. Groundwater abstraction for potable water use is unlikely to be realised due to availability of reticulated water.	Groundwater contaminant concentrations offsite exceed the potable water guideline concentrations for NH3 (aesthetics), As, Ni, Mn, SO4 (health and aesthetics) . NH3 especially is orders of magnitude above the potable use aesthetic guideline concentrations, particularly in the wells immediately adjacent to the eastern and northeastern boundary of the site. A plume extending beneath the residential area beyond Richardson Street contains groundwater with elevated salinity above Segment A background levels (to Segment C), accompanied by increases in SO4, BTEX, CN and NH3. There are no known groundwater extraction wells in the vicinity of the site, and the area would not appear to be within any declared Groundwater Quality Restricted Use Zone. It would be possible for use to be controlled by the bore licensing Authority (Southern Rural Water) if advised by EPA.	The extent of elevated concentrations in offsite areas is an area of uncertainty. Further, it is uncertain whether groundwater is being used by residents in the vicinity of the site.
		Agriculture, parks & gardens	TDS	4	C	Medium	As above, noting that groundwater use for irrigation is considered possible.	The elevated salinity in the area bounded by Richardson, Greig and Bridport Streets of up to 3600mg/L in GW27 is above desirable concentrations for watering of gardens, and is the limiting contaminant. Boron and manganese are elevated and can exceed guideline levels for irrigation use. There is potential for the groundwater in the residential area adjacent to the site to be used for irrigation.	As above.
		Stock watering	NH3, CN,	4	A	Low	Groundwater use for stock watering is considered improbable	Contaminant concentrations in immediate offsite wells appear to be within or only slightly above the guideline concentrations for stock watering, except for ammonia. Stock watering is unlikely to be a realised beneficial use in the urban area, and the contamination is therefore considered to represent a low risk with respect to this beneficial use.	As above.
		Industrial water use	TDS, NH3	2	B	Negligible	Groundwater use for industrial water use is considered unlikely.	The elevated NH3 and TDS could limit the use of the groundwater for industrial use. It is not expected that shallow groundwater on the site is likely to be used for industrial purposes because of the ready availability of reliable mains supply.	As above.
		Primary contact recreation (e.g. bathing, swimming)	NH3	4	C	Medium	Groundwater use for filling swimming pools is considered possible.	Groundwater contaminant concentrations exceed the guideline concentrations for primary contact recreation for NH3 by several orders of magnitude in the NE corner around Richardson St as well as elevated As, CN, boron and manganese. It is possible that groundwater could be used by residents for make up for swimming pools.	As above.
3ABCEGKQ	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater -> Direct contact	Buildings & structures	SO4, pH	1	B	Negligible	Groundwater is currently below the likely depth of most structures at the site.	The elevated salinity and the SO4 is not considered to be high enough to be of concern for deep foundations and basements and the range of pH suggests that the waters are non aggressive .	There is uncertainty as to whether the sewers might be repaired in the future, and in which case the groundwater might rise and affect high rise apartments with potentially deep foundations and basements.
3ABCEGKR	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater	Maintenance of ecosystems	NH3	4	A	Low	There are no nearby surface waters into which the groundwater will discharge. The Bay is approximately 1 km distant from the site.	It is highly unlikely that contamination would discharge at concentrations greater than ecosystem protection criteria at such a distance from the site.	
3ABDFHLP	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Deep groundwater -> Transfer -> Offsite deep groundwater -> Extraction	Potable water supply: Desirable/ Acceptable	TDS, NH3	4	B	Medium	Deep sewers intercept groundwater and restrict flow under most residential areas surrounding the site, although not in all areas. The likely low yield of the Brighton Group aquifer could be a restriction on the abstraction of groundwater for extractive uses. Groundwater abstraction for potable water use is unlikely to be realised due to availability of reticulated water.	It is not expected that dissolved phase groundwater contamination at the site will migrate vertically downward to deeper aquifers, unless via DNAPL migration (covered in later Flowchart 8). Migration downwards would include similar contaminants to those identified in the shallow aquifer, and in the absence of deeper groundwater data the same severity as shallow groundwater has been assumed.	There are no direct data about the deeper aquifer water quality in the vicinity the site. Uncertain use of deep groundwater by residents in the area.
		Agriculture, parks & gardens	TDS	4	C	Medium	As above, noting that groundwater use for irrigation is considered possible.	As above.	As above.
		Stock watering	NH3, CN,	4	A	Negligible	Groundwater use for stock watering is considered improbable	As above.	As above.
		Industrial water use	TDS, NH3	2	B	Negligible	Groundwater use for industrial water use is considered unlikely.	As above.	As above.
		Primary contact recreation (e.g. bathing, swimming)	NH3	4	C	Medium	Groundwater use for filling swimming pools is considered possible.	As above.	As above.
3ABDFHLQ	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Deep groundwater -> Transfer -> Offsite deep groundwater	Buildings & structures	SO4, pH	1	B	Negligible	Groundwater is currently below the likely depth of most structures at the site.	Deep groundwater will not come into contact with buildings and structures, other than the deep sewers. It is not expected that groundwater contamination will migrate and affect the deeper aquifers. The low pH if it were to migrate to depth could affect concrete structures.	There is uncertainty as to whether the sewers might be repaired in the future, and in which case the groundwater might rise and affect high rise apartments with potentially deep foundations and basements. There is uncertainty about the long term effect of the contamination on the structure of the sewers.
3ABDFHLR	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Deep groundwater -> Transfer -> Offsite deep groundwater -> Discharge -> Offsite water bodies	Maintenance of ecosystems	NH3	4	A	Low	There are no nearby surface waters into which the groundwater will discharge. The Bay is approximately 1 km distant from the site.	There are no nearby surface waters into which the groundwater will discharge. The Bay is approximately 1 km distant from the site and it is highly unlikely that contamination would discharge at concentrations greater than ecosystem protection criteria at such a distance from the site.	

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Exposure path no.	Exposure path description	Beneficial use	Limiting contaminant	Severity	Likelihood	Risk	Controls	Comment	UNCERTAINTY
Flowchart 4	**GASWORKS SITE, Groundwater and Surface Water Segment: Off-site beneficial uses (far from the site)**								
4ABCEHKN	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater -> Extraction/direct contact	Potable water supply: Desirable/ Acceptable	NH3, TDS	3	A	Low	No controls on groundwater use regionally.	Contamination will attenuate with distance and it is highly unlikely that contaminants could migrate at concentrations of concern far from the site.	The actual use of groundwater regionally is uncertain. The offsite extent of groundwater contamination is not fully delineated.
		Agriculture, parks & gardens	TDS, boron	2	C	Low	As above.	As above.	As above.
		Stock watering		0	A	Negligible	As above.	As above.	As above.
		Industrial water use	TDS	1	B	Negligible	As above.	As above.	As above.
		Primary contact recreation (e.g. bathing, swimming)	NH3	3	B	Low	As above.	As above.	As above.
		Buildings and structures	pH, sulphates	1	B	Negligible	Groundwater that is impacted from the site is expected to be below the likely depth of most structures.	Groundwater unlikely to make contact with building footings.	As above.
4ABCEHKOS	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater -> offsite discharge -> Offsite water body I.e. **Port Phillip Bay**	WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Substantially natural ecosystems with some modifications	NH3	3	B	Low	Deep sewers intercept groundwater, although not in all areas.	The groundwater plume from the site in the direction of Port Phillip Bay mostly appears to be contained by the sewers along Bridport, Graham and Pickles Streets. The concentration of NH3 exceeds the ecosystem criteria by several orders of magnitude, and CN, As, Mn and possibly Se are also elevated above what could be background concentrations by at least ten times. The closest surface water receptor for groundwater from the site is Port Phillip Bay approx 1km south of the site. In the event that sewers are repaired in future, preventing groundwater level control by the sewers surrounding the site, a conservative estimate of the velocity of flow towards the Bay could be around 0.4 - 4 m/yr (based on groundwater level of 1m AHD at the site and for the range of hydraulic conductivity for the Brighton Group of 0.1 -1 m/day), although the extent of migration will relate to localised soil conditions (and hydraulic conductivity). It can be expected that at this flow velocity the extent of attenuation will be very high and contaminants will not reach the Bay at concentrations of concern.	There is no information regarding the rate of attenuation of the contaminants by degradation, retardation or dispersion of the plume. It is uncertain as to the extent to which soil contamination, such as gasworks wastes, is present that could give rise to groundwater contamination. The groundwater flow rate suggested by Golder is very low (0.01 - 0.002m/yr) and appears to be based on very low hydraulic conductivity of the material around the sewer (4 x 10-9 m/sec, ie 3.5 x 10 4 m/day). The Brighton Group could have higher hydraulic conductivity than this, in which case the estimated offsite migration rates may be higher (0.4 -4 m/yr). In the Richardson St area, there is already offsite contaminant migration of 70m or more - which implies at least 0.5m/yr. This anomaly should be clarified.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Highly modified ecosystems with some habitat values	NH3	3	B	Low	Deep sewers intercept groundwater, although not in all areas.		
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Primary contact	NH3	1	B	Negligible	Deep sewers intercept groundwater, although not in all areas.		
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Secondary contact	NH3	1	B	Negligible	Deep sewers intercept groundwater, although not in all areas.		
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aesthetics enjoyment	PAHs	1	B	Negligible	Deep sewers intercept groundwater, although not in all areas.		
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Normal populations	PAHs	1	B	Negligible	Deep sewers intercept groundwater, although not in all areas.		
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aquaculture	PAHs	1	B	Negligible	Deep sewers intercept groundwater, although not in all areas.		
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Commercial and recreation use of edible fish and crustacea	PAHs	1	B	Negligible	Deep sewers intercept groundwater, although not in all areas.		
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Navigation & shipping		1	B	Negligible	Deep sewers intercept groundwater, although not in all areas.		
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Industrial water use	TDS	1	B	Negligible	Deep sewers intercept groundwater, although not in all areas.		
4ABCEHKLPT	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater -> sewer -> discharge -> Offsite water body ie. **Western Treatment Plant**	Effluent discharge from the treatment plant is to Port Phillip Bay under EPA waste discharge licence.	NH3, TDS, Mn,	1	E	Low	Deep sewers intercept groundwater, although not in all areas.	The contaminant load into the sewers has been estimated by Golder to be very low, and the inflow to the sewers from the site is estimated to be around 0.001% of the typical daily flow rate in the sewer in this area. The overall contaminant load contributed to the sewer from the Gasworks site which could affect the treatment system is expected to be low to negligible.	The basis for the modelling and load to the sewer is uncertain and further clarification being sought from Golder.
4ABCFIMQ	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation ->Deep groundwater -> Transfer -> Deep groundwater -> Extraction/direct contact	Potable water supply: Desirable/ Acceptable	TDS, NH3	3	A	Low	No controls on groundwater use regionally.	It is not expected that groundwater contamination at the site will migrate vertically downward to deeper aquifers nor likely to be extracted. Migration downwards would include similar contaminants to those identified in the shallow aquifer. It is unlikely that groundwater will be used for potable purposes because of the availability of reticulated supplies.	There are no data concerning groundwater in deeper (basalt) aquifers in the vicinity the site
		Agriculture, parks & gardens	TDS	2	C	Low	No controls on groundwater use regionally.	As above.	As above.
		Stock watering	NH3, CN	0	A	Negligible	No controls on groundwater use regionally.	As above.	As above.
		Industrial water use	TDS, NH3	1	B	Negligible	No controls on groundwater use regionally.	As above.	As above.
		Primary contact recreation (e.g. bathing, swimming)	NH3, CN	3	B	Low	No controls on groundwater use regionally.	As above.	As above.
		Buildings and structures	SO4, pH	1	B	Negligible	Groundwater that is impacted from the site is expected to be below the likely depth of most structures.	As above.	As above.

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4ABCFIMRU	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Deep groundwater -> Transfer -> Offsite deep groundwater -> offsite discharge -> Offsite water body I.e. **Port Phillip Bay**	WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Substantially natural ecosystems with some modifications	NH3	3	B	Low	Deep sewers intercept groundwater, although not in all areas.	Migration downwards would include similar contaminants to those identified in the shallow aquifer. Contamination will attenuate with distance and it is highly unlikely that contaminants could migrate at concentrations of concern to Port Phillip Bay.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Highly modified ecosystems with some habitat values	NH3	3	B	Low	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Primary contact	NH3	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Secondary contact	NH3	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aesthetics enjoyment	PAHs	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Normal populations	PAHs	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aquaculture	PAHs	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Commercial and recreation use of edible fish and crustacea	PAHs	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Navigation & shipping		1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Industrial water use	TDS	1	B	Negligible	As above.	As above.	
4ABDGJU	Historical activities -> Contaminated soil -> Runoff -> Stormwater Drainage -> Discharge -> Offsite water body i.e. **Port Phillip Bay**	WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Substantially natural ecosystems with some modifications	Sediment/turbidity	1	B	Negligible	The site is capped, although the integrity of the capping is uncertain.	It is possible for some contamination to be present in the surface soils above sediment criteria applicable to the Bay. It may erode under storm conditions into the stormwater drainage system and reach the Bay. Dilution will occur with other run off into the stormwater system, and the potential for the contamination to give rise to significant areas of contaminated sediments (from the site) is low.	Uncertainties include the extent of surface soil contamination exceeding sediment criteria, the potential for surface soils to enter stormwater system, and the level of dilution that will occur prior to final discharge into the Bay.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Highly modified ecosystems with some habitat values	Sediment/turbidity	1	B	Negligible	As above.		As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Primary contact	Sediment/turbidity	1	B	Negligible	As above.	As above.	As above.

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		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Secondary contact	Sediment/turbidity	1	B	Negligible	As above.	As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aesthetics enjoyment	Sediment/turbidity	1	B	Negligible	As above.	As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Normal populations	Sediment/turbidity	1	B	Negligible	As above.	As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aquaculture	Sediment/turbidity	1	B	Negligible	As above.	As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Commercial and recreation use of edible fish and crustacea	Sediment/turbidity	1	B	Negligible	As above.	As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Navigation & shipping		1	B	Negligible	As above.	As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Industrial water use	Sediment/turbidity	1	B	Negligible	As above.	As above.	As above.

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Exposure path no.	Exposure path description	Beneficial use	Limiting contaminant	Severity	Likelihood	Risk	Controls	Comment	UNCERTAINTY
Flowchart 5	**GASWORKS SITE, Land Segment: Off-site beneficial uses (near to the site)**								
5ABCFEDGIK	Historical activities -> Contaminated soil -> Leaching/Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater -> Volatile emission -> Soil gas -> Diffusion into Buildings and structures	Human health: General Public - Adult	NH3	2	C	Low	Deep sewers intercept groundwater, minimising offsite transfer of contaminated groundwater, although the sewers do no intercept flow in all areas.	Field logs from the offsite bores MW26-28 and MW30 drilled in the Richardson St area where the highest impacts of groundwater have been detected do not report significant odours at the water table level. A nearby bore MW29 reported slight hydrocarbon odours at about 8m, but no hydrocarbons were detected in groundwater samples from this bore. In MW15 offsite in Bridport St on the SW corner a slight to moderate odour was detected at a depth of 7.5 - 7.7m, just above the water table (around 8.8m). PID readings were 0 ppm for the soil sample collected from this location. Groundwater is typically below the likely depth of most buildings in the vicinity the site. However there is presently potential for volatile emissions to migrate into deep foundations and basements. In the event of the sewers being repaired and water levels being re-established to natural levels, there is potential for shorter pathways to vapour receptors. The ammonia plume that has been identified offsite (NE & W) would present an odour issue rather than a health issue.	No soil gas or air monitoring data for off site scenarios available.
		Human health: General Public - Child	NH3	2	C	Low	As above.	As above..	As above.
		Human health: Workers - Surface	NH3	2	C	Low	As above..	As above.	As above.
		Human health: Workers - Subsurface	NH3	3	C	Medium	Typical OHS procedures for entry into deep sewers should be protective of sewer/maintenance workers.	As above - though noting that the pathway is shorter, and the concentrations of gases can be higher, but time duration of exposure can be less for works being carried out in trenches compared with exposure occurring in buildings. Understood that Melbourne Water was informed of the contamination that may be entering the sewer from the Site. Golder Associates recommended that a similar agreement to that proposed with Melbourne Water be sought with South East Water to inform workers of the potential contamination status of the sewer due to the ingress of contaminated groundwater (see Further Groundwater Investigation, Pickle Street Sewer, West of the Former South Melbourne Gasworks, Gasworks Precinct, October 2007). Low rate of seepage, minimal exposure to seepage because of the low rate of discharge, OHS and confined space procedures in place for deep sewer entry should be protective of personnel.	The effectiveness of the Water Authority notifications/agreements is not known.
		Aesthetics	NH3	2	C	Low	As above.	Unlikely that volatiles (eg ammonia) would be at levels that would give rise to odours within buildings.	No soil gas or air monitoring data for off site scenarios available.
5ABCFEDGIL	Historical activities -> Contaminated soil -> Leaching/Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater -> Volatile emission -> Soil gas -> Diffusion into Residential homes	Human health: Residents	NH3	2	C	Low	As above.	Field logs from the offsite bores MW26-28 and MW30 drilled in the Richardson St area where the highest impacts of groundwater have been detected do not report significant odours at the water table level. A nearby bore MW29 reported slight hydrocarbon odours at about 8m, but no hydrocarbons were detected in groundwater samples from this bore. In MW15 offsite in Bridport St on the SW corner a slight to moderate odour was detected at a depth of 7.5 - 7.7m, just above the water table (around 8.8m). PID readings were 0 ppm for the soil sample collected from this location. Groundwater is typically below the likely depth of most buildings in the vicinity the site. However there is presently potential for volatile emissions to migrate into deep foundations and basements. In the event of the sewers being repaired and water levels being re-established to natural levels, there is potential for shorter pathways to vapour receptors. The ammonia plume has been identified offsite (NE & W) and can be expectged to present an odour issue rather than a health issue.	No soil gas or air monitoring data for off site scenarios available.
		Aesthetics	NH3	2	C	Low	As above.	Ammonia from soil gas unlikely to be detectable (as odour) inside buildings.	As above.
5ABCFEDGIM	Historical activities -> Contaminated soil -> Leaching/Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater -> Volatile emission -> Soil gas -> Diffusion into ambient air	Human health: General Public - Adult	NH3	1	B	Negligible	Deep sewers intercept groundwater, minimising offsite transfer of contaminated groundwater, although the sewers do no intercept flow in all areas.	Field logs from the offsite bores MW26-28 and MW30 drilled in the Richardson St area where the highest impacts of groundwater have been detected do not report significant odours at the water table level. A nearby bore MW29 reported slight hydrocarbon odours at about 8m, but no hydrocarbons were detected in groundwater samples from this bore. In MW15 offsite in Bridport St on the SW corner a slight to moderate odour was detected at a depth of 7.5 - 7.7m, just above the water table (around 8.8m). PID readings were 0 ppm for the soil sample collected from this location. Groundwater is typically below the likely depth of most buildings in the vicinity the site. However there is presently potential for volatile emissions to migrate into deep foundations and basements. In the event of the sewers being repaired and water levels being re-established to natural levels, there is potential for shorter pathways to vapour receptors. The ammonia plume has been identified offsite (NE & W) would present an odour issue rather than a health issue.	No soil gas or air monitoring data for off site scenarios available.
		Human health: General Public - Child	NH3	1	B	Negligible	As above.	As above.	As above.
		Aesthetics		2	C	Low	As above.	As above.	As above.
5ABCFEDGIN	Historical activities -> Contaminated soil -> Leaching/Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater -> Volatile emission -> Soil gas -> Root zones/ Plants/ Produce	Ecosystems: Natural/Modified/ Highly Modified	Ammonia	1	B	Negligible	Deep sewers intercept groundwater, minimising offsite transfer of contaminated groundwater, although the sewers do no intercept flow in all areas.	It is highly unlikely that soil gas associated with ammonia and other contaminants will cause adverse impact to ecosystems and plants compared to direct contact with contamination.	No data that relates to soil gas impacts on offsite ecosystems/plants, but this is not considered to be a significant area of uncertainty as risk is expected to be very low.
		Food production	Ammonia	1	B	Negligible	As above.	As above.	As above.

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5ABCFHJO	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Discharge -> Sewer -> Dermal contact/direct contact	Human health: Workers - Subsurface	NH3	3	C	Medium	Typical OHS procedures for entry into deep sewers should be protective of sewer/maintenance workers.	Understood that Melbourne Water was informed of the contamination that may be entering the sewer from the Site. Golder Associates recommended that a similar agreement to that proposed with Melbourne Water be sought with South East Water to inform workers of the potential contamination status of the sewer due to the ingress of contaminated groundwater (see Further Groundwater Investigation, Pickle Street Sewer, West of the Former South Melbourne Gasworks, Gasworks Precinct, October 2007). Low rate of seepage, minimal exposure to seepage because of the low rate of discharge, OHS and confined space procedures in place for deep sewer entry should be protective of personnel.	The frequency that works need to access sewer is unknown. Sewers thought to be too narrow to allow entry. The effectiveness of the Water Authority notifications/agreements is not known.
		Buildings & structures	SO4, pH	1	B	Negligible		The concentration of the groundwater and the pH is generally between 7 and 7.9. One location GW5 has pH 6 and 6.2 which also coincides with sulphate concentrations of 2400 and 2000 mg/L The groundwater discharge into the sewer is not considered to be highly corrosive. Likewise the salinity at less than 5000mg/L is unlikely to be corrosive to the sewer infrastructure.	Uncertain whether the sewerage system has been constructed with materials that can accommodate aggressive groundwater conditions - they are known to be leaky, in that groundwater is leaking into them.
5ABCFHJP	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Discharge -> Sewer -> Volatile emission	Human health: Workers - Subsurface	NH3	3	C	Medium	Typical OHS procedures for entry into deep sewers should be protective of sewer/maintenance workers.	Understood that Melbourne Water was informed of the contamination that may be entering the sewer from the Site. Golder Associates recommended that a similar agreement to that proposed with Melbourne Water be sought with South East Water to inform workers of the potential contamination status of the sewer due to the ingress of contaminated groundwater (see Further Groundwater Investigation, Pickle Street Sewer, West of the Former South Melbourne Gasworks, Gasworks Precinct, October 2007). Low rate of seepage, minimal exposure to seepage because of the low rate of discharge, OHS and confined space procedures in place for deep sewer entry should be protective of personnel.	The effectiveness of the Water Authority notifications/agreements is not known.

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Exposure path no.	Exposure path description	Beneficial use	Limiting contaminant	Severity	Likelihood	Risk	Controls	Comment	UNCERTAINTY
Flowchart 6	**GASWORKS SITE, NAPL, Land Segment: On-site beneficial uses**								
6ABCFK	Historical activities -> NAPL on-site -> Volatile emission -> Soil gas -> Diffusion into buildings & structures	Human health: Park users - Adult	coal tars & tar oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	2	D	Medium	Controls as per ICMP ie Potential vapour exposure within the buildings to be minimised through the continual use of air conditioning systems and adequate ventilation. Time spent in poorly ventilated locations should be minimised pending further measurements and recommendations.	Vapour and Edible Vegetation Risk Assessment (July 2004) - Golder tested for VOCs, SVOCs and CN within four onsite buildings. Four chemicals of interest (COIs) were identified: phenol, ethylbenzene, toluene and xylenes. The risk assessment of the COIs detected in indoor air used the highest concentrations of each chemical measured at any of the indoor monitoring locations. The 2004 Golder sampling was undertaken on a Monday morning to be conservative as it was considered that any vapours inside the buildings may be at higher concentrations after the buildings were closed/less frequently used over the weekend. Two park based buildings were selected based on the site history to be as close as practical to the worst potential areas for vapours, i.e. one location was in the bookshop in the administration area of the site (west of the former coal gasification plant); and the other in the dressing room of the theatre (in the administration building area of the site, and east of the former underground purifiers). Golder concluded that the gasworks waste on the site did not appear to be posing vapour risks to worker	NAPL is expected to be at the Site but there is uncertainty about where, such as whether NAPL is present in the southeast part of the site as well as in the vicinity of the Southport Nursing Home in the northeast. Uncertain about the extent to which volatiles may migrate into buildings, as a function of location and different atmospheric conditions. Uncertainty regarding the robustness of the ventilation systems ie. could they shut off?
		Human health: Park users - Child	As above.	2	D	Medium	As above.	As above.	As above.
		Human health: Workers - Surface	As above.	2	D	Medium	As above.	As above.	As above.
		Aesthetics	As above.	2	D	Medium	Not explicitly addressed in the ICMP, but odours expected to be managed by use of the ventilation systems.	Reports of objectionable odours within buildings have not been seen by the auditor, however the contaminants of concern at the site are known to be odorous. Odours have been observed during the soil and groundwater investigation, and noted on bore logs.	As above.
6ABCFL	Historical activities -> NAPL on-site -> Volatile emission -> Soil gas -> Diffusion into residential homes/Southport	Human health: Residents	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	2	D	Medium	Controls as per ICMP ie Potential vapour exposure within the buildings to be minimised through the continual use of air conditioning systems and adequate ventilation. Time spent in poorly ventilated locations should be minimised pending further measurements and recommendations.	As for pathway 6ABCFK. Four non-carcinogenic COIs were detected within some of the four buildings sampled at the site (2004). Two locations were within the Southport site. A quantitative RA based on the highest concentrations was conducted and concluded that based on the data collected there did not appear to be a risk to workers or residents.	Vapour samples were collected on one occasion and may not be representative of the high-end of the vapour that may be emitted, or what may be emitted in the future. The 2005 vapour study represents a point in time and is not substantial enough to understand current risk or future risks. At the time of preparing the ICMP indoor vapour testing was about to be commenced to provide further information for guidance on this issue. The ICMP was to be updated should the testing indicate additional actions are required - ICMPs were not updated, probably because Golder concluded that risk was low.
		Aesthetics	As above.	2	D	Medium	Not explicitly addressed in the ICMP, but odours expected to be managed by use of the ventilation systems.	Reports of objectionable odours within buildings have not been seen by the auditor, however the contaminants of concern at the site are known to be odorous. Odours have been observed from the soil and groundwater investigation bores.	As above.
6ABCFM	Historical activities -> NAPL on-site -> Volatile emission -> Soil gas -> Diffusion into excavations	Human health: Workers - Subsurface	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	3	D	Medium	Park ICMP - task specific management for any works > 30cm bgl.	Contamination by volatile substances is present in the subsurface. Risks from vapours to subsurface workers was not included into the Golder 2004 study.	Uncertain whether the results from the gas sampling can be applied to assess risk to subsurface workers. Uncertain whether the Park ICMP is being adequately implemented to protect workers.
6ABCFN	Historical activities -> NAPL on-site -> Volatile emission -> Soil gas -> Diffusion into ambient air	Human health: Park users - Adult	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	1	C	Low	No controls on this exposure pathway.	The outdoor air vapour risk assessment (Golder 2004) involved sampling four soil gas bores installed at various locations around the Park. Twenty COIs were identified, and not all COIs were detected at all of the soil gas bore locations. Soil gas concentrations varied significantly between locations. A quantitative risk assessment of the highest measured concentrations of the COIs did not find unacceptable risks to child and adult recreational users of the Park or outdoor maintenance workers on the Park. Therefore, based on the data collected for the outdoor air vapour risk assessment, Golder concluded that gasworks waste on the site did not appear to be posing vapour risks to recreational users of, or workers on, the Park. The assessment of risks to both child and adult recreational park users found that risks from all noncarcinogenic COIs to be less than a value of 0.2, and carcinogenic risks from benzene to child and adult recreational park users were found to be less than 1 x 10-5 and therefore also acceptable. In general, dilution in unconfined ambient air can be expected to be very high and the risk low.	Uncertainty as to the adequacy of results of investigations in characterising the concentrations of volatile gases (study was limited in scope and conclusions based on a single sampling event at 4 soil gas bore locations).
		Human health: Park users - Child	As above.	1	C	Low	As above.	As above.	As above.
		Human health: Workers - Surface	As above.	1	C	Low	As above.	As above.	As above.
		Human health: Residents	As above.	1	C	Low	As above.	As above.	As above.
		Aesthetics	As above.	1	C	Low	As above.	Objectionable odours in the parkland does not appear to be a significant issue, however hydrocarbon odours and staining have been noted in several soil and groundwater borehole locations.	As above.
6ABCFO	Historical activities -> NAPL on-site -> Volatile emission -> Soil gas -> Diffusion into plant root zones	Ecosystems: Natural/modified/highly modified	coal tars, tar oils, PAHs	1	D	Low	No controls - plants grow through the site, in many areas established on capping rather than directly on waste/contaminated soil.	Some gases may kill or harm plants but are generally not bioaccumulative . The other bioaccumulative chemicals tend to solid liquid such as PAHs, PCBs, pesticides.	As above.
		Food production	coal tars, tar oils, PAHs	1	D	Low	Edible vegetables are not being proactively grown at the site, ie. bush tucker trail and fruit trees. Golder identified that some part of plants that grow at the site could be eaten (see Report 5) but that it is unlikely this would occur.	Some gases may kill or harm plants but are generally not bioaccumulative . The other bioaccumulative chemicals tend to solid liquid such as PAHs, PCBs, pesticides.	As above.
6ABDG	Historical activities -> NAPL on-site -> Direct contact -> Dermal contact/direct contact	Human health: Park users - Adult	As above.	2	C	Low	Maintenance of the separation layer over the site required as part of the ICMP.	Soils on Gasworks Park and Southport are contaminated to various degrees with gasworks waste and free product/tars/NAPL and while expected to remain at the site free product not observed on site surface.	NAPL is expected to be at the Site but there is uncertainty about where, such as whether NAPL is present in the southeast part of the site as well as in the vicinity of the Southport Nursing Home in the northeast.
		Human health: Park users - Child	As above.	2	C	Low	As above.	As above.	As above.
		Human health: Workers - Surface	As above.	2	C	Low	As above.	As above.	As above.
		Human health: Workers - Subsurface	As above.	2	D	Medium	Park ICMP - task specific management for any works > 30cm bgl.	Soils on Gasworks Park and Southport are contaminated to various degrees with gasworks waste and free product/tars/NAPL are expected to be encountered at depth.	As above.
		Human health: Residents	As above.	2	C	Low	Maintenance of the separation layer over the site required as part of the ICMP.	As above.	As above.

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		Buildings & structures	coal tars and tar oils	1	B	Low	No specific controls on existing building w.r.t. resistance to NAPL/tars. Golder advice CoPP (as per reports) is limited to the need to assess new building designs for compatibility with low pH and high sulphates.	NAPL/tar has been identified in wells in the southern portion of the site and would be expected to be in contact with subsurface structures at depth. Potential for attack on existing and new structures has not been characterised, although extent of attack is likely to be limited.	There is potential for tar and soil contamination present to attack concrete structures, the extent of free product occurrence has not been determined.
6ABDH	Historical activities -> NAPL on-site -> Direct contact -> Ingestion	Human health: Park users - Adult	coal tars & tar oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	2	C	Low	ICMP requires that the separation layer be maintained over the non-building areas of the site to minimise access to subsurface contamination.	Soils on Gasworks Park and Southport are contaminated to various degrees with gasworks waste and NAPL/tars are expected to remain at the site. In terms of assessing the contamination, Golder has applied NEPM D and E criteria - these appear appropriate.	NAPL is expected to be at the Site but there is uncertainty about where, such as whether NAPL is present in the southeast part of the site as well as in the vicinity of the Southport Nursing Home in the northeast.
		Human health: Park users - Child	As above.	2	C	Low	As above.	As above.	As above.
		Human health: Workers - Surface	As above.	2	C	Low	ICMP - Golder recommended that workers or people who spend more than two days a week at the site be briefed by the Health and Safety Coordinator regarding site issues, the need to minimise exposure to soil at the site and the need to adopt standard hygiene practices following contact with the surrounding soils.	Free product not observed on site surface and unlikely to encountered by workers (ie within buildings, gardeners etc) at the site.	As above.
		Human health: Workers - Subsurface	As above.	2	C	Low	ICMP - All intrusive maintenance works (>30cm bgl) must prepare a task specific contamination management plan in consultation with a CoPP Health and Safety Coordinator. Considerations to be included: dust management, what to do is coloured or odorous soils are encountered, hygiene practices such as washing hands after working at the site.	Tar observed in at least two bore holes in the southern portion of the site. Expected to be contacted should subsurface works be undertaken in the area.	As above.
		Human health: Residents	As above.	2	C	Low	Southport ICMP puts controls over access to fill/natural soils underlying the separation layers.	Soils on Gasworks Park and Southport are contaminated to various degrees with gasworks waste, but free product is not being observed on the site surface and is unlikely to be contacted/ingested by users of the park.	As above.
6ABDI	Historical activities -> NAPL on-site -> Direct contact -> Surface contamination/ waste	Aesthetics	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	2	B	Low	ICMP - Golder recommended that workers or people who spend more than two days a week at the site be briefed by the Health and Safety Coordinator regarding site issues, the need to minimise exposure to soil at the site and the need to adopt standard hygiene practices following contact with the surrounding soils.	Free product not observed on site surface.	As above.
6ABEJ	Historical activities -> NAPL on-site -> Root zone/ Plants/ Produce	Ecosystems: Natural/modified/highly modified	coal tars, tar oils, PAHs	3	B	Low	Plants grow through the site, in many areas established on capping rather than directly on waste/contaminated soil. Planting situation and plant varieties are generally suitable for the conditions. Produce of the plants is not thought to be used for human consumption (refer next item).	The major contaminants in soil have been found to be PAHs, including benzo(a)pyrene) and TPHs (>C9). The PAHs are considered to have potential to be in two forms in soils on the site – a liquid form (e.g., tars, liquors in and near tanks and pits) and in solid form (e.g., ash, coke, coal in and near hoppers and bunkers). PAHs in solid form are expected to have a lower potential for uptake by plant roots and effect on plant growth. PAHs in liquid form are expected to have a higher potential for uptake by plant roots, and effect on plant growth, but it is not likely that NAPL will be in the plant root zone. Metals have been found above NEPM EILs, and other contaminants such as low pH and sulphate may impact the beneficial use of maintenance of ecosystems - but these are not expected to be NAPL-related issues.	NAPL is expected to be at the Site but there is uncertainty about where, and at what depth it may occur.
		Human health: Park users - Adult	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	1	B	Negligible	The bush tucker trail is understood to have been removed from the site. Golder identified that some part of plants that grow at the site could be eaten (see Report 5) but that it is unlikely this would occur. Not sure about the status of fruit trees on the site.	As above. To derive an overall risk ranking for contaminant uptake and potential consumption, Golder identified site plants, and assessed the expected root depth, the edible portion of the plant, the likelihood of consumption, and the expected form of the PAHs contamination. Golder ranked the hazard as “nil” when the exposure pathway for a particular plant did not exist (i.e., the plant was not consumed). A hazard was ranked “negligible” when the plant had an expected shallow root depth. A hazard was ranked “low” when a plant had an expected deep root depth near areas that had potential for the presence of liquid PAHs (NAPL) and the plant had an edible portion that had potential to be consumed by Gasworks Park users. No hazards were ranked higher than low due to the low potential for PAH uptake by plants - as uptake was expected to be low and consumption of vegetation expected to be infrequent.	Extent of uptake by fruit trees is uncertain. Extent of consumption of produce is uncertain. Golder suggested that should quantitative confirmation of the qualitative findings be required, that may be possible by analysing the fruit from the fruit trees on the site.
		Human health: Park users - Child	As above.	1	B	Negligible	As above.	As above for adult park users.	As above,
		Human health: Workers - Surface	As above.	1	B	Negligible	As above.	As above for park users, but considering that frequency at the park is expected to be less than park users.	As above.
		Human health: Workers - Subsurface	As above.	1	B	Negligible	As above.	As above for park users, but sub-surface workers are not likely to consume produce.	As above.
		Human health: Residents	As above.	1	B	Negligible	As above.	As above for adult park users, although residents are not likely to consume produce.	As above.
		Food production	coal tars, tar oils, PAHs	3	B	Low	As above.	As above, plants are not expected to be used for systematic food production. Most VOCs and SVOC results have not been compared to EILs or similar.	Toxicity of contaminants to plants has not been evaluated. Effect of contaminants on food production has not been evaluated.

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Flowchart 7	**GASWORKS SITE, NAPL, Groundwater Segment: On-site beneficial uses**								
7ABCEH	Historical activities -> NAPL on-site -> Dissolution into groundwater on-site -> Shallow groundwater -> Extraction	Potable water	PAHs, metals	4	A	Low	Extractive uses of groundwater are not addressed in the ICMPs, but unlikely to occur given CoPP management/control over activities at the site.	Considering the history of the site, NAPL might be expected; however, there does not appear to be a positive identification of NAPL within the saturated zone at the site, although some very high dissolved phase concentrations of PAH and some odours in well MW24 suggest that NAPL may be present nearby. If NAPL is extracted by pumping either by a well penetrating NAPL or by being pumped from the surrounding aquifer into a well, the concentrations will exceed extractive use levels. In addition, NAPL will comprise an on-going source of contaminants to be dissolved in migrating groundwater.	In the absence of positive identification of NAPL, there is uncertainty about the application in this situation of the SEPP GoV clause 18 that requires that NAPL be removed from an aquifer unless the Authority is satisfied that there is no acceptable risk posed to any beneficial use by the NAPL.
		Agriculture, parks & gardens	PAHs, metals	4	B	Medium	As above.	As above. The risk has been assessed as medium on the basis that the extractive use of groundwater at the site for irrigation is unlikely ('B')	As above for potable water use.
		Stock animals	PAHs, metals	4	A	Low	As above.	As above. Use is improbable.	As above for potable water use.
		Industrial Use		2	A	Low	As above.	Groundwater unlikely to be suitable for industrial uses without some treatment prior to use. Use is improbable.	As above for potable water use.
		Primary contact: recreation	PAHs, metals	4	A	Low	As above.	As above. Use is improbable.	As above for potable water use.
7ABCEI	Historical activities -> NAPL on-site -> Dissolution into groundwater on-site -> Shallow groundwater -> Discharge	Maintenance of Ecosystems	PAHs, metals	5	No surface water body onsite.	Negligible	No surface water/groundwater dependant ecosystem at the site.		
7ABF	Historical activities -> NAPL on-site -> Direct contact	Buildings & structures	PAHs, metals	2	B	Low	No explicit controls however groundwater is currently below the likely depth of most structures at the site.	Structures on site are well above the groundwater level and as the park is expected to remain as public space, this is considered to be an unlikely impact.	Uncertainty as to whether the sewers will be repaired at some time in the future, giving rise to groundwater rise.
7ABDGJ	Historical activities -> NAPL on-site -> Dissolution into groundwater on-site -> Deep groundwater -> Extraction	Potable water	PAHs, metals	4	A	Low	Extractive uses of groundwater are not addressed in the ICMPs, but unlikely to occur given CoPP management/control over activities at the site.	DNAPL such as tar can migrate vertically downwards through an aquifer. There is no data on the deeper aquifer water quality at the site. It is suspected that NAPL may be present in the SE and NE corners, but it have not been encountered by the investigations to date. For the purposes of ranking the risk, it is assumed that some DNAPL may be present and may have migrated vertically.	In the absence of positive identification of NAPL, there is uncertainty about the application in this situation of the SEPP GoV clause 18 that requires that NAPL be removed from an aquifer unless the Authority is satisfied that there is no acceptable risk posed to any beneficial use by the NAPL.
		Agriculture, parks & gardens	PAHs, metals	4	B	Medium	Use of groundwater for irrigation onsite is unlikely.	As above. The risk has been assessed as medium on the basis that the extractive use of groundwater at the site for irrigation is unlikely ('B')	As above for potable water use.
		Stock animals	PAHs, metals	4	A	Low	Use of groundwater for stock watering onsite is improbable.	As above.	As above for potable water use.
		Industrial use	PAHs, metals	2	A	Low	Use of groundwater for industrial purposes onsite is improbable.	As above.	As above for potable water use.
		Primary contact: recreation	PAHs, metals	4	A	Low	Use of groundwater for filling swimming pools or other recreational use onsite is improbable.	As above.	As above for potable water use.
7ABDGK	Historical activities -> NAPL on-site -> Dissolution into groundwater on-site -> Deep groundwater -> Discharge	Maintenance of Ecosystems	PAHs, metals	5	No surface water body onsite.	Negligible	No surface water/groundwater dependant ecosystem at the site.		

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Exposure path no.	Exposure path description	Beneficial use	Limiting contaminant	Severity	Likelihood	Risk	Controls	Comment	UNCERTAINTY
Flowchart 7	**GASWORKS SITE, NAPL, Groundwater Segment: On-site beneficial uses**								
7ABCEH	Historical activities -> NAPL on-site -> Dissolution into groundwater on-site -> Shallow groundwater -> Extraction	Potable water	PAHs, metals	4	A	Low	Extractive uses of groundwater are not addressed in the ICMPs, but unlikely to occur given CoPP management/control over activities at the site.	Considering the history of the site, NAPL might be expected; however, there does not appear to be a positive identification of NAPL within the saturated zone at the site, although some very high dissolved phase concentrations of PAH and some odours in well MW24 suggest that NAPL may be present nearby. If NAPL is extracted by pumping either by a well penetrating NAPL or by being pumped from the surrounding aquifer into a well, the concentrations will exceed extractive use levels. In addition, NAPL will comprise an on-going source of contaminants to be dissolved in migrating groundwater.	In the absence of positive identification of NAPL, there is uncertainty about the application in this situation of the SEPP GoV clause 18 that requires that NAPL be removed from an aquifer unless the Authority is satisfied that there is no acceptable risk posed to any beneficial use by the NAPL.
		Agriculture, parks & gardens	PAHs, metals	4	B	Medium	As above.	As above. The risk has been assessed as medium on the basis that the extractive use of groundwater at the site for irrigation is unlikely ('B')	As above for potable water use.
		Stock animals	PAHs, metals	4	A	Low	As above.	As above. Use is improbable.	As above for potable water use.
		Industrial Use		2	A	Low	As above.	Groundwater unlikely to be suitable for industrial uses without some treatment prior to use. Use is improbable.	As above for potable water use.
		Primary contact: recreation	PAHs, metals	4	A	Low	As above.	As above. Use is improbable.	As above for potable water use.
7ABCEI	Historical activities -> NAPL on-site -> Dissolution into groundwater on-site -> Shallow groundwater -> Discharge	Maintenance of Ecosystems	PAHs, metals	5	No surface water body onsite.	Negligible	No surface water/groundwater dependant ecosystem at the site.		
7ABF	Historical activities -> NAPL on-site -> Direct contact	Buildings & structures	PAHs, metals	2	B	Low	No explicit controls however groundwater is currently below the likely depth of most structures at the site.	Structures on site are well above the groundwater level and as the park is expected to remain as public space, this is considered to be an unlikely impact.	Uncertainty as to whether the sewers will be repaired at some time in the future, giving rise to groundwater rise.
7ABDGJ	Historical activities -> NAPL on-site -> Dissolution into groundwater on-site -> Deep groundwater -> Extraction	Potable water	PAHs, metals	4	A	Low	Extractive uses of groundwater are not addressed in the ICMPs, but unlikely to occur given CoPP management/control over activities at the site.	DNAPL such as tar can migrate vertically downwards through an aquifer. There is no data on the deeper aquifer water quality at the site. It is suspected that NAPL may be present in the SE and NE corners, but it have not been encountered by the investigations to date. For the purposes of ranking the risk, it is assumed that some DNAPL may be present and may have migrated vertically.	In the absence of positive identification of NAPL, there is uncertainty about the application in this situation of the SEPP GoV clause 18 that requires that NAPL be removed from an aquifer unless the Authority is satisfied that there is no acceptable risk posed to any beneficial use by the NAPL.
		Agriculture, parks & gardens	PAHs, metals	4	B	Medium	Use of groundwater for irrigation onsite is unlikely.	As above. The risk has been assessed as medium on the basis that the extractive use of groundwater at the site for irrigation is unlikely ('B')	As above for potable water use.
		Stock animals	PAHs, metals	4	A	Low	Use of groundwater for stock watering onsite is improbable.	As above.	As above for potable water use.
		Industrial use	PAHs, metals	2	A	Low	Use of groundwater for industrial purposes onsite is improbable.	As above.	As above for potable water use.
		Primary contact: recreation	PAHs, metals	4	A	Low	Use of groundwater for filling swimming pools or other recreational use onsite is improbable.	As above.	As above for potable water use.
7ABDGK	Historical activities -> NAPL on-site -> Dissolution into groundwater on-site -> Deep groundwater -> Discharge	Maintenance of Ecosystems	PAHs, metals	5	No surface water body onsite.	Negligible	No surface water/groundwater dependant ecosystem at the site.		

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Exposure path no.	Exposure path description	Beneficial use	Limiting contaminant	Severity	Likelihood	Risk	Controls	Comment	UNCERTAINTY
Flowchart 10	**GASWORKS SITE, NAPL, Groundwater Segment: Off-site beneficial uses (far from the site)**								
10ABCEHKN	Historical activities -> NAPL -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater ->Extraction/direct contact	Potable water supply: Desirable/ Acceptable	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	0	A	Negligible	Deep sewers intercept groundwater, and although do not offer complete groundwater containment, NAPL (if present) is not expected to migrate far from the site.	The high viscosity and density of NAPL make it unlikely to migrate within aquifers towards other users or ecosystems far from the site. Considerable attenuation can be expected to occur on migration of groundwater contamination some distance from the site.	
		Agriculture, parks & gardens	As above.	0	A	Negligible	As above.	As above.	
		Stock watering	As above.	0	A	Negligible	As above.	As above.	
		Industrial water use	As above.	0	A	Negligible	As above.	As above.	
		Primary contact recreation (e.g. bathing, swimming)	As above.	0	A	Negligible	As above.	As above.	
		Buildings and structures	As above.	0	A	Negligible	As above.	As above.	
10ABCEHKOS	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater -> offsite discharge -> Offsite water body I.e. **Port Phillip Bay**	WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Substantially natural ecosystems with some modifications	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	1	B	Negligible	Deep sewers intercept groundwater, and although do not offer complete groundwater containment, NAPL (if present) is not expected to migrate far from the site.	The high viscosity and density of NAPL make it unlikely to migrate within aquifers towards other users or ecosystems far from the site. Considerable attenuation can be expected to occur on migration of groundwater contamination some distance from the site.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Highly modified ecosystems with some habitat values	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Primary contact	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Secondary contact	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aesthetics enjoyment	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Normal populations	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aquaculture	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Commercial and recreation use of edible fish and crustacea	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Navigation & shipping	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Industrial water use	As above.	1	B	Negligible	As above.	As above.	

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Exposure path no.	Exposure path description	Beneficial use	Limiting contaminant	Severity	Likelihood	Risk	Controls	Comment	UNCERTAINTY
10ABCEHKLPT	Historical activities -> NAPL -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater -> sewer -> discharge -> Offsite water body ie. **Western Treatment Plant**	Effluent discharge from the treatment plant is to Port Phillip Bay under EPA waste discharge licence.	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	1	B	Negligible	Dilution in sewer; waste water treatment at the plant; discharge limits set my EPA as per licence.	Because of the very high level of dilution in the sewer, ingress into the sewer is not expected to give rise to problems at the discharge of effluent from the sewage treatment plant.	The basis for the modelling and load to the sewer is uncertain and is being clarified.
10ABCFIMQ	Historical activities -> NAPL -> Leaching/ Infiltration/ Percolation ->Deep groundwater -> Transfer -> Deep groundwater -> Extraction/direct contact	Potable water supply: Desirable/ Acceptable	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	0	A	Negligible	Deep sewers intercept groundwater, although not in all areas.	Dissolved phase groundwater contamination has been identified in localised areas off site and close to the site. It is not clear that contamination of the deep aquifer has occurred, and this is less likely than the shallow aquifer. Considerable attenuation of contamination can be expected to occur on migration of groundwater some distance from the site.	Extent of contamination in deep aquifer is uncertain. Uncertain as to extent to which the deep groundwater will be intercepted by the sewer.
		Agriculture, parks & gardens	As above.	0	A	Negligible	As above.	As above.	As above.
		Stock watering	As above.	0	A	Negligible	As above.	As above.	As above.
		Industrial water use	As above.	0	A	Negligible	As above.	As above.	As above.
		Primary contact recreation (e.g. bathing, swimming)	As above.	0	A	Negligible	As above.	As above.	As above.
		Buildings and structures	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	0	A	Negligible	Groundwater is currently below the likely depth of most structures at the site.	Unlikely for structures to intersect deep aquifers.	Uncertainty as to whether the sewers will be repaired at some time in the future, giving rise to groundwater rise.
10ABCFIMRU	Historical activities -> NAPL -> Leaching/ Infiltration/ Percolation -> Deep groundwater -> Transfer -> Offsite deep groundwater -> offsite discharge -> Offsite water body I.e. **Port Phillip Bay**	WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Substantially natural ecosystems with some modifications	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	0	A	Negligible	Deep sewers intercept groundwater, and although do not offer complete groundwater containment, NAPL (if present) is not expected to migrate far from the site.	The high viscosity and density of NAPL make it unlikely to migrate within aquifers towards other users or ecosystems far from the site. Considerable attenuation can be expected to occur on migration of groundwater contamination some distance from the site.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Highly modified ecosystems with some habitat values	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Primary contact	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Secondary contact	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aesthetics enjoyment	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Normal populations	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aquaculture	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Commercial and recreation use of edible fish and crustacea	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Navigation & shipping	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Industrial water use	As above.	0	A	Negligible	As above.	As above.	
10ABDGJU	Historical activities -> NAPL -> Runoff -> Stormwater Drainage -> Discharge -> Offsite water body i.e. **Port Phillip Bay**	WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Substantially natural ecosystems with some modifications	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	0	A	Negligible	The site is capped, although the extent and integrity of the capping is uncertain.	It is possible for some contamination to be present in the surface soils above sediment criteria applicable to the Bay. It may erode under storm conditions into the stormwater drainage system and reach the Bay. Dilution will occur with other run off into the stormwater system, and the potential for the contamination to give rise to significant areas of contaminated sediments (from the site) is low.	Uncertainties include the extent of surface soil contamination exceeding sediment criteria, the potential for surface soils to enter stormwater system, and the level of dilution that will occur prior to final discharge into the Bay.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Highly modified ecosystems with some habitat values	As above.	0	A	Negligible		As above.	As above.

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		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Primary contact	As above.	0	A	Negligible		As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Secondary contact	As above.	0	A	Negligible		As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aesthetics enjoyment	As above.	0	A	Negligible		As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Normal populations	As above.	0	A	Negligible		As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aquaculture	As above.	0	A	Negligible		As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Commercial and recreation use of edible fish and crustacea	As above.	0	A	Negligible		As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Navigation & shipping	As above.	0	A	Negligible		As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Industrial water use	As above.	0	A	Negligible		As above.	As above.

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Exposure path no.	Exposure path description	Beneficial use	Limiting contaminant	Severity	Likelihood	Risk	Controls	Comment	UNCERTAINTY
Flowchart 10	**GASWORKS SITE, NAPL, Groundwater Segment: Off-site beneficial uses (far from the site)**								
10ABCEHKN	Historical activities -> NAPL -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater ->Extraction/direct contact	Potable water supply: Desirable/ Acceptable	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	0	A	Negligible	Deep sewers intercept groundwater, and although do not offer complete groundwater containment, NAPL (if present) is not expected to migrate far from the site.	The high viscosity and density of NAPL make it unlikely to migrate within aquifers towards other users or ecosystems far from the site. Considerable attenuation can be expected to occur on migration of groundwater contamination some distance from the site.	
		Agriculture, parks & gardens	As above.	0	A	Negligible	As above.	As above.	
		Stock watering	As above.	0	A	Negligible	As above.	As above.	
		Industrial water use	As above.	0	A	Negligible	As above.	As above.	
		Primary contact recreation (e.g. bathing, swimming)	As above.	0	A	Negligible	As above.	As above.	
		Buildings and structures	As above.	0	A	Negligible	As above.	As above.	
10ABCEHKOS	Historical activities -> Contaminated soil -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater -> offsite discharge -> Offsite water body I.e. **Port Phillip Bay**	WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Substantially natural ecosystems with some modifications	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	1	B	Negligible	Deep sewers intercept groundwater, and although do not offer complete groundwater containment, NAPL (if present) is not expected to migrate far from the site.	The high viscosity and density of NAPL make it unlikely to migrate within aquifers towards other users or ecosystems far from the site. Considerable attenuation can be expected to occur on migration of groundwater contamination some distance from the site.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Highly modified ecosystems with some habitat values	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Primary contact	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Secondary contact	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aesthetics enjoyment	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Normal populations	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aquaculture	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Commercial and recreation use of edible fish and crustacea	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Navigation & shipping	As above.	1	B	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Industrial water use	As above.	1	B	Negligible	As above.	As above.	

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Exposure path no.	Exposure path description	Beneficial use	Limiting contaminant	Severity	Likelihood	Risk	Controls	Comment	UNCERTAINTY
10ABCEHKLPT	Historical activities -> NAPL -> Leaching/ Infiltration/ Percolation -> Shallow groundwater -> Transfer -> Offsite shallow groundwater -> sewer -> discharge -> Offsite water body ie. **Western Treatment Plant**	Effluent discharge from the treatment plant is to Port Phillip Bay under EPA waste discharge licence.	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	1	B	Negligible	Dilution in sewer; waste water treatment at the plant; discharge limits set my EPA as per licence.	Because of the very high level of dilution in the sewer, ingress into the sewer is not expected to give rise to problems at the discharge of effluent from the sewage treatment plant.	The basis for the modelling and load to the sewer is uncertain and is being clarified.
10ABCFIMQ	Historical activities -> NAPL -> Leaching/ Infiltration/ Percolation ->Deep groundwater -> Transfer -> Deep groundwater -> Extraction/direct contact	Potable water supply: Desirable/ Acceptable	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	0	A	Negligible	Deep sewers intercept groundwater, although not in all areas.	Dissolved phase groundwater contamination has been identified in localised areas off site and close to the site. It is not clear that contamination of the deep aquifer has occurred, and this is less likely than the shallow aquifer. Considerable attenuation of contamination can be expected to occur on migration of groundwater some distance from the site.	Extent of contamination in deep aquifer is uncertain. Uncertain as to extent to which the deep groundwater will be intercepted by the sewer.
		Agriculture, parks & gardens	As above.	0	A	Negligible	As above.	As above.	As above.
		Stock watering	As above.	0	A	Negligible	As above.	As above.	As above.
		Industrial water use	As above.	0	A	Negligible	As above.	As above.	As above.
		Primary contact recreation (e.g. bathing, swimming)	As above.	0	A	Negligible	As above.	As above.	As above.
		Buildings and structures	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	0	A	Negligible	Groundwater is currently below the likely depth of most structures at the site.	Unlikely for structures to intersect deep aquifers.	Uncertainty as to whether the sewers will be repaired at some time in the future, giving rise to groundwater rise.
10ABCFIMRU	Historical activities -> NAPL -> Leaching/ Infiltration/ Percolation -> Deep groundwater -> Transfer -> Offsite deep groundwater -> offsite discharge -> Offsite water body I.e. **Port Phillip Bay**	WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Substantially natural ecosystems with some modifications	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	0	A	Negligible	Deep sewers intercept groundwater, and although do not offer complete groundwater containment, NAPL (if present) is not expected to migrate far from the site.	The high viscosity and density of NAPL make it unlikely to migrate within aquifers towards other users or ecosystems far from the site. Considerable attenuation can be expected to occur on migration of groundwater contamination some distance from the site.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Highly modified ecosystems with some habitat values	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Primary contact	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Secondary contact	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Secondary contact	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aesthetics enjoyment	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Normal populations	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aquaculture	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Commercial and recreation use of edible fish and crustacea	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Navigation & shipping	As above.	0	A	Negligible	As above.	As above.	
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Industrial water use	As above.	0	A	Negligible	As above.	As above.	
10ABDGJU	Historical activities -> NAPL -> Runoff -> Stormwater Drainage -> Discharge -> Offsite water body i.e. **Port Phillip Bay**	WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Substantially natural ecosystems with some modifications	coal tars & are oils; likely chemicals - VOCs and SVOCs, ie PAHs, BTEX, phenols	0	A	Negligible	The site is capped, although the extent and integrity of the capping is uncertain.	It is possible for some contamination to be present in the surface soils above sediment criteria applicable to the Bay. It may erode under storm conditions into the stormwater drainage system and reach the Bay. Dilution will occur with other run off into the stormwater system, and the potential for the contamination to give rise to significant areas of contaminated sediments (from the site) is low.	Uncertainties include the extent of surface soil contamination exceeding sediment criteria, the potential for surface soils to enter stormwater system, and the level of dilution that will occur prior to final discharge into the Bay.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Maintenance of aquatic ecosystems with some modification - Highly modified ecosystems with some habitat values	As above.	0	A	Negligible		As above.	As above.

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		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Primary contact	As above.	0	A	Negligible		As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Water based recreation - Secondary contact	As above.	0	A	Negligible		As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aesthetics enjoyment	As above.	0	A	Negligible		As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Normal populations	As above.	0	A	Negligible		As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Production of molluscs for human consumption - Aquaculture	As above.	0	A	Negligible		As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Commercial and recreation use of edible fish and crustacea	As above.	0	A	Negligible		As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Navigation & shipping	As above.	0	A	Negligible		As above.	As above.
		WoV Schedule F6 "General" Segment of Port Phillip Bay: Industrial water use	As above.	0	A	Negligible		As above.	As above.

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