ABIGAIL BOYD MLC

MEMBER OF THE NSW LEGISLATIVE COUNCIL

7th September 2020

Dear Public Works Committee,

Inquiry into costs for remediation of sites containing coal ash repositories

Please find enclosed the following documents to be tabled as part of the above inquiry:

1. **Bayswater Power Station**

   a. Preliminary Environmental Site Assessment - Part 1 – Environmental Resources Management – October 2013

   b. Stage 2 Environmental Site Assessment - Part 1 – Environmental Resources Management – 31 January 2014

2. **Eraring Power Station**

   a. Preliminary Environmental Site Assessment – Part 1 – Environmental Resources Management – 27 June 2013

   b. Stage 2 Environmental Site Assessment – Part 1 – Environmental Resources Management – December 2015

3. **Liddell Power Station**

   a. Preliminary Environmental Site Assessment – Part 1 – Environmental Resources Management – October 2013

   b. Stage 2 Environmental Site Assessment – Part 1 – Environmental Resources Management – 31 January 2014

   c. Updated Groundwater Quality Assessment – Part 1 – Environmental Resources Management – 5 June 2015

4. **Liddell and Bayswater Power Stations – Stage 2 PFAS Investigation – Part 1 – AECOM – 28 June 2019**

Parliament House
6 Macquarie Street
Sydney NSW 2000
Tel: (02) 9230 3676

abigailboyd.org

abigailboydmlc

5. Mt Piper Power Station

a. Preliminary Environmental Site Assessment - Part 1 – Environmental Resources Management – July 2013

b. Sampling Analysis and Quality Plan - Part 1 – Environmental Resources Management – September 2013

c. Stage 2 Environmental Site Assessment - Part 1 – Environmental Resources Management – August 2014

6. Vales Point Power Station

a. Preliminary Environmental Site Assessment - Part 1 – Environmental Resources Management – 5 February 2014

b. Stage 2 Environmental Site Assessment - Part 1 – Environmental Resources Management – July 2014

c. A Station, Environmental Site Assessment – Part 1 – Environmental Resources Management – September 2014

d. Additional Baseline Contamination Assessment – Part 1 – Jacobs – July 2017

e. Consolidated PFAS Report – Part 1 – Jacobs – 14 December 2018

Warm regards,

Abigail

Parliament House
6 Macquarie Street
Sydney NSW 2000
Tel: (02) 9230 3676

abigailboyd.org

abigailboydmlc

DOCUMENT 1a

Bayswater Power Station

Preliminary Environmental Site Assessment – Part 1

Environmental Resources Management

October 2013

Macquarie Generation

COMMERCIAL IN CONFIDENCE

Macquarie Generation – Project Symphony

Bayswater Power Station

Preliminary Environmental Site Assessment

Ref: 0213879RP01_DRAFTRev02

October 2013

The world's leading sustainability consultancy

ERM

COMMERCIAL IN CONFIDENCE

Bayswater Power Station

Preliminary Environmental Site Assessment

Macquarie Generation - Project Symphony

October 2013

Approved by:	Joseph Ferring
Position:	Project Manager
Signed:	DRAFT
Date:	18 October 2013
Approved by:	Matthew Klein
Position:	Managing Partner - Asia Pacific Transaction Services
Signed:	DRAFT
Date:	18 October 2013

Environmental Resources Management Australia Pty Ltd Quality System

0213879RP01_DRAFT Rev02

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EXECUTIVE SUMMARY

ERM was engaged by Macquarie Generation to provide advice in relation to potential soil and groundwater contamination issues which may be relevant to the sale of certain electricity generation assets owned and operated by Macquarie Generation. The subject of this report is the Bayswater Power Station.

The specific objectives for this stage of ERM's scope of works were to:

- *assess the nature and extent of potential soil and groundwater contamination issues which may be present at the Site;*
- *develop a preliminary Conceptual Site Model; and*
- *develop an abridged Sampling, Analysis and Quality Plan (SAQP) for the future intrusive investigations required to establish a baseline of soil and groundwater conditions present at the Site to support the potential sale of the Site.*

ERM has undertaken this Preliminary Environmental Site Assessment (ESA) which includes background research from a variety of sources as well as management and staff interviews and site visits.

The Preliminary ESA identified a number of potential contamination sources, of which several were determined as Areas of Environmental Concern (AECs) as follows in no particular order:

- *brine concentrator holding pond (potential seepage of brine);*
- *brine concentrator decant basin (historical seepage of brine);*
- *fuel oil installation (potential leaks);*
- *vehicle refuelling depot (potential leaks);*
- *coal storage area (historical and potential leaks);*
- *coal unloaders, rail infrastructure and coal transfer lines (potential and historic leaks);*
- *contaminated water treatment plant (potential leaks);*
- *cooling water treatment plants (historical and potential leaks, releases to ground);*
- *demineraliser plant (historical and potential leaks);*
- *former contractor staging area (potential spills, leaks and undocumented fill material);*
- *former large items assembly area ((potential spills, leaks and undocumented fill material);*

- *generator transformer areas (large volume of transformer oil used and stored);*
- *landfill (unknown waste disposal, potential for leaching to occur);*
- *lime softening plant (storage of chemicals, potential for leaks);*
- *lime softening plant sludge lagoons (disposal of spent softening plant sludge and potential for leaching);*
- *mobile plant maintenance and refuelling (historical leaks and spills of diesel fuel and lubricants, potential leak of waste oil);*
- *Pikes Gully Ash Dam (seepage to groundwater and surface water receptors);*
- *Ravensworth Rehabilitation Area (seepage to groundwater and surface water receptors);*
- *high pressure pumping station (potential leaks/spills of transformer oil);*
- *low pressure pumping station (potential leaks/spills of transformer oil);*
- *main store – dangerous goods storage area (potential leaks/spills and release through sump/dam);*
- *power block (historical and potential leaks of various chemicals); and*
- *Lake Liddell sediments (sediments may have accumulated contaminants from Liddell Power Station drainage and discharges over a lifetime of station operation and precipitation of calcium carbonate).*

Based on the results of the Preliminary ESA undertaken by ERM and consideration of Macquarie Generation's intended approach to establishing a baseline of soil and groundwater contamination, a programme of intrusive (Stage 2) assessment of potential soil and groundwater contamination issues is provided.

The most appropriate sampling design is considered to be a judgemental (targeted) sampling of soil, groundwater and sediments at the established AECs for the Site, which is also considered to provide suitable spatial coverage to act as a baseline assessment.

LIST OF ABBREVIATIONS

AEC	Area of Environmental Concern
ACM	Asbestos Containing Materials
AHD	Australian Height Datum
ANZECC	Australia and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASLP	Australian Standard Leaching Procedure
AST	Above-ground Storage Tank
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
CEC	Cation Exchange Capacity
COPC	Contaminant of Potential Concern
DNAPL	Dense, Non-Aqueous Phase Liquid
DP	Deposited Plan
DQO	Data Quality Objective
EC	Electrical Conductivity
EDD	Environmental Due Diligence
EIL	Ecological Investigation Level
EIS	Environmental Impact Statement
EMS	Environmental Management System
EPA	Environment Protection Authority
EP&A	Environmental Protection and Assessment
EPL	Environment Protection Licence
ERM	Environmental Resources Management
ESA	Environmental Site Assessment
ESL	Ecological Screening Level

HIL	Health Investigation Level
HSL	Health Screening Level
LDPE	Low-Density Polyethylene
LEP	Local Environmental Plan
LGA	Local Government Area
LNAPL	Light, Non-aqueous Phase Liquid
m bgl	metres below ground level
m btoc	metres below top of casing
MGA	Map Grid of Australia
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NSW	New South Wales
OEH	Office of Environment and Heritage
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
PID	Photo-ionisation Detector
PRP	Pollution Reduction Plan
PSH	Phase Separated Hydrocarbon
QA/QC	Quality Assurance and Quality Control
RCU	Rail Coal Unloader
RFP	Request for Proposal
RIVM	Netherlands National Institute of Public Health and the Environment
RO	Reverse Osmosis

SAQP	Sampling, Analysis and Quality Plan
SOC	State-Owned Corporation
SOP	Standard Operating Procedure
SPR	Source-Pathway-Receptor
SVOC	Semi-Volatile Organic Compound
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TRH	Total Recoverable Hydrocarbons
UPSS	Underground Petroleum Storage System
UST	Underground Storage Tank
VEDD	Vendor Environmental Due Diligence
VOC	Volatile Organic Compound

1 INTRODUCTION

1.1 BACKGROUND

On 24 November 2011, the New South Wales (NSW) State Government (Government) announced that it would divest certain State-owned electricity generation assets..

In order to support the sale of certain electricity generation assets owned and operated by Macquarie Generation (a State Owned Corporation - SOC), ERM were engaged as the Site Contamination Environmental Adviser (the 'Adviser') to provide advice in relation to potential soil and groundwater contamination issues which may be relevant to the transaction. The subject of this report is Bayswater Power Station (the 'Site').

1.2 OBJECTIVE

The specific objectives for ERM's scope of works were to:

- assess the nature and extent of potential soil, sediment and groundwater contamination issues which may be present at the Site and relevant receiving environments; and
- identify what additional works may be required to establish a baseline of soil, sediment and groundwater conditions present at the Site to support the potential sale of the asset.

This Preliminary Environmental Site Assessment (ESA) comprises Stage 1 of the overall assessment, with Stage 2 comprising a detailed ESA in order to achieve the overall project objectives stated above.

1.3 SCOPE OF WORK

The scope of this Preliminary ESA was presented in the ERM proposal dated 3 July 2013 and included the following key elements:

- development of a site history via interviews with employees and review of information such as:
  - relevant documents identified by employees;
  - the database managed by the NSW Office of Environment and Heritage for information on notices issued by the NSW EPA under the *Protection of the Environment Operations Act 1997* and the *Contaminated Land Management Act 1997;*

- aerial photographs; and
- civil engineering works records.

- review of existing soil and groundwater reports;
- desktop assessment of the environment in which the Site is set such as site drainage, geology, hydrogeology and soil conditions at the Site and surrounding areas;
- inspection of the Site;
- identification of actual and/or potential soil and groundwater Areas of Concern (AECs) via:
  - identification of past and present potentially contaminating activities at, and adjacent to, the Site;
  - identification of potentially impacted areas;
  - identification and assessment of the chemicals of potential concern (COPCs) that may have been associated with historical and current use of the Site;
  - evaluation of the possible migration pathways of the COPCs;
  - assessment of the sensitivity of surrounding areas and/or property; and
  - compiling a preliminary Conceptual Site Model (CSM).
- Identifying where Stage 2 intrusive investigations are necessary on each site and, more specifically:
  - where it may be necessary to undertake a preliminary sampling and analysis program at each site to assess the need for detailed investigation; and
  - a detailed scope-of-works for Stage 2 investigations at each site.

Spatially, the scope of ERM's assessment was limited to those areas shown within the Site boundary presented in *Figures* 1 and 2 of *Annex A*.

1.4 *MATERIAL THRESHOLD*

ERM adopts a technically rigorous approach to assessing potential risks and liabilities during Environmental Due Diligence (EDD), and typically focuses on what is *material* to the transaction. In this situation, a material threshold was applied to items contained within the EDD reports.

Based on ERM's experience of similar projects and discussions with the Client, ERM adopted a material threshold of $0.5M (+ GST if applicable) per contamination source.

In other words, in identifying contamination sources, ERM sought to define actual or potential sources where costs of remediation or management of the sources as required by regulators would exceed $0.5M (+ GST if applicable). Remediation or management includes additional assessment, environmental monitoring, management, containment or other remediation measures.

In addition, any issue that ERM considers could have the potential to lead to prosecution by the regulatory authorities that could lead to significant business disruption or reputational impact will be considered material.

1.5 *APPROACH AND METHODOLOGY*

ERM's approach to the assessment was to break the work down into individual tasks as presented in the following sections.

1.5.1 *Project Initiation Meeting*

In order to ensure that ERM and Macquarie Generation were fully aligned in terms of the scope and anticipated deliverables, the key members of the ERM project team attended a project initiation meeting with Macquarie Generation and NSW Treasury at the Site.

1.5.2 *Review of Existing Data*

Relevant environmental information on Bayswater Power Station was made available to ERM via an electronic dataroom.

In addition, ERM conducted background research using publicly available information on the Site. Background research included those items identified in *Section 3*, and *Annex D*. Following discussions with Macquarie Generation and given the timescale of this assessment, the large number of lots comprising the Site, the good level of information available on the history of the Site available from both knowledgeable Macquarie Generation personnel and a review of historic aerial photography (refer to *Section 3.2*) a search of historic land titles and S. 149 certificates has not been undertaken.

A site setting review was also undertaken to understand both the sensitivity of the surrounding area to environmental impact and the potential impact on the Site resulting from neighbouring activities, past and present. Key areas addressed included site description and activities, site history, geology, hydrogeology and hydrology (refer to *Section 2*).

1.5.3 *Site Visits and Management Interviews*

ERM mobilised to site and completed site management interviews and a site visit to Bayswater Power Station on 15 and 16 August 2013.

The assessment focussed on potentially material contamination issues that were considered likely to require further assessment relevant to Bidders and to identify where a baseline assessment may be required. Topics that were evaluated as non-material were not assessed in detail.

During the site visit, discussions and interviews were undertaken with the following staff:

- Environmental Manager - Mr. Howard Richards (environment team manager for both stations, based at Liddell Power Station);
- Environment Officer - Mr. Matthew Parkinson (environment specialist for Bayswater Power Station, based at Bayswater Power Station);
- Environment Officer - Ms. Elle Hutchinson (environment specialist for Bayswater Power Station, based at Bayswater Power Station);
- Electrical Engineer - Mr. Trevor Woolley (Bayswater Power Station); and
- Site Engineer - Mr. John Bennetts (Liddell and Bayswater Power Stations).

1.5.4 *Preparation of Stage 1 ESA Reports*

The Stage 1 ESA Reports were prepared in general accordance with the *Guidelines for Consultants Reporting on Contaminated Sites* (NSW OEH, 2011) on the basis of information collected during the previous tasks. In preparing these reports, (and in particular the proposed scope of work for Stage 2 assessments) ERM utilised a combination of experience gained in the planning and delivery of similar vendor due diligence projects for government, professional judgement of suitably qualified contaminated land professionals and reference to relevant guidelines made or approved under the *Contaminated Land Management Act 1997*, the National Environment Protection Council (NEPC) (2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1), the* Australian and New Zealand Environment and Conservation Council (ANZECC) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* and guidelines and technical notes relating to the *Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation* 2008 (made under the *Protection of the Environment Operations Act 1997*).

1.6 *REPORT STRUCTURE*

This report has been structured in order to align generally with the requirements for a Preliminary Environmental Site Assessment outlined in NSW EPA (2011) *Guidelines for consultants reporting on contaminated sites.* Where necessary, minor additions and modifications to the structure have been made to accommodate the fact that this assessment is being undertaken for a specific purpose (that being Vendor Environmental Due Diligence - VEDD).

2 SITE DESCRIPTION AND SURROUNDING ENVIRONMENT

2.1 SITE IDENTIFICATION

Macquarie Generation owns and operates two large conventional coal-fired power stations in the Hunter Valley region of New South Wales. Liddell Power Station and Bayswater Power Station are located within three kilometres (km) of each other on either side of the New England Highway, approximately 25 km north-west of the township of Singleton and approximately 10 km to the south-east of the township of Muswellbrook. The two power stations share some infrastructure such as coal and water supply.

A site location plan is provided as *Figure 1* of *Annex A*. The approximate coordinates of Bayswater Power Station are 307 144 m E and 6 413 998 m S. The Lot and Deposited Plan (DP) information relevant to the Site is outlined in *Annex C*. ERM notes that this information is considered to be preliminary at the time of preparation of this report as the Macquarie Generation ownership boundaries are in the process of being clarified.

Based on the possible separation of assets between Bayswater and Liddell Power Stations as set out in *Proposed Liddell & Bayswater B Subdivision* (Chelace GIS, 2013), the shared infrastructure has been allocated as follows:

- the land associated with the water transfer lines and coal transfer lines between the power stations have been separated by assessing the portions located within the boundaries of the respective sites as indicated on *Figure 3* of *Annex A;*
- Antiene Rail Coal Unloader (RCU) and Ravensworth RCU have been assessed as part of Bayswater Power Station; and
- Lake Liddell has been assessed as part of Bayswater Power Station.

2.2 SITE DESCRIPTION

2.2.1 *Overview*

Bayswater Power Station received development approval from Muswellbrook Shire Council on 18 September 1980, with construction occurring between 1980 and 1986. The power station was commissioned in 1986.

Photographs of the Site are presented in *Annex B*.

2.2.2 *Site Layout*

According to information provided by Macquarie Generation, Bayswater Power Station is one of Australia's largest power stations. The total site area of Bayswater Power Station is approximately 8 300 hectares (ha), including the Ravensworth Rehabilitation Area, Lake Liddell and surrounds and buffer lands not currently in active use . The power station operational area itself occupies approximately 300 ha, which includes the Pikes Gully Ash Dam. A plan showing the layout of the operational area is provided as *Figure* 2 of *Annex A*.

Bayswater Power Station comprises four coal-fired units (Units 1 to 4, each generating 660 MW) which have a combined generating capacity of 2,640 MW for the station. Further information on electricity generation and distribution processes is presented in *Section 4*.

The Site is composed of the following key features:

- Bayswater Power Station and associated infrastructure;
- Pikes Gully Ash Dam, located approximately 200m to the east and associated pipelines for ash slurry and return water;
- Ravensworth Rehabilitation Area (fly ash disposal), including the former Ravensworth No.2 and Ravensworth South final voids, located approximately 8 km east south-east of the power station and associated ash delivery and return water system;
- coal conveyors transporting from Antiene RCU and nearby mines and between Liddell Power Station and the Site; and
- buffer lands surrounding the infrastructure described above;
- A 330 kV and 500kV switching station located to the south-west of the power block. This station switchyard is owned and operated by the transmission SOC TransGrid (assessment of conditions within the switchyard boundary is outside the scope of this report) ;

In addition to Lake Liddell, water is supplied from off-site storage facilities detailed in *Section 4*. Review of environmental conditions at these off-site water storage facilities is outside the scope of this report.

2.3 *TOPOGRAPHY*

The Site lies within a broad river valley created by the Hunter River and its tributaries. Whilst the general slope in the area is towards the Hunter River in the south, the topography is characterized by undulating hills that leads to high variability in slope direction across the Site.

The Bayswater Power Station operational area was identified to gently slope to the north with the main power block cut into the slope of a hill. The power block lies at an elevation of approximately 200 m above sea level, dropping to an elevation of approximately 170 m above sea level at the northern edge of the coal storage facility. The Pikes Gully Ash Dam lies at an elevation of approximately 170m above sea level, with the down gradient Pikes Gully valley sloping towards the east. The Ravensworth Rehabilitation Site lies at an elevation of 120 m above sea level, with the local topography highly disturbed by former mining operations.

2.4 *GEOLOGY*

The Site is located on the northern section of the Sydney Geological Basin and the 1:100 000 Hunter Coalfield geological map (Department of Mineral Resources 1993) indicates that the Bayswater Power Station is underlain by Permian age conglomerate, sandstone, siltstone and claystone of the marine derived Maitland Group.

While the majority of the Pikes Gully Ash Dam (see *Section 4.9.1* for a description of the ash dam) is located on the Mulbring Siltstone of the Maitland Group, the eastern most extent of the Pikes Gully Ash Dam is located on the sandstone, siltstone and minor coal bands of the Saltwater Creek Formation of the Wittingham Coal Measures, Singleton Supergroup.

The 1:100 000 Hunter Coalfield geological map further indicates that Quaternary age alluvial sediments (consisting of silt, sand and gravel) are associated with the Bayswater Creek, Foy Creek and the Hunter River.

The Ravensworth Rehabilitation Site (in the location of the former Ravensworth No.2 Mine and a section of the Ravensworth South Mine, see *Section 4.9.2* for further details) is underlain by the Jerrys Plain Subgroup, Archfield Sandstone and the Foybrook Formation within the Wittingham Coal Measures. Together these sedimentary deposits consist of a sequence of sandstones, shales, mudstone, minor conglomerate and coal seams (Pacific Power, 1993).

The surface geology has been extensively disturbed by mining in the vicinity of the Ravensworth Rehabilitation Site. Much of the opencast mine workings at the Ravensworth Rehabilitation Site have been backfilled with mine spoil largely composed of course fragments (often boulders) of mudstone, siltstone and medium to fine grained lithic sandstone mixed together. In addition, the spoil contains coal from uneconomic seams which were included with the overburden material (Pacific Power, 1993).

This remnant coal is subject to spontaneous combustion which has been documented at the Site. Where mining has been completed at Ravensworth No.2 Mine, approximately 60 to 80 metres of disturbed overburden or mine spoil overlies the Archerfield Sandstone which forms the base of the opencast mine workings (Pacific Power, 1993). In addition, part of the Ravensworth No.2 Mine have been backfilled with fly ash (Voids 1 to 3) and coal preparation plant rejects (eastern ramp of Void 4) (Aurecon, 2012).

The Ravensworth Rehabilitation Site further occurs in a synclinal structure known as the Bayswater Syncline, with the axis of the syncline trending approximately north south along the centre of the mined area and plunging gently (1 to 2 degrees) to the south. The slopes on the flanks of the syncline dip gently (about 3 degrees) towards the centre. It is further noted that isolated basalt dykes or sills may occur within the stratigraphy in the general area (Pacific Power, 1993).

Bore logs for existing monitoring wells at the Site were not available for review at the time of preparation of this report; consequently local geology specific to various areas of the Site is not reviewed herein.

2.5 *HYDROGEOLOGY*

From a hydrogeology perspective, the sedimentary deposits can be categorised into the following units:

- Low permeability conglomerate, sandstone, siltstone and mudstone that comprise the majority of the Permian sediments.
- Low to moderately permeable coal seams, typically ranging in thickness from 2.5 m to 10 m, which are the prime water bearing strata within the Permian sequence.
- Medium to highly permeable Quaternary alluvial sediments associated with the Bayswater Creek, Foy Creek and the Hunter River.

Regional groundwater flow is expected to be towards the Hunter River located to the south of the Site. Due to the undulating nature of the topography, variation in localised groundwater flow directions are however probable with groundwater flow expecting to follow topography. Inferring localised groundwater flow from topography would suggest a northerly groundwater flow component at the Bayswater Power Station towards Lake Liddell, predominantly easterly groundwater flow at the Pikes Gully Ash Dam, westerly flow at the Landfill, westerly to north westerly at the Brine Concentrator Decant Basin, and predominantly southerly flow at Lime Softening Sludge Lagoons (refer to *Section 3.4.3* for a description of the aforementioned operational areas).

Groundwater flow at the Ravensworth Rehabilitation Site is predominantly towards the Hunter River (along the southerly dip of the Bayswater Syncline) with a minor component of lateral discharge to the Bayswater Creek and Foy Brook (Pacific Power, 1993).

The sediments of marine origin are responsible for the naturally highly saline groundwater in the area. Groundwater in the Permian coal measures is reportedly moderately to highly saline with total dissolved solids (TDS) levels that can be higher than 6 000 mg/L (Pacific Power, 1993). Water quality monitoring conducted in Void 4 (used as a water management storage system receiving drainage water from the surrounding voids and mine spoils) further indicate that salinity levels in water from Void 4 averaged approximately 4 600 mg/L (based on an average electrical conductivity of 7 079 μS/cm and a conversation factor of 0.65) during monitoring conducted in 2012 (Macquarie Generation, 2012).

2.6 *GROUNDWATER USE*

The NSW Natural Resource Atlas online bore register (accessed 14 August 2013) identifies groundwater bores within a 5 km radius of the Bayswater Power Station registered for dewatering purposes, industrial use and groundwater monitoring. Thirteen licensed bores were identified within a 5 km radius of the Site and are listed in *Annex D*. These bores were registered for various uses, comprising industrial, dewatering and test/monitoring purposes.

The NSW Natural Resource Atlas was also accessed for registered bores in relation to the Ravensworth Rehabilitation Site. Due to the large number of registered bores within a 5 km radius of this area (>150), the search area was reduced to 1km. Forty-one licensed bores were identified within a 1 km radius of the Ravensworth Rehabilitation Area and are listed in *Annex D*.

Four of the identified bores for the Ravensworth Rehabilitation Site are registered for domestic water supply purposes. These bores (GW046786 to GW046789) are located within 300 m to the east of the Ravensworth Rehabilitation Site, and have been installed at relatively shallow depths (<7 metres below ground surface) in alluvial sediments likely associated with the nearby Foy Creek. Note that these bores have been identified in close proximity to a residential property located at 7 and 9 Hebden Road (see *Section 2.8* for further details). Information provided verbally by Macquarie Generation indicated that this residential property is currently owned by Glencore Xstrata and the bores are no longer used for the registered purposes.

A bore licensed for irrigation stock use (GW024385, with an installation depth of 4.6 metres below ground surface and unknown lithology) was identified within approximately 600 m of the Ravensworth Rehabilitation Site to the east.

In addition, a bore licensed for industrial use with intended use specified as domestic stock use in the database (GW078054, with an installation depth of 16.2 metres below ground surface installed in sandstone) was identified within approximately 100 m of the Ravensworth Rehabilitation Site to the east. The remaining bores within a 1km radius of Ravensworth presented in *Annex D* are licensed for test bore purposes, dewatering, unknown purposes or as monitoring bores Current uses of these bores were unknown at the time of assessment.

2.7 *HYDROLOGY*

The major hydrological feature in the Hunter Valley is the Hunter River, located approximately 10 km and 3 km to the south of the Bayswater Power Station and the Ravensworth Rehabilitation Site, respectively. In addition, several local waterways are found in the vicinity of the Site and the main hydrological features can be summarised as follows:

- Tinkers Creek, running along the western boundary of the Bayswater Power Station and draining into Lake Liddell in the north;
- Lake Liddell, located approximately 1.5 km to the north east of the Bayswater Power Station;
- Bayswater Creek, draining from Lake Liddell. Bayswater Creek runs along the western boundary of the Ravensworth Rehabilitation Site, ultimately draining into the Hunter River;
- Foy Creek, running along the eastern boundary of the Ravensworth Rehabilitation Site, ultimately draining into the Hunter River;
- Saltwater Creek and Wisemans Creek, draining to the south into the Plashett Dam;
- the Plashett Dam (also known as Plashett Reservoir), located approximately 4 km to the south west of the Bayswater Power Station;
- the Freshwater Dam, located adjacent and directly to the west of the Bayswater Power Station;
- the Bayswater Cooling Water Makeup Dam, located directly to the south of the Bayswater Power Station;
- the Pikes Gully Ash Dam (which holds a considerably amount of surface water) located to the east of the Bayswater Power Station;
- the Brine Concentrator Holding Pond, located approximately 740m to the south east of the Bayswater Power Station;

- the Brine Concentrator Decant Basin, located approximately 1.3 km to the south west of the Bayswater Power Station; and
- void 4 at the Ravensworth Rehabilitation Site, which acts as a water management storage system.

Operational use of the dams and ponds listed above are outlined in *Section 4.2*.

2.8 *SURROUNDING ENVIRONMENT*

The Site is surrounded by areas used mainly for mining purposes with some grazing, bushland, viticulture and thoroughbred horse stud farms in the region.

Key industrial uses in the area include:

- Macquarie Generation's Liddell Power Station located approximately 4 km to the north-east of the Bayswater Power Station; and
- existing and former coal mines surrounding the Site and within the Site footprint at the Ravensworth Rehabilitation Site.

The closest residential areas to the Site include:

- rural residencies that do not form part of residential centres. The closest identified residential property is located at 7 and 9 Hebden Road (in close proximity to the intersection with the New England Highway). The identified property is located approximately 130 m east of the Ravensworth Rehabilitation Site; however verbal information provided by Macquarie Generation indicates that this property is owned by Glencore Xstrata and is no longer occupied as a residence;
- Muswellbrook, located approximately 11 km to the north-west of the Bayswater Power Station;
- Jerrys Plains Village, located approximately 11 km to the south of the Bayswater Power Station; and
- Singleton, located approximately 25 km to the south-east of the Bayswater Power Station and 12 km south-east from the Ravensworth Rehabilitation Site.

2.9 *SENSITIVE RECEPTORS*

A summary of sensitive receptors identified as relevant to the Site include:

- indoor and outdoor human health receptors in the form of industrial on-site and off-site users;

- intrusive maintenance workers both on and on-site;
- residential receptors and potential groundwater users;
- recreational users of Lake Liddell (the closest surface water body where recreational access is currently approved);
- aquifers beneath the Site and nearby potable water wells; and
- ecological receptors, including freshwater ecological receptors in the local creeks, Lake Liddell, the Plashett Dam and the Hunter River.

3 SITE HISTORY AND REGULATORY SETTING

3.1 SUMMARY OF SITE HISTORY

Information provided by Macquarie Generation management and a review of aerial photographs (refer below) indicates that prior to construction of the Bayswater Power Station, the Site and surrounds were primarily occupied by a mixture of farms, native vegetation and coal mines.

Construction of the power station commenced in 1980, with completion in 1986. Two large areas outside of the current power station operational area were used as staging areas during construction; a contractor staging area was located to the south of Freshwater Dam and the Large Items Assembly Area was located to the north-west of the current coal stockpile area. Both of these areas ceased being used upon completion of the power station in 1986. The layout of the power station and surrounding buffer lands owned by Macquarie Generation has stayed largely consistent since 1986.

3.2 SUMMARY OF HISTORICAL AERIAL PHOTOGRAPHS

A review of historic aerial photographs was conducted by ERM and is summarised in *Table 3.1* (below). Copies of the photographs reviewed are included in *Annex D*.

Table 3.1 Summary of Historical Aerial Photographs

Year	Site	Surrounding Area
1974	The Bayswater Site is undeveloped with the exception of Freshwater Dam. The area surrounding the dam is vegetated, and the remainder of the site is clear with unsealed tracks and roadways. East of the primary Bayswater Site, within the Ravensworth Rehabilitation Area, the Ravensworth open-cut mine is in operation. Site infrastructure including office buildings, roadways, and surface water bodies (located immediately north of the cutting, and on the eastern site boundary) are established. This area is sparsely vegetated.	The Liddell Power Station is located on the western foreshore of Lake Liddell, located north-east of the Site. The Liddell Ash Dam and Ash Skimmer Dam north of the Bayswater Site supports the Liddell Power Station. A coal conveyor runs south of the Lake, between the Liddell Power Station and Ravensworth Coal Unloader facility. Several apparent dams occupy an area along the south-eastern foreshore of Lake Liddell. The Howick open-cut mine is located immediately east of the Site, and the Swamp Pit mine is situated north-east of the Ravensworth mine. A third open cut mine is situated east of Lake Liddell and adjacent to Swamp Pit mine. Generally, the surrounding area is sparsely vegetated, and no other significant features noted in the area.

Year	Site	Surrounding Area
1982	The Bayswater Power Station appears to be under construction. The site footprint and roadways have been established adjacent to the Freshwater Dam. The Dry Surface Area, and Switch Yard area has been is cleared, construction has commenced on the power station, and one of the four cooling towers has been erected. The Pikes Gully Ash Dam has yet to be built, however the lime softening plant sludge lagoons have been constructed. Plashett Dam is also yet to be constructed. Construction of Plashett Dam has commenced to the south west of the sludge lagoons, and west of the apparent southern extent of the Howick open cut mine.	Where apparent dams were previously identified south-east of Lake Liddell, several of these dams appear to have been backfilled, with only the footprint now evident. A major coal stockpile is noted, and a rectangular clearing (inferred to be the Hunter Valley Load Point) has been established. The Howick open-cut mine has expanded towards the east, and older portions of the mine appear to have been rehabilitated. Swamp Pit mine appears to remain in operation.
1993	The Bayswater Power Station has been completed and is operational. In addition to the sludge lagoons identified in 1982 aerial photographs, key features on the Site in the vicinity of the power station include the cooling water reservoir, brine concentrator contaminated water ponds, waste water decanting basin, the Plashett Dam, and the Pikes Gully Ash Dam. Ash slurry occupies half of the area of the Ash Dam. Coal appears to be stockpiled in the Dry Surface Area. The Ravensworth Mine has expanded operations.	The surrounding mines appear to have expanded operations.
2003	The site layout and infrastructure appears to be the same as previously identified, and consistent with the current site layout. The northern portion of the Ravensworth Mine has been rehabilitated. Except two open cut areas filled with surface water, the Site is typically covered with grass. Open cut mining is still active south of this area, however outside the site boundaries.	Several large coal stockpiles, buildings, and other infrastructure are located where the apparent dams were present south-east of Lake Liddell. The dams appear to have been backfilled and re-vegetated. A small open cut mine has been established within this area, north of the Howick mine. A significant open-cut mine - Liddell Mine in in operation north of the area, immediately east of Lake Liddell. The Drayton Mine is evident north-west of the Bayswater Power Station. Howick Mine remains in operation, and the Hunter Valley Coal Preparation Plant has been established between Howick and Ravensworth mines.

Year	Site	Surrounding Area
2009 (reviewed via Google Earth)	No changes to site features within the Bayswater or Ravensworth rehabilitation areas are apparent.	A large area north east of the Hunter Valley Coal Preparation Plant has been cleared. Whilst it appears to be associated with mining operations the purpose of this area is not known. The Ashton open-cut mine is evident east of the Ravensworth mine.

3.3 *ZONING & LANDUSE*

The Macquarie Generation land holding covers approximately 10 074ha and encompasses the Liddell and Bayswater Power Stations, ash dams and ancillary operations. Land holdings occur within the Muswellbrook Shire and Singleton LGA.

A large portion of the Bayswater Power Station land is zoned SP2 Infrastructure Zone under *Muswellbrook Local Environmental Plan* (LEP) 2009 with smaller parcels of land in the north (near Antiene) and west (to the south of Bayswater Conveyor) zoned RU1 Rural 1 Primary Production.

The southern and easternmost extents of the land holdings occur within Singleton LGA and are zoned under the Singleton LEP 1996 as Zone 1(a) Rural and as RU1 Primary Production under the draft Singleton LEP 2012. This includes the Ravensworth Coal Unloading Facility, Ravensworth Mine Restoration Area, and the area south of Bayswater Power Station and Pikes Gully Ash Dam encompassing Plashett Dam and the land holding to the Hunter River.

3.4 *ENVIRONMENTAL APPROVALS, LICENSES AND MANAGEMENT*

Macquarie Generation operates under a range of State and Commonwealth Government environmental legislation. It is noted that whilst a comprehensive review of planning approvals and general environmental management was beyond ERM's scope of work for this assessment, in some instances these approvals and management systems provide context for potential contamination sources (e.g. ash disposal) and hence a summary of salient points in relation to these issues has been presented in the following sections.

3.4.1 *Planning Approvals*

The original approval for the Bayswater Power Station was granted by Muswellbrook Shire Council on 18 September 1980 under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The approval relates to the construction and operation of the Bayswater Power Station as described in the environmental impact statement and supplementary information volume dated June 1979. The EIS describes the project as including storage sites for ash disposal and water supply and associated pipeline routes.

The approval document lists various approvals and licences required to be obtained from the State Pollution Control commission. Infrastructure associated with Bayswater Power Station has undergone a number of upgrades, alterations and additions since commission in 1985. Key planning approvals known to ERM are summarised in *Table 3.2*.

Table 3.2 *Key Planning Approvals for Bayswater Power Station*

Development	Description	Approval Authority and Number	Date
Bayswater Power Station	Original Development Consent for Bayswater Power Station (as per EIS June 1979).	Muswellbrook Shire Council DA 47209	18/9/1980
Barnard River Water Supply Project	Approval for Barnard River Water Supply Project (as per EIS July 1981).	Scone Shire Council DA 81/42	18/11/1981
Ravensworth South Coal Mine	Consent for open cut coal mine, including a requirement to rehabilitate upon closure, potentially by filling with power station rejects (subject to any approval).	Minister for Planning and Environment DA 86/51	15/12/1986
Ravensworth Ash Disposal (No. 2 Void)	Disposal of Bayswater Power Station ash to Ravensworth No. 2 Mine Void. Included ash pumping infrastructure, ash pipeline, a return water system and staged rehabilitation. Based on the Environmental Impact Statement (Pacific Power 1993).	Singleton Council (jointly with Muswellbrook Council) DA 144/1993	8/12/1993
Bayswater Ash Disposal	Covers ash transfer and water return infrastructure components of the Ravensworth Ash Disposal EIS that occur within the Muswellbrook Shire Council LGA.	Muswellbrook Shire Council DA 138/1993	16/12/1993
Ravensworth Ash Disposal (No. 2 Void) Modification	Approves noise generating activities on Saturdays.	DA 144193.2	17/3/1994

Development	Description	Approval Authority and Number	Date
Antiene Rail Coal Unloader	State Significant Development. Rail coal unloader and associated infrastructure (rail spurs, crossings etc.) at Antiene.	Minister for Planning DA 50-3-2005	7/11/2005
Antiene Rail Coal Unloader Modification	Modification for: relocation of ancillary buildings; construction of a small single--span bridge; diversion of Maidswater Creek; changes to construction hours.	Minister for Planning DA 50-3-2005 (1)	31/3/2006
Ravensworth Ash Disposal Modification	Modification of Development Consent No. 144/1993 based on Statement of Environmental Effects (2006) to allow additional parallel return water pipeline from Ravensworth ash emplacement to Bayswater Power Station.	Singleton Council DA 144/1993.3	20/7/2006
Ash Disposal s96 Amendment	As above as it relates to infrastructure within the Muswellbrook LGA.	Muswellbrook Shire Council DA 138/1993 Modification	1/2/2006
Water Treatment Plant Upgrade	Upgrade of Bayswater WWTP	Minister for Planning MP 06_0047	6/4/2006
Ravensworth Ash Disposal Void 4 Tailings Emplacement Operations Plan	Void 4 Tailings Emplacement Operation Plan (TEOP) Approval - expired 2012 and not audited.	Department of Primary Industries L 03/0154	21/5/2007
Water Pump Station Upgrade	Bayswater Water Pump Station upgrade to increase capacity. Out of scope and not audited	Minister for Planning MP 06_0259	23/5/2007
Water Pump Station Upgrade Modification	Modification to allow undergrounding of pipeline; two surge mitigation tanks; discharge to the dam at a location closer to the river; modification to the compliance reporting and platypus management practices.	Minister for Planning MP 06_0259 Mod 1	26/11/2007
Ravensworth Ash Disposal Void 3 Augmentation	Increase ash disposal capacity by 6.6M cubic metres over an additional approximate 5 year facility life. Modification of Ravensworth Rehabilitation Site EMP (1993) through Macquarie Generation's letter of 2 March 2009 and supporting Concept Design Report (Connell Wagner 13 February 2009). No Council consent was applied for or received and not audited.	Department of Primary Industries	17/3/2009

Development	Description	Approval Authority and Number	Date
Ravensworth Ash Disposal Modification	Extension of the existing ash delivery pipeline and installation of new pipelines to facilitate rehabilitation of Ravensworth South Mine Void 5 and deferment of filling and rehabilitation of existing Void 4 (as per Statement of Environmental Effects Aurecon 2012).	Singleton Council DA 144/1993.6	29/10/2012
Ravensworth South Final Void Rehabilitation Plan	Filling and final rehabilitation of Macquarie Generation's portion of Ravensworth South Void 5.	Department of Resources and Energy (DRE) Consistent with Planning Consent DA 86/51	20/12/2012
Bayswater B Power Station	Concept Plan approval	Minister for Planning S 09_0118 DoP	12/1/2012

3.4.2 *Environmental Protection Licences*

Bayswater Power Station holds Environmental Protection Licence (EPL) No. 779 (issued under *Section 55* of the *Protection of the Environment Operations Act 1997)* for the premises described as Bayswater Power Station, New England Highway, Muswellbrook, NSW, 2333.

The EPL authorises the generation of electrical power from coal (> 4,000 GWh generated), a scheduled activity under the *Protection of the Environment Operations Act 1997.*

The EPL applies to all activities conducted at the Site, including the listed ancillary activities:

- aircraft (helicopter) facilities (the plant has a landing area for helicopters);
- chemical storage facilities;
- crushing, grinding or separating works; and
- sewage treatment systems.

The EPL has recently been reviewed and amended through discussion between the EPA and Macquarie Generation. The latest variation to the EPL is dated 20 September 2013 and is next due for review in February 2018.

The EPL includes load-based licensing provisions, monitoring requirements and/or setting of concentration limits for emissions of pollutants discharged to air, water and land (for various locations), although dominantly relates to emissions to air. The EPL includes a range of conditions from the general requirement to operate in a "proper and efficient" manner to specific conditions such as methods for monitoring and analysis.

The EPL includes Pollution Reduction Programs (PRPs) relating to the following issues:

- management of water in relation to the ash dam;
- upgrades to water quality monitoring in Tinkers Creek; and
- spill containment at the alkalinity reduction plant.

ERM notes that this PRP requirement is considered to be an operational issue and is thus outside the scope of this investigation.

Non-compliances reported under EPL 779 identified in the 2013 Environmental Compliance Audit (ERM, 2013), and considered to represent potential contamination of soil and groundwater, are outlined in *Table 3.3* (below).

Table 3.3 ***Summary of Environmental Non-Compliances which are relevant to Potential Contamination Issues***

EPL Report Reference	Requirement	Comment	Contamination Significance
L.1	Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.	Annual Return 2011-2012 reported three non-compliances for discharge at Point 7 (Tinkers Creek) (high and low pH). Last 12 month scan of incidents - 30.1.2013 coal fines were washed into stormwater by contractor. Anecdotally, the conveyer to the coal station currently leaks and drops water which drains into stormwater. Normally all water in area drains to coal settling basins. Preliminary review of water quality results indicate elevated levels of some metals when compared against ANZECC (2000) freshwater criteria (90% protection level).	Contaminants may be exiting the Site from discharge points to Tinkers Creek.
L3.2	Where a pH quality limit is specified in the table, the specified percentage of samples must be within the specified ranges.	Review of data between Nov 2012 and April 2013 indicates parameters within range. Annual Return 2012-2013 indicates pH outside of limits three times over reporting period.	Contaminants may be exiting the Site from discharge points to Tinkers Creek.
L3.3	To avoid any doubt, this condition does not authorise the pollution of waters by any pollutant other than those specified in the table\s.	Refer EPL condition L.1	Refer EPL condition L.1
L3.6	Water and/or Land Concentration Limits	Refer EPL condition L.1	Refer EPL condition L.1
O1.1	Licensed activities must be carried out in a competent manner. This includes: a) the processing, handling, movement and storage of materials and substances used to carry out the activity; and b) the treatment, storage, processing, reprocessing, transport and disposal of waste generated by the activity.	Dangerous Goods Storage Observations during site inspection include: - anecdotally chemical deliveries are unsupervised. A risk assessment is underway to identify main risks and appropriate mitigation if any issues identified; - staining and corrosion from chemical deliveries noted around unloading facilities. - Audits on DGs have been completed with actions outstanding. Waste collected around site every couple of days - no waste noted around site during inspections	Potential contamination of soil and groundwater due to chemical spills/leaks.

EPL Report Reference	Requirement	Comment	Contamination Significance
O2.1	All plant and equipment installed at the premises or used in connection with the licensed activity: a) must be maintained in a proper and efficient condition; and b) must be operated in a proper and efficient manner.	Challenges in maintenance were noted during the site visit: - Significant corrosion of concrete was noted in the dangerous goods compound used primarily to house demineralisation chemicals. - Several bunds around bulk storage tanks were observed to be heavily stained on the external walls, suggesting that seal is not provided/maintained and bunds do not provide appropriate containment.	Potential contamination of soil and groundwater due to chemical spills/leaks.

3.4.3 *Environmental Management*

Macquarie Generation maintains an ISO14001 certified Environmental Management System (EMS) for Bayswater Power Station which is audited annually. The audit focuses on compliance with the aspects of ISO14001 and does not assess the implementation or effectiveness of the system.

A number of environmental plans for Bayswater Power Station have been developed under the EMS and/or in response to regulatory requirements, however the assessment of the implementation of these has not been completed as part of this assessment.

Environment specialists form a joint team that covers both the Liddell and Bayswater Power Stations, although some staff are specifically responsible for a site and are based at that location:

- Environmental Manager - Mr. Howard Richards (environment team manager for both stations, based at Liddell Power Station);
- Environment Officer - Mr. Stephen Fell (environment specialist for Liddell Power Station, based at Liddell Power Station);
- Environment Officer - Ms. Kathryn Yates (environment specialist for Liddell Power Station, based at Liddell Power Station);
- Environment Officer - Ms. Elle Hutchinson (environment specialist for Bayswater Power Station, based at Bayswater Power Station); and
- Environment Officer - Mr. Matthew Parkinson (environment specialist for Bayswater Power Station, based at Bayswater Power Station).

A recent Environmental Compliance Audit undertaken by ERM in July 2013 (ERM, 2013) generally found that Macquarie Generation has achieved a high level of compliance with the conditions of the Development Approvals and EPL. Primarily the main issues revolve around the storage of dangerous goods potentially resulting in releases, and also discharge to waters which may result in soil and/or groundwater contamination.

Water management challenges for Bayswater, which could result in soil and/or groundwater contamination, include potential overflows and seepage from the Pikes Gully Ash Dam to surface water courses which flow into Lake Liddell and seepage from Ravensworth Voids 4 and 5 into neighbouring land. It is understood Macquarie Generation is currently investigating options to manage these issues.

The audit found several non-compliances with the relevant approvals and licence that apply to the Site which had potential to be associated with soil and/or groundwater contamination. These include:

- exceedance of specific environmental performance criteria relating to historical water quality discharges (specifically pH). The primary root cause of these issues is failure of infrastructure and accidental releases of untreated water; and

- actions are outstanding from previous Dangerous Goods audits with the site inspections confirming challenges in this area.

ERM understands that Macquarie Generation are aware of the relevant issues identified in the July 2013 audit which relate to exceedances of the EPL performance criteria, and that these issues are being addressed in consultation with the EPA.

4 OPERATIONS

4.1 INTRODUCTION

The following sections present an overview of operations in order to provide context to the subsequent assessment of potential for contamination. A brief description of key activities is provided including, in particular, chemical and waste storage.

4.2 WATER SUPPLY

4.2.1 Water Sources and Storage

Water for the Liddell and Bayswater Power Stations is sourced primarily from the Hunter River. This can be supplemented by the Barnard River Scheme which takes water from the upper reaches of the Manning River and pumps it to the upper reaches of the Hunter River.

Approximately half of Macquarie Generation's water supply is held in Glenbawn Dam under a Major Utility Allocation Licence. The other half of the water supply is intended to be pumped periodically during high flow events in the Hunter River, which occur downstream of Glenbawn Dam (Macquarie Generation website 21 June 2013).

Water is dammed at the following locations:

- Glenbawn Dam (Hunter River), which holds the bulk of the storage capacity (72-76 ML);
- Barnard Weir (Barnard River) (62 ML);
- Orham Creek Dam (Barnard River); and
- Oakey Regulating Dam (Barnard River tributary).

Macquarie Generation holds various conditional water licences that permit the taking of water from various sources.

Water from these sources is pumped to various constructed dams near the Power Stations:

- Lake Liddell, adjacent to Liddell Power Station, holds the bulk of the cooling water storage capacity;
- Plashett Dam (also known as Plashett Reservoir), approximately 4.5 kilometres south-west of Bayswater Power Station;

- Freshwater Dam (also known as the Bayswater Domestic Water Dam or Bayswater Reservoir), adjacent to Bayswater Power Station and used for process and domestic water supply for both sites; and

- Bayswater Cooling Water Makeup Dam.

Water pumped from the Hunter River either pumps directly to the Bayswater Cooling Water Makeup Dam or passes through a Lime Softening Plant to remove hardness. The Softening Plant and associated Sludge Lagoons are located between Plashett Dam and the Bayswater Power Station. This treated water is then transferred to either Lake Liddell or the Freshwater Dam.

4.2.2 *Lake Liddell*

Lake Liddell was constructed as water storage for Bayswater and Liddell Power Stations and is located immediately adjacent to Liddell Power Station, approximately 500 m to the east/north-east of Bayswater Power Station at its nearest point. The Lake has a surface area of around 1100 hectares (ha), approximately 5km by 5km and is up to 32m deep (Lake Liddell Hydrodynamic Modelling, Worley Parsons, March 2009).

The Lake supplies cooling water to Liddell and make-up water for the Bayswater Cooling Water Makeup Dam. It also accepts a range of treated discharges as discussed elsewhere in this report.

The Lake is constructed in a natural valley at the confluence of Bayswater, Tinkers and Maidswater Creeks (Macquarie Generation, undated). The Lake is dammed on the eastern side and is equipped with a spillway leading to a large holding pond.

Water is periodically discharged from Lake Liddell to manage salinity and level. The discharge point is at the dam wall, and discharges flow via Bayswater Creek to the Hunter River, 12.8km downstream.

Discharges are under the Hunter River Salinity Trading Scheme (regulated under Bayswater's Environment Protection Licence (EPL) 779) and are made at times of high river flows and low background salinity levels.

Lake Liddell is also used by the public for recreation. The Lake Liddell Recreation Area is situated on a northern reach of the lake off Hebden Road. It caters for day visitors and campers, and the area is used for water-skiing, sailing, swimming and fishing (NSW Government Visit NSW website 21 June 2013). The area is managed by the Lake Liddell Recreation Area Reserve Trust appointed by the NSW Government to manage Crown Land (NSW Government LPMA website 21 June 2013).

Lake Liddell is surrounded by buffer land to the north. The eastern side is bordered by an open cut coal mine. The west and south are occupied by Liddell Power Station and Bayswater Power Station, respectively.

4.3 *FUEL SUPPLY AND STORAGE*

4.3.1 *Sources and Receival*

Bayswater Power Station receives black coal from local coal mines via overland conveyor, and from regional coal mines via rail. Rail receival facilities are located at Ravensworth and Antiene as detailed below. Facilities are available to receive coal by road; Station staff advised that this is not a significant transport mode at present.

Liddell and Bayswater Power Stations operate an integrated system of coal procurement and receival. While stockpiles are located at each plant, coal can be conveyed between the power stations and Bayswater holds the bulk of the coal stockpile.

Major sources of coal include Wilpinjong mine (Peabody, Ulan), Mount Arthur (BHP, Hunter Valley), Ravensworth (Xstrata, Hunter Valley) and Mangoola (Xstrata, Hunter Valley). Coal is generally unwashed.

4.3.2 *Antiene Rail Coal Unloader*

Antiene Rail Coal Unloader (RCU) is the main delivery point for coal for Bayswater Power Station. As discussed previously, Antiene RCU is assessed as part of the Preliminary ESA for Liddell Power Station and is included here for information purposes only. Antiene RCU is located approximately 4 km to the north of Bayswater Power Station and 2.5 km north of Liddell Power Station, adjacent to a northern branch of Lake Liddell and two creeks that feed into it (Maidswater Creek and an unnamed creek).

Antiene RCU was constructed in 2006 and consists of:

- a rail spur off the Main Northern Line and balloon loop for turning;
- a coal receival area including access roads, an in-ground coal hopper, conveyor systems and a control house; and
- conveyors leading to the Power Stations.

The facility is operated by Pacific National under an Operational Environmental Management Plan.

4.3.3 *Ravensworth Rail Coal Unloader*

Ravensworth Rail Coal Unloader, located approximately 250 meters to the north-east of the Ravensworth Rehabilitation Area, is not currently operational. It is understood that the coal loader can be placed into service if required. It has been used quarterly as a training facility for driver training.

4.3.4 *Bayswater Coal Stockpiling and Delivery*

Bayswater's coal stockpiles are located on the north side of the power block. Coal is delivered by conveyor which can either be fed directly to the power station bunkers or deposited in the storage area for later use. The storage area is capable of storing up to two million tonnes (Mt) of coal.

Perimeter drains collect run-off from rainfall on the storage area which drains to a settling basin to trap silt and coal particles. Discharge from the settling basin drains to Tinkers Creek and then to Lake Liddell.

Clean water run-off from areas around the coal storage area is intercepted before it reaches the coal stockpile by perimeter drains which discharge to Tinkers Creek and Lake Liddell.

The coal towers along the conveyors are also equipped with sedimentation ponds that discharge to Lake Liddell along drainage lines.

4.3.5 *Mobile Plant Maintenance And Refuelling*

A maintenance and refuelling area for mobile plant associated with coal stockpiling is located adjacent to the coal storage area. The refuelling/lubricating facilities include an area covered in concrete hardstand equipped with drainage sumps that discharge to the Site's contaminated water treatment system.

An underground waste oil storage tank is located to the north of the mobile plant maintenance workshop, which ERM understands is constructed of concrete and is 9 000L in volume. No information was available at the time of assessment regarding integrity testing. The *Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008* (the 'UPSS Regulation') does address underground storage systems for used (waste) oil; however there is an exemption from the need to install and monitor groundwater monitoring wells and to develop an Environment Protection Policy for underground waste oil storage systems.

Diesel is stored in a steel aboveground storage tank (AST) of 68 000 L capacity located immediately to the north of the refuelling and lubrication facilities. ERM understands that the mobile plant maintenance and refuelling area was constructed during construction of the power station in 1980-1986.

4.4 AUXILIARY FUEL STORAGE

Bayswater Power Station uses diesel as auxiliary fuel for boiler ignition and so on. The Fuel Oil Installation is located on the south-east corner of the power block and consists of three 1.2ML tanks in a bunded area.

Refer to *Annex E* for a site layout and associated identifier numbers from the 2013 Dangerous Goods Notification - NDG023009.

4.5 WORKSHOPS, STORES AND COMPOUNDS

Various chemical and dangerous goods stores are located throughout the Site. Refer to *Annex E* for the list of registered chemicals from the 2013 Dangerous Goods Notification - NDG023009. Larger quantities of dangerous goods are stored at the water treatment plants, demineraliser, transformer areas, and fuel depots. Small quantities of dangerous goods are stored within workshop areas in the power block.

The Main Store and workshop is located to the east of the power block and includes the flammable gases and flammable liquids store. The Vehicle Refuelling Depot is located adjacent to the Main Store and consists of two Underground Storage Tanks which are used to store unleaded petrol and diesel. The Vehicle Refuelling Depot is discussed further in *Section 6.1.13*.

4.6 ELECTRICITY GENERATION UNITS

4.6.1 *Main Generating Plant Area (Power Block)*

The main generating plant area houses four units and associated infrastructure:

- coal hoppers, bowl mills and pulverised fuel feed systems;
- four coal-fired boilers;
- turbine house incorporating four steam turbines driving four hydrogen cooled generators;
- a centralised control room;
- four 660MW generator units;
- station service and auxiliary transformers;
- DC systems and associated internal battery banks;
- uninterrupted Power Supply; and
- pulsed bag filter houses and two chimney stacks (each serving two boilers).

4.6.2 *Hydrogen Supply*

Hydrogen for generator cooling is supplied via cylinders stored near the demineralisation plant. Cylinders are housed in a fixed roofed store (approximately 58 272L). Cylinders are refilled by road tanker from a separate location.

The former hydrogen manufacturing plant (located nearby) is not in service.

4.6.3 *Ammonia Supply*

Anhydrous ammonia is stored in a 50 000L AST at the demineralisation plant.

4.7 *TRANSMISSION*

The Bayswater 330 kiloVolt (kV) and 500 kV switchyard is located to the west of the power block and is operated by TransGrid. According to information provided by Macquarie Generation management, ERM understands that this area is also owned by TransGrid and that it was upgraded in 2009-2010. Overhead lines run from the generator transformers for units 1/2 and 3/4 located on the western portion of the power block approximately 300m to the TransGrid switchyard

4.8 *EMERGENCY GENERATOR*

The emergency generator building, located on the north side of the power block, houses two generators used to provide emergency electrical supplies to safely shut down plant in the event of a station shutdown and disconnection from the power grid. Both generators are understood to be currently operational and are run on diesel, supplied via two steel ASTs located within a concrete bunded area on the south side of the building. The ASTs are supplied with diesel via on aboveground pipeline from the fuel oil installation.

4.9 *ASH PLACEMENT*

Ash placement is divided into two areas. Pikes Gully Ash Dam, located in the Bayswater Power station area, is primarily used for bottom ash disposal but currently also receives some fly ash. Fly ash is currently piped in a slurry to for beneficial reuse to fill voids from the former Ravensworth Number 2 Colliery (Ravensworth void 1, 2, 3 and 4) and Ravensworth South (Ravensworth Void 5), collectively referred to as the Ravensworth Rehabilitation Site. Fly ash has been directed from the power station to the Ravensworth Rehabilitation Site since the mid-1990s.

4.9.1 *Pikes Gully Ash Dam*

The Pikes Gully Ash Dam covers an estimated 125 ha and at its nearest point is approximately 200m to the south-east of the Bayswater Power Station. The Dam has been formed by the construction of an earth dam across Pikes Gully in the east and a saddle dam on the dividing rise between Pikes Gully and Chilcotts Creek.

The dam is approved as part of the original Bayswater Power Station approval. No specific management requirements are established by the approval document. State Pollution Control Commission (SPCC) approval under the Clean Water Act was received 8 September 1982 based on information supplied however; this approval has now been superseded by the current Bayswater Power Station Environment Protection Licence (EPL 779).

Bottom ash is delivered to the dam via pipes and is discharged in the western corner. Water is then directed to the south west corner as the furthest point from the over boarding spill way located in the north east. A water return system is in place that returns water to the ash return water tank for reuse.

A seepage water return system is in place at the toe of the dam wall in Pikes Gully. This system was assessed in the original EIS. A second return water pumping station has been installed approximately 400m east of the first in Pikes Gully in response to complaints from the Ravensworth Underground Mine (RUM). It was reported during the Site visit and in follow up discussions that these complaints lead to Macquarie Generation purchasing land from the RUM operation. A large clean water catchment area drains to this water return pump location and may be contributing to excess water issues that exist following periods of extended rainfall.

No water is permitted to be discharged from the ash dam to Lake Liddell under the EPL. Pikes Gully Ash Dam is therefore part of a closed water system with the exception of evaporation and infiltration. Occasionally there are emergency discharges, following extended periods of wet weather, which are monitored and reported to the Environment Protection Authority (EPA). Macquarie Generation has indicated that a detailed site-wide water management strategy and water balance is being developed to manage the Pikes Gully Dam levels.

A significant Bottom Ash and Fly Ash reuse operation is undertaken from the Pikes Gully Ash Dam by third party contractors.

4.9.2 *Ravensworth Rehabilitation Site*

The Ravensworth Rehabilitation Site is located approximately eight kilometres east south-east of the Bayswater Power Station and is used for the disposal of fly ash.

Fly ash is transported 11km in a dense slurry form via two steel pipes. The ash disposal system occurs in two Local Government Areas (LGA); starting at the Bayswater Power Station in Muswellbrook LGA, with the Ravensworth Rehabilitation Site in Singleton LGA.

Current operations at the Ravensworth Rehabilitation Site were reported as:

- filling of subsidence cracks and ongoing vegetation and rehabilitation maintenance on Void 1;
- filling of subsidence cracks and ongoing vegetation and rehabilitation maintenance on Void 2;
- ash disposal to Void 3 nearing completion with capping recently commencing from the central area and progressing to the north as the southern portion filling is completed;
- Void 4 used as a water management storage system with relocation of pumping infrastructure in Void 4 from the originally approved location in the south west corner to the eastern bank, with associated upgrades to pumping infrastructure and transmission lines as a result of the Ravensworth North expansion;
- construction of Void 5 regulated dam wall recently commenced and extension of ash delivery and return water system pipelines underway; and
- ongoing Spontaneous Combustion Control measures (Xstrata responsibility), subsidence monitoring and rehabilitation works occurring generally across the Site.

Approximately 1.5 million tonnes per annum (Mtpa) of fly ash has been reused for rehabilitation of voids in the Ravensworth Rehabilitation Site in each of the previous two years.

4.10 WATER MANAGEMENT SYSTEMS

4.10.1 Cooling Water

Cooling water for Bayswater Power Station is sourced from the Cooling Water Make-Up Dam which is treated through the demineralisation plant before use. This dam normally consists of a 50/50 blend of unsoftened Hunter River water and Lake Liddell Return Water.

After passing through the plant condensers and other cooling systems, cooling water is treated through two Cooling Tower Water Treatment Plants (alkalinity reduction plant and reverse osmosis (RO) plant).

The waste products from the water treatment plants are transferred to the Lime Softening Plant sludge lagoons and Brine Concentrator Holding Pond for further water recovery and treatment. Three Brine Concentrators (vapour recompression evaporators) have been installed to reclaim some of this waste water which is then transferred to the station demineralisation plant for further treatment or transferred to the Cooling Water Make-Up Dam.

Overflows from the Brine Concentrator Holding Pond drain to the Pikes Gully Ash Dam. The highly saline wastewater from the treatment process goes to the Brine Concentrator Decant Basin.

4.10.2 *Process Water*

Process water is sourced from either the Bayswater Demin treated water or the Freshwater Dam. Water from the Freshwater Dam is pre-treated in a demineralisation plant located near the main stores area.

The demineralisation plant area includes:

- cation and anion resin bed vessels;
- storage tanks for flocculation (ferric chloride, two tanks of 18 000L);
- storage tanks for acid regeneration (sulphuric acid, two tanks of 68 000L);
- storage tanks for caustic regeneration (sodium hydroxide, two tanks of 93 000L); and
- four demineralised water storage tanks located above the plant.

Spent resin and regeneration wastewater is disposed to the effluent ponds, located to the south of the fuel oil installation.

4.10.3 *Domestic Supply and Firewater*

Water for domestic use and fire fighting is taken from the domestic dam and is treated at the chlorination plant prior to use. The chlorination plant is located adjacent to the demineralisation plant. Fire fighting water can also be derived from other sources when necessary.

4.10.4 *Sewage*

Sewage is pumped to effluent ponds where it evaporates. Any overflows would discharge to Pikes Gully Dam; however, the ponds were reportedly installed to cater for a population three times greater than currently on site.

4.10.5 *Stormwater*

Boiler and fly ash collection plant floor areas are periodically 'hosed down' and any ash, oil or other material that may be present in the wash down effluent is conveyed to the ash pits and pumped to the ash disposal areas.

Boiler blowdown goes to the stormwater system. Drainage from workshops, electrical service areas and induced draft fans area together with drainage from the turbine house floor area, cable tunnels, transformer areas and lift pits is directed to the wash-down water tank via an oil/solids/water separator and holding basin. Water will be drawn from the wash-down water tank for re-use in the station.

Oil removed from the oil/solids/water separator is collected by an oil reclamation contractor while solids collected are disposed in the Pikes Gully or Ravensworth Rehabilitation ash disposal areas.

Stormwater from the power block area and surrounds is assumed to be potentially contaminated with oil, ash or coal. Stormwater is directed to a large oil-grit trap adjacent to the sewage treatment plant (STP).

Rainwater draining from the switchyard, coal storage area clean water drains, roof drainage, and paved and open areas are directed to Tinkers Creek.

4.11 *WASTE DISPOSAL*

4.11.1 *Landfills*

The landfill is located to the south of the Site. Macquarie Generation management has indicated that the operation of this landfill is not licensed by the EPL (779). A number of materials are licensed to be disposed on site by the EPL (unspecified location), but these aren't currently disposed in the landfill.

Waste currently placed in the landfill comprises primarily domestic wastes (e.g. general rubbish) and minor construction waste resulting from recent renovation of the administration building. Waste historically placed in the landfill include various wastes associated with the construction of the power station in the early 1980s; however detailed records were not available for review at the time of assessment. It is considered possible that hazardous wastes have been placed in the landfill.

This landfill is scheduled for closure in late 2013, with wastes after this period to be collected by waste contractors. A Waste Management Plan for Bayswater Power Station is currently under development to further manage waste management and disposal.

4.12 *FIRE SUPPRESSION SYSTEM*

The fire suppression system uses a combination of water (obtained from the Freshwater Dam) and gas suppression. A water sprinkler and deluge system is located throughout the power block, with hydrants and hose reels present in the administration area and throughout the remainder of the power station.

Carbon dioxide (CO_2) gas is supplied to portions of the turbine generators and the coal mill from large CO2 storage vessels and via wheeled extinguishers. Inergen gas, comprised of nitrogen, argon and carbon dioxide, is used in the Simulator building and some IT server rooms.

A manually-operated, fixed foam injection system is present in the fuel oil storage tank area. Information on the type of foam used in this system was not available at the time of assessment.

4.13 *INVENTORY OF CHEMICALS AND WASTES*

An inventory of significant storage facilities is provided in *Annex E*, based on the Site's most recent Dangerous Goods Notification (May 2013). Minor stores are also kept in the maintenance workshops and other operational areas.

The Site holds a variety of bulk (>1,000 L) chemical storage:

- Petrol
- Diesel
- Waste oil
- Transformer oils
- Anhydrous ammonia
- Hydrogen
- Chlorine
- Coagulants (e.g. Ferric chloride)
- Sodium hydroxide
- Sulfuric acid
- Nitrogen
- Hydrogen peroxide

The storage and contamination potential of these chemicals are discussed in detail in *Section 6*.

A number of large transformers contain significant quantities of insulating oil. Due to the age of the facility, polychlorinated biphenyl additives would have historically been used in insulating oils in transformers, capacitors and light fittings. The Bayswater Power Station Environmental Manual (Macquarie Generation, 2010) states, "Currently there are no known PCB's at Bayswater with the exception of some older capacitors at the River Pumping Stations. However it remains possible for PCB's to be introduced to the Station via contaminated transformer oils." The Manual also contains a requirement for monitoring PCBs during regular transformer maintenance works to assess whether transformer oil has been contaminated as a result of the works. All transformer oils externally supplied to Bayswater are required to be certified as being free of PCBs with appropriate documentation provided on supply.

5 *SITE CONTAMINATION HISTORY*

5.1 *OVERVIEW*

The provision of a detailed account of the contamination history at Bayswater Power Station is limited based upon the absence of previously conducted environmental assessments into potential gross contamination issues at the Site. The current processes being undertaken at the Site have generally not changed significantly since operation of the Site commenced in 1986. As such, potential and actual areas of contamination can be assessed based upon current operations, in conjunction with a review of chemical and waste inventories (*Section 4.2*), spill and incident information, a review of the limited soil and groundwater investigations completed to date (*Section 5.4*) and discussions with Macquarie Generation staff. Potential and actual AECs are presented in *Section 6*.

5.2 *NSW EPA CONTAMINATED SITE RECORDS*

The *Contaminated Land Management Record of Notices* is a public database of information regarding significantly contaminated land in NSW and is managed by the NSW EPA under the *Contaminated Land Management Act 1997.* At the time of this assessment (August 2013), the Bayswater Power Station was not listed on the record and no sites within a 5 km radius of the Site were listed on the record.

NSW landowners and occupiers who believe that their sites may be contaminated above certain levels specified in the *Contaminated Land Management Act 1997* must notify the NSW EPA of the suspected contamination. The contamination may or may not be significant enough to warrant regulation by the EPA. Following notification, the EPA conducts an assessment process to determine whether regulation is required. The *NSW EPA List of Contaminated Lands Notified to the EPA* describes these sites.

At the time of this assessment, Bayswater Power Station has not been notified to the NSW EPA as being potentially contaminated; however Liddell Power Station has been notified to the EPA as being potentially contaminated. The EPA initial assessment is listed as 'in progress' with the contamination of this Site being assessed by the EPA. Sites which have yet to be determined as significant enough to warrant regulation may result in no further regulation under the *Contaminated Land Management Act 1997.*

5.3 *PRODUCT SPILL AND LOSS HISTORY & OTHER DISCHARGES*

The history of the Site as a power station encompasses over 30 years; as such, a comprehensive listing of spills and inadvertent discharges is not feasible as part of this assessment. ERM reviewed available information on spills, leaks and unplanned discharges in the dataroom and through discussions with Macquarie Generation management. Specific information relevant to identifying AECs is presented in *Section 6.1.*

5.4 *PREVIOUS ENVIRONMENTAL INVESTIGATIONS*

The Site has undergone a limited amount of intrusive soil and groundwater assessments to date as set out below. Works were generally completed to achieve compliance with water licence requirements and underground petroleum storage system (UPSS) regulations. No comprehensive or systematic assessment of Site conditions has been undertaken..

The following section summarises the relevant reports reviewed by ERM.

Water Management Licence Package Annual Monitoring and Compliance Reports with water quality data from July 2006 to June 2010 (Macquarie Generation, 2010).

The monitoring and compliance reports provide the results from monitoring associated with activities carried out under water licenses issued to Macquarie Generation. Areas monitored for groundwater quality from a limited number of monitoring wells (three in total monitored on a regular basis) that apply directly to the Bayswater Site included the Pikes Gulley Ash Dam, the Lime Softening Sludge Lagoons and the Brine Concentrator Decant Basin. Parameters monitored included electrical conductivity (EC), pH, hardness, arsenic and metals (including aluminium, copper, iron, lead, manganese, nickel, and selenium. Data were assessed against guidelines for irrigation and livestock water quality - Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000. The results of the monitoring area discussed in the relevant area of environmental concern (AEC) in *Section 6* (specifically, *Sections 0, 6.1.19* and *6.1.20*).

Ravensworth Rehabilitation Site. Environmental Management Plan Report 2012 (Macquarie Generation, 2012).

The Environmental Management Plan Report includes the results of monitoring conducted at the Ravensworth Rehabilitation Site, including water quality results obtained from Void 4 that is used as a water management storage system receiving drainage water from the surrounding voids and mine spoils. Water quality results reported for Void 4 are outlined in in *Section 6.1.21.*

Saline Groundwater Plume Determination Downstream of Bayswater Power Station Brine Concentrator Decant Basin Letter Report (HLA, 2003).

The letter report makes reference to the identification of an increasing trend in groundwater salinity downgradient of the Brine Concentrator Decant Basin and reports the results of a geophysical survey (utilising electrical resistivity imaging) in the affected area.

Pikes Gully Ash Dam – Geophysical Survey Letter Report (HLA, 2004).

The letter report outlines the results of a geophysical survey conducted to the south of the Pikes Gully Ash Dam. The survey identified shallow conductive zones consistent with groundwater with elevated salinity that may have presented preferential pathways of saline groundwater extending towards the south of the ash dam.

UPSS Report

The investigation completed by DLA Environmental in 2010 in relation to the UPSS located at the vehicle refuelling depot was not available for review at the time of this assessment. However, based on information provided by Macquarie Generation management, ERM understands that four groundwater monitoring wells were installed for the purpose of monitoring the UPSS in accordance with regulatory requirements. Laboratory analytical results for samples collected from these wells indicated that the contaminants of concern (i.e. petroleum hydrocarbons) were all below the detection limits from the most recent sampling event in 2012.

6 PRELIMINARY CONCEPTUAL SITE MODEL

A conceptual site model (CSM) is a representation of the sources of contamination, potential receptors and pathways which the receptors may be exposed to the contaminants. The development of a CSM is an iterative process, staring with a preliminary CSM based on a review of background data for the Site and any available data from previous intrusive investigations. The CSM is refined by identifying data gaps and undertaking additional investigation to address these gaps, often in a staged approach. Typically the CSM is based on a 'lines-of evidence' approach where multiple data sources are used in the assessment of actual and potential risks to human health and the environment.

The preliminary CSM for the Site is derived from an assessment of the information reviewed to date and presented in the preceding sections of this report. The sources, pathways and receptors (SPR) are specifically addressed in the following sections and a graphical representation of the preliminary CSM is presented in *Annex G*.

In order to generate what the SPR linkages are, the first step is to identify the Areas of Environmental Concern (AECs) which may give rise to potential contamination issues. Following a review of site data and site visits, a number of AECs were identified that limit ERM's ability to assess risk currently (environmental, financial or regulatory) and require further investigation. The following sections describe AECs that are considered to represent data gaps in the CSM that warrant further assessment. The location of the AECs is shown on *Figure 3* of *Annex A*.

6.1 AREAS OF ENVIRONMENTAL CONCERN

6.1.1 Main Generating Plant Area (Power Block)

Power Block

The main building of the power station contains the four power generating units previously described. The primary source of potential contamination results from lubricating oil leaks at various points around the plant due to continuous vibration. Observations during the site visit confirmed this oil loss in various areas. Within the power block, leaks and spills are generally captured in internal contaminated water drains and transferred to the contaminated water treatment system; however larger spills which pool on the ground surface below various infrastructure and from the drainage system have the potential to directly impact underlying soil and groundwater by migration through cracks in concrete or via damaged drains.

No investigation has previously been completed within the immediate area of the power generating units due to access and safety limitations and a lack of a specific requirement to do so. Targeted investigation of these units is not considered possible at this time due to the operational nature of the facility.

Workshops and Minor Dangerous Goods Storage Areas

Various small workshops are present throughout the power block which service specific areas. Many of these workshops hold small quantities of lubricating oils, cleaners and similar chemicals. During the site visit, dangerous goods were generally observed to be appropriately stored within bunded or contained areas. However, staining of the concrete surface in various areas in relation to the workshops was observed, which indicates the potential for pooled spills and leaks to penetrate the concrete through cracks and joints into the subsurface. No investigations are known to have been undertaken to date which specifically target the small workshops within the power block. Targeted investigation of these areas is not considered possible at this time due to the operational nature of the facility.

Power Block Drainage Network

The network of drains which runs beneath the power block represent a potential contamination source to soil and groundwater due to the subsurface nature of this network and the various contaminants of potential concern (including corrosive chemicals) likely to be currently present or having been historically present as a result of the collection and conveyance of spills and leaks in various areas. In addition to the dedicated stormwater and contaminated water drainage systems, a sluiceway which transports ash and coal fines collected in various surface drains in the power block runs through the power block from west to east, eventually discharging into Pikes Gully Ash Dam.

No investigations are known to have been undertaken to date which specifically target the drainage network within the power block. Outside of the eastern end of the sluiceway, targeted investigation of these areas is not considered possible at this time due to the operational nature of the facility.

Power Block Investigation Approach

Targeted investigation of the power block, including the workshops and minor dangerous goods storage areas and the drainage network, is not considered safe or possible due to the operational nature of this area. To address this AEC, it is considered data collected from around the perimeter of the power block, and supplemented with investigation data from other AECs outside of the power block, will be sufficient in terms of spatial coverage and to assess the potential for migration of COPCs (of a material nature), if any, that may have migrated from the power block.

6.1.2 *Main Store - Dangerous Goods Storage Area*

The Main Store compound is located on the eastern edge of the operational area of the power station and comprises a covered section and an open lay-down area and storage yard covered in concrete hardstand. This area is used for storage of various spare parts and materials used throughout the power station, including dangerous goods. There are two dangerous goods storage areas located the Main Store; one is located within a bunded area on the southern portion of the Main Store and the other is located on the south-western portion. Both storage areas hold smaller quantities (<200L) of various solvents such as acetone, turpentine and kerosene and other liquid chemicals such as sodium hydroxide, sodium hypochlorite, formaldehyde and ammonia. ERM understands that flammable gases were previously stored in this area also, but are not currently stored here. Both dangerous goods storage areas within the Main Store are covered.

Surface water drainage from the Main Store compound is collected into a concrete sump located to the east of the compound. Whilst this sump is normally pumped out by a contractor, it can also discharge to the adjacent dam, which in turn has the potential to overflow into Pikes Gully Ash Dam. Any spills from inside the dangerous goods areas that end up in the sump have some potential to be discharged to the dam, although there is no record of this having occurred. No previous investigations are known to have been undertaken in this area.

Given the lack of investigation data in this AEC and the potential sources of contamination, further investigation is considered to be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

6.1.3 *Landfill*

The landfill is located approximately 1.3 km to the south of the power block and has a largely undefined footprint due to the long-term use of the Site coupled with overgrowth in areas no longer actively used for waste disposal. The unlined landfill is understood to have become operational during the construction phase of the Bayswater Power Station and has received both construction waste and waste generated during operations following commissioning of the power station. The level of waste management during the circa 30 year life of the landfill is largely unknown and the potential exists that hazardous wastes have been disposed in the landfill.

Two groundwater wells have been installed down gradient from the landfill to monitor potential groundwater impacts. ERM understands that limited monitoring has been conducted to date, and the results are not reported in the *Water Management Licence Package Annual Monitoring and Compliance Reports* outlined in *Section 5.4*.

ERM did not identify groundwater results for the monitoring well located at the landfill site within the dataroom and a review of data for this monitoring well is outstanding.

However, given the paucity of groundwater characterization data, the lack of records on the extent of waste disposal, the lack of knowledge on extent and the potential that hazardous wastes have been disposed in the landfill, further investigation would be required to confirm soil and groundwater conditions.

6.1.4 *Low Pressure Pumping Station*

The Low Pressure Pumping Station is located approximately 9.6 km to the south-west of the operational area. The station pumps water from the Hunter River and transfers the water to the high pressure pumping station via an open channel. The low pressure pumping station include a series of five pumps within the Hunter River, a pump house building and power supply with a (brick) bunded external transformer.

As outlined previously, low concentrations of PCBs are expected to be present in the transformers at the Low Pressure Pumping Station, although no spills or leaks in this area have been previously reported. No investigations are known to have been completed to date in this area.

Given the lack of groundwater characterization data coupled with the potential for impact presented by the PCB-containing transformers, further investigation would be required to soil and groundwater conditions.

6.1.5 *High Pressure Pumping Station*

The High Pressure Pumping Station is located approximately 8.6 km to the south-west of the operational area of the power station. The pump receives water from the low pressure pumping station and pumps the water via above ground pipelines to Plashett Dam or storage facilities at Bayswater or Liddell Power Stations. The high pressure pump house contains pumps and associated lubrication facilities, and power supply with a (brick) bunded external transformer forms part of the station.

Hydrocarbon staining on the concrete floor of the pump house was observed during a facilities and process audit conducted in 2007 (Parsons Brinckerhoff, 2007). As noted previously, low concentrations of PCBs further expected to be present in the transformer at the High Pressure Pumping Station.

Groundwater quality is not being monitoring in the immediate vicinity of the pumping station. Given the lack of groundwater characterization data coupled with the potential for impact as indicated by the noted oil staining and PCB containing transformers, further investigation would be required to confirm soil and groundwater conditions.

6.1.6 *Lime Softening Plant*

At its nearest point, the Lime Softening Plant is located approximately 1.2 km (at its nearest point) to the south of the Bayswater Power Station. The plant includes the gypsum and lime storage area, acid storage area, ferric chloride storage area, the mechanical plant room shed and two large clarifiers.

Oil stains were observed beneath the hydro-pneumatic tank and unbunded 205 litre oil drums in the mechanical plant room during the facilities and process audit conducted in 2007 (Parsons Brinckerhoff, 2007). Ferric chloride staining on the ferric chloride pump room inside the mechanical plant room and on the ferric chloride storage tanks is however considered to be of limited environmental significance. Groundwater quality is not being monitoring in the immediate vicinity of the Lime Softening Plant.

Given the lack of groundwater characterization data coupled with the potential for impact as indicated by the oil staining in the mechanical plant room, limited further investigation would be required to confirm soil and groundwater conditions.

6.1.7 *Contaminated Water Treatment System*

The Contaminated Water Treatment System is an oil-water separation facility providing treatment for water captured by the contaminated water drain system at the Bayswater Power Station. Water entering the facility could contain a range of potential contaminants including fuels, chemicals, coal and ash.

All the elements of the Contaminated Water Treatment System facility are located in the north-eastern section of the operational area. The facility comprises a sediment basin (with a surface area of approximately 0.3 Ha) with an oil skimmer and a separate secondary oil water separation section. After passing through the secondary oil water separation section, water discharges to a downstream storage pond (with a surface area of approximately 0.5 ha) before ultimately discharging to Tinkers Creek via a weir.

Visual inspection during ERM's site visit in August 2013 identified a layer of oily residue in the sediment on the edges of the sediment basin, and an oily layer of light non-aqueous phase liquid (LNAPL) on the water within the sediment basin. While oily residue was not observed in the holding pond, dissolved phase impact may still be present in water held within the pond. Groundwater quality is not being monitored in the immediate vicinity of the Contaminated Water Treatment System.

Given the lack of groundwater characterization data coupled with the potential for impact from the oily residues and contaminated water, further investigation would be required to assess potential material environmental issues associated with soil and groundwater conditions.

6.1.8 *Coal Storage Area*

The coal storage area is approximately 35 ha in size and is used for stockpiling of coal prior to being transferred via conveyor to the coal mill and boilers. Potential contamination sources include contaminated stormwater runoff from this area, which is captured in the retention ponds located in the northern portion of the stockpile area, and leaching of contaminants from the coal stockpiled on open ground to groundwater. The retention ponds are understood to be cleaned out on a regular basis and any fines collected are deposited in the Pikes Gully Ash Dam.

No soil and groundwater investigations are known to have been completed within the Coal Storage Area. EPL discharge monitoring point #1 is located at the outlet from the Treated Contaminated Water Pond, which is directly to the south of the Coal Storage Area, prior to discharge into Tinkers Creek, Although previous surface water analytical data collected from EPL discharge monitoring point #1 indicates that the conditions of the EPL are consistently complied with, there is some potential for contaminants from the coal stockpile area to impact surface water and groundwater between the EPL monitoring point and the discharge into Tinker's Creek.

Based on the potential sources of contamination and the relatively low likelihood of receptor exposure, and that this area will continue to be used for coal storage, the coal stockpile is considered to be relatively low risk in the context of the Site-wide assessment. However, based on the lack of investigation data for this AEC, further investigation is considered to be required to provide a baseline and to assess potential material environmental issues associated with soil and groundwater conditions.

6.1.9 *Coal Unloaders, Rail Infrastructure And Coal Transfer Lines*

Antiene RCU

The Antiene facility is considered an AEC due to its current and historical bulk fuel storage and operations associated with rail infrastructure and locomotive refuelling and maintenance. The Site currently has bulk storage tanks containing diesel and oil which appear to be recently installed and in good condition. There is no evidence to suggest any issues with the current fuel storage infrastructure, however limited information was available on the historic fuel storage at the facility. Leakage of oil and diesel from trains is also a potential risk and it is anticipated this has occurred historically. There is potential for this along the entire rail corridor, however greatest risk is at the unloader where trains may be parked or idle for long periods.

Ravensworth RCU

The Ravensworth RCU is considerably smaller than Antiene and only used occasionally. It has no bulk fuel or chemical storage as part of current operations, but is expected to have similar potential contamination issues as those presented for Antiene. The Ravensworth unloader has had reported diesel releases from locomotives as recent as 2003.

Given the absence of previous environmental characterisation work at both coal unlading facilities, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

Coal Transfer Lines

Overland coal transfer lines are present in several areas of the Site:

- the northern portion of the Site, extending from the north-west site boundary to the coal stockpiling area (inbound);
- the north-eastern portion of the Site extending from Antiene Rail Coal Unloader to the coal stockpiling area (inbound);
- the south-eastern portion of the Site extending from the adjoining mine to the coal stockpiling area (inbound); and
- the eastern portion of the Site extending from the coal stockpiling area to Liddell Power Station (primarily outbound).

These conveyors are located above the ground surface and are generally unsealed. According to information supplied by Macquarie Generation management, there is likely to have been historical oil leaks in the older coal conveyors due to a design fault with the initial gearboxes, which likely resulted in lubricating oil leaks to open ground. Further documentation of these leaks (e.g. volume, recurrence, precise locations, etc.) was not available at the time of this assessment and no previous investigations along the coal transfer lines are known to have been undertaken.

Despite the lack of detailed information for review in relation to these leaks, it is considered unlikely that potential receptors would be exposed to contaminants on a widespread basis. However, based on the lack of investigation data for this AEC, further investigation is considered to be required to provide a baseline and to assess potential material environmental issues associated with soil and groundwater conditions.

6.1.10 *Lime Softening Plant Sludge Lagoons*

The Lime Softening Plant Sludge Lagoons are located approximately 1.8km (at the nearest point) to the south of the Bayswater Power Station. Five individual lagoons cover a total area of approximately 10 ha. Sludge contained within the lime softening sludge lagoons includes residue from the water softening process, constituting calcium oxides, magnesium hydroxide and other precipitates from the water treatment process.

Groundwater monitoring at the lime softening sludge lagoons is limited to the sampling of one groundwater bore (BWGM1/D7) located approximately 100 m downgradient of the sludge lagoons. Parameters monitored included electrical conductivity (EC), pH, hardness, arsenic and metals (including aluminium, copper, iron, lead, manganese, nickel, and selenium). Sampling frequency has varied from twice per year to more than seven times per year.

Monitoring has indicated that conductivity in groundwater monitoring bore BWGM1/D7 has been above typical groundwater background values for the region with EC as high as 14 180 µS/cm measured in September 2009 (Macquarie Generation, 2010).

Analytes that have exceeded one or more of the guidance criteria (for irrigation and livestock water quality - Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000) for BWGM1/D7 during one or more sampling events include nickel and manganese (Macquarie Generation, 2010).

Given the elevated salinity measured in groundwater bore BWGM1/D7 and the other exceedences of screening levels noted above coupled with the potential for impact to downgradient receptors which includes the downgradient creek, further investigation would be required to assess potentially significant soil and groundwater contamination issues associated with the Lime Softening Plant Sludge Lagoons.

6.1.11 *Transformer Area*

The Transformer Area houses the main transformers for the Site and is located immediately west of the power block and is separated into two portions, with the administration buildings located in between. In addition to the potentially contaminating activity of transformer operation, also located within this area are five ASTs used for the storage of transformer oil. Based on verbal information supplied by Macquarie Generation management during the site visit, ERM understands that a PCB removal program was undertaken during the 1990s, which consisted primarily of changing transformer oil containing PCBs with oil that did not contain PCBs during regular maintenance activities.

Due to the construction of the oil tanks within the transformers, not all PCB-containing oil could be drained at once and low concentrations of PCBs are expected to be present currently in the transformers in this area. As presented previously, current levels of PCBs in transformer oil in these transformers are expected to be low.

While the transformers are now contained within new bund systems that drain to the contaminated water treatment system, there have been reports of transformers leaking and replacements have been undertaken over time. In addition to this, a failure of the 2A Generator Transformer and associated fire in 1986 resulted in a rupture of the transformer oil tank and is likely to have released transformer oil to the surrounding area. The use of fire fighting foam during this fire indicates that perfluorooctane sulfonate (PFOS) and/or perflurooctanoic acid (PFOA) are also contaminants of potential concern for this area. No investigations are known to have been completed within this AEC to date.

Given the absence of previous environmental investigations, historic release events and the volume and content of transformer oils contained within the area, further investigation would be required to assess potential material environmental issues associated with soil and groundwater conditions.

6.1.12 *Fuel Oil Installation and Associated Pipeworks/ASTs*

The Fuel Oil Installation comprises four 1.2 ML steel ASTs, three of which are used for the storage of diesel. One of the ASTs is not used for any purpose currently. Integrity testing was completed during 2011 on the three tanks currently in use, with no failures reported. These ASTs supply diesel via an above ground pipeline to the operational area, servicing several diesel ASTs located throughout the facility. The volume of fuel being stored and transferred across the Site represents a significant source of potential contamination.

Each of the four ASTs are individually bunded with drainage from the bund discharging to a local oil/water separator. This containment system is understood to be separate from the contaminated water containment and treatment system servicing the operational area. Anecdotal evidence provided by Macquarie Generation management and the results of previous environmental audits in this area indicated that the local separator may have been bypassed, with drainage from the tank bunds discharging directly to a dam located approximately 35 meters to the south-east of the fuel oil installation. Although this could not be confirmed, this scenario represents a significant risk to the area to the south-east of the fuel oil installation (upgradient of the Pikes Gully Ash Dam) should a spill occur within the bund.

No information was available at the time of assessment regarding procedures for reconciling delivery and usage volumes. Regardless, given the limitations of wet stock reconciliation when dealing with such large volumes, there is a potential for leaks to have caused the migration of contaminants to the underlying soil and groundwater.

There have been no soil and groundwater investigations completed in the area of the Fuel Oil Installation or adjacent to any of the associated pipeworks or site ASTs to achieve a suitable degree of environmental characterisation. Given the absence of previous environmental investigations, the age of infrastructure, volume of stored and transferred fuel, and the potential for historic release events to impact soil and groundwater receptors, further investigation would be required to assess potential material environmental issues associated with soil and groundwater conditions.

6.1.13 *Vehicle Refuelling Depot*

The vehicle refuelling area comprises an area of approximately 250 m^2 in the north-east portion of the operational area near the Main Store. There is one unleaded petrol UST (21 000L) and one diesel UST (37 000L) and associated fuel dispensing infrastructure. For reference, the mobile plant maintenance and refuelling area associated with the coal storage area is a separate facility. The USTs are understood to have been installed at the time of the construction of the power station. Tank integrity test results reported in 2009 (Hodge Industrial Installations Pty Ltd, 2009) indicate that the petrol UST passed, but the diesel UST failed the wet pressure test. According to this report, the diesel tank failure may have been due to a fault in the non-return valve at the top of the tank or could be indicative of the commencement of tank shell failure.

Dataroom documents indicate that one UST (30 000 L), which previously held petrol, was decommissioned in 2007 in this area by pumping out the residual fuel, excavating the overlying soil above the tank, cutting the top off the tank and backfilling the tank with compacted fly ash (Hodge Industrial Installations Pty Ltd, 2007). No further information relating to validation of the decommissioning of this UST was available at the time of assessment.

Soil and groundwater investigations have been completed in the areas of underground tank infrastructure to ensure compliance with relevant underground petroleum storage system (UPSS) legislation, and ensure protection of soil and groundwater receptors. Four groundwater monitoring wells were installed during a previous investigation (DLA Environmental, 2010), three wells were installed downgradient of the USTs and fuel dispensers (to the north) and one well was installed up hydraulic gradient from the USTs (to the south). The wells were initially sampled following installation and are sampled every six months for laboratory analysis. Results in November 2012 indicated that no contaminants related to petroleum hydrocarbons were detected.

Based on the previous investigation results, it is considered that contamination related to the presence of the USTs and aboveground fuel dispensing infrastructure does not appear to be present. However, it is recommended that these existing groundwater wells are sampled to provide up-to-date baseline data in this area. The existing monitoring well network is considered to be sufficient to provide data on baseline conditions in this area.

6.1.14 *Mobile Plant Maintenance and Refuelling*

Mobile plant associated primarily with the coal storage area are serviced and refuelled in this area, located directly to the south of the coal storage area and comprising an area of approximately 2 500 m^2. Significant surface staining of the concrete in the refuelling and lubrication area indicates that spills and leaks of diesel from the AST and lubrication dispensers in this area have potential to have impacted the subsurface. A concrete subsurface sump (9 000L) used for storage of waste oil prior to pump-out by a contractor is located to the north of the workshop. This sump is understood to have been installed during construction of the power station and no integrity testing is known to have been completed on this sump to date. Whilst no spills or leaks of waste oil have been documented from this sump, it is possible that damage to the sump would result in releases of oil to the subsurface. No investigations are known to have been completed in this area.

Surface water from this area discharges to the coal storage area retention ponds, which in turn discharge to Tinkers Creek via a weir. Given the lack of investigation data available and the evidence of leaks and spills of hydrocarbons, further investigation would be required to assess potentially significant soil and groundwater contamination issues associated with this AEC.

6.1.15 *Cooling Water Treatment Plants*

The cooling water treatment system comprises separate plants for generation units 1/2 and units 3/4, both located on opposite sides of the power block and covering an area of approximately 3 ha in total. There are a number of ASTs located in these areas, which hold the following chemicals used in the treatment process:

- Anhydrous ammonia;
- Sulphuric acid;
- Sodium hydroxide;
- Chlorine; and
- Ferric chloride.

The results of several previous environmental compliance audits indicated that various areas of these systems had leaks via corroded valves and unlined, damaged concrete sumps. These leaks at the ground surface could have resulted in releases of contaminants to the environment in these areas. No investigations are known to have been completed in this area to date.

Whilst it is considered that the risk from potential releases in these areas to the surrounding areas is relatively low in the context of the Site-wide assessment, no previous investigations have been undertaken in these areas to date and no baseline has been established. It is recommended that further investigation is completed to establish a baseline at this AEC and to assess the potential for material issues to be present in relation to soil and groundwater contamination.

6.1.16 *Demineraliser Plant*

The demineraliser plant comprises an area of approximately 3 500 m^2 and is located on the north-eastern corner of the power block, approximately 40 meters west/north-west of the vehicle refuelling depot. Significant quantities of sulphuric acid, sodium hydroxide and ferric chloride are stored in ASTs in this area for use in the demineralising process water. Previous compliance audits have noted damage to the bunds or bund linings surrounding some of the ASTs and corrosion to associated pipework. These conditions have the potential to lead to uncontrolled releases of chemicals to stormwater or directly to the subsurface via cracks or other preferential pathways.

Impacted stormwater originating from this area has some potential to impact aquatic ecology in discharges to surface water bodies surrounding the Site.

Overall, the likelihood of receptors being exposed to contaminants originating from the demineralisation area is considered to be low. However, given the lack of investigation in this area to date and the potential for subsurface impact to be present due to damage to the containment system, further investigation is considered to be required to establish a baseline for this area and to assess the potential for material issues to be present related to soil and groundwater contamination.

6.1.17 *Former Large Items Assembly Area and Former Contractor Staging Area*

The Large Items Assembly Area and Contractor Staging Area are two large portions of the Site used during construction of the power station which have been largely unused since the power station was commissioned in 1986. Negligible formal documentation was available on these areas, but Macquarie Generation management supplied verbal information during site interviews in relation to historical activities.

Large Items Assembly Area

The Large Items Assembly Area is located to the north-west of the coal storage area and adjacent to Tinkers Creek and comprises an area of approximately 8 hectares. This area was previously used for assembly of large pieces of infrastructure such as boiler components, the electrical supply system, and the fire water system for the Site. The area was cut out of the hillside, with the natural excavated material being used to fill the Site to level. It is unknown whether imported fill materials were used in this area. The area is predominantly flat and is understood to have been unsealed since it was levelled. A sedimentation pond was constructed on the north-eastern side of this area and is currently present.

Site activities included primarily welding, with the only buildings present being portable toilets. Information on electricity supply to this area was not provided during site interviews, but it considered likely that generators were used during assembly works. No chemical stores were confirmed to have been present, but it is likely that various fuels were used or stored temporarily in this area. No significant spills or other environmental incidents were known to have occurred in this area; however detailed information on incidents in this area was not available for review at the time of this assessment. No investigations are known to have been completed to date in this area.

Potential contaminants include liquid fuels (e.g. petrol and diesel) and heavy metals from welding activities and associated waste products such as slag.

Given the lack of detailed information for this area and the large spatial area, it is difficult to assess potential risks currently. Further investigation is considered to be required to assess the potential for material contamination issues related to soil and groundwater contamination to be present in this area.

Contractor Staging Area

The Contractor Staging Area is located approximately 250 m south/south-west of Freshwater Dam and comprises an area of approximately 30 hectares. The north-western portion of this area (approximately 2.5 ha) is currently used by the local civil contractor on the Site for temporary storage of equipment and materials. Roads and lots constructed in a grid across this area were evident during the site walkover and during review of historical aerial photos. The area slopes gently from the north to the south and two retention ponds are constructed in the southern portion of the Site and are currently present.

Macquarie Generation management indicated that various activities occurred in this area during construction of the power station; however, more detailed information on any specific activities was not available.

It is understood that various contractors associated with the construction of the power station may have had site offices and/or accommodation here, and that plant and equipment were likely to have been stored in the area also, with associated maintenance activities likely having been conducted. It is unclear whether electricity, water, sewer and other utilities were supplied to this area. No previous investigations are known to have been undertaken in this area.

Potential contaminants include fuels, solvents and other cleaners associated with workshops/maintenance and various contaminants associated with potential undocumented fill materials used or stored in this area (potentially including asbestos).

Given the lack of detailed information for this area and the large spatial area, it is difficult to assess potential risks currently. It is therefore recommended that further investigation be undertaken at this AEC to assess the potential for material issues related to soil and groundwater contamination to be present.

6.1.18 *Brine Concentrator Holding Pond*

The Brine Concentrator Holding Pond is located approximately 700m to the south of the eastern section of the Bayswater Power Station and has a surface area of approximately 6 ha. As outlined previously, waste products from the Cooling Water Treatment Plants are transferred to the Brine Concentrator Holding Pond for further water recovery and treatment by the Brine Concentrators. ERM understands that, in addition to receiving treated water from the Cooling Water Treatment Plants, the holding pond can also receive return water from the Pikes Gully Ash Dam.

Water stored in the holding pond has the potential to be impacted by high levels of salinity, heavy metals and biocides. Overflows from the Brine Concentrator Holding Pond can drain to the Pikes Gully Ash Dam, although there is no evidence to indicate that this happened to date. Groundwater monitoring of the holding pond has not been conducted to date.

Based on the low likelihood of receptor exposure (with the Pikes Gully Ash Dam located directly downgradient) this area is considered to represent a relatively low risk in the context of the site-wide assessment. However, given the lack of investigation in this area to date, further investigation is recommended to confirm soil and groundwater contamination.

6.1.19 *Brine Concentrator Decant Basin*

The Brine Concentrator Decant Basin is located approximately 1.4 km to the south-west of the Bayswater Power Station and covers an area of approximately 14 ha. The decant basin receives highly saline wastewater from the Brine Concentrator treatment process.

Groundwater monitoring conducted at the decant basin has been limited to monitoring one groundwater monitoring well (BWGM1/D10) located approximately 300 m downgradient of the decant basin dam wall. Parameters tested included EC, pH, hardness, arsenic and metals (including aluminium, copper, iron, lead, manganese, nickel, and selenium). EC levels in BWGM1/D10 showed a steady increase from 10 000 µS/cm in 1989 to 45 000 µS/cm in 2003. With an expected background EC level in the region of 3 000 µS/cm in the area the increase in EC was attributed to leakage of saline water from the decant basin (HLA, 2003).

Following the identification of the increasing trend in groundwater salinity levels, a geophysical survey utilising electrical resistivity imaging was conducted downgradient of the decant basin dam wall. The survey identified a region of very low resistivity interpreted to represent saline groundwater, with the saline plume constrained to a narrow zone following the surface drainage path down the centre of the valley to the north west (HLA, 2003).

An interception curtain was subsequently installed to intercept seepage from the decant basin, creating a new pondage (referred to as 'Seepage Pond 2') downgradient from the decant basin dam wall. The return water pumps and associated control systems for Seepage Pond 2 and the pre-existing Seepage Pond 1 were completed on 11 April 2008 (Macquarie Generation, 2008).

Groundwater monitoring of BWGM1/D10 following the installation of the interception curtain has shown varying levels of EC over time, with elevated levels recorded from time to time (with EC as high as 38 060 µS/cm in February 2010 - Macquarie Generation, 2010).

Analytes that have exceeded one or more of the guidance criteria (for irrigation and livestock water quality - Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000) for BWGM1/D10 during one or more sampling events include nickel, manganese and iron (Macquarie Generation, 2010).

Given the continued measurement of high levels of salinity in groundwater bore BWGM1/D10, along with the other exceedences of screening levels noted above, and the potential for impact to the downgradient creek, further investigation would be required to assess potentially significant soil and groundwater contamination issues associated with the Brine Concentrator Decant Basin.

6.1.20 *Pikes Gully Ash Dam*

The Pikes Gully Ash Dam is located approximately 200 m (at its nearest point) to the east/south-east of the Bayswater Power Station and covers an area of approximately 150 ha.

The ash dam receives runoff received from the sluiceways draining from the Bayswater Power Station. In addition, sections of fly ash slurry pipes and return water pipes with asbestos containing material (ACM) are reportedly buried in the ash within the dam once a section is decommissioned. The fly ash slurry pipeline and water return water pipeline (with ACM) runs along the northern side of the ash dam.

The EPL (779) licenses several materials for disposal on site, but does not specify disposal locations. Macquarie Generation management indicated that the following items from the EPL may have been disposed of in the ash dam:

- acid solutions or acids in solid form;
- asbestos;
- fly ash and bottom ash;
- waste mineral oils unfit for their original use;
- waste oil / water hydrocarbon / water mixtures or emulsions;
- boiler cleaning residues;
- spent fly ash filter bags; and
- water treatment residues.

As outlined previously, seepage has been noted at the toe of the dam wall in Pikes Gully. In addition, a report by HLA (HLA, 2004) makes reference to the presence of saline groundwater seepage at and below a small dam located approximately 250 m from the south of the Pikes Gully Ash Dam. A geophysical survey conducted by HLA identified shallow conductive zones consistent with groundwater with elevated salinity that may have presented preferential pathways of saline groundwater extending towards the south of the ash dam (HLA, 2004). During ERM's site visit conducted in August 2013, seepage was also observed on the saddle dam wall on the northern section of the dam.

Seepage from the ash repository has the potential to be saline and contain arsenic and heavy metals (specifically barium, beryllium, boron, cadmium, chromium, cobalt, lead, manganese, mercury, molybdenum, nickel, thallium, selenium and zinc).

Parameters assessed during groundwater monitoring conducted at the ash dam included EC, pH, hardness, arsenic and metals (including aluminium, copper, iron, lead, manganese, nickel, and selenium) in up to six monitoring wells located downgradient of the ash dam wall.

Available results indicate that analytes exceeding one or more of the guidance criteria (for irrigation and livestock water quality - Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000) for one or more sampling events include nickel, manganese and iron (Macquarie Generation, 2010).

While some environmental assessment has been undertaken in this area, it is not considered that suitable characterisation of environmental conditions has been established, and further investigation would be required to confirm soil and groundwater conditions.

6.1.21 *Ravensworth Rehabilitation Site*

The Ravensworth Rehabilitation Site is located approximately 8 km east/south-east of the Bayswater Power Station and is currently used for the disposal of fly ash. The Site is located in the former Ravensworth No.2 Mine (the location of Void 1 to 4) and a section of the Ravensworth South Mine (the location of Void 5). The surface geology has been extensively disturbed by mining.

Much of the former opencast mine workings at the Site have been backfilled with mine spoil that includes coal from uneconomic seams, and the remnant coal is subject to spontaneous combustion. Part of the Ravensworth No.2 Mine have been backfilled with fly ash (Voids 1 to 3) and coal preparation plant rejects (eastern ramp of Void 4) (Aurecon, 2012). ERM understands that Void 5 is currently being prepared for future fly ash disposal.

The base of the voids is expected to be in contact with regional groundwater flow. Seepage from the ash filled voids has the potential to be saline and contain heavy metals.

The available groundwater sampling reports state that samples have not been obtained from the Ravensworth Rehabilitation Site during sampling events covering the monitoring period from 2006 to 2010 as underground heat generated from spontaneous combustion does not permit samples to be taken from the available monitoring wells (Macquarie Generation, 2010). Six wells were reportedly installed in this area, but Macquarie Generation has advised that none of the wells are currently useable due to subsidence, being covered by fill material, or being affected by high temperatures from spontaneous combustion.

Water quality monitoring has however been conducted in Void 4, which is currently used as a water management storage system receiving drainage water from the surrounding voids and mine spoils. Surface water samples collected from Void 4 were analysed for EC, pH, boron, chromium, fluoride, lithium, molybdenum, selenium and vanadium.

Monitoring has indicated that salinity levels are relatively saline with an average electrical conductivity of 7 079 µS/cm for monitoring conducted in 2012 (Macquarie Generation, 2012). Relatively alkaline conditions were further observed with pH levels generally ranging between pH 8 and pH 9. While the report with the Void 4 monitoring data did not compare the results against guidance criteria, a comparison of data collected prior to the ash disposal commencing indicate that boron and molybdenum have increased by approximately a factor of six and an order of magnitude respectively between 1992/1995 and 2012 (Macquarie Generation, 2012).

Given the lack of groundwater characterization data coupled with the potential for impact considering the nature of the mine spoils and the ash disposed of at the Ravensworth Rehabilitation Site, further investigation would be required to assess potential material environmental issues associated with soil and groundwater conditions.

6.1.22 *Lake Liddell Sediments*

Lake Liddell was constructed adjacent to Liddell Power Station in order to provide cooling water storage. Liddell Power Station is designed to operate without cooling towers and instead uses the capacity of Lake Liddell to manage waste heat.

Lake Liddell sediments have been identified as a potential AEC due to the discharges it receives from the Liddell Power Station, which include:

- cooling water that has passed through the plant and therefore:
  - has been treated with biocides and anti-scale chemicals;
  - is heated;
  - may contain traces of oil;
  - has potentially elevated salts and metals due to concentration created by evaporation.
- backwash from the process water pre-treatment plant (sand filter, clarifier and demineralisation plant) including lime enriched water (potentially resulting in the precipitation of calcium carbonate within Lake Liddell) from the from the water softening plant;
- treated effluent from the oil-water separator associated with the operational site drainage network and oil and grit trap (noting that the oil water separator was only installed in 1976, five years after commencement of site operation);

- overflow and potential seepage from the ash dam and associated tributary streams;

- stormwater from the sediment traps around the coal stockpiles and conveyor systems; and

- stormwater from other areas including the HVGT.

The recirculation of water through the Lake has the potential to concentrate impurities within the system.

Given the absence of available previous detailed environmental characterisation work, the numerous discharge points and sources of potential contaminants, and the presence of recreational users of the Lake, further investigation of selected depositional areas would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

6.1.23 *TransGrid Switchyard*

The TransGrid Switchyard, although not owned by Macquarie Generation, is a potential AEC due to the storage/use of transformer oil which may have historically contained PCBs. The surrounding topography slopes gently to the south and west, indicating that there is some potential for impacts at the switchyard to migrate onto land owned by Macquarie Generation.

Given the absence of previous environmental characterisation work, further investigation would be required to confirm soil and groundwater conditions surrounding the switchyard (investigation is not proposed within TransGrid owned land).

6.2 *EXPOSURE PATHWAYS*

There are several potential exposure pathways in which contaminants may impact sensitive receptors:

- transport via the site drainage system into surface waters;

- leakage from the site drainage system into groundwater;

- seepages of spilt chemicals/fuels direct to ground;

- leaching of metals from soil into groundwater;

- dermal contact with contaminated soils;

- ingestion of contaminated soils/sediments;

- inhalation of vapours related to impacted soils/groundwater (e.g. in presence of high concentrations of volatile contaminants or NAPL);

- seepage from the Ash Dam, and overflow/skimmer ponds into local creeks;

- inhalation of asbestos fibres; and

- groundwater flow into surface water bodies (e.g. Freshwater Dam and Lake Liddell).

6.3 *SENSITIVE RECEPTORS*

The sensitive receptors identified are as follows:

- indoor and outdoor human health receptors in the form of industrial on-site and off-site users;

- intrusive maintenance workers both on and on-site;

- residential receptors and potential groundwater users, the closest of which are located at 7 and 9 Hebden Road, approximately 130 m east of the Ravensworth Rehabilitation Site;

- recreational users of Lake Liddell (the closest surface water body where recreational access is currently approved);

- aquifers beneath the Site and nearby potable water wells; and

- ecological receptors, including freshwater ecological receptors in the local creeks, Lake Liddell, the Plashett Dam and the Hunter River.

7 *RECOMMENDATIONS FOR STAGE 2 ASSESSMENT*

Based on the results of the Preliminary ESA undertaken by ERM and consideration of Macquarie Generation's intended approach to the assignment of liability relating to soil and groundwater contamination issues, a programme of intrusive (Stage 2) assessment of potential soil, groundwater, sediment and surface water contamination issues is proposed to assess current conditions at the Site and relevant off-site receiving environments.

The following sections set out the proposed scope for the Stage 2 works in general accordance with the requirements set out in NSW EPA (2011).

It is noted that the Stage 2 ESA scope of work presented herein is preliminary, and the final agreed scope of works for the Stage 2 ESA will be detailed in a separate Sampling Analysis and Quality Control Plan (SAQP) which should be viewed in conjunction with this report.

The primary objective for the Stage 2 ESA is to gather data from applicable environmental media in order to develop a baseline assessment of environmental conditions at the Site and immediate surrounding receiving environments (including water, land and sediments), at the time of the transaction. Data obtained during completion of the Stage 2 ESA will also be used to assess whether there are contamination issues present which will exceed the material threshold and may also be used to inform future management of contamination issues both at the Site and in relation to the relevant receiving environments.

7.1 *DATA QUALITY OBJECTIVES*

Prior to commencement of the Stage I works, Data Quality Objectives (DQOs) were established for the project in line with the requirements and process outlined in NSW DEC (2006) *Guidelines for the NSW Site Auditor Scheme (2nd edition).*

These DQOs were developed to define the type and quality of data required from the site assessment program to achieve the project objectives outlined in *Section 1*. The DQOs were selected with reference to relevant guidelines published by the NSW Environmental Protection Authority (EPA), ANZECC and the NEPC, which define minimum data requirements and quality control procedures. The application of the seven-step DQO approach identified in NSW DEC (2006) is presented in full in *Annex H*.

7.2 SAMPLING RATIONALE

Based on a review of the available data, and the establishment of AECs, the most appropriate sampling design to achieve the stated project objectives is considered to be primarily based on a judgemental (targeted) sampling program, with additional sampling undertaken to provide spatial coverage for low risk areas of the Site (e.g. buffer lands) or to fill material data gaps within the CSM. It is noted that intrusive investigations may be limited to areas where access and site activities enable investigations to occur without unacceptable health and safety risks to personnel and / or unacceptable disruption to site operations. The sampling plan will be discussed with site management prior to the commencement of works to assess this risk. The sampling plan will be discussed with site management prior to the commencement of works to assess this risk. As such, the sampling design currently proposed is considered indicative, and subject to minor alteration.

Given the scale of the Site, different sampling densities are proposed to be adopted relative to the contamination risk and logistical constraints in different areas of the Site. The sampling approach is generally in accordance with the NSW EPA (1995) *Sampling Design Guidelines*. The NSW EPA (1995) guidelines do not recommend a minimum number of sampling points for sites larger than 5.0 hectares. The Site has been divided into smaller areas of concern based on a review of historical activities and identified potentially contaminating activities as recommended in the NSW EPA (1995) guidelines.

The proposed sampling locations are provided in *Figures 4a* to *4j* of *Annex A*, with information on rationale, constituents of potential concern and number of investigation locations provided in *Table 7.1* (over).

Table 7.1 ***Proposed Sampling Approach***

Area of Environmental Concern	AEC ID	Issue.	Analytes	Proposed Boreholes & Monitoring Wells
Brine Concentrator Holding Pond	BA	Leaching of brine to surrounding areas	Standard Suite* plus 13 metals and boron, molybdenum, thallium and selenium, pH, major cations/anions	• 3 monitoring wells
Brine Concentrator Decant Basin	BB	Leaching of brine to surrounding areas	Standard Suite* plus 13 metals and boron, molybdenum, thallium and selenium, pH, major cations/anions	• 5 monitoring wells
Fuel Oil Installation	BC	Contamination of soil and groundwater from loss of fuel and oil	Standard Suite*	• 4 soil bores • 5 monitoring wells • Supplemented with additional investigation locations from other surrounding AECs
Vehicle Refuelling Depot	BD	Contamination of soil and groundwater from loss of fuel and oil (UPSS)	Standard Suite*	• 4 existing monitoring wells
Coal Storage Area	BE	Potential leaching of contaminants from stockpiled coal and retention ponds	Standard Suite*	• 9 monitoring wells
Coal Unloaders, Rail Infrastructure and Coal Transfer Lines	BF	Contamination of soil and groundwater from transfer line gearbox oil leaks, fugitive coal fines, current and historic fuel storage, locomotive maintenance, and rail infrastructure activity.	Standard Suite*	• 7 soil bores • 7 monitoring wells • Visual inspection of coal transfer lines to assess the need for further investigation
Contaminated Water Treatment Plant	BG	Contamination of soil and groundwater from contaminated water from operational areas	Standard Suite* plus VOCs and PCBs	• 7 monitoring wells
Cooling Water Treatment Plants	BH	Contamination of soil and groundwater use of chemicals in water treatment (sulphuric acid)	Standard Suite* plus pH, major cations/anions,	• 8 soil bores • 8 monitoring wells

Area of Environmental Concern	AEC ID	Issue	Analytes	Proposed Boreholes & Monitoring Wells
Demineraliser Plant	BI	Contamination of soil and groundwater from spills and leaks of chemicals used in demineraliser process	Standard Suite* plus pH, major cations/anions	• 3 monitoring wells
Former Contractor Staging Area	BJ	Contamination of soil and groundwater from spills and leaks of fuels and chemicals used during facility construction	Standard Suite* plus VOCs	• 19 soil bores • 5 monitoring wells
Former Large Items Assembly Area	BK	Contamination of soil and groundwater from spills and leaks of fuels and chemicals used during facility construction	Standard Suite* plus VOCs	• 7 soil bores • 4 monitoring wells
Generator Transformer Areas	BL	Contamination of soil and groundwater from transformer oil	Standard Suite*plus PCBs & PFOS/PFOA	• 7 soil bores • 6 monitoring wells
Landfill	BM	Contamination of soil and groundwater from current and historical waste burial	Standard Suite* plus VOCs and PCBs	• 9 soil bores • 6 monitoring wells
Lime Softening Plant	BN	Contamination of soil and groundwater from chemicals used in softening (ferric chloride, sulphuric acid, lime)	Standard Suite* plus 13 metals, pH, major cations/anions	• 3 monitoring wells
Lime Softening Plant Sludge Lagoons	BO	Contamination of soil and groundwater from spent softening plant sludge	Standard Suite* plus 13 metals, pH, major cations/anions	• 5 monitoring wells
Mobile Plant Workshop and Refuelling	BP	Contamination of soil and groundwater from fuel storage/dispensing and waste oil sump	Standard Suite*plus VOCs	• 6 monitoring wells
Pikes Gully Ash Dam	BQ	Contamination of soil and groundwater from ash dam leachate, waste disposal and ash slurry/return water lines with ACM.	Standard Suite* plus 13 metals and boron, molybdenum, thallium and selenium, pH, major cations/anions	• 14 monitoring wells • 21 surface soil samples for asbestos only (beneath ACM pipeline)
Ravensworth Rehabilitation Area	BR	Contamination of soil and groundwater from CCP leachate.	Standard Suite* plus 13 metals and boron, molybdenum, thallium and selenium, pH, major cations/anions	• 11 monitoring wells • Visual inspection of fly ash transfer lines to assess the need for further investigation

Area of Environmental Concern	AEC ID	Issue	Analytes	Proposed Boreholes & Monitoring Wells
Low Pressure Pumping Station	BS	Contamination of soil and groundwater from transformer oil	Standard Suite*plus PCBs	• 2 soil bores • 1 monitoring wells
High Pressure Pumping Station	BT	Contamination of soil and groundwater from transformer oil	Standard Suite*plus PCBs	• 2 soil bores • 1 monitoring wells
Main Store - Dangerous Goods Storage Area	BU	Contamination of soil and groundwater from spills and leaks of chemicals	Standard Suite* plus VOCs	• 2 soil bores • 3 monitoring wells
Power Block	BV	Contamination of soil and groundwater from spills and leaks of various chemicals	Standard Suite* plus VOCs and PCBs	• 9 soil bores • 13 monitoring wells • Supplemented with additional investigation locations from other surrounding AECs
Sediments in Surrounding Waterways and Lake Liddel	BW	Contamination of sediments in Cullens Gully and Tinkers Creek from discharges (drainage lines and groundwater seepage) related to Bayswater site operations. Contamination of sediments in Lake Liddell from discharges (drainage lines and groundwater seepage) related to Liddell Power Station operations.	Standard Suite* plus PCBs and PSD and TOC for ecological risk.	• 6 sediment samples from Tinkers Creek • 4 sediment samples from unnamed creek (tributary of Cullens Gully) • 44 sediment samples from Lake Liddell • Surface water samples at each sediment sampling location (10)
TransGrid Switchyard	BX	Contamination of soil and groundwater from surface water and groundwater migrating from the TransGrid switchyard onto land owned by Macquarie Generation	Standard Suite*plus VOCs and PCBs	• 4 monitoring wells
Site Boundary Monitoring Wells	BY	Assessing migration of potential contamination across the Site boundaries where there are no investigations locations as part of other AECs	Standard Suite*	• 36 monitoring wells • Supplemented with additional investigation locations from other surrounding AECs

Notes:

* - Standard Suite includes TRH (C_6 - C_{40}), BTEX, suite of 8 metals, PAHs, phenols. Asbestos will be analysed in one shallow fill sample at each borehole in operational areas.

One soil sample from each AEC will be analysed for cation exchange capacity and pH for use in determining the appropriate ecological screening levels to apply.

All sediment samples and selected soil samples will be analysed for particle size distribution and total organic carbon to allow for adoption of appropriate health screening levels for vapour inhalation risk.

7.2.1 *Waterways*

Bayswater Power Station Operational Area

Sediment sampling is proposed to target potential contamination from cooling water discharges or other potential instances of off-site migration of contaminants from the Site and includes sampling in two areas:

- within Tinkers Creek (a potential depositional zone from cooling water discharges and discharges from the coal storage area retention basin); and
- Cullens Gully, a creek to the north of the spillway from Pikes Gully Ash dam, which has been reported to have received unplanned overflow from the ash dam.

The proposed sediment sampling design for these areas is targeted at the source and limited downgradient areas. A transect approach to sampling is not considered to be required initially, but may be considered upon receipt of laboratory results from the initial sediment samples.

Lake Liddell and associated waterways

Sediment sampling is proposed to target potential contamination from cooling water discharges or other potential instances of off-site migration of contaminants from Liddell Power Station and includes sampling in areas including an unnamed tributary of Lake Liddell that flows north east from the Hunter Valley Gas Turbine (HVGT), which has been reported to have received contaminant flow, including petroleum hydrocarbons, for the HVGT operations.

The proposed sediment sampling design for these areas is targeted at the source and limited downgradient areas. A transect approach to sampling is not considered to be required initially, but may be considered upon receipt of laboratory results from the initial sediment samples.

7.2.2 *Existing Groundwater Wells*

Where existing groundwater monitoring wells have been identified, the locations of these wells are presented on *Figure 4a to 4j* of *Annex A.*

It is proposed that existing groundwater monitoring wells will be sampled during Stage 2 investigation works. Sampling will only occur where the groundwater monitoring wells are deemed to be suitable.

The suitability of the existing groundwater monitoring wells will be assessed based on the following steps:

- ground truthing of the groundwater monitoring wells;
- bore logs will be reviewed to confirm that the wells were appropriately constructed and screened within the groundwater bearing strata;
- where bore logs are not available, wells will be assessed for suitability on a case-by-case basis; and
- the groundwater monitoring wells will be gauged to confirm the total depth of the well against the bore logs and the depth of groundwater.

The sampling process and analytical suite for existing wells deemed suitable will be in accordance with that adopted for newly installed wells.

7.3 *PROPOSED SAMPLING METHODOLOGIES*

The soil, sediment and groundwater investigation works will generally involve the following key steps:

- underground service location and mark-out (this may influence currently proposed investigation design);
- proposed borehole location mark-out;
- coring of hard standing surfaces where present;
- drilling and soil sampling of subsurface material using a combination of hand auger, push tube and / or auger drilling;
- installation of 50 mm diameter groundwater monitoring wells in selected boreholes screened appropriately to intersect the aquifer of interest and facilitate measurement of NAPL (if present);
- backfilling of boreholes;
- test pitting/trenching using excavator or backhoe in selected locations outside of the operational area where access permits;
- reinstatement of hardstanding surfaces;
- surveying the location of boreholes and monitoring wells; and
- development, measurement of standing water levels and sampling of the groundwater monitoring wells.

7.3.1 *Proposed Field Screening Protocols*

The following field screening protocols are proposed for the Stage 2 works:

Soil and Sediment

Soils will be logged by an appropriately trained and experienced scientist/engineer to record the following information: soil/sediment type, colour, grain size, sorting, angularity, inclusions, moisture condition, structure, visual signs of contamination (including staining and fragments of fibrous cement sheeting or similar) and odour in general accordance with AS 1726-1993;

A duplicate of each soil sample will be collected for field screening and will be placed in a sealed zip lock bag and screened in accordance with ERM Standard Operating Procedures (SOPs – available upon request) using a Photo Ionisation Detector (PID) fitted with a 10.6 eV lamp, calibrated at the beginning of each working day. Where the presence of VOCs or other impact is indicated by field screening, additional laboratory analysis may be undertaken.

Groundwater

Prior to sampling or gauging each monitoring well, the well cap will be partially removed to allow the headspace to be screened using a calibrated PID over a period of one minute. The presence of odours will also be noted following removal of the well cap and described by reference to their intensity and character. Following a period of no pumping (24 hours as a minimum) all wells will be dipped to gauge the depth to groundwater and, if necessary, the presence and thickness of Non-aqueous Phase Liquids (NAPLs). Wells will be purged using a thoroughly decontaminated peristaltic pump under low flow conditions where conditions allow. During this process, a calibrated water quality parameter meter will be used to record field measurements of pH, conductivity, redox potential, temperature and dissolved oxygen.

7.3.2 *Laboratory Analysis*

Primary samples will be couriered under chain of custody documentation to ALS Environmental Pty Ltd (ALS), a NATA accredited analytical laboratory. Inter-laboratory duplicate samples will be couriered under chain of custody documentation to Envirolab Services Pty Ltd (Envirolab) also a NATA accredited analytical laboratory.

Soil and groundwater samples will be analysed for the primary contaminants of potential concern listed below along with additional contaminants of potential concern associated with activities undertaken in that area.

- metals and metalloids (arsenic, boron, cadmium, chromium, copper, molybdenum, nickel, lead, mercury, selenium, thallium and zinc);
- Major cations and anions (including sulfate and chloride);
- Total Recoverable Hydrocarbons (TRH);
- BTEX - benzene, toluene, ethylbenzene and xylenes -BTEX);
- Polycyclic Aromatic Hydrocarbons (PAHs) and Phenols;
- Polychlorinated biphenyls (PCBs)
- Perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA)
- asbestos (presence / absence).

Additional contaminants of potential concern may also be analysed if required based on observations made in the field. Leachate analysis will be undertaken on soil samples based on observations made in the field and preliminary laboratory results. The Australian Standard Leachate Procedure (ASLP) is the preferred analytical method and is considered to be more representative of site conditions than the Toxicity Characteristic Leaching Procedure (TCLP).

8 CONCLUSIONS

The Preliminary ESA undertaken by ERM has identified that limited previous intrusive ESAs appear to have been completed on the Site and a number of potential areas of environmental concern have been identified based on the understanding of current and historic operations undertaken. These include:

- brine concentrator holding pond (potential seepage of brine);
- brine concentrator decant basin (historical seepage of brine);
- fuel oil installation (potential leaks);
- vehicle refuelling depot (potential leaks);
- coal storage area (historical and potential leaks);
- coal unloaders, rail infrastructure and coal transfer lines (potential and historic leaks);
- contaminated water treatment plant (potential leaks);
- cooling water treatment plants (historical and potential leaks, releases to ground);
- demineraliser plant (historical and potential leaks);
- former contractor staging area (potential spills, leaks and undocumented fill material);
- former large items assembly area ((potential spills, leaks and undocumented fill material);
- generator transformer areas (large volume of transformer oil used and stored);
- landfill (unknown waste disposal, potential for leaching to occur);
- lime softening plant (storage of chemicals, potential for leaks);
- lime softening plant sludge lagoons (disposal of spent softening plant sludge and potential for leaching);
- mobile plant maintenance and refuelling (historical leaks and spills of diesel fuel and lubricants, potential leak of waste oil);
- Pikes Gully Ash Dam (seepage to groundwater and surface water receptors);

- Ravensworth Rehabilitation Area (seepage to groundwater and surface water receptors);
- high pressure pumping station (potential leaks/spills of transformer oil);
- low pressure pumping station (potential leaks/spills of transformer oil);
- main store - dangerous goods storage area (potential leaks/spills and release through sump/dam);
- power block (historical and potential leaks of various chemicals); and
- Lake Liddell Sediments (sediments may have accumulated contaminants from site drainage and discharges over lifetime of station operation and precipitation of calcium carbonate).

Based on the results of the Preliminary ESA and consideration of the intended approach to establishing a baseline of soil and groundwater contamination, a programme of intrusive (Stage 2) assessment of potential soil and groundwater contamination issues is provided. The most appropriate sampling design is considered to be a judgemental (targeted) sampling of soil, groundwater and sediments at the established AECs for the Site, which is also considered to provide suitable spatial coverage to act as a baseline assessment.

Based on the information available at the time of preparation of this report ERM has not identified any contamination issues which are currently undergoing or likely to require material remediation, assuming ongoing industrial land use as a coal fired power plant. A number of potential material issues were identified, which will be assessed during Stage 2 investigation works.

9 LIMITATIONS

This report is based solely on the scope of work described in *Section 1.3* and performed pursuant to a contract between ERM and Macquarie Generation ("Scope of Work"). The findings of this report are solely based on, and the information provided in this report is strictly limited to the information covered by, the Scope of Work.

In preparing this report for the Client, ERM has not considered any question, nor provides any information, beyond the Scope of Work.

This report was prepared between 15 August 2013 and 18 October 2013 and is based on conditions encountered and information reviewed at the time of preparation. The report does not, and cannot, take into account changes in law, factual circumstances, applicable regulatory instruments or any other future matter. ERM does not, and will not, provide any on-going advice on the impact of any future matters unless it has agreed with the Client to amend the Scope of Work or has entered into a new engagement to provide a further report.

Unless this report expressly states to the contrary, ERM's Scope of Work was limited strictly to identifying typical environmental conditions associated with the subject site(s) and does not evaluate structural conditions of any buildings on the subject property, nor any other issues. Although normal standards of professional practice have been applied, the absence of any identified hazardous or toxic materials or any identified impacted soil or groundwater on the site(s) should not be interpreted as a guarantee that such materials or impacts do not exist.

This report is based on one or more site inspections conducted by ERM personnel and information provided by the Client or third parties (including regulatory agencies). All conclusions and recommendations made in the report are the professional opinions of the ERM personnel involved. Whilst normal checking of data accuracy was undertaken, except to the extent expressly set out in this report ERM:

a) did not, nor was able to, make further enquiries to assess the reliability of the information or independently verify information provided by;

b) assumes no responsibility or liability for errors in data obtained from, the Client, any third parties or external sources (including regulatory agencies).

Although the data that has been used in compiling this report is generally based on actual circumstances, if the report refers to hypothetical examples those examples may, or may not, represent actual existing circumstances.

Only the environmental conditions and or potential contaminants specifically referred to in this report have been considered. To the extent permitted by law and except as is specifically stated in this report, ERM makes no warranty or representation about:

a) the suitability of the site(s) for any purpose or the permissibility of any use;

b) the presence, absence or otherwise of any environmental conditions or contaminants at the site(s) or elsewhere; or

c) the presence, absence or otherwise of asbestos, asbestos containing materials or any hazardous materials on the site(s).

Use of the site for any purpose may require planning and other approvals and, in some cases, environmental regulator and accredited Site Auditor approvals. ERM offers no opinion as to the likelihood of obtaining any such approvals, or the conditions and obligations which such approvals may impose, which may include the requirement for additional environmental works.

The ongoing use of the site or use of the site for a different purpose may require the management of or remediation of site conditions, such as contamination and other conditions, including but not limited to conditions referred to in this report.

This report should be read in full and no excerpts are to be taken as representative of the whole report. To ensure its contextual integrity, the report is not to be copied, distributed or referred to in part only. No responsibility or liability is accepted by ERM for use of any part of this report in any other context.

This report:

a) has been prepared and is intended only for the Client and any party that ERM has agreed with the Client in the Scope of Work may use the report;

b) has not been prepared nor is intended for the purpose of advertising, sales, promoting or endorsing any client interests including raising investment capital, recommending investment decisions, or other publicity purposes;

c) does not purport to recommend or induce a decision to make (or not make) any purchase, disposal, investment, divestment, financial commitment or otherwise in or in relation to the site(s); and

d) does not purport to provide, nor should be construed as, legal advice.

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DOCUMENT 1b

Bayswater Power Station

Stage 2 Environmental Site Assessment – Part 1

Environmental Resources Management

31 January 2014

Macquarie Generation

COMMERCIAL IN CONFIDENCE

Macquarie Generation

Project Symphony, Bayswater Power Station

Stage 2 Environmental Site Assessment

Ref: 0224193RP02

31 January 2014

ERM

The world's leading sustainability consultancy

Approved by:	Peter Lavelle
Position:	*Technical Director*
Signed:	
Date:	31 January 2014
Approved by:	Matthew Klein
Position:	*Managing Partner - Asia Pacific Transaction Services*
Signed:	
Date:	31 January 2014

Environmental Resources Management Australia Pty Ltd Quality System

Project Symphony, Bayswater Power Station

Stage 2 Environmental Site Assessment

Macquarie Generation

31 January 2014

0224193RP02

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EXECUTIVE SUMMARY

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by Macquarie Generation to undertake a Stage 2 Environmental Site Assessment (Stage 2 ESA) at Bayswater Power Station (herein referred to as the "Site") in accordance with the work scope presented in the Preliminary Environmental Site Assessment (Preliminary ESA; ERM Reference 0213879RP01, Draft Rev 02) prepared by ERM.

The primary objective for the Stage 2 ESA was to gather soil, sediment, surface water and groundwater data in order to develop a baseline assessment of environmental conditions at the Site, as at or near the time of the transaction. Data obtained during completion of this Stage 2 ESA may also be used to inform future management of contamination at the Site.

Investigation Methodology

To achieve the stated objectives, ERM collected soil, sediment, surface water and groundwater samples and submitted those collected samples to environmental laboratories for analysis of Constituents of Potential Concern (COPCs). A Conceptual Site Model (CSM) developed for the Site during the Preliminary ESA was further refined and the analytical data was compared against published environmental screening levels to assess potential risks to human health and the environment.

The following conclusions were made based on the data collected during the investigation.

Investigation Outcomes

- *The impacts identified in soil and groundwater at the sites are unlikely to represent a risk to human health and/or the environment given appropriate ongoing management based on the current and continued use of the Site as a Power Station.*

- *The key impacts identified included asbestos in soils at specific locations, certain metals in groundwater, as well as surface water and sediments in Lake Liddell.*

- *Asbestos was identified beneath the pipelines linking the Power Station and the Pikes Gully Ash Dam and in one location within the Coal Storage Area.*

- *Certain metals were identified at concentrations in excess of screening levels designed for the protection of freshwater environments across the Site. Potential health and environmental risks associated with these exceedences have been interpreted in four broad groups, based upon the location of the samples, as follows.*

- *Exceedences identified in groundwater discharging to the Pikes Gully Ash Dam are likely to be minor contributors to any overall potential health or environmental risks associated with the Ash Dam, given the volume and nature of the ash and water stored within this reservoir;*

- *Exceedences identified in groundwater discharging to Plashett Reservoir, are not considered to represent a significant risk to human health or the environment on the basis that this reservoir was created as a part of the Power Station water management system, no public access to the reservoir is allowed and waters discharging from the reservoir flow back into the Power Station within a closed system design.*

- *Exceedences identified in groundwater discharging directly to offsite receptors including Bowmans Creek and the Hunter River were generally consistent with background concentrations and are not therefore considered to represent a significant risk to human health or the environment in the context of the surrounding environment. The one exception to this is arsenic, which was detected in groundwater beneath the Ravensworth Coal Unloader. Further assessment is warranted to assess potential risks associated with this issue.*

- *Exceedences identified in groundwater discharging to Lake Liddell were evaluated on the basis of sediment and surface water samples collected from Lake Liddell, although it is noted that Lake Liddell also receives discharges from Liddell Power Station. Metals and PAHs in sediment and metals (specifically boron and selenium) in surface water were identified at concentrations in excess of the adopted ecological screening values. Further assessment of these issues is considered warranted in order to assess the potential risks, however it is considered unlikely that a need for active remediation of sediments within the Lake or associated waterways would result from this. It should be noted that <u>none</u> of the surface water results gathered exceeded the adopted human health (recreational) guidelines relating to direct contact activities such as swimming, boating etc.*

<u>Site Management and Remediation Requirements</u>

- *No contamination issues were identified which would require material management or remediation based on the current and continued use of the Site as a Power Station with the potential exception of the identified asbestos impacts in soils surrounding the asbestos pipelines and works associated with surface water, seepage and groundwater management works in the vicinity of the Pikes Gully Ash Dam. Both of these issues are known independently of this assessment and Macquarie Generation has been developing appropriate management approaches alongside independent professional experts and regulators. It is considered that the costs for management of these issues may be potentially material depending on the option selected.*

- *The preparation and implementation of a suitable Environmental Management Plan (EMP) by an appropriately qualified professional is recommended to mitigate the risk of exposure to asbestos associated with areas in close proximity to the ACM pipelines and relating to the potential for asbestos to occur in soils across the site as a whole.*

- *Whilst some further assessment may be required to undertake confirmatory sampling in various areas of the Site (refer below), it is unlikely that costs related to this work would exceed the adopted material threshold for the purposes of this assessment.*

Requirements under the Contaminated Land Management (CLM) Act 1997

With regard to the duty to report contamination which exists under the CLM Act (1997) and the potential for regulation, ERM notes the following:

- *In many instances, the exceedences of the adopted groundwater, surface water and sediment screening levels are related to activities which are already regulated and monitored under the Site EPL (No. 779) and (in the case of Pikes Gully Ash Dam) a current PRP (PRP1). ERM considers that NSW EPA would most likely continue to manage this issue under the POEO Act via the Site EPL, and hence would not require formal notification of potential contamination under the CLM Act (and subsequently is unlikely to be regulated under that Act), however this approach should be confirmed with NSW EPA to ensure strict adherence to the NSW DECC (2009) guidelines.*

- *ERM understands that Macquarie Generation is in the process of developing a management strategy in relation to the identified asbestos issues in the vicinity of the ACM pipelines. Further, ERM understands that access to these areas has been restricted to mitigate potential risks to human health in the short term and that further delineation and quantification of asbestos in soils in this area is being undertaken. It is recommended that the outcomes of this further assessment are reviewed prior to a decision relating to notification of NSW EPA under Sec. 60 of the CLM Act 1997. It is also noted that Macquarie Generation has discussed the broader asbestos pipeline issue (given that it relates predominantly to infrastructure and the soil impacts are secondary) with WorkCover NSW. It is therefore considered that, if required, they would likely be the key regulator for this issue rather than NSW EPA.*

Additional Baseline Data Recommendations

- *The data presented in this Stage 2 ESA was generally considered to be of a suitable quality and completeness to provide a baseline of environmental conditions at the Site and immediate surrounding receiving environments.*

On the basis of the outcomes of this investigation, some limited additional characterisation of the baseline conditions at the Site is considered to be required as follows:

- *Delineation of asbestos contamination identified in the vicinity of the pipelines linking the Power Station to the Ash Dam and within the Coal Storage Area. Macquarie Generation is aware of the ACM issue at the pipelines and is currently further investigation and risk assessment (refer to Macquarie Generation (2013) Ash & Dust - Position Paper (Ref: 06.03.03.38 ENV.03.03.048)). It is recommended that this delineation be carried out in accordance with the methodology outlined in the ASC NEPM (2013) and should include more detailed inspections of these areas and the collection of soil samples for quantitative analysis.*

- *Additional confirmatory groundwater sampling is recommended within the Mobile Plant Workshop and Refuelling Area, Power Block and in the area of the Coal Unloaders to confirm the measured concentrations of metals. Additional confirmatory groundwater sampling is also recommended within the Fuel Oil Installation and Transformer Area to confirm the measured concentrations of benzene with specific reference to clarification of the duty to report contamination under Section 60 of the CLM Act.*

- *Further monitoring of metals in groundwater within the Plashett Reservoir and its catchment would be prudent in order to gain a better understanding of the effectiveness of the interception curtain which was installed to manage groundwater salinity down gradient of the Brine Concentrator Decant Basin.*

- *Further assessment of the bioavailability of the sediment contaminants and whether sediment and surface water impacts have the potential to pose a risk to ecological and recreational receptors (via consumption of fish) associated with identified metals and hydrocarbon impacts within Lake Liddell may also be required, however this is dependent on the outcomes of the recommended discussions with NSW EPA.*

1 INTRODUCTION

1.1 BACKGROUND

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by Macquarie Generation to undertake a Stage 2 Environmental Site Assessment (Stage 2 ESA) at Bayswater Power Station. Bayswater Power Station, herein referred to as the "Site", is situated on the New England Highway, approximately 15 kilometres (km) to the south-east of the township of Muswellbrook and approximately 28 km to the north-east of the township of Singleton, in New South Wales (NSW), Australia.

The works detailed herein were completed to support the potential sale of the business and in accordance with the work scope presented in the ERM (2013) *Preliminary Environmental Site Assessment (ESA)* (ERM Reference 0213879RP01 Draft Rev 02).

A Site location plan is presented as *Figure 1* of *Annex A*. The general site layout is presented in *Figures 2, 3* and *4.1* to *4.11* of *Annex A*.

1.2 OBJECTIVES

The primary objective for the Stage 2 ESA was to gather soil, sediment, surface water and groundwater data in order to develop a baseline assessment of environmental conditions at the Site and immediate surrounding receiving environments (including water, land and sediments), as at or near the time of the transaction. Data obtained during completion of the Stage 2 ESA may also be used to inform future management of contamination issues both at the Site and in relation to the relevant receiving environments.

1.3 MATERIALITY THRESHOLD

For the purposes of this report, a consistent approach regarding the materiality of a contamination issue has been adopted to that utilised in the *Preliminary ESA* (ERM, 2013) which was as follows:

- ERM adopted a materiality threshold of AUD 0.5 M (+ GST if applicable) per contamination source.
- Material costs are those costs for that item to meet relevant requirements of NSW EPA under its current land use to remediate or manage the contamination issue. Remediation or management includes additional assessment, environmental monitoring, management, containment or other remediation measures.

- In addition, any issue that ERM considers could have the potential to lead to prosecution by the regulatory authorities that could lead to significant business disruption or reputational impact will be considered material.

1.4 *APPROACH AND SCOPE OF WORK*

The adopted approach and scope of works for the Stage 2 ESA works comprised the following general tasks, in accordance with the requirements set out in the ERM Sampling, Analysis and Quality Plan (SAQP). It is noted that this Bayswater assessment was undertaken concurrently with a similar assessment at Liddell Power Station, but that these are reported in two separate reports.

Preliminaries

- preparation of a site-specific Health and Safety Plan (HASP), Environmental Management Plan (EMP) and overarching Site Management Plan (SMP);
- assessment of whether suitable monitoring wells exist at the Site, and whether they can be sampled as part of this investigation;
- identification of areas and constituents of potential concern additional to those identified during the *Preliminary ESA* (ERM, 2013);
- revision and amendment of the *SAQP*, as necessary;
- engagement of subcontractors including underground utility locator, drillers, laboratories and surveyors;
- scheduling of Site works with Macquarie Generation; and
- completion of site-specific inductions and permitting, as required.

Site Works

- ground-truthing of proposed sampling locations including clearance of underground services as noted below;
- identification of above and below ground services in the vicinity of drilling locations by reviewing publically available Dial Before You Dig (DBYD) plans and site engineering drawings, and engaging a qualified underground service locator.
- intrusive drilling works and environmental sampling, including soil groundwater, sediment and surface water sampling, in accordance with the requirements of the *SAQP*. Final investigation locations are presented in *Figures 4.1 to 4.11* of *Annex A*;

- laboratory analysis of select soil and groundwater samples for particular constituents of potential concern (COPC) in accordance with the requirements of the *SAQP* and as outlined in *Section 4.8;*
- completion of a visual inspection of exposed pipework known or suspected to contain asbestos. Where necessary, sampling of underlying surface soils was undertaken; and
- the survey of newly installed monitoring wells by a registered surveyor to Australian Height Datum (AHD) and Map Grid of Australia (MGA).

Reporting

- preparation and submission of weekly progress reports to Macquarie Generation;
- preparation and submission of an interim report with available data; and
- preparation and submission of this Stage 2 ESA report at the completion of works.

1.5 *REPORT STRUCTURE*

This Stage 2 ESA report has been prepared in general accordance with the NSW Environmental Protection Agency (EPA) (1997) *Guidelines for Consultants Reporting on Contaminated Sites,* as follows:

- *Section 1* - Introduction, background, objectives and scope of works;
- *Section 2* - Site setting including a summary of the Site history and Site conditions;
- *Section 3* - Data quality objectives (DQOs) for the works conducted;
- *Section 4* - Sampling and works methodologies for completing the investigation;
- *Section 5* - Results of the Stage 2 ESA works and Site-specific discussions and recommendations; and
- *Section 6* – Conclusions.

Other key guidelines utilised during completion of this Stage 2 ESA included, but were not limited to:

- Australian Standard AS 4482.1-2005 (2005) *Guide to the Sampling and Investigation of Potentially Contaminated Soil. Part 1 – Non-volatile and Semi-volatile Compounds;*

- Australian Standard AS 4482.2-1999 (1999) *Guide to the Sampling and Investigation of Potentially Contaminated Soil. Part 2 –Volatile Substances;*
- Australia and New Zealand Environmental and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) *Australia and New Zealand Guidelines for Fresh and Marine Water Quality*; and
- National Environment Protection Council (NEPC) (April 2013) *National Environment Protection (Assessment of Site Contamination) Measure 1999, NEPC, Canberra,* hereafter referred to as *ASC NEPM* (2013).

A full list of all references is also appended to this report.

1.6 *LIMITATIONS*

The findings of this report are based on the client-approved sampling plan within the *Preliminary ESA* (ERM, 2013) and the scope of work summarised in *Section 1.3* of this report.

ERM performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental assessment profession. No warranties, express or implied, are made. Although normal standards of professional practice have been applied, the absence of any identified hazardous or toxic materials on the subject Site should not be interpreted as a guarantee that such materials do not exist on the Site.

This assessment is based on Site inspections conducted by ERM personnel, sampling and analyses described in the report, and information provided by people with knowledge of Site conditions.

All conclusions and recommendations made in the report are the professional opinions of the ERM personnel involved with the project and, while normal checking of the accuracy of data has been conducted, ERM assumes no responsibility or liability for errors in data obtained from regulatory agencies or any other external sources, nor from occurrences outside the scope of this project.

ERM is not engaged in environmental assessment and reporting for the purpose of advertising, sales promoting, or endorsement of any client interests, including raising investment capital, recommending investment decisions, or other publicity purposes. The client acknowledges that this report is for the exclusive use of the client, its representatives and advisors and any investors, lenders, underwriters and financiers who agree to execute a reliance letter, and the client agrees that ERM's report or correspondences will not be, except as set forth herein, used or reproduced in full or in parts for such promotional purposes, and may not be used or relied upon in any prospectus or offering circular.

2 *SITE SETTING*

Macquarie Generation owns and operates two large conventional coal-fired power stations in the Hunter Valley region of NSW. Bayswater Power Station and Liddell Power Station located within three km of each other on either side of the New England Highway, approximately 15 km to the south-east of the township of Muswellbrook and approximately 28 km north-west of the township of Singleton. The two power stations share some infrastructure such as coal and water supply.

2.1 *SITE IDENTIFICATION*

The approximate coordinates of Bayswater Power Station are 307 144 m E and 6 413 998 m S. A site location plan is provided as *Figure 1* of *Annex A*.

The Site is composed of the following key features:

- Bayswater Power Station, comprising four coal-fired units (Units 1 to 4) and associated infrastructure;
- Pikes Gully Ash Dam, located approximately 200 metres (m) to the east and associated pipelines for ash slurry and return water;
- Ravensworth Rehabilitation Area (fly ash disposal), including the former Ravensworth No.2 and Ravensworth South final voids, located approximately ten km east- south-east of the Power Station and associated ash delivery and return water system;
- coal conveyors transporting from Antiene Rail Coal Unloader (RCU) and nearby mines and between Liddell Power Station and the Site; and
- buffer lands surrounding the infrastructure described above; and
- a switchyard (330 kV and 500 kV), located to the south-west of the main power block. This switchyard is owned and operated by the State owned corporation, TransGrid. Whilst conditions around the boundary of this area were assessed as part of this Stage 2 ESA, assessment of conditions within the switchyard boundary was not part of the scope of works.

Based on the proposed separation of assets between Bayswater and Liddell Power Stations as set out in *Proposed Liddell & Bayswater B Subdivision* (Chelace GIS, 2013), the shared infrastructure has been allocated as follows:

- the land associated with the water transfer lines and coal transfer lines between the power stations have been separated by assessing the portions located within the boundaries of the respective sites as indicated on *Figure 3* of *Annex A;*

- Antiene RCU and Ravensworth RCU have been assessed as part of this Stage 2 ESA; and
- Lake Liddell has been assessed as part of this Stage 2 ESA.
- The total area of the Site is approximately 8,300 hectares (ha), including the Ravensworth Rehabilitation Area, Lake Liddell and surrounds and buffer lands not currently in active use. The Power Station operational area itself occupies approximately 300 ha which includes the Pikes Gully Ash Dam. A plan showing the layout of the operational area is provided as *Figure 2* of *Annex A*.

For the purpose of this assessment, the Site has been considered as 25 individual areas of environmental concern (AECs), according to usage and the presence of potential sources of contamination as identified in the *Preliminary ESA* (ERM, 2013). These areas, listed in *Table 2.1*, are discussed in detail in the *Preliminary ESA* (ERM, 2013).

Table 2.1 *Summary of Areas of Environmental Concern*

Identification	AEC Description	Figure Reference
BA	Brine concentrator holding pond	Figure 4.3
BB	Brine concentrator decant basin	Figure 4.4
BC	Fuel oil installation	Figure 4.3
BD	Vehicle refuelling depot	Figure 4.2
BE	Coal storage area	Figure 4.1
BF	Coal unloaders, rail infrastructure and coal transfer lines	Figures 4.6 and 4.7
BG	Contaminated water treatment plant	Figure 4.1
BH	Cooling water treatment plants	Figure 4.2
BI	Demineraliser plant	Figure 4.2
BJ	Former contractor staging area	Figure 4.4
BK	Former large items assembly area	Figure 4.1
BL	Generator transformer areas	Figure 4.2
BM	Landfill	Figure 4.4
BN	Lime softening plant	Figure 4.3
BO	Lime softening plant sludge lagoons	Figure 4.4
BP	Mobile plant workshop and refuelling	Figure 4.1
BQ	Pikes Gully Ash Dam	Figure 4.3
BR	Ravensworth Rehabilitation Area	Figure 4.6
BS	Low pressure pumping station	Figure 4.5
BT	High pressure pumping station	Figure 4.5
BU	Main store – dangerous goods storage area	Figure 4.2

Identification	AEC Description	Figure Reference
BV	Power block	Figure 4.2
BW	Sediments in surrounding waterways and Lake Liddell	Figures 4.8 to 4.10
BX	TransGrid switchyard	Figure 4.4
BY	Buffer lands	Figure 4.11

2.2 *SITE HISTORY*

Bayswater Power Station received development approval from Muswellbrook Shire Council on 18 September 1980, with construction occurring between 1980 and 1986. The Power Station was commissioned in 1986.

Information provided by Macquarie Generation management and a review of aerial photographs (conducted and summarised in the *Preliminary ESA* (ERM, 2013)) indicate that prior to construction of the Bayswater Power Station, the Site and surrounds were primarily occupied by a mixture of farms, native vegetation and coal mines.

Further information regarding the history of the Site, including historical aerial photographs, zoning and environmental approvals, licenses and management is presented in the *Preliminary ESA* (ERM, 2013).

2.3 *SURROUNDING ENVIRONMENT*

The Site is surrounded by areas used mainly for mining purposes with some grazing, bushland, viticulture and thoroughbred horse stud farms in the region.

Key industrial uses in the area include:

- Macquarie Generation's Liddell Power Station located approximately three km to the north-east of the Bayswater Power Station; and
- existing and former coal mines surrounding the Site and within the Site footprint at the Ravensworth Rehabilitation Area.

The closest residential areas to the Site include:

- rural residencies that do not form part of residential centres. The closest identified residential property is located at 7–9 Hebden Road (near the intersection with the New England Highway). The identified property is located approximately 130 m east of the Ravensworth Rehabilitation Area. Verbal information provided by Macquarie Generation, however, indicates that this property is owned by Glencore Xstrata and is no longer occupied as a residence;

- Muswellbrook, approximately 15 km to the north-west of the main power block;
- Jerrys Plains Village, approximately 12 km to the south of the Site; and
- Singleton, located approximately 28 km to the south-east of the Site and 18 km south-east of the Ravensworth Rehabilitation Area.

2.4 *TOPOGRAPHY*

The Site lies within a broad river valley created by the Hunter River and its tributaries. Whilst the general slope in the area is towards the Hunter River in the south, the local topography is characterized by undulating hills leading to high variability in slope direction across the Site.

The Bayswater Power Station operational area gently slopes to the north with the main power block cut into the slope of a hill. The power block lies at an elevation of approximately 200 m AHD, dropping to an elevation of approximately 170 m AHD at the northern edge of the coal storage facility. The Pikes Gully Ash Dam lies at an elevation of approximately 170 m AHD, with the down gradient Pikes Gully valley sloping towards the east. The Ravensworth Rehabilitation Area lies at an elevation of approximately 120 m AHD, with the local topography highly disturbed by former mining operations.

2.5 *GEOLOGY*

Regional Geology

The Site is located on the northern section of the Sydney Geological Basin. The *Hunter Coalfield Regional 1:100 000 Geological Map, 2nd Edition* (Glen & Beckett, 1993) indicates that the Bayswater Power Station is underlain by Permian age conglomerate, sandstone, siltstone and claystone of the marine derived Maitland Group. This map further indicates that Quaternary age alluvial sediments (consisting of silt, sand and gravel) are associated with nearby the Bayswater Creek, Foy Creek and the Hunter River.

The *Muswellbrook 1:25 000 Geological Map, 9033-II-N* (Summerhayes, 1983) indicates that the Liddell Power Station, located approximately three km to the north-east, and the areas adjacent to and north of Lake Liddell are underlain by Permian Age, Maitland Group, Mulbring siltstone consisting of dark-grey shale and siltstone.

The *Jerry Plains 1:25 000 Geological Map, 9033-II-S* (Sniffin & Summerhayes, 1987) indicates that the geology in the area to the south of Lake Liddell consists of Permian Age, Singleton Super Group, Wittingham Coal Measures, Saltwater Creek formation, comprising sandstone and siltstone with thin lenticular coaly bands and marine siltstone intercalated towards base.

While the majority of the Pikes Gully Ash Dam is located on the Mulbring Siltstone of the Maitland Group, the eastern most extent of the Pikes Gully Ash Dam is located on the sandstone, siltstone and minor coal bands of the Saltwater Creek Formation of the Wittingham Coal Measures, Singleton Supergroup.

The Ravensworth Rehabilitation Area is underlain by the Jerrys Plain Subgroup, Archfield Sandstone and the Foybrook Formation within the Wittingham Coal Measures. Together these sedimentary deposits consist of a sequence of sandstones, shales, mudstone, minor conglomerate and coal seams (Pacific Power, 1993). The Ravensworth Rehabilitation Area further occurs in a synclinal structure known as the Bayswater Syncline, with the axis of the syncline trending approximately north south along the centre of the mined area and plunging gently (1 to 2 degrees) to the south. The slopes on the flanks of the syncline dip gently (about 3 degrees) towards the centre. It is further noted that isolated basalt dykes or sills may occur within the stratigraphy in the general area (Pacific Power, 1993).

The surface geology has been extensively disturbed by mining in the vicinity of the Ravensworth Rehabilitation Area. Much of the opencast mine workings at the Ravensworth Rehabilitation Area have been backfilled with mine spoil largely composed of coarse fragments (often boulders) of mudstone, siltstone and medium to fine grained lithic sandstone mixed together. In addition, the spoil contains coal from uneconomic seams which were included with the overburden material (Pacific Power, 1993). This remnant coal is subject to spontaneous combustion which has been documented at the site. Where mining has been completed at the former Ravensworth No.2 Mine, approximately 60 to 80 metres of disturbed overburden or mine spoil overlies the Archerfield Sandstone which forms the base of the opencast mine workings (Pacific Power, 1993). In addition, part of the former Ravensworth No.2 Mine has been backfilled with fly ash (Voids 1 to 3) and coal preparation plant rejects (eastern ramp of Void 4) (Aurecon, 2012).

Local Geology

Bore logs for previously existing monitoring wells at the site were not available for review at the time of preparation of this report. Local geology specific to various areas of the Site, as encountered during the current drilling program, are discussed in *Section 5.1* of this report.

Soil

The *Atlas of Australian Soils* (Northcote et al., 1960-68) categorises soil in the area as sodosol. Typical characteristics of these soils are high sodium contents, abrupt increases in clay content at depth, prone to crusting, unstable soil structure prone to erosion, with seasonally perched water tables.

2.6 HYDROGEOLOGY

Regional Hydrogeology

From a hydrogeological perspective, the sedimentary deposits can be categorised into the following units:

- low permeability conglomerate, sandstone, siltstone and mudstone that comprise the majority of the Permian sediments.
- low to moderately permeable coal seams, typically ranging in thickness from 2.5 m to 10 m, which are the prime water bearing strata within the Permian sequence.
- medium to highly permeable Quaternary alluvial sediments associated with the nearby Bayswater Creek, Foy Creek and the Hunter River.

Regional groundwater flow is expected to be towards the Hunter River located to the south of the site.

The sediments of marine origin are responsible for the naturally highly saline groundwater in the area. Groundwater in the Permian coal measures is reportedly moderately to highly saline with total dissolved solids (TDS) levels that can be higher than 6000 mg/L (Pacific Power, 1993). Water quality monitoring conducted in Void 4 (used as a water management storage system receiving drainage water from the surrounding voids and mine spoils) further indicate that salinity levels in water from Void 4 averaged approximately 4600 mg/L (based on an average electrical conductivity of 7079 µS/cm and a conversion factor of 0.65) during monitoring conducted in 2012 (Macquarie Generation, 2012).

Local Hydrogeology

Due to the undulating nature of the topography, variation in localised groundwater flow directions are probable and groundwater flow is expected to follow topography. Inferring localised groundwater flow from topography would suggest a northerly groundwater flow component at the Bayswater Power Station towards Lake Liddell, predominantly easterly groundwater flow at the Pikes Gully Ash Dam, westerly flow at the landfill, westerly to north westerly at the brine concentrator decant basin, and predominantly southerly flow at lime softening sludge lagoons.

Groundwater flow at the Ravensworth Rehabilitation Area is predominantly towards the Hunter River (along the southerly dip of the Bayswater Syncline) with a minor component of lateral discharge to the Bayswater Creek and Foy Brook (Pacific Power, 1993).

Details of hydrogeological conditions encountered during this Stage 2 ESA are summarised in *Section 5.2*.

2.7 GROUNDWATER USE

As part of the *Preliminary ESA* (ERM, 2013), search for publically listed boreholes on the NSW Natural Resource Atlas (NRAtlas) identified 13 groundwater bores within a five km radius of the main power block at the Site and 41 groundwater bores within a one km radius of the Ravensworth Rehabilitation Area. The bores within a 5km radius are listed below in *Table 2.2* and are registered for monitoring, testing and industrial uses.

Table 2.2 Registered Groundwater Bores in Proximity to the Site

Bore ID	Distance from Power Station (km)	Direction from site	Water Bearing Zone(s) (m)	Registered Use
GW024022	1.6	North East	3	Industrial
GW047486	3.75	North West	12-25, 28-40, 43-70, 75-92	Industrial
GW053862	3.2	North West	15-17, 26-29, 66-69, 80-81, 96-97	Industrial
GW060263	4.91	North West	57.9-58.5	Industrial
GW080212	4.7*	North East	-	Monitoring Bore
GW080725	4.57*	South East	-	Dewatering (Groundwater) Bore
GW200743	2.65	North West	-	Test Bore
GW200746	2.62	North West	-	Test Bore
GW200956	4.55*	South West	93.6-96.6 ^	Monitoring Bore
GW201061	2.4*	East	12-15.10	Monitoring Bore (Abandoned)
GW201062	2.35*	East	14.50-17.40	Monitoring Bore (Abandoned)
GW201110	4.52*	East	-	Dewatering (Groundwater) Bore
GW201266	1.4*	South	-	Monitoring Bore

* Distance from Pikes Gully Ash Dam (located at a closer proximity than the Power Station).

- No details available.

^ Depth of well screen.

Four of the identified bores in the area of the Ravensworth Rehabilitation Area are registered for domestic water supply purposes. These bores (GW046786 to GW046789) are located to the east and within 300 m of the Ravensworth Rehabilitation Area, and have been installed at relatively shallow depths (<7 m below ground level (bgl)) in alluvial sediments likely associated with the nearby Foy Creek. It is noted that these bores have been identified to be within close proximity to a residential property located at 7 - 9 Hebden Road. Information provided verbally by Macquarie Generation indicated that this residential property is currently owned by Glencore Xstrata and the bores are no longer used for the registered purposes.

A bore licensed for irrigation stock use (GW024385, with an installation depth of 4.6 m bgl in unknown lithology) was identified to be located to the east of and approximately 600 m from the Ravensworth Rehabilitation Area. A further bore (GW078054, with an installation depth of 16.2 m bgl, installed in sandstone) registered for industrial use was identified to be located to the east of and approximately 100 m from the Ravensworth Rehabilitation Area. The remaining bores within a one km radius of Ravensworth are registered for test, dewatering, monitoring or unknown purposes.

Given the naturally elevated salinity of groundwater across the majority of the Site it is of limited use for beneficial purposes and no groundwater abstraction wells in the vicinity of the Site are known to be used for the supply of drinking water.

2.8 *HYDROLOGY*

The major hydrological feature in the Hunter Valley is the Hunter River, located approximately 11 km and 5 km to the south of the Bayswater Power Station and the Ravensworth Rehabilitation Area, respectively. In addition, several local waterways are found in the vicinity of the Site and the main hydrological features can be summarised as follows:

- Tinkers Creek, which runs along the western boundary of the Bayswater Power Station and flows into Lake Liddell;
- Bayswater Creek and associated tributaries flow into Liddell Ash Dam and then into the western arm of Lake Liddell. Bayswater Creek then flows south from Lake Liddell, runs along the western boundary of the Ravensworth Rehabilitation Area, and ultimately flows to the Hunter River;
- Foy Creek, which runs along the eastern boundary of the Ravensworth Rehabilitation Area and ultimately joins with the Hunter River;
- Saltwater Creek and Wisemans Creek, flowing to the south into the Plashett Dam;

- the Plashett Dam (also known as Plashett Reservoir), located approximately six km to the south-west of the Bayswater Power Station;
- the Freshwater Dam, located adjacent and directly to the west of the Bayswater Power Station;
- the Bayswater Cooling Water Makeup Dam, located directly to the south of the Bayswater Power Station;
- the Pikes Gully Ash Dam, located to the east of the Bayswater Power Station;
- the Brine Concentrator Holding Pond, located approximately 740 m to the south-east of the Bayswater Power Station;
- the Brine Concentrator Decant Basin, located approximately 1.3 km to the south-west of the Bayswater Power Station; and
- Void 4 at the Ravensworth Rehabilitation Area, which acts as a water management storage system.

2.8.1 Lake Liddell

Lake Liddell was constructed as a water storage reservoir for the Power Stations and is a critical part of the Power Station infrastructure. It is located approximately 1.5 km to the north east of the Bayswater Power Station Power Block and is adjacent to the Liddell Power Station (to the east, north and south). The lake has a surface area of around 1100 ha and is up to 32 m deep (*Lake Liddell Hydrodynamic Modelling*, Worley Parsons, 2009).

The Lake supplies cooling water to Liddell Power Station and make-up water for the Bayswater Cooling Water Makeup Dam. It also accepts a range of treated discharges as discussed in the *Preliminary ESA* (ERM, 2013).

The Lake is constructed in a natural valley at the confluence of Bayswater, Tinkers and Maidswater Creeks (Macquarie Generation, undated). The lake is dammed on the eastern side and is equipped with a spillway leading to a large holding pond.

Water is periodically discharged from Lake Liddell to manage salinity and level. The discharge point is at the dam wall, and discharges flow via Bayswater Creek to the Hunter River, approximately 13 km downstream.

Discharges are under the Hunter River Salinity Trading Scheme (regulated under Bayswater's Environment Protection Licence (EPL) 779) and are made at times of high river flows and low background salinity levels.

Lake Liddell is also used by the public for recreation. The Lake Liddell recreation area is situated on a northern reach of the lake off Hebden Road. It caters for day visitors and campers, and the area is used for water-skiing, sailing, swimming and fishing (NSW Government Visit NSW website 21 June 2013). The area is managed by the Lake Liddell Recreation Area Reserve Trust appointed by the NSW Government to manage Crown Land (NSW Government LPMA website 21 June 2013).

- Lake Liddell is surrounded by buffer land to the north. The eastern side is bordered by an open cut coal mine (Liddell Colliery). The west and south are occupied by Liddell Power Station and Bayswater Power Station, respectively.

2.9 *SENSITIVE RECEPTORS*

- Sensitive receptors relevant to the Site identified as part of the *Preliminary ESA* (ERM, 2013), included:
- indoor and outdoor human health receptors in the form of industrial on-site and off-site users;
- intrusive maintenance workers both on and on-site;
- residential receptors and potential groundwater users;
- recreational users of Lake Liddell (the closest surface water body where recreational access is currently approved);
- aquifers beneath the Site and nearby potable water wells; and
- ecological receptors, including freshwater ecological receptors in Lake Liddell and the Hunter River (whilst various gullies / creeks exist across the site, these are generally intermittent drainage lines which feed into these larger receptors and most form part of the site Water Management System and hence have not been considered further herein).

2.10 *POTENTIAL AND KNOWN SOURCES OF CONTAMINATION*

The following potential and known sources of contamination were identified as part of the *Preliminary ESA* (ERM, 2013):

- brine concentrator holding pond (potential seepage of brine);
- brine concentrator decant basin (historical seepage of brine);
- fuel oil installation (potential leaks);
- vehicle refuelling depot (potential leaks);

- coal storage area (historical and potential leaks);
- coal unloaders, rail infrastructure and coal transfer lines (potential and historic leaks);
- contaminated water treatment plant (potential leaks);
- cooling water treatment plants (historical and potential leaks, releases to ground);
- demineraliser plant (historical and potential leaks);
- former contractor staging area (potential spills, leaks and undocumented fill material);
- former large items assembly area ((potential spills, leaks and undocumented fill material);
- generator transformer areas (large volume of transformer oil used and stored);
- landfill (unknown waste disposal, potential for leaching to occur);
- lime softening plant (storage of chemicals, potential for leaks);
- lime softening plant sludge lagoons (disposal of spent softening plant sludge and potential for leaching);
- mobile plant maintenance and refuelling (historical leaks and spills of diesel fuel and lubricants, potential leak of waste oil);
- Pikes Gully Ash Dam (seepage to groundwater and surface water receptors);
- Ravensworth Rehabilitation Area (seepage to groundwater and surface water receptors);
- high pressure pumping station (potential leaks/spills of transformer oil);
- low pressure pumping station (potential leaks/spills of transformer oil);
- main store - dangerous goods storage area (potential leaks/spills and release through sump/dam);
- power block (historical and potential leaks of various chemicals); and
- Lake Liddell sediments (sediments may have accumulated contaminants from Liddell Power Station drainage and discharges over a lifetime of station operation and precipitation of calcium carbonate).

3 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) were developed to define the type and quality of data required to achieve the project objectives outlined in *Section 1.2* of this report. The DQOs have been prepared in line with the seven-step approach outlined in NSW Department of Environment and Conservation (DEC) (2006) *Guidelines for the NSW Site Auditor Scheme (2nd Edition)*, and with reference to relevant guidelines published by the NSW EPA, ANZECC/ARMCANZ, and NEPC.

The DQO process is validated, in part, by the Quality Assurance and Quality Control (QA/QC) procedures and assessment, summarised in *Section 4.9* and presented as *Annex F* of this report.

The seven steps of the DQO process, and how they were applied to this assessment, are presented below in *Sections 3.1* to *3.7*.

3.1 STEP ONE: STATE THE PROBLEM

A statement of the problem is provided by the particular objectives of the assessment as stated in *Section 1.2*. Background information is provided by *Sections 1* and 2 of this report, and by the conceptual site model (CSM) which was developed as part of the *Preliminary ESA* (ERM, 2013).

3.2 STEP TWO: IDENTIFY THE DECISION

Decision Statements

The principal decision to be made is:

- Are there actual or potential material contamination issues relevant to the proposed sale of the Liddell Power Station?

Additional decisions to be made include:

- Is there sufficient data to provide an environmental baseline at the time of the transaction?
- What is the nature and extent of soil and groundwater impact on or beneath the Site?
- Does the impact at the Site represent a risk to human health, based on the current and continued use of the site?
- Is the impact at the Site likely to warrant regulation and/or remediation under the *NSW Contaminated Land Management Act, 1997*?
- Is material remediation likely to be required?

Adopted assessment criteria and waste classification guidelines which will assist in making some of these decisions are identified below in *Section 3.5.2.*

3.3 *STEP THREE: IDENTIFY INPUTS TO DECISION*

The inputs required to make the above decisions are:

- existing relevant environmental data, taking into consideration the number and location of existing soil and groundwater sampling locations, the construction of existing groundwater monitoring wells and the date of the most recent sampling events;
- direct measurement of environmental variables including soil type, soil gas concentrations, odours, staining, water strike, groundwater level and water quality parameters;
- collection and laboratory analysis of soil, groundwater, sediment and surface water samples for identified COPCs;
- field and laboratory QA/QC data; and
- comparison of data against adopted assessment criteria and waste classification guidelines (outlined in *Section 3.5.2*).

3.4 *STEP FOUR: DEFINE THE STUDY BOUNDARIES*

Spatial Boundaries

The site location and description is provided in *Section 2*. Figures identifying the site boundary and investigation areas are presented in *Annex A*. The physical spatial boundaries of the investigation included the surface and subsurface soils as well as groundwater beneath the site. Vertical boundaries of the investigation were limited to the depth of borehole advancement.

Temporal Boundaries

Temporally, the study is intended to provide a baseline assessment of the nature and extent of contamination at the Site, and in relevant receiving environments, as at or near the time of completion of the transaction to the extent practicable.

Constraints Within The Study Boundaries

Constraints on the delivery of the objectives of the Stage 2 ESA program within the study boundaries may include:

- location of underground services or infrastructure;
- the condition of existing monitoring wells;

- obtaining permission/access to enter and sample in off-site areas (where deemed necessary); and
- delay in delivery due to inclement weather or similar.

3.5 *STEP FIVE: DEVELOP A DECISION RULE*

The DQOs were designed to facilitate the collection of adequate soil and groundwater data to address the decisions in Step 2 of the DQO process. During the course of the project, various constraints had varying impact on the implementation of the Stage 2 program. Examples of these constraints included restrictions of siting investigation locations due to physical access or to the presence of sub-surface services and or depth constraints due to the presence of shallow bedrock or the absence of groundwater. It is noted however that more than 90% of the originally proposed locations were sampled. Deviations from the Stage 2 program were tracked during the course of the investigation via the weekly progress spreadsheet and were communicated to the relevant project stakeholders. An extract of the weekly progress spreadsheet is provided below as *Table 3.1* which highlights locations proposed but abandoned during the course of the investigation.

Table 3.1 *Bayswater Stage 2 Investigation Location Abandonment*

AEC	Location	Location Type	Total Drilling Depth (m bgl)	Comments
BA	BA_MW02	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
BC	BC_MW01	Monitoring Well	1.6	Abandoned due to depth to groundwater (anticipated to be >20m bgl)
BC	BC_MW02	Monitoring Well	2.7	Abandoned due to depth to groundwater (anticipated to be >20m bgl)
BC	BC_MW03	Monitoring Well	15	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
BC	BC_MW04	Monitoring Well	1.6	Abandoned due to depth to groundwater (anticipated to be >20m bgl)
BE	BE_MW09	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
BF	BF_MW04	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.

AEC	Location	Location Type	Total Drilling Depth (m bgl)	Comments
BF	BF_MW06	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
BF	BF_MW07	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
BF	BF_MW08	Monitoring Well	15	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
BF	BF_MW10	Monitoring Well	13	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BF	BF_MW11	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BJ	BJ_MW01	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BJ	BJ_MW02	Monitoring Well	15	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BJ	BJ_MW03	Monitoring Well	1.7	Monitoring well abandoned due to absence of significant contamination source and predicted depth to groundwater (based on adjacent drill locations).
BJ	BJ_MW04	Monitoring Well	1.2	Monitoring well abandoned due to absence of significant contamination source and predicted depth to groundwater (based on adjacent drill locations).
BJ	BJ_MW05	Monitoring Well	15	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BK	BK_MW01	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BK	BK_MW02	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BK	BK_MW03	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.

AEC	Location	Location Type	Total Drilling Depth (m bgl)	Comments
BM	BM_MW01	Monitoring Well	0.5	Monitoring well abandoned due to access constraints (no rig access). Soil bore completed by hand auger.
BM	BM_MW02	Monitoring Well	1.1	Soil bore completed by hand auger. Monitoring well abandoned due to the presence of landfill material at this drill location.
BM	BM_MW04	Monitoring Well	9	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BM	BM_MW06	Monitoring Well	1.5	Soil bore completed by hand auger. Monitoring well abandoned due to the presence of landfill material at this drill location.
BN	BN_MW01	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BQ	BQ_MW06	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BQ	BQ_MW09	Monitoring Well	4	Abandoned due to depth to groundwater.
BQ	BQ_MW12	Monitoring Well	9	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BR	BR_MW02	Monitoring Well	Not Attempted	Monitoring well location abandoned due to subsurface conditions (presence of mine spoil).
BR	BR_MW03	Monitoring Well	Not Attempted	Monitoring well location abandoned due to subsurface conditions (presence of mine spoil).
BR	BR_MW04	Monitoring Well	Not Attempted	Monitoring well location abandoned due to subsurface conditions (presence of mine spoil).
BR	BR_MW07	Monitoring Well	Not Attempted	Monitoring well location abandoned due to subsurface conditions (presence of mine spoil).
BR	BR_MW08	Monitoring Well	Not Attempted	Monitoring well location abandoned due to subsurface conditions (presence of mine spoil).
BR	BR_MW09	Monitoring Well	3	Monitoring well location attempted but abandoned due to subsurface conditions (presence of mine spoil). Spontaneous combustion also noted at this location.
BR	BR_MW10	Monitoring Well	Not Attempted	Monitoring well location abandoned due to subsurface conditions (presence of mine spoil).
BR	BR_MW11	Monitoring Well	9.5	Monitoring well location attempted but abandoned due to subsurface

AEC	Location	Location Type	Total Drilling Depth (m bgl)	Comments
				conditions (presence of mine spoil).
BS	BS_MW01	Monitoring Well	15	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BV	BV_MW02	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BV	BV_MW03	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BV	BV_MW05	Monitoring Well	12.3	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BW	BW_SS02	Sediment Sample	Not Attempted	Sample location abandoned due to physical access constraints.
BW	BW_SS03	Sediment Sample	Not Attempted	Sample location abandoned due to physical access constraints.
BW	BW_SS04	Sediment Sample	Not Attempted	Sample location abandoned due to physical access constraints.
BW	BW_SS05	Sediment Sample	Not Attempted	Sample location abandoned due to physical access constraints.
BX	BX_MW02	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BX	BX_MW04	Monitoring Well	Not Attempted	Monitoring well abandoned due to safety concerns (presence of subsurface utilities and location unable to be cleared through fill material).
BY	BY_MW01	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.
BY	BY_MW02	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.
BY	BY_MW03	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.
BY	BY_MW04	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.

AEC	Location	Location Type	Total Drilling Depth (m bgl)	Comments
BY	BY_MW05	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.
BY	BY_MW06	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.
BY	BY_MW07	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.
BY	BY_MW08	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.
BY	BY_MW09	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.
BY	BY_MW10	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.
BY	BY_MW11	Monitoring Well	Not Attempted	Remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low. NDD completed at this location.
BY	BY_MW13	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.
BY	BY_MW14	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low. NDD completed.
BY	BY_MW15	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.

AEC	Location	Location Type	Total Drilling Depth (m bgl)	Comments
BY	BY_MW16	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.
BY	BY_MW17	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.
BY	BY_MW18	Monitoring Well	12	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BY	BY_MW19	Monitoring Well	Not Attempted	Abandoned due to access and time constraints.
BY	BY_MW20	Monitoring Well	15	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BY	BY_MW22	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.
BY	BY_MW27	Monitoring Well	Not Attempted	Monitoring well abandoned due to physical access constraints (no rig access). NDD completed at this location.
BY	BY_MW28	Monitoring Well	Not Attempted	Monitoring well abandoned due to physical access constraints (no rig access).
BY	BY_MW30	Monitoring Well	Not Attempted	Monitoring well abandoned due to physical access constraints (no rig access).
BY	BY_MW31	Monitoring Well	Not Attempted	Abandoned due to access constraints (no access granted from Rio Tinto).
BY	BY_MW32	Monitoring Well	15	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well location abandoned.
BY	BY_MW33	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.
BY	BY_MW34	Monitoring Well	Not Attempted	Difficult access, remote location on edge of property boundary with groundwater anticipated at >30m bgl. Potential for impacts from site operations considered to be low.

3.5.1 *Field and Laboratory QA/QC*

The reliability of soil, sediment, surface water and groundwater data was assessed based on comparison with acceptable limits for field and laboratory QA/QC samples outlined in relevant guidelines made or approved under the *NSW Contaminated Land Management Act 1997,* including the *ASC NEPM* (2013). In the event that acceptable QA/QC limits were not met, the field observations of the samples were reviewed and if no obvious source for the non-conformance was identified (such as an error in sampling, preservation of sample(s) or heterogeneity of sample(s), etc.) liaison with the laboratories was undertaken in an effort to identify the issue that had given rise to the non-conformance.

A summary of the QA/QC procedures and assessment is presented in *Section 4.9* and *Annex F* of this report.

3.5.2 *Screening Values*

Individual soil and groundwater data, along with the maximum, minimum, mean, standard deviation and 95% upper confidence limit (UCL) of the mean concentration (if required) were compared to adopted assessment criteria. Exceedence of adopted assessment criteria does not necessarily indicate the requirement for remediation and/or a risk to human health or the environment. If individual or 95% UCL concentrations exceeded the adopted assessment criteria, consideration of the extent of the impact, the potential for receptors to be exposed to the impact, and regulatory compliance was considered.

The adopted assessment criteria have generally been sourced from guidelines made or approved under the *Contaminated Land Management Act 1997,* which includes the *ASC NEPM* (2013). Where alternative sources have been utilised, appropriate justification has been provided.

Soil Screening Values

Soil data was assessed against investigation criteria published in the following documents:

- NEPC (2013) *National Environment Protection (Assessment of Site Contamination) Measure 1999,* Schedule B1 - Guideline on Investigation Levels for Soil and Groundwater. Health Investigation Level (HIL) 'D' - Commercial/Industrial HIL 'C' - Public Open Space and Ecological Investigation / Screening Levels (EILs/ESLs) (as applicable). It is noted that laboratory analysis for pH and CEC is required to establish site specific EILs/ESLs, and an assessment of background conditions may be necessary. The establishment of EILs/ESLs was undertaken, and sample locations in up-gradient non-operational areas were utilised in establishing background conditions; and

- Application of the HILs will be considered on a case by case basis in accordance with the NEPM 2013 amendment to reflect local conditions encountered at the time of the intrusive works. Health Screening Levels for Vapour Intrusion and Direct Soil Contact (HSL) 'D' - Commercial/Industrial and Health Screening Levels for Vapour Intrusion and Direct Soil Contact Intrusive Maintenance Worker (Shallow Trench) will also be adopted.

Groundwater and Surface Water Screening Values

Water data will be assessed against investigation criteria published in NEPC (2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)*, Schedule B1 - Guideline on Investigation Levels for Soil and Groundwater, which references the following guidance:

- ANZECC and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Trigger values for fresh water, level of protection 95% species and level of protection 99% species (for potential bioaccumulation of mercury and selenium);

- National Health and Medical Research Council (NHMRC) and National Resource Management Ministerial Council (NRMMC) (2011) *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy;*

- NHMRC (2008) *Guidelines for Managing Risks in Recreational Waters* (note that these will be applied with reference to NHMRC and NRMMC 2011 - referenced above); and

- Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) (2011) *Technical Report No. 10, Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater*. Health Screening Levels for Vapour Intrusion (HSL) 'D' - Commercial/Industrial and Health Screening Levels for Vapour Intrusion - Intrusive Maintenance Worker (Shallow Trench).

It should be noted that the on-site waterways form part of the Site Water Management System and, in the case of Lake Liddell, were specifically constructed for the purpose of supplying water to power stations and receiving water from power stations. As such it may be more appropriate to assess the metals concentrations detected in surface water against a guideline providing a lower threshold of protection of species (e.g. 80%). As set out in the ANZECC (2000) guidelines however, the adoption of a lower level of should only be undertaken following consultation with relevant stakeholders and may also require more detailed assessment of potential toxicity, hence the 95% and 99% guidelines (for potential bioaccumulation of mercury and selenium) have been adopted for screening purposes in this assessment.

In the absence of Australian endorsed assessment criteria, a health screening value of 0.3 μg/L for PFOS in groundwater has been adopted. This value is proposed by both the UK Health Protection Agency (UK HPA, 2009) and the Minnesota Department of Health (MDH, 2011). Whilst it is noted that groundwater is not used on-site for potable supply, in the absence of a more appropriate criteria, the health screening value was adopted.

Sediment Screening Values

Sediment quality data will be assessed against screening values published in:

ANZECC / ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* - Interim Sediment Quality Guidelines (ISQGs), or the equivalent Commonwealth of Australia (2009) *National Assessment Guidelines for Dredging.*

3.5.3 *Appropriateness of Laboratory Limit of Reporting*

Comparison of the laboratory Limit of Reporting (LOR) to the screening values has been undertaken confirming that the screening values are less than the laboratory LOR with the exception of the following compounds:

- some volatile organic compounds in water (including vinyl chloride, chloromethane, bromomethane, 1,2-Dichloroethane, hexachlorobutadiene, 1,2,3-trichlorobenzene and 1,2-dibromomethane) and pentachlorophenol have LORs marginally above the adopted ecological protection criteria and/or above the drinking water guidelines. With the exception of vinyl chloride, it is noted that these contaminants are not regarded as key contaminants of concern and no drinking water receptors have been identified within the vicinity of the Site. In the event that a detection of these compounds is noted, further investigation and/or explanation may be required. As vinyl chloride is a breakdown product of PCE and TCE, detections of these compounds may trigger the need for further consideration;

- Selenium and mercury in water have LORs marginally above the adopted 99% freshwater ecosystem protection guideline. This guideline has been adopted as a precautionary approach and it is noted that the LOR is below the 95% guideline value. A detection of either of these compounds may require further investigation and/or explanation.

3.6 *STEP SIX: SPECIFY LIMITS ON DECISION ERRORS*

The acceptable limits on decision errors applied during the review of the results will be based on the data quality indicators (DQIs) of precision, accuracy, representativeness, comparability and completeness (PARCC) in accordance with NEPC (2013) *National Environment Protection (Assessment of*

Site Contamination) Amendment Measure 2013, Schedule B3 - Guideline on Laboratory Analysis of Potentially Contaminated Soils.

The potential for significant decision errors was minimised by:

- completing a robust QA/QC assessment of the validation data and application of the probability that 95% of data will satisfy the DQIs, therefore a limit on the decision error would be 5% that a conclusive statement may be incorrect;
- assessing whether appropriate sampling and analytical density has been achieved for the purposes of providing a baseline of soil, sediment and groundwater conditions at the point of transaction; and
- ensuring that the criteria set was appropriate for the ongoing use of the site as a power generation facility.

3.7 *STEP SEVEN: DEVELOP (OPTIMISE) THE PLAN FOR COMPLETING THE WORKS*

The DQOs have been developed based on a review of existing data and discussions with Macquarie Generation. If data gathered during the assessment indicated that the objectives of the assessment programme were not being met, the sampling design (including sampling pattern, type of samples and analytes) was adjusted accordingly using feedback (where necessary) from project stakeholders.

4 SAMPLING METHODOLOGY

4.1 RATIONALE

Based on a review of the available data and the establishment of potential AECs, the most appropriate sampling design to achieve the stated project objectives was considered to be primarily based on a judgemental (targeted) sampling program, which in itself provides good coverage of operational areas or areas, and minimal additional sampling undertaken to provide spatial coverage for low risk areas of the site (e.g. buffer lands) or to fill material data gaps within the CSM. It is noted that intrusive investigations may be limited to areas where access and site activities enable investigations to occur without unacceptable health and safety risks to personnel and/or unacceptable disruption to site operations. The sampling plan was discussed with site management prior to the commencement of works to assess this risk and was subject to minor alteration.

Given the scale of the site, different sampling densities to be adopted based on estimated contamination risk and logistical constraints of different areas of the site. The sampling approach was generally in accordance with the NSW EPA *Sampling Design Guidelines* (1995) which does not recommend a minimum number of sampling points for sites larger than 5.0 ha. As recommended in these guidelines, the Site has been divided into smaller areas of concern based on a review of historical activities and identified potentially contaminating activities.

4.2 SITE INSPECTION

The work areas of the Site were inspected and the soil and groundwater sampling locations were marked out to target identified Site features and potential contamination sources. At the same time as clarifying the investigation locations, sub-surface utilities were marked out using an appropriately qualified service locator. Ground Penetrating Radar (GPR) and cable avoidance tool (CAT), along with Dial Before You Dig (DBYD) plans and Site engineering drawings were utilised to identify underground services and utilities.

4.3 SOIL INVESTIGATION

4.3.1 *Soil Sampling Procedure*

Soil investigation and sampling works were undertaken in general accordance with ERM's standard operating procedures (SOPs) (ERM, 2012). The location and number of sampling locations are presented within *Figures 4.1 to 4.11* of *Annex A* and listed by AEC (Area BA - Area BY) in *Table 1* of *Annex B*.

Where practicable, all boreholes were advanced to an initial depth of 1.5 m bgl using hand augering techniques in accordance with ERM's sub-surface clearance procedures. Drilling and soil sampling of subsurface material beyond 1.5 m bgl, were undertaken using a Geoprobe® drilling rig with a continuous push tube sampler where conditions allowed. Other methods of borehole advancement included solid stem mechanical augering, and air rotary methods, where bedrock was encountered or subsurface material could not be penetrated using push tube methods.

Regardless of the drilling methodology adopted, soil sampling techniques which minimised the potential for loss of volatiles were utilised. Where the collection of undisturbed samples was not possible (e.g. during hand augering) the potential for loss of volatiles was minimised by sampling from larger clods and minimising the duration between sample excavation and placement into the sample container.

Field screening was conducted in accordance with ERM's SOPs using a photo-ionisation detector (PID) fitted with a 10.6 eV lamp, calibrated at the beginning of each working day. Calibration certificates are presented in *Annex E*. Where practicable, soil was collected at 0.5 m depth intervals (or where significant changes in lithology were identified) to 2 m bgl and at 1 m depth intervals thereafter. Soil samples were placed in a zip lock bag, sealed and screened for the presence of ionisable volatile compounds. Where the presence of volatiles or other impact was suspected, additional samples were collected.

Soil properties were logged by an appropriately trained and experienced field scientist in general accordance with *Australian Standard AS 1726-1993, Geotechnical Site Investigations* (Australian Standards Committee, 1993). Representative soil samples were collected for laboratory analysis at selected locations, based on visual and/or olfactory evidence of the following:

- multiple layers of fill material;
- changes in the soil profile; and
- potential impact.

Soil samples were collected, to the extent practicable, in accordance with techniques described in *Australian Standard AS4482-2005* (Parts 1 and 2) to maintain the representativeness and integrity of the samples. Soil samples for laboratory analysis were collected from either the hand auger or directly from the push tube core. No samples were collected for laboratory analysis from solid flight augers, unless otherwise stated within borehole logs presented in *Annex D*. The frequency and nature of field QA/QC samples collected during the assessment works are summarised in *Annex F*.

Soil samples were generally labelled using the nomenclature presented in *Table 4.1* (below).

Table 4.1 *Sample Naming Protocol*

Sample	Identification
Surficial sample taken from SU01 within work area BA	BA_SU01
Sample taken from shallow hand auger soil bore or deeper soil bore, SB01 at depth of 0.5 m bgl, within work area BA	BA_SB01_0.5
Sample taken from depth of 5 m bgl from a soil bore to be installed as Monitoring Well MW07, within work area BA	BA_MW07_5.0
Sediment samples taken from SS01 within work area BW at a depth of 0.25 m bgl	BW_SS01_0.25
Surface water samples taken from SS01 within work area BW	BW_SW01

Sample jars were sealed and immediately placed in an insulated cooler, on ice, and stored to minimise potential loss or degradation of volatile compounds. Samples were shipped under chain of custody documentation to the analytical laboratory. Trip blanks and field blanks were used to assess if cross contamination occurred during the sample collection process.

Soil samples were collected for asbestos analysis in general accordance with the *ASC NEPM* (2013) and the ERM *Assessment of Asbestos Impacted Areas SOP* (ERM, 2012). Discrete 500 mg samples of soil were collected in snap lock bags. These samples were submitted to the laboratory for asbestos identification and (where identified) quantification (%w/w analysis) in accordance with the WA DOH (2009) guidelines.

4.3.2 *Decontamination Procedure*

Down-hole drilling and sampling equipment was decontaminated by initially removing any residual soil with a stiff brush and then washing the equipment in a 2% Decon 90 solution and rinsing with potable water.

4.3.3 *Soil Bore Reinstatement*

Upon completion, soil bores will be backfilled and the surface covering reinstated to match existing.

4.3.4 *Waste Materials Generated During Drilling*

All non-liquid waste materials generated during drilling works were stored on-site in drums or other appropriate sealed containers at a designated staging area. If evidence of significant contamination was observed during drilling (e.g. staining or odour) an attempt was made to store any potentially impacted wastes separately. All wastes are proposed to be disposed off-site (if required) to an appropriately licenced landfill by an approved and appropriately licensed waste removal contractor.

4.4 GROUNDWATER INVESTIGATION

4.4.1 *Monitoring Well Construction*

Selected boreholes were converted to groundwater monitoring wells in accordance with ERMs SOPs. The groundwater monitoring well locations are presented in *Figures 4.1 to 4.11* of *Annex A*. The following methodology was implemented to install new monitoring wells:

- wells were constructed of heavy duty 50 mm diameter class 18 uPVC with factory slotted screen (0.4 mm slots) and plain well casing. Where practicable, the wells were screened within groundwater bearing strata in accordance with ERMs SOPs with consideration of potential regional and seasonal fluctuations of the water table and constructed to allow the potential ingress of non-aqueous phase liquids (NAPLs);

- following drilling, the well casing and screen were inserted into the drill casing. Washed and graded filter sand was poured into the annulus between the well screen and casing wall, ensuring that the sand covered the entire screened level and generally extended approximately 0.5 m above the top of the well screen;

- bentonite granules were then poured on top of the sand to an approximate thickness of 1 m and hydrated to effectively seal off the well from surface water or perched/shallow groundwater inflows; and

- the remaining annulus from the top of the seal to the base of the concrete was grouted with cement/bentonite grout to within 0.25 m of the surface and the final 0.25 m reinstated with concrete and a heavy duty well cover (flush gatic cover or raised monument as appropriate). The well casings were sealed with air-tight, lockable 'envirocaps'.

Following monitoring well installation, each well was developed using a submersible 12V electric 'Typhoon' pump to remove any fine or granular materials or contaminants potentially introduced during drilling and to optimise hydraulic connectivity with the surrounding aquifer.

Wells were considered developed when either a minimum of 10 well volumes had been removed, when water quality parameters had stabilised or if the well was developed dry prior to this. Where sufficient well volumed could not be obtained, attempts were made to remove fines and construction material by purging the well over several days to allow for recharge.

Monitoring well construction details are presented within the borehole logs in *Annex D*.

4.4.2 *Groundwater Purging and Sampling Protocol*

Groundwater purging and the sampling of newly installed monitoring wells generally occurred at least one week following monitoring well installation and development, to allow subsurface conditions to stabilise. Both new and existing monitoring wells were purged and sampled as outlined below.

The presence of odours was noted, where applicable, following removal of the well cap and prior to purging. Any odours were described by reference to their intensity and character.

Following a period of no pumping (as a minimum 24 hours), wells were dipped to gauge the depth to groundwater, and the potential presence and depths of NAPLs.

Monitoring wells were purged using either a thoroughly decontaminated peristaltic or micro purge pump under low flow conditions, where hydrogeological conditions allowed, until sufficient water has been removed to obtain stabilised readings of pH, conductivity, redox potential, temperature and dissolved oxygen which was calibrated prior to use (refer to *Table 4.2* below). The stabilisation criteria are as described below.

Table 4.2 ***Water quality parameter stabilisation criteria***

Parameter	Stabilisation criteria
pH	± 0.1 pH units
Electric Conductivity (EC)	± 3% (µS/cm or mS/cm)
Temperature	± 0.5°C
Oxidation Reduction Potential (ORP)	± 10 mV
Dissolved Oxygen (DO)	± 0.3 mg/L

It is noted that both ORP and DO are typically slower to stabilise than the other parameters. Where ORP and DO did not stabilise, therefore, greater weight was given to pH and EC as the stabilising parameters.

Low-flow sampling techniques were used to obtain samples that were representative of the local groundwater environment at the Site. The inlet of the micro purge pump was placed approximately 50 cm from the base of the well in order to obtain a representative sample. Water samples were collected using equipment dedicated to each monitoring well to reduce the potential for cross-contamination between sampling locations.

The following order of sampling was adopted:

- samples to be analysed for volatile compounds placed into 40 mL amber vials;
- samples to be analysed for semi-volatile compounds placed into one 250 mL solvent washed amber bottles and two 1 litre solvent washed amber bottles;

- samples to be analysed for metals filtered through disposable 0.45 µm filters and placed in 125 mL plastic bottles preserved with nitric acid; and
- samples to be analysed for PFOS/PFOA placed into 125 mL plastic (Teflon free) unpreserved bottles.

No Non-Aqueous Phase Liquids (NAPLs) were observed during the groundwater monitoring and sampling event.

The containers were filled, where practical, to minimise headspace, before being sealed and appropriately labelled. Labels included the following information:

- sample identification number;
- sampler;
- job number; and
- date of collection.

Samples were sealed and immediately placed in a cooler on ice to minimise potential for degradation of the sample. All samples were shipped under chain of custody documentation to the analytical laboratories.

4.4.3 *Waste Material Generated During Groundwater Development/Purging*

Waste water from development and purging of groundwater monitoring wells was collected and stored in appropriately labelled intermediate bulk containers (IBCs) and was subsequently classified for off-site disposal at an appropriately licenced facility.

4.5 *SURVEYING*

All investigation locations were digitally located by field staff with a handheld Global Positioning System (GPS) unit. Additionally, all groundwater monitoring wells were surveyed by a registered surveyor (Tony Mexon and Associates) to AHD for elevation and MGA coordinates for location. The elevation of the highest point of the top of the uPVC well casing was surveyed to facilitate appropriate groundwater elevation calculations and groundwater flow direction interpretations.

4.6 *SEDIMENT INVESTIGATION*

Sediment samples were collected from 49 sample locations (shown on *Figures 4.8* to *4.10* of *Annex A)*, including one from a reference location (BW_SS25).

Sediment samples were collected in general accordance with the methodologies outlined in CSIRO *Handbook for Sediment Quality Assessment* (Simpson et al., 2005). Sediment was collected from each sampling location with a stainless steel Van Veen grab sampler. The grab sample was inspected and if it was deemed to be of acceptable quality i.e. Van Veen fully closed, the sediment-water interface undisturbed with no evidence of loss of fines, and sufficient sample volume, the sediment was transferred to a container and homogenised. If there was insufficient sample volume in a single grab sample, but the sample was otherwise of acceptable quality, sediment from multiple grabs was included in the sample.

At BW_SS01, BW_SS07, BW_SS08, and BW_SS09, a 5 cm diameter polycarbonate corer was used to collect the sediment samples. At BW_SS06 and BW_SS10, a corer would not penetrate, and the sediment sample was collected using a shovel.

Sample handling and labelling procedures were consistent with those adopted for soil sampling and those outlined in *Handbook for Sediment Quality Assessment* (CSIRO, 2005). The sediment volume, colour, grain size, odour, and presence of debris, organic matter, or biota were noted. Sediment samples were transferred to laboratory supplied glass jars for chemical analysis and 500 mL snap lock bags for grain size analysis. Care was taken to minimise head space in the sample jars to reduce the potential for loss of volatile COPCs. The samples were stored on ice and transported under chain of custody to the analytical laboratory. The Van Veen and all other equipment used in the process of collecting the sediment samples were decontaminated between sampling locations.

4.7 *SURFACE WATER INVESTIGATION*

Surface water sample locations were co-located with sediment sample locations. Water samples were collected prior to the collection of sediment samples, to avoid increased turbidity which may occur following sediment sampling.

Surface water samples were collected from Tinkers Creek, the unnamed creek to the north of the Pikes Gully Ash Dam spillway which discharges into Chilcotts Gully, and Lake Liddell. Surface water samples from Tinkers Creek and the unnamed creek to the north of the Pikes Gully Ash Dam spillway were collected by hand dipping containers at least 100 mm below the surface of the water.

Samples were collected beneath the surface of the water with the container facing upstream, while avoiding disturbing substrate. Surface water samples from Lake Liddell were collected approximately 1.0 m above the sediment. Water samples from Lake Liddell were collected using a 1 litre Van Dorn sampler. The water was transferred directly from the Van Dorn sampler to analyte-specific laboratory supplied containers.

Sample containers were sealed and immediately placed in a cooler on ice to reduce potential for degradation of COPCs. The samples were then transported under chain of custody conditions to the analytical laboratory, and analysed for a combination of COPCs.

A calibrated water quality meter was used to measure field parameters including pH, conductivity, redox potential, temperature, total dissolved solids (TDS), and dissolved oxygen. Observations of the general condition of the surface water and its surrounds were recorded during sampling.

4.8 *LABORATORY ANALYSIS*

The laboratories used for the investigations were accredited by the National Association of Testing Authorities (NATA), Australia. The primary laboratory used for soil and groundwater analysis was ALS Environmental Pty Ltd (ALS). Inter-laboratory duplicate samples were analysed by a secondary laboratory, Envirolab Services Pty Ltd (Envirolab). The analytical methods used by each laboratory are provided in the laboratory certificates in *Annex H*.

Soil, sediment, groundwater and surface water samples were analysed for the following COPCs:

- metals and metalloids (arsenic, cadmium, chromium, copper, nickel, lead, mercury, selenium and zinc);
- Total Recoverable Hydrocarbons (TRH);
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Benzene, Toluene, Ethylbenzene and Xylenes (BTEX); and

  Additional contaminants of concern were analysed on a sub-section of the soil and groundwater samples collected. These contaminants included:

- asbestos (presence / absence and quantification where asbestos was identified - soil only);
- Polychlorinated Biphenyls (PCBs) - related to use of PCB-containing transformer oils on site;
- Volatile Organic Compounds (VOCs); and
- Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) - to target areas where fire retardants may have been used or stored.

Selected soil samples were also analysed for the following to allow for adoption of appropriate screening levels:

- Total Organic Carbon (TOC);

- Particle Size Distribution (PSD);
- Electrical Conductivity (EC); and
- pH and Cation Exchange Capacity (CEC).
- Sediment samples were also analysed for Particle Size Distribution (PSD) and TOC.

4.9 *QUALITY ASSURANCE / QUALITY CONTROL*

A detailed QA/QC report including field procedures, laboratory methods and an analysis of QA/QC results from the investigation is provided in *Annex F.*

In summary, the QA/QC data reported by ALS for soil and groundwater samples and field duplicate results were generally free of systematic and method biases and were assessed to be of sufficient quality for the purposes of this investigation.

5 RESULTS AND DISCUSSION

5.1 SITE GEOLOGY OBSERVATIONS

A generalised description of the lithology encountered at the Site is presented in *Table 5.1*. Detailed descriptions of the Site geology as observed during the investigation are presented on the borehole logs in *Annex D*.

Within disturbed portions of the Site, subsurface soil conditions largely comprised (cutting and/or) filling or reworked natural weathered soils and rock overlying natural bedrock. Within undisturbed areas, native soils were present at shallow depths with varying degrees of weathering and some alluvial deposits observed adjacent to water courses. The depth to bedrock varied across the Site with topography but was generally within 1 m of the surface with outcropping of siltstone and sandstone bedrock observed at elevated areas.

Table 5.1 Generalised Field Lithology Descriptions

Lithological Unit	Description	Depth[1] (m bgl)
Hardstanding (present for operational locations)	Concrete generally in good condition	0 - 0.2
Fill [2]	Reworked silty clay, clay and/or gravel, brown or brown with orange or grey mottling, dry to moist, non-plastic, no odours or staining,	5 (extending to 3.5 m within the main operational area (BH and BV)
Silty Clay	Orang-brown with grey mottling and light brown with grey mottling, moist, shale or siltstone gravel inclusions (completely weathered)	0.5 – 1.0
Bedrock	Siltstone, shale or sandstone bedrock, brown becoming grey with depth, generally dry, fine grained.	1.0 – 30.0

1. Given the variation in topography across the Site, depths and lithologies may vary.
2. Depth of fill within the Ravensworth Mine Rehabilitation Area (BR) was noted to be significantly deeper due to the presence of mine overburden having been used to backfill void space.

5.2 GROUNDWATER FIELD OBSERVATIONS

Existing groundwater monitoring wells on-site were gauged and sampled between 29th November 2013 and 5th December 2013. Due to access constraints, the existing wells could not be gauged in a single event on the same calendar day.

Newly installed monitoring wells were generally gauged and sampled at least 72 hours after well installation and development to allow subsurface conditions to stabilise. Groundwater gauging and sampling was completed between 28 November 2013 and 20 December 2013. During this time, a total of 12.2 mm of rain was recorded. Rainfall was largely recorded between 29th November and 6th December, 2013.

Groundwater gauging data is presented in *Table 2* of *Annex B*. Groundwater was encountered at depths ranging from 0.35 m bgl to 43.126 m Below Top of Casing (TOC).

Field records for groundwater well development and sampling are presented in *Annex E*. Groundwater field parameters recorded during purging of wells, prior to sampling, are presented in *Table 3a* of *Annex B*.

5.3 *SEDIMENT AND SURFACE WATER SAMPLES*

A total of 49 sediment and surface water samples were collected to assess potential impacts of discharges from the Liddell Power Station on Lake Liddell. Sampling locations were distributed around the AEC as presented in *Figures 4.8* to *4.10* of *Annex A*. As all sediment and surface water samples were collected from one AEC (BW) further details of these works are presented in *Section 5.4.23*.

5.4 *AREAS OF ENVIRONMENTAL CONCERN (AEC) SUMMARY*

5.4.1 *Area BA – Brine Concentrator Holding Pond*

Background

The Brine Concentrator Holding Pond is located approximately 700 m to the south of the eastern section of the Bayswater Power Station and occupies an area of approximately 5.5 ha. Waste products from the Cooling Water Treatment Plants are transferred to the Brine Concentrator Holding Pond for further water recovery and treatment by the Brine Concentrators. In addition to receiving treated water from the Cooling Water Treatment Plants, the holding pond can also receive return water from the Pikes Gully Ash Dam.

Water stored in the holding pond has the potential to be impacted by high levels of salinity, heavy metals and biocides. Overflows from the Brine Concentrator Holding Pond can drain to the Pikes Gully Ash Dam, although the *Preliminary ESA* (ERM, 2013) found no evidence to indicate that this had occurred to date. Groundwater monitoring within the vicinity of the holding pond had not been conducted prior to these Stage 2 works being undertaken.

Based on the low likelihood of receptor exposure (with the Pikes Gully Ash Dam located directly down-gradient), the *Preliminary ESA* (ERM, 2013) considered this area to represent a relatively low risk in the context of the site-wide assessment. However, given the lack of investigation in this area to date, further investigation was recommended to assess the potential for soil and groundwater contamination.

AEC Methodology and Investigation Field Observations

A total of three soil investigation bores, all of which were completed as groundwater monitoring wells, were installed within this AEC. Monitoring wells were distributed with one on the up and two on the down hydraulic gradient side of the Holding Pond. The sampling locations within this AEC are presented on *Figure 4.3* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 4.5 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.2*

Table 5.2 ***Field Observations Summary – AEC BA***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BA_MW01	8.8	None	0- 4.5
BA_MW02	10	None	0–2.9
BA_MW03	5.8	None	0-0.5

Groundwater samples were collected from the three monitoring wells within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range, with EC readings indicating that groundwater conditions were saline within all groundwater monitoring wells located within this AEC.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented in field sampling sheets within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4a of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5a of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs were below the laboratory LOR in all groundwater samples analysed. The exceptions to this were some detections of metals within groundwater across this AEC.

Boron, cadmium, copper, manganese, nickel and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from all groundwater monitoring wells within this AEC. At BA_MW01 the measured concentration of lead also exceeded the adopted ecological screening values.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

All three of the groundwater monitoring wells reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included boron, cadmium, copper, lead, manganese, nickel and zinc. Cadmium and nickel concentrations in excess of the adopted human health (drinking water and/or recreational) screening values were also reported in a number of samples.

As the groundwater in this area is generally unsuitable for beneficial use and there are no groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. As noted previously, groundwater from this AEC discharges to the Pikes Gully Ash Dam and thus the observed metals impacts to groundwater are not considered significant in the context of the water quality within the ash dam.

5.4.2 *Area BB -Brine Concentrator Decant Basin*

Background

The Brine Concentrator Decant Basin is located approximately 1.4 km to the south-west of the main power block of Bayswater Power Station and occupies an area of approximately 14 ha. The decant basin receives highly saline wastewater from the Brine Concentrator treatment process.

Groundwater monitoring conducted at the decant basin has historically been limited to monitoring one groundwater monitoring well (BWGM1/D10) located approximately 300 m downgradient of the decant basin dam wall. Parameters tested have included Electrical Conductivity (EC), pH, hardness, arsenic and metals (including aluminium, copper, iron, lead, manganese, nickel, and selenium). EC levels in BWGM1/D10 have showed a steady increase from 10 000 µS/cm in 1989 to 45 000 µS/cm in 2003. With an expected background EC level in the region of 3000 µS/cm, the increase in EC was attributed to leakage of saline water from the decant basin (HLA, 2003).

Following the identification of the increasing trend in groundwater salinity levels, a geophysical survey utilising electrical resistivity imaging was conducted downgradient of the decant basin dam wall. The survey identified a region of very low resistivity interpreted to represent saline groundwater, with the saline plume constrained to a narrow zone following the surface drainage path down the centre of the valley to the north west (HLA, 2003).

An interception curtain was subsequently installed to intercept seepage from the decant basin, creating a new pondage (referred to as 'Seepage Pond 2') downgradient from the decant basin dam wall. The return water pumps and associated control systems for Seepage Pond 2 and the pre-existing Seepage Pond 1 were completed on 11 April 2008 (Macquarie Generation, 2008).

Groundwater monitoring of BWGM1/D10 following the installation of the interception curtain has shown varying levels of EC over time, with elevated levels recorded from time to time (with EC as high as 38 060 µS/cm in February 2010 - Macquarie Generation, 2010).

Analytes that have exceeded one or more of the guidance criteria (for irrigation and livestock water quality - Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000) for BWGM1/D10 during one or more sampling events include nickel, manganese and iron (Macquarie Generation, 2010).

Given the continued measurement of high levels of salinity in groundwater bore BWGM1/D10, along with the other exceedences of screening values noted above, and the potential for impact to the downgradient creek, further investigation was considered to be warranted to assess potential soil and groundwater contamination issues associated with the Brine Concentrator Decant Basin.

AEC Methodology and Investigation Field Observations

A total of five soil investigation bores, all of which were completed as groundwater monitoring wells, were installed within this AEC to supplement the existing monitoring well (BWGM1/D10). Monitoring wells were distributed around the AEC as presented in *Figure 4.4* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile however it was noted that some salt crystals were present at a depth of approximately 3.5 m bgl in BB_MW03. Some potential hydrocarbons were also noted during the groundwater monitoring event at BB_MW04. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.1 ppm (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.3 (below)*.

Table 5.3 ***Field Observations Summary – AEC BB***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BB_MW01	4.8	None	0-0.1
BB_MW02	9.2	None	0-0.1
BB_MW03	6.0	Salt crystals at 3.5 m bgl.	0-0.1
BB_MW04	10.0	None	0
BB_MW05	3.0	None	0-0.1

Groundwater samples were collected from the five groundwater monitoring wells within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. It is noted that the electrical conductivity in the wells sampled ranged from 2298 µs/cm in BB_MW05 to 86 593 µs/cm in BB_MW01. BB_MW01 is located approximately 20 m north west (i.e. downgradient) of Seepage Pond 2 and BB_MW05 is located approximately 250 m north west of Seepage Pond 2.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4b of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC, however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5b of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs were below the adopted laboratory LOR in all groundwater samples analysed. The exceptions to this were some detections of metals within groundwater across this AEC and minor detections of TRH in the C15-C28 fraction in samples collected from BB_MW03 and BB_MW04.

Cadmium, copper, lead, manganese, selenium, nickel and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

All monitoring wells within this AEC reported metals concentrations in groundwater greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, manganese, nickel, selenium and zinc. Cadmium, lead, nickel and selenium concentrations in excess of the adopted human health (drinking water or recreational) screening values were also reported in a number of wells.

As the groundwater in this area is generally unsuitable for beneficial use and there are no groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself.

The observed spatial trends also indicate that the installation of the interception curtain to manage salinity issues within this AEC may also be assisting in the containment of metals in groundwater (particularly selenium which was not detected above the screening values in the downgradient well (BB_MW05).

Groundwater from this AEC most likely discharges within the catchment of Plashett Reservoir. The elevated concentrations of metals above human health and ecological criteria in groundwater within this AEC are not considered significant given that discharge of waters from Plashett Reservoir are managed as per the closed system design (*refer to Section 5.6.2*).

Measurements of electrical conductivity (EC) in the existing and newly installed monitoring wells indicates some significantly elevated results in the immediate vicinity of both the brine concentrator decant basin and immediately downgradient (i.e. less than 20 m) of Seepage Pond 2. It is however noted that these elevated results do not extend as far downgradient as BB_MW05, which is located approximately 250 m down-gradient of seepage pond 2 and adjacent to a tributary of Saltwater Creek which flows to Plashett Reservoir. This indicates that whilst some localised impacts to groundwater quality associated with storage of saline waters in the Brine Concentrator Decant Basin and Seepage Pond 2, these impacts have not migrated to the nearby down-gradient receptors. As noted above, discharges from Plashett Reservoir are managed as per the closed system design (*refer to Section 5.6.2*).

5.4.3 *Area BC - Fuel Oil Installation*

Background

The Fuel Oil Installation comprises four 1.2 ML steel ASTs, three of which are used for the storage of diesel. One of the ASTs is not currently in use. Integrity testing was completed during 2011 on the three tanks currently in use, with no failures reported. These ASTs supply diesel via an above ground pipeline to the operational area, servicing several diesel ASTs located throughout the facility. The volume of fuel being stored and transferred across the Site represents a significant potential source of contamination.

Each of the four ASTs is individually bunded with drainage from the bund discharging to a local oil/water separator. This containment system is understood to be separate from the contaminated water containment and treatment system servicing the operational area.

No information was available at the time of completion of the *Preliminary ESA* regarding procedures for reconciling delivery and usage volumes. Given the limitations of wet stock reconciliation when dealing with such large volumes, there is a potential for leaks to have occurred, which may have resulted in impacts to underlying soil and groundwater.

There have been no soil or groundwater investigations historically completed in the vicinity of the Fuel Oil Installation or adjacent to any of the associated pipework or site ASTs to achieve a suitable degree of environmental characterisation.

Given the absence of previous environmental investigations, the age of infrastructure, volume of stored and transferred fuel, and the potential for historic release events to impact soil and groundwater receptors, it was considered that further investigation was required to assess potential impacts to soil and groundwater within this AEC.

AEC Methodology and Investigation Field Observations

A total of nine soil investigation bores, with one location (BC_MW05) being converted to a groundwater monitoring well were completed within this AEC to assess potential impacts to soil and groundwater. A number of monitoring well locations were attempted but abandoned as noted in *Table 3.1*. Soil bores and monitoring wells were distributed around the AEC as presented in *Figure 4.3* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.2 ppm (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.4 (below)*.

Table 5.4 *Field Observations Summary – AEC BC*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BC_SB01	1.6	None	0
BC_SB02	1.6	None	0-0.2
BC_SB03	2.0	None	0
BC_SB04	1.7	None	0
BC_MW01*	1.6	None	0
BC_MW02*	15	None	0
BC_MW03*	2.0	None	0-0.1
BC_MW04*	1.6	None	0
BC_MW05	30	None	0

* Well not installed as hole remained dry after being left for a period of 72 hours or groundwater noted to be deeper than 20 m bgl and monitoring well abandoned.

One groundwater sample was collected from groundwater monitoring well BC_MW05. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range, with the EC reading at BC_MW05 indicating that groundwater conditions were brackish within this groundwater monitoring well.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4c of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5c of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in the groundwater sample analysed. The exception to this was some detections of metals and benzene within the groundwater sample collected from BC_MW05.

Copper, nickel and zinc were detected at concentrations in excess of the adopted ecological screening values in the groundwater sample collected from BC_MW05. Benzene was detected at a concentration of 1.0 μg/L which is equal to the relevant ADWG screening values for drinking water but below the adopted human health (recreational) and ecological screening values. Given the proximity of this result to the drinking water guideline it is not considered to represent a significant issue.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

Monitoring well BC_MW05 reported metals concentrations greater than the adopted ecological screening values but below the adopted human health screening values. Metals exceeding the adopted ecological screening values included copper, nickel and zinc.

As the groundwater in this area is generally unsuitable for beneficial use and there were no groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. Groundwater from the vicinity of BC_MW05 most likely discharges to the Pikes Gully Ash Dam and thus the observed metals impacts and minor benzene detection to groundwater are not considered significant in the context of the water quality within the ash dam.

Whilst it is acknowledged that only one monitoring well was installed within the AEC, based on the absence of hydrocarbon contamination in soil or groundwater and field observations during investigations, the likelihood that a significant source of contamination is present is considered to be low. Furthermore, given the depth to groundwater and the geology encountered, significant impacts to adjacent receptors is considered unlikely.

5.4.4 *Area BD – Vehicle Refuelling Depot*

Background

The Vehicle Refuelling Depot occupies an area of approximately 250 m² in the north-east portion of the operational area near the Main Store. The fuel storage and dispensing infrastructure comprises one unleaded petrol UST (21 000 L) and one diesel UST (37 000 L) and associated pipelines and bowsers. For reference, the mobile plant maintenance and refuelling area associated with the coal storage area is a separate facility. The USTs within this AEC are understood to have been installed at the time of construction of the Power Station. As reported in the *Preliminary ESA* (ERM, 2013), tank integrity test results reported in 2009 (Hodge Industrial Installations Pty Ltd, 2009) indicate that the petrol UST passed, but the diesel UST failed the wet pressure test. According to the associated report, the diesel tank failure may have been related to a fault in the non-return valve at the top of the tank or may have been indicative of the commencement of tank shell failure.

Dataroom documents reviewed as part of the *Preliminary ESA* indicated that one UST (30 000 L), which previously held petrol, was decommissioned in 2007 in this area by pumping out the residual fuel, excavating the overlying soil above the tank, cutting the top off the tank and backfilling the tank with compacted fly ash (Hodge Industrial Installations Pty Ltd, 2007). No further information relating to validation of the decommissioning of this UST was available at the time of the *Preliminary ESA* (ERM, 2013).

Soil and groundwater investigations have been completed by Macquarie Generation in the areas of underground tank infrastructure to facilitate compliance with relevant underground petroleum storage system (UPSS) legislation.

Four groundwater monitoring wells were installed during a previous investigation (DLA Environmental, 2010), three wells were installed downgradient of the USTs and fuel dispensers (to the north) and one well was installed up hydraulic gradient from the USTs (to the south). The wells were initially sampled following installation and have reportedly been sampled at six monthly intervals since. Results in November 2012 indicated that no contaminants related to petroleum hydrocarbons were detected.

Based on the previous investigation results, the *Preliminary ESA* (ERM, 2013) concluded that significant contamination related to the presence of the USTs and aboveground fuel dispensing infrastructure did not appear to be present. However, it was recommended that the existing groundwater wells be sampled to provide up-to-date baseline data in this area.

AEC Methodology and Investigation Field Observations

Additional assessment work within AEC BD was limited to the sampling of four existing monitoring wells in the vicinity of the UST and associated infrastructure. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range, with EC readings indicating that groundwater conditions were saline within all groundwater monitoring wells located within this AEC.

During groundwater sampling at three of the four existing monitoring wells (BD_EW_MW01, BD_EW_MW02 and BD_EW_MW04), sulfur odours within groundwater were noted. No other indications of contamination (such as a sheen) were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5d of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in all samples analysed. The exceptions to this were detections of various metals within groundwater collected from monitoring wells within this AEC.

Cadmium, copper, manganese, nickel and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in various groundwater samples collected from wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

Concentrations of BTEX compounds and TRH were below the laboratory LOR in all monitoring wells within AEC BD. These results were consistent with historical monitoring rounds conducted by Macquarie Generation. Concentrations of metals were greater than the adopted ecological screening values in all monitoring wells within AEC BD. Metals exceeding the adopted ecological screening values included cadmium, copper, manganese, nickel and zinc. It is noted that groundwater from the this area is likely to discharge into an intermittent stream to the north east and into Chilcott's Gully (and ultimately into Lake Liddell). Metals impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23*.

Nickel concentrations in excess of the human health (drinking water) screening values but below the human health (recreational) screening values were also reported in all wells sampled. Whilst it is noted that nickel concentrations were above human health criteria, in the absence of abstraction bores for domestic potable or non-potable uses and the general unsuitability of the groundwater due to high salinity, these exceedences are not considered to represent a significant risk.

As the groundwater in this area is generally unsuitable for beneficial use and there are no groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23*.

5.4.5 *Area BE - Coal Storage Area*

Background

The coal storage area occupies an area of approximately 35 ha and is used for the stockpiling of coal prior to it being transferred via conveyor to the coal mill and thence to the boilers. Potential contamination sources include contaminated stormwater runoff from this area, which is captured in the retention ponds located in the northern portion of the stockpile area, and leaching of contaminants from the coal stockpiled on open ground to groundwater. The retention ponds are understood to be cleaned on a regular basis and any fines collected are deposited in the Pikes Gully Ash Dam.

No soil or groundwater investigations are known to have been previously completed within the Coal Storage Area.

EPL discharge monitoring point #1 is located at the outlet from the Treated Contaminated Water Pond, which is directly to the south of the Coal Storage Area, prior to discharge into Tinkers Creek. Previous surface water analytical data collected from EPL discharge monitoring point #1 indicates that the conditions of the EPL are consistently complied with, there is some potential for contaminants from the coal stockpile area to impact surface water and groundwater between the EPL monitoring point and the discharge into Tinker's Creek.

Based on the potential sources of contamination, the relatively low likelihood of receptor exposure, and the fact that this area will continue to be used for coal storage, the coal stockpile is considered to be relatively low risk in the context of the Site-wide assessment. However, based on the lack of existing investigation data for this AEC, further investigation is considered to be required to provide a baseline and to assess the potential for soil and groundwater contamination.

AEC Methodology and Investigation Field Observations

A total of nine soil investigation bores (with eight being converted to groundwater monitoring wells), were completed around the perimeter of this AEC to assess potential impacts to soil and groundwater. One groundwater monitoring well was abandoned as noted in *Table 3.1*. Soil bores and monitoring wells were distributed around the AEC as presented in *Figure 4.1* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 3.2 ppm (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.5 (below).*

Table 5.5 ***Field Observations Summary – AEC BE***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BE_MW01	6.0	None	0-0.1
BE_MW02	7.5	None	0
BE_MW03	6.0	None	0-0.3
BE_MW04	8.9	None	0.4-0.5
BE_MW05	7.3	None	0.3-0.5
BE_MW06	9.0	None	0.1-1.2
BE_MW07	9.0	None	0-1.7
BE_MW08	6.8	None	0-0.2
BE_MW09*	10	None	0-3.2

* - Well not installed as hole remained dry after being left for a period of 72 hours

Groundwater samples were collected from eight monitoring wells within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B.* Field parameters were generally within the expected range, with EC readings indicating that groundwater conditions were brackish to saline within at BE_MW03, BE_MW04, BE_MW05, BE_MW06 and BE_MW08 and relatively fresh at BE_MW01, BE_MW02 and BE_MW07. pH measurements at BE_MW02 and BE_MW03 were high. However, field notes indicate a possible pH sensor fault, with field persons describing the pH readings as fluctuating.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Anne E.*

Soil Analytical Results

The soil analytical results were compared to the adopted human health and ecological screening values as presented in *Table 4e of Annex B.*

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Amosite asbestos was detected within the soil sample collected from 0.1 m bgl at location BE_MW01. The identified asbestos material was described by the laboratory as "two small friable asbestos fibre bundles approximately 3 x 0.5 x 0.5 mm" which would be classified as "Asbestos Fines (AF)" under the definitions provided in the ASC NEPM (2013). The asbestos quantification result for this sample was equal to the human health screening criteria (0.001 % w/w).

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5e of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in all samples analysed. The exceptions to this were various metals within the majority of the monitoring wells located across this AEC.

Cadmium, copper, lead, nickel and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from wells within this AEC.

Discussion

Although the quantification result for the sample collected from BE_MW01 was equal to the screening criteria, given the shallow depth at which this sample was collected (0.1 m bgl) and the isolated nature of this detection, it is considered that some further assessment of the extent of potential asbestos impacts to soil in the vicinity of this sample be undertaken to allow for an appropriate management strategy to be developed. If necessary, some form of management and / or remediation may be required in order to manage potential risks to human receptors.

All monitoring wells within this AEC reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, nickel and zinc. It is noted that groundwater from the this area is likely to discharge into Tinkers Creek to the north or into Chilcott's Gully (and ultimately into Lake Liddell). The screening values were adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Section5.4.23*.

Concentrations of lead and nickel in excess of the adopted human health (drinking water or recreational) screening values were also reported in a number of wells. Whilst it is noted that nickel concentrations were above human health criteria, in the absence of abstraction bores for domestic potable or non-potable uses and the general unsuitability of the groundwater due to high salinity, these exceedences are not considered to represent a significant risk.

5.4.6 *Area BF – Coal Unloaders, Rail Infrastructure And Coal Transfer Lines*

Background

Antiene Rail Coal Unloader

The Antiene Rail Coal Unloader (RCU) is considered an AEC due to its current and historical bulk fuel storage and operations associated with rail infrastructure and locomotive refuelling and maintenance. The Site currently has bulk storage tanks containing diesel and oil which appear to be recently installed and in good condition. There is no evidence to suggest any issues with the current fuel storage infrastructure, however limited information was available on the historic fuel storage at the facility. Leakage of oil and diesel from trains is also a potential risk and it is anticipated this has occurred historically. There is potential for this along the entire rail corridor, however it is considered a greater risk at the unloader where trains may be parked or idle for long periods.

Ravensworth Rail Coal Unloader

The Ravensworth RCU is considerably smaller than Antiene and only used occasionally. It has no bulk fuel or chemical storage as part of current operations, but is expected to have similar potential contamination issues as those presented for Antiene. The Ravensworth RCU has had reported diesel releases from locomotives as recently as 2003.

Given the absence of previous environmental characterisation work at both coal unloading facilities, further investigation would be required to provide a baseline for this area and to assess potential issues associated with soil and groundwater contamination.

Coal Transfer Lines

Overland coal transfer lines are present in several areas of the Site:

- the northern portion of the Site, extending from the north-west site boundary to the coal stockpiling area (inbound);
- the north-eastern portion of the Site extending from Antiene Rail Coal Unloader to the coal stockpiling area (inbound);
- the south-eastern portion of the Site extending from the adjoining mine to the coal stockpiling area (inbound); and
- the eastern portion of the Site extending from the coal stockpiling area to Liddell Power Station (primarily outbound).

These conveyors are located above the ground surface and are generally unsealed. According to information supplied by Macquarie Generation management, there is likely to have been historical oil leaks in the older coal conveyors due to a design fault with the initial gearboxes, which likely resulted in lubricating oil leaks to open ground. Further documentation of these leaks (e.g. volume, recurrence, precise locations, etc.) was not available at the time of the *Preliminary ESA* and no previous investigations along the coal transfer lines are known to have been undertaken.

Despite the lack of detailed information for review in relation to these leaks, it is considered unlikely that potential receptors would be exposed to contaminants on a widespread basis. However, based on the lack of investigation data for this AEC, further investigation is considered warranted to provide a baseline and to assess potential soil and groundwater impacts.

AEC Methodology and Investigation Field Observations

A total of eighteen soil investigation bores, (with five being converted to groundwater monitoring wells), were completed within this AEC to assess potential impacts to soil and groundwater. Three monitoring wells were installed at the Antiene RCU and one monitoring well was installed at the Ravensworth RCU and the Coal Transfer lines respectively. Soil bores and monitoring wells were distributed around the AEC as presented in *Figures 4.6* and *4.7* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 1.9 ppm (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.6* (below).

Table 5.6 ***Field Observations Summary - AEC BF***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BF_SB01	1.8	None	0-0.1
BF_SB02	1.3	None	0-0.1
BF_SB03	3.5	None	0-0.2
BF_SB04	0.5	None	0.1
BF_SB05	3.5	None	0.4-1.2
BF_SB06	3.4	None	0.1-0.9
BF_SB07	3.1	None	0.7-1.4
BF_MW01	14	None	0.1-0.2
BF_MW02	16	None	0.1
BF_MW03	20	None	0.1-0.2
BF_MW04*	10	None	0.1

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BF_MW05	10	None	0.1-1.4
BF_MW06*	10*	None	0.2-1.4
BF_MW07*	10*	None	0.1-1.6
BF_MW08*	15*	None	0-0.2
BF_MW09	15	None	0-0.2
BF_MW10*	13*	None	0
BF_MW11*	10*	None	0-1.9

* Well not installed as hole remained dry after being left for a period of 72 hours.

Groundwater samples were collected from five groundwater monitoring wells within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B* noting that there was insufficient volume from BF_M03 to obtain parameter readings during sampling.

Field parameters were generally within the expected range, with EC readings indicating that groundwater conditions were relatively fresh at BF_MW09 and brackish to saline within all other groundwater monitoring wells located within this AEC.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E.*

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4f of Annex B.*

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5f of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A.*

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in all samples analysed. The exceptions to this were various metals within the majority of the existing monitoring wells located across this AEC.

Arsenic, copper, lead, nickel and zinc were detected at concentrations in excess of the adopted ecological and/or human health screening values in groundwater samples collected from wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

All of the monitoring wells reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values at monitoring wells within Antiene RCU (BF_MW01, BF_MW02 and BF_MW03) included copper, lead, nickel and zinc.

Groundwater at the Antiene sites is likely to discharge into Maidswater Creek, flow adjacent to the Site, then south east into Lake Liddell. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23.*

The metal exceeding the adopted ecological screening values at monitoring well BF_MW05 within the Ravensworth RCU included arsenic, copper, nickel and zinc. Groundwater at the Ravensworth sites is likely to discharge into Bowmens Creek which flows south and ultimately into the Hunter River.

The metal exceeding the adopted ecological screening value at monitoring well BF_MW09 adjacent to the Coal Transfer Lines was zinc. Groundwater within the area is likely to discharge into Saltwater Creek (and ultimately into Plashett Reservoir). Minor exceedences of metals are not considered significant given that discharge of waters from Plashett Reservoir are managed as per the closed system design (*refer to Section 5.6.2*).

Arsenic, lead and nickel concentrations in excess of adopted human health (drinking water and/or recreational) screening values were also reported in a number of samples. Whilst it is noted that arsenic, lead and nickel concentrations were above human health (drinking water) criteria, given the absence of abstraction bores for domestic potable or non-potable uses and the general unsuitability of the groundwater due to high salinity, these exceedences are not considered to represent a significant risk. Given the scale of the arsenic exceedences noted at BF_MW03 above the recreational criteria further assessment of this exceedence may be warranted as noted in *Section 5.6.*

5.4.7 *Area BG – Contaminated Water Treatment Plant*

Background

The Contaminated Water Treatment Plant provides treatment for water captured by the contaminated water drainage system at Bayswater Power Station. Water entering the facility could contain a range of potential contaminants including fuels, chemicals, coal and ash.

All the elements of the Contaminated Water Treatment System facility are located in the north-eastern section of the operational area. The facility comprises a sediment basin (with a surface area of approximately 0.3 ha) with an oil skimmer and a separate secondary oil water separation section. After passing through the secondary oil water separation section, water discharges to a downstream storage pond (with a surface area of approximately 0.5 ha) before ultimately discharging to Tinkers Creek via a weir.

Visual inspection during ERM's site visit in August 2013 identified a layer of oily residue in the sediment on the edges of the sediment basin, and an oily layer of light non-aqueous phase liquid (LNAPL) on the water within the sediment basin. While oily residue was not observed in the holding pond, dissolved phase impact may still be present in water held within the pond. Groundwater quality is not being monitored in the immediate vicinity of the Contaminated Water Treatment Plant.

Given the lack of groundwater characterization data coupled with the potential for impact from the oily residues and contaminated water, further investigation was considered to assess the potential for soil and groundwater contamination.

AEC Methodology and Investigation Field Observations

A total of seven soil investigation bores, all of which were completed as groundwater monitoring wells, were installed within this AEC to assess potential impacts to soil and groundwater. Soil bores and monitoring wells were distributed around the AEC as presented in *Figure 4.1* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 1.6 ppm (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.7*.

Table 5.7 *Field Observations Summary - AEC BG*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BG_MW01	6.0	None	0.2-1.4
BG_MW02	6.3	None	0.2-1.6
BG_MW03	4.0	None	0.1-1.1
BG_MW04	4.5	None	0.1-1.4
BG_MW05	5.5	None	0.2-2.6
BG_MW06	6.0	None	0-1.8
BG_MW07	5.5	None	0-0.1

Groundwater samples were collected from the seven groundwater monitoring wells located within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range.

EC readings indicating that groundwater conditions were brackish at BG_MW07 and saline within all other groundwater monitoring wells located within this AEC. pH conditions at BG_MW01, BG_MW05 and BG_MW06 were noted to be acidic.

During groundwater sampling at BG_MW07 sulfur odours within groundwater were noted. No other indications of contamination, such as sheens or odours were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4g of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5g of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in all samples analysed. The exceptions to this were various metals within the majority of monitoring wells located across this AEC.

Boron, cadmium, copper, lead, manganese, nickel, selenium and zinc were detected at concentrations in excess of the adopted ecological and/or human health screening values in groundwater samples collected from wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

All of the monitoring wells within this AEC reported metals concentrations greater than the adopted ecological assessment criteria. Metals exceeding the adopted ecological screening values included boron, cadmium, copper, lead, manganese, nickel, selenium and zinc. The elevated concentrations of metals within this AEC are likely to be related to localised mobilisation in areas of low pH as described above. It is noted that groundwater from AEC BG is likely to discharge to an intermittent creek and into Chilcott's Gully (and ultimately into Lake Liddell). The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23*.

Concentrations of cadmium, lead, nickel and selenium in excess of the adopted human health (drinking water or recreational) screening values were also reported in a number of groundwater samples. Whilst it is noted that cadmium, lead, nickel and selenium concentrations were above human health criteria, given the absence of abstraction bores for domestic potable or non-potable uses and the general unsuitability of the groundwater due to high salinity, these exceedences are not considered to represent a significant risk. Nickel is noted to be above the recreational criteria in a number of groundwater wells with groundwater likely to discharge eventually into Lake Liddell. The potential risks due to metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23*

Sulfur odours and oxidising condition noted within the groundwater sampled from BG_MW07 are likely a function of the contaminated water storage process which is consistent with the current use of this area.

5.4.8 *Area BH - Cooling Water Treatment Plants*

Background

The cooling water treatment system comprises separate plants for generation units 1/2 and units 3/4, both located on opposite sides of the power block and covering an area of approximately 3 ha in total. There are a number of ASTs located in these areas, which hold the following chemicals used in the treatment process:

- Anhydrous ammonia;
- Sulfuric acid;
- Sodium hydroxide;
- Chlorine; and
- Ferric chloride.

The results of several previous environmental compliance audits indicated that various areas of these systems had leaks via corroded valves and unlined, damaged concrete sumps. These leaks at the ground surface could have resulted in releases of contaminants to the environment in these areas. No previous intrusive investigations were known to have been completed in this area prior to commencement of this ESA.

Whilst it was considered in the *Preliminary ESA* (ERM, 2013) that the risk from potential releases in these areas to the surrounding areas was relatively low in the context of the Site-wide assessment, no previous investigations had been undertaken in these areas and hence no baseline had been established.

It was therefore recommended that further investigation be completed to establish a baseline within this AEC and to assess the potential for soil and groundwater contamination.

AEC Methodology and Investigation Field Observations

A total of sixteen soil investigation bores, eight of which were completed as groundwater monitoring wells, were installed within this AEC to assess potential impacts to soil and groundwater. Soil bores and monitoring wells were distributed around the AEC as presented in *Figure 4.2* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC with the exception of some corrosion of concrete in an open drain adjacent to BH_MW04.

No staining or unusual odours were detected at any depth through the sampled soil profile with the exception of hydrocarbon odours from 3.0 m bgl in BH_MW08. The maximum measured concentration of ionisable volatile compounds via headspace analysis in this AEC was 36.6 ppm v (isobutylene equivalent) in a sample collected from BH_MW08 at 3.0 m bgl (associated with the hydrocarbon odour noted above).

A summary of the field observations from the drilling works are presented within *Table 5.8 (below)*

Table 5.8 ***Field Observations Summary – AEC BH***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BH_SB01	1.8	None	0-0.3
BH_SB02	0.6	None	0.1-0.2
BH_SB03	1.2	None	0-0.1
BH_SB04	1.05	None	0.1-0.2
BH_SB05	1.7	None	0-6.6*
BH_SB06	1.7	None	0.1-0.2
BH_SB07	3.1	None	0-2.4
BH_SB08	3.5	None	0-0.3
BH_MW01	9.0	None	0-0.2
BH_MW02	8.0	None	0-1.0
BH_MW03	9.0	None	0-0.1
BH_MW04	9.0	Acid etching of concrete in adjacent open drain noted.	0.1-0.3
BH_MW05	9.9	None	0-0.1
BH_MW06	8.0	None	0.2-0.5
BH_MW07	3.8	None	0.1-0.2
BH_MW08	7.0	Hydrocarbon odour from 3.0 m bgl	0.1-36.6

*PID results noted to be potentially inaccurate in field records due to hot and humid conditions.

Groundwater samples were collected from the eight monitoring wells located within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range. EC readings indicating that groundwater conditions were brackish to saline within all groundwater monitoring wells located within this AEC with BH_MW04 recording the highest EC reading of 14 260 µS/cm. pH conditions at BH_MW01 were noted to be acidic (3.89).

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4h of Annex B.*

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5h of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in all samples analysed. The exceptions to this were various metals within the majority of monitoring wells located across this AEC.

Arsenic, cadmium, copper, lead, manganese, nickel, selenium and zinc were detected at concentrations in excess of the adopted ecological and/or human health screening values in groundwater samples collected from wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC. As noted previously, hydrocarbon odour and PID readings of up to 36.6 ppm were detected during the drilling of MW08 from 3 m bgl. No representative soil sample could be collected for analysis, however, as the lithology at this location was sandstone from 1.2 m bgl. It is noted that concentrations of BTEX compounds and TRH in groundwater from all BH monitoring wells was less than the laboratory LOR. Whilst field observations potentially indicated the presence of TRH contamination within soils, groundwater analytical results at BH_MW08 did not indicate presence of a significant contamination issue.

All of the monitoring wells reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, manganese, nickel, selenium and zinc. The elevated concentrations of metals within this AEC are likely to be related to localised mobilisation in areas of low pH as described above. It is noted that groundwater from AEC BH is likely to discharge to either an intermittent creek/ Tinkers Creek or into Chilcott's Gully (and ultimately into Lake Liddell). The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Section* 5.4.23.

Concentrations of arsenic, cadmium, lead, nickel and selenium in excess of the adopted human health (drinking water and/or recreational) screening values were also detected in a number of groundwater samples. Whilst it is noted that arsenic, cadmium, lead, nickel and selenium concentrations were above human health criteria, given the absence of abstraction bores for domestic potable or non-potable uses and the general unsuitability of the groundwater due to high salinity, these exceedences are not considered to represent a significant risk. Nickel is noted to be above the recreational criteria in a number of groundwater wells with groundwater likely to discharge eventually into Lake Liddell. The potential risks due to metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23.*

5.4.9 Area BI - Demineraliser Plant

Background

The demineraliser plant comprises an area of approximately 3500 m^2 and is located on the north-eastern corner of the power block, approximately 40 m west/north-west of the vehicle refuelling depot. Significant quantities of sulfuric acid, sodium hydroxide and ferric chloride are stored in ASTs in this area for use in the demineralisation of process water. Previous compliance audits have noted damage to the bunds or bund linings surrounding some of the ASTs and corrosion to associated pipework. These conditions have the potential to lead to releases of chemicals to stormwater or directly to the subsurface via cracks or other preferential pathways.

If released, impacted stormwater originating from this area has some potential to impact aquatic ecology in discharges to surface water bodies surrounding the Site.

Within the *Preliminary ESA* (ERM, 2013) the likelihood of receptors being exposed to contaminants originating from the demineralisation area were considered to be low. However, given the lack of investigation in this area to date and the potential for subsurface impact to be present due to damage to the containment systems, further investigation was considered warranted to establish a baseline for this area and to assess the potential for soil and groundwater contamination.

AEC Methodology and Investigation Field Observations

A total of three soil investigation bores, all of which were completed as groundwater monitoring wells, were installed within this AEC to assess potential impacts to soil and groundwater. Monitoring wells were distributed around the AEC as presented in *Figure 4.2* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile with the exception of hydrocarbon odours from 3.0 m bgl in BH_MW08. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.3 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.9* (below).

Table 5.9 ***Field Observations Summary - AEC BI***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BI_MW01	14.5	None	0-0.1
BI_MW02	10.3	None	0-0.2
BI_MW03	12	None	0.1-0.3

Groundwater samples were collected from the three groundwater monitoring wells located within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range. EC readings indicating that groundwater conditions were brackish to saline within all groundwater monitoring wells located within this AEC. pH conditions at BI_MW02 were noted to be acidic.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4i of Annex B*. Exceedences of adopted screening values are graphically presented in *Annex A*.

Measured concentrations of all COPCs with the exception of zinc (discussed below) were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC. All concentrations were below the adopted screening values, with the exception of zinc in a sample collected from 0.2 m bgl at BI_MW02 which exceeded the adopted EIL.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5i of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in all samples analysed. The exceptions to this were various metals within the majority of monitoring wells located across this AEC.

Cadmium, copper, lead, manganese, nickel, and zinc were detected at concentrations in excess of the adopted ecological and/or human health screening values in groundwater samples collected from wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC with the exception of zinc in a sample collected from 0.2 m bgl at BI_MW02 which exceeded the adopted EIL. The sample collected from AEC BI_MW02 was collected from immediately beneath concrete hardstanding, and appears to be a localised hotspot unlikely to impact upon terrestrial ecological receptors.

All of the monitoring wells reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, manganese, nickel, and zinc. The elevated concentrations of metals within this AEC may also be related to localised areas of low pH as described above in relation to BI_MW02. It is noted that groundwater from AEC BI is likely to discharge to an intermittent stream and then into Chilcott's Gully (and ultimately into Lake Liddell). The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23*.

Concentrations of nickel in excess of the adopted human health (drinking water) screening values but below the human health (recreational) screening values were detected in all groundwater samples. Whilst it is noted that lead and nickel concentrations were above human health criteria, given the absence of abstraction bores for domestic potable or non-potable uses and the general unsuitability of the groundwater due to high salinity, these exceedences are not considered to represent a significant risk.

5.4.10 *Area BJ - Former Contractor Staging Area*

Background

The Former Contractor Staging Area is one of two large portions of the Site used during construction of the Power Station which have been largely unused since the Power Station was commissioned in 1986. Negligible formal documentation was available on these areas, but Macquarie Generation management supplied verbal information during site interviews in relation to historical activities.

The Contractor Staging Area is located approximately 250 m south/south-west of Freshwater Dam and comprises an area of approximately 30 hectares. The north-western portion of this area (approximately 2.5 ha) is currently used by the local civil contractor on the Site for temporary storage of equipment and materials. Roads and lots constructed in a grid across this area were evident during the site walkover and during review of historical aerial photos. The area slopes gently from the north to the south and two retention ponds are constructed in the southern portion of the Site and are currently present.

Macquarie Generation management indicated that various activities occurred in this area during construction of the Power Station; however, more detailed information on any specific activities was not available.

It is understood that various contractors associated with the construction of the Power Station may have had site offices and/or accommodation here, and that plant and equipment were likely to have been stored in the area also, with associated maintenance activities likely having been conducted within the area. It is unclear whether electricity, water, sewer and other utilities were supplied to this area. No previous investigations are known to have been undertaken in this area.

Potential contaminants include fuels, solvents and other cleaners associated with workshops/maintenance and various contaminants associated with potential undocumented fill materials used or stored in this area (potentially including asbestos).

Given the lack of detailed information for this AEC and the large spatial area, it is difficult to assess potential risks based on existing information. It was therefore a recommendation of the *Preliminary ESA* (ERM, 2013) that further investigation be undertaken within this AEC to assess the potential for soil and groundwater contamination.

AEC Methodology and Investigation Field Observations

A total of twenty four soil investigation bores, five of which were originally scheduled to be completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. It is noted that none of the wells were installed as groundwater was not encountered at any location despite drilling to a maximum depth of 15 m bgl. Soil bores were distributed around the AEC as presented in *Figure 4.4* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.1 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *5.10 (below)*

Table 5.10 Field Observations Summary - AEC BJ

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BJ_SB01	0.8	None	0
BJ _SB02	1.7	None	0
BJ _SB03	1.8	None	0
BJ _SB04	0.8	None	0
BJ _SB05	0.5	None	0
BJ _SB06	3.0	None	0-0.1
BJ _SB07	1.6	None	0
BJ_SB08	3.0	None	0
BJ_SB09	0.5	None	0
BJ_SB10	1.05	None	0
BJ_SB11	0.5	None	0
BJ_SB12	2.5	None	0
BJ_SB13	3.0	None	0
BJ_SB14	3.0	None	0
BJ_SB15	0.85	None	0
BJ_SB16	1.7	None	0
BJ_SB17	1.8	None	0-0.1
BJ_SB18	3.6	None	0
BJ_SB19	3.6	None	0-0.1
BJ_MW01	10.0*	None	0
BJ_MW02	15.0*	None	0
BJ_MW03	1.7*	None	0

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BJ_MW04	1.2*	None	0
BJ_MW05	15.0*	None	0

* - Well not installed as hole remained dry after being left for a period of 72 hours.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4j of Annex B*. Exceedences of adopted screening values are graphically presented in *Annex A*.

Measured concentrations of all COPCs with the exception of zinc (discussed below) were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC. All concentrations were below the adopted screening values, with the exception of zinc in samples collected from 0.2 m bgl at BJ_MW01 and 0.2 and 0.7 m bgl at BJ_SB04 which exceeded the adopted EIL.

Groundwater Analytical Results

No groundwater samples were taken from within this AEC as no monitoring wells were installed.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC with the exception of zinc in samples collected from 0.2 m bgl at BJ_MW01 and 0.2 and 0.7 m bgl at BJ_SB04 which exceeded the adopted EIL. The zinc impacts identified in AEC BJ were all <250% of the relevant screening level and the 95% UCL of the mean concentration for samples collected within the upper 1 m of the soil profile within this AEC was 900.3 mg/kg which was less than the adopted EIL. It is also noted that the standard deviation of these samples was less than 50% of the adopted EIL (refer to *Annex I* for details of all relevant calculations). These impacts are therefore considered unlikely to represent a significant risk to the terrestrial environment under the ongoing use of the Site as a power station.

5.4.11 *Area BK - Former Large Items Assembly Area*

Background

The Former Large Items Assembly Area is the second of two large portions of the Site used during construction of the Power Station which have been largely unused since the Power Station was commissioned in 1986. Negligible formal documentation was available on these areas, but Macquarie Generation management supplied verbal information during site interviews in relation to historical activities.

The Large Items Assembly Area is located to the north-west of the coal storage area and adjacent to Tinkers Creek and comprises an area of approximately 8 hectares. This area was previously used for assembly of large pieces of infrastructure such as boiler components, the electrical supply system, and the fire water system for the Site. The area was cut out of the hillside, with the natural excavated material being used to fill the Site to level. It is unknown whether imported fill materials were used in this area. The area is predominantly flat and is understood to have been unsealed since it was levelled. A sedimentation pond was constructed on the north-eastern side of this area and is currently present.

Site activities included primarily welding, with the only buildings present being portable toilets. Macquarie Generation staff involved in the construction of the plant have advised that there was an extensive grid of overhead lines in both the Large Items Assembly and Storage Areas that all contractors connected to. There was therefore not extensive use of generators in either area.

No chemical stores were confirmed to have been present, but it is likely that various fuels were used or stored temporarily in this area. No significant spills or other environmental incidents were known to have occurred in this area; however detailed information on incidents in this area was not available for review at the time of this assessment. No investigations are known to have been completed to date in this area.

Potential contaminants include liquid fuels (e.g. petrol and diesel) and heavy metals from welding activities and associated waste products such as slag.

Given the lack of detailed information for this AEC and the large spatial area, it is difficult to assess potential risks based on existing information. It was therefore a recommendation of the *Preliminary ESA* (ERM, 2013) that further investigation be undertaken within this AEC to assess the potential for soil and groundwater contamination.

AEC Methodology and Investigation Field Observations

A total of eleven soil investigation bores, four of which were originally scheduled to be completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. It is noted that only one of the four proposed wells (BK_MW04) was installed as groundwater was not encountered at the other three monitoring well locations despite drilling to a maximum depth of 10 m bgl. Sampling locations were distributed around the AEC as presented in *Figure 4.1* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 1.0 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.11* (below).

Table 5.11 Field Observations Summary – AEC BK

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BK_MW01	10.0*	None	0
BK_MW02	10.0*	None	0
BK_MW03	10.0*	None	0
BK_MW04	10.0	None	0
BK_SB01	0.6	None	0
BK_SB02	1.2	None	0.0-0.1
BK_SB03	2.7	None	0.0-1
BK_SB04	1.0	None	0.0-0.2
BK_SB05	2.0	None	0.1-0.6
BK_SB06	0.8	None	0.0-0.1
BK_SB07	3.0	None	0.0-0.1

* - Well not installed as hole remained dry after being left for a period of 72 hours.

A groundwater sample was collected from the monitoring well (BK_MW04) within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range with EC readings indicating that groundwater conditions were brackish at BK_MW04.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4k of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5k of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the COPCs in groundwater were reported below the laboratory LOR in the sample collected from this AEC. It is noted that no metals analysis was conducted on groundwater collected from this AEC due to the sample bottle being lost during transport.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil or groundwater samples collected from within this AEC. It is noted that groundwater from AEC BK is likely to discharge to Tinkers Creek (and ultimately into Lake Liddell). During investigation works, limited groundwater was identified and thus risk to the environment and/or human health from groundwater is considered to be low.

5.4.12 Area BL -Transformer Area

Background

The Transformer Area houses the main transformers for the Site and is located immediately west of the power block and is separated into two portions, with the administration buildings located in between. In addition to the potentially contaminating activity of transformer operation, also located within this area are five ASTs used for the storage of transformer oil. Based on verbal information supplied by Macquarie Generation management during the site visit, ERM understands that a PCB removal program was undertaken during the 1990s, which consisted primarily of changing transformer oil containing PCBs with oil that did not contain PCBs during regular maintenance activities.

Due to the construction of the oil tanks within the transformers, not all PCB-containing oil could be drained at once and low concentrations of PCBs are expected to be present currently in the transformers in this area.

While the transformers are now contained within new bund systems that drain to the contaminated water treatment system, there have been reports of transformers leaking and replacements have been undertaken over time. In addition to this, a failure of the 2A Generator Transformer and associated fire in 1986 resulted in a rupture of the transformer oil tank and is likely to have released transformer oil to the surrounding area. The use of fire fighting foam during this fire indicates that perfluorooctane sulfonate (PFOS) and/or perflurooctanoic acid (PFOA) are also contaminants of potential concern for this area. No investigations are known to have been completed within this AEC to date.

Given the absence of previous environmental investigations, historic release events and the volume and content of transformer oils contained within the area, the *Preliminary ESA* (ERM, 2013) concluded that further investigation was warranted to assess potential soil and groundwater contamination.

AEC Methodology and Investigation Field Observations

A total of thirteen soil investigation bores, six of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. Sampling locations were distributed around the AEC as presented in *Figure 4.2* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile with the exception of some minor yellow crystals observed at 3 m bgl in BL_MW01. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 1.9 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.12* (below).

Table 5.12 ***Field Observations Summary - AEC BL***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BL_MW01	6	Minor yellow crystals observed at 3 m bgl.	0.1-0.2
BL_MW02	10	None	0-0.2
BL_MW03	4	None	0
BL_MW04	3.5	None	0.2-1.7
BL_MW05	7	None	0-0.1

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BL_MW06	4.3	None	0-0.2
BL_SB01	3.0	None	0-0.2
BL_SB02	2.9	None	0.1-1.9
BL_SB03	3.5	None	0-0.2
BL_SB05	3.0	None	0-0.1
BL_SB06	3.0	None	0-0.1
BL_SB07	3.0	None	0-0.2

Groundwater samples were collected from the six groundwater monitoring wells located within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a of Annex B*. Groundwater parameters were not measured at BL_MW02 due to insufficient water volume. Field parameters at the other locations were generally within the expected range, with EC readings indicating that groundwater conditions were brackish for all groundwater monitoring wells located within this AEC. pH was noted to be acidic in BL_MW01.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4l of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

It is noted that hexavalent chromium was added to the analytical suite for soil collected from 3.0 m bgl at BL_MW01 in response to the observation of yellow crystals at this location and depth. The reported concentration at this location, however, was below the laboratory LOR.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5l of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in all samples analysed. The exceptions to this were detections of benzene, toluene and lighter TRH fractions in groundwater collected from BL_MW02. These concentrations were below the adopted screening values with the exception of benzene (reported as 2 µg/L), which marginally exceeded the adopted human health (drinking water) screening values of 1 µg/L. Perfluorooctane sulfonate (PFOS) was detected at BL_MW05 at 0.12 µg/L above the LOR (0.02 µg/L).

Concentrations of metals above the laboratory LOR were also detected in groundwater from all wells within this AEC, with the exception of BL_MW02 for which metals analysis was not conducted.

Cadmium, copper, lead, nickel, and zinc were detected at concentrations in excess of the adopted ecological and/or human health screening values in groundwater analysed samples from wells within this AEC. Concentrations of metals were noted to be above the adopted recreational criteria including nickel and BL_MW01 (0.501 mg/L compared to 0.2 mg/L) and lead at BL_MW04.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

The concentration of benzene detected in groundwater collected from BL_MW02 exceeded the adopted human health screening values for drinking water. However, given the absence of nearby abstraction bores for domestic potable or non-potable uses and the general unsuitability of the groundwater, this exceedences are not considered to represent a significant risk to human health. A minor detection of PFOS was measured at BL_MW05. However, this was below the adopted screening values and not considered indicative of significant contamination.

All monitoring wells within this AEC reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, nickel, and zinc. Concentrations of cadmium, lead and nickel in excess of the adopted human health (drinking water and/or recreational) screening values were also detected in a number of groundwater samples.

Whilst it is noted that groundwater within this area would likely discharge to an intermittent stream into Chilcott's Gully and ultimately into Lake Liddell, the concentrations of contaminants were generally below the recreational screening values (with the exception of lead and nickel). It is noted that elevated metals concentrations at BL_MW01 may be attributable to the lower pH measured at this location. Metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23*.

5.4.13 *Area BM - Landfill*

Background

The landfill is located approximately 1.3 km to the south of the power block and has a largely undefined footprint due to the long-term use of the area coupled with overgrowth in areas no longer actively used for waste disposal. The unlined landfill is understood to have become operational during the construction phase of the Bayswater Power Station and has received both construction waste and waste generated during operations following commissioning of the Power Station. The level of waste management during the circa 30 year life of the landfill is largely unknown and the potential exists that hazardous wastes have been disposed in the landfill. Waste is no longer disposed at the landfill and access was shutdown via physical barrier in 2013.

Two groundwater wells have historically been installed down gradient from the landfill to monitor potential impacts to groundwater. ERM understands that limited monitoring of these wells has been conducted prior to this assessment, and the results are not reported in the *Water Management Licence Package Annual Monitoring and Compliance Reports.*

During completion of the *Preliminary ESA* (ERM, 2013), ERM did not identify groundwater results for the monitoring wells located at the landfill site within the dataroom. Given the paucity of groundwater characterization data, the lack of records on the extent of waste disposal and the potential that hazardous wastes have been disposed in the landfill, further investigation was considered warranted to assess potential soil and groundwater impacts.

AEC Methodology and Investigation Field Observations

A total of sixteen soil investigation bores, three of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. One existing monitoring well (BM_EW_MW01) was also gauged and sampled as part of the ESA. Monitoring wells BM_MW01 was abandoned due to access constraints and BM_MW02 was abandoned due to the presence of landfill materials identified during initial drilling. In each case, the hand auger soil bore was advanced.

Due to the presence of landfill materials identified during initial drilling at BM_MW06, this location was only advanced as a soil bore and location BM_SB08 was instead converted to a monitoring well (BM_MW07). An additional soil bore was completed as BM_SB01(2) due to the presence of landfill materials. Sampling locations were distributed around the AEC as presented in *Figure 4.4* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 1.9 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.13* (below).

Table 5.13 ***Field Observations Summary – AEC BM***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v -isobutylene equivalents)
BM_MW01	0.45*	None	0.3
BM_MW02	1.1*	None	0.2-0.3
BM_MW03	3.1	None	0.1
BM_MW04	9*	None	0.1-1.5
BM_MW05	3.3	None	0.1-0.2
BM_MW06	1.5*	None	1.5
BM_MW07 (was BM_SB08)	6.0	None	0.2-1.8
BM_SB01	2.5	None	0.1-0.8
BM_SB01(2)#	0.8	None	0.1-0.2
BM_SB02	0.9	None	0.1
BM_SB03	1.7	None	0.1-0.6
BM_SB04	1.3	None	0.1-1.0
BM_SB05	1.8	None	0.1-0.8
BM_SB06	1.8	None	0.2
BM_SB07	1.7	None	0.1-1.5
BM_SB09	3.1	None	0-0.8

*-No well installed
- Additional location completed due to the presence of landfill material in original proposed location

Groundwater samples were collected from the four monitoring wells located within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range with EC readings indicating that groundwater conditions were brackish within this AEC.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4m of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5m of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs were below the laboratory LOR in all groundwater samples analysed. The exceptions to this were detections of metals within groundwater collected from within this AEC and 1,1-dichloroethane which was marginally above the laboratory LOR (6 μg/L compared to 5 μg/L) in groundwater collected from BM_MW05.

Cadmium, copper, lead, nickel and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater collected from wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

Drilling in this area identified buried landfill materials at locations BM_SB01, BM_SB01(2), BM_MW02 and BM_MW06. These buried materials consisted of uncontrolled soil fill, steel, plastic, foam, timber, gravel and concrete and extended to a depth of 1.5 m bgl. Landfill materials above ground were noted adjacent to locations BM_SB04, BM_SB05 and BM_SB06.

Based on the observations during the drilling works and site inspections, the buried waste area is estimated to be approximately 2 ha in area and the above ground (active) waste area is estimated to be 2 ha. Based on the local topography, it appears that waste materials were historically backfilled into a natural depression before being covered with a minimal layer of soil and vegetated.

All monitoring wells within this AEC reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, lead, copper, nickel and zinc. Concentrations of these metals in groundwater was consistent with concentrations detected at boundary locations within the Site which essentially represent background conditions. It is noted that groundwater at the landfill is likely to discharge to either an intermittent creek and into Saltwater Creek (and ultimately into Plashett Reservoir) or in Freshwater Dam/Tinkers Creek (and ultimately into Lake Liddell). Minor exceedences of metals are not considered significant given that discharge of waters from Plashett Reservoir are managed as per the closed system design (*refer to Section 5.6.2*). Metals impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23.*

Concentrations of lead and nickel in excess of the adopted human health (drinking water) but below the human health (recreational) screening values were also detected at a number of locations. Whilst it is noted that lead and nickel concentrations were above human health criteria, given the absence of abstraction bores for domestic potable or non-potable uses and the general unsuitability of the groundwater due to high salinity, these exceedences are not considered to represent a significant risk.

A minor detection of 1,1-dichloroethane marginally above the laboratory LOR (6 µg/L compared to 5 µg/L) was noted in groundwater collected from BM_MW05. Soil concentrations of chlorinated hydrocarbons were below the LOR for all soil samples collected at BM and no field observations (olfactory or PID) indicating the presence of volatile compounds were noted. Whilst the minor detection is acknowledged, based on the concentration measured and field observations, this is not considered to represent a significant contamination issue.

5.4.14 *Area BN - Lime Softening Plant*

Background

At its nearest point, the Lime Softening Plant is located approximately 1.2 km to the south of the Bayswater Power Station. The plant includes the gypsum and lime storage area, acid storage area, ferric chloride storage area, the mechanical plant room shed and two large clarifiers.

Oil stains were reportedly observed beneath the hydro-pneumatic tank and unbunded 205 litre oil drums in the mechanical plant room during a facilities and process audit conducted in 2007 (Parsons Brinckerhoff, 2007). Ferric chloride staining on the ferric chloride pump room inside the mechanical plant room and on the ferric chloride storage tanks is however considered to be of limited environmental significance. ERM understands that groundwater quality has not been historically monitored in the immediate vicinity of the Lime Softening Plant.

Given the lack of groundwater characterization data coupled with the potential for impact as indicated by the oil staining in the mechanical plant room, limited further investigation was considered warranted to assess soil and groundwater conditions.

AEC Methodology and Investigation Field Observations

A total of three soil investigation bores, two of which were completed as groundwater monitoring wells, were installed within this AEC to assess potential impacts to soil and groundwater. Sampling locations were distributed around the AEC as presented in *Figure 4.3* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile with the exception of a hydrocarbon odour detected in BN_MW03 at 7.5 m bgl. It is noted that this odour was detected in competent siltstone at depth and as such, the drilling method used (rotary air hammer) and the matrix being drilled were not conducive to the collection of representative undisturbed solid (i.e. soil / rock) matrix samples. A monitoring well was installed at BN_MW03 at the same depth as the adjacent well BN_MW02 (where groundwater ingress had occurred). Whilst groundwater was noted observed during drilling of BN_MW03, a well was installed in an attempt to assess whether any impacts to groundwater were present to the identified odour. Groundwater ingress did not occur at BN_MW03 and therefore no groundwater sample was collected. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.0 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.14*.

Table 5.14 ***Field Observations Summary – AEC BN***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BN_MW01	10*	None	0
BN_MW02	10	None	0
BN_MW03	10.2#	Hydrocarbon odour from 7.5 m bgl.	0

* - Well not installed as hole remained dry 72 hours after drilling.
# - Well installed but groundwater not present and not collected.

A groundwater sample was collected from BN_MW02. Groundwater parameters and water quality observations were not noted, however, due to insufficient water volume.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4n of Annex B.* Exceedences of adopted screening values are graphically presented in *Annex A.*

Measured concentrations of all COPCs with the exception of TRH C_{10}-C_{16} (discussed below) were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Concentrations of TRH fractions were above the corresponding laboratory LORs in soil samples collected from 10 m bgl at both BN_MW01 and BN_MW02. All concentrations were below the adopted screening values with the exception of TRH C_{10}-C_{16} which exceeded the adopted ESL in both BN_MW01 and BN_MW02.

Concentrations of various heavy metals were above the corresponding laboratory LORs in a number of soil samples collected from within this AEC but all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5n of Annex B.* Exceedences of the adopted screening values are also graphically presented in *Annex A.*

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in the groundwater sample analysed. The exceptions to this were naphthalene, phenanthrene, pyrene, TRH fractions and various metals.

All detected concentrations were below adopted screening values with the exception of a number of metals.

Arsenic, boron, copper, lead, nickel, and zinc were detected at concentrations in excess of the adopted ecological and/or human health drinking water screening values in the groundwater sample collected from within this AEC. All groundwater results were below the adopted screening values for recreational users.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC with the exception of concentrations of TRH C_{10}-C_{16} in soils collected from 10 m bgl at BN_MW01 and BN_MW02, which exceeded the adopted ESL. Given the depth of the sample collected, the exceedence is not considered to be significant given ESL criteria applies only to shallow soils (<2 m bgl) which corresponds to the root zone and habitation zone of many species (*ASC NEPM* (2013).

Groundwater collected from the monitoring well within this AEC reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included boron, copper, nickel and zinc. Groundwater from BN discharges to an intermittent creek then into Wisemans Creek and ultimately into Plashett Reservoir. The elevated concentrations of metals above ecological criteria in groundwater within this AEC are not considered significant given that discharge of waters from Plashett Reservoir are managed as per the closed system design (*refer to Section 5.6.2*).

Concentrations of arsenic and nickel in excess of the adopted human health (drinking water) screening values were also detected in groundwater from this location. Whilst it is noted that arsenic and nickel concentrations were above human health criteria, given the absence of abstraction bores for domestic potable or non-potable uses and the general unsuitability of the groundwater due to high salinity, these exceedences are not considered to represent a significant risk.

Minor detections of PAHs (naphthalene, phenanthrene and pyrene) and TRH fractions were noted within the groundwater sample collected from BN_MW02 however concentrations were below the adopted screening values. Based on the observations made during drilling works, the geology encountered and the potential onsite sources, these minor detections are not considered to represent a risk to human health or the environment.

5.4.15 *Area BO - Lime Softening Plant Sludge Lagoons*

Background

The Lime Softening Plant Sludge Lagoons are located approximately 1.8 km (at the nearest point) to the south of the Bayswater Power Station. Five individual lagoons cover a total area of approximately 10 ha. Sludge contained within the lime softening sludge lagoons includes residue from the water softening process, constituting calcium oxides, magnesium hydroxide and other precipitates from the water treatment process.

Groundwater monitoring at the lime softening sludge lagoons is limited to the sampling of one groundwater bore (BWGM1/D7) located approximately 100 m downgradient of the sludge lagoons. Parameters monitored included electrical conductivity (EC), pH, hardness, arsenic and metals (including aluminium, copper, iron, lead, manganese, nickel, and selenium). Sampling frequency has historically varied from twice per year to more than seven times per year.

Monitoring has indicated that electrical conductivity in groundwater monitoring bore BWGM1/D7 has been above typical groundwater background values for the region with EC as high as 14 180 µS/cm measured in September 2009 (Macquarie Generation, 2010).

Analytes that have exceeded one or more of the guidance criteria (for irrigation and livestock water quality - Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000) for BWGM1/D7 during one or more sampling events include nickel and manganese (Macquarie Generation, 2010).

Given the elevated salinity measured in groundwater bore BWGM1/D7 and the other exceedences of screening levels noted above coupled with the potential for impact to downgradient receptors which includes the downgradient creek, the *Preliminary ESA* (ERM, 2013) concluded that further assessment was warranted to assess potential soil and groundwater contamination issues associated with the Lime Softening Plant Sludge Lagoons.

AEC Methodology and Investigation Field Observations

A total of five soil investigation bores, all of which were completed as groundwater monitoring wells, were installed within this AEC to assess potential impacts to soil and groundwater. Sampling locations were distributed around the AEC as presented in *Figure 4.4* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 1.5 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.15* (below).

Table 5.15 ***Field Observations Summary - AEC BO***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BO_MW01	10	None	0
BO_MW02	3	None	0.1-0.3
BO_MW03	4	None	0-0.4
BO_MW04	3	None	0-0.3
BO_MW05	4.5	None	0.2-1.5

Groundwater samples were taken from the five monitoring wells located within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range. EC readings indicating that groundwater conditions were brackish to saline within this AEC.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4o of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5o of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in all samples analysed. The exceptions to this were detections of toluene and lighter TRH fractions in groundwater collected from BO_MW01. These concentrations were below the adopted screening values.

Concentrations of metals above the laboratory LOR were also detected in groundwater from all wells within this AEC. Copper, lead, nickel, selenium and zinc were detected at concentrations in excess of the adopted ecological and/or human health screening values in groundwater samples from wells within this AEC. No groundwater concentrations were reported above the adopted recreational screening values.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

Groundwater samples collected from all monitoring wells within this AEC reported metals concentrations greater than adopted ecological screening values. Metals exceeding the adopted ecological screening values included, copper, lead, nickel, selenium and zinc. Groundwater from this BO discharges to an intermittent creek then into Wisemans Creek and ultimately into Plashett Reservoir. The elevated concentrations of metals above ecological criteria in groundwater within this AEC are not considered significant given that discharge of waters from Plashett Reservoir are managed as per the closed system design (*refer to Section 5.6.2*).

Concentrations of lead, nickel and selenium in excess of the adopted human health (drinking water) but below the human health (recreational) screening values were also detected in a number of samples. Whilst it is noted that lead, nickel and selenium concentrations were above human health criteria, given the absence of abstraction bores for domestic potable or non-potable uses and the general unsuitability of the groundwater due to high salinity, these exceedences are not considered to represent a significant risk.

A minor detection of toluene at the laboratory LOR was noted within the groundwater sample collected from BO_MW01. Based on the observations made during drilling works, the geology encountered and the potential onsite sources, this minor detection is not considered to represent a risk to human health or the environment.

5.4.16 *Area BP - Mobile Plant Workshop And Refuelling*

Background

Mobile plant associated primarily with the coal storage area are serviced and refuelled in this area, located directly to the south of the coal storage area and comprising an area of approximately 2500 m^2. Significant surface staining of the concrete in the refuelling and lubrication area indicates that spills and leaks of diesel from the AST and lubrication dispensers in this area have potential to have impacted the subsurface. A concrete subsurface sump (9000 L) used for storage of waste oil prior to pump-out by a contractor is located to the north of the workshop. This sump is understood to have been installed during construction of the Power Station and no integrity testing is known to have been completed on this sump to date. Whilst no spills or leaks of waste oil have been documented from this sump, it is possible that damage to the sump would result in releases of oil to the subsurface. No previous investigations are known to have been completed in this area.

Surface water from this area discharges to the coal storage area retention ponds, which in turn discharge to Tinkers Creek via a weir. Given the lack of investigation data available and the evidence of historical leaks and spills of hydrocarbons, the *Preliminary ESA* (ERM, 2013) concluded that further investigation was warranted to assess potential soil and groundwater contamination issues associated with this AEC.

AEC Methodology and Investigation Field Observations

A total of six soil investigation bores, all of which were completed as groundwater monitoring wells, were installed within this AEC to assess potential impacts to soil and groundwater. Sampling locations were distributed around the AEC as presented in *Figure 4.1* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.3 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.16*.

Table 5.16 ***Field Observations Summary - AEC BP***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BP_MW01	4	None	0
BP_MW02	8.2	None	0-1.1
BP_MW03	4	None	0
BP_MW04	8	None	0-0.2
BP_MW05	7	Coal dust noted at 0.1 m bgl	0-0.3
BP_MW06	7	None	0.1-0.3

Groundwater samples were collected from the six monitoring wells located within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range. EC readings indicating that groundwater conditions were relatively fresh at BP_MW01 and brackish at all other locations.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4p of Annex B*. Exceedences of adopted screening values are graphically presented in *Annex A*.

Measured concentrations of all COPCs with the exception of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} (discussed below) were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Concentrations of some TRH fractions were above the corresponding laboratory LOR in soil collected from 0.1 m bgl at BP_MW05. All concentrations were below the adopted screening values with the exception of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} which exceeded the adopted ESLs.

Concentrations of various heavy metals were above the corresponding laboratory LORs in a number of soil samples collected from within this AEC but all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results are compared to the adopted screening levels in *Table 5p of Annex B*. Exceedences of the adopted screening levels are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in all samples analysed. The exceptions to this were various metals within monitoring wells located across this AEC.

Arsenic, boron, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, and zinc were detected at concentrations in excess of the adopted ecological and/or human health screening values in groundwater samples collected from wells within this AEC. Lead and nickel were noted to be above the recreational screening values.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC with the exception of concentrations of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} in soil collected from 0.1 m bgl at BP_MW05 which exceeded the adopted ESLs. Coal dust was observed in this sample although the hydrocarbon impacts identified at this location may also be related to historical leaks or spills associated with workshop activities in this area. Area BP is largely covered in concrete hardstanding and not considered to have significant ecological value and thus the application of the ESLs is considered to be overly conservative in this instance.

Groundwater from all monitoring wells within this AEC reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included boron, cadmium, copper, lead, manganese, mercury, nickel, selenium and zinc. It is noted that groundwater from AEC BP is likely to discharge to an intermittent creek and into Chilcott's Gully (and ultimately into Lake Liddell). The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23*.

Concentrations of arsenic, chromium, lead, nickel, and selenium in excess of adopted human health (drinking water and/or recreational) screening values were detected in a number of samples.

Whilst it is noted that arsenic, chromium, lead, nickel and selenium concentrations were above human health criteria, given the absence of abstraction bores for domestic potable or non-potable uses and the general unsuitability of the groundwater due to high salinity, these exceedences are not considered to represent a significant risk. Lead and nickel were noted to be above the recreational criteria in groundwater well BP_MW04. The potential risks due to metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23*.

5.4.17 *Area BQ – Pikes Gully Ash Dam*

Background

The Pikes Gully Ash Dam is located approximately 200 m (at its nearest point) to the east/south-east of the Bayswater Power Station and covers an area of approximately 150 ha.

The ash dam receives runoff from the sluiceways draining Bayswater Power Station. In addition, sections of fly ash slurry pipes and return water pipes with asbestos containing material (ACM) are reportedly buried in the ash within the dam once a section is decommissioned. The fly ash slurry pipeline and water return water pipeline (with ACM) run along the northern side of the ash dam.

The EPL (779) licenses several materials for disposal on site, but does not specify disposal locations. Macquarie Generation management indicated that the following waste streams may have been disposed of in the ash dam:

- acid solutions or acids in solid form;
- asbestos;
- fly ash and bottom ash;
- waste mineral oils unfit for their original use;
- waste oil / water hydrocarbon / water mixtures or emulsions;
- boiler cleaning residues;
- spent fly ash filter bags; and
- water treatment residues.

As outlined in the *Preliminary ESA* (ERM, 2013), seepage has been noted at the toe of the dam wall in Pikes Gully. In addition, a report by HLA (HLA, 2004) makes reference to the presence of saline groundwater seepage at and below a small dam located approximately 250 m from the south of the Pikes Gully Ash Dam.

A geophysical survey conducted by HLA identified shallow conductive zones consistent with groundwater with elevated salinity that may have presented preferential pathways of saline groundwater extending towards the south of the ash dam (HLA, 2004). During ERM's site visit for the *Preliminary ESA* conducted in August 2013, seepage was also observed on the saddle dam wall on the northern section of the dam.

Seepage from the ash repository has the potential to be saline and contain arsenic and heavy metals (specifically barium, beryllium, boron, cadmium, chromium, cobalt, lead, manganese, mercury, molybdenum, nickel, thallium, selenium and/or zinc).

Parameters historically assessed during groundwater monitoring conducted at the ash dam included EC, pH, hardness, arsenic and metals (including aluminium, copper, iron, lead, manganese, nickel, and selenium) in up to six monitoring wells located downgradient of the ash dam wall.

Available results indicate that analytes exceeding one or more of the guidance criteria (for irrigation and livestock water quality - Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000) for one or more sampling events include nickel, manganese and iron (Macquarie Generation, 2010).

The *Preliminary ESA* (ERM, 2013) concluded that whilst some environmental assessment has been undertaken in this area, it was not considered that suitable characterisation of environmental conditions has been established, and further investigation was warranted to assess soil and groundwater conditions.

AEC Methodology and Investigation Field Observations

A total of fourteen soil investigation bores, eleven of which were completed as groundwater monitoring wells, were installed around the perimeter of this AEC to assess potential impacts to soil and groundwater. In addition, three existing monitoring wells were gauged and sampled. A programme of inspection and surface soil sampling for asbestos along several pipelines constructed of ACM was undertaken within this AEC.

In total, thirty two individual surface samples were collected from surficial soils (<0.1 m bgl) utilising a stainless steel trowel. The surface samples were collected as a combination of judgemental samples (based on the condition of the pipe) and targeted locations approximately 100 m apart in close proximity to the pipeline. Visual identification of potential asbestos materials were also noted during the surface soil sampling as presented in *Table 5.17*. Sampling locations were distributed around the AEC as presented in *Figure 4.3* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.2 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.17* (below).

Table 5.17 ***Field Observations Summary - AEC BQ***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BQ_MW01	50.0	None	0.0-0.2
BQ_MW02	5.7	None	0
BQ_MW03	5.7	None	0
BQ_MW04	10	None	0
BQ_MW05	7.5	None	0
BQ_MW06	10*	None	0
BQ_MW07	10	None	0
BQ_MW08	6.5	None	0-0.2
BQ_MW09	4*	None	0.1
BQ_MW10	5.3	None	0-0.2
BQ_MW11	5	None	0-0.1
BQ_MW12	8.9*	None	0
BQ_MW13	5.8	None	0.1-0.2
BQ_MW14	2.5	None	0
BQ_SU01	0.1	None	N/A
BQ_SU02	0.1	None	N/A
BQ_SU03	0.1	None	N/A
BQ_SU04	0.1	None	N/A
BQ_SU05	0.1	Potential fibres observed	N/A
BQ_SU06	0.1	None	N/A
BQ_SU07	0.1	None	N/A
BQ_SU08	0.1	None	N/A
BQ_SU09	0.1	Possible fibres observed	N/A
BQ_SU10	0.1	Possible fibres observed	N/A
BQ_SU11	0.1	None	N/A
BQ_SU12	0.1	None	N/A
BQ_SU13	0.1	None	N/A
BQ_SU14	0.1	None	N/A
BQ_SU15	0.1	None	N/A
BQ_SU16	0.1	None	N/A
BQ_SU17	0.1	None	N/A
BQ_SU18	0.1	None	N/A
BQ_SU19	0.1	None	N/A
BQ_SU20	0.1	None	N/A
BQ_SU21	0.1	None	N/A
BQ_SU22	0.1	None	N/A
BQ_SU23	0.1	Possible fibres observed	N/A
BQ_SU24	0.1	Possible fibres observed	N/A
BQ_SU25	0.1	Possible fibres observed	N/A
BQ_SU26	0.1	Possible fibres observed	N/A

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BQ_SU27	0.1	Possible fibres observed	N/A
BQ_SU28	0.1	Possible fibres observed	N/A
BQ_SU29	0.1	None	N/A
BQ_SU30	0.1	None	N/A
BQ_SU31	0.1	None	N/A
BQ_SU32	0.1	None	N/A

* Well not installed due to either deemed refusal or an absence of water following a period of 72 hours.

Groundwater samples were collected from the 14 monitoring wells located within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range. EC readings indicated that groundwater was fresh at BQ_MW03 and brackish to saline at all other locations. Measured pH indicated alkaline conditions at BQ_MW14 but field notes indicate that the pH sensor was possibly malfunctioning.

A sulfurous odour was noted during sampling at BQ_EW_MW03. No other indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4q of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Asbestos was detected in soils at a total of sixteen of the thirty two locations sampled within this AEC immediately beneath the ACM pipelines. Potential asbestos fibres were noted at ten locations during sampling as presented in *Table 5.17*. Asbestos quantification results were reported above the human health screening criteria for fifteen of the sixteen samples where asbestos was identified.

Groundwater Analytical Results

Groundwater analytical results are compared to the adopted screening levels in *Table 5q of Annex B*. Exceedences of the adopted screening levels are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in all samples analysed. The exceptions to this were various metals within monitoring wells located across this AEC.

Boron, cadmium, copper, lead, manganese, nickel, and zinc were detected at concentrations in excess of the adopted ecological and/or human health (drinking water) screening values in groundwater samples collected from wells within this AEC. Lead and nickel were reported above the recreational screening values within monitoring wells BQ_MW02 and BQ_MW10 respectively.

Discussion

The identified asbestos impacts in shallow soils beneath the ACM pipelines will require some form of management and / or remediation in order to manage potential risks to human receptors.

The asbestos impacts identified in soils beneath the pipelines within AEC BQ (along with the pipelines) has been recognised by Macquarie Generation as an issue which represent a potential health risk and hence at the time of writing Macquarie Generation were in the process of developing a management strategy to appropriately mitigate these risks as set out in Macquarie Generation (December 2013) *Ash & Dust - Position Paper* -(Ref: 06.03.03.38 ENV.03.03.048). Actions to address these risks may include the sealing of the pipeline to prevent further ACM degradation and consideration of options to address ACM in soils.

No other exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

Groundwater collected from all monitoring wells within this AEC reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included boron, cadmium, copper, lead, manganese, nickel and zinc.

Concentrations of lead and nickel in excess of the adopted human health (drinking water or recreational) screening values were also detected in a number of samples.

It is noted that the current EPL for the Site (No. 779 dated 20 September 2013) includes a Pollution Reduction Program (PRP 1) which requires that *"The licensee must investigate and provide a detailed report on options to maximise the onsite storage and management of waste water associated with ash disposal on the premises."* This PRP includes the requirements to develop an understanding of the pollutants in the Ash Dam and in downgradient surface water bodies, and to identify options for reducing inputs to and overflows from the Ash Dam and seepage from the toe drains below the ash dam wall.

In response to the conditions of this PRP, a report was prepared by Worley Parsons on behalf of Macquarie Generation entitled *Bayswater EPL PRP 1 - Bayswater Ash Dam Water Management Study* (20 December 2013). Given that this report covers the investigation / and management options for this specific issue in a significant level of detail, the information contained therein has not been duplicated here and a separate detailed assessment of the issues has not been undertaken by ERM. Suffice to say there are a number of options and management recommendations related to the PRP to address, amongst others, the discharge from the Dam to ground and groundwater.

5.4.18 *Area BR - Ravensworth Rehabilitation Area*

Background

The Ravensworth Rehabilitation Site is located approximately 8 km east/south-east of the Bayswater Power Station and is currently used for the disposal of fly ash. The AEC is located in the former Ravensworth No. 2 Mine (the location of Void 1 to 4) and a section of the Ravensworth South Mine (the location of Void 5). Both these former mines operated as open cut coal mines. The surface geology has been extensively disturbed by mining.

Much of the former opencast mine workings within this AEC have been backfilled with mine spoil that includes coal from uneconomic seams, and the remnant coal is subject to spontaneous combustion. Part of the Ravensworth No.2 Mine has been backfilled with fly ash (Voids 1 to 3) and coal preparation plant rejects (eastern ramp of Void 4) (Aurecon, 2012). ERM understands that Void 5 is currently being prepared for future fly ash disposal.

The base of the voids is expected to be in contact with regional groundwater flow. Seepage from the ash filled voids has the potential to be saline and contain heavy metals.

The available groundwater sampling reports state that samples have not been obtained from the Ravensworth Rehabilitation Site during sampling events covering the monitoring period from 2006 to 2010 as underground heat generated from spontaneous combustion did not permit samples to be taken from the available monitoring wells (Macquarie Generation, 2010). Six wells were reportedly installed in this area, but Macquarie Generation has advised that none of the wells are currently useable due to subsidence, being covered by fill material, or being affected by high temperatures from spontaneous combustion.

Water quality monitoring has however been conducted in Void 4, which is currently used as a water management storage system receiving drainage water from the surrounding voids and mine spoils. Surface water samples collected from Void 4 were analysed for EC, pH, boron, chromium, fluoride, lithium, molybdenum, selenium and vanadium.

Monitoring has indicated that water within Void 4 is relatively saline with an average electrical conductivity of 7079 μS/cm for monitoring conducted in 2012 (Macquarie Generation, 2012). Relatively alkaline conditions were further observed with pH levels generally ranging between pH 8 and pH 9.

While the report with the Void 4 monitoring data did not compare the results against guidance criteria, a comparison of data collected prior to the ash disposal commencing indicates that boron and molybdenum concentrations have increased by approximately a factor of six and an order of magnitude respectively between 1992/1995 and 2012 (Macquarie Generation, 2012).

The *Preliminary ESA* (ERM, 2013) concluded that given the lack of groundwater characterisation data coupled with the potential for impact considering the nature of the mine spoils and the ash disposed of at the Ravensworth Rehabilitation Site, further investigation was warranted to assess potential soil and groundwater impacts.

AEC Methodology and Investigation Field Observations

A total of five soil investigation bores, three of which were completed as groundwater monitoring wells, were installed within this AEC to assess potential impacts to soil and groundwater.

Due to the subsurface conditions encountered within the AEC the drilling scope was reduced considerably. During the Stage 2 ESA it was found that the vast majority of the site is underlain with mine spoil comprising rock fragments (varying in diameter from approximately 0.03m to 1.5m) consisting of siltstone and sandstone with minor waste coal embedded in a gravelly silt matrix.

The three bores successfully converted to groundwater monitoring wells (BR_MW01, BRMW05 and BR_MW06) were positioned on the northern, southern and eastern periphery of the AEC respectively where mine spoil thickness were likely to be limited (following drilling, the mine spoil was found to vary between 0.7 m and 17m in thickness in the bores advanced in these locations). Two more centrally located bores (BR_MW09 and BR_MW11) were advanced in an attempt to install additional groundwater monitoring wells, but the nature of the mine spoil in these locations was considered to create a significant risk of loss or severe damage to the available drilling equipment due to collapse within boreholes and the loss of air pressure within the borehole needed for completion of rotary air drilling. Spontaneous combustion was also identified at one location (BR_MW09) during drilling, which led to hot and noxious-smelling gases being released from the borehole.

Bores BR_MW09 and BR_MW11 were therefore abandoned and not installed as groundwater monitoring wells as sufficient bore depth could not be achieved in these locations. Given the drilling restrictions posed by the subsurface conditions and the similarity in the undrilled locations to BR_MW09 and BR_MW11, ERM concluded that the safety risk and potential risks of loss or damage to drilling equipment was significant enough to prevent completion of eight locations (BR_MW02 to 04 and BR_MW07 to 11) using the available equipment. Further drilling was stopped at these locations on 27 November.

Sampling locations of bores advanced in the AEC are presented in *Figure 4.6* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No staining or unusual odours were detected at any depth through the sampled soil profile with the exception of indicators of spontaneous combustion (as described above) within BR_MW09 at 3.0 m bgl (after which the location was abandoned due to safety concerns). Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 1 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.18* (below).

Table 5.18 *Field Observations Summary - AEC BR*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v -isobutylene equivalents)
BR_MW01	52	None	0-1
BR_MW05	32.6	None	0-0.1
BR_MW06	20	None	0-1
BR_MW09	3*	Indicators of spontaneous combustion.	0-1
BR_MW11	9.5*	None	0.1

* Well not installed due to safety concerns (spontaneous combustion) and/or borehole collapse.

Groundwater samples were collected from the three monitoring wells located within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range with EC readings indicating that groundwater conditions were brackish to saline.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening levels as presented in *Table 4r of Annex B*. Exceedences of the adopted screening levels are also graphically presented in *Annex A*.

Measured concentrations of the majority of PCOCs were either reported at or near the corresponding LOR, and thus, below the adopted screening levels within all soil samples collected from within this AEC.

Of the trace metals arsenic, chromium, copper, nickel, mercury and zinc were reported more than a factor of two above the laboratory LOR in one or more sample, but below the adopted human health and ecological screening levels in all the bores sampled. While barium, cobalt, manganese and vanadium were above the laboratory LOR in the samples, these metals do not have Australian based screening criteria available.

Concentrations of TRH were reported at concentrations above the laboratory LOR in samples analysed from boreholes BR_MW01, BR_MW05 and BR_MW09. The reported concentrations for these samples were however below the adopted human health and ecological screening levels. It is further noted that the samples with the highest reported TRH concentrations were deep samples (taken from 25 and 14 m bgl from BR_MW01 and BR_MW05 respectively) and both were samples of coal.

Benzene was detected at a concentration marginally below the adopted human health based screening criteria in a sample collected from BR_MW09 between 2 and 3 m bgl i.e. within the zone immediately above the point at which the hole was abandoned due to indications of spontaneous combustion. Coal based spontaneous combustion gas has been shown to include a range of VOCs including benzene (Pone *et al*, 2007), and it is considered likely that the detected benzene concentration is associated with the observed spontaneous combustion in the area.

Groundwater Analytical Results

Groundwater analytical results are compared to the adopted screening levels in *Table 5r of Annex B*. Exceedences of the adopted screening levels are also graphically presented in *Annex A*.

Measured concentrations of the majority of the PCOCs in groundwater were reported below the laboratory LOR, with the exception of phenanthrene and TRH in BR_MW05 and trace metals in BR_MW01, BR_MW05 and BR_MW06.

The phenanthrene concentration in the sample taken from BR_MW05 was reported as 1.2 μg/L, marginally above the laboratory LOR of 1 μg/L. Detected TRH fell predominantly in the C_{15}-C_{28} range, and to a lesser extent in the C_{29}-C_{36} range. Australian based screening criteria are not available for phenanthrene or the aforementioned TRH carbon fractions. Given that the monitoring well screen in BR_MW05 intersects a coal layer, the hydrocarbons detected in the aforementioned monitoring well may be attributed to naturally occurring conditions at the AEC.

Of the trace metals, arsenic, boron and manganese, were above the laboratory LOR but below the adopted human health and ecological screening levels in all monitoring wells sampled.

Trace metals that exceeded the adopted screening criteria include copper exceeding the ecological based screening criteria in BR_MW01, nickel exceeding both the drinking water guideline and ecological based screening criteria in BR_MW01 and BR_MW05, and zinc exceeding the ecological based screening criteria in BR_MW01 and BR_MW05. Note that the concentrations of analytes that have exceeded the adopted screening criteria are lower in downgradient monitoring wells compared to the upgradient monitoring well BR_MW01. The trace metal exceedences of adopted screening criteria are therefore not attributed to the on-site activities at the AEC.

Discussion

For the soil samples, PCOC detections above the laboratory LOR were limited to petroleum hydrocarbons and trace metals with the highest concentrations of these PCOCs generally related to coal containing material sampled at depth (≥14 m bgl) and/or material sampled in an area where spontaneous combustion was observed (with the detected benzene in bore BR_MW09 considered likely to be associated with spontaneous combustion). Where detectable concentrations were reported in soil samples, these concentrations were however all below the adopted screening criteria (for analytes with available screening criteria).

In groundwater, the phenanthrene and TRH concentrations reported in downgradient monitoring well BR_MW05 may be attributed to naturally occurring conditions at the AEC considering that the water intake screen of BR_MW05 intersects a coal layer. PCOCs that exceeded the adopted screening criteria in one or more monitoring well at the AEC were limited to copper, nickel and zinc. The concentrations of these PCOCs were lower in downgradient monitoring wells compared to the upgradient monitoring well, and the trace metal exeedences of adopted screening criteria are therefore not attributed to the on-site activities at the AEC.

5.4.19 Area BS – Low Pressure Pumping Station

Background

The Low Pressure Pumping Station is located approximately 9.6 km to the south-west of the operational area. The station pumps water from the Hunter River and transfers the water to the high pressure pumping station via an open channel. The low pressure pumping station include a series of five pumps within the Hunter River, a pump house building and power supply with a (brick) bunded external transformer.

As outlined previously, low concentrations of PCBs are expected to be present in the transformers at the Low Pressure Pumping Station, although no spills or leaks in this area have been previously reported. No investigations are known to have been completed to date in this area.

The *Preliminary ESA* (ERM, 2013) concluded that, given the lack of groundwater characterisation data coupled with the potential for impact presented by the PCB-containing transformers, further investigation was warranted to assess soil and groundwater conditions.

AEC Methodology and Investigation Field Observations

A total of three soil investigation bores, none of which were completed as groundwater monitoring wells were advanced within this AEC to assess potential impacts to soil. As noted in *Table 3.1* previously, no monitoring wells were installed due to the depth of groundwater being greater than 15 m bgl. Sampling locations were distributed around the AEC as presented in *Figure 4.5* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.19* (below).

Table 5.19 ***Field Observations Summary - AEC BS***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BS_MW01	15*	None	0
BS_SB01	2.7	None	0
BS_SB02	3.0	None	0

* Well not installed as no water present in borehole 72 hours after completion of drilling.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4s of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Groundwater Analytical Results

No groundwater samples were collected from within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC. Whilst it is noted that groundwater was not encountered at monitoring well location BS_MW01 completed within AEC BS, based on the soil results and field observations during investigations, it is unlikely that a significant source of contamination is present. Furthermore, given the depth to groundwater and the geology encountered, significant impacts to adjacent receptors is considered unlikely.

5.4.20 *Area BT - High Pressure Pumping Station*

Background

The High Pressure Pumping Station is located approximately 8.6 km to the south-west of the operational area of the Power Station.

The pump receives water from the low pressure pumping station and pumps the water via above ground pipelines to Plashett Dam or storage facilities at Bayswater or Liddell Power Stations. The high pressure pump house contains pumps and associated lubrication facilities, and power supply with a (brick) bunded external transformer forms part of the station.

Hydrocarbon staining on the concrete floor of the pump house was observed during a facilities and process audit conducted in 2007 (Parsons Brinckerhoff, 2007). As noted previously, low concentrations of PCBs are also expected to be present in the transformer at the High Pressure Pumping Station.

The *Preliminary ESA* (ERM, 2013) concluded that given the lack of groundwater characterisation data for this AEC, coupled with the potential for impact as indicated by the noted oil staining and PCB containing transformers, further investigation was warranted to assess soil and groundwater conditions.

AEC Methodology and Investigation Field Observations

A total of three soil investigation bores, one of which was completed as a groundwater monitoring well, were advanced within this AEC to assess potential impacts to soil and groundwater. Sampling locations were distributed around the AEC as presented in *Figure 4.5* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC, although it is noted that hydrocarbon staining was noted on the floor of the pump house during a Site inspection undertaken by Parsons Brinkerhoff in 2007. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.20* (below).

Table 5.20 ***Field Observations Summary – AEC BT***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BT_MW01	15	None	0
BT_SB01	3	None	0
BT_SB02	3	None	0

A groundwater sample was collected from BT_MW01. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters at this location were generally within the expected range with EC readings indicating that groundwater conditions were brackish.

A strong organic odour was noted during sampling at BT_MW01. No indications of contamination, such as sheens or hydrocarbon odours, were observed during groundwater sampling. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4t of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5t of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in the groundwater sample analysed. The exceptions to this were detections of phenol and 3-&4-methylphenol (at concentrations below adopted screening values) and various metals.

Copper, lead, and zinc were detected at concentrations in excess of the adopted ecological screening values in groundwater analysed from the groundwater sample collected from within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC

Groundwater collected from BT_MW01 reported detections of phenol and 3-&4-methylphenol. These concentrations were below the adopted ecological screening values.

Whilst human health screening levels were not identified for phenol, the US EPA (2009) has published a human health water criterion for phenol of 10 000 µg/L. Although this value has no regulatory standing in Australia, it indicates that the phenol concentration detected in BT_MW01 is unlikely to represent a significant risk to human receptors.

Groundwater collected from BT_MW01 report metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included copper, lead and zinc. Whilst, it is noted that groundwater at AEC BT is likely discharging to an intermittent creek which flows into Parnells Creek (and ultimately into the Hunter River), concentrations of metals within BT_MW01 were noted to be an order of magnitude lower than concentrations report in background samples from AEC BY and hence are considered unlikely to be related to activities within this AEC.

5.4.21 *Area BU – Main Store – Dangerous Goods Storage Area*

Background

The Main Store compound is located on the eastern edge of the operational area of the Power Station and comprises a covered section and an open lay-down area and storage yard covered in concrete hardstand. This area is used for storage of various spare parts and materials used throughout the Power Station, including dangerous goods.

There are two dangerous goods storage areas located within the Main Store; one is located within a bunded area on the southern portion of the Main Store and the other is located on the south-western portion. Both storage areas hold smaller quantities (<200 L) of various industrial chemicals such as acetone, turpentine, kerosene, sodium hydroxide, sodium hypochlorite, formaldehyde and ammonia. ERM understands that flammable gases were previously stored in this area also, but are not currently stored here. Both dangerous goods storage areas within the Main Store are covered.

Surface water drainage from the Main Store compound is collected into a concrete sump located to the east of the compound. Whilst this sump is normally pumped out by a contractor, it can also discharge to the adjacent dam, which in turn has the potential to overflow into Pikes Gully Ash Dam. Any spills from inside the dangerous goods areas that end up in the sump have some potential to be discharged to the dam, although there is no record of this having occurred. No previous investigations are known to have been undertaken in this area.

The *Preliminary ESA* (ERM, 2013) concluded that given the lack of investigation data in this AEC and the potential sources of contamination, further investigation was warranted to provide a baseline for this area and to assess potential soil and groundwater contamination.

AEC Methodology and Investigation Field Observations

A total of five soil investigation bores, three of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. Sampling locations were distributed around the AEC as presented in *Figure 4.2* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 7.3 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.21*.

Table 5.21 *Field Observations Summary – AEC BU*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BU_MW01	10	None	0-2.1
BU_MW02	10	None	0-1.8
BU_MW03	10	None	0-2.1
BU_SB01	3	None	0-7.3
BU_SB02	3	None	0-3.4

Groundwater samples were collected from the three monitoring wells located within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range with EC readings indicating that groundwater conditions were saline and pH noted to be tending towards acidic.

Sulfur odours were noted during sampling of BU_MW01 and BU_MW02. No other indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4u of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results are compared to the adopted screening levels in *Table 5u of Annex B*. Exceedences of the adopted screening levels are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in all samples analysed. The exceptions to this were various metals within monitoring wells located across this AEC.

Cadmium, copper, lead, manganese, nickel, and zinc were detected at concentrations in excess of the adopted ecological and/or human health screening values in groundwater samples collected from wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

Sulfur odours were noted at BU_MW01 and BU_MW02. Given the proximity of these monitoring wells to the adjacent surface water collection pond to the east of AEC BU, these sulfur odours are likely a function of the water collected within this pond and consistent with odours noted in monitoring wells adjacent to this area.

Groundwater collected from all monitoring wells within this AEC reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, manganese, nickel and zinc. It is noted that groundwater is likely to be interacting with the adjacent surface water collection pond or discharges to Chilcott's Gully and ultimately into Lake Liddell. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23.*

Concentrations of lead and nickel in excess of the adopted human health (drinking water and/or recreational) screening values were also detected in a number of samples. Whilst it is noted that lead and nickel concentrations were above human health criteria, given the absence of abstraction bores for domestic potable or non-potable uses and the general unsuitability of the groundwater due to high salinity, these exceedences are not considered to represent a significant risk. Nickel was noted to be above the recreational criteria in groundwater well BU_MW03. The potential risks due to metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23.*

5.4.22 *Area BV - Power Block*

Background

The facilities and potential contamination sources within the power block area are discussed as follows.

Power Block

The main building of the Power Station contains the four power generating units previously described. The primary source of potential contamination results from lubricating oil leaks at various points around the plant due to continuous vibration. Observations during the site visit confirmed this oil loss in various areas. Within the power block, leaks and spills are generally captured in internal contaminated water drains and transferred to the contaminated water treatment system; however larger spills which pool on the ground surface below various infrastructure and from the drainage system have the potential to directly impact underlying soil and groundwater by migration through cracks in concrete or via damaged drains.

No investigation has previously been completed within the immediate area of the power generating units due to access and safety limitations and a lack of a specific requirement to do so. Targeted investigation of these units is not considered possible at this time due to the operational nature of the facility.

Workshops and Minor Dangerous Goods Storage Areas

Various small workshops are present throughout the power block which service specific areas. Many of these workshops hold small quantities of lubricating oils, cleaners and similar chemicals. During the site visit, dangerous goods were generally observed to be appropriately stored within bunded or contained areas. However, staining of the concrete surface in various areas in relation to the workshops was observed, which indicates the potential for pooled spills and leaks to penetrate the concrete through cracks and joints into the subsurface.

No investigations are known to have been undertaken to date which specifically target the small workshops within the power block. Targeted investigation of these areas is not considered possible at this time due to the operational nature of the facility.

Power Block Drainage Network

The network of drains which runs beneath the power block represent a potential contamination source to soil and groundwater due to the subsurface nature of this network and the various contaminants of potential concern (including corrosive chemicals) likely to be currently present or having been historically present as a result of the collection and conveyance of spills and leaks in various areas. In addition to the dedicated stormwater and contaminated water drainage systems, a sluiceway which transports ash and coal fines collected in various surface drains in the power block runs through the power block from west to east, eventually discharging into Pikes Gully Ash Dam.

No investigations are known to have been undertaken to date which specifically target the drainage network within the power block. Outside of the eastern end of the sluiceway, targeted investigation of these areas is not considered possible at this time due to the operational nature of the facility.

Power Block Investigation Approach

Targeted investigation of the power block, including the workshops and minor dangerous goods storage areas and the drainage network, is not considered safe or possible due to the operational nature of this area. To address this AEC, it is considered data collected from around the perimeter of the power block, and supplemented with investigation data from other AECs outside of the power block, is sufficient in terms of spatial coverage and to assess the potential for migration of COPCs (of a material nature), if any, that may have migrated from the power block.

AEC Methodology and Investigation Field Observations

A total of twenty two soil investigation bores, eleven of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. Sampling locations were distributed around the AEC as presented in *Figure 4.2* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile with the exception of some possible dark staining from 2.4 - 2.6 m bgl in BV_MW03.

Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 2.5 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.22* (below).

Table 5.22 ***Field Observations Summary – AEC BV***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BV_MW01	8.0	None	0.1-2.5
BV_MW02*	8.0	None	0-0.2
BV_MW03*	10.0	Possible dark staining 2.4-2.6 m bgl.	0-0.5
BV_MW04	11.35	None	0-1.0
BV_MW05*	12.0	None	0-1.8
BV_MW06	11.7	None	0-0.3
BV_MW07	3.5	None	0
BV_MW08	12.0	None	0-0.2
BV_MW09	10.3	None	0.1-0.2

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BV_MW10	8.5	None	0-0.3
BV_MW11	4.0	None	0-0.3
BV_MW12	6.0	None	0-0.2
BV_MW13	7.5	None	0-0.3
BV_SB01	3.0	None	0
BV_SB02	2.6	None	0-0.3
BV_SB03	1.2	None	0.1
BV_SB04	3.9	None	0-0.5
BV_SB05	3.0	None	0-0.2
BV_SB06	3.0	None	0-0.2
BV_SB07	3.0	None	0
BV_SB08	3.8	None	0.1-0.2
BV_SB09	3.9	None	0

* - Well not installed as hole remained dry 72 hours after drilling.

Groundwater samples were collected from the ten monitoring wells within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range with EC readings indicating that groundwater conditions were brackish to saline. pH measurements at BV_MW08, BV_MW12 and BV_MW13 indicated acidic conditions.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4v of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results are compared to the adopted screening levels in *Table 5v of Annex B*. Exceedences of the adopted screening levels are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in all samples analysed. The exceptions to this were various metals within monitoring wells located across this AEC.

Arsenic, cadmium, copper, lead, manganese, mercury, nickel, selenium, and zinc were detected at concentrations in excess of the adopted ecological and/or human health screening values in groundwater samples collected from wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

Groundwater was noted to be saline and pH acidic in a number of monitoring wells throughout the power block. These conditions were consistent with groundwater wells in adjacent areas.

Groundwater collected from all monitoring wells within this AEC reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, manganese, mercury, nickel, selenium, and zinc. It is noted that groundwater is likely to be discharging from AEC BV into Chilcott's Gully and ultimately into Lake Liddell. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms.

Metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23.*

Concentrations of arsenic, lead, cadmium, nickel and selenium in excess of the adopted human health (drinking water and/or recreational) screening values were also detected in a number of samples. Whilst it is noted that arsenic, lead, cadmium, nickel and selenium concentrations were above human health criteria, given the absence of abstraction bores for domestic potable or non-potable uses and the general unsuitability of the groundwater due to high salinity, these exceedences are not considered to represent a significant risk. Nickel was noted to be above the recreational criteria in a number of groundwater wells. The potential risks due to metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23.*

5.4.23 *Area BW -Surrounding Waterways And Lake Liddell*

Background

Lake Liddell was constructed adjacent to Liddell Power Station in order to provide cooling water storage. Liddell Power Station is designed to operate without cooling towers and instead uses the capacity of Lake Liddell to manage waste heat. Based on proposed asset separation boundaries, Lake Liddell was included as a Bayswater Power Station asset.

Lake Liddell sediments have been identified as a potential AEC due to the discharges it receives from the Liddell Power Station, which include:

- cooling water that has passed through the plant and therefore:
  - has been treated with biocides and anti-scale chemicals;
  - is heated;
  - may contain traces of oil;
  - has potentially elevated salts and metals due to concentration created by evaporation.
- backwash from the process water pre-treatment plant (sand filter, clarifier and demineralisation plant) including lime enriched water (potentially resulting in the precipitation of calcium carbonate within Lake Liddell) from the from the water softening plant;
- treated effluent from the oil-water separator associated with the operational site drainage network and oil and grit trap (noting that the oil water separator was only installed in 1976, five years after commencement of site operation);
- overflow and potential seepage from the ash dam and associated tributary streams;
- stormwater from the. sediment traps around the coal stockpiles and conveyor systems; and
- stormwater from other areas including the Hunter Valley Gas Turbine.

The recirculation of water through the Lake has the potential to concentrate impurities within the system.

The *Preliminary ESA* (ERM, 2013) concluded that given the absence of available previous detailed environmental characterisation work, the numerous discharge points and sources of potential contaminants, and the presence of recreational users of the Lake, further investigation of selected depositional areas was warranted to provide a baseline for this area and to assess potential soil and groundwater contamination issues.

AEC Methodology and Investigation Field Observations

A total of 49 sediment and 49 surface water samples were collected within this AEC to assess potential impacts of discharges from the Liddell Power Station on Lake Liddell. Sampling locations were distributed around the AEC as presented in *Figures 4.8* to *4.10* of *Annex A*. Proposed sample locations BW_SS02 to BW_SS05 could not be accessed due to dense vegetation. No sediment or surface water samples were collected from these locations.

Sediment and surface water samples were, however, collected at the inlet (BW_SS01) and outlet (BW_SS06) of the unnamed creek along which BW_SS02 to BW_SS05 were located.

Sediment and surface water field notes are presented in *Annex E*. A summary of the field parameters recorded during the surface water sampling is presented in *Table 3b* of *Annex B*.

The depth to sediment in areas of Lake Liddell where sediment and surface water sampling were conducted was between 1.0 m and approximately 17.0 m. Depth to sediment in the unnamed creek to the north of the Pikes Gully Ash Dam spillway ranged from 0.05 to 0.2 m and the unnamed creek was approximately 0.05 to 0.4 m in depth.

Sediments sampled from BW_SS06 in Tinkers Creek consisted of clayey silt, while at BW_SS01, the sediment consisted of clay overlain by brown sandy gravel. Sediment in the unnamed creek to the north of the Pikes Gully Ash Dam spillway were greyish brown silty clay or brown clay. Sediment sampled from Lake Liddell were generally grey, clayey or sandy silts.

No field indicators of contamination, such as staining, sheen, or odours were noted at the majority of sample locations in this AEC; however, coal fragments or fines and a sheen were noted in five sediment samples.

Sediment Analytical Results

The sediments were analysed for grain size, phenols, TRH, BTEX, PAHs, PCBs and metals. The sediment analytical results were compared to the ANZECC (2000) ISQG-Low and ISQG-High values. The sediment analytical results compared to the adopted screening levels are presented in *Table 4a of Annex B*.

Phenol, BTEX, and PCB concentrations were less than the LOR and the adopted screening values in all sediment samples.

Arsenic concentrations exceeded the ISQG-Low at all but five sampling locations. Copper exceedences were also commonly measured. Mercury and nickel exceeded the ISQG-Low, but at a smaller number of sampling locations than arsenic or copper. There were two exceedences of the copper ISQG-High, both in the bay north of the Liddell Power Station, and one exceedence of the mercury ISQG-High, at the sampling location closest to the Power Station (BW_SS27).

Acenaphthene and fluorene were the most commonly observed PAH exceedences. Exceedences of the ISQG-Low and, in some instances, the ISQG-High were noted for PAHs in samples immediately east of Liddell Power Station (BW_SS26 to BW_SS27) and in the bay south of the Power Station (BW_SS11, BW_SS12, and BW_SS45 to BW_SS54). According to the ANZECC (2000) document, the ISQG values should be normalised to 1% TOC, to account for the reductions in bioavailability that can be associated with the presence of organic matter in sediment. Measured TOC values across the sampling area ranged between 1.1% and 64.2% TOC (*Table 4b* of *Annex B*); however, sediments at BW_SS27, BW_SS28, BW_SS45, BW_SS46, and BW_SS47 contained fine coal fragment. It was not considered appropriate to normalise to TOC, as the organic carbon in coal would not reduce the bioavailability of PAHs in coal fines.

There was no screening value identified for selenium in sediments. The measured selenium concentrations ranged from 1 to 45.2 mg/kg, with an average concentration of 6.2 mg/kg.

The highest selenium concentrations of selenium were measured in samples collected from the bay north of the Liddell Power Station. Water from Tinkers Creek drains into this part of Lake Liddell.

TRH concentrations exceeded the ISQG-trigger value (550 mg/kg) provided in the Commonwealth of Australia (2009) *National Assessment Guidelines for Dredging*. The TRH concentrations ranged from 22 to 3790 mg/kg with an average concentration of 483 mg/kg. The TRH concentrations generally followed trends noted in PAH concentrations; however, the highest TRH concentration was noted at BW_SS19, where only three PAHs exceeded the ISQG-Low.

Surface Water Analytical Results

The surface water samples collected from AEC BW were analysed for phenols, TRH, BTEX, PAHs, and metals. The surface water analytical results were compared to the ANZECC (2000) trigger values for the protection of 95% of freshwater species and the NHMRC (2008) *Guidelines for Managing Risks in Recreational Waters*. The surface water analytical results compared to the adopted screening levels are presented in *Table 5w* of *Annex B*.

There were no exceedences of the recreational guidelines.

Boron and copper exceeded the ecological screening value in the majority of samples. Nickel exceeded the ecological screening value in BW_SS07 through BW_SS10 in the unnamed creek to the north of the Pikes Gully Ash Dam spillway. Selenium exceeded the ecological screening criteria in surface water samples collected from the unnamed creek to the north of the Pikes Gully Ash Dam spillway and in eight samples collected from within Lake Liddell. Zinc concentrations marginally exceeded the ecological screening value in 19 of the surface water samples collected.

Discussion

The arsenic concentration at the reference location, BW_SS25 was the highest recorded in the lake. The exceedences of the arsenic ISQG-Low are therefore not considered to be a result of site activities. The highest copper concentrations were detected in the bay to the north of the Liddell Power Station, potentially resulting from inputs from Tinkers Creek. Nickel concentrations exceeded the ISQG-Low at 14 locations. The nickel exceedences were generally noted in clusters, but there was no overall spatial trend in the distribution of these clusters. Mercury exceeded the ISQG-High at one location, BW_SS27, where coal fines were noted.

Acenaphthene and fluorene exceeded the ISQG-Low in approximately half of the samples and ISQG-exceedences and ISQG-High exceedences were noted to the east of the Liddell Power Station and in the bay to the south of the Power Station. The highest PAH concentrations were noted at BW_SS26 to BW_SS28, the sampling locations closest to the Liddell Power Station, and at BW_SS45 to BW_SS47, located near the coal storage area. Coal was noted at five sampling locations (BW_SS27, BW_SS28, and BW_SS45 to BW_SS47). Coal from the coal storage area was likely transported by wind or surface water to Lake Liddell. Although no coal was visible in the other sediment samples from the bay south of the Power Station, the spatial distribution and magnitude of the PAH exceedences suggest that the elevated PAH concentrations also results from coal stemming from the coal area. Based on the PAH and TRH exceedences, there is the potential for localised ecological impacts related to coal fines. Further study would have to be undertaken to determine if the elevated PAH and TRH concentrations are having an effect on biota.

Boron and copper concentrations in surface water exceeded the adopted ANZECC (2000) screening values for the protection of 95% of freshwater species at most of the locations sampled. The boron concentrations in the unnamed creek to the north of the Pikes Gully Ash Dam spillway were approximately threefold greater than those measured in Lake Liddell. The highest nickel exceedences were concentrated in the unnamed creek to the north of the Pikes Gully Ash Dam spillway. The Pikes Gully Ash Dam is considered a potential source of boron and nickel to the unnamed creek. Selenium exceeded the ecological screening criteria in surface water samples collected from the unnamed creek to the north of the Pikes Gully Ash Dam spillway and in eight samples from within Lake Liddell.

The highest copper concentrations were measured in the bay north of the Liddell Power Station; however, ISQG-Low exceedences were noted in sediments throughout the AEC. Tinkers Creek may contribute copper to the bay north of the Power Station, however it is noted that relatively high concentrations of copper were identified in groundwater at some background locations and data presented in *Hydrogeochemistry of the Upper Hunter River Valley* (Kellett *et al*, 1987) which identifies average concentrations of copper in groundwater in the vicinity of the Site at 0.02 mg/L. Hence the identified copper exceedences in surface water are considered likely to be largely attributable to background conditions. The zinc exceedences identified were generally within two times the ANZECC (2000) trigger value and did not show a clear spatial trend, and may be a result of natural variability in zinc concentrations, particularly given that the observed results are also within background ranges identified within Kellet et al (1987) It is therefore considered that boron and selenium are the primary metals of ecological concern in relation to surface water within Lake Liddell.

5.4.24 *Area BX - Transgrid Switchyard*

Background

The TransGrid Switchyard, although not owned by Macquarie Generation, is a potential AEC due to the storage/use of transformer oil which may have historically contained PCBs. The surrounding topography slopes gently to the south and west, indicating that there is some potential for impacts at the switchyard to migrate onto land owned by Macquarie Generation.

The *Preliminary ESA* (ERM, 2013) concluded that, given the absence of previous environmental characterisation work, further investigation would be required to assess soil and groundwater conditions surrounding the switchyard (investigation is not proposed within TransGrid owned land).

AEC Methodology and Investigation Field Observations

A total of four soil investigation bores, two of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. Monitoring well locations not completed are summarised in *Table 3.1*. Sampling locations were distributed around the AEC as presented in *Figure 4.4* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.1 ppm v (isobutylene equivalent) in any sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.23* (below).

Table 5.23 ***Field Observations Summary - AEC BX***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BX_MW01	10.0	None	0-0.1
BX_MW02*	10.0	None	0
BX_MW03	6.0	None	0
BX_MW04#	0.6	?	?

* - Well not installed as hole remained dry after being left for a period of 72 hours.
# - Locations aborted due to the presence of subsurface utilities.

Groundwater was collected from BX_MW01 as a grab sample (due to the lack of groundwater) and BX_MW03 with a peristaltic pump within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range. EC readings indicated that groundwater conditions were brackish at BX_MW03. pH measurement indicated that conditions were acidic.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4x of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5x of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in groundwater samples analysed. The exceptions to this were detections of various metals within groundwater sampled from within this AEC and phenol and 3-&4-methylphenol (at concentrations below adopted screening values) in groundwater sampled from BX_MW01.

Cadmium, copper, lead, nickel and zinc were detected at concentrations in excess of the adopted ecological and/or human health screening values in groundwater analysed from the groundwater sample collected from within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC

Groundwater collected from BX_MW01 reported detections of phenol and 3-&4-methylphenol. These concentrations were below the adopted ecological screening values. Whilst human health screening levels were not identified for phenol, the US EPA (2009) has published a human health water criterion for phenol of 10 000 μg/L. Although this value has no regulatory standing in Australia, it indicates that the phenol concentration detected in BX_MW01 is unlikely to represent a significant risk to human receptors.

Groundwater collected from the monitoring well within this AEC reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, nickel, and zinc.

The elevated concentrations of metals within this AEC may be related to localised mobilisation in areas of low pH as described above. It is noted that groundwater is likely to be discharging from AEC BX Freshwater Dam or Tinkers Creek and ultimately into Lake Liddell. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23*.

Concentrations of cadmium, lead and nickel in excess of adopted human health (drinking water and/or recreational) screening values were also detected in a number of samples. Whilst it is noted that cadmium, lead, and nickel concentrations were above human health criteria, given the absence of abstraction bores for domestic potable or non-potable uses and the general unsuitability of the groundwater due to high salinity, these exceedences are not considered to represent a significant risk.

Lead and nickel were noted to be above the recreational criteria in a number of groundwater wells. The potential risks due to metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23*

5.4.25 *Area BY - Buffer Lands*

Background

The buffer lands define the extant boundary areas of the Site and were defined to establish boundary conditions at the Site. The topography of the buffer lands is highly variable, as is the adjacent land use. Whist the layout of the surrounding buffer lands owned by Macquarie Generation has stayed largely consistent since 1986, activities on neighbouring properties have changed considerably including various mining operations to the west, south and south east.

The majority of the buffer land area has no infrastructure present (with the exception of adjacent AECs BS and BT) and consists of relatively undisturbed farm land (used for agistment) or unoccupied vegetated areas. No significant contamination sources were identified within the buffer lands however investigations within this area provides information to fill material data gaps within the CSM and provide background data for the Site conditions.

Methodology and Investigation Field Observations

A total of twelve soil investigation bores, of which six were converted to groundwater monitoring wells, were advanced within the buffer lands to assess potential impacts to soil and groundwater. Sampling locations were distributed around the AEC as presented in *Figure 4.11* of *Annex A* noting that each well is located on the boundary of Site. Relevant borehole logs are presented within *Annex A*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within the buffer lands. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.9 ppm v (isobutylene equivalent) in any sample collected from this area.

A summary of the field observations from the drilling works are presented within *Table 5.24*.

Table 5.24 ***Field Observations Summary - Area BY***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
BY_MW11#	0.9	None	0.1-0.2
BY_MW12	9.0	None	0-0.1
BY_MW18*	12.0	None	0-0.1
BY_MW20*	15.0	None	0
BY_MW21	10.0	None	0
BY_MW23	5.5	None	0.1-0.7
BY_MW24	8.2	None	0.1-0.9
BY_MW25	8.2	None	0.1-0.9
BY_MW26	3.0	None	0.1-0.3
BY_MW27#	1.5	None	0-0.1
BY_MW29	12.0	None	0.1-0.3
BY_MW32*	15	None	0.0

#- NDD only completed at this location

* - Well not installed as hole remained dry after being left for a period of 72 hours.

Groundwater samples were collected from six monitoring wells within this area. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3a* of *Annex B*. Field parameters were generally within the expected range based on the location of the monitoring wells at the perimeter of the Site. Electrical conductivity readings indicated that groundwater conditions were saline (consistent with regional conditions) with pH noted to be acidic in a number of wells with the lowest value of 3.53 recorded at BY_MW24 (adjacent to Lake Liddell).Temperature readings were noted to be erroneous at two locations due to a faulty sensor.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this area. A summary of field observations from the groundwater sampling works are presented within *Annex E*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Table 4y of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this area. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this area however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results are compared to the adopted screening levels in *Table 5y of Annex B*. Exceedences of the adopted screening levels are also graphically presented in *Annex A*.

Measured concentrations of the majority of the COPCs in groundwater were reported below the laboratory LOR in all samples analysed. The exceptions to this were various metals within all monitoring wells located across this area.

Arsenic, cadmium, copper, lead, nickel, and zinc were detected at concentrations in excess of the adopted ecological and/or human health screening values in groundwater samples collected from wells within this area. Lead was noted to be an order of magnitude higher in BY_MW29 (at 0.158 mg/L, above the ecological and human health criteria) and zinc was noted to be an order of magnitude higher in BY_MW24 (at 3.25 mg/L, above the ecological criteria).

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this area.

Groundwater field parameters were consistent with those measured across the site and anticipated regional levels for salinity. It is noted that pH was measured as acidic at BY_MW24. During the site inspection and sampling, no sources of acidity were observed. Field parameters at BY_MW29 (representing effluent groundwater from Lake Liddell) were noted to be within normal ranges with salinity indicating brackish conditions and pH being neutral.

Groundwater collected from all monitoring wells within this area reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, nickel, and zinc.

Monitoring wells BY_MW24, BY_MW25 and BY_MW26 (located within the northern part of the Site) are considered to be representative of influent groundwater discharging to Lake Liddell (based on the proximity to Lake Liddell and local topography). Elevated concentrations of nickel and zinc within BY_MW24 are likely due to the low pH conditions at this location. BY_MW21 within the central portion of the Site is also noted to likely discharge to Lake Liddell. Metal impacts within Lake Liddell and its tributaries are discussed further in *Section 5.4.23*.

Groundwater at monitoring well BY_MW12 in the southern portion of the Site is likely to discharge to Plashett Reservoir.

The elevated concentrations of metals above ecological criteria in groundwater within this area are not considered significant given that discharge of waters from Plashett Reservoir are managed as per the closed system design (*refer to Section 5.6.2*).

Groundwater at BY_MW29 is considered to be representative discharging groundwater seeping through the dam wall from Lake Liddell which in turn flows to Bayswater Creek and as such is discussed in *Section 5.4.23*.

Concentrations in groundwater of arsenic, cadmium, lead, and nickel in excess of the adopted human health (drinking water and/or recreational) screening values were also detected in a number of samples. Whilst it is noted that metals concentrations were above human health criteria, given the absence of abstraction bores for domestic potable or non-potable uses and the general unsuitability of the regional groundwater due to high salinity, these exceedences are not considered to represent a significant risk.

5.5 *DATA QUALITY*

The data presented in the ESA was considered to generally be of a suitable quality and completeness to provide a baseline of environmental conditions at the Site. Whilst some minor non-conformances have been identified in relation to field and laboratory QA/QC none of these are considered to have a material impact on the outcomes of this assessment. With specific regard to the completeness of the assessment, it is noted that samples were collected from more than 90% of the proposed locations. A summary of those locations unable to be completed due to various locations is provided in *Table 3.1*. An assessment of additional assessment works considered warranted is provided in *Section 5.6.5*.

5.6 *OVERALL DISCUSSION*

The Primary Objective Of This Stage 2 ESA Was To Develop A Baseline Assessment Of Environmental Conditions At The Site And Within The Immediate Surrounding Receiving Environments At Or Near The Time Of The Transaction. The Results Of The Assessment Have Also Been Used To Assess;

- The nature and extent of soil, sediment and/or groundwater impact on / beneath the Site and in relation to neighbouring sensitive receptors.
- Whether the impacts at the Site represent a risk to human health and/or the environment, based on the continuation of the current use.
- Whether the impact at the Sites is likely to warrant notification and / or regulation under the *Contaminated Land Management Act 1997*.
- Whether material remediation is considered likely to be required.
- Whether the data collected during the assessment was of a suitable quality and completeness to provide a baseline of environmental conditions at the Site.

The overall results of the assessment are discussed herein, with reference to these objectives.

5.6.1 *Summary – The Nature And Extent Of Soil, Sediment, Groundwater And Surface Water Impact*

A CSM was developed, which identified the following ecological and human receptors:

- onsite employees, including intrusive workers potentially labouring within shallow trenches/excavations;
- recreational users of Lake Liddell and the Hunter River;

- terrestrial ecological receptors within the open space areas both on and surrounding the Site; and
- freshwater aquatic organisms within Lake Liddell and the Hunter River.

The soil, sediment, surface water and groundwater data was compared against published environmental quality levels to provide a screening level assessment of potential risks to these identified receptors. The findings of this screening indicated that concentrations in soil, sediment, groundwater and surface water generally complied with the adopted screening levels, with the following exceptions:

Onsite Soil

- Asbestos was detected in soils beneath pipelines constructed of ACM within AEC BQ (Pikes Gully Ash Dam). Fifteen of the sixteen samples collected for asbestos quantification were reported with results above the human health screening criteria. Asbestos was detected in soils at one location in AEC BE (Coal Storage Area), where the quantification result reported was equal to the human health screening criteria.
- TRH were detected in excess of the ecological screening levels in AECs BN (Lime Softening Plant) and BP (Mobile Plant Workshop and Refuelling).
- Zinc was detected at concentrations in excess of the ecological investigation levels for commercial/industrial sites in soil samples collected from AECs BI (Demineraliser Plant) and BJ (Former Contractor Staging Area).

Onsite Groundwater

- Metals including arsenic, cadmium, chromium, lead, nickel, selenium and zinc were detected at concentrations in excess of the NHMRC (2011) drinking water values in groundwater samples collected from various monitoring wells collected across the Site. Arsenic, cadmium, lead and nickel also exceeded the NHMRC (2008) recreational water values in a smaller subset of those locations.
- Benzene was detected at concentrations in excess of the NHMRC (2011) ADWG values in groundwater samples collected from AECs BC (Fuel Oil Installation) and BL (Transformer Area).
- Metals including boron, cadmium, copper, lead, manganese, mercury, nickel, selenium and zinc were detected at concentrations in excess of the ecological screening levels for freshwater environments in groundwater samples collected from various monitoring wells located across the site.

Onsite Surface Water

- Boron and copper exceeded the ecological screening value in the majority of surface water samples analysed from within Lake Liddell and its tributaries.

- Nickel exceeded the ecological screening value in surface water samples collected from the unnamed creek to the north of the Pikes Gully Ash Dam spillway but not in any samples within the lake itself.

- Selenium exceeded the ecological screening criteria in surface water samples collected from the unnamed creek to the north of the Pikes Gully Ash Dam spillway and in eight samples from Within Lake Liddell.

- Zinc exceeded the adopted ecological screening criteria in 19 of the surface water samples collected with the highest concentrations detected in samples collected from Tinkers Creek.

- No exceedences of the adopted human health (recreational) screening criteria were noted in the surface water samples collected.

Onsite Sediments

- Arsenic concentrations exceeded the ISQG-Low at all but five sampling locations. Copper exceedences were also commonly measured. Mercury and nickel exceeded the ISQG-Low, but at a smaller number of sampling locations than arsenic or copper. There were also two exceedences of the copper ISQG-High, both in the bay north of the Liddell Power Station, and one exceedence of the mercury ISQG-High, at the sampling location closest to the Power Station (BW_SS27).

- Polycyclic Aromatic Hydrocarbons (PAHs), and particularly acenaphthene and fluorene were observed at concentrations exceeding the ISQG-Low and, in some instances, the ISQG-High were noted for PAHs in samples immediately east of Liddell Power Station (BW_SS26 to BW_SS27) and in the bay south of the Power Station (BW_SS11, BW_SS12, and BW_SS45 to BW_SS54).

- There was no screening value identified for selenium in sediments, however the measured selenium concentrations ranged from 1 to 45.2 mg/kg, with an average concentration of 6.2 mg/kg. The highest concentrations of selenium were measured in samples collected from the bay north of the Liddell Power Station. Water from Tinkers Creek drains into this part of Lake Liddell.

- TRH concentrations exceeded the trigger value (550 mg/kg) provided in the Commonwealth of Australia (2009) *National Assessment Guidelines for Dredging*. The TRH concentrations ranged from 22 to 3790 mg/kg with an average concentration of 483 mg/kg. The TRH concentrations generally followed similar spatial trends as those noted in PAH concentrations.

General Observations

No free-phase product was observed at any of the sampling locations.

Potential asbestos fibre bundles were observed in shallow soils in the immediate vicinity of the pipework which runs between the power block and the Pikes Gully Ash Dam (coinciding with many of the locations where asbestos fibres were detected in soil samples). It is noted that the vertical boring of soils is not an ideal method via which to identify asbestos impacts in soils. The absence of asbestos within fill materials or upon surface soils in other areas across the Site therefore cannot be guaranteed on the basis of the results of this assessment.

5.6.2 ***Summary - Does The Identified Impact Represent A Risk To Human Health And/Or The Environment?***

The approach to the screening of the data gathered in this assessment was to initially adopt the most conservative potential assessment values. The exceedences of the screening values outlined in *Section 5.6.1* were subsequently assessed on a case by case basis, in light of the specific characteristics of the individual samples and the AEC from which those samples were collected. The conclusions of these further assessments were as follows;

Onsite Soil

The asbestos impacts identified in soils beneath the pipelines within AEC BQ (along with the pipelines) has been recognised by Macquarie Generation as an issue which represents a potential health risk. Macquarie Generation is therefore in the process of developing a management strategy to appropriately mitigate these risks. This is set out in Macquarie Generation (December 2013) *Ash & Dust - Position Paper* -(Ref: 06.03.03.38 ENV.03.03.048).

Hydrocarbons (as TRH) were detected at concentrations exceeding the relevant ESLs in soil samples collected from the lime softening plant (Area BN) and the mobile plant workshop (Area BP). The detections in area BN are not considered significant as they occurred at a depth of 10 m bgl. Given the depth of the samples collected, the exceedence is not considered to be significant since ESLs apply only to shallow soils (<2 m bgl) which corresponds to the root zone and habitation zone of many species (*ASC NEPM* (2013).

Coal dust was observed in the sample collected from BP_MW05 although the hydrocarbon impacts identified at this location may also be related to historical leaks or spills associated with workshop activities in this area. Area BP is largely covered in concrete hardstanding and not considered to have ecological value and thus the application of the ESLs is considered to be overly conservative in this instance. The identified exceedence of these values is not therefore considered to be representative of a potential environmental risk.

Zinc was detected at concentrations in excess of the adopted EILs in AEC's BI (Demineraliser Plant) and BJ (Former Contractor Staging Area). The sample collected from AEC BI was collected from immediately beneath concrete hardstanding, and appears to be a localised hotspot unlikely to impact upon terrestrial ecological receptors. The zinc impacts identified in AEC BJ were all <250% of the relevant screening level and the 95% UCL of the mean concentration for samples collected within the upper 1 m of the soil profile within this AEC was 900.3 mg/kg which was less than the adopted EIL. It is also noted that the standard deviation of these samples was less than 50% of the adopted EIL (refer to *Annex I* for details of all relevant calculations).

These impacts are therefore considered unlikely to represent a significant risk to the terrestrial environment under the ongoing use of the Site as a Power Station.

On-site Groundwater

Groundwater beneath the Site is not extracted for potable use and a search of licensed groundwater bores has not identified any potential groundwater abstraction receptors in the vicinity of the Site. The saline groundwater conditions are also likely to reduce the opportunity for the potable or domestic use of groundwater in the vicinity of the Site in the future.

Similarly, the groundwater beneath the Site is not considered to be an aquatic environment of significance for the purpose of this assessment.

The ANZECC (2000) freshwater ecological trigger values and NHMRC (2008) recreational screening levels were therefore adopted in this assessment to evaluate potential risks to the aquatic environment and recreational users of Lake Liddell and its tributaries. The NHMRC (2011) ADWG were also adopted to evaluate the requirement to report groundwater contamination across the Site, in accordance with the DECC (2009) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* (refer to *Section 5.6.3).*

Measured concentrations of metals in groundwater exceeded the ANZECC (2000) marine trigger values and NHMRC (2011) ADWG values in a large number of wells across the Site. Exceedences of the NHMRC (2008) recreational screening levels were also reported in a smaller number of wells.

These identified exceedences can be broadly divided into four groups based upon their location and the catchment within which they occur, since this determines the receptors upon which they might impact (refer to *Table 6* in *Annex B*). The four groups can be defined as follows:

- AEC's discharging to the Pikes Gully Ash Dam (and the Pikes Gully Ash Dam itself)
- AEC's discharging to Plashett Reservoir;
- AEC's discharging directly to offsite receptors including Bowmans Creek and the Hunter River; and
- AEC's discharging to Lake Liddell.

Pikes Gully Ash Dam Catchment

Areas of Environmental Concern including the Brine Concentrator Holding Pond (BA), the south eastern portion of the Fuel Oil Installation (BC), parts of the Main Store (BU) and the Pikes Gully Ash Dam (BQ) itself are within this catchment.

The NSW EPA has issued a PRP (PRP1) in relation to water management issues at the Pikes Gully ash dam. This PRP includes the requirements to develop an understanding of the pollutants in the Ash Dam and in downgradient surface water bodies and to identify options for reducing overflows from the Ash Dam and seepage from the toe drains below the ash dam wall.

While the Ash Dam is not considered to be a sensitive environmental receptor in itself, due to the operational nature of this water body, the issuance of the PRP indicates that contamination within the Ash Dam is considered to represent a potential risk to the environment (and potentially human health although the observed exceedences in groundwater are some distance from any surface water body where recreational use is possible).

As noted previously, boron, cadmium, copper, lead, manganese, nickel, and zinc were detected at concentrations in excess of the adopted ecological screening values in groundwater samples collected from the majority of the wells within this catchment. Lead and nickel have also been detected at concentrations exceeding the human health (recreational) guidelines in MW02 and MW10. Given the volume and nature of the ash and water stored within the Ash Dam, it is considered that impacts observed in the other AECs within this catchment would be minor contributors to the overall potential impacts arising from the Ash Dam.

In summary, potential impacts associated with surface and groundwater discharges from the Pikes Gully Ash Dam are considered to represent a potential risk to the environment, as indicated by the EPA's issuance of a PRP in relation to this matter. In response to the conditions of this PRP, a report was prepared by Worley Parsons on behalf of Macquarie which sets out management responses and options to deal with the identified issues and ERM understands that Macquarie Generation is in the process of assessing and implementing the recommended measures.

Plashett Reservoir Catchment

The Plashett Reservoir, located approximately six kilometres to the south-west of the Bayswater Power Station, is a man-made surface water body entirely within the bounds of the Site.

Areas of Environmental Concern within the south western portion of the Site including the Brine Concentrator Decant Basin (BB), the Western Rail Line portion of the Coal Unloaders, Rail Infrastructure and Coal Transfer Lines (BF), the Lime Softening Plant (BN) and Lime Softening Plant Sludge Lagoons (BO) and some parts of the Buffer Lands (BY) all fall within this catchment.

As noted previously, metals including boron, cadmium, copper, lead, manganese, nickel selenium and zinc were detected at concentrations in excess of the adopted ecological screening values in groundwater samples collected from wells within this catchment. Nickel and cadmium were the only metals detected at concentrations exceeding the adopted human health (recreational) screening values and these detections were primarily confined to the area surrounding the Brine Concentrator Decant Basin (with one additional exceedence for nickel identified in BY_MW12 immediately adjacent to Plashett Reservoir).

Plashett Reservoir was created in order to form part of the Power Station water management system (operated under the Site EPL). Furthermore no public access to the reservoir is allowed and recreational use of this water body is not permitted. It is also noted that waters discharging from Plashett Reservoir flow back to the low pressure pumping station (AEC BS), onto the high pressure pumping station (AEC BT) and into Bayswater Power Station as per the closed system design. On this basis, the exceedences of ecological and recreational guidelines for metals in groundwater are not considered to represent a significant risk to human health or the environment.

Further monitoring of metals in groundwater within this catchment (particularly within AEC BB) along with sampling and analysis of the water within Plashett Reservoir would however be prudent in order to gain a better understanding of temporal variations and to assess the effectiveness of the interception curtain which was installed to manage groundwater salinity down gradient of the Brine Concentrator Decant Basin.

Offsite Catchments

Groundwater from some AECs in close proximity to the external boundaries of the Site, including the Ravensworth Coal Unloader (part of AEC BF), the Ravensworth Rehabilitation Area (AEC BR) and the Low Pressure and High Pressure Pumping Stations (AECs BS and BT respectively) are likely to discharge directly to surface water receptors outside of the Site boundary.

Monitoring wells installed within the Ravensworth Rehabilitation Area detected metals including copper, nickel and zinc exceeding the ecological and/or human health (drinking water) based screening values. However, the concentrations of analytes that exceeded the adopted screening criteria are lower in downgradient monitoring wells compared to the upgradient monitoring well BR_MW01.

The metal exceedences of adopted screening criteria are therefore considered likely to be indicative either of naturally occurring background conditions or of a broader groundwater quality issue in this area. The observed metals impacts in groundwater at the Ravensworth Rehabilitation Area are not therefore considered to represent a significant risk to human health or the environment in the context of the surrounding environment.

Groundwater at the Ravensworth Coal Unloader was assessed via the installation of one monitoring well at location BF_MW05 (it is noted that two other boreholes drilled to a similar depth within the same AEC did not encounter groundwater). Arsenic, copper, nickel and zinc were detected at concentrations exceeding the relevant ecological screening values and arsenic and zinc exceeded the relevant human health (drinking water) screening values.

Monitoring well BF_MW05 is located between 1 – 2 km across and down-gradient from the wells installed around the Ravensworth Rehabilitation Area. The concentrations of the majority of metals in BF_MW05 were lower than those in the upgradient well at the Ravensworth Rehabilitation Area (BR_MW01) and are thus also considered likely to be consistent with background conditions. The one exception to this is arsenic, which was detected at a concentration approximately three times the human health (drinking water) screening values in BF_MW05. Whilst the application of the drinking water guideline in this instance is considered conservative, it is noted that this is the second highest detection of arsenic in groundwater from any sample collected at the site, with the only higher concentration being in the sample collected from BF_MW03 (which is located adjacent to the Antiene Coal Unloader). Given the anomalous results for arsenic detected at the Ravensworth Coal Unloader, the location of this area in relatively close proximity to both the site boundary and an off-site surface water receptor (Bowmans Creek) and the lack of any down-gradient data points, we consider that further assessment is warranted to assess potential risks associated with this elevated result and to investigate the potential correlation between arsenic impacts and rail / coal unloading infrastructure at these locations. Initially, this could be limited to resampling of both BF_MW03 and BF_MW05 and analysing both samples for metals including arsenic.

Groundwater at the High Pressure Pumping Station (AEC BT) was assessed via the installation of one monitoring well at location BT_MW01 (it is noted that one monitoring well was drilled within AEC BS to a similar depth but did not encounter groundwater). Metals including copper, lead and zinc were reported in BT_MW01 at concentrations greater than the adopted ecological screening values. Whilst, it is noted that groundwater at AEC BT is likely discharging to an intermittent creek which flows into Parnells Creek (and ultimately into the Hunter River), concentrations of metals within BT_MW01 were noted to be an order of magnitude lower than concentrations reported in background samples from AEC BY.

Lake Liddell Catchment

Groundwater from all other identified AECs on the Site fall within the catchment of Lake Liddell (either directly or indirectly). It is also important to note that all identified AECs on the Liddell Power Station Site also fall within this catchment and that there are also direct and indirect discharges of storm, process and cooling waters to the Lake as described in *Section 0.* Monitoring wells installed within the catchment of Lake Liddell reported a number of metals at concentrations exceeding the adopted human health and / or ecological screening values as detailed in the summary of each AEC provided in *Section 5.4.*

Given the widespread nature of these detections and since Lake Liddell represents the primary surface water receptor from both an ecological and human health (recreational) perspective, potential impacts to groundwater within this catchment should be assessed in that context, that is via direct assessment of the quality of surface water and sediment within the lake itself. The potential for risks to human health and the environment from groundwater impacts occurring within the catchment of Lake Liddell are therefore assessed in the following sections.

Onsite Sediments

As noted in Simpson *et al.* (2005), the ISQG-Low represent concentrations below which the frequency of adverse biological effects is expected to be very low, while the ISQG-High represent concentrations above which adverse biological effects are expected to occur more frequently. If a detected concentration exceeds the relevant ISQG, it does not necessarily mean that adverse biological effects will occur, but rather that more detailed consideration of the results may be required. Given that Lake Liddell is a human-made lake created for the purposes of providing water to service the power stations, the adoption of the ISQG-Low guidelines is considered conservative and hence only exceedences of the ISQG-High guidelines are considered further within this section.

Elevated concentrations of copper and mercury were relatively prevalent across the locations sampled within the lake and both metals were detected at concentrations exceeding the ISQG-High screening values in certain locations. The highest copper concentrations were detected in the bay to the north of the Liddell Power Station, potentially resulting from inputs from Tinkers Creek. Mercury exceeded the ISQG-High at one location, BW_SS27, where coal fines were noted.

The PAHs acenaphthene and fluorene exceeded the ISQG-Low in approximately half of the samples analysed and ISQG-High exceedences were noted to the east of the Liddell Power Station and in the bay to the south of the Power Station.

The highest PAH concentrations were noted in sampling locations closest to the Liddell Power Station, and near the coal storage area. Coal fines were noted at five of these sampling locations and are considered likely to have been transported by wind or surface water to Lake Liddell. The spatial distribution and magnitude of the PAH exceedences suggest that the elevated PAH concentrations are most likely to be related to coal dust / fines from the coal storage area.

Based on the exceedences of the ISQG-High screening values that have been identified in sediments, there is considered to be the potential for localised ecological impacts, primarily related to coal fines. Further study would however have to be undertaken to assess the bioavailability of the sediment contaminants and whether these impacts are having a significant effect on biota.

The ISQG values are not specifically designed to evaluate potential risks to human users of surface water bodies. In the absence of Australia human health sediment quality guidelines however, the ISQGs are frequently used to provide an indication of sediment contaminant levels that require further consideration from a human health perspective. Lake Liddell is used for recreational fishing and the potential therefore exists for recreational users of the area to be exposed to metal and PAH contaminants in sediments through the consumption of fish, particularly as metal and PAH constituents have the potential to bioaccumulate in fish tissue. Documents such as the RIVM (2001) *Technical Evaluation of the Intervention values for Soil, Sediment and Groundwater* demonstrate that frequently, ecological effects of sediment contamination are likely to occur at lower concentrations than those at which human health risks are observed. Further study would be required to assess the human health implications of the sediment impacts identified within Lake Liddell

In the event that a potential health risk associated with the consumption of fish were identified, such a risk could be effectively managed via an administrative control on fish consumption (rather than necessitating extensive remediation of sediments within Lake Liddell).

Onsite Surface Water

As noted previously, boron and copper concentrations in surface water exceeded the adopted ANZECC (2000) screening values for the protection of 95% of freshwater species at most of the locations sampled. Nickel, selenium and zinc also exceeded the adopted ecological screening in certain locations. As noted in Section 3.5.2, the adoption of the 95% trigger values, whilst appropriate for a screening level assessment such as this, is considered quite conservative given the nature of Lake Liddell and the associated waterways.

The on-site waterways form part of the Site Water Management System and, in the case of Lake Liddell, were specifically constructed for the purpose of supplying water to power stations and receiving water from power stations. As such it would be more appropriate to assess the metals concentrations detected in surface water against a guideline providing a lower threshold of protection of species (e.g. 80%). If these criteria were adopted the identified exceedences for boron and selenium (which are the two metals of ecological concern most likely to be related to coal combustion products) would not constitute exceedences. As set out in the ANZECC (2000) guidelines however, the adoption of a lower level of should only be undertaken following consultation with relevant stakeholders and may also require more detailed assessment of potential toxicity. The adoption of this proposed approach would therefore need to be confirmed as acceptable by NSW EPA.

No exceedences of the adopted human health (recreational) screening values were identified. Indicating no direct risk to human health via recreational use of the Lake. Given the exceedences of the adopted ecological screening criteria noted however, further assessment of risks associated with the consumption of fish from Lake Liddell should be considered.

5.6.3 *Summary - Does The Impact Warrant Notification Under The Contaminated Land Management Act 1997?*

Under Section 60 of the CLM Act, a person whose activities have contaminated land or a landowner whose land has been contaminated is required to notify NSW EPA when they become aware of the contamination. The DECC (2009) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997*, state that a landowner or a person whose activities have contaminated land is required to notify NSW EPA that the land is contaminated if;

- the level of the contaminant exceeds the appropriate published screening level with respect to a current or approved use of the land, <u>and</u> people have been, or foreseeably will be, exposed to the contaminant; or
- the contamination meets a specific criterion prescribed by the regulations; or
- the contaminant has entered, or will foreseeably enter, neighbouring land, the atmosphere, groundwater or surface water, <u>and</u> the contamination exceeds, or will foreseeably exceed, an appropriate published screening value and will foreseeably continue to remain above that level.

The soil, groundwater, surface water and sediment results obtained in this assessment have been compared against the screening levels specified in NSW DECC (2009) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* and a number of exceedences have been identified.

Every exceedence of these screening levels is not however required to be reported to the NSW EPA. If the exceedence is representative of background conditions; or offsite migration of contamination to an adjoining property has not occurred and any onsite contamination has been adequately addressed under the Environmental Planning and Assessment Act then reporting under the CLM Act is not required. Further to this, in the case of onsite soil contamination, if no plausible exposure pathway to people or the environment is present, reporting is also not required.

On the basis of the discussions outlined in *Section 5.4*, the constituents that have been identified in onsite soil, sediment, surface water and groundwater are generally not exceeding the relevant screening values as cited in NSW DECC (2009).

The identified impacts which exceed the relevant screening values and are considered to warrant further consideration with regards to whether a duty to report may exist under the CLM Act include the following:

- asbestos fines and fibres identified in surface soils beneath the asbestos pipelines within AEC BQ and in one location within AEC BE;
- benzene detected in groundwater at one location in AEC BC and one location in AEC BL
- metals detected at concentrations not attributable to background conditions in groundwater at various locations across the Site;
- metals detected at concentrations not attributable to background conditions in surface water within Lake Liddell; and
- metals and hydrocarbons at concentrations not attributable to background conditions in sediments within Lake Liddell.

Each of these issues is discussed in further detail below.

Asbestos in Soils

Asbestos was identified in soils in two areas of the Site. The first of these was beneath the asbestos pipelines within AEC BQ. As noted previously, Macquarie Generation is in the process of developing a management strategy in relation to this issue as set out in Macquarie Generation (December 2013) *Ash & Dust - Position Paper*. Further, ERM understands that access to these areas has been restricted to mitigate potential risks to human health in the short term and that further delineation and quantification of asbestos in soils in this area is being undertaken by external specialist consultants.

It is recommended that the outcomes of this further assessment are reviewed prior to a decision relating to notification of NSW EPA. It is also noted that Macquarie Generation has stated that WorkCover NSW is considered the relevant regulatory body in relation to this issue given that there is no public access to the area and that the pipelines themselves represent a greater potential source of airborne fibres than the fibres within surface soils.

The second area where asbestos was detected in soil was an isolated single detection within AEC BE (the Coal Storage Area). The demarcation and restriction of access to the area immediately surrounding this detection should be undertaken to reduce potential for exposure to workers in the short term. Given that a comprehensive asbestos assessment has not been undertaken within the scope of this investigation, further delineation of this isolated impact is recommended. This should be undertaken in accordance with the methodology outlined in the ASC NEPM (2013). It is recommended that the outcomes of this further assessment are reviewed prior to a decision in relation to notification of NSW EPA.

Benzene in Groundwater

Benzene was identified in groundwater at a concentration equal to or marginally exceeding the human health (drinking water) screening value at locations within the Fuel Oil Installation (AEC BC) and the Transformer Area (AEC BL).

Given that the detection within AEC BC was at a concentration equal to the screening value and laboratory LOR and the detection with AEC BL was only marginally above the screening value, it is suggested that an additional round of confirmatory sampling be undertaken to confirm these results and assess the likelihood that the detected concentration will foreseeably remain above the human health (drinking water) screening value.

It is however unlikely in ERM's opinion that these impacts would be considered significant enough to warrant regulation by the NSW EPA given the absence of groundwater use on-site, its saline nature and the proximity of the results to the screening value.

Metals in Groundwater

Various metals which were not attributable to background conditions were detected at concentrations above the human health (drinking water) and / or ecological screening values in groundwater at a number of locations across the Site. In the majority of instances, results from monitoring wells BY_MY24, BY_MW25 and BY_MW26 (located near the north eastern site boundary well) were utilised in establishing background conditions.

It is noted that low pH was observed in groundwater at BY_MW24 which may have resulted in elevated concentrations of metals in this location and hence data from this well was utilised with caution when assessing results. In addition to the background monitoring wells on-site, background values based on data presented in the *Hydrogeochemistry of the Upper Hunter River Valley* groundwater report (Kellett *et al*, 1987) have also been considered.

A summary of metals exceeding the adopted screening values with regard to the duty to report is provided in *Table 5.25* (over).

Table 5.25 ***Groundwater Screening in Relation to a Potential Duty to Report***

Metal	Exceedences of Human Health (Drinking Water) or Ecological Screening Value	Relevant AECs
Arsenic	Yes, drinking water value exceeded. All except those in AEC BF are however in same order of magnitude as background locations and exceedences were <165% of guideline. Reporting of BF MW03 and MW05 may be required however some further assessment is warranted.	BF, BH, BV and BY
Boron	Yes, ecological value and average background concentration reported in Kellett et al (1987) (0.17 mg/L) were both exceeded in some locations. It should be noted that the exceedences were in the vicinity of the Pikes Gully Ash Dam which is regulated under the Site EPL and is currently subject to a PRP in relation to water management.	BA, BG, BN and BQ
Cadmium	Yes, both ecological and drinking water were exceeded however background concentrations of 0.002 - 0.003 mg/L were recorded in BY_MW25 and BY_MW24 respectively. The majority of exceedences were of the same order of magnitude with the exception of BB_MW04 and BX_MW03 which may warrant reporting.	BA, BB, BD, BE, BG, BH, BI, BL, BM, BP, BQ, BU, BV, BX and BY.
Chromium	One isolated exceedence of drinking water screening value was identified at BP_MW04 and this exceedence was only marginal. Confirmatory sampling could be undertaken to confirm the result and assess the likelihood that the detected concentration will foreseeably remain above the human health (drinking water) screening value. It is also noted that the drinking water screening value is designed to be protective of risks associated with chromium VI, rather than the less toxic chromium III. As such, any confirmatory sampling should include chromium an evaluation of chromium speciation.	BP
Copper	Yes, ecological value exceeded however background concentrations of 0.0131 - 0.0601 mg/L were identified in BY_MW26 and BY_MW24 (respectively). Some results exceed these values and hence may warrant reporting (particularly within AECs BG and BV).	BA, BB, BC, BD, BE, BF, BG, BH, BI, BL, BM, BN, BO, BP, BQ, BR, BT, BU, BV, BX and BY.
Lead	Yes, both ecological and drinking water values were exceeded however background concentrations of 0.0375 - 0.04 mg/L were identified in BY_MW26 and BY_MW24 (respectively) several results exceed these values and hence may warrant reporting.	BA, BB, BE, BF, BG, BH, BI, BL, BM, BO, BP, BQ, BT, BU, BV, BX and BY.
Manganes e	Yes, ecological value exceeded, and average background concentration (1.13 mg/L) are lower than the ecological value, hence the noted exceedences may warrant reporting.	BA, BB, BD, BG, BH, BI, BP, BQ, BU and BV
Mercury	Yes, two minor exceedences of the ecological value were identified within AEC BV. Both results only marginally exceed the guideline and are close to the LOR, therefore suggest confirmatory samples to confirm result and assess the likelihood that the detected concentrations will foreseeably remain above the ecological screening value.	BV
Nickel	Yes, both ecological and drinking water values were exceeded however background concentration of 0.195 mg/L was identified in BY_MW25 several results exceed this value and hence may warrant reporting (particularly those in AECs BB, BG, BV, BX).	BA, BB, BD, BE, BF, BG, BH, BI, BL, BM, BN, BO, BP, BQ, BR, BU, BV, BX and BY.
Selenium	Yes, both ecological and drinking water values exceeded, it appears that background concentrations are lower than the screening values, hence the noted exceedences may warrant reporting (particularly within AEC BB). It should be noted that many exceedences appear to be associated with Pikes Gully Ash Dam which is regulated under the Site EPL and is currently subject to a PRP in relation to water management.	BB, BG, BH, BO and BV.
Zinc	Yes, both ecological and drinking water values were exceeded however background concentrations of 0.142 mg/L were identified in BY_MW25 (which aligns closely with the literature background value of 0.15 mg/L). Several results exceed these values and hence may warrant reporting. It should be noted that many exceedences appear to be associated with Pikes Gully Ash Dam which is regulated under the Site EPL and is currently subject to a PRP in relation to water management.	BA, BB, BC, BD, BE, BF, BG, BH, BI, BL, BM, BN, BO, BP, BQ, BR, BT, BU, BV, BX and BY.

Whilst many of the metals exceedences can be related to background concentrations, some elevated concentrations which appear to be related to on-site sources have been identified. In many instances however, these impacts are related to activities which are already regulated and monitored under the Site EPL (No. 779) and (in the case of Pikes Gully Ash Dam) a current PRP (PRP1).The identified impacts are also generally located well within the site boundaries and up gradient of Lake Liddell, the discharge from which is also monitored and regulated under the Site EPL.

In ERM's professional experience, it is NSW EPA's preference to regulate issues such as these under either the POEO Act or the CLM Act rather than both, and, in the case of licensed premises, it is usually the POEO Act which is preferred. ERM therefore considers that NSW EPA would most likely continue to manage this issue under the POEO Act via the Site EPL, and hence would not require formal notification under the CLM Act, however this approach should be confirmed with NSW EPA to ensure strict adherence to the NSW DECC (2009) guidelines.

In some cases where groundwater results appear anomalous and / or are close to the laboratory LOR / screening values (chromium in AEC BP and mercury in AEC BV) an additional round of confirmatory sampling is recommended. At the Ravensworth Coal unloader, the identified arsenic exceedence in groundwater is located in relatively close proximity to both the site boundary and an off-site surface water receptor (Bowmans Creek), however in the absence of additional data points in this area, further assessment is recommended.

Surface water and Sediments in Lake Liddell

Concentrations of various metals exceeded the adopted ecological screening values in surface water. Given the nature of Lake Liddell and the other surface water bodies in the area, it is difficult to establish background concentrations, however given the elevated concentrations of these metals in and around on-site sources (in particular the Pikes Gully Ash Dam) it may be difficult to attribute all of these observed exceedences to background levels (particularly those for boron and selenium). As noted in relation to groundwater, ERM considers that NSW EPA would most likely continue to manage this issue under the POEO Act via the Site EPL, and hence the issue would not require formal notification under the CLM Act, however this approach should be confirmed with NSW EPA to ensure strict adherence to the NSW DECC (2009) guidelines.

Whilst the NSW DECC (2009) guidelines do not provide a specific requirement for notification in relation to sediments, it is recommended that the observed exceedences for metals and TRH of the ISQG-High values also be discussed with NSW EPA as part of this process.

5.6.4 *Summary - Is Material Remediation Or Management Likely To Be Required?*

Based on the results of this assessment, the issues where potentially material remediation or management is likely to be required relate to the identified asbestos impacts in soils surrounding the asbestos pipelines located within AEC BQ and works associated with surface water, seepage and groundwater management works in the vicinity of the Pikes Gully Ash Dam. Both of these issues are known to Macquarie Generation independently of this assessment. Macquarie Generation has been developing appropriate management approaches alongside independent professional experts.

The remediation of the identified asbestos impacts surrounding the pipelines is an issue which Macquarie Generation is in the process of engaging a contractor to manage / remediate. Given that this issue has been identified specifically within the Sale Purchase Agreement for the Site as pre-existing contamination and that a separate process is underway to address the issue, ERM has not prepared an estimate of the costs associated with the management / remediation of this issue since the actual costs will soon be known. It is considered that the costs for soil management are potentially material depending on the option selected.

Costs for the implementation of various options to manage surface and groundwater issues in the vicinity of Pikes Gully Ash Dam have been summarised in Worley Parsons (20 December 2013) report and cost estimates are potentially material depending on the option selected. It is noted that the options are focussed on reducing seepage rather than remediating the existing impact.

Whilst some other issues have been identified which may warrant further assessment (as summarised in Section 5.6.5 below) it is not anticipated that any of these additional assessment works would be likely to constitute a material issue on an individual basis.. Similarly it is not considered likely that any of these issues would proceed beyond the stages of quantitative risk assessment and / or the preparation and implementation of an appropriate environmental management plan to manage potential exposure, none of which are considered likely to constitute a material cost.

5.6.5 *Summary - Is The Data Suitable To Provide A Baseline Of Environmental Conditions At The Site And Immediate Surrounding Receiving Environments*

The data presented in the ESA was considered to generally be of a suitable quality and completeness to provide a baseline of environmental conditions at the Site as at or near to the time of the transaction.

It is noted that the vast majority of locations proposed in the Preliminary ESA were able to be advanced. The purchaser also has the ability to resample or monitor groundwater on an ongoing basis, given that the wells are a permanent installation.

It is noted that the vertical boring of soils is not an ideal method via which to identify asbestos impacts in soils. The absence of asbestos within fill materials or upon surface soils in other areas across the Site therefore cannot be guaranteed on the basis of the results of this assessment. Similarly, as with any investigation of this nature, the potential exists for unidentified contamination to exist between the completed sampling locations both within and between AECs.

Some limited additional characterisation of the baseline conditions at the Site is however considered to be required in the following areas, on the basis of the outcomes of this investigation;

- Asbestos – delineation of asbestos contamination in the vicinity of the asbestos containing pipelines within AEC BQ and in the vicinity of BE_MW01. It is recommended that this delineation be carried out in accordance with the methodology outlined in the ASC NEPM (2013) and should include more detailed inspections of these areas and the collection of soil samples for quantitative analysis.

- Groundwater – Additional confirmatory groundwater sampling is recommended within AECs BP, BV and BF to confirm the measured concentrations of metals and AECs BC and BL to confirm the measured concentrations of benzene with specific reference to clarification of the duty to report contamination under Section 60 of the CLM Act.

Lake Liddell - Further assessment of the risks to potential ecological and recreational receptors associated with identified metals and hydrocarbon impacts Lake Liddell may also be required, however this is dependent on the outcomes of proposed discussions with NSW EPA as discussed in *Section 5.6.3.*

6 CONCLUSIONS

ERM completed a Stage 2 ESA at Bayswater Power Station in order to develop a baseline assessment of environmental conditions at the Site as at or near the time of the transaction. Soil, sediment, surface water and groundwater data were compared against published environmental quality levels to provide a screening level assessment of potential risks to identified human and environmental receptors. The following conclusions were made based on the data collected during the investigation:

- The impacts identified in soil and groundwater at the sites are unlikely to represent a risk to human health and/or the environment given appropriate ongoing management based on the current and continued use of the Site as a Power Station.

- The key impacts identified include asbestos in soils at specific locations, metals in groundwater as well as surface water and metals and hydrocarbons in sediments in Lake Liddell (refer below).

- Asbestos was identified beneath the pipelines linking the Power Station and the Pikes Gully Ash Dam and in one location within the Coal Storage Area.

- Various metals were identified at concentrations in excess of screening levels designed for the protection of freshwater environments across the Site. Potential health and environmental risks associated with these exceedences have been interpreted in four broad groups, based upon the location of the samples, as follows;

  - Exceedences identified in groundwater discharging to the Pikes Gully Ash Dam are likely to be minor contributors to any overall potential health or environmental risks associated with the Ash Dam, given the volume and nature of the ash and water stored within this area;

  - Exceedences identified in groundwater discharging to Plashett Reservoir, are not considered to represent a significant risk to human health or the environment on the basis that this reservoir was created as a part of the Power Station water management system, no public access to the reservoir is allowed and waters discharging from the reservoir flow back into the Power Station within a closed system design;

  - Exceedences identified in groundwater discharging directly to offsite receptors including Bowmans Creek and the Hunter River were generally consistent with background concentrations and are not therefore considered to represent a significant risk to human health or the environment in the context of the surrounding environment. The one exception to this is arsenic, which was detected in groundwater beneath the Ravensworth Coal Unloader. Further assessment is warranted to assess potential risks associated with this issue; and

- Exceedences identified in groundwater discharging to Lake Liddell were evaluated on the basis of sediment and surface water samples collected from Lake Liddell, although it is noted that Lake Liddell also receives discharges from Liddell Power Station. Metals and PAHs in sediment and metals in surface water were identified at concentrations in excess of the adopted ecological screening values. Further assessment of these issues is considered warranted in order to assess potential risks associated with these issues, however it is considered unlikely that a need for active remediation of sediments within the Lake or associated waterways would result from this.

- No contamination issues were identified which would require material management or remediation based on the current and continued use of the Site as a Power Station with the potential exception of the identified asbestos impacts in soils surrounding the asbestos pipelines and works associated with surface water, seepage and groundwater management works in the vicinity of the Pikes Gully Ash Dam. Both of these issues are known independently of this assessment and Macquarie Generation has been developing appropriate management approaches alongside independent professional experts. It is considered that the costs for management of these issues may be potentially material depending on the option selected.

- With regard to the duty to report contamination which exists under the CLM Act (1997) ERM notes that in many instances, exceedences of the adopted groundwater, surface water and sediment screening levels have been identified which are related to activities which are already regulated and monitored under the Site EPL (No. 779) and (in the case of Pikes Gully Ash Dam) a current PRP (PRP1). ERM considers that NSW EPA would most likely continue to manage this issue under the POEO Act via the Site EPL, and hence would not require formal notification of potential contamination under the CLM Act, however this approach should be confirmed with NSW EPA to ensure strict adherence to the NSW DECC (2009) guidelines.

- The preparation and implementation of a suitable Environmental Management Plan (EMP) by an appropriately qualified professional is recommended to mitigate the risk of exposure to asbestos associated with areas in close proximity to the ACM pipelines and relating to the potential for asbestos to occur in soils across the site as a whole.

7 *REFERENCES*

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