- A screening assessment of the risks posed by ground contamination at the Site and identification of environmental investigation levels (**Section 8**) for assessing soil contamination, groundwater contamination, aesthetics, and soil-gas quality;
- A computer analysis of the volatilisation and vapour transport of volatile gases from contaminated soil and groundwater and their impact on indoor air quality (**Sections 9 & 11**);
- A site-specific health and ecological risk assessment, which has involved hazard identification, toxicological assessment, human health exposure assessment and ecological risk characterisation (**Section 13**); and
- Provision of conclusions and recommendations (**Section 14**).

The scope of the additional fieldwork and laboratory testing undertaken by SKM for this assessment comprised the following:

- The drilling of 13 clustered monitoring wells (both shallow and deep) for soil and groundwater sampling purposes (MW30 – MW42S);
- Soil gas sampling from 5 permanent monitoring wells located in areas of elevated volatile contamination (MW30-MW34);
- Sampling and laboratory testing of soil (8 locations) and groundwater samples (30 locations);
- Field screening of volatile soil-gas concentrations in sampled soils using a photo-ionisation detector (PID); and,
- In-situ falling head permeability tests at three wells.

2.3 Standards and Guidelines

2.3.1 Investigations

The site works conducted as part of the additional investigation have been undertaken in accordance with the appropriate legislative, health and safety (human and environmental) requirements.

The investigation has also been undertaken in accordance with the methodologies and technical requirements of:

- The NSW DEC (formerly NSW EPA) as specified in the DEC-endorsed documents listed on the NSW DEC webSite at www.epa.nsw.gov.au/clm/guidelines.htm;
- The Voluntary Investigation Agreement entered into by StateRail and the DEC; and
- State Environmental Planning Policy (SEPP) 55 for the remediation of contaminated land.

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2.3.2 Risk Assessment

The methodologies used by this study follow the latest protocols endorsed by the DEC for assessing the human health and ecological risks posed by ground contamination. These protocols are specified in the following guidelines issued by Australian health and environmental agencies:

- National Environment Protection Measures (1999) produced for the assessment of Site contamination by the National Environment Protection Council (NEPC)
- NSW EPA Guidelines on contaminated land
- National Environmental Health Forum Monographs
- South Australian Health Commission National Workshops on the health and ecological risk assessment and management of contaminated Sites
- Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines

The assessment has given precedence to the use of the most up-to-date criteria and guideline levels that have been developed by Australia and New Zealand regulatory agencies where available.

2.4 Risk Assessment Methodology

2.4.1 Use of Investigation Levels

The ANZECC/NHMRC (1992) and NEPC (1999d) guidelines define an *Investigation Level* as a *"concentration of a contaminant above which further appropriate investigation and evaluation will be required"*. This means that environmental media that have contaminant levels less than a set of appropriate Investigation Levels are considered no to pose a risk to human health or the environment for a specified land use and require no further investigation or evaluation. The first step in a risk assessment is therefore to determine whether environmental media at a site exceed *Investigation Levels* that are appropriate for the current or intended land use.

This first step in the risk assessment process has been undertaken in this study by:

- Reviewing and assessing the information and contamination data provided by previous investigations **(Section 5)**;
- Identifying the areas of environmental concern, the potential pathways of exposure, potential receptors of concern and contaminants of concern and then by assessing the data gaps in the previous investigations and designing an investigation that addresses these data gaps **(Section 6)**;
- Establishing *Investigation Levels* for the potential contaminants of concern at the Site for the land uses that are relevant to the future management of the Site **(Section 8)**; and

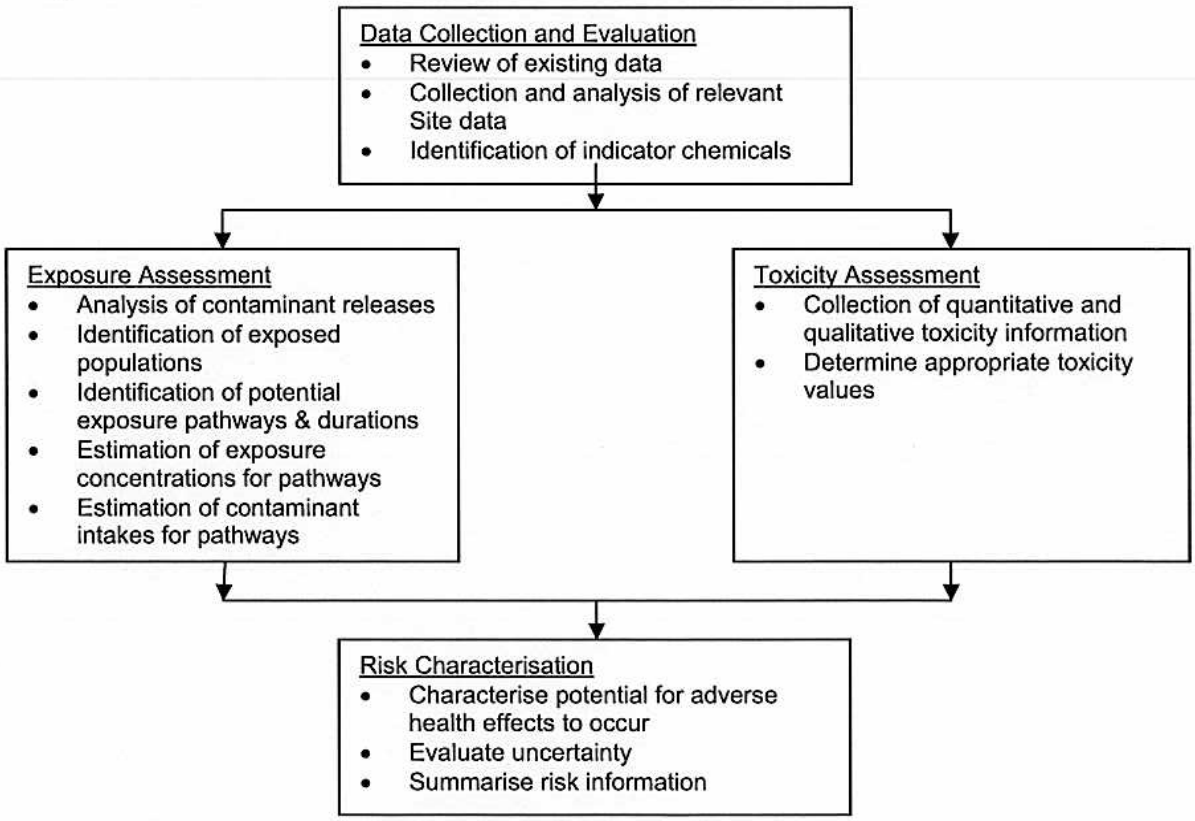
- Assessing the additional contamination data in terms of soil and soil vapour (**Section 9**) and groundwater and identifying areas of the site (if any) that exceed the *Investigation Levels* (**Section 10**).

For those portions of the Site found to exceed Investigation Levels, a site specific risk assessment has been undertaken. The methodology used in this study for undertaking a site-specific risk assessment for human health is described in **Section 2.4.2**, with the results provided in Section 12. The methodology for the site-specific ecological assessment is described in **Section 2.4.3**, with the results provided in **Section 13.5.**

2.4.2 Site Specific Risk Assessment for Human Health

The methodology used in this study for assessing risks to human health from ground contamination is based on the methodology given in the NEPC (1999a) Schedule B(4) guidelines, which have been endorsed by the DEC. The approach is consistent with international risk assessment methodologies. A diagrammatic representation of the health risk assessment methodology is shown in **Figure 2.**

- Figure 2 Human Health Risk Assessment Methodology



Reference: ANZECC & NHMRC (1992) & Langley (1993)

This methodology is intended to achieve the following four objectives:

- To establish baseline risks and whether site remediation or other action is necessary;
- To determine a tolerable level of contaminants that can remain in place with adequate protection of public health;
- To enable comparison of potential health impacts of various remediation techniques; and
- To provide a consistent method of appraising and recording public health risks at Sites.

The health risk assessment has been undertaken in four stages, with the following steps undertaken:

- Review of existing data, site inspection and collection and assessment of chemical data;
- Assessment of hazards posed by soil and groundwater contamination at the Site and the toxicity of contaminants of concern resulting in the derivation of a tolerable daily intake that is protective of human health;
- A human health exposure assessment examining the various ways that exposure to the contaminants may occur, background concentrations, identifying the affected population groups, and estimating the contaminant uptake levels for these groups; and,
- Risk characterisation involving the establishment of the remedial objectives and development of remediation strategies.

2.4.3 Site Specific Risk Assessment for Ecological Receptors

The methodology used in this study for assessing ecological risks from soil and groundwater contamination is based on the methodology given in the NEPC (1999c) Schedule B(5) guidelines, which have been endorsed by the DEC. This approach is consistent with international risk assessment methodologies. The methodology of Ecological Risk Assessment (ERA) consists of five basic components, these being problem identification, receptor identification, exposure assessment, toxicity assessment and risk characterisation. These components and the relationships between them are demonstrated in **Figure 3**.

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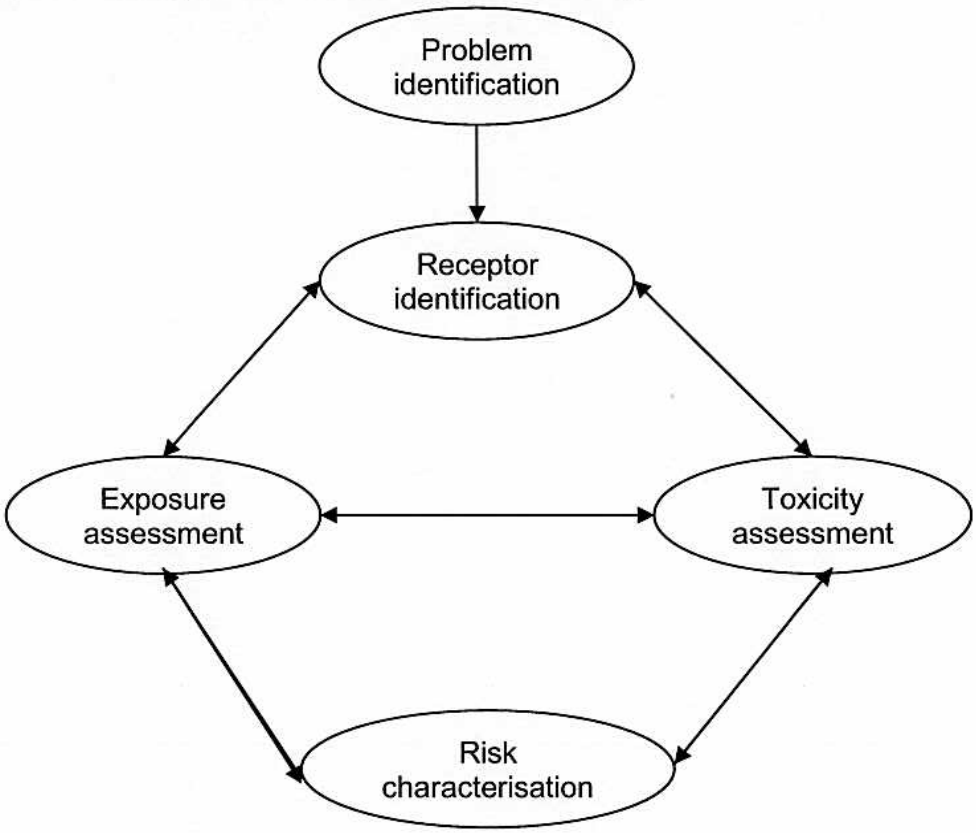
- Figure 3 Ecological Risk Assessment Methodology



Reference: NEPC (1999c)

The Problem Identification component is a scoping phase that establishes the objectives of the ERA and identifies the data that is required to achieve those objectives. The Receptor Identification component focuses on 'what species may be at risk' and 'what do we want to protect?' The NEPC (1999c) guidelines advise that this concept propose that not every organism may be at risk and not every organism can be protected. The assessment needs to focus on identifying the ecological values of a Site that need to be protected, taking into consideration societal relevance, ecological and economic significance. The Toxicity Assessment component involves determining the toxicity effects of the contaminants of concern to the potential receptors of concern. The Exposure Assessment component characterises the physical setting identifies potential exposure pathways and estimates exposure duration, concentrations and intakes. Risk Characterisation combines the exposure and toxicity information to determine the level of individual contaminants that may impact upon the receptors.

The NEPC guidelines describe how the ERA process can be undertaken at three different levels of detail. Each level consists of the same basic components but incorporates an increasing degree of data collection and complexity and decreasing uncertainty as an assessment proceeds from Level 1 to Level 3. Level 1 is a simple screening method designed to suit generic situations and protect all

biota likely to inhabit a Site. Level 2 involves a desktop study with limited field studies that provide an increased level of detail to components of the ERA process. Level 3 is a detailed risk assessment that involves field studies and detailed assessment techniques. Higher risk assessment levels are generally only applied to those contaminants and organisms that fail environmental criteria when assessed during a lower level risk assessment.

2.5 Definitions and Acronyms

A number of abbreviations have been adopted throughout this report and are detailed below:

- ANZECC – Australia New Zealand Environment and Conservation Council
- ANZFA – Australia New Zealand Food Authority
- ARMCANZ – Agriculture and Resource Management Council of Australia and New Zealand
- ATSDR – Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services
- BTEX – Benzene, Toluene, Ethyl benzene and Xylene
- CLM Act – Contaminated Land Management Act
- CoC – Chain of Custody
- DEC – Department of Environment and Conservation
- DIPNR – Department of Infrastructure, Planning and Natural Resources
- DO – Dissolved Oxygen
- DP – deposited Plan
- EIL – Ecological Investigation Levels
- EMP – Environmental Management Plan
- EPA – Environment Protection Authority
- ERA – Ecological risk assessment
- FDA – US Food and Drug Administration
- HIL – Health Investigation Levels
- IARC – International Agency for Research on Cancer
- IPCS – International Programme on Chemical Safety
- IRIS – US EPA Integrated Risk Information System
- mg – milligrams (10^{-3} grams)
- MRLs – Maximum residue limits
- MS – Matrix Spike
- MSD – Matrix Spike Duplicate
- NATA – National Association of Testing Authorities, Australia
- NEHF – National Environment and Health Forum
- NEPC – National Environment Protection Council
- NEPM – National Environment Protection Measure
- ng – nanograms (10^{-9} grams)

- NHMRC – National Health and Medical Research Council
- NSW – New South Wales
- OCPs – Organochlorine Pesticides
- OH&S – Occupational Health and Safety
- OPPs – Organophosphate Pesticides
- OSHA – Occupational Safety & Health Administration (US Department of Labor)
- PAHs – Polycyclic Aromatic Hydrocarbons
- PCBs – Polychlorinated biphenyls
- PID – Photo-ionisation Detector
- pg – picograms (10^{-12} grams)
- ppb – parts per billion (ie. µg/kg)
- ppt – parts per trillion (ie. ng/kg)
- PTDI – Provisional Tolerable Daily Intake
- QA/QC – Quality Assurance/Quality Control
- RAP – Remediation Action Plan
- RPD – Relative Percent Difference
- SEPP – State Environment Planning Policy
- SKM – Sinclair Knight Merz
- SLRA – Screening level health and ecological risk assessment
- SPCC – State Pollution Control Commission
- TSS – Total suspended solid
- TDS – Total Dissolved Solids
- TPH – Total Petroleum Hydrocarbons
- UCL – Upper confidence limit
- µg – micrograms (10^{-6} grams)
- US EPA – United States Environment Protection Agency
- WHO – World Health Organisation

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3 Site Description

This section of the report provides an overview of the physical conditions at the Site and surrounding areas. The physical features that are assessed include Site location, surrounding land uses, topography, surface hydrology, geology, hydrogeology, surface conditions, underground structures and buried services, and sensitive environments. The information is used as a basis for the contamination assessments provided in later sections of this report.

3.1 Site Location and Surrounding Land Uses

The Former Gasworks site along with the adjacent Former Cleaning Shed site is referred to as "The Macdonaldtown Triangle" and is identified as Lot 50 in Deposited Plan 1001467 in the Local Government Area of South Sydney, Parish of Petersham and County of Cumberland. The site comprises the former gasworks area and the former cleaning sheds (**Figure 4**). Two additional areas, referenced as the "Neck" and the "Adjoining properties" also make up part of the site, however these are not to be considered under the current scope of works. Groundwater wells that have been installed in these areas may however be included in the sampling regime and groundwater modelling exercise.

A gasworks operated by the predecessors of StateRail formerly occupied approximately 8,000 m^2 of "The Macdonaldtown Triangle" site, with the remaining 15,000 m^2 being used for a range of railway related activities that included cleaning, sheds and rail sidings. The site is generally bounded by railway and rail related activities to the north, the south and east. The Former Cleaning Shed site to the north is to be redeveloped by RailCorp for use as a train stabling facility that is to consist of six siding tracks, staff amenities buildings, drainage infrastructure and landscaping. Residential properties are located to the west.

The site is generally unsealed, triangular in shape, with all buildings and structures removed except for two disused gas holders in the south west of the site and associated structures such as tar pits and building foundations. Surrounding land uses include Macdonaldtown Railway Station and the main Western railway line to the north, railway lines to the east, the Illawarra railway line to the south and residential properties to the west.