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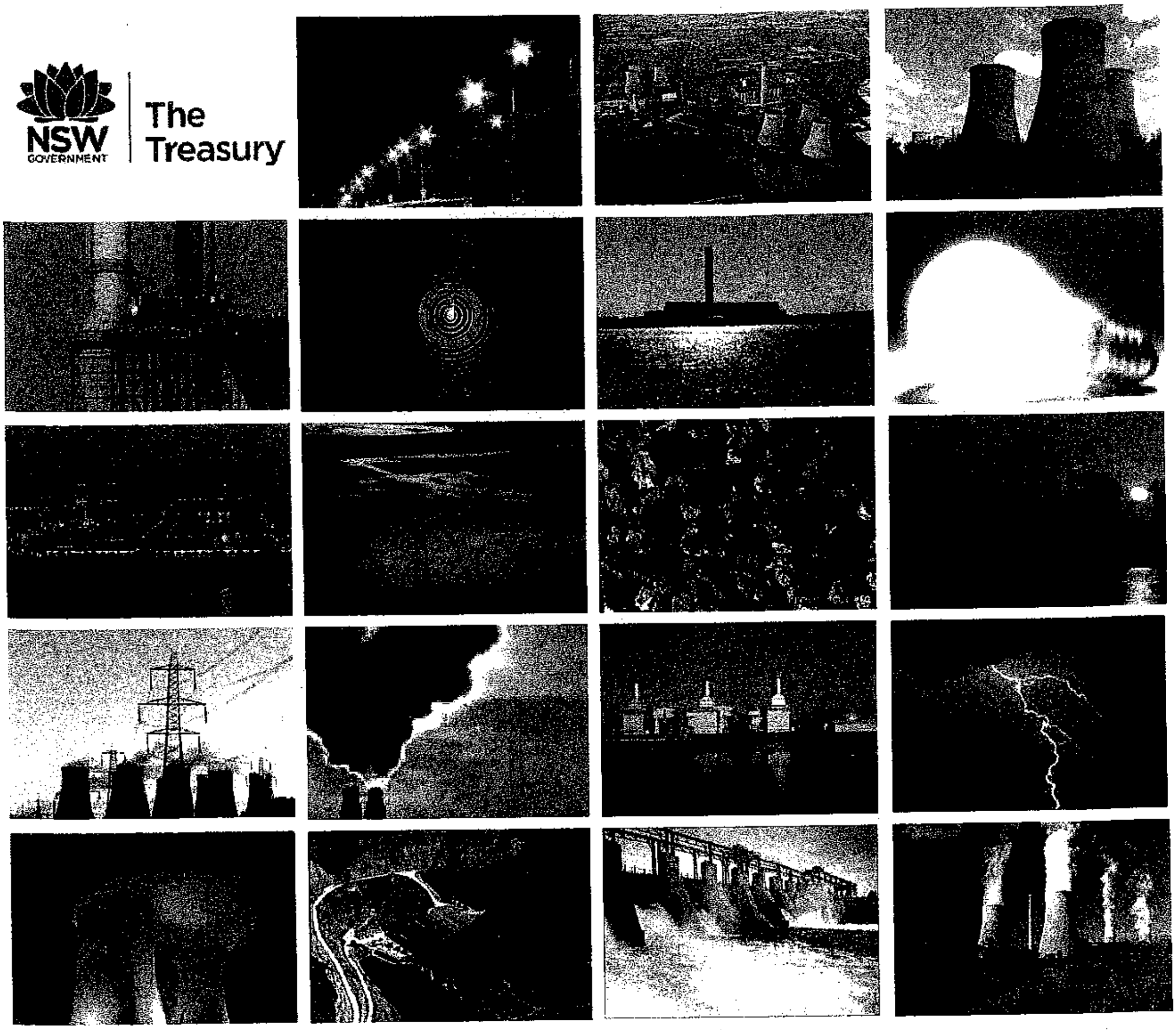
Mount Piper Power Station

Preliminary Environmental Site Assessment – Part 1

Environmental Resources Management

July 2013

NSW GOVERNMENT | The Treasury



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NSW Treasury

Mt. Piper Power Station

Preliminary Environmental Site Assessment

Ref: 0194708RP03 DRAFT

July 2013

The world's leading sustainability consultancy

ERM

Mt. Piper Power Station

Preliminary Environmental Site Assessment

NSW Treasury - Project Symphony

July 2013

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EXECUTIVE SUMMARY

ERM was engaged by NSW Treasury 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 Delta Electricity and Erraring Energy. The subject of this report was the Mount Piper Power Station.

The specific objectives for 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 sites;*
- *assess the potential financial liabilities associated with those issues (assuming ongoing commercial / industrial use as power generating facilities);*
- *identify what additional works may be required to establish a baseline of soil and groundwater conditions present at the sites to support the potential sale of the sites.*

ERM reported these in this Preliminary Environmental Site Assessment (ESA) which included background research from a variety of sources as well as management and staff interviews and site visits.

The Preliminary ESA identified that limited previous intrusive ESAs have been completed on the sites and a number of potential contamination sources were identified as follows:

- *Former Mine and Backfilling of Operational Area;*
- *Former Landfills;*
- *Coal Storage Area;*
- *Electrical Transformers;*
- *Water Holding Ponds;*
- *Workshops;*
- *Mobile Plant Refuelling Area;*
- *Operational and Decommissioned USTs;*
- *Operational ASTs;*
- *Current Ash Repository; and*
- *Lamberts North Ash Repository.*

Based on the results of the Preliminary ESA undertaken by ERM and consideration of Government's intended approach to establishing a baseline of soil and groundwater contamination, a programme of intrusive (Phase 2) assessment of potential soil and groundwater contamination issues is provided. The most appropriate sampling design is considered to be a combination of systematic (grid based) and judgemental (targeted) sampling of soil and groundwater at locations across the Site.

Based on the information available at the time of preparation of this report, ERM has not identified any actual contamination issues which are currently undergoing or likely to require material remediation, assuming ongoing industrial land use as a coal fired power plant. Preliminary remediation costs have not therefore been prepared at this point in time. It is proposed that the subject of remedial costs be revisited following completion of the proposed Stage 2 investigations.

1 INTRODUCTION

1.1 BACKGROUND

On 24 November 2011, the New South Wales (NSW) State Government (Government) announced that it would divest specific State-owned electricity generation assets and the Cobbora Coal Mine development. More specifically, the Government intends to:

- sell the electricity generation assets of Macquarie Generation, Erraring Energy and Delta Electricity, including the assets related to the generation trading ('GenTrader') agreements of Erraring Energy and Delta Electricity;
- sell the electricity generation development sites at Bayswater B, Munmorah and Tomago; and
- sell or lease the Cobbora Coal Mine development.

In order to support the sale of certain electricity generation assets owned and operated by Delta Electricity (a State Owned Corporations – SOC), NSW Treasury (Treasury) on behalf of the State of New South Wales, engaged ERM 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 Mount Piper Power Station.

1.2 OBJECTIVE

The specific objectives 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 sites;
- assess the potential financial liabilities associated with those issues (assuming ongoing commercial / industrial use as power generating facilities);
- identify what additional works may be required to establish a baseline of soil and groundwater conditions present at the sites to support the potential sale of the sites.

1.3 *SCOPE OF WORK*

The scope of this Preliminary ESA was outlined in the Request for Proposal (RFP) issued by Treasury on 14 February 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;
    - historical Titles;
    - S. 149 certificates from Local Council; 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 via:
    - identification of past and present potentially contaminating activities at, and adjacent to, the Sites;
    - identification of potentially impacted areas;
    - identification and assessment of the chemicals of potential concern (COPC) that may have been associated with historical and current use of the site;
    - evaluation of the possible migration pathways of the COPC; and
    - assessment of the sensitivity of surrounding areas and/or property.

- preliminary identification of potential cost implications of actual and/or potential soil and groundwater areas of concern, to assist in assessing whether those issues may be material.
- 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.
- comment on possible remediation options (Stage 3) for any clearly identified issues and their associated remediation cost estimates.

It is noted that Treasury also specifically requested that the Stage 1 ESA reports be prepared in general accordance with the NSW OEH (2011) *Guidelines for Consultants Reporting on Contaminated Sites*, (refer to *Section 1.7* for further discussion of report structure).

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 materiality threshold of AUD 0.5 M (+ GST if applicable) per contamination source. In addition, any issue that ERM considered could have the potential to lead to prosecution by the regulatory authorities that could lead to significant business disruption or reputational impact was considered material.

1.5 *APPROACH AND METHODOLOGY*

ERM's approach to the assessment was to break the work down into individual tasks as follows.

1.5.1 *Project Initiation Meeting*

In order to ensure that ERM and Treasury were fully aligned in terms of the scope and anticipated deliverables, the ERM Partner in Charge and Project Manager attended a project initiation meeting with Treasury.

1.5.2 *Introductory meetings with the individual SOCs*

In order to facilitate cooperation with the SOCs and to seek assistance from the asset maintenance and environmental team throughout the project, ERM completed introductory meetings with key contacts within both Erraring Energy and Delta Electricity.

1.5.3 *Review of Existing Data*

Relevant environmental information on the specific SOC assets was made available to ERM via an electronic dataroom. ERM reviewed relevant information on all sites and a list of all documents reviewed is included in *Section 11*.

In addition, ERM conducted background research using publicly available information on each of the sites. Following discussions with Treasury, 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 Delta Electricity 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).

15.4 *Site Visits and Management Interviews*

ERM mobilised to site and completed site management interviews and a site visit to the assets on 19, 20 and 21 March 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.

1.5.5 *Preparation of Stage 1 ESA Reports*

The Stage 1 ESA Reports were prepared in general accordance with 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 and remedial cost estimation) 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).

Following a process of review by Treasury and other key advisors, draft reports were finalised for issue.

1.6 *REPORT STRUCTURE*

This report has been structured in order to align generally with the requirements for a Preliminary Environmental Site Assessment outlined with NSW OEH (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

Mount Piper Power Station is owned and operated by Delta Electricity, a State Owned Corporation (SOC) that manages a number of electricity generating assets located throughout NSW, Australia.

Mount Piper Power Station is situated approximately 18 km north-north-west of Lithgow in the Central West region of New South Wales. The approximate coordinates of the Power Station are 223759 m E and 6304970 m S and the street address is 350 Boulder Road, Portland, NSW 2847.

The boundary of the Site is identified in *Figure 1, Annex A*. A listing of the registered titles for the Site at the time of reporting is provided in *Annex F*. The Site includes the main power station operational area, ash repositories and the associated water assets, Lake Lyell and Thompsons Creek Reservoir.

2.2 SITE DESCRIPTION

2.2.1 *Overview*

Mount Piper Power Station is a large coal-fired Power Station providing base load for the region via two 700 MW units. The Mount Piper and Wallerawang Power Stations form Delta Electricity's western region operation, known collectively as Delta West.

The station commenced operations in approximately 1993 and is expected to continue operations until the GenTrader Agreement contract closure date of 2042/43. The station was originally designed to allow installation of an additional two units however this has not yet been required.

The total area of the Mount Piper site is approximately 820 hectares and includes:

- the main operational area of the Power Station, which comprises electricity generating activities and the associated coal stockpile;
- the ash emplacement area within a former mine void adjacent to the operational area;
- a buffer zone comprising native forested areas and open woodland and rehabilitated and revegetated land, and including a number of ancillary activities such as transmission line easements and former waste dumps; and
- the associated water assets, Lake Lyell located directly south, and Thompsons Creek Reservoir to the south-east.

The entire area is described as "the Site" or "Mount Piper" in this report and is shown in the Site Layout Plan provided as *Figure 2.*

Water is supplied from off-site storage facilities detailed in *Section 4.1.1.* These water storage facilities are outside the scope of this report.

There are several parcels of land within the Mount Piper "fenceline" most of which are owned and operated by other electricity SOCs and Energy Australia, and these are outside the scope of this report. The affected parcels consist of:

- a large area of land on the western side of the operational area that has been transferred for potential future expansion of the Power Station (additional units). ERM's review of NSW government property mapping indicates that the parcel of land appears to consist of Lots 1, 2, 3 and 4 of DP1092737;
- a large triangular parcel of land to the south earmarked for the proposed rail coal unloader. ERM's review of NSW government property mapping indicates that the parcel of land appears to consist of Lots 1 and 2 of DP800003. This is agricultural land and is leased for agricultural pursuits;
- the Power Station's switchyard which is owned and operated by the transmission SOC Transgrid. ERM's review of NSW government property mapping indicates that the parcel of land appears to consist of Lots 1, 2, 3 and 4 of DP1092737;
- a high voltage substation which is owned and operated by the transmission SOC Transgrid. ERM's review of NSW government property mapping indicates that the parcel of land appears to consist of Lot 22 of DP832446; and
- a section of forested land along Boulder Road that has been sold to the Lithgow District Car Club. ERM's review of NSW government property mapping indicates that the parcel of land appears to consist of Lot 1 of DP1127747.

2.2.2 *Operational Area*

Processes conducted within the main operational area are detailed in *Section 4.* The operational area incorporates the coal stockpile and conveyors, electricity generation (coal mills, boilers, turbines, generators), air emission controls (fabric filters and chimney stack), cooling water processes (intakes, pre-treatment facilities, cooling towers and returns), wastewater holding ponds and treatment facilities; maintenance facilities; and administration offices.

The switchyard is adjacent to the main operational area (on the southern side) but as noted above is owned and operated by Transgrid.

2.2.3 *Ash Repository*

Ash generated as a by-product of the combustion process is transported either pneumatically (flyash) or via truck (bottom ash) to the on-site Ash Repository. Fly ash is conditioned with site process water to increase moisture content for better handling, compaction and reduction of dust emissions during transport and placement.

The current Ash Repository is located in the former Western Main open cut mine void adjacent to the Power Station on the north-eastern side (refer to *Figure 2*). Brine is co-disposed in the Ash Repository within an area specified by the relevant development approvals. The current Ash Repository area covers approximately 43 ha and is nearing capacity: with two to 12 years of storage remaining (Worley Parsons 2013). Capacity increases to the upper end of the range if normal water conditioned ash is placed in the recently approved Lamberts North Ash Repository area. Otherwise the remaining brine conditioned ash storage area will be exhausted with Normal Water Conditioned Ash. The Ash Repository is operated by Delta's contractor Lend Lease.

In February 2012, Delta Electricity obtained Project Approval from the Minister for Planning and Infrastructure for a new Ash Repository at Lamberts North to cater for the ash generated from the existing Mount Piper Power Station and proposed Power Station extension. The Lamberts North site is located adjacent to the existing ash repository, and is a former open cut coal mine operated by Centennial Coal (who continue to mine coal to the immediate south). Lamberts North includes an area known as the Huon Void (refer to *Figure 2*), which is a former groundwater collection pit and is currently being filled with a base to elevate ash placement above the groundwater level. Lamberts South is proposed as a washery rejects disposal area by Centennial Coal. Part of the former mine void adjacent to Delta's Lamberts North Ash Repository to the east is also being considered by Lithgow City Council for a large municipal waste landfill.

2.2.4 *Buffer Lands*

Extensive buffer lands are located to the north and west of the operational area.

The buffer land to the west is the larger area and consists of hilly forested country on a ridge above the operational area. The ridge separates the operational area from the township of Portland to the west. The western buffer land has been subject to both open cut and underground coal mining. The western buffer land includes:

- former landfills used by the Power Station and former coal mines (discussed in more detail in later sections);

- two large water storage tanks of 25 ML each holding Fish River water supply for the Power Station;
- transmission line easements; and
- a high voltage substation and switchyard (as noted earlier) which are owned and operated by Transgrid.

The buffer land to the north runs mainly in a strip on the opposite side of the Boulder Road and Castlereagh Highway, and consists of hilly forested country to the west, and valleys used for agriculture to the east. Much of the land has been subject to underground coal mining.

In addition, an area of forested land between the operational area and Lamberts North has been purchased relatively recently from Centennial Coal. The land consists of a ridge between the operational area and Lamberts North and has been subject to extensive underground coal mining.

2.2.5 *Lake Lyell*

The Coxs River was dammed downstream of Lake Wallace to form the Lake Lyell reservoir in 1982. Prior to the construction of Lake Lyell the area was predominantly bush and agricultural land. Lake Lyell has an active capacity of approximately 31 GL, sourced from local runoff, and the water is also pumped to off-stream storage at Thompsons Creek, which supplies Mt Piper, or to Lake Wallace, which supplies Wallerawang.

A pumping station is located on the western side of the dam wall adjacent to the spillway and comprises a brick building and a small fenced compound. Aboveground infrastructure in the fenced compound includes two surge tanks which are supplied with compressed air from a compressor in a small brick building. Two transformers are located in a concrete bund adjacent to the pump house. Small volumes of hydraulic oils are stored within the compound for use in the pump house.

During construction of the dam soil and rock materials were quarried from the adjacent hillside, and the area was revegetated. A small brick building is located on the access road from the Rydal Sodwalls Tarana Road which is currently used as a weather station. This building formerly housed an air compressor which was used to inflate a rubber dam bladder which was temporarily used to raise the height of the dam wall prior to the current dam wall configuration. Adjacent to the weather station building is a switchyard owned and operated by Transgrid.

The pumping station supplies water through a pipeline travelling approximately 250 m in elevation from Lake Lyell to Thompsons Creek Reservoir (full supply level (fsl) at Lake Lyell 785.5 m AHD, Thompsons Creek Reservoir 1033.5 m AHD). The pipeline runs underground within an easement from the pumping station to Thompsons Creek Reservoir, with a surge tank and a valve house located at intervals along the pipeline.

There are currently three local farmers with agreements with Delta to agist stock within the buffer lands around Lake Lyell. Lithgow City Council owns a portion of lands adjacent to Lake Lyell, as well as leasing additional lands which are publicly accessible for camping and recreation areas.

2.2.6 *Thompsons Creek Reservoir*

Thompsons Creek Reservoir was constructed in 1992 on a small creek to provide off-stream storage for supply of the water to Mt Piper and Wallerawang. The dam wall was constructed of earth and rock fill. Prior to the construction of the dam, the area was predominantly bush and agricultural land. Although the surface runoff catchment of Thompson Creek is relatively small, Thompsons Creek Reservoir has a storage capacity of up to 27.5 GL with water routinely pumped from Lake Lyell.

The dam wall can be accessed by vehicles through a locked gate with an access road running along the northern side of the reservoir. An emergency spillway is located on the northern side of the reservoir at the end of the access road, however this is not frequently required, as the water level in the reservoir is controlled with releases through the pipeline. A small brick building in a fenced compound is located adjacent to the spillway and contains an air compressor. Black staining was observed on the gravel surface of the compound (<5 m^2) during the inspection which appeared to be oil residue leaking from an air outlet hose from the air compressor however this is not likely to be a material issue.

Pedestrian access to the reservoir is also available to the public for recreational fishing. The buffer lands are generally vacant vegetated lands, with some areas used for stock grazing by local farmers under agreements with Delta.

2.3 SENSITIVE RECEPTORS

The closest major population centre in the region is Lithgow, located approximately 18 km to the south-east of the site. Other population centres within reasonable proximity to the Power Station site are Portland, approximately 4 km to the west, and Wallerawang approximately 10 km to the south-east. Smaller centres are located at Cullen Bullen, approximately 6 km to the north, Lidsdale approximately 6 km to the south-east, with small settlements at Blackmans Flat approximately 3 km to the east and Angus Place approximately 7 km to the north-east. There are two schools, one child care facility and a hospital within 5 km of the Power Station, all situated within the town of Portland.

The site is located within the Upper Cox's River Catchment. Key waterways near the site include:

- Western Drain located within the site on the western boundary of the operational area. This diverts runoff from the hills above the site along the western boundary and into Neubecks Creek;
- Neubecks Creek (also known as Wangcol Creek) located immediately to the north of the site. Neubecks Creek drains from the area west and north of Mt Piper Power Station to join the Cox's River north of Lidsdale;
- Huons Gully located along the western edge of the area mined by Centennial Coal. This natural drain line has been significantly disrupted by coal mining and is being partially reinstated at a slightly higher elevation by Delta in the recently purchased Lamberts North area. Due to the land purchase this drain line runs between the current ash emplacement area and the new Lamberts North ash repository. The drain line includes the large void known as Huons Void. This void was used as a Groundwater Collection Pit by the coal mine but as noted above is now being filled with a base to allow ash emplacement;
- the Cox's River located approximately 2.5 km east from the site boundary. The Cox's River runs from north to south, and is dammed at Lake Wallace and Lake Lyell to provide water supply for the Delta Electricity Power Stations. The lakes are also used for other purposes including public recreation such as boating and fishing. The river ultimately flows to Lake Burragorang;
- Pipers Flat Creek located approximately 1.5 km south of the site boundary, running from west to east beyond the forested ridge behind the site; and
- Thompsons Creek Dam located approximately 8 km south-west from the site boundary of Mt Piper. This dam impounds Thompsons Creek to supply water to the Delta Electricity Power Stations. As the dam has a small catchment it is supplemented with water from Lake Lyell. It is used recreationally for trout-fishing. Thompsons Creek appears to run south to north joining Pipers Flat Creek mentioned above.

2.4 *SURROUNDING ENVIRONMENT*

Coal mining and power generation are the important industries in the region, and cement production was also a major industry until the closure of the Portland works in 1986. The residential areas of Lithgow, Portland, Lidsdale and Blackmans Flat are surrounded by areas used mainly for mining purposes with some grazing and commercial forestry activities.

Key industrial uses in the area are:

- Delta Electricity's Wallerawang Power Station located approximately 7 km to the south east.
- Existing and former coal mines surrounding the site and within the site footprint;
- The former Portland cement works are located 4 km to the west.

Immediate neighbours around the site are:

- North - Ben Bullen State Forest, located on ranges above the site. A small area of land in a valley created by a reach of Neubecks Creek is occupied by agricultural land rather than State Forest;
- East - coal mining (Centennial Coal), beyond which is the hamlet of Blackmans Flat;
- South-east - Ben Bullen State Forest;
- South-west - forested hills; and
- West - valley housing agricultural land and the town of Portland.

Almost all land around and within the site boundaries has been subject to underground or open cut coal mining over time and hence has been subject to considerable disturbance.

2.5 *TOPOGRAPHY*

According to the Mt Piper Environmental Impact Assessment (Electricity Commission 1980), the elevation of the site ranges from 925 to 960 m above sea level while the hills surrounding the site rise to elevations of about 1000 m at distances approximately 3 km to the north, and 1 km to the south, east and west of the centre of the Mount Piper Power Station.

The operational area lies within a valley created by ridges forming a U-shape to the east, south and west. The floor of the valley has been levelled to construct the Power Station. Hilly forested country lies across the Castlereagh Highway to the north.

2.6 *GEOLOGY*

2.6.1 *Regional Geology*

The site is located on the western edge of the Sydney Basin which is characterised by easterly dipping sedimentary deposits. The 1:100 000 Western Coalfield geological map indicates that the site is underlain by the

Permian Illawarra Coal Measures comprising interbedded shale, sandstone, conglomerate and coal (Department of Mineral Resources, 1992). The Illawarra Coal Measures are in turn underlain by Permian age sandstone, shale and conglomerate of the Shoalhaven Group.

2.6.2 *Local Geology*

A description of the local geology based on environmental investigations conducted in the vicinity of the site cited by CDM Smith (2012) is provided in *Table 2.1*.

Table 2.1 *Description of Local Geology*[1]

Stratigraphic Unit	Geological Formation	Description	Approximate Thickness (m)
Illawarra Coal Measures	Bunnyong Sandstone	Silty sandstone	1 - 1.5
		Sandstone, siltstone and shale	12 - 14
	Lidsdale Seam	Coal, carbonaceous shale and sandstone	1.1 - 1.8
	Blackmans Flat Conglomerate	Sandstone (medium to coarse grained) with interbedded siltstone	3 – 6
	Lithgow Seam	Coal, carbonaceous shale	1.9 - 2.3
		Siltstone, mudstone and shale	0.3 - 0.6
	Marrangaroo Conglomerate	Sandstone with siltstone bands and some boulders	3.5 - 4.6
Shoalhaven Group	Berry Formation	Siltstone or silty sandstone, some pebbles.	>30

1 Table modified from CDM Smith (2012)

Coal seams within the Illawarra Coal Measures have been widely mined in the region, and sections of the site are underlain by abandoned coal workings (both underground and backfilled open cut) from mining of the Lidsdale and Lithgow seams. The Irondale seam has also been mined on higher elevations to the west in the Pipers Flat area.

The existing ash repository is located within a former open cut mine and the Lamberts North Ash Repository will be as well. Both open cut mine workings extended to the base of the Lithgow Seam. Whilst approximately 1 m of fill material was placed at the base of the existing ash repository prior to ash deposition, 5 m of fill material will be placed at the base of the Lamberts North ash repository prior to ash deposition (Nino Di Falco, personal communication, 20 March, 2013 and SKM, 2010).

2.7 HYDROGEOLOGY

2.7.1 *Regional Hydrogeology*

Information on regional aquifer properties is limited (CDM Smith, 2012). No regional scale productive aquifer has however been identified in the vicinity of the site. Large scale regional groundwater flow is expected to be towards the north/east, following the dip of the sedimentary deposits.

2.7.2 *Local Hydrogeology*

Historic mining activities have had a significant impact on the groundwater regime underlying the site, impacting aquifer properties and groundwater flows.

Where underground workings have been left in place, hydraulic conductivities as high as 5 to 50 m/d have been reported for the disturbed coal seams (Merrick 2007, as cited in CDM Smith 2012). A hydrogeological investigation (HLA-Envirosciences 2004) for the proposed Blackmans Flat Waste Management Facility (located directly down-gradient of the Site) reported an approximate hydraulic conductivity of 10^{-1} m/d for the material used for backfilling of the open cut mine voids and approximately 10^{-3} m/d for the Marrangaroo Conglomerate underlying the Lithgow seam. Groundwater seepage has been observed in remaining mine voids (such as the Huon Void/Pond, formerly known as the Groundwater Collection Basin).

Considering the above, the base of the open cut fill materials are considered to present the shallowest laterally extensive groundwater bearing unit at the site in locations of former open cut mining. Localised perched shallow groundwater has been noted in various groundwater monitoring wells installed for the purpose of assessing potential contamination from Underground Petroleum Storage Systems (UPSS). In areas where former underground mines remain in place, the disturbed coal seams are considered to present the shallowest laterally extensive groundwater bearing unit.

The groundwater flow direction at the site reportedly has a north-easterly to south-easterly component (CDM Smith 2012). Locally there may however be different directions in groundwater flow due to local variations in topography and surface water interactions.

It is further noted that groundwater quality has reportedly been affected by coal mining activities, with groundwater impacted by low pH, elevated salinity and trace metal concentrations in a number of locations (Connell Wagner 2008).

2.7.3 *Groundwater Use and Potential Surface Water Receptors*

The *NSW Natural Resource Atlas* online bore register identifies that a number of groundwater bores are located within a 10 km radius of the site which are registered for irrigation, private domestic and stock use. The standing water level in the bores reportedly varies between 1 and 15 m bgl.

Neubecks Creek presents the closest surface water body, located adjacent to the site in a north to north easterly direction.

Information from Lithgow City Council indicates that municipal water is sourced from surface water dams (Farmers Creek Dam #2 and Oberon Dam) which are not linked to or used for water supply by the Delta Western Power Stations and hence are not considered to be a sensitive receptor for the purposes of this assessment. The Lithgow City Council Local Government Area covers a large area and incorporates all the townships within the vicinity of the Delta Western Power Stations.

3 SITE HISTORY AND REGULATORY SETTING

3.1 SUMMARY OF SITE HISTORY

3.1.1 *Coal Mining (1880s – current)*

The area was home to a number of collieries from the 1880s onwards including the Irondale Colliery from 1883, the Cullen Bullen Colliery from 1885, the Ivanhoe Colliery from 1893, and the Commonwealth Colliery in 1895, which in 1940 became the first open cut mine in NSW. Numerous other mines opened in the Lithgow Valley particularly around Cullen Bullen such as the Great Western Mine in 1899 and the Invincible Colliery in 1900, along with a number of smaller mines.

The site and immediately surrounding areas have been mined for coal since at least the 1940s, firstly by shallow underground 'bord and pillar' methods, secondly by 'roof lifting' activities to extract coal pillar remnants, and thirdly by open-cut mining (CDM 2012). Collieries that mined within the Mount Piper site boundary include (PPK 2000):

- Ivanhoe No1. Colliery
- Huon Extended No 3. Colliery
- Huon Extended No 4. Colliery
- Western Main Colliery

Mining activities in the 1990s moved away from underground mining to open-cut mining, often utilising the existing underground mined areas. Some areas of underground workings still remain across the valley.

Open-cut mining generally focused on removing the remnants of the Lidsdale Coal Seam as well as extracting coal from the Lithgow Coal Seam which runs beneath it (CDM 2012). At the end of mining operations, nearby old open-cut mine voids have been used as ash repositories for Mt Piper Power Station. The current Ash Repository and part of Lamberts North, including the Huon Gully, lie within the former Western Main Colliery holding (SKM 2010 in CDM 2012).

Centennial Coal undertook coal mining and washing operations on the Lamberts North site until early 2012, when it was acquired by Delta Electricity and used for construction of the Lamberts North Ash Repository. Centennial Coal continues to operate open-cut mining and coal washery activities in Lamberts South, immediately adjacent to Lamberts North Ash Repository.

Based on historical mining maps (CDM 2012 and PPK 2000), former open-cut mines were present beneath the current operational areas of the power-station. These voids were backfilled with overburden at the end of mining operations.

3.1.2 *Construction of Mt Piper Power Station*

Construction of Mt Piper Power Station began in 1984, was halted in 1986 and began again in the early 1990s, with the station commissioned in 1993. Substantial earthworks were required to level the land and backfill the former open-cut mine on the site.

Site management advised that there have been no substantial changes to the building footprint and the current operational areas are representative of operations over the period from 1993 to 2013.

There are three landfills which date from the early years of construction and operation of Mt Piper Power Station:

- Construction Landfill -the use of this landfill was uncontrolled and was used by contractors for disposal of building waste and materials from the construction of Mt Piper Power Station;
- Uncontrolled Domestic Waste Landfill - a series of trenches were constructed and used for disposal of unknown wastes from 1993-1997. Historical maps indicate that part of the landfill was constructed over an old open cut mine (which may have been first backfilled with overburden); and
- Chitter Dam Landfill - was constructed originally as a surface water dam but was never used for storage of water supplies, although there is some indication from aerial photos that water may have ponded within the dam. The dam was converted for use as a landfill for chitter, which is a coarse reject material from coal washing (PPK 2000). 'Hard' construction waste such as concrete was also disposed in this landfill (PPK 2000).

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).

Table 3.1 Aerial Photograph Review

Year	Site	Surrounding Area
1950	Large areas of the Site have been cleared of vegetation, including the square which now forms the coal storage area. An open-cut mine is visible in the south-west corner of the Site, extending to the north-east. Mine workings are also visible north of Boulder Road at the Ivanhoe Colliery. A small open-cut mine void is visible along the highway north of the current ash repository. Mine workings are visible near the location of the current Lamberts North.	Roads and cleared areas south-east of the Site may be related to underground mine workings. The area to the north, around Blackmans Flat has been cleared with some buildings present. A dam is visible on Pipers Flat Creek immediately south of the Site.
1961	The open-cut mine has been extended, with a second working also running south-west to north-east. Clearings in the forested area in the western part of the site indicate small mining operations. The Huon Colliery is visible (current location of Huons Gully).	An open-cut mine is located to the south-east of Huons Gully. Mine workings are visible on the ridges to the north of the Site along the highway.
1969	Open-cut mine workings can be seen across the Site as well as the mine heads of small underground workings in the forested area in the western part of the Site. Water is present in some open mine voids, and Neubecks Creek can be seen connecting a series of ponded open mine voids. Huon Colliery remains active. The remainder of the Site is crossed with tracks, with no other activities visible.	There are two large open-cut mine workings to the south of Huon Colliery, both north and south of the highway. Several flooded mine voids are visible on Blackmans Flat along Neubecks Creek.
1975	The footprints of the two open-cut mine workings on the Site remain unchanged. The mine workings in the forested area have been expanded, with more cleared areas. Trees have been cleared for transmission lines along the ridgetops to the south of the Site.	Further development on Blackmans Flat, with larger mine workings and buildings constructed.
1984	The Site has been cleared and earthworks are partially completed for construction of the Mt Piper Power Station. The mine voids have been backfilled. The Chitter Dam and the Construction Landfill are visible. Ponds are being constructed to the east of the coal storage area which has been levelled. Construction has begun on the main operations area. Temporary buildings are present on the buffer land to the east of the main operations area. The water ponds to the north of the highway (within the buffer lands) are present. Transmission lines have been cleared along ridgetops. Most of the current road network is visible. The Huon Colliery is still visible, with water present in Huon's Gully flowing to the south-west. A small mine working is present in the south of the Site near the current Transgrid switchyard. This is connected by a track to the Pipers Flat Creek.	A track has been cleared to the dam on Pipers Flat Creek to the south of the Site. Further development on Blackmans Flat, and to the south-east of the Site along the highway.
1998	The power station is active in its present-day layout. The mine working in the south of the Site is still active. The three landfills are filled and have started to regenerate vegetation, but the outlines are clearly visible. Water tanks are visible in the western part of the Site. Brine-ash has been deposited in the current ash repository on the western side, with former mine workings still visible on the eastern side. Huons void is flooded and a second flooded mine void can be seen north of the highway. Coal mining operations are active in Lamberts North (and South)	The Ivanhoe Colliery is still active to the north of Boulder Road.

Table 3.2 *Summary of Historical Aerial Photographs - Lake Lyell*

Year	Site of Present Day Lake Lyell	Surrounding Area
1958	The Coxs River runs north to south through the Site, before heading east. The Site is largely forested, with limited development. The Site is bisected by several streams which join the Coxs River. The Rydal Sodwalls-Tarana Road crosses the Site east-west.	The surrounding area is largely forested gullies, with agriculture on flatter land to the west.
1966	The Site is similar to 1958, with some homesteads and agriculture along small streams to the east of the Coxs River.	The surrounding area is similar to 1958, with further agricultural development.
1975	The Site is similar to 1966.	The surrounding area is similar to 1966.
1984	Lake Lyell has been constructed by damming of the Coxs River. The Rydal Sodwalls-Tarana Road has been diverted around the new lake, and the old road is still visible on the east bank of the lake. The dam wall and infrastructure are visible on the southern end of the lake. A small cluster of buildings is present next to the dam wall.	The surrounding area is similar to 1975, with further development for agriculture and forestry.
1994	The Site is similar to 1984, with further development of the small homesteads on the eastern side of the lake.	The surrounding area is similar to 1984, with further development for agriculture and forestry.
2012	The Site is similar to 1994.	The surrounding area is similar to 1994.

Table 3.3 *Summary of Historical Aerial Photographs – Thompsons Creek Reservoir*

Year	Site of Present Day Thompsons Creek Reservoir	Surrounding Area
1952	The Site is forested with some areas of land cleared for agriculture. Several small streams run through the Site.	The Great Western Highway runs along the southern side of the Site.
1954	The Site is similar to 1952.	The surrounding area is similar to 1952.
1964	The Site is similar to 1954, with further land clearing for agriculture.	The surrounding area is similar to 1954, with further development of agriculture.
1989	The Site is similar to 1964, with further land clearing for agriculture. There are several (>10) small farm dams present along small creeks.	The surrounding area is similar to 1964 with further land clearing to the north and south for agriculture.
1993	The streams previously present on the Site have been dammed to form the Thompsons Creek Reservoir.	The surrounding area is similar to 1989.
2012	Thompsons Creek Reservoir is a large reservoir located in an agricultural area, with a roadway along the north edge. There is no visible infrastructure aside from the dam wall and the air compressor building along the northern shore of the lake.	The surrounding area is similar to 1993 with further development for agriculture and forestry.

3.3 *ZONING & LANDUSE*

The land is zoned Rural 1a under the City of Greater Lithgow LEP dated 1994, current version for 1 March 2011 (PPK 2000). Delta management reported that all uses are permissible with consent under this zoning. Delta management has advised that a revision to the LEP is proposed which will preserve the right to generate electricity is preserved.

3.4 *ENVIRONMENTAL APPROVALS, LICENSES AND MANAGEMENT*

Delta Electricity 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 system provide context for potential contamination sources (eg ash disposal) and hence a summary of salient points in relation to these issues has been set out in this report.

3.4.1 *Planning Approvals*

Original approval for the construction and operation of the Mount Piper Power Station was granted to the then Electricity Commission of New South Wales by the then Minister for Planning and Environment on 1 April 1982 subject to certain conditions. Mount Piper commenced operations in 1992 with a Board approved life to 2046.

Since the original approval, a number of modification applications were granted Ministerial approval. There have also been new applications approved by Lithgow City Council or internally by Delta Electricity under Part 5 of the Environment Planning and Assessment Act 1979. A summary of planning approvals and consents that have been granted to Mount Piper follows (Worley Parsons 2013):

- 1982 Development Consent for the construction and operation of the Mount Piper Power Station (approved by Minister for Planning and Environment, 1 April 1982);
- 1990 Development Consent for Dry Ash Placement at Mount Piper (approved by Lithgow Council, March 1990);
- 1991 Modification to allow temporary storage of brine waste until 30 June 1996 (approved 18 March 1991);
- 1996 Modification to extend temporary storage by four years to 30 June 2000 (approved 21 June 1996);
- 1999 Modification adding a condition requiring that all necessary approvals be obtained prior to construction or modification (approved by Lithgow City Council, 18 January 1999);

- 2000 Modification to allow brine co-placement in ash (approved by Minister for Urban Affairs and Planning, 3 April 2000);
- 2006 Modification to increase the capacity of the Power Station in two phases (approved by Minister for Planning, 3 June 2006);
- 2006 Development Consent for construction of a substation (approved by Lithgow Council, 7 November 2006);
- 2008 Modification to extend the brine and ash co-placement area (approved by Minister for Planning, 23 March 2008);
- 2009 Construction and operation of the Western Rail Coal Unloader (approved by Minister for Planning, 27 June 2009) – this development site was subsequently sold to TRUenergy;
- 2011 Subdivision – 6 into 3 Lots (approved by Lithgow Council, 3 May 2011); and
- 2012 Mount Piper Stage 2 Ash Placement Project (approved by Minister for Planning and Infrastructure, 16 February 2012).

The Mount Piper Extension development site (MP 09_0119) and Western Rail Coal Unloader development site was sold to TRUenergy (now Energy Australia) as part of the NSW Government's Energy Reform Strategy.

3.4.2 *Environmental Protection Licences*

Delta Electricity holds Environmental Protection Licence EPL No. 13007 for Mount Piper, issued under Section 55 of the Protection of the Environment Operations Act 1997, for the premises described as Mount Piper Power Station 350 Boulder Road, Portland, NSW 2847. The EPL also references the relevant property descriptors however these have been superseded by recent land acquisitions and Delta advised that these will be updated in the upcoming EPL review.

The EPL authorises the following activities:

- Generation of electrical power from coal (> 4,000 GWh generated);
- Chemical storage;
- Coal works;
- Crushing, grinding or separating;
- Sewage treatment; and
- Waste storage.

According to Worley Parsons (2013), Mount Piper and Wallerawang were both previously included in EPL No. 766, until the current separate licence (EPL 13007) was issued for Mount Piper in early 2009.

The licence includes a range of general 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 is a Load Based Licensing licence. Site -specific conditions in the EPL include:

- water monitoring requirements and one licensed monitoring point (with no specified limits) for surface water runoff, which is the final holding point at Neubecks Creek;
- air monitoring requirements and two licensed discharge points for air emissions;
- a condition permitting certain wastes generated at the Power Station to be disposed at the Ash Repository (fabric filter bags, ion exchange resins etc.);
- a condition permitting Wallerawang wastewater to be disposed at the Ash Repository (referred to as the "Ash Storage Area" in the Licence);
- monitoring of weather conditions; and
- monitoring of impurities in any alternative fuels used, and restrictions on alternative fuels.

The EPL does not set emission limits for noise.

3.4.3 *Environmental Management*

Delta has an Environmental Management System (EMS) for the management of environmental issues. The EMS is certified *to ISO 14001:2004 Environmental Management Systems – Specifications and Guidance for Use*. According to Worley Parsons (2013), the original certification was achieved in June 2005 and includes Delta Electricity Western and Central Coast Power Stations on the one certificate. The most recent external EMS surveillance audit was undertaken by DNV in August 2012, with the certificate being valid until 4 August 2014.

In addition to AS/NZS ISO 14001:2004 audits, Mount Piper undertakes external audits every three years to assess ongoing compliance and environmental performance at the station (Worley Parsons 2013).

Delta Electricity operates an environmental incident recording and reporting procedure that incorporates Mount Piper. Environmental, health and safety, and other incidents are recorded on an incident notification form, located on the Delta intranet (Worley Parsons 2013).

Mount Piper maintains a complaints register as part of its EMS, which includes the date and details of the communication, inquiry type, the required action (if any) and details of the response (Worley Parsons 2013).

4 OPERATIONS

4.1 GENERAL DESCRIPTION OF PROCESSES

4.1.1 *Water Supply*

Water supply for Delta Electricity's Western Region Power Stations is sourced from four main supplies:

- the Cox's River scheme;
- the Fish River water supply scheme;
- Angus Place and Springvale Mines; and
- Reverse Osmosis plant.

The majority of the water used at Mount Piper and Wallerawang is supplied form the Cox's River System, which includes three storages:

- Lake Wallace which supplies Wallerawang and has an active capacity of 3230 ML;
- Lake Lyell which is further downstream and has an active capacity of about 31 000 ML;
- Thompsons Creek Reservoir which provides additional storage capacity of up to 27 500 ML.

Mount Piper uses approximately 1.65 ML of water per GWh of electricity generated (Worley Parsons 2013). It is used for the production of high purity steam, condensate cooling, supply of domestic water and miscellaneous operations including dust suppression..

A Water Management Licence was first issued on 1 July 2000 and sets out conditions for Power Station access to the Cox's River water supplies. Delta Electricity is authorised to take and use up to 23 000 ML/year from the Cox's River water source for the operation of Mount Piper and Wallerawang (Worley Parsons 2013). In the event that Delta Electricity's Minimum Annual Quantity from the Fish River water supply is reduced by 30% or greater, Delta Electricity is entitled to obtain an additional 2000 ML/year from the Cox's River water source. The Water Management Licence requires Delta Electricity to operate Mount Piper to achieve certain average annual water use efficiency targets; to monitor water quality, river health and geomorphics; and to report on key matters such as dam releases, incidents and water extraction. This information is provided in the Delta Electricity Western Water Management Licence Annual Compliance Report (Worley Parsons 2013).

Delta Electricity is the major customer of the Fish River Water Supply Scheme and has an annual allocation of 8184 ML (Worley Parsons 2013). Fish River water is currently sourced from the Duckmaloi Weir and the Oberon Dam. Due to the quality of water from the Fish River system, this water is more suitable for use at Wallerawang Power Station. Delta Electricity's allocation is restricted according to the level at Oberon Dam.

In 2011, Delta Electricity constructed a reverse osmosis water treatment plant at Wallerawang which was commissioned to treat up to 6 ML/day of cooling water blowdown (Worley Parsons 2013). The RO plant reduces the quantity of the cooling water makeup and thereby eliminates reliance on the Fish River scheme during drought. The wastewater from the Wallerawang RO Plant is transferred by a 5 km pipeline to the Mount Piper brine concentrator system.

4.1.2 *Fuel Supply*

Coal for Mount Piper is sourced from several local open cut and underground mines, including: Angus Place; Springvale; Ivanhoe North; Pinedale; Invincible and Cullen Valley (Worley Parsons 2013). Coal is primarily supplied by truck, although Springvale coal is supplied via conveyor. Mount Piper currently consumes around 4 Mt per annum (Worley Parsons 2013).

The coal handling plant is located on the north-west corner of the operational area and consists of a truck dump hopper and truckwash (with associated settling ponds); the Springvale conveyor; a receival bin and weighers; a 1 Mt longterm stockpile; stackers; a dry storage silo; conveyors and crushers; a mobile plant workshop and refuelling area; and runoff settling ponds.

To reduce dependence on local coal mines, Delta Electricity investigated coal supply from regional mines via the proposed Western Rail Coal Unloader and Western Rail Upgrade, located on land to the south of Mount Piper. The Western Rail Coal Unloader project received Project Approval in June 2009 but has not proceeded at this stage (Worley Parsons 2013).

Mount Piper Power Station uses refined recycled oil (RRO) for its auxiliary fuel requirements at start-up, mill change-over and low load running. The auxiliary fuel is delivered to the station by road tanker (Worley Parsons 2013).

Mount Piper also uses diesel fuel for operation of the emergency diesel generator and for trucks and mobile plant (Worley Parsons 2013).

4.1.3 *Electricity Generation*

Mt Piper Power Station comprises two 700MW units, which commenced operation as 660MW units in 1992/1993 and were upgraded to current capacity in 2009/10 (WorleyParsons 2013).

The main features of Mt Piper generating assets include (WorleyParsons 2013 and Delta Electricity pers comms Nino DiFalco 2013):

- coal bunkers and feeders;
- seven ball mills generating pulverised coal feed;
- air fans and associated rotary air heaters for conveying coal and for combustion;
- feedwater/steam/condensate system including pre-treatment of boiler feedwater (ion exchange resin demineralisation of makeup water and chemical treatment of feedwater); economisers, steam drums, furnace water wall tubes, superheaters, re-heaters, condensers, de-aerators and condensate polishing plant (ion exchange resins);
- light fuel ignition system;
- two semi-clad balanced draught, natural circulation, sub-critical boilers incorporating reheat and divided convection back pass;
- boiler blowdown systems;
- tandem compound steam turbines driving hydrogen and water cooled generators, in a fully enclosed turbine building;
- emergency diesel generator and associated transformer and switchboard;
- generator, auxiliary, station and external plant transformers;
- hydrogen plant (no longer used as hydrogen is supplied by cylinder);
- compressed air system;
- cooling water system including two natural draft hyperbolic cooling towers;
- flue gas cooling/heat recovery systems;
- 40 cell fabric filter fly ash collector;
- one flue gas chimney serving both boilers; and
- a central control room servicing both units and accommodating a distributed control system.

Ancillary activities include offices, maintenance workshops, contractors compounds, process water storage and treatment and fuel stores. These are detailed in following sections where relevant.

4.1.4 *Transmission*

The two Mount Piper units are directly connected to the 330 kV network at the nearby Transgrid 330 kV switchyard which is directly connected by tie transformers to the Transgrid 500 kV switchyard immediately adjacent to the Site. A secondary connection to the national grid also exists via the 132/66 kV switchyard.

4.1.5 *Ash Disposal*

The bulk of Mount Piper's ash is placed in a dry on-site ash repository described in earlier sections. A percentage of fly ash is sold to the cement industry.

Fly ash collected in the fabric filters is discharged from the filter hoppers to a pneumatic conveying vessel. The pneumatic conveying system transfers the fly ash to one of two storage silos - one is for fly ash that is to be sold as a cement-replacement for the production of concrete; the other is for the balance of fly ash that has to be disposed of. Fly ash that has been sold is removed from the site by use of privately owned road tankers (Worley Parsons 2013).

Fly ash is conditioned with either water or brine and then transported by covered conveyor from the Power Station silo to a silo at the Mount Piper ash repository.

Submerged chain conveyors remove bottom ash from the furnace and, after de-watering, bottom ash is trucked to the Mount Piper ash repository.

Placement of the ash at the repository is carried out using mechanical plant. The operation and maintenance of the ash handling system (inclusive of the fabric filter) is contracted to Lend Lease.

Delta gained approval in February 2012 to place ash at Lamberts North which is immediately east of the existing ash repository as discussed in earlier sections.

4.2 INVENTORY OF CHEMICALS AND WASTES

An inventory of significant storage facilities is provided below, based on the site's Dangerous Goods Licence and observation. Minor stores are also kept in the maintenance workshop and other operational areas.

In addition, a number of large transformers contain significant quantities of insulating oil. The PCB content of oil in all Mount Piper transformers is reportedly less than 2 mg/kg (the concentration below which the oil is no longer subject to the relevant Chemical Control Order under the *Environmentally Hazardous Chemicals Act 1997*). Delta site management advised that transformers were installed without PCB-contaminated oil.

Transformers are housed on concrete bases that drain to the contained oily water system described in this report.

Chemical storage tanks reportedly undergo testing quarterly, and site management were not aware of any integrity issues in tanks or associated pipework. ERM has requested documentation relating to testing and suggest confirmation during Phase II in order to further assess the need for intrusive investigation. An apparent release from the diesel UST at the coal stockpile refuelling plant is described further in *Section 4.3*. A total of 47 individual storage vessel are listed on the Site's register as detailed in *Annex E*.

4.3 *PRODUCT SPILL AND LOSS HISTORY & OTHER DISCHARGES*

Several minor spills have occurred but were captured onsite:

- overfilling of a diesel Aboveground Storage Tank (AST) resulted in loss of material to the eastern site drain, but this spill was captured in the Final Pond;
- a minor leakage in a diesel fuel oil pipe (less than 100 L) was contained locally. This issue was not discussed in detail as it is not considered material; and
- a breach in the bund wall on the dry ash stockpile following heavy rain occurred in approximately 2002 resulting in spillage of ash to Delta land. This issue was not discussed in detail as it is not material from a contamination perspective (note dam wall integrity is an engineering issue outside the scope of this report).

Groundwater impact has been identified in the vicinity of the wash bay in the mobile plant refuelling area which indicates a historical unreported spill / release has occurred here at some point in the past (as discussed further in *Section 5.1.2)*. The identified Light Non-aqueous Phase Liquid (LNAPL) was weathered with an age estimate of 25 years and was unrelated to the diesel currently in the UST. Documentation for the diesel UST was not available, however it is understood that the UST dates to the commissioning of Mt Piper in 1993, approximately 20 years ago, and there are no other known USTs in the mobile plant refuelling area.

4.4 *FUEL MANAGEMENT*

The site's main fuel is coal, and large stockpiles are located to the north of the main plant. While some contamination may be associated with stormwater percolating through these stockpiles, the use of the land for coal stockpiling has been approved through various planning processes. A settling pond for the removal of sediment from stormwater is located along the northern edge of the coal stockpile.

The site also uses diesel for backup generators as well as mobile plant used in the coal stockpile, ash stockpile, and operational area. Fuel is stored in several locations as detailed in *Annex E:*

- two 1.2ML diesel ASTs;
- 34 200L E10 and 20 900L diesel UST;
- 11 800L diesel UST; and
- 10 000L diesel UST and 5000l AT day tank for back-up generator.

4.5 WASTE AND ASH DISPOSAL

4.5.1 *Ash Management*

Ash generated as a by-product of the combustion process is transported either pneumatically (flyash) or via truck (bottom ash) to the on-site Ash Repository. Fly ash is conditioned with site process water to increase moisture content for better handling, compaction and prevention of dust emissions during transport and placement.

The current Ash Repository is located in the former Western Main open cut mine void adjacent to the Power Station. Brine is co-disposed in the ash placement area within an area specified by the relevant development approvals. The current Ash Repository covers approximately 43 ha and is nearing capacity - two to twelve years of storage remain (Worley Parsons 2013). Capacity increases to the upper end of the range if normal water conditioned ash is placed in the recently approved Lamberts North Ash Repository area. Otherwise the remaining brine conditioned ash storage area will be exhausted with Normal Water Conditioned Ash. The Ash Repository is operated by Delta's contractor Lend Lease.

In February 2012, Delta Electricity obtained Project Approval from the Minister for Planning and Infrastructure for a new Ash Repository at Lamberts North to cater for the ash generated from the existing Mount Piper Power Station and proposed Power Station extension. The Lamberts North Ash Repository site is located adjacent to the existing Ash Repository, and includes an area known as the Huon Void, which is currently being filled with a base to prepare the site for ash placement. According to Worley Parsons 2013, the Mount Piper Ash Placement Project originally proposed the development of four sites (Lamberts North, Lamberts South, Ivanhoe 4 and Neubecks Creek), however the other three sites are being redeveloped for alternate purposes.

4.5.2 *Other Waste Management*

The Mt Piper EPL permits the site to dispose the following types of waste at the ash disposal area (WorleyParsons 2013):

- ash;
- mill pyrates;
- demineralisation and polisher paint effluents;
- chemical clean solutions;
- cooling tower sediments;
- ion exchange resins;
- fabric filter bags;
- brine conditioned fly ash;
- biomass co-firing ash;
- settling pond sediments; and
- oil and grit trap sediments.

4.6 *WATER AND WASTEWATER MANAGEMENT*

Stormwater from "clean" operational areas (such as carparks and grassed areas) is collected through a network of grates and pipes (colour coded red) and carried via the West and East Drains to the Final Holding Pond. A reclamation pump is used to allow stormwater to be used as makeup water for the cooling towers. An underflow weir allows excess water (eg associated with a large storm event) to discharge to Neubecks Creek at an EPA licenced monitoring point (with no discharge limits).

Sewage from plant amenities is collected and treated in a Pasveer channel treatment plant, originally built in the early 1980s to service both the construction period and subsequent operation period. Treated effluent is used as makeup water for the cooling towers, and the sludge from this process is stockpiled and disposed of off-site by licensed contractors, although this has never yet been required.

Process wastewater is reused on site as cooling tower make-up water, after treatment to ensure appropriate quality. Process wastewaters fall into the following main categories:

- wastewater from cooling tower blowdown;

- stormwater and wastewater from areas that are likely to generate oil contamination, such as fuel store bunds (colour coded green);
- floor washings and stormwater that is likely to be contaminated with ash (colour coded blue); and
- floor washings and stormwater that is likely to be contaminated with chemicals, such as bund areas (colour coded purple).

Treatment processes for these streams vary depending on the nature of the contaminant and include settlement, chemical neutralisation, oil water separation, brine concentration and reverse osmosis.

Potential contamination sources from wastewater process include pipework and in-ground pits and open ponds used to store and treat wastewaters.

The integrity of the pipework and pits has not been assessed and may present a contamination source if leaks have occurred.

Site management reported that the open ponds used to store and treat wastewaters are lined with rubber to prevent wastewater loss, and that monitoring bores are located near the ponds to allow detection of leakage. Site management reported that monitoring results indicate that leakage has not occurred. Site management also reported that the lining is reaching the end of its technical lifespan, however an independent engineers review has confirmed that the liners remain in good condition and as such may not require replacement for some time.

The main open and lined ponds include:

- contaminated water - one 8 ML contaminated water pond collecting wastewater from areas where oil spills may occur;
- ash washdown and chemical waste settling ponds - three 8 ML settling ponds that allow suspended solids to settle while chemical wastes are neutralised;
- cooling water blowdown pond B – the 103 ML blowdown pond B collects feeds to the brine concentrators, consisting mainly of cooling tower blowdown, but also high TDS wastewater from the demineralisation and polisher regeneration plant, waste from the cooling water reverse osmosis plant and clean water from the setting ponds;
- cooling water blowdown pond A – the 77 ML blowdown pond A receives the high TDS water from Pond B and provides feed to the brine concentrators.
- Brine Concentrator brine waste ponds - High salinity waste from the brine concentrators is stored in two 20 ML waste brine ponds, and is used to condition ash prior to placement in the ash repository.

- clean water pond - one 30 ML clean water pond receiving good quality water from the contaminated water oil water separators, the brine concentrator, boiler blowdown and sewage plant.

5 SITE CONTAMINATION HISTORY

5.1 OVERVIEW

The current processes being undertaken upon the Site have not changed greatly since operation of the Site commenced in 1993. Potential and actual areas of contamination can be assessed based upon historical mining and landfilling activities (*Section 3.1)*, current operations (*Section 3.1.2*), chemical storage and waste inventory (*Section 3.7*), and a review of the limited soil and groundwater investigations completed to date (*Section 3.6*). Potential and actual soil and groundwater areas of concern are presented in *Section 4*.

5.2 REGULATED CONTAMINATED SITES IN VICINITY

The *NSW EPA Contaminated Lands Register* lists sites that are known to be contaminated and are regulated by the NSW EPA under the *Contaminated Land Management Act 1997*. At the time of this assessment (March 2013) the site was not listed on the register.

Sites listed on the *NSW EPA Contaminated Lands Register* in the Lithgow City Council Local Government Area are as follows:

Table 5.1 ***Sites in the Vicinity of Mount Piper which appear on the Contaminated Lands Register***

Suburb	Location	Site	Notices
Hartley Vale	Hartley Vale Road	Hartley Vale Former Shale Oil Refinery	1 current
Lithgow	Methven Street	ADI Lithgow Small Armaments	1 former
Portland	Williwa Street	Blue Circle Southern Cement	2 former

NSW landowners and occupiers who are aware or ought reasonably be aware 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. Information provided by site management indicated that the site has recently self-reported potential or actual contamination to NSW EPA under Section 60 of the *Contaminated Land Management Act 1997* in relation to the Mobile Plant Re-fuelling Area within the CMP.

An adjacent site, the Ivanhoe Colliery on Pipers Flat Road, has reported potential or actual contamination to NSW EPA under Section 60 of the *Contaminated Land Management Act 1997*. The Ivanhoe Colliery extends to the north of the Site, and it appears that part of the Ivanhoe Colliery is within the lands owned by Delta. However, the nature and exact location of the reported contamination is not known.

Table 5.2 ***Sites in Vicinity of Mount Piper Notified to NSW EPA under the CLM Act***

Name	Location	Use	EPA Review Status
Blackmans Flat	Lamberts Gully Castlereagh Highway	Other Industry	In progress
Blackmans Flat	Mount Piper Extension Development Site 2847 Boulder Road	Other Industry	In progress
Cullen Bullen	Baal Bone Colliery Castlereagh Highway	Other Industry	In progress
Lidsdale	Angus Place Colliery Wolgan Road	Other Industry	In progress
Lithgow	BP Service Station 1106 Great Western Highway	Service Station	In progress
Lithgow	Caltex Lithgow (Quota Park) Adjacent to 1131 Great Western Highway	Unclassified	Completed
Lithgow	Former Gasworks Mort Street	Gasworks	Completed
Lithgow	Former Shell Depot 6 Gasworks Lane	Other Petroleum	In Progress
Lithgow	Lithgow Thales 4 Martini Parade	Metal Industry	Completed
Lithgow	Mobil Depot 353 Main Street	Other Petroleum	In Progress
Portland	Ivanhoe Colliery Pipers Flat Road	Other Industry	In progress
Wallerawang	Delta Electricity 1 Main Street	Other Petroleum	In Progress
Wallerawang	Lidsdale Coal Loading Facility Main Street	Other Industry	In progress

5.3 PREVIOUS ENVIRONMENTAL INVESTIGATIONS

In accordance with industry practices Mt Piper Power Station has undergone a limited amount of intrusive soil and groundwater assessments to date. As summarised below, these have been targeted to specific identified issues rather than presenting a comprehensive assessment of site conditions, which is not an unreasonable approach for an operational industry of this type.

Regular groundwater monitoring has been undertaken since construction to monitor conditions around the settlement ponds and the Brine-Ash Repository, and more recently a program has been initiated to achieve compliance with underground petroleum storage system (UPSS) legislation.

The following section summarises the relevant reports reviewed by ERM.

PPK (2000), Phase 1 Environmental Site Assessment, Uncontrolled Landfill Sites, Mt Piper Power Station, Portland, NSW

A Phase 1 Environmental Site Assessment (ESA) was undertaken of a number of uncontrolled landfills previously operated at Mt Piper Power Station. As discussed in *Section 3.1,* these included a construction landfill, uncontrolled/domestic waste landfill and the Chitter Dam landfill. PPK 2000 identified the following potential contaminants:

- Acid drainage from the weathering of sulphide-rich waste from mining activities may result in the mobilisation of heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc);
- Hydrocarbon based contaminants from the disposal of waste products. This may include total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylenes (BTEX), polycyclic aromatic hydrocarbons (PAHS);
- Organochlorine and organophosphorus pesticides from the disposal of drums or residues; and
- Nitrates, nitrites, ammonia phenols from the breakdown of putrescible waste within the uncontrolled landfill.

SMEC (2012) Draft Report: Design and Installation of Underground Tank Testing Boreholes at Mount Piper Power Station (January 2012)

Eight groundwater monitoring wells were installed around three USTs within the shallow aquifer at depths between 4 and 7 m below ground level (bgl). No soil samples were collected or analysed during the well installation. A round of groundwater monitoring was also conducted. Groundwater monitoring results identified concentrations of TPH, BTEX and PAH exceeding the adopted site assessment criteria in both wells installed in the Mobile Plant Refuelling Area (MWMP7 and MWMP8), and in one well located near the Store UPSS (MWMP1). SMEC considers the likely source of hydrocarbon contamination in MWMP1 (up-gradient of the Store UPSS) to be from a potential spill in the area, although it is noted that no delineation was undertaken to confirm the extent or the source.

SMEC (2012) - Underground Petroleum Storage System (UPSS) Groundwater Monitoring – Mt Piper and Wallerawang Power Stations (September 2012)

Quarterly monitoring of groundwater wells at Mt Piper for compliance with UPSS Regulations was undertaken in 2012. Light non-aqueous phase liquid (LNAPL) was identified in a groundwater monitoring well (MWMP8) screened to intersect perched groundwater on the northern side of the wash bay, adjacent to the oil-water separator in October 2012 (SMEC 2012). There were no other groundwater issues identified during the UPSS monitoring.

GHD (2012a) Preliminary Baseline Contamination Assessment & Duty to Report Contamination Western Region - Wallerawang Power Station, Mt Piper Power Station

Delta engaged GHD to review the findings of the PB (2010) Duty to Report Contamination Background Report and conduct a risk screening of contaminated and potentially contaminated areas at Mt Piper and Wallerawang. GHD (2012) identified 33 Areas of Environmental Concern (AECs) and assessed each AEC against a standard risk screening tool. GHD noted that the risk ranking could be lowered if monitoring wells were installed downgradient of landfills and if the analytical suite of the existing groundwater monitoring program was modified. GHD (2012) recommended that notification be made to NSW EPA in regards to the Mobile Plant Area.

GHD (2012b) Western Region Summary Report - Contaminated Sites and Landfills

This report summarises the key findings of GHD (2012a), documenting the nature, location and estimated risk of potential contamination issues for preoprties in the Delta Western region.

Merrick, N.P. (NCGM) (2007) Groundwater Modelling of Brine Conditioned Fly Ash Co-Placement at Mount Piper Power Station

This report provides an assessment of the effects of the proposed extension of the brine-conditioned ash placement area on groundwater quality and trace elements at Neubecks Creek, Huon Creek (formerly referred to as the Eastern Drain) and Huon Pond. Huon Pond is the Huon Mine No. 6 Void and has also been formerly referred to as the Groundwater Collection Basin. This report also explores the contribution of water in mine goaf areas to the water quality observed in Huon Pond.

This study found that there was no risk at Neubecks Creek, with extremely low concentrations predicted. There is also a low risk that some trace elements generated from ash disposal will increase background levels by more than guidelines at Huon Creek or Huon Pond. The modelling indicates that the worst case is silver, with a maximum concentration at about 56% of the guideline value. The water-conditioned ash and the brine-conditioned ash appear to contribute fairly evenly to concentrations of groundwaters discharging into the pond and Huon Creek.

It appears that the mine goaf zones are bleeding continuously into the spoil material, which otherwise would flush readily, under the attraction of the groundwater sink at the Huon Pond. The goaf was found to be contributing some trace elements to the Pond at concentrations above ANZECC guideline levels but this is unrelated to the brine-conditioned ash placement.

CDM Smith (2012) Lamberts North Ash Placement Project Groundwater Modelling Report.

CDM Smith Australia Pty Ltd (CDM Smith) undertook groundwater modelling in order to assess the potential impacts of the proposed ash placement works on groundwater at Lamberts North in accordance with the requirements in Section B2 of the Conditions of Approval (CoA).

CDM Smith concluded that construction of Lamberts North would not affect groundwater flow or levels. Groundwater monitoring and modelling indicated that recent high chloride concentrations detected in a borehole (Bore D10) were likely to be due to upstream coal reject ponds (now abandoned) in the south-west corner of Lamberts North.

The model also confirmed that there was no evidence of chloride contamination in the groundwater from either Mount Piper Ash Repository or from the site of the ash placement area at Lamberts North. The model predicted that once the chloride source has been halted, chloride contamination in groundwater is likely to decline rapidly over time.

The model predicted that it would take about 12 years (from the commencement of brine conditioned ash placement in 2000) for the brine leachates to reach the groundwater under the ash. The model also predicted that the brine and water conditioned ash leachate plumes would not degrade the water quality in the GCB and Neubecks Creek to a point where it would exceed the ANZECC (2000) guidelines for metals.

Aurecon (2011) Mt Piper Brine Conditioned Fly ash Co-Placement Water Quality Monitoring Annual Update Report 2010Delta Electricity Western

This report is an annual update of the Mt Piper Power Station brine co-placement surface and groundwater report and covers the period January, 2010 to December, 2010. The 2010 monitoring data found that there has been:

- an increase in the salinity of the water conditioned ash runoff collection ponds;
- a local increase of salinity and chloride in the groundwater bore MPGM4/D10;
- decrease in chloride concentrations in the GCB in 2010;
- a recent increase in the magnitude of chloride spikes at the northern seepage detection bore, located just outside the ash placement area; and
- further decrease in sulphate and boron in the seepage detection bore D1.

Groundwater monitoring for the first ten years of operation of the brine conditioned flyash co-placement program at Mt Piper Power Station indicates that leachates from the brine conditioned flyash have not yet reached the local groundwater. However, the groundwater modelling indicates that leachates could be expected to reach the groundwater in the near future.

Rainfall runoff from exposed ash batters appears to be the cause of the local increase of salinity and chloride in the groundwater bore MPGM4/D10. This finding suggests that batter runoff controls and liners under the existing runoff collection ponds are required in several areas of the ash placement area to minimise seepage into the local groundwater.

Recent chloride data in the Groundwater Collection Basin shows that the previous trend for increase has changed to a decrease with the return to normal rainfall patterns and has remained well below the local ANZECC (2000) guidelines. The cause of the small increase since 2006 was confirmed as not being due to brine leachates penetrating the groundwater under the water conditioned ash placement, but rather, being due to the movement of nearby high chloride goaf water. The movement of mine water toward the GCB was most likely due to the groundwater level rise caused by the large area of water conditioned ash now placed in the ash placement area.

The seepage detection bore D1 showed a significant decrease in sulphate and boron with the wetter weather in 2010, due to dilution by rainfall runoff. The changes in the water quality characteristics are due to local mine water movement with the groundwater level rise and are not related to the brine conditioned ash placement operations.

The seepage detection bore D3, located north of the brine placement area, showed chloride concentration spikes with rainfall. The spikes appear to be due to the groundwater level rise with water conditioned ash placement and leaching of low levels of chloride from the local mine spoil during rainfall events. However, some of the spikes have recently been higher than expected from the mine spoil, suggesting some input from ash leachates. Accordingly, runoff from exposed batters was suggested to be investigated.

Aurecon (2012) Mt Piper Brine Conditioned Fly ash Co-Placement Water Quality Monitoring Annual Update Report 2011

This report is an annual update of the Mt Piper Power Station brine co-placement surface and groundwater report. The key findings of the 2011 report include the following:

- locally derived and ANZECC (2000) guideline trigger values were not exceeded in receiving waters and there was no evidence of brine leachates migrating beyond two bores adjacent to brine conditioned ash areas;
- increased chloride, salinity and trace metals at bore D10 have not affected concentrations in the Groundwater Collection Basin (GCB);

- Stage I and II brine co-placements have had limited effects on the local groundwater flowing to the northern area seepage detection bores and there were no measureable effects on Neubecks Creek at site WX22;

- there were no significant effects on water quality and trace metals in groundwater at bore MPGM4/D11, inside the ash placement area, in the GCB and in the seepage detection bores. Therefore, the brine co-placement system appears to have effectively contained brine leachates in the ash pores, as predicted by the groundwater model; and

- the chloride and salinity increase at bore D10 have continued in 2011, and are suggested to be due to either brine conditioned ash leachates entering the local groundwater by some unknown flow path or seepage from underground workings or runoff from the local mine spoil and/or coal reject in the adjacent open cut mine.

Based on the findings of the report, several enhancements/controls to collect runoff from the B4 and B5 benches and batters have been recommended to minimise runoff from the brine conditioned ash areas into the local groundwater.

Birch, G., Siaka, M., Owens, C. (2001) The Source of Anthropogenic Heavy Metals in Fluvial Sediments of a Rural Catchment: Coxs River, Australia, Water, Air and Soil Pollution 126: 13-35.

Birch et al (2001) investigated the characteristics of fluvial sediments of the Coxs River catchment to determine the extent of impact by industry, mining, and urbanisation. A total of 133 sediment samples were collected along the entire length of the river and were analysed for heavy metals including Pb, Cu, Zn, Mn, Ni, Co, Fe, and Cr.

It was concluded that the surrounding town, sewage treatment plants, and the power stations were sources of elevated concentrations of heavy metals in sediments. Sediments in the Coxs River downstream of Mt Piper power station had elevated concentrations of nickel, cadmium and cobalt.

Birch et al (2001) concluded that sediments in the Coxs River, Lake Wallace and Lake Lyell contained concentrations of heavy metals which were above background conditions. Acid leaching analysis suggested that the heavy metals in sediments were generally not bioavailable (Birch et al, 2001). However, a proportion of sulphide-bound and organic matter-bound metals may become bioavailable under specific physiochemical conditions such as increases in redox potential (Birch et al, 2001). These results were based on laboratory analysis of sediments, and the study did not include monitoring of surface water conditions to determine the likelihood of these conditions occurring at the sampled sites.

Birch et al (2001) concluded that sediments in the Coxs River, Lake Wallace, and Lake Lyell contain concentrations of heavy metals which are higher than background conditions. Concentrations of heavy metals in the Coxs River downstream of the dam wall at Lake Lyell were close to background levels, and Birch et al (2001) concluded that Lake Wallace and Lake Lyell effectively contain the sediment impacts.

6 SUMMARY OF FINDINGS

6.1 AREAS OF ENVIRONMENTAL CONCERN

Based upon a review of current and historic site operations, previously completed environmental assessments, and chemicals and wastes stored and/or disposed of on the Site, a number of actual and/or potential areas of environmental concern have been identified. The following sections provide an assessment of each of these areas, followed by an assessment of the materiality of the issues identified in the context of the transaction.

6.1.1 *Former Mine and Backfilling of Operational Area*

Mount Piper's main operational area was constructed on former open cut coal mines. Material used for backfill is not recorded however site management believed that it was most likely to be mine overburden and mine wastes, and this is consistent with typical mine practice. Along with mine overburden, it is feasible that other smaller waste streams used as backfill may be contributing to elevated salt, metals and acidity in groundwater.

It is also feasible that isolated areas of contamination relating to previous mine operation may remain at the facility. Historical activities with the potential to cause isolated contamination issues include maintenance and refuelling.

A former chitter dam associated with the former Ivanhoe Mine is located in the buffer lands acquired by Delta Electricity, to the south-west of the main operational area. The chitter dam is visible in aerial photographs in 1984, with vegetation covering the area in subsequent photographs. The approximate extent of the filled area is indicated in maps of the Mount Piper site (PPK, 2000) and site management believed that it was three to four metres deep. The chitter dam is located upgradient from the former putrescible waste dump described in the following section, with an unsealed road separating the two areas. The position of the chitter dam in a surface water drainage line indicates a potential for saturation and pondage of surface water in this area, and a high potential for seepage. Potential contamination concerns include impact from chitter (that is, coarse carbonaceous wastes) such as acidity, dissolved salts and heavy metals.

The remnants of several large structures are evident in the buffer land to the north. Aerial photographs and old maps suggest that these were water treatment dams, and interview with site staff indicated that these have been filled and are no longer in use. Given that they are within the footprint of the former Huon mine, it is feasible that these are coal washery ponds that present potential contamination concerns associated with acidity, dissolved salts and heavy metals. Site staff also suggested that these may have been sewage ponds however this could not be confirmed, and given the limited population in the area the ponds appear to be relatively large and as such may not relate to that speculated use.

A contractors yard/ staging area was established during the construction of the power station to the south of the current staff carpark. Other former mine infrastructure may be present in the buffer lands and for that reason it is recommended that a broad-scale assessment of potential contamination be undertaken to rule out potential material environmental issues associated with soil and groundwater conditions.

6.1.2 *Former Landfills*

There are two closed landfills which date from the early years of construction and operation of Mt Piper Power Station. Whilst each landfill was intended for a specific purpose and such practices were not uncommon at that time, the disposal of waste was uncontrolled and a range of potential contaminants may be present:

- the former construction waste landfill was used by contractors for disposal of building waste and materials from the construction of Mt Piper Power Station. The landfill is located in a gully in the western buffer land.
- the former general waste landfill included putrescible waste and site management indicated that it was not used for disposal of restricted wastes (ash or related wastes). The landfill consisted of an unlined trench without controls on landfill gas or leachate. The landfill was reportedly used between 1993 and 1995, when the Power Station changed its policy and disposed of waste off-site. A relatively small proportion of the planned landfill was therefore filled. The landfill is located to the south-west of the main operational area in the western buffer land.

There have been limited investigations into the potential for leaching from the uncontrolled landfills, however, documentation of these investigations was not available at the time of reporting. Two existing groundwater monitoring wells located in the area are monitored on a quarterly basis however it is noted that the analytical suite does not include all of the identified potential contaminants of concern.

Potential contamination concerns include impact from non-inert construction wastes (oils, solvents, paints) and putrescible wastes (leachate). Further assessment of these areas via intrusive assessment is therefore recommended.

6.1.3 *Coal Storage Area*

The coal storage area is approximately 16 ha in size and is used for stockpiling of coal prior to being transferred via conveyor to the boilers. Potential contamination sources or activities include coal stockpiling, use and maintenance of conveyors, coal truck washdown bays and associated settling ponds, and seepage from contaminated stormwater settling ponds. Refuelling of mobile plant is discussed in a separate section.

While there have been no soil and groundwater investigations completed within the Coal Storage Area, based upon the potential sources of contamination and low likelihood of receptor exposure, and that this area will continue to be used for coal storage, this area is considered to represent a relatively low risk in the context of this assessment.

6.1.4 *Electrical Transformers*

Transformers and associated oil storage tanks are located on concrete within a contained area. In general, transformers are considered to be "PCB free", with transformers are tested regularly to assess PCB concentrations. There was a marginal exceedance of the statutory limit under the Environmentally Hazardous Chemicals Act 1985 for the notification of PCBs (Unit 2B 11/3.3kV Auxiliary Transformer) of 2 ppm (mg/kg) with 3.1 ppm (mg/kg). Delta did not report any spills within the transformer area and given the general level of housekeeping and monitoring, it is unlikely that a release of sufficient quantity has occurred and not been reported.

While there have been no soil and groundwater investigations completed within and around the transformers, based upon the absence of known historical release and the low likelihood of a pathway to soil and groundwater, this area is considered to represent a relatively low risk in the context of this assessment.

6.1.5 *Water Holding Ponds*

Site management reported that the open ponds used to store and treat wastewaters are lined with rubber to prevent wastewater loss, and that monitoring bores are located near the ponds to allow detection of leakage. Site management reported that monitoring results indicate that leakage has not occurred. At present, although there have been limited soil and groundwater investigations completed related to the water holding ponds, based upon the management advice that no impact has been registered, these areas are considered to represent a relatively low risk in the context of this assessment.

6.1.6 *Workshops*

Maintenance workshops are located at:

- the western side of the main plant, behind Unit 2; and
- the south-east corner of the coal handling area (this is a combined workshop and mobile plant refuelling area).

Site management indicated that the workshops have remained in the same location since plant operation commenced. Delta management reported that some chlorinated hydrocarbons such as "Dev-Tap" (1,1,1, Trichloroethane) have been used historically, but that such products are no longer used.

A washdown pit is located adjacent to the day maintenance workshop and the integrity of this in-ground pit is unknown.

Although a covered concrete platform is provided at the mobile plant yard, some staining is evident on surrounding open ground. It is also feasible that the formal wash area was not available historically. A separate known issue relating to fuel storage is discussed in *Section 4.1.2*. There have been no soil and groundwater investigations completed within the workshop areas to achieve a suitable degree of environmental characterisation. Given the absence of previous environmental investigations, and the potential presence of chlorinated solvent use on site, further investigation may be required rule out potentially significant soil and groundwater contamination issues.

6.1.7 *Mobile Plant Refuelling Area*

The mobile plant refuelling area is located adjacent to the coal storage area and is used by large mobile plant. The infrastructure comprises a shed, small workshop and a wash bay, with a diesel UST and bowser located on the southern side of the wash bay. The wash bay drains to an oil-water separator located on the northern side of the wash bay. The ground immediately surrounding the mobile plant area is unsealed and there was staining observed on bare ground beneath the large plant.

Light non-aqueous phase liquid (LNAPL) was identified in a groundwater monitoring well (MWMP8) on the northern side of the wash bay, adjacent to the oil-water separator in October 2012 (SMEC, 2012). Further investigations were undertaken, including integrity testing and excavation to inspect the UST and lines, which indicated no issues with the UST. Hydrocarbon fingerprint analysis was undertaken on samples of the diesel from the UST and the LNAPL in March 2013. The LNAPL was weathered with an age estimate of 25 years and was unrelated to the diesel currently in the UST.

The presence of LNAPL in perched groundwater with an age estimated at 25 years, unrelated to the current UST, suggests a historic aboveground release of diesel in this area. The extent of the impact has not been delineated and further investigation would be required to rule out potentially significant soil and groundwater contamination issues.

6.1.8 *Operational and Decommissioned USTs*

Four underground storage tanks (USTs) are present on site, containing diesel and petrol (E10), in the stores, diesel generator and the mobile plant area. The USTs are understood to be approximately 20 years old and no information was available during the assessment on their construction. Site management advised that tank integrity tests are undertaken routinely at the site and have not identified any issues. In addition, site management were not sure whether the programme included underground pipework. Documentation relating to the programme has been requested from the Stores Manager.

The USTs are located as follows:

- Petrol and diesel USTs near the main store (approx. 33 000L and 20 000L);
- Diesel UST for the emergency generator (11 700L) and associated above ground day tank; and
- Diesel USTs at the mobile plant refuelling area (discussed above).

Soil and groundwater investigations have been completed in the areas of below ground tank infrastructure to ensure compliance with relevant underground petroleum storage system (UPSS) legislation, and ensure protection of soil and groundwater receptors. Based upon the environmental characterisation achieved, this area is considered to represent a relatively low risk in the context of this assessment, with the exception of the mobile plant area which is separately discussed in *Section 6.1.7*.

6.1.9 *Operational ASTs*

The site houses numerous above ground storage facilities, ranging from small roofed stores for minor quantities of maintenance chemicals to very large diesel tanks. The facilities that present a higher contamination risk are described below, based on compliance assessments in the dataroom and discussion with site management.

Site management advised that tank integrity tests are undertaken routinely at the site and have not identified any issues. However documentation relating to the programme was not available during the site visit, and the tanks included within this programme could not be confirmed. In addition, site management were not sure whether the programme included underground pipework. Documentation relating to the programme has been requested from the Stores Manager.

As noted earlier, Mount Piper Power Station uses refined recycled oil (RRO) for its auxiliary fuel requirements at start-up, mill change-over and low load running. The auxiliary fuel is delivered to the station by road tanker (Worley Parsons 2013). The fuel oil installation was installed in 1990/91 and consists of two bunded 1.2 ML steel tanks, an unloading station for unloading two road tankers simultaneously and a small 36 kL overflow tank (Worley Parsons 2013). The fuel tanks are located on the south-east corner of the operational area. The fuel is supplied to the boilers through underground gravity pipes, to dedicated duty and standby ignition oil pumps for each boiler (Worley Parsons 2013). The volume of fuel being stored and transferred across the site represents a significant source of potential contamination. There have been no soil and groundwater investigations completed in the area of the Fuel Oil Installation or associated pipework to achieve a suitable degree of environmental characterisation.

A 28 000 L diesel tank is located near the ash stockpile. Previous investigations (Premier Engineering Services Pty Ltd 2010) have noted housekeeping issues and disposal of contaminated bund water to the ground.

The sulfuric acid, caustic and alum tanks at the demineralisation plant (depots 26 and 27) were reportedly in poor condition and a sulfuric acid tank had suffered an overflow (Premier Engineering Services Pty Ltd 2010).

Given the absence of previous environmental investigations, the volume of stored and transferred fuel and other chemicals, and the potential for historic release events to impact soil and groundwater receptors, further investigation would be required rule out potentially significant soil and groundwater contamination issues.

6.1.10 *Ash Repositories*

Groundwater-Surface water Context

Groundwater modelling of the impact of placement of brine conditioned fly ash in the current ash repository was undertaken prior to commencement of brine co-placement (NCHM, 2007) and more recently (CDM Smith, 2012). The groundwater modelling undertaken indicated that construction of the Lamberts North Ash Repository would not affect groundwater flow or levels (CDM Smith, 2012). The model predictions suggest that there is a low risk that some trace elements generated from ash disposal will increase background levels by more than guidelines at Huon Creek or Huon Pond but not at Neubecks Creek (NCHM, 2007, CDM Smith, 2012).

Annual groundwater monitoring generally supports the findings of the modelling, with results from 2011 indicating that brine leachates are presently contained to the ash repositories (Aurecon, 2012). Brine leachates were not detected in groundwater beyond the two repository boundary wells and surface water quality in receiving waters (Huon Pond and Neubecks Creek) continued to comply with the applicable guidelines (Aurecon, 2012).

Elevated chloride, salinity and trace metal concentrations continue to be detected at bore D10, however no impacts have been identified in the Huon Pond (Aurecon, 2012). Aurecon (2012) concluded that the impacts identified at bore D10 are likely related to seepage from coal rejects or mine spoil from the adjacent open cut mine, seepage from the underground mine workings and/or migration of the leachates from the brine conditioned ash by an unidentified flow path.

The groundwater modelling also identified the role of the mine goaf zones (former tunnel and pillar extraction mine workings) in contributing some trace elements to the Pond at concentrations above ANZECC guideline levels which is unrelated to the brine-conditioned ash placement (NCHM, 2007). Further, the Huon Pond was shown to act as a groundwater sink, exerting an influence on groundwater flow direction.

Current Ash Repository

The current ash repository is located directly to the north east of the Power Station, in the former Western Main open-cut mine void. The repository covers an area of approximately 40 ha.

The ash disposal site was designed as a dry ash repository, with water addition being limited to water added for ash conditioning prior to disposal and dust suppression following disposal. Ash disposal commenced at the repository when the first power generating unit came on-line at Mount Piper Power Station in 1993.

ERM understands that brine conditioned ash was disposed at the repository following an assessment and modification of development approval of potential impacts to groundwater in 1999. Brine conditioned ash is currently disposed in a designated area as permitted by the EPL license (GHD, 2012). Reportedly, approximately 246 ML of brine has been used to condition fly-ash since the placement of brined conditions ash began in November 2000 up to 31 December 2010 (Aurecon, 2010).

Seepage from the ash repository has the potential to be saline and contain heavy metals. Potential receptors include the Neubecks Creek and Huon Pond (formerly known as the Groundwater Collection Basin, currently being filled as preparation of ash placement at Lamberts North).

Groundwater monitoring is undertaken at the repository for a range of potential constituents of concern including salinity, pH, heavy metals and chloride (used as tracer for brine mobilisation) (Aurecon, 2012). Boron and sulfate concentrations exceeding the ANZECC 95% protection levels for fresh water have been attributed to historical coal mining operations, and a marked increase in chloride concentrations in monitoring bore MPGM4/D10 is considered to be caused by seepage from the coal washery rejects ponds (discussed in the following section) (Aurecon, 2012). A groundwater quality review undertaken in 2011 further found that surface and groundwater quality guidelines in the receiving waters of the Neubecks Creek and Huon Pond continued to be met at the time of writing (Aurecon, 2012).

While considerable environmental assessment has been undertaken in this area, it is not considered that suitable characterisation of environmental conditions has been established. Further assessment of this area via sampling of existing wells and additional intrusive assessment is therefore recommended.

Lamberts North Ash Repository

As noted previously, Delta Electricity is expanding its existing ash repository into land previously used by Centennial Coal for open-cut coal mining activities. Delta Electricity obtained Project Approval from the Minister for Planning in February 2012 for the ash placement in an area known as

Lamberts North. The repository, located to the south-east and adjacent to the existing ash repository, is currently being prepared for ash placement. Seepage from the ash repository has the potential to be saline and contain dissolved salts and heavy metals. Potential receptors include the Neubecks Creek. Whilst disposal of ash has not commenced at Lamberts North, groundwater monitoring associated with the existing ash repository is undertaken in the western section of the Lamberts North area. Constituents monitoring include salinity, pH, heavy metals and chloride (used as tracer for brine mobilisation). Boron and sulfate concentrations exceeding the ANZECC 95% protection levels for fresh water have been attributed to historical coal mining operations, and a marked increase in chloride concentrations in monitoring bore MPGM4/D10 is considered to be caused by seepage from the coal washery rejects ponds (CDM Smith, 2012).

During the site visit, it was noted that two unlined coal washery reject ponds were constructed by Centennial Coal along the former drainage line (known as Huon's Gully). These were constructed on a disturbed creek bed and open cut mine filled with overburden. Seepage from washery rejects ponds has the potential to enter the groundwater aquifer. Potential contamination concerns to groundwater include impact through dissolved salts and heavy metals.

During the site inspection on 20 March 2013 the ponds were observed to be almost filled with washery rejects that had dried into a black sludge with no standing water. There are currently no controls on the free movement of surface water along the former drainage line and hence potentially contaminated sludge material could become entrained in surface water.

A freshwater pond is present below the second washery rejects pond, with a poorly battered dam wall construction composed of excavated materials. Delta management reported that the freshwater pond was temporarily used to direct water from the Huon Void. There is potential for seepage from the washery ponds to migrate into the freshwater dam. The freshwater pond is blocked from down-gradient drainage, and the ultimate receiver of waters from this pond is unclear. A drainage channel is currently being excavated by Delta Electricity to divert current surface water flow away from Huon's Gully, and along the boundary between Lamberts North and the ridge above the facility. The intent of the drainage channel is to divert up-gradient surface water runoff around the proposed ash repository, and the rejects ponds. This will divert any further inflows of water to the freshwater pond.

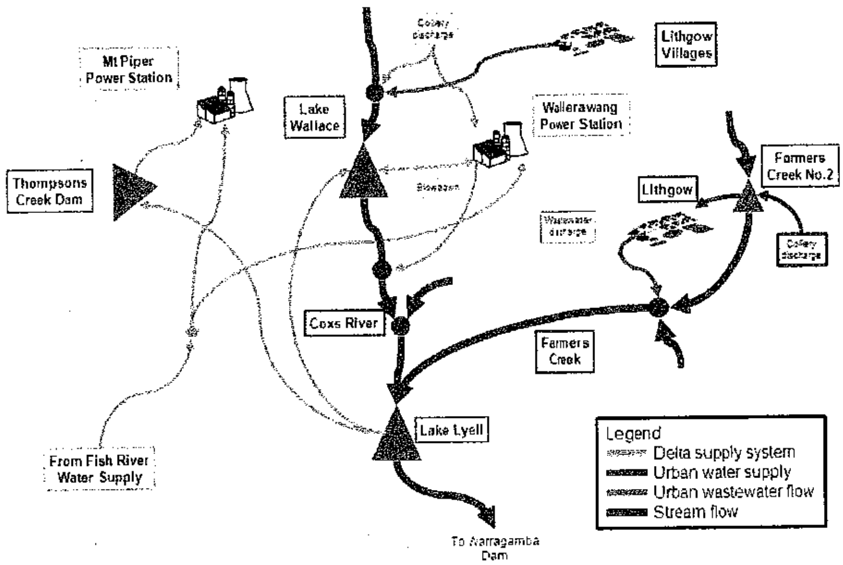
Given the potential for impact to soil and groundwater receptors, further investigation would be required rule out potentially significant soil and groundwater contamination issues associated with the new Lamberts North Ash Repository.

6.1.11 *Water Assets And Receptors (Cox River, Lake Lyell, Thompsons Creek Reservoir)*

Coxs River System

Mount Piper Power Station is situated within the catchment for Neubecks Creek, a tributary of the Coxs River, both of which are potential ecological receptors. The Coxs River catchment includes several current and historical coal mines as well as the Mt Piper Power Station. The Coxs River is dammed at Lake Lyell, with water pumped to off stream storage at Thompsons Creek Reservoir and on to Mount Piper to supply water for the cooling towers. Lake Lyell receives waters from the Coxs River and Farmers Creek, both of which are disturbed river systems. A schematic of the Coxs River water supply scheme, including the location of Lake Lyell, Thompsons Creek Reservoir and Mount Piper is shown in *Figure 6.1* below.

Figure 6.1 Schematic of Coxs River Water Supply (SKM, 2011)



Neubecks Creek

Neubecks Creek (also known as Wangcol Creek) drains from the area west and north of Mt Piper Power Station, and receives waters from Western Drain which is located on the western boundary of the operational area of the Mount Piper site. The two main sources of potential impacts to Neubecks Creek are drainage through former and current coal mine areas and leachates from the ash repositories.

Potential migration pathways for contamination into Lake Lyell include discharges into the Coxs River from Lake Wallace, the Tortuous Watercourse and Farmers Creek upstream of Lake Lyell.

Lake Lyell

Routine surface water sampling in Lake Lyell on one occasion detected low level concentrations of trace elements including molybdenum and uranium at the base of the dam wall (GHD, 2012). These elements were found to be naturally occurring in local igneous rocks used in the construction of the dam wall and were not representative of contamination in surface water. Limited investigations by Birch et al (1999) indicated heavy metals concentrations in sediments in Lake Lyell were slightly elevated above mean concentrations for the Coxs River, with sediment concentrations downstream of Lake Lyell being close to background.

It is noted that the buffer lands around Lake Lyell are used for stock grazing and public camping, however there are not likely to be material environmental issues associated with these uses. Lake Lyell receives water from the Coxs River and Lake Wallace, as well as Farmers Creek and runoff from the buffer lands, all of which may be potential sources of contamination.

Sediment studies on the Coxs River catchment (Birch et al, 1999) have identified elevated concentrations of heavy metals in sediment in the Coxs River, Lake Wallace and Lake Lyell. The Coxs River receives surface water and sediment inputs from both direct discharges from the Wallerawang Power Station as well discharge from several coal mines upstream of Lake Lyell. Wright (2001) demonstrated that discharges of mine water directly alter water geochemistry in freshwater streams, which has the potential to alter the bioavailability of heavy metals in sediments which may otherwise be immobile, thereby contributing to overall heavy metal loads as well as the availability and mobility of heavy metals within the Coxs River system.

Farmers Creek drains the City of Lithgow and heavy metal contamination in sediments (including Cd, Co, Cr, Pb, Ni, Zn) have been identified within and downstream of Lithgow (Birch et al, 1999). Potential historical and current sources of pollutants to Farmers Creek include coal mines, an iron and steel blast furnace (circa 1875), refining of copper, pottery and brick works, a small arms factory, sewage treatment effluent, railway activities (including locomotive workshops) and traffic (Birch et al, 1999).

The investigations by Birch et al (1999) suggest that concentrations of metals in sediments are elevated above background conditions in Lake Lyell. Further investigation is required to assess whether potential material environmental issues exist.

Thompsons Creek Reservoir

Thompsons Creek Reservoir receives runoff from surrounding agricultural lands as well as direct water transfers from Lake Lyell. It is unlikely that any material environmental issues exist at Thompsons Creek Reservoir due to the low risk of impacts from agricultural land use, and the settling of sediments within Lake Lyell prior to water transfers.

Black staining was observed on the gravel surface at the rear of the air compressor building (<5 m^2) however this is not likely to be a material issue. It is noted that the buffer lands around Thompsons Creek Reservoir are used for stock grazing and public access for recreational fishing, however there are not likely to be material issues associated with these uses.

There have been limited investigations into surface water and sediment quality in Lake Lyell and Thompsons Creek Reservoir and therefore an investigation is considered to be required to assess surface water and sediment quality and assess whether potential material environmental issues exist. It should be noted that the Coxs River, and its tributaries including Farmers Creek, receive discharge water from other sources, and it will be necessary to take into account the technical and legal implications of other potential contaminant sources.

6.2 *SUMMARY OF KEY ISSUES*

Of the potential areas of concern identified in *Section 6*, the following issues have been identified as being potentially the most significant in the context of the transaction:

- Former Mine activities including chitter dam and wastewater treatment ponds;
- Former Power Station landfills (Construction waste and putrescible waste)
- Fuel Oil Installation and Associated Pipeworks and ASTs;
- Workshop areas to assess chemical use, washdown pits and known diesel issue at the mobile plant area;
- Current Ash Repository;
- Lamberts North Ash Repository coal washery reject ponds; and
- Water assets at Lake Lyell and Thompsons Creek Reservoir.

7 PRELIMINARY REMEDIATION COSTINGS

Based on the information available at the time of preparation of this report ERM has not identified any actual contamination issues which are currently undergoing or likely to require material remediation, assuming ongoing industrial land use as a coal fired power plant. Preliminary remediation costs have not therefore been prepared at this point in time. As discussed in the previous section, a number of AECs have been identified which further assessment in order to more accurately assess the potential for remediation to be required. It is proposed that the subject of remedial costs be revisited following completion of the proposed Stage 2 investigations.

8 RECOMMENDATIONS FOR STAGE 2 ASSESSMENT

Based on the results of the Phase 1 assessment undertaken by ERM and consideration of Government's intended approach to the assignment of liability relating to soil and groundwater contamination issues, a programme of intrusive (Phase 2) assessment of potential soil and groundwater contamination issues is proposed. The following sections set out the proposed scope for the Phase 2 works in accordance with the requirements set out in NSW EPA (2011).

8.1 DATA QUALITY OBJECTIVES

Prior to commencement of the Phase 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), Australian and New Zealand Environment and Conservation Council (ANZECC) and National Environment Protection Council (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 C*.

8.2 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) will be prepared during preparation of the SAQP for the Stage 2 works and will then incorporate the findings of the Stage 2 investigations. Based on the Stage 1 investigation a preliminary CSM has been developed and is summarised below in *Table 8.1*.

Table 8.1 ***Preliminary Conceptual Site Model***

Contaminants of Potential Concern	The primary contaminants of concern include: • metals and metalloids (arsenic, boron, cadmium, chromium, copper, nickel, lead, mercury, selenium, zinc, fluoride, manganese); • Major cations and anions (including sulfate and chloride); • Total Recoverable Hydrocarbons (TRH); • Polycyclic Aromatic Hydrocarbons (PAHs); • BTEX - benzene, toluene, ethylbenzene and xylenes (BTEX); • Volatile Organic Compounds (VOCs) including chlorinated hydrocarbons; and • asbestos (presence / absence). Additional contaminants of concern may also be analysed if required based on observations made in the field.
Potential Migration Pathways	• Groundwater • Surface water • Fluvial sediment transport • Leaching from landfills • Aeolian transport of fines (dust)
Potentially Affected Receptors	• Nearby residents • Workers at the site • Waterways – Nuebecks Creek, Coxs River, Lake Lyell

Notes:
1. A detailed conceptual site model will be undertaken during the Stage 2 works.

8.3 SAMPLING RATIONALE

Based on a review of the available data, the most appropriate sampling design is considered to be a combination of systematic (grid based) and judgemental (targeted) sampling. 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.

Given the scale of the site (greater than 1000 ha), a tiered systematic sampling approach is proposed with different sampling densities 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.

8.3.1 *Systematic Sampling Locations*

Boreholes will be advanced on an approximately square grid pattern across the areas to be assessed in order to establish an adequate baseline assessment of soil and groundwater conditions where one does not currently exist. ERM proposes to divide the site into five general areas with sampling approaches to be adopted as outlined in *Table 8.2 (below)*.

Table 8.2 ***Proposed Systematic Sampling Approach***

Area	Approach
Accessible operational areas	Boreholes to be advanced on a 50 x 50 m grid where practical + targeted sampling (see below).
Inaccessible operational areas	Boreholes to be advanced around perimeter where practical
Buffer land with minimal historic disturbance	Visual inspection only.
Buffer land with historic disturbance (e.g. mine workings)	Visual inspection and up to 15 soil / groundwater sampling locations around perimeter of buffer lands + targeted sampling (see below).

8.3.2 *Targeted Sampling Locations*

It is proposed that additional targeted sampling locations be advanced in or adjacent to areas of potential concern identified during the Phase 1 assessment and site visits. Justification for additional targeted sampling locations is provided in *Table 8.3* (over).

Table 8.3 ***Proposed Targeted Sampling Approach***

Area of Environmental Concern	Issue	Analytes	Proposed Boreholes & Monitoring Wells
Former Mine and Backfilling of Operational Area	Contamination of soil and groundwater from historical activities or use of impacted fill material.	Standard Suite* plus PCBs	To be assessed via systematic sampling programme in the operational and non-operational areas.
Former Landfills	Potential leaching of contaminants from landfilled materials	Standard Suite* plus PCBs and VOCs	12 soil bores / monitoring wells
Coal Storage Area	Potential leaching of contaminants from stockpiled coal	Standard Suite	5 soil bores / monitoring wells
Electrical Transformers	Contamination of soil and groundwater from transformer oil.	Standard Suite* plus PCBs	4 soil bores / monitoring wells (along southern perimeter – highly dependent on access / logistics)
Water Holding Ponds	Contamination of soil and groundwater via leakage.	Standard Suite*	Sample from existing monitoring well network Additional 8 soil bores
Workshops	Contamination of soil and groundwater from loss of parts washing solvents	Standard Suite* plus chlorinated hydrocarbons (TCE etc.)	5 soil bores / monitoring wells around perimeter
Mobile Plant Refuelling Area	Contamination of soil and groundwater from loss of fuel	Standard Suite*	4 additional soil bores / monitoring wells downgradient of existing LNAPL detection.
Operational USTs	Contamination of soil and groundwater from loss of fuel	Standard Suite*	Sample from existing monitoring well network.
Operational ASTs	Contamination of soil and groundwater from loss of fuel and other chemicals	Standard Suite*	5 soil bores / monitoring wells around perimeter.
Current Ash Repository	Contamination of soil and groundwater from leachate.	Standard Suite*	Sample from existing monitoring well network and 3 additional soil bores to establish ground conditions
Lamberts North Ash Repository	Contamination of soil and groundwater from leachate.	Standard Suite*	6 soil bores/1 monitoring well (highly dependent on access / logistics) near coal settling ponds, and 3 sediment and surface water samples in the adjacent freshwater pond.
Water Assets (Lake Lyell and Thompsons Creek Reservoir)	Contamination of sediments from upstream sources.	Standard Suite* + PCBs, TOC# and PSD##	Co-located surface water/ sediment sampling at Lake Lyell (6) and Thompsons Creek Dam (6).

Note: * - Standard Suite is as set out in Section 8.3.1; # - TOC – Total Organic Carbon; ## - PSD – Particle Size Distribution.

Existing Groundwater Wells

Where existing groundwater monitoring wells have been identified the locations of these wells is presented on *Figure 3* of *Annex A*.

It is proposed that existing groundwater monitoring wells will be sampled during Phase II soil and groundwater investigation works. Sampling will only occur where the groundwater monitoring well 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; 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.

8.3.3 *Waterways*

Sediment and surface water sampling is proposed to target potential contamination from cooling discharges from the Site and includes sampling within:

- Coxs River;
- Lake Lyell; and
- Thompsons Creek Reservoir

8.4 *PROPOSED SAMPLING METHODOLOGIES*

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

- underground service location and mark-out;
- proposed borehole location mark-out;
- coring of hard standing surfaces;
- drilling and soil sampling of subsurface material using 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;
- reinstatement of hardstanding surfaces;
- surveying the location of boreholes and monitoring wells; and
- development, measurement of water levels and sampling of the groundwater monitoring wells.
- Where required, sediment samples will be collected using a remotely operated stainless steel grab unit lowered from a sampling vessel or other equivalent method as deemed appropriate based on site conditions.

A comprehensive methodology providing further details of the intrusive site works investigation process is outlined in *Annex C*.

8.4.1 *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 concern listed below along with additional contaminants of concern associated with activities undertaken in that area.

- metals and metalloids (arsenic, boron, cadmium, chromium, copper, nickel, lead, mercury, selenium and zinc);
- Major cations and anions (including sulfate and chloride);
- Total Recoverable Hydrocarbons (TRH);
- Polycyclic Aromatic Hydrocarbons (PAHs) and Phenols;
- BTEX - benzene, toluene, ethylbenzene and xylenes -BTEX); and
- asbestos (presence / absence).

Additional contaminants of 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 leachate potential under site conditions than the Toxicity Characteristic Leaching Procedure (TCLP).

8.5 *PROPOSED FIELD SCREENING PROTOCOLS*

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

8.5.1 *Soil and Sediment*

Soils and sediments (if required) 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.

8.5.2 *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 (as a minimum 24 hours) 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 and 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.

8.6 *BASIS FOR SELECTION OF ASSESSMENT CRITERIA*

The adopted assessment criteria have generally been sourced from guidelines made or approved under the Contaminated Land Management (CLM) Act 1997 where alternative sources have been utilised appropriate justification has been provided.

8.6.1 *Soil*

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

- National Environmental Protection Council (NEPC) (2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)* Schedule B1 Guideline on the Investigation Levels for Soil and Groundwater (NEPM). Health Investigation Level (HIL) 'D' - Commercial/Industrial and Ecological Screening Levels (ESLs) (as applicable); and
- NSW Environment Protection Authority (EPA) (1994) *Guidelines for Assessing Service Station Sites.* Threshold concentrations for sensitive land use - soils.

Where no Australian endorsed assessment criteria is available, reference to the National Institute of Public Health and the Environment (RIVM) (2001) *Technical Evaluation of the Intervention Values for Soil/sediment and Groundwater: Human and Ecotoxicological Risk Assessment and Derivation of Risk Limits for Soil, Aquatic Sediments and Groundwater* - Human Toxicological Serious Risk Concentrations in soil (SRC_{human} soil) will be made it is noted that these guideline values have no regulatory standing in NSW and hence further assessment of any exceedences of these criteria may be required.

8.6.2 *Groundwater*

Groundwater data will be assessed against investigation criteria published in the following documents:

- Australian and New Zealand Environment and Conservation Council (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, Volume 1 The Guidelines.* Trigger values for freshwater, level of protection for 95% of species;
- 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,* Commonwealth of Australia, Canberra; and
- National Environmental Protection Council (NEPC) (2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)* Schedule B1 Guideline on the Investigation Levels for Soil and Groundwater (NEPM).

Where no Australian endorsed assessment criteria is available reference to the National Institute of Public Health and the Environment (RIVM) (2001) *Technical Evaluation of the Intervention Values for Soil/sediment and Groundwater:*

Human and Ecotoxicological Risk Assessment and Derivation of Risk Limits for Soil, Aquatic Sediments and Groundwater. Human Toxicological Serious Risk Concentrations in Groundwater (SRC_{human} groundwater). It is noted that these guideline values have no regulatory standing in NSW and hence further assessment of any exceedences of these criteria may be required.

8.6.3 *Sediment*

Sediment quality data will be assessed against investigation criteria published in:

- ANZECC / ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* - Interim Sediment Quality Guidelines (ISQGs).

9 *CONCLUSIONS*

The Preliminary ESA undertaken by ERM has identified that limited previous intrusive ESAs appear to have been completed on the sites and a number of potential contamination sources were identified as follows:

- Former Mine and Backfilling of Operational Area;
- Former Landfills;
- Coal Storage Area;
- Electrical Transformers;
- Water Holding Ponds;
- Workshops;
- Mobile Plant Refuelling Area;
- Operational and Decommissioned USTs;
- Operational ASTs;
- Current Ash Repository; and
- Lamberts North Ash Repository.

Based on the results of the Preliminary ESA and consideration of Government's intended approach to establishing a baseline of soil and groundwater contamination, a programme of intrusive (Phase 2) assessment of potential soil and groundwater contamination issues is provided. The most appropriate sampling design is considered to be a combination of systematic (grid based) and judgemental (targeted) sampling of soil, groundwater and sediments at locations across the Sites.

Based on the information available at the time of preparation of this report ERM has not identified any actual contamination issues which are currently undergoing or likely to require material remediation, assuming ongoing industrial land use as a coal fired power plant. Preliminary remediation costs have not therefore been prepared at this point in time. It is proposed that the subject of remedial costs be revisited following completion of the proposed Stage 2 investigations.

10 *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 NSW Treasury ("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 March 2013 and 11 April 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.

11 *REFERENCES*

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WorleyParsons, (2013), *Independent Engineer's Report Mount Piper Power Station (January 2013)*

Mount Victoria to Lithgow Alliance, 2011: *Great Western Highway Upgrade, Corridor Study, Groundwater.*

Table 11.1 ***Dataroom Documents Reviewed***

04.01.02.02.19	MP.EQP.01.02 Mt Piper DG License Expiry Date 07.08.2013.pdf [B916990] [GTA1] [1.0].pdf
04.01.07.01.09	MP.DVP.01.01 western rail unloader Director-General's Report Part 1 [A252027] [GTA0] [1.0].pdf
04.01.07.01.10	MP.DVP.01.01 western rail unloader Director-General's Report Part 2 [A252026] [GTA0] [1.0].pdf
04.01.07.01.11	MP.DVP.01.01 western rail unloader Project Approval [A252024] [GTA0] [1.0].pdf
04.01.07.02.27	MP.DVP.01.02 WRCU EA cover contents and executive summary_April07 [A191586] [GTA0] [1.0].pdf
04.01.07.03.02	MP.DVP.01.03 20121123 Groundwater Modelling Report #2 Final [B916213] [GTA1] [1.0].pdf
04.01.07.04.14	MP.DVP.01.04 Fig 3-1 Groundwater MPGM4 series [B897221] [GTA1] [1.0].pdf
04.01.07.04.15	MP.DVP.01.04 Fig 4-1-Site Catchment [B897224] [GTA1] [1.0].pdf
04.01.07.04.16	MP.DVP.01.04 Fig 4-4- SWMonitor [B897223] [GTA1] [1.0].pdf
04.01.09.01.03	MP.ENV.02.01 20090528 Letter from DECCW re changes to Environment Protection Licensing for Mt Piper [B915623] [GTA1] [1.0].pdf
04.01.09.01.05	MP.ENV.02.01 20100121 Licence variation to Mt Piper EPL 13007 [B915679] [GTA1] [1.0].pdf
04.01.09.01.06	MP.ENV.02.01 20100809 Letter from DECCW containing Draft Notice of licence variation 1118174 to Mt Piper EPL 13007 [B915687] [GTA1] [1.0].pdf
04.01.09.01.07	MP.ENV.02.01 20100820 Letter from DECC containing notice of licence variation 1118174 to Mt Piper EPL 13007 [B915684] [GTA1] [1.0].pdf
04.01.09.01.09	MP.ENV.02.01 20121128 Aerial Image of Mt Piper LDPs [B917469] [GTA1] [1.0].jpg
04.01.09.02.01	MP.ENV.02.02 Mt Piper EPA Licence 13007 - Downloaded from EPA Website 19-04-2012 [B576884] [GTA1] [5.0].pdf
04.01.10.03.20	MP.ENV.03.03 Scan of Phase 1 Environmental Site Assessment, Uncontrolled Landfill Sites, Mt Piper Power Station, Portland, NSW (December 2000)
04.01.11.01.264	MP.ENV.04.01 130219 Signed Cover Letter and CLM Notification re MP CHP [B938134] [GTA1] [2.0].pdf
04.01.11.03.01	MP.ENV.04.03 Mt Piper Power Station Water Overview Diagram [B918460] [GTA1] [1.0].pdf
04.01.11.04.01	MP.ENV.04.04 121130 MP Groundwater Monitoring results Jul2010 - Jul2012 (RFI 148MP) [B918268] [GTA1] [1.0].xlsx
04.01.11.04.02	MP.ENV.04.04 121210 MP Groundwater Monitoring Results Jul2007-Jul2012 RFI52 [B921088] [GTA1] [1.0].xlsx
04.01.11.04.03	MP.ENV.04.04 Mt Piper Underground Storage Tanks [B917651] [GTA1] [1.0].xlsx
04.01.11.04.04	MP.ENV.04.04 S12382.01_Groundwater Rpt_Final 25-10-2012 [B907483] [GTA1] [1.0].docx
04.01.11.04.05	MP.ENV.04.04 UPSS locations - MP [B917101] [GTA1] [1.0].docx
04.01.11.04.14	MP.ENV.04.04 WX639510__14 - STATION CHEMICAL SUPPLY DANGEROUS GOODS LOCATIONS LAYOUT-Layout1 [B918384] [GTA1] [1.0].pdf
04.03.06.01.01	WR.ENV.01.01 DES EN 001-01 Environmental Management System v 1.6 [A146257] [CIC1] [5.0].pdf
04.03.06.02.32	WR.ENV.01.02 Duty to report Contamination Background Report PB Feb 2010 [D735089] [CIC1] [1.0]_Redacted.pdf
04.03.06.02.55	WR.ENV.01.02 GHD Western Baseline Contaminated Land Report 2012-185826 [D854329] [GTA1] [2.0].pdf
04.03.06.02.56	WR.ENV.01.02 GHD_184556_Summary Report Western Region 14.12.12 [A459822] [GTA1] [1.0].pdf
04.03.06.02.58	WR.ENV.01.02 Land Management Plan Edition 2 August 2012 [B889259] [GTA1] [3.0].docx
04.01.03.01.097	MP.EQP.02.01 Mt Piper Micro Hydro Energy Recovery System [B927818] [GTA1] [1.0]
04.03.04.03.210	WR.PWR.04.03 Coxs River Storages Yield Review - System Reliability and Salinity Report Rev4a [D757477] [GTA1] [1.0]

DOCUMENT 5b

Mount Piper Power Station

Sampling Analysis and Quality Plan – Part 1

Environmental Resources Management

September 2013

Delta electricity

COMMERCIAL IN CONFIDENCE

Delta Electricity

Project Symphony

Sampling Analysis and Quality Plan

Ref: 0207423RP01_SAQP_DRAFT

September 2013

ERM

Project Symphony

Sampling Analysis and Quality Plan

Approved by:	Jonathan Lekawski
Position:	*Project Manager*
Signed:	*DRAFT*
Date:	18 September, 2013
Approved by:	Peter Lavelle
Position:	*Partner Director*
Signed:	*DRAFT*
Date:	18 September, 2013

Environmental Resources Management Australia Pty Ltd Quality System

Delta Electricity

September 2013

0207423RP01_SAQP_DRAFT

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1 *INTRODUCTION*

This document presents the Sampling, Analysis and Quality Plan (SAQP) developed by Environmental Resources Management Australia Pty Ltd (ERM) for a Stage 2 Environmental Site Assessment (ESA) to be undertaken on behalf of Delta Electricity (Delta) at Wallerawang and Mt Piper power stations, including the water assets at Lake Wallace, Lake Lyell and Thompsons Creek Reservoir. Wallerawang Power Station is situated approximately 8 km north-north-west, and Mount Piper Power Station is situated approximately 18 km north-north-west of Lithgow, in the Central West region of New South Wales (NSW). The sites are located north west of Sydney, between Lithgow and Portland, approximately 10 kilometres apart as presented in *Figure 1* of *Annex A* and will herein be referred to as "the Sites".

The Sites were formerly owned and operated by Delta Electricity (a State Owned Corporation - SOC) however have recently been transferred to the ownership of Energy Australia (EA). The Sites include the main electricity generating areas and associated coal stockpiles, ash emplacement areas, buffer zones (comprising dominantly native forested areas and open woodland and rehabilitated and revegetated land) and associated water assets (including water supply reservoirs).

Based on results of the Preliminary Environmental Site Assessments (PESAs) undertaken by ERM, a number of Areas of Environmental Concern (AECs) were identified across both Sites. Site layout plans identifying the AECs are presented in *Figure 2 to 11, Annex A*. The primary objective for the Stage 2 Environmental Site Assessment (Stage 2 ESA) is to gather soil, sediment, surface water and groundwater data in order to develop a baseline assessment of environmental conditions at the site, 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.

The objectives of this SAQP are to:

- provide a clear summary to all stakeholders of the scope of work to be undertaken; and
- provide guidance in the delivery of the field and analytical programs to facilitate collection of data of an appropriate type and quality to meet the overarching objectives of the Stage 2 ESA.

2 PRELIMINARY CONCEPTUAL SITE MODEL

The preliminary conceptual site model for the Sites, derived from an assessment of the findings of the Preliminary ESA, is presented in the following sections and is also graphically presented in *Annex H*.

2.1 MOUNT PIPER POWER STATION

2.1.1 *Site Identification*

Mount Piper Power Station is a large coal-fired Power Station providing base load for the region via two 700 MW units. It is situated approximately 18 km north-north-west of Lithgow in the Central West region of New South Wales. The approximate coordinates of the Power Station are 223759 m E and 6304970 m S and the street address is 350 Boulder Road, Portland, NSW 2847. A site location map is provided in *Figure 1*.

The total site area is approximately 820 Hectares (ha) which includes:

- The main operational area of the Power Station, which comprises electricity generating activities and the associated coal stockpile;
- The ash emplacement area within a former mine void adjacent to the operational area;
- A buffer zone comprising native forested areas and open woodland and rehabilitated and revegetated land, and including a number of ancillary activities such as transmission line easements and former waste dumps; and
- The associated water asset, Lake Lyell located directly south, and Thompsons Creek Reservoir to the south-east.

2.1.2 *Site History*

The site and surrounding areas have been mined for coal since around the 1940s including underground, roof lifting, and open-cut mining. Based on historical mining maps (CDM Smith 2012 and PPK 2000), formed open-cut mines were present beneath the current operational areas of the power station. These voids are understood to have been backfilled with overburden at the end of mining operations.

Construction of Mount Piper Power Station began in 1984, was halted in 1986 and began again in the early 1990s, with the station commissioned in 1993. Substantial earthworks were required to level the land and backfill the former open-cut mine on the site.

Site management advised during the completion of the PESA that there have been no substantial changes to the building footprint and the current operational areas are representative of operations over the period from 1993 to 2013. There are three landfills which date from the early years of construction and operation of the station:

- Construction Landfill – the use of this landfill was uncontrolled and was used by contractors for disposal of building waste and materials from the construction of the station;
- Uncontrolled Domestic Waste Landfill – a series of trenches were constructed and used for disposal of unknown wastes from 1993 – 1997. Historical maps indicate that part of the landfill was constructed over an old open cut mine;
- Chitter Dam Landfill – was constructed originally as a surface water dam but was never used for storage of water for supply purposes, although there is some indication from aerial photographs that water may have ponded in the dam. The dam was reportedly converted for use as a landfill for chitter, which is a coarse reject material from coal washing (PPK 2000). 'Hard' construction waste such as concrete was also reportedly disposed in this landfill (PPK 2000).

2.1.3 *Potential and Known Sources of Contamination*

The preliminary ESA undertaken by ERMs identified that limited previous intrusive ESAs appear to have been completed on the site and a number of potential contamination sources were identified as follows:

- Former mine and backfilling of operational area;
- Former landfills;
- Coal storage area;
- Electrical transformers;
- Water holding ponds;
- Workshops;
- Mobile plant refuelling area;
- Operational and decommissioned USTs;
- Operational ASTs;
- Current ash repository; and
- Lamberts north ash repository.

2.1.4 *Geology*

Regional Geology

The site is located on the western edge of the Sydney Basin which is characterised by easterly dipping sedimentary deposits. The 1:100 000 Western Coalfield geological map indicates that the site is underlain by the Permian Illawarra Coal Measures comprising interbedded shale, sandstone, conglomerate and coal (Department of Mineral Resources, 1992). The Illawarra Coal Measures are in turn underlain by Permian age sandstone, shale and conglomerate of the Shoalhaven Group.

Soil

A description of the local geology based on environmental investigations conducted in the vicinity of the site cited by CDM Smith (2012) is provided in *Table 2.1*.

Table 2.1 ***Description of Local Geology[1]***

Stratigraphic Unit	Geological Formation	Description	Approximate Thickness (m)
Illawarra Coal Measures	Bunnyong Sandstone	Silty sandstone	1 - 1.5
		Sandstone, siltstone and shale	12 - 14
	Lidsdale Seam	Coal, carbonaceous shale and sandstone	1.1 - 1.8
	Blackmans Flat Conglomerate	Sandstone (medium to coarse grained) with interbedded siltstone	3 – 6
	Lithgow Seam	Coal, carbonaceous shale	1.9 - 2.3
		Siltstone, mudstone and shale	0.3 - 0.6
	Marrangaroo Conglomerate	Sandstone with siltstone bands and some boulders	3.5 - 4.6
Shoalhaven Group	Berry Formation	Siltstone or silty sandstone, some pebbles.	>30

1 Table modified from CDM Smith (2012)

Coal seams within the Illawarra Coal Measures have been widely mined in the region, and sections of the site are underlain by abandoned coal workings (both underground and backfilled open cut) from mining of the Lidsdale and Lithgow seams.

The existing ash repository and the recently established ash repository at Lamberts North are located within a former open cut mine and the . Both open cut mine workings extended to the base of the Lithgow Seam. Whilst approximately 1 m of fill material was placed at the base of the existing ash repository prior to ash deposition, 5 m of fill material will be placed at the base of the Lamberts North ash repository prior to ash deposition (Nino Di Falco, personal communication, 20 March, 2013).

2.1.5 *Hydrogeology*

The NSW Natural Resource Atlas online bore register identifies that a number of groundwater bores are located within a 10 km radius of the site which are registered for irrigation, private domestic and stock use. The standing water level in the bores reportedly varies between 1 and 15 m bgl.

Neubecks Creek presents the closest surface water body, located adjacent to the site in a north to north easterly direction.

Information from Lithgow City Council indicates that municipal water is sourced from surface water dams (Farmers Creek Dam #2 and Oberon Dam). The Lithgow City Council Local Government Area covers a large area and incorporates all the townships within the vicinity of the Delta Western Power Stations.

Historic mining activities have had a significant impact on the groundwater regime underlying the site, impacting aquifer properties and groundwater flows.

Where underground workings have been left in place, hydraulic conductivities as high as 5 to 50 m/d have been reported for the disturbed coal seams (Merrick 2007, as cited in CDM Smith 2012). A hydrogeological investigation (HLA-Envirosciences 2004) for the proposed Blackmans Flat Waste Management Facility (located directly down-gradient of the Site) reported an approximate hydraulic conductivity of 1 m/d for the material used for backfilling of the open cut mine voids and approximately 0.01 m/d for the Marrangaroo Conglomerate underlying the Lithgow seam. Groundwater seepage has been observed in remaining mine voids (such as the Huon Void/Pond, formerly known as the Groundwater Collection Basin).

Considering the above, the base of the open cut fill materials are considered to present the shallowest laterally extensive groundwater bearing unit at the site in locations of former open cut mining. Localised perched shallow groundwater has been noted in various groundwater monitoring wells installed for the purpose of assessing potential contamination from Underground Petroleum Storage Systems (UPSS). In areas where former underground mines remain in place, the disturbed coal seams are considered to present the shallowest laterally extensive groundwater bearing unit.

The groundwater flow direction at the site reportedly has a north-easterly to south-easterly component (CDM Smith 2012). Locally there may however be different directions in groundwater flow due to local variations in topography and surface water interactions.

It is further noted that groundwater quality has reportedly been affected by coal mining activities, with groundwater impacted by low pH, elevated salinity and trace metal concentrations in a number of locations (Connell Wagner 2008).

2.1.6 *Topography*

According to the Mt Piper Environmental Impact Assessment (Electricity Commission 1980), the elevation of the site ranges from 925 to 960 m above sea level while the hills surrounding the site rise to elevations of about 1000 m at distances approximately 3 km to the north, and 1 km to the south, east and west of the centre of the Mount Piper Power Station.

The operational area lies within a valley created by ridges forming a U-shape to the east, south and west. The floor of the valley has been levelled to construct the Power Station. Hilly forested country lies across the Castlereagh Highway to the north.

2.1.7 *Sensitive Receptors*

The closest major population centre in the region is Lithgow, located approximately 18 km to the south-east of the site. Other population centres within reasonable proximity to the Power Station site are Portland, approximately 4 km to the west, and Wallerawang approximately 10 km to the south-east. Smaller centres are located at Cullen Bullen, approximately 6 km to the north, Lidsdale approximately 6 km to the south-east, with small settlements at Blackmans Flat approximately 3 km to the east and Angus Place approximately 7 km to the north-east. There are two schools, one child care facility and a hospital within 5 km of the Power Station, all situated within the town of Portland.

The site is located within the Upper Coxs River Catchment. Key waterways near the site include:

- Western Drain located within the site on the western boundary of the operational area. This appears to divert runoff from the hills above the site along the western boundary and into Neubecks Creek;
- Neubecks Creek (also known as Wangcol Creek) located immediately to the north of the site. Neubecks Creek drains from the area west and north of Mt Piper Power Station to join the Coxs River north of Lidsdale.
- Huons Gully located along the western edge of the area mined by Centennial Coal. This natural drain line has been significantly disrupted by coal mining and is being reinstated at a slightly higher elevation by Delta in the recently purchased Lamberts North area. Due to the land purchase this drain line runs between the current ash emplacement area and the new Lamberts North ash dam. The drain line includes the large void known as Huons Void. This void was used as a Groundwater Collection Pit by the coal mine but as noted above is now being filled with a base to allow ash emplacement.

- The Coxs River located approximately 2.5 km east from the site boundary. The Coxs River runs from north to south, and is dammed at Lake Wallace and Lake Lyell to provide water supply for the Delta Electricity Power Stations and other uses. The river ultimately flows to Lake Burragorang.
- Pipers Flat Creek located approximately 1.5 km south of the site boundary, running from west to east beyond the forested ridge behind the site.
- Thompsons Creek Dam located approximately 8 km south-west from the site boundary. This dam impounds Thompsons Creek to supply water to the Delta Electricity Power Stations. As the dam has a small catchment it is supplemented with water from Lake Lyell. It is also used recreationally for trout-fishing. Thompsons Creek appears to run south to north joining Pipers Flat Creek mentioned above.

2.1.8 *Surrounding Environment*

Coal mining and power generation are the important industries in the region, and cement production was also a major industry until the closure of the Portland works in the 1990s. The residential areas of Lithgow, Portland, Lidsdale and Blackmans Flat are surrounded by areas used mainly for mining purposes with some grazing and commercial forestry activities.

Key industrial uses in the area are:

- Delta Electricity's Wallerawang Power Station located approximately 7 km to the south east.
- Existing and former coal mines surrounding the site and within the site footprint;
- The former Portland cement works are located 4 km to the west.

Immediate neighbours around the site are:

- North - Ben Bullen State Forest, located on ranges above the site. A small area of land in a valley created by a reach of Neubecks Creek is occupied by agricultural land rather than State Forest;
- East - coal mining (Centennial Coal), beyond which is the hamlet of Blackmans Flat;
- South-east - Ben Bullen State Forest;
- South-west - forested hills;
- West - valley housing agricultural land and the town of Portland.

Almost all land around and within the site boundaries has been subject to underground or open cut coal mining over time.

2.2 *WALLERAWANG POWER STATION*

2.2.1 *Site Identification*

Wallerawang is also a coal-fired power station providing base load for the region via two 500 MW units. It is situated approximately 8 km north-north-west of Lithgow in the Central West region of New South Wales. The approximate coordinates of the main operational area are 228734 m E and 6300266 m S and the street address is 1 Main Street Wallerawang NSW 2845. A site location map is provided in *Figure 1*.

The total site includes:

- The main operational area of the Power Station, which comprises electricity generating activities and the associated coal stockpile (covering an area of approximately 1.1 square kilometres (km^2);
- The Coxs River, which runs through the main operational area and provides water supply to the Power Station through a large dam (Lake Wallace) located on the southern area of the site;
- The southern buffer lands that surround Lake Wallace, and consist of open plains and small forested areas (covering approximately 5.2 Km^2 including Lake Wallace);
- The ash emplacement dams (Kerosene Vale and Sawyers Swamp) located within a former river valley approximately 850 metres to the north-east of the operational area;
- The northern buffer lands that bound the ash emplacement dams, incorporating hilly forested country that slopes to the west, including waste dumps on the lower land (covering approximately 5.2 km^2).

2.2.2 *Site History*

Coal mining began in the area near Wallerawang in the 1870s. The area was home to a number of collieries from 1880s onwards. The main operational area of the site is not known to have been mined historically, however the northern buffer lands are known to have been mined by underground workings and open-cut mines. The northwest corner of the Kerosene Vale Ash Repository lies within the former Kerosene Vale open-cut mine. The footprint of the former Lidsdale open-cut mine was partly backfilled with mine overburden, and partly used a general waste and asbestos landfills by the power station, while the former centre of the mine remains as open void known as the 'Lidsdale Cut'. The Lidsdale Cut has flooded from groundwater intercepted in the old mine workings, and also receives surface water.

The site has operated as a power station since 1957 and has been commissioned in stages:

- 1957 – A Station's four 30 MW units (Units 1,2,3,4);
- 1961 – B Stations two 60 MW units (Units 5 and 6);
- 1976 – C Stations two 500 MW units (Unit 7 and 8)
- The damming of Coxs River to create the Lake Wallace Reservoir;

Both A and B stations were decommissioned in the early 1990s. The infrastructure below ground level remains in place and voids have been backfilled with unspecified material. The footprint of A and B stations and associated coal stockpiles is known to be limited to the current operational area west of the Coxs River. Key features of A and B station were located as follows:

- The switchyard was located to the immediate south of Units 1-6, and is still in place;
- The main store and the fuel installation were located to the west of the old switchyard, in an area that is still occupied by the store building and a more recent fuel installation;
- Cooling towers were located in the current carpark in north-western of the operational area;
- The ash stockpile was located at the bend in the Coxs River near the current fly ash precipitators.

Over time, Sawyers Swamp Creek to the north has been dammed and diverted to allow construction of the ash placement areas. These have extended progressively northwards towards the head of the valley, starting with the Kerosene Vale Wet Ash Dam in the former Kerosene Vale open cut mine, extending northwards to create the Sawyers Swamp Creek Wet Ash Dam, and finally creating a Kerosene Vale dry Ash Repository by capping the Kerosene Vale Wet Ash Dam and placing additional lifts of ash on the surface.

2.2.3 *Potential and Known Sources of Contamination*

The preliminary ESA identified that some previous intrusive ESAs have been completed on the site and a number of additional potential contamination sources were also identified as follows:

- Former 'A' and 'B' Stations;
- Current fuel installation and fuel line;
- Coal plant refuelling area;

- Past and current maintenance, store and workshops;
- Settling ponds and discharges (Coal Settling Basin, CIP Settling Ponds, Retention Basins);
- Transformer operations;
- Kerosene Vale and Sawyers Swamp Creek Ash Repositories;
- Lidsdale Cut;
- Landfills near Lidsdale Cut;
- Former demolition landfill;
- Sediments in Lake Wallace and associated waterways;
- Former mines in buffer land.

2.2.4 *Geology*

Regional Geology

The site is located on the western edge of the Sydney Basin which is characterised by easterly dipping sedimentary deposits.

The 1:100 000 Western Coalfield geological map (Department of Mineral Resources 1992) indicates that the Wallerawang operational area is underlain by Permian age siltstone, lithic sandstone and conglomerate of the Shoalhaven Group.

The 1:100 000 Western Coalfield geological map indicates that the former landfill site, current asbestos landfill site and the former and current ash placement areas are underlain by the Permian age Illawarra Coal Measures comprising interbedded shale, sandstone, conglomerate and coal. The Illawarra Coal Measures are in turn underlain by sandstone, shale and conglomerate of the Permian Shoalhaven Group.

Soil

Available geological information sourced from environmental investigations for the site is limited to the area in which the Kerosene Vale Ash Dam (KVAD) and the Sawyers Swamp Creek Ash Dam (SSCAD) are located.

Bore logs indicate that the geology in this area is generally characterised by sandy clay layers to between 5 and 7 metres below ground level (m bgl), with the sandy clay layers underlain by shale and sandstone. Deposits of coal and coaly siltstone of between 0.5 and 1.5 m thickness, interspersed with mudstone, siltstone and claystone at depths between 7 and 15 metres are shown on some bore logs (Parsons Brinckerhoff, 2008).

2.2.5 *Hydrogeology*

The NSW Natural Resource Atlas online bore register identifies that groundwater bores within a 10 km radius of the site are registered for irrigation, private domestic and stock use as well as a number of monitoring bores. The standing water level in the bores varied between 1 and 15mbgl.

The Coxs River intersects the main operational area, and, based on local topography, groundwater flow in this area is expected to flow locally to the Coxs River and Lake Wallace to the south.

Groundwater site investigation work at the main operational area is limited to an Underground Petroleum Storage Systems (UPSS) monitoring program discussed in detail in later sections. Groundwater gauging associated with the UPSS monitoring program indicates that shallow groundwater in the vicinity of the site fuel handling facilities ranges between 1 and 4 m bgl (SMEC, 2012). Borelogs for the monitoring wells associated with the UPSS monitoring program were not available during the completion of the PESA by ERM and nor was information on specific water bearing.

Groundwater reportedly flows in a general north-westerly direction from the ash placement areas towards the Lidsdale Cut, which collects groundwater flow from upgradient areas. The Lidsdale Cut is the former centre of the Lidsdale open cut mine and is an unfilled void that has flooded from surface water and groundwater intercepted in the old mine workings. Historical coal mining activities and the disposal of coal ash slurry are considered to have had a significant effect on the groundwater regime in the vicinity of the Wallerawang Power Station landfills and ash placement areas. The landfills are located within historical open cut mine workings. The north-western corner of the KVAD is located within the former Kerosene Vale open cut mine workings. Large volumes of ash slurry were deposited in the SSCAD and KVAD up to the early 2000s, at which time Wallerawang switched to dry ash disposal.

Groundwater levels in the available monitoring network have varied between 1 and 12 m bgl, with the shallowest groundwater levels observed in the vicinity of Sawyers Swamp Creek (Parsons Brinckerhoff, 2008). Numerous groundwater seeps were observed between the KVAD and Sawyers Swamp Creek during the site visit conducted in March 2013.

2.2.6 *Topography*

The operational area lies within a fairly broad river valley created by the Coxs River and its tributaries. The area is dissected by various creeks and rivers that drain the plateau. The site lies at an elevation of approximately 880 m above sea level. Higher hilly country is located on all sides.

2.2.7 *Sensitive Receptors*

The closest major population centre in the region is Lithgow, located about 14 km to the south-east of the site's centre. The smaller townships of Wallerawang and Lidsdale are located on the boundary of the buffer land. There is one school and one child care facility within 5 km of the centre of the main operational area located in the town of Wallerawang.

Other population centres within reasonable proximity to the site are Portland about 12 km to the north-west, Cullen Bullen about 13 km to the north, and a small settlement at Blackmans Flat about 6.5 km to the north.

The site is located within the Upper Coxs River Catchment. Key waterways near the site include:

- The Coxs River which flows through the centre of the site. The Coxs River runs from north to south, and is dammed at Lake Wallace and Lake Lyell to provide water supply for the Delta Electricity power stations and other uses. The river ultimately flows to Lake Burragorang.
- Springvale Creek, which runs in a general westerly direction along the edge of the coal stockpile and joins the Coxs River;
- The "torturous watercourse" which is partially a former natural drainage line and properly constructed earthen channel and has been converted to receive blowdown water from a discharge pipe from Wallerawang Power Station and directs discharge into the Coxs River downstream of the reservoir;
- Sawyers Swamp Creek which was dammed and diverted around the Wallerawang Power Station ash placement areas.

2.2.8 *Surrounding Environment*

Coal mining and power generation are the important industries in the region, and cement production was also a major industry. The residential areas of Lithgow, Portland, Wallerawang, Lidsdale and Blackmans Flat are surrounded by areas used mainly for mining purposes with some grazing and commercial forestry activities.

Key industrial uses in the area include:

- Delta Electricity's Mt Piper Power Station located approximately 7 km to the north-west; and
- Existing and former coal mines surrounding the site and within the site footprint.

The Main Western Railway and Castlereagh Highway run through the operational area. Immediate neighbours around the site include:

- West - the townships of Wallerawang and Lidsdale;
- East - grazing lands and Centennial Coal's Springvale Colliery (underground);
- North - Centennial Coal's Angus Place Colliery (underground) and Newnes State Forest; and
- South - Lidsdale State Forest.
- Much of the land around and within the site boundaries has been subject to underground or open cut coal mining. Centennial Coal has a number of development projects in the immediate vicinity of the site including extensions to Angus Place and Springvale, as well as the Neubeck open cut project.

3 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) have been developed to define the type and quality of data required to achieve the project objectives outlined in *Section 1.2.* The DQOs were selected with reference to relevant guidelines published by the NSW Environmental Protection Authority (EPA), Australian and New Zealand Environment and Conservation Council (ANZECC) and National Environment Protection Council (NEPC), which define minimum data requirements and quality control procedures.

The DQOs have been prepared in line with the DQO process outlined in NSW Department of Environment and Conservation (DEC) (2006) *Guidelines for the NSW Site Auditor Scheme 2nd Edition.* The seven-step DQO approach identified in NSW DEC (2006) is described in the following sections.

3.1 STEP 1: STATE THE PROBLEM

Objectives

The objectives of the SAQP and the project objectives are as stated previously in *Section 1.1.*

3.2 STEP 2: IDENTIFY THE DECISIONS

3.2.1 Decision Statements

Overall, the principal decision to be made is whether there are actual or potential material contamination issues related to the proposed sale of the power generation assets. Additional decisions to be made include:

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

3.2.2 Assessment Criteria

The proposed sources of site assessment criteria are presented in *Section 5.4.1.*

3.2.3 *Waste Classification for Off-Site Disposal*

Any excess soil or groundwater generated during the Stage 2 program will be classified in accordance with the NSW Department of Environment, Climate Change and Water (2009) *Waste Classification Guidelines, Part 1: Classifying Waste* and relevant associated Chemical Control Orders.

3.3 *STEP 3: IDENTIFY INPUTS TO DECISION*

The inputs required to make the above decisions are as follows:

- Existing relevant environmental data, taking into consideration the number and location of existing sampling locations, the construction and condition of existing groundwater monitoring wells and the date of the most recent surface and groundwater monitoring event;
- direct measurement of environmental variables including soil type, soil gas concentrations, odours, staining, water strike, groundwater level and water quality parameters;
- laboratory measurement of soil, sediment and water samples for one or more of the identified potential contaminants of concern;
- field and laboratory quality assurance/quality control data;
- the relevant soil and water quality criteria outlined in Section 5.4.1; and
- assessment of whether the concentrations of the contaminants of concern are greater than or equal to or less than the adopted criteria.

3.4 *STEP 4: DEFINE THE STUDY BOUNDARIES*

3.4.1 *Spatial Boundaries*

The spatial boundaries of the study are as per the description of the Site provided previously in *Section* 2 and figures presented in *Figure 2 to 11, Annex A*. The study also includes consideration of potential impacts to off-site receptors within relevant receiving environments including sampling in Lake Wallace, the Coxs River (and tributaries including Sawyers Swamp Creek) Lake Lyell, Thompsons Creek Reservoir.

3.4.2 *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. An indicative timeframe for the investigation process is provided within the Gantt chart presented within *Annex F*, it is noted however that this may be subject to change based upon conditions encountered in the field.

3.4.3 *Constraints Within the Study Boundaries*

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

- location of underground or overhead services or infrastructure;
- constraints associated with other safety issues or causing unacceptable disruption to site operations;
- the condition of existing monitoring wells; and
- obtaining permission/access to enter and sample in off-site areas (where deemed necessary.

3.5 STEP 5: DEVELOP A DECISION RULE

The DQOs have been designed to facilitate the collection of adequate soil, sediment and groundwater data to address the decisions in Step 2 of the DQO process. Some project constraints may impact on the implementation of the Stage 2 program, for example access to certain locations may be restricted by the presence of sub-surface services. Deviations from the Stage 2 program will be communicated to the relevant project stakeholders during the course of the assessment and discussed in the Stage 2 report, acknowledging the source of any available information and any limitations on the assessment.

3.5.1 *Field and Laboratory QA/QC*

The suitability of soil and groundwater data will be assessed based on acceptable limits for field and laboratory QA/QC samples outlined in relevant guidelines made or endorsed under the *Contaminated Land Management Act (1997)* which includes the National Environmental Protection Council (NEPC) (1999) *National Environment Protection (Assessment of Site Contamination)* as amended by *Amendment Measure 2013 (No. 1)*. In the event that acceptable limits are not met by laboratory analyses, the field observations relating to the nature of the samples will be reviewed and if no obvious source for the non-conformance is identified, such as an error in sampling, preservation of sample/s or heterogeneity of sample/s, liaison with the laboratories will be undertaken in an effort to identify the issue that had given rise to the non-conformance.

If the soil and groundwater data is deemed to be unsuitable, additional analyses may be undertaken on the original sample/s, on duplicate samples or on other samples, if required to meet the objectives of the assessment. If no explanation for the non-conformance is identified, the concentrations for the affected samples will be considered as an estimate.

3.5.2 *Assessment Criteria*

Individual soil, sediment and groundwater data, along with the maximum, minimum, mean, standard deviation and 95% Upper Confidence Limit (UCL) of the mean concentration (if required) will be compared to the relevant assessment criteria. Exceedence of the assessment criteria will not necessarily indicate the requirement for remediation or a risk to human health and / or the environment. If individual or 95% UCL concentrations exceed the assessment criteria, consideration of the extent of the impact, the potential for receptors to be exposed and regulatory compliance will be considered.

The adopted assessment criteria have generally been sourced from guidelines made or approved under the *Contaminated Land Management (CLM) Act (1997)* which includes the National Environmental Protection Council (NEPC) (1999) *National Environment Protection (Assessment of Site Contamination)* as amended by *Amendment Measure 2013 (No. 1)* and where alternative sources have been utilised appropriate justification has been provided.

Soil

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

- National Environmental Protection Council (NEPC) (1999) *National Environment Protection (Assessment of Site Contamination)* as amended by *Amendment Measure 2013 (No. 1)* Schedule B1 Guideline on the Investigation Levels for Soil and Groundwater (NEPM). 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 whilst the HIL 'C' screening criteria are generally not applicable to undeveloped, urban bushlands and reserves, they will be adopted at sampling locations in non-operational areas considered to present a more sensitive land use category. Application of the HILs will be considered on a case by case basis in accordance with the new NEPM 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;

- Where no Australian endorsed assessment criteria is available reference to the National Institute of Public Health and the Environment (RIVM) (2001) *Technical Evaluation of the Intervention Values for Soil/sediment and Groundwater: Human and Ecotoxicological Risk Assessment and Derivation of Risk Limits for Soil, Aquatic Sediments and Groundwater* - Human Toxicological Serious Risk Concentrations in soil (SRC_{human} soil) will be made it is noted that these guideline values have no regulatory standing in NSW and hence further assessment of any exceedences of these criteria may be required.

Groundwater

Groundwater data will be assessed against investigation criteria published in the National Environmental Protection Council (NEPC) (1999) *National Environment Protection (Assessment of Site Contamination)* as amended by *Amendment Measure 2013 (No. 1)* Schedule B1 Guideline on the Investigation Levels for Soil and Groundwater (NEPM) which references the following guidance:

- Australian and New Zealand Environment and Conservation Council (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;

- 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*, Commonwealth of Australia, Canberra;

- NHMRC(2008) *Guidelines for Managing Risks in Recreational Waters*, Commonwealth of Australia, Canberra (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).

Where no Australian endorsed assessment criteria is available reference to the National Institute of Public Health and the Environment (RIVM) (2001) *Technical Evaluation of the Intervention Values for Soil/sediment and Groundwater: Human and Ecotoxicological Risk Assessment and Derivation of Risk Limits for Soil, Aquatic Sediments and Groundwater*. Human Toxicological Serious Risk Concentrations in Groundwater (SRC_{human} groundwater). It is noted that these guideline values have no regulatory standing in NSW and hence further assessment of any exceedences of these criteria may be required.

Sediment

Sediment quality data will be assessed against investigation criteria 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 LOR*

Comparison of the laboratory Limit of Reporting (LOR) to the assessment criteria will be undertaken to confirm that the laboratory LORs are less than the assessment criteria, any exceptions to this will be appropriately noted and justified, please refer to the table and associated footnotes presented in *Annex C* for further details.

3.6 STEP 6: 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 the National Environment Protection (Assessment of Site Contamination) Measure 1999, (as amended by *Amendment Measure 2013, No. 1*), Schedule B (3) - Guidelines on Laboratory Analysis.

The potential for significant decision errors will be minimised by:

- completing a robust Quality Assurance/Quality Control (QA/QC) assessment of the assessment 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 Continuing use consistent with current usage (i.e. industrial for the power station site or open space for non-operational areas / buffer land)

3.7 STEP 7: DEVELOP (OPTIMISE) THE PLAN FOR COMPLETING THE WORKS

The DQOs have been developed based on a review of existing data, discussions with Treasury, Delta Electricity and other stakeholders. If data gathered during the assessment indicates that the objectives of the assessment programme are not being met, the sampling design (including sampling pattern, type of samples and analytes) will be adjusted accordingly using feedback (where necessary) from project stakeholders. In the event that the findings of the baseline ESA identify issues which require delineation or further investigation these will be delineated to the extent practicable, the scope of which is subject to approval from Delta Electricity and NSW Treasury.

4 SCOPE OF WORKS

The scope of works for Stage 2 ESA works comprises the following tasks:

Preliminaries

- preparation of a site specific SAQP, Health and Safety Plan (HASP) and Environmental Management Plan (EMP);
- assess whether suitable monitoring boreholes exist, and whether they can be sampled as part of this investigation;
- identify additional areas of concern or chemicals from the Phase I interviews/site visits;
- review and amend SAQP for the site if necessary;
- engage subcontractors including underground utility locator, drillers, laboratories and surveyors;
- schedule soil and groundwater investigation works with Delta Electricity;
- complete site specific inductions and permitting as required.

Site Works

- ground-truth proposed sampling locations including clearance of underground services as noted below;
- obtain Dial Before You Dig plans, site engineering drawings identifying the location of services and commission a qualified underground utility locator to clear proposed sampling locations; conduct intrusive drilling works and environmental sampling in accordance with the SAQP at the locations presented in *Figures 2 to 11* of *Annex A* and *Table B1 and B4* of *Annex B*; and
- complete visual inspections of non-operational areas. The purpose is to assess the potential for contamination issues not previously identified during the Stage 1 assessment based on a visual observation.

Reporting

At the completion of the investigation works a Stage 2 ESA report in accordance with the NSW EPA (1997) *Guidelines for Consultants Reporting on Contaminated Sites* will be produced. The report will contain factual information including, but not limited to, the following:

- details of works undertaken;
- identification and confirmation of sources of contamination;

- information on the nature, extent and concentrations of contamination;
- assessment of contaminant dispersal in air, surface water, groundwater, sediments, soil, and dust (as relevant);
- details of the appropriate investigation levels to be used in the assessment of the site;
- assessment of the sensitivity of receiving environments (where applicable);
- identification of offsite impacts to soil, sediments, groundwater and surface water (where applicable);
- identification of the potential effects of contaminants on public health, the environment and building structures;
- a geological and hydrogeological assessment;
- assessment of the adequacy and completeness of information available to be used in making decisions on management or remediation of contamination;
- information demonstrating compliance with relevant regulations and guidelines;
- discussion of variations to the strategy or methodology undertaken during the implementation of the investigation works and justification for the variation to the strategy (if applicable);
- a summary of the results of environmental monitoring undertaken during the course of the investigation works; and
- the key decisions identified in Step 2 of the DQO process will be addressed in the interpretative section of the report, which will also include discussion of the findings, an updated and revised CSM and concluding statements which relate directly to the stated project objectives.

5 SAMPLING METHODOLOGY

The soil and groundwater investigation works will generally involve the following key steps, as outlined in the following sections:

- underground service location and mark-out;
- proposed borehole location mark-out;
- coring of hard standing surfaces;
- drilling and soil sampling of subsurface material using push tubing techniques. Alternative drilling methods may be engaged should ground conditions preclude the use of push tubing techniques. Alternative sampling methods could include solid or hollow stem mechanical augering or air rotary methods where bedrock is encountered which cannot be penetrated using push tube methods. Regardless of the drilling methodology adopted, soil sampling techniques will be utilised which minimise the potential for loss of volatiles. Where the collection of undisturbed samples is not possible (eg during hand augering or non-destructive digging (NDD)) the potential for loss of volatiles will be minimised to the extent practical by sampling from larger clods and minimising the duration between sample excavation and placement into the sample container. All samples will be placed immediately into a laboratory supplied container and into an insulated box containing ice to minimise potential loss of volatiles. Samples will also be collected of visibly homogenous material to prevent sampling a mix of soil layers. The proposed depth of investigation will be 3 m below ground level (bgl) for soil bores.
- installation of 50 mm diameter uPVC groundwater monitoring wells in selected boreholes screened appropriately to intersect the aquifer of interest and facilitate measurement of non-aqueous phase liquids (NAPL -if present). The proposed depths of monitoring well installation include both perched groundwater within soil strata at depths estimated at 2-5 m bgl, and deep groundwater within rock strata at depths estimated at 15 m bgl. The depth of deep groundwater wells may extend to 30 m bgl in some areas of the Site, for example, around the ash repositories.;
- backfilling of boreholes;
- reinstatement of hardstanding surfaces;
- surveying the location of boreholes and monitoring wells; and
- development, measurement of water levels and sampling of the groundwater monitoring wells.

Sediment samples in Lake Wallace, Lake Lyell and Thompsons Creek Reservoir will be collected using a grab unit lowered from a sampling vessel. Sediment samples in the Coxs River will be collected by hand from the bank or wading into shallow waters.

5.1 *RATIONALE*

Based on a review of the available data, the most appropriate sampling design is considered to be a combination of systematic (grid based) and judgemental (targeted) sampling. 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. If it is not practicable to undertake intrusive works due to health and safety, or operational constraints, down gradient sampling will be used to assess the level of migration of contaminants from these areas whilst minimising the potential risks. Sampling locations will not be moved more than 10 m without prior approval from relevant stakeholders, except for those sampling points defined as location-critical, which will require prior approval from relevant stakeholders to be moved regardless of the distance.

Given the scale of the sites, a tiered systematic sampling approach is proposed with different sampling densities to be adopted relative to the contamination risk and logistical constraints in different areas of the site. ERM proposes to divide the site into four general areas with sampling approaches to be adopted as outlined in *Table 5.1*.

Table 5.1 ***Proposed Systematic Sampling Approach***

Area	Approach
Accessible operational areas	Boreholes to be advanced on a 50 x 50 m grid in areas not covered by targeted sampling (see below).
Inaccessible operational areas	Boreholes to be advanced around perimeter where possible and in areas not covered by targeted sampling (see below).
Non-operational areas	Visual inspection and additional soil bores / monitoring wells focused primarily on assessing background conditions and identifying potential for migration both on and off-site (including Coxs River and other contributions to Coxs River from up-stream)
Waterways	Targeted sampling only (see below)

5.1.1 *Systematic Sampling Locations*

Boreholes will be advanced on an approximately square grid pattern (50 x 50 m) across the accessible operational area in order to establish an adequate baseline assessment of soil and groundwater conditions where one does not currently exist. The accessible operational area shown in *Figure 7 and 8, Annex A* and includes the central area of the Site excluding hazardous operational areas. It is anticipated that 64 soil bores and 10 monitoring wells will be drilled in the accessible operational area.

5.1.2 *Targeted Sampling Locations*

It is proposed that targeted sampling locations will be advanced in or adjacent to the areas of potential concern identified during the Preliminary ESA and site visits. The areas of potential concern and the proposed targeted sampling locations are shown in *Figures 2 to 11, Annex A*. The rationale for the targeted sampling locations in each area of potential concern is summarised in *Table B1 and B4, Annex B*.

The location of proposed targeted sampling locations may be adjusted in the field where access and site activities enable investigations to occur without unacceptable health and safety risks to personnel and / or unacceptable disruption to site operations. Pending further assessment in relation to access constraints around Lamberts North an additional three monitoring wells may be installed.

5.1.3 *Sediment and Surface Water Sampling*

Aquatic sediment and surface water sampling is proposed in the three water reservoirs, Lake Lyell, Lake Wallace and Thompsons Creek Reservoir, as well as in the Coxs River and tributaries of the Coxs River (Sawyers Swamp Creek, Dump Creek, Tortuous Watercourse) and Lidsdale Cut. Background reference samples will also be collected from areas up-stream of the Delta Sites on the Coxs River and Sawyers Swamp Creek. Co-located sampling points will be distributed across the lakes, and evenly distributed along targeted river sections.

5.1.4 *Existing Groundwater Wells*

It is proposed that existing groundwater monitoring wells will be sampled during Stage 2 ESA works. Where existing groundwater monitoring wells have been identified the locations of these wells are presented in *Figures 2 to 11, Annex A*. 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; 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.

If the existing monitoring wells cannot be located, or their condition not deemed fit for the purposes of this investigation (e.g. not screened at the appropriate depth or if the well casing presents with a blockage or obstruction), then these wells will be replaced during the Stage 2 drilling program.

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

5.2 SOIL INVESTIGATION

5.2.1 *Sub-Surface Clearance*

All proposed drilling locations will be cleared of underground and above ground utilities in accordance with Delta and ERM requirements including "Access Rule Procedure 21 Authority to Dig" (Delta reference: D947485) and ERM's Sub-Surface Clearance (SSC) Procedure (*Annex D*). The key steps involved in ERM's SSC procedure include:

- assigning a SSC Experienced Person (EP) who is responsible for all SSC activities;

- obtaining Dial Before You Dig Plans and marking out public utilities if required;

- obtaining site utility plans and obtaining approval from the site contact for the proposed drilling locations;.

- completing the internal Delta Electricity excavation permitting process;

- conducting a site walkover to identify any visual clues of site services;

- checking all locations for the presence of underground services using a cable location tool;

- where possible soil bores will be located to avoid working in critical areas, defined as areas with 3 m of a subsurface obstruction; and

- each soil bore will be cleared using a hand auger or Non-Destructive Drilling (NDD) to a depth of 1.5 m bgl in non-critical zones or 2.4 m bgl in areas classed as critical zones.

ERM will complete the Delta "Authority to Dig Form - ARP21" for each AEC in accordance with the "Access Rule Procedure 21 Authority to Dig" (Delta reference: D947485). Concurrently, ERM will issue a Sub-Surface Clearance (SSC) location disturbance permit for every investigation location (i.e. for every borehole).

5.2.2 *Soil Bore Drilling*

Soil bores will be drilled in accordance with ERM SOPs using the general methodology outlined below

- Where necessary hardstand drilling locations will be penetrated using a concrete corer prior to physical borehole clearance and drilling;
- each soil bore will be cleared using a hand auger or Non-Destructive Drilling (NDD) techniques to the depth required by ERM's SSC Procedure;
- a drilling rig, incorporating direct push-tube methodology will be used to advance the boreholes to the target depth or until deemed refusal is encountered. Note that alternative drilling methods, such as solid or hollow stem augering may be utilised depending on ground conditions.;
- prior to the commencement of drilling and between drilling locations, all down-hole drilling equipment will be decontaminated to minimise potential for cross contamination between the sampling locations.

5.2.3 *Soil Sampling Protocol*

Soil samples will be collected and logged in accordance with ERM SOPs. In summary the following work procedures will be followed:

- the soil will be logged by an appropriately trained and experienced scientist/engineer to record the following information: soil/rock type, colour, grain size, sorting, angularity, inclusions, moisture condition, structure, visual signs of contamination (including staining and fragments of fibre cement sheeting) and odour in general accordance with AS 1726-1993;
- soil samples will be collected from the surface and at 0.5 m intervals thereafter, or from each lithological unit (whichever is greater), and will be collected based on field observations noted above including visual and olfactory signs of contamination;
- suitable PPE including fresh disposable nitrile gloves will be used during sampling and equipment decontamination;

- a duplicate of each soil sample collected for field screening will be placed in sealed zip lock bags and screened in accordance with ERM SOPs using a 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 suspected, additional laboratory analysis may be undertaken;
- representative soil samples will be collected (to the extent practicable) in accordance with techniques described in Australian Standard AS4482 (Part 2) to maintain the representativeness and integrity of the samples. The samples will be placed in pre-treated laboratory supplied sample containers. The containers will be filled, where practical, to minimise headspace, before being sealed and appropriately labelled. Labels will include the following information:
    - sample identification number;
    - job number; and
    - date of collection.
- field quality control/quality assurance (QA/QC) samples will be collected including field duplicates, inter-laboratory duplicates, rinsate blanks, trip blanks and trip spikes (as required);
- Sample jars will be sealed and immediately placed in a cooler on ice to minimise potential degradation of organic compounds.

5.2.4 *Soil Bore Reinstatement*

Upon completion soil bores will be backfilled in accordance with the works specification requirements and the surface covering reinstated to match existing.

5.2.5 *Waste Materials Generated During Drilling*

All non-liquid waste materials generated during drilling works will be stored on-site in drums or other appropriate containers at a designated staging area. If evidence of significant contamination is observed during drilling (e.g. staining or odour) an attempt will be made to store any potentially impacted wastes separately. All wastes will be disposed to an appropriately licenced landfill.

5.3 *GROUNDWATER INVESTIGATION*

5.3.1 *Groundwater Well Installation*

Selected boreholes will be converted to groundwater monitoring wells in accordance with ERM SOPs. The following methodology will be implemented to install the new monitoring wells.

- the wells will be constructed of 50 mm diameter factory slotted screen (0.4 mm slots) and blank Class 18 uPVC well materials. The wells will be screened within groundwater bearing strata and constructed to allow the ingress of non-aqueous phase liquids (NAPLs) which may be present;
- the well casing and screen will be inserted into the borehole. Washed and graded filter sand will be poured into the annulus between the well screen and borehole wall, ensuring that the sand covers the entire screened level and extends at least 0.5 m above the top of the screen;
- bentonite pellets will then poured on top of the sand at a minimum thickness of one metre and hydrated to effectively seal off the well from surface water or perched / shallow groundwater inflows; and
- each well will be grouted using cement /bentonite grout to within 0.5 m of the surface and the final 0.5 m reinstated with concrete and a heavy duty cover (flush cover or raised monument as appropriate), well casing will be sealed with air-tight, lockable 'envirocaps';
- the well cap will be labelled with the groundwater monitoring well I.D.; and
- following monitoring well installation, each well will be developed to remove any fine materials or contaminants potentially introduced during drilling. Wells will be considered developed when either a minimum of 10 well volumes had been removed, or when water quality parameters stabilise or if the well is pumped dry prior to this. Where sufficient well volumes cannot be obtained, attempts will be made to remove fines and construction material by purging the well over several days to allow for recharge.

5.3.2 *Groundwater Purging and Sampling Protocol*

Where new monitoring wells are installed, groundwater purging and sampling will occur at least one week after well installation and development to allow subsurface conditions to stabilise. Both new and existing monitoring wells will be purged and sampled as outlined below.

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 (as a minimum 24 hours) all wells will be dipped to gauge the depth of groundwater and if necessary the presence and depths of NAPLs. Wells will be purged using a thoroughly decontaminated peristaltic pump under low flow conditions 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. The stabilisation criteria are as described in *Table* 5.2 below.

Table 5.2 *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, and may be particularly unstable when not using a closed flow through cell. In this case, greater weight will be given to pH and EC as the 'stabilising' parameters.

Low-flow sampling techniques will be used to obtain samples that are representative of the local groundwater environment at the site. The inlet of the low-flow pump will be placed approximately 50 cm from the base of the well in order to obtain a representative sample of the aquifer. Water samples will be collected using equipment dedicated to each monitoring well to eliminate the potential for cross-contamination between sample locations.

The following order of sampling will be adopted:

- samples to be analysed for volatile compounds placed into 40 mL amber vials;
- samples to be analysed for semi-volatile compounds placed in 250 mL solvent washed amber bottles; and
- samples to be analysed for metals filtered through disposable cartridges containing 0.45 µm filters and placed in 125 mL plastic bottles preserved with nitric acid.

If NAPL is observed in any groundwater wells, attempts will be made to collect a representative sample of the NAPL for characterisation using a dedicated disposable bailer.

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

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

Sample jars will be sealed and placed in a cooler on ice immediately to minimise potential for degradation of the sample.

5.3.3 *Waste Materials Generated During Groundwater Development/Purging*

Water from development of the wells will be collected and stored in appropriately labelled dedicated drums or an intermediary bulk container (IBC) within the designated staging area. The water will be classified and disposed off-site in accordance with relevant NSW Waste Classification Guidelines.

5.4 *SURVEY*

All groundwater wells (excluding existing groundwater monitoring wells) will be surveyed to Australian Height Datum (AHD) for elevation and Map Grid of Australia (MGA) coordinates for location. For groundwater monitoring wells, the elevation of the highest point of the top of the PVC casing will be measured. A notch will be embedded in the casing to indicate the location surveyed. This mark will be the measuring point for future groundwater elevation measurements. This will allow for the appropriate groundwater elevations calculations and groundwater flow direction interpretations.

5.5 *SEDIMENT INVESTIGATION*

The proposed sediment sampling regime discussed in this section relates to sampling sites as outlined in *Section 5.5* of this report.

Sediment samples will be collected in general accordance with the methodologies outlined in CSIRO (2005) *Handbook for Sediment Quality Assessment.* Sediment and surface water samples will be collected by grab samples by hand, access from the shore along the Coxs River. In larger water bodies (i.e. Lake Wallace, Lake Lyell and Thompsons Creek Reservoir) sediment samples will be collected by technicians from a boat using a mini ponar (grab device) and a niskin sampler will be used to collect water samples. Both a shallow (approximately 1 metre from the surface and a deep (approximately 1 metre from the sediment) water sample will be collected at each location at Lake Wallace. In Lake Lyell and the Thompson's Creek Reservoir, only a deep (approximately 1 metre from the sediment) water sample will be collected in order to gauge if contaminant mobilisation is occurring.

All grab sampling equipment will be decontaminated between sample locations to prevent cross-contamination. The sediment grabs will be emptied into a stainless steel container. A description and photos of the sediment will be logged. The sediment will be homogenised and placed in the appropriate laboratory supplied containers. Equipment used to homogenise the sediment samples will be decontaminated between sampling. For water, field parameters will be recorded using a hand-held multi-parameter meter and the water samples will be emptied directly into the appropriate laboratory prepared containers. If sample location access is difficult or the substrate is not conducive to sample collection, alternative approaches will be considered and appropriate modifications made to the scope.

The sediment samples will be stored on ice and submitted to ALS Laboratory for analysis. The number of sample locations in each section is presented in *Table B1 and B4, Annex B* and shown on *Figures 2 to 11, Annex A*. Samples will be analysed at NATA certified labs for total elemental content (arsenic, cadmium, chromium, copper, nickel, lead, mercury, selenium and zinc), TRH, BTEX, PAH, Phenols and PCBs. PSD and TOC have also been included to assist with interpretation of presumptive contaminant content, which will inform any future requirement for assessment of ecological risk. This would only occur in sediment samples for the % fines fraction less than 75 microns.

Sediment concentrations will be screened against that outlined in ANZECC/ARMCANZ (2000). Additional samples will also be collected from each site. These samples would be stored within the laboratory for a period of 3 months in the event that further monitoring is required based on initial results.

In the event that concentrations exceed stipulated criteria, a detailed Sediment Sampling & Analysis Plan (SAP) would be undertaken to meet the detailed requirements of NEPM and for marine sediment *"National Assessment Guidelines for Dredging"* (SEWPaC 2009). That future sampling plan and program would relate to and concentrate on any area of elevated contaminant concentrations.

5.6 *SURFACE WATER INVESTIGATION*

Water samples will be collected at approximately 1 m above the lake and/or river bed at each proposed sediment sampling location. Water samples will be collected in laboratory prepared glass bottles, prior to the collection of sediment samples to avoid increased turbidity.

Surface water samples will be collected by hand using a sampling container and at least 100 mm below the surface of the water. For shallow streams, samples will be collected beneath the surface of the water with the container facing upstream, while avoiding disturbing substrate.

Sample containers will be sealed and immediately placed in a cooler on ice to minimise potential degradation of organic compounds. The samples will be transported under chain of custody documentation to a NATA accredited laboratory at the end of each day, and analysed for the analytical suite presented in *Table B3 and B6, Annex B*. A calibrated water quality meter will be used to analyse this subsample for field parameters including pH, conductivity, redox potential, temperature and dissolved oxygen. Observations of the general condition of the surface water and its surrounds will also be recorded during sampling.

6 LABORATORY ANALYSIS

6.1 SAMPLE HANDLING

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 a suite of potential contaminants of concern listed below with some samples in specific areas being scheduled for additional analysis as outlined in *Tables B2, B3, B5 and B6, Annex B*.

- metals and metalloids (arsenic, cadmium, chromium, copper, nickel, lead, mercury, boron, fluoride, ferrous iron, manganese, selenium and zinc);
- Total Recoverable Hydrocarbons (TRH);
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Phenols
- Volatile Organic Compounds (benzene, toluene, ethylbenzene and xylenes -BTEX); and
- asbestos (presence / absence - soil only).

Additional contaminants of concern may be analysed to target specific contaminants of concern or if required based on observations made in the field. These contaminants can include (though are not limited to):

- Polychlorinated Biphenyls (PCBs) - related to use of PCB-containing transformer oil on site;
- Volatile Organic Compounds (Chlorinated Hydrocarbons);
- Particle Size Distribution (PSD);
- Total Organic Carbon (TOC);
- pH; and
- Cation Exchange Capacity (CEC).

6.2 *ANALYTICAL METHODOLOGY*

A summary of the laboratory analytical methodologies are provided herein. Based on discussions with the laboratories, it was understood that these methodologies are currently being updated to comply with the recent changes to the NEPM (as amended in 2013). Hence the methodologies herein are subject to change, though these changes will be outlined in the quality control reports submitted by the laboratory at the time of receipt of the results.

6.2.1 *Volatile TPH C_6-C_9/BTEX*

ALS (soil): USEPA SW 846 - 8260B; Extracts are analysed by Purge and Trap, Capillary GC/MS. Quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Method 501). .

ALS (water): USEPA SW 846 - 8260B; Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

ALS (sediments): Extracts are analysed by Purge and Trap, Capillary GC/MS. Quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Method 501).

Envirolab (soil): Analysed via purge and trap, gas chromatography-mass spectrometer (method reference USEPA 8260 method; USEPA5030 (P/T)).

Envirolab (water): VOC vial analysed directly. Determination is completed by PT-GC/FID. PT internal system standard injected into sample to monitor system performance (reference modified "in house" USEPA 8015, 8020 or 8260 method).

6.2.2 *Semi-volatile TPH*

ALS (soil): USEPA SW 846 - 8015A; Sample extracts are analysed by Capillary GC/FID and quantified against alkane standards over the range C10 - C36. This method is compliant with NEPM (1999) Schedule B(3) (Method 506.1).

ALS (water): USEPA SW 846 - 8015A; The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2).

ALS (sediments): Ultra trace including sum of C10-C40: (USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Method 504).

Envirolab (soil): Solid samples are extracted with dichloromethane/acetone (1:1) and extracts are injected into capillary Gas Chromatograph equipped with Flame Ionisation Detector (reference method USEPA 3500 and USEPA 3510.

Envirolab (water): Water samples are double/triple extracted with dichloromethane and extracts are injected into capillary Gas Chromatograph equipped with Flame Ionisation Detector (reference method USEPA 8000.

6.2.3 *Selected Inorganics (As, Hg, Cd, Cr, Cu, Pb, Ni, B, Mn, Se, Zn)*

ALS (soil): Total Metals by ICP-AES: (APHA 21st ed., 3120; USEPA SW 846 - 6010) (ICPAES). Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (1999) Schedule B(3).

Total Mercury by FIMS: AS 3550, APHA 21st ed., 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3).

ALS (water): APHA 20th ed., 3125; USEPA SW846 – 6020. The ICPMS technique utilizes highly efficient argon plasma to ionise selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector. Quantification is achieved by measuring the intensity of the element in the sample against an established calibration curve for that element.

Mercury: AS 3550. Flow Injection Mercury – Atomic Absorption Spectrometry (FIM-AAS) is a flameless atomic absorption technique. Water samples are analysed in their 'as received' nitric acid preserved state. For the determination of total mercury a further oxidation using a bromate/bromide reagent is employed to oxidise organic mercury compounds. The ionic mercury is reduced to atomic mercury vapour by a reducing agent (SnCl2). Atomic mercury vapour is then purged into a heated quartz cell. Quantification is achieved using an established absorbance versus concentration calibration curve.

Fluoride: APHA 4500-FC. Ion-Selective Electrode Method - The fluoride electrode is an ion-selective sensor. The key element in the fluoride electrode is the laser-type doped lanthanum fluoride crystal across which a potential is established by fluoride solutions of different concentrations. The crystal contacts the sample solution at one face and an internal reference solution at the other.

Ferrous Iron: APHA 35000Fe-B. Phenanthroline Method - Iron is brought into solution, reduced to the ferrous state by boiling with acid and hydroxylamine, and treated with 1,10-phenanthroline at pH 3.2 to 3.3. Three molecules of phenanthroline chelate each atom of ferrous iron to form an orange-red complex. A pH between 2.9 and 3.5 insures rapid colour development in the presence of an excess of phenanthroline.

ALS (sediments): (APHA 21st ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector. Analyte list and LORs per NADG.

Total Mercury by FIMS (Low Level): AS 3550, APHA 21st ed., 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3)

Envirolab (soil): Solid samples are digested with mineral acids (Hydrochloric and Nitric Acid) before analysis with Inductively Coupled Plasma - Optical Emission Spectrometry (ICP-OES) (reference method USEPA 6010C). Determination of mercury is by cold vapour AAS. Solid samples are digested with mineral acids (Hydrochloric and Nitric Acid) before analysis (reference method USEPA 7471A).

Envirolab (water): Determination via ORC-ICP-MS (reference method USEPA 200.8, USEPA 3005A (prep), USEPA 6020A or USEPA 7010/APHA 3113). Water samples are further acidified on receipt (Nitric Acid) before analysis with Inductively Coupled Plasma - Mass Spectrometry (ICP-MS) and Inductively Coupled Plasma - Optical Emission Spectrometry (ICP-OES). Water samples are digested with strong oxidants (Hydrochloric Acid, Bromine Monochloride, Nitric Acid and Potassium Permanganate) before analysis. Mercury determination is via cold vapour AAS. Filtered water samples are digested with strong oxidants (Hydrochloric Acid, Bromine Monochloride, Nitric Acid and Potassium Permanganate) before analysis.

6.2.4 *PAH*

ALS (soil): (USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS in Selective Ion Mode (SIM) and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Method 502 and 507).

ALS (water): USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2).

ALS (sediments): Super ultratrace PAH by USEPA 3640. Extracts are analysed by 8270 GCMS Capillary column, SIM mode using large volume programmed temperature vaporisation injection.

Envirolab (soil): Solid samples are extracted with dichloromethane/acetone (1:1) and the extracts are injected into capillary Gas Chromatograph equipped with a Mass Selective Detector (MSD) in SIM mode (reference method USEPA 8270).

Envirolab (water): Water samples undergo double/triple extraction with dichloromethane and analysis by capillary Gas Chromatograph equipped with Mass Selective Detector (MSD) in SIM mode (reference method 8310 and USEPA 8270).

6.2.5 *Phenols*

ALS (soil): (USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS in Selective Ion Mode (SIM) and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3) (Method 502 and 507).

ALS (water): USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2).

ALS (sediments): USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3) (Appdx. 2).

Envirolab (soil): Solid samples are determined colorimetrically following distillation, based upon APHA 22nd ED 5530 D.

Envirolab (water): Determined colorimetrically following distillation, based upon APHA 22nd ED 5530 D.

6.2.6 *Volatile Organic Compounds*

ALS (soil): (USEPA SW 846 - 8260B) Extracts are analysed by Purge and Trap, Capillary GC/MS. Quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Method 501).

ALS (water): Volatile Organic Compounds: USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2).

Envirolab (soil): Determination by Purge and Trap GC-MS (reference method 8260).

Envirolab (water): Determination by Purge and Trap GC-MS (reference method USEPA 8260B).

6.2.7 *Asbestos Fibres In Soil*

ALS (soil): AS 4964 - 2004 Method for the qualitative identification of asbestos in bulk samples.

Envirolab (soil): Asbestos fibres are qualitatively identified in soil using polarized light microscopy (PLM) in accordance with Australian Standard AS 4964-2004. It is noted in AS 4964-2004 that this method is not necessarily suitable to quantify asbestos in soil however an estimate of the %w/w of asbestos fibres and fragments in soil will be made for assessment against the soil asbestos investigation criteria reported in the Western Australian Department of Health (2009) *Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia.* This will involve manually separating any visible asbestos fragments and fibres from the soil matrix and weighing the resulting material. It is considered that the %w/w results will be an estimate only and will be dependent on the soil matrix.

6.2.8 *Cation Exchange Capacity*

ALS (soil): Rayment & Higginson (1992) Method 15A1. Cations are exchanged from the sample by contact with Ammonium Chloride. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil. This method is compliant with NEPM (1999) Schedule B(3) (Method 301).

Envirolab (soil): Solids are washed with Ethanol and Glycerine to remove soluble salts such as NaCl. The solid is then exchanged (by default) with a solution of 1M Ammonium Chloride. The solution is then analysed for Cations using Inductively Coupled Plasma - Optical Emission Spectrometry (ICP-OES). Alternative exchange solutions can be used on request.

6.2.9 *pH*

ALS (soil): (APHA 21st ed., 4500H+) pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM (1999) Schedule B(3) (Method 103).

Envirolab (soil): Solids are extracted with Ultra High Purity (UHP) water at a ratio of 1:5 soil:water. Analysis is by a pH selective electrode. Waters are analysed directly using a pH selective electrode Determination by electrode (reference method USEPA 9045).

6.2.10 *PCBs*

ALS (soil): (USEPA SW 846 - 8270B) Extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Method 504).

ALS (water): USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2).

ALS (sediments): USEPA Method 3640 (GPC cleanup),3620 (Florisil), 8081/8082 (GC/uECD/uECD) This technique is compliant with NEPM (1999) Schedule B(3) (Method 504).

Envirolab (soil and water): Sample extracts are analysed by injecting a measured aliquot into a gas chromatograph equipped with either a narrow- or wide-bore fused-silica capillary column and either an electron capture detector (GC/ECD) or an electrolytic conductivity detector (GC/ELCD).

6.2.11 *Total Organic Carbon*

ALS (soil): Dried and pulverised sample is reacted with acid to remove inorganic Carbonates, then combusted in a LECO furnace in the presence of strong oxidants / catalysts. The evolved (Organic) Carbon (as CO2) is automatically measured by infra-red detector.

ALS (water): APHA 21st ed., 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2).

6.2.12 *Particle Size Distribution*

ALS (soil and sediment): Analysis of the particle size of soils in accordance with Australian Standards AS 1289.3.6.1 and/or AS 1289.3.6.2 by sieving, with analysis of clays and fine particles by sedimentation and hydrometer analysis (based on the AS 1289.3.6.3).

7 QUALITY ASSURANCE/QUALITY CONTROL

QA/QC procedures for this project will be aligned with the requirements of both NEPM (1999 – as amended 2013) and NSW DEC (2006) *Guidelines for the NSW Site Auditor Scheme (2nd edition)* and can be summarised as follows:

7.1 CALIBRATION PROCEDURES

All equipment used in the field will be used under the appropriate technical procedures and calibrated prior to use in accordance with the manufacturer's specifications. The PID will be calibrated at the beginning of each working day in accordance with ERM's SOPs. Water quality meters will be calibrated by the hire company prior to use and relevant calibration certificates retained by ERM. Water quality meters will also be calibrated at the beginning of each day in accordance with the manufacturer specifications. All of the relevant calibration records will be provided as an annex in the investigation reports.

7.2 DECONTAMINATION PROCEDURES

All sampling equipment will be decontaminated between sampling locations where designated disposable materials are not used.

All non-dedicated equipment will be decontaminated as follows:

- all loose soil removed with a wire brush;
- washed in potable (tap) water and brush scrubbing using tap water and a non-phosphate detergent (Decon 90);
- rinsed with water; and
- air dried.

During push tube drilling the soil samples will be collected in single use plastic tubes minimising the potential to cross-contaminate soil samples. Between sampling locations the cutting shoe and rod containing the single use shoes will be decontaminated as listed above. Any visible soil material will be removed from the drill rig equipment using a wire brush and water (if required).

7.3 SAMPLE CONTAINERS, PREPARATION AND PRESERVATION

All samples for laboratory analysis will be placed in appropriate containers as required by the laboratory. Groundwater samples will also be pre-treated (e.g. filtering, preservative) where required by the laboratory. A list of the appropriate sample containers from ALS and Envirolab to use during soil and groundwater investigation works is included in *Annex G*. A summary of the sample containers required for the standard suite of analytes is presented below.

Table 7.1 *Laboratory Sample Container Schedule - Soil*

Analytes	ALS Container	Envirolab Container
Metals, TRH, BTEX, PAH and VOCs, CEC, pH	150 mL glass jar	250 mL glass jar
Asbestos	100 g - 200g soil in zip lock bag (double bagged)	500 mL zip lock bag
Particle sizing	100 g - 200g soil in zip lock bag or jar	-

Table 7.2 *Laboratory Sample Container Schedule - Groundwater*

Analytes	ALS Container	Envirolab Container
Metals (via ORC-ICP-MS)	125 mL plastic bottle with red on white label.	50 mL plastic or glass
Volatile TRH, BTEX and VOC	2 40 mL amber glass vials with purple labels.	3 40 mL amber glass vials
PAH and semi-volatile TRH	2 x 500 mL and 1 x 100 mL amber glass bottle with orange label[1]	500 mL glass bottle

7.4 SAMPLE LABELLING, TRANSPORT & CHAIN OF CUSTODY

All sample containers will be labelled and placed on ice immediately after collection and shipped in insulated boxes under chain of custody documentation to the laboratory for analysis. Regular pick-ups from the site have been pre-arranged with ALS. ALS will be responsible for sending samples to the secondary laboratory.

Separate chain of custody forms must be filled out for each laboratory (ALS and Envirolab). If there are samples from multiple sites a separate chain of custody form will be prepared for each site. The chain of custody forms must also include the analytical suite code and the quote number (refer to *Annex G*).

7.5 FIELD QUALITY ASSURANCE SAMPLES

7.5.1 *Rinsate Blanks*

A rinsate blank checks the effectiveness of the process of equipment decontamination. One rinsate blank sample will be obtained each day by each sampling team where sampling equipment that is not "single use" is employed (i.e. hand auger). The rinsate solution is collected by washing laboratory supplied distilled water over the equipment after decontamination and submitting the sample for laboratory analysis.

It is not anticipated that groundwater rinsate samples will be required given that disposable tubing will be used during groundwater sampling and the pump mechanism is not in direct contact with the groundwater during sampling.

7.5.2 *Field Duplicate Samples*

A blind duplicate sample is obtained by splitting a primary sample in the field into two portions and sending the duplicate sample to the laboratory with a disguised identification. Intra-laboratory duplicate samples are used to check the repeatability of the laboratory results and to assess the heterogeneity of the analyte and will be collected at a rate of one in 20. Inter-laboratory samples are similar to blind duplicate samples however they are submitted to a secondary laboratory, to check upon the proficiency of the primary laboratory. Inter-laboratory samples will be collected at a minimum rate of one per 20 samples.

7.5.3 *Trip Blank and Trip Spike*

Trip blanks and trip spikes are prepared by the laboratory, and are designed to assess the potential for loss of volatiles and cross contamination resulting from the sampling storage and handling procedures. One of each will be taken to the field to accompany soil or water samples analysed for volatile contaminants to the primary laboratory. One trip blank and trip spike samples will be included with each group of samples transported to the laboratory.

7.6 *LABORATORY QA/QC PROCEDURES*

Laboratory Quality Assurance and Quality Control (QA/QC) procedures will be undertaken in accordance with NEPC (1999) *National Environment Protection (Assessment of Site Contamination) Measure 1999,* as amended by *Amendment Measure 2013, Schedule B(3) - Guidelines on Laboratory Analysis of Potentially Contaminated Soils* and will comprise matrix spikes, method blanks and surrogate recoveries. The results of the quality control testing will be presented in the laboratory reports. Duplicate testing will also be undertaken by the laboratories to compare the results obtained in analysing samples.

ALS and Envirolab will provide the following quality assurance data:

- NATA approval for analyses undertaken;
- sample receipt confirmation;
- laboratory duplicates;
- instrument blank;
- detection limits;

- 10% matrix spike and matrix spike duplicates;
- 10% laboratory duplicates; and
- acceptable limits for spike recoveries.

7.6.1 *Accuracy*

Accuracy is defined as the proximity of an averaged result to the true value, where all random errors have been statistically removed. Unless the true value is known, accuracy may take on a meaning equivalent to the term bias due to the existence of systematic errors. Accuracy is measured by percent recovery, '%R'. Unless otherwise stated, accuracy data for matrix spike and matrix spike duplicates will be expected to vary within the following ranges:

Table 7.3 *Expected Matrix Spike Percentage Recovery*

Analyte	Acceptable Percentage Recovery
General analytes	70-130 %R
Organophosphate pesticide analytes (if required)	60-130 %R
Chromium	62-120 %R

Accuracy of data is treated as an estimate where the data is below the lower recovery limit and above 10%R (i.e. 10-69%R for general analytes, 10-59%R for OPP and 10-61%R for chromium). In the event that the data value is below the 10%R the data value should be rejected.

7.6.2 *Precision*

Precision is considered to be the degree to which data generated from replicate or repetitive measurements differ from one another due to random errors. Precision is measured using the standard deviation, 'SD', or Relative Percent Difference, '%RPD'. Replicate data existing in the %RPD range presented below shall be accepted as quality data, whereas data outside of the acceptance criteria will require further discussion.

%RPD Range: if result > 10 x EQL, the maximum of 30% RPD;

if result < 10 x EQL, the maximum of 50% RPD.

7.6.3 *Blanks*

Laboratory method blanks are designed to check for artefacts and interferences during the analysis stages, which may lead to the reporting of false positive results. In the event that a positive blank is reported for this project, the following remedies will proceed:

- laboratory to review data;
- positive blank results may not be subtracted from sample results;

- no further action necessary if sample results reported were less than laboratory reporting limit;
- analyse additional field blanks if taken and within holding times;
- positive sample results may be acceptable if analyte concentrations were significantly greater than the amount reported in the blank (ten times for laboratory reagents such as methylene chloride, chloroform, and acetone etc., and five times for all other analytes). Alternatively, the laboratory reporting limit may be raised to accommodate blank anomalies provided that regulatory guidelines were not compromised by any adjustment made to the laboratory reporting limit; and
- professional expertise would be used in all cases, which may include conducting additional testing.

7.6.4 *Matrix Spikes*

Environmental samples are spiked with laboratory grade standards to assess the interactive effects between the sample matrix and the analytes being measured. Matrix Spikes 'MS' are reported as a percent recovery %R, at a minimum rate of 1 in every 20 samples for this project.

Percent Recovery is expressed as: $$\%R = \frac{(SSR-SR)}{SA} \times 100$$

where: SSR = spiked sample result

SR = sample result (blank)

SA = spike added

7.6.5 *Laboratory Duplicates*

Laboratory duplicate samples measure precision, which is calculated as standard deviation SD or Relative Percent Difference %RPD. Duplicates are collected in a single sample container in the field and are analysed as two separate extractions.

Relative Percent Difference is expressed as: $$\% RPD = \frac{(D1-D2)}{D1+D2)/2} \times 100$$

where: D1=sample concentration

D2=duplicate sample concentration

7.6.6 *Laboratory Surrogates*

Surrogates are QC monitoring spikes, which are added at the beginning of the sample extraction process in the laboratory where applicable. Surrogates were measured as Percent Recovery %R.

Percent Recovery is expressed as:

$$\%R = \frac{(SSR)}{SA} \times 100$$

where: SSR=spiked sample result

SA =spike added

Surrogate spike recoveries indicate the presence of sample specific interferences. In the event that the USEPA have not published a surrogate recovery limit, the range 70 - 130% recovery soil will be used. In the event that a surrogate recovery fails to comply with the documented or established limits, the sample will be re-extracted and reanalysed. Should the recovery breaches occur again, this will be regarded as an indication of matrix interference and a decision will be made to accept or reject the dataset.

7.7 *QUALITY ASSURANCE/QUALITY CONTROL*

Table 7.4 *Sampling & Analysis Methodology Assessment*

Field Considerations	Laboratory Considerations
Precision Requirements	
The investigation will be conducted following ERM SOPs and any variations from these procedures will be documented and justified.	Analysis of the following will be reported: • Laboratory and inter-laboratory duplicates; • Field duplicates; • Laboratory prepared volatile trip spikes.
Accuracy Requirements	
The investigation will be conducted following ERM SOPs and any variations from these procedures will be documented.	Analysis of the following will be reported: • Field blanks; • Rinsate blanks; • Reagent blanks; • Method blanks; • Matrix spikes; • Matrix spike duplicates; • Surrogate spikes; • Reference materials; • Laboratory control samples; • Laboratory prepared spikes
Representativeness Requirements	
Appropriate media will be identified and sampled according to the SAQP.	All samples will be analysed according to the SAQP.

Field Considerations	Laboratory Considerations
Comparability Requirements	
The same SOPs will be used during each sampling event.	Analytical methods suitable for the target media will be used.
All sampling will be conducted by an appropriately qualified and experienced sampler.	The PQLs used to report analyte concentrations will be less than the adopted investigation levels.
Impacts of climatic conditions on sample integrity will be minimised by immediately placing samples into insulated ice-filled containers. Trip spike samples will be collected to monitor potential loss of volatile analytes.	The same laboratories will be used to analyse all sample.
The types of samples collected will be consistent.	The same units will be used to report analyte concentrations.
Completeness Requirements	
All accessible proposed locations will be sampled.	All accessible proposed locations will be sampled. All analytes will be analysed according to the SAQP.
The investigation will be conducted following ERM SOPs and any variations from these procedures will be documented.	Appropriate analysis methods and PQLs will be used.
All sampling will be conducted by an appropriately qualified and experienced sampler.	Sample documentation will be provided.
Documentation of field works will be provided.	Sample holding times will be complied with.

8 CONTINGENCY PLANNING

Due to the uncertain nature of subsurface investigations, variations to the proposed scope of work may be necessary based on conditions encountered in the field. The most relevant potential uncertainties are described below, along with proposed contingency actions to address these issues:

Unexpected contaminants/unexpected high concentrations encountered: The analytical suite for soil and groundwater is based on the results of the historical investigations and knowledge of contaminants that are commonly associated with the former land use. In the event that field observations indicate the potential for unexpected contaminants, additional analysis may be requested to characterise these contaminants. In the event that unexpectedly high concentrations of contaminants are encountered, health and safety procedures will be re-evaluated, and alternative sampling methods may be utilised.

LNAPL and/or DNAPL encountered: If LNAPL and/or DNAPL is observed at any groundwater wells, attempts will be made to collect a representative sample of the separate phase liquid for characterisation. The benefits and costs of this additional analysis would be discussed with the client prior to proceeding with additional works.

Difficult ground conditions encountered: If difficult ground conditions are encountered at an investigation location, an alternative adjacent location will be attempted to bypass potential subsurface obstacles encountered. In the unlikely event that laterally extensive difficult ground conditions prevent completion of the scope of work (i.e. achieving required depth), alternative investigation methods may be considered.

Insufficient sediment present for sampling: In the event that no sediment is encountered at the natural level at identified locations alternative locations will be identified based on conditions observed in the field. In the event that In the event that the grab sampling methods are not effective in obtaining sufficient volumes of sediments, alternative methods may be used including collection by hand push-tubes by divers.

Access to an area of potential concern is not feasible: If access to an area is not granted by Delta within the required time frame ERM will target locations around the perimeter of that area where access can safely be made available.

Existing monitoring wells are damaged or unsuitable for sampling: It may be necessary to install replacement wells where existing wells are damaged or unsuitable.

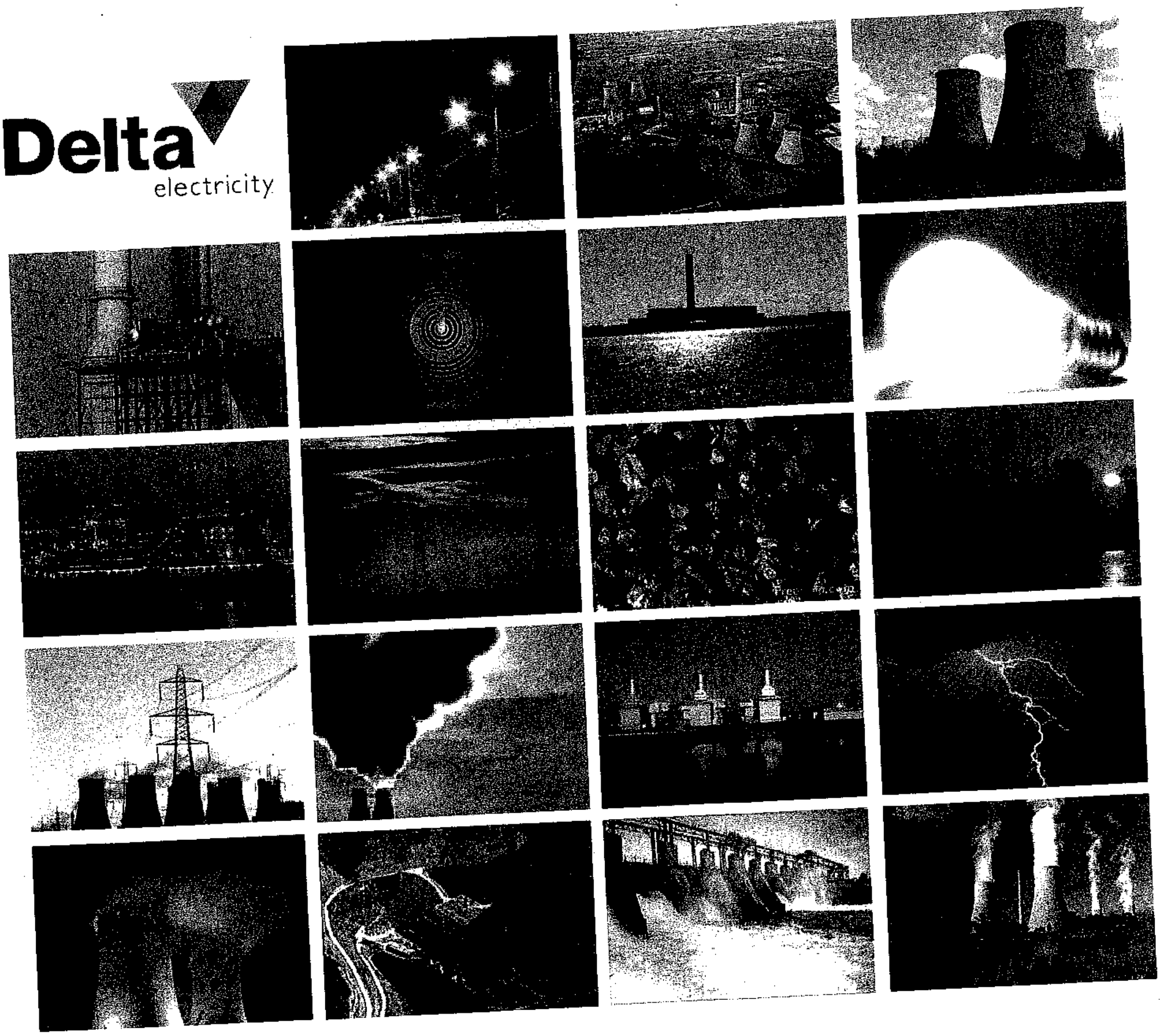
DOCUMENT 5c

Mount Piper Power Station

Stage 2 Environmental Site Assessment – Part 1

Environmental Resources Management

August 2014



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Delta Electricity

Project Symphony – Mt Piper

Stage 2 Environmental Site Assessment

Ref: 0207423RP01

August 2014

ERM

The world's leading sustainability consultancy

Project Symphony - Mt Piper

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Stage 2 Environmental Site Assessment

Approved by:	Anne Ashworth
Position:	Project Manager
Signed:	
Date:	14 August 2014
Approved by:	Peter Lavelle
Position:	Partner
Signed:	
Date:	14 August 2014

Environmental Resources Management Australia Pty Ltd Quality System

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LIST OF ANNEXES

EXECUTIVE SUMMARY

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by Delta Electricity to undertake a Phase 2 Environmental Site Assessment (Phase 2 ESA) at Mt. Piper Power Station (herein referred to as the "Site") in accordance with the work scope presented in the Preliminary Environmental Site Assessment (PESA; ERM Reference 01947098RP03, 24 July 2013) prepared by ERM.

The primary objective for the Phase 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 Phase 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 PESA was further refined and the analytical data was compared against published environmental screening values 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 certain metals in groundwater, hydrocarbons and Light non-Aqueous Phase Liquid (LNAPL) in groundwater in the Mobile Plant Refuelling Area and benzene in groundwater near a UST.*
- *Certain metals were identified at concentrations in excess of human health and/or ecological screening values across the Site. However the concentrations of metals in groundwater across the Site are generally comparable to background groundwater quality. Where metals were above background concentrations, impact generally appears to be associated with contributions from former mine workings both on the Site and in surrounding areas.*

Site Management and Remediation Requirements

- *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 hydrocarbon impacts in soil and groundwater surrounding the Mobile Plant Refuelling Area. On the basis of the data available to ERM at the time of this assessment, the potential for vapour inhalation risks to industrial workers and/or intrusive maintenance workers in this area could not be ruled out. However, ERM understands that the current site operator (Energy Australia) (and prior to the transaction Delta Electricity) has been developing appropriate management approaches in relation to this issue alongside independent consultants and regulators. It is noted that Delta Electricity has previously notified this issue to NSW EPA. It is considered that the costs for management of this issue may be potentially material depending on the remediation / management option selected.*

- *It is recommended that the grit blasting impacts to surface observed in the former contractors' yard in the Non-Operational Area be removed as part of general housekeeping. The costs associated with these works are not anticipated to be material.*

- *Whilst some further assessment may be required to undertake confirmatory sampling in various areas of the Site (refer to "Additional Baseline Data Recommendations" below), it is considered unlikely that costs related to this work would exceed the adopted material threshold for the purposes of this assessment (A$ 0.5 million).*

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:

- *ERM considers that NSW EPA would most likely continue to manage the LNAPL issue under the existing notification of potential contamination under the CLM Act, however, the additional results should be provided to NSW EPA for review and consideration.*

- *ERM considers that NSW EPA would most likely continue to manage the metals in groundwater issue under the POEO Act (1997) via the Site EPL (including the existing groundwater and surface water monitoring and reporting required as part of the conditions of consent issued under the EP&A Act), and hence would not require formal notification under the CLM Act (1997), however this approach should be confirmed with NSW EPA to ensure strict adherence to the NSW DECC (2009) guidelines. It is noted that NSW EPA could potentially request some modifications to the existing groundwater and surface water monitoring program under the EPL.*

Additional Baseline Data Recommendations

The data presented in this Phase 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, additional characterisation of the baseline conditions at the Site is not considered to be required. It is noted that groundwater impacts associated with Underground Petroleum Storage System (UPSS) infrastructure at the Site were identified independently of this assessment and the current site operator (EnergyAustralia) has been developing appropriate management approaches alongside independent consultants and regulators. On the basis of the outcomes of this Phase 2 ESA, it is considered that further monitoring may be required in these areas as follows:

- *Additional confirmatory groundwater sampling is recommended in AEC MJ (Operational USTs) 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 (1997).*

- *Additional groundwater monitoring and gauging in AEC ME (Mobile Plant Refuelling Area) to confirm the extent of Light Non-Aqueous Phase Liquid (LNAPL) prior to reporting to NSW EPA. This may have already been scheduled at the time of preparation of this report as part of the existing scheduled UPSS monitoring program and/or separate investigations initiated by Energy Australia. It is further recommended that the integrity of the oil pit and the adjacent oil-water interceptor in the Mobile Plant Refuelling Area is investigated.*

1 INTRODUCTION

1.1 BACKGROUND

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by Delta Electricity to undertake a Phase 2 Environmental Site Assessment (Phase 2 ESA) at Mt Piper Power Station. Mt Piper Power Station, herein referred to as "the Site", is situated approximately 18 km north-north-west of Lithgow in the Central West region of New South Wales. The street address of the Site is 350 Boulder Road, Portland, NSW 2847.

The works detailed herein were completed to support the sale of the Site and in accordance with the work scope presented in the *Sampling Analysis and Quality Plan* [*SAQP*; ERM Reference 0207423RP01_SAQP_DRAFT] (ERM, 2013a), and *Preliminary Environmental Site Assessment* [*PESA*; ERM Reference 0194708RP03_FINAL] (ERM, 2013b).

A site location plan is presented as Figure 1 of Annex A. The general Site layout is presented in Figure 2 and Figure 3 of Annex A.

1.2 OBJECTIVES

The primary objective for the Phase 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 within surrounding receiving environments (including sediments samples from Lake Lyell and Thompsons Creek Reservoir), as at or near the time of the transaction. Data obtained during completion of the Phase 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 *PESA* (ERM, 2013b) 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 Phase 2 ESA works comprised the following general tasks, in accordance with the requirements set out in the *SAQP* (ERM, 2013a):

Preliminaries

- preparation of a site-specific Health and Safety Plan (HASP) and Environmental Management Plan (EMP);
- 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 *PESA* (ERM, 2013b);
- revision and amendment of the *SAQP* (ERM, 2013a), as necessary;
- engagement of subcontractors including underground utility locator, drillers, laboratories and surveyors;
- scheduling of Site works with Delta Electricity and Energy Australia; 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* (ERM, 2013a)

- laboratory analysis of selected soil and groundwater samples for particular constituents of potential concern (COPC) in accordance with the requirements of the *SAQP* (ERM, 2013a) and as outlined in *Section 4.9*; and
- the survey of newly installed and existing 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 Delta Electricity; and
- preparation and submission of this Phase 2 ESA report at the completion of works.

1.5 REPORT STRUCTURE

This Phase 2 ESA report has been prepared in general accordance with the NSW Environmental Protection Agency (EPA) *Guidelines for Consultants Reporting on Contaminated Sites* (EPA, 1997), 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 Phase 2 ESA works and Site-specific discussions and recommendations; and
- *Section 6* – Conclusions.

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

- Australian Standard (2005) AS 4482.1 *Guide to the Sampling and Investigation of Potentially Contaminated Soil. Part 1 – Non-volatile and Semi-volatile Compounds* (Australian Standard, 2005);
- Australian Standard (1999) AS 4482.2 *Guide to the Sampling and Investigation of Potentially Contaminated Soil. Part 2 –Volatile Substances* (Australian Standard, 1999);

- 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* (ANZECC/ARMCANZ, 2000); and

- National Environment Protection Council (NEPC) (April 2013) *National Environment Protection (Assessment of Site Contamination) Measure 1999, NEPC, Canberra,* (NEPC, 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 *SAQP* (ERM, 2013a) 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 (with the exception of accredited laboratories engaged by ERM to undertake analysis as part of these works), 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*

Mount Piper Power Station is a large coal-fired Power Station providing base load for the region via two 700 megawatt (MW) generating units. It is situated approximately 18 km north-north-west of Lithgow, in the Central West region of New South Wales (NSW). The Site is located north west of Sydney, between Lithgow and Portland, and is situated approximately 10 kilometres north-west of the Wallerawang Power Station (where a similar Phase 2 ESA has also been undertaken by ERM) as presented in *Figure 1* of *Annex A*.

The Site was formerly owned and operated by Delta Electricity (a State Owned Corporation - SOC) however, along with Wallerawang Power Station, has recently been transferred to the ownership of Energy Australia (EA). The Site includes the main electricity generating area and associated coal stockpiles, ash emplacement areas, buffer zones (comprising dominantly native forested areas and open woodland and rehabilitated and revegetated land) and associated water assets as outlined in *Figure 3* of *Annex A*.

2.1 *SITE IDENTIFICATION*

The approximate coordinates of the Power Station are 223759 m E and 6304970 m S. A Site location plan is provided as *Figure 1 of Annex A*. The total area of the Mount Piper site is approximately 820 hectares and includes:

- the main operational area of the Power Station, which comprises electricity generating activities and the associated coal stockpile;
- the ash emplacement area within a former mine void adjacent to the operational area;
- a buffer zone comprising native forested areas and open woodland and rehabilitated and revegetated land, and including a number of ancillary activities such as transmission line easements and former waste dumps; and
- the associated water assets, Lake Lyell located directly south, and Thompsons Creek Reservoir to the south-east. Water is supplied from off-site storage facilities which are outside the scope of this report.
- The entire area is shown in the Site Layout Plan provided *Figure 3.1* and *Figure 3.2, Annex A*.

There are several parcels of land within the Mount Piper "fenceline" most of which are owned and operated by other electricity SOCs and Energy Australia, and these are outside the scope of this report.

The affected parcels consist of:

- a large area of land on the western side of the operational area that was previously transferred for potential future expansion of the Power Station (additional units). ERM's review of NSW government property mapping indicates that the parcel of land appears to consist of Lots 1, 2, 3 and 4 of DP1092737;
- a large triangular parcel of land to the south earmarked for the proposed rail coal unloader. ERM's review of NSW government property mapping indicates that the parcel of land appears to consist of Lots 1 and 2 of DP800003. This is agricultural land and is leased for agricultural use;
- the Power Station's switchyard which is owned and operated by the transmission SOC Transgrid. ERM's review of NSW government property mapping indicates that the parcel of land appears to consist of Lots 1, 2, 3 and 4 of DP1092737;
- a high voltage substation which is owned and operated by the transmission SOC Transgrid. ERM's review of NSW government property mapping indicates that the parcel of land appears to consist of Lot 22 of DP832446; and
- a section of forested land along Boulder Road that has been sold to the Lithgow District Car Club. ERM's review of NSW government property mapping indicates that the parcel of land appears to consist of Lot 1 of DP1127747.

For the purpose of this assessment, the Site has been divided into 13 individual areas of environmental concern (AECs), according to usage and the presence of potential sources of contamination. These areas, listed in *Table 2.1*, are discussed in detail in the *PESA* (ERM, 2013b).

Table 2.1 *Summary of Areas of Environmental Concern*

Identification	AEC Description	Figure Reference	Approximate Area (Ha)
MA	Former Landfills	Figure 5.1	16.2
MB	Coal Storage Area	Figure 5.2	26.6
MC	Electrical Transformers	Figure 5.3	n/a (see MK)
MD	Workshops	Figure 5.3	0.2
ME	Mobile Plant Refuelling Area	Figure 5.3	1.3
MF	Operational ASTs	Figure 5.4 & 5.5	1.7
MG	Current Ash Repository	Figure 5.5	49.1
MH	Lamberts North Ash Repository	Figure 5.5	54.0
MI	Water Holding Ponds	Figure 5.3 & 5.5	18.5
MJ	Operational USTs	Figure 5.3	n/a (see MK)
MK	Accessible Operational Areas	Figure 5.3 & 5.4	21.9

Identification	AEC Description	Figure Reference	Approximate Area (Ha)
ML	Non Operational Areas	Figure 5.1, 5.2 & 5.4	627.9
MM	Water Assets	Figure 5.6	282.6

2.2 *SITE HISTORY*

Construction of Mount Piper Power Station began in 1984, was halted in 1986 and began again in the early 1990s, with the station commissioned in 1993. Substantial earthworks were required to level the land and backfill a former open-cut mine which was historically operated on the Site.

Based on historical mining maps (CDM Smith, 2012; PPK Environment & Infrastructure Pty Ltd, 2000) open-cut mines were present beneath the current operational areas of the power station. These voids are understood to have been backfilled with overburden at the end of mining operations and are presented in *Figure 4, Annex A*. Site management advised during the completion of the Preliminary Environmental Site Assessment (PESA) that there have been no substantial changes to the building footprints and the current operational areas are representative of operations over the period from 1993 to 2013. There are three landfills which date from the early years of construction and operation of the station, as shown in *Figure 3.1, Annex A*.

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

2.3 *SURROUNDING ENVIRONMENT*

The Site is surrounded by areas used mainly for mining purposes with some grazing, recreational and commercial forestry activities in the locality. Ben Bullen State Forest neighbours the site to the north and south-east.

Key industrial uses in the area are:

- Wallerawang Power Station located approximately 7 km to the south-east.
- existing and former coal mines surrounding the site (including Centennial Coal mine immediately east of the Site) and within the site footprint;
- the former Portland cement works are located 4 km to the west.

The closest residential areas to the Site include:

- rural residences that do not form part of residential centres. The closest identified residential property is located at 28 Jarrah Way, Portland. The identified property is located adjacent the buffer lands on the north-western site boundary, and approximately 2 km west of the Mt Piper operational area;
- Portland, approximately 4 km to the west. Two schools, one child care facility and a hospital are located within 5 km of the Power Station, all of these are situated within the town of Portland.
- Blackmans Flat approximately 3 km to the east.
- Cullen Bullen, approximately 6 km to the north.
- Lidsdale approximately 6 km to the south-east.
- Angus Place approximately 7 km to the north-east.
- Wallerawang, approximately 10 km to the south-east.

2.4 *TOPOGRAPHY*

The Site lies at an elevation of between 925 and 960 m Australian Height Datum (AHD) within a valley created by ridges forming a U-shape to the east, south and west. The floor of the valley has been levelled to construct the Power Station. The U shaped ridges surrounding the site rise to elevations of about 1000 m approximately 1 km to the south, east and west of the centre of the Mount Piper Power Station, whilst to the north the surrounding hills peak around 1000 m approximately 3 km from the centre of the power station. Hilly forested country lies across the Castlereagh Highway to the north.

2.5 *GEOLOGY*

Regional Geology

The Site is located on the western edge of the Sydney Basin which is characterised by easterly dipping sedimentary deposits. The *Western Coalfield Regional Geology (southern part) 1:100 000 Geological Map, 1st Edition* (Yoo, 1992) indicates that the site is underlain by the Permian age Illawarra Coal Measures comprising interbedded shale, sandstone, conglomerate and coal. This map further indicates the Narrabeen Group, comprising claystone, shale and sandstone, overlies the Illawarra Coal Measures and outcrops at high elevations across the Site within the buffer land.

North-south trending faults, and north-east to south-west lineaments are featured in the region. Two faults (position accurate) *(Yoo, 1992)* are reported to dissect the northern and southern site boundaries, passing through the former contractors yard and the operational area in the southern portion of the site and the coal storage area in the northern portion of the site.

Surrounding the site, the Narrabeen Group features in the Ben Bullen State Forest (which forms part of the Great Dividing Range) north east of the site. Permian age sandstone, shale and conglomerate of the Shoalhaven Group underlie the Illawarra Coal Measures and are located south and west of the site.

Local Geology

A description of the local geology based on environmental investigations conducted in the vicinity of the Site cited by CDM Smith (2012) is provided in *Table 2.1*.

Table 2.2 ***Description of Local Geology[1]***

Stratigraphic Unit	Geological Formation	Description	Approximate Thickness (m)
Illawarra Coal Measures	Irondale Coal Seam	Coal, mainly bright, claystone, black carbonaceous and also buff	1.3-1.4[2]
	Long Swamp Formation	Silty sandstone	1 - 1.5
		Sandstone, siltstone and shale	12 - 14
	Lidsdale Coal Seam	Coal, carbonaceous shale and sandstone	1.1 - 1.8
	Blackmans Flat Conglomerate	Sandstone (medium to coarse grained) with interbedded siltstone	3 - 6
	Lithgow Coal Seam	Coal, carbonaceous shale	1.9 - 2.3
		Siltstone, mudstone and shale	0.3 - 0.6
	Marrangaroo Conglomerate	Sandstone with siltstone bands and some boulders	3.5 - 4.6
Shoalhaven Group	Berry Formation	Siltstone or silty sandstone, some pebbles.	>30

- 1 Table modified from (CDM Smith, 2012)
- 2 (Geoscience Australia)

Coal seams within the Illawarra Coal Measures have been widely mined in the region, and sections of the site are underlain by abandoned coal workings (both underground and backfilled open cut) from mining of the Lidsdale and Lithgow seams. The Lidsdale and Lithgow coal seams converge approximately one kilometre north-east of the Site. The Irondale Coal Seam has also been mined at higher elevations to the west in the Pipers Flat area.

The surface geology across the site has been extensively disturbed by mining activities. Voids created during open-cut mining were backfilled with overburden (CDM Smith, 2012), which likely included a mixture of coarse fragments (gravels, cobbles and boulders) of shale, siltstone, mudstone and sandstone. Geological features of the Site are presented in *Figure 4 of Annex A*.

Both the existing and the Lamberts North Ash Repository are located within former open cut mines. Both open cut mine workings extended to the base of the Lithgow Seam. Whilst approximately 1 m of fill material was placed at the base of the existing ash repository prior to ash deposition, 5 m of fill material was placed at the base of the Lamberts North ash repository prior to ash deposition (SKM, 2010).

Local geology specific to various areas of the Site, as encountered during the current drilling program, are discussed further in *Section 5.1* of this report.

2.6 HYDROGEOLOGY

Regional Hydrogeology

Information on regional aquifer properties is limited as most investigations in the area have focussed on shallow aquifers (CDM Smith, 2012). No regional scale productive aquifer has however been identified in the vicinity of the Site. Large scale regional groundwater flow is expected to be towards the north/east, following the dip of the sedimentary deposits.

Local Hydrogeology

CDM Smith (2012) inferred that two aquifers are present beneath the site. Based on groundwater investigations associated with the Ash Repositories in the north-eastern portion of the site, a shallow aquifer is located at approximately 915 m AHD and flows in a north-easterly direction. Locally there may however be different directions in groundwater flow due to local variations in topography and surface water interactions. It is noted that between 2004 and 2012, groundwater levels of the shallow aquifer fluctuated up to 5 m with rainfall (CDM Smith, 2012). A deeper intermediate aquifer present at approximately 885 m AHD and within the Marrangaroo Conglomerate flows in a south-easterly direction. These aquifers are reportedly not connected.

Limited information is available regarding the north-south trending faults through the contractors yard, operational area, and coal storage area. Depending on the type, displacement, and whether infilling has occurred, the fault may connect the shallow and intermediate aquifers, or create a barrier between groundwater across the site.

Historic mining activities have had a significant impact on the groundwater regime underlying the site, impacting aquifer properties and groundwater flows. Where underground workings have been left in place, hydraulic conductivities as high as 5 to 50 m/d have been reported for the disturbed coal seams (Merrick, 2007), as cited in (CDM Smith, 2012).

A hydrogeological investigation (HLA Envirosciences, 2004)for the proposed Blackmans Flat Waste Management Facility (located directly down-gradient of the Site) reported an approximate hydraulic conductivity of 10^{-1} m/d for the material used for backfilling of the open cut mine voids and approximately 10^{-3} m/d for the Marrangaroo Conglomerate underlying the Lithgow seam. Groundwater seepage has been observed in remaining mine voids (such as the Huon Void/Pond, formerly known as the Groundwater Collection Basin).

Considering the above, the base of the open cut fill materials are considered to present the shallowest laterally extensive groundwater bearing unit at the site in locations of former open cut mining. Localised perched shallow groundwater has been noted in various groundwater monitoring wells installed for the purpose of assessing potential contamination from Underground Petroleum Storage Systems (UPSS). In areas where former underground mines remain in place, the disturbed coal seams are considered to present the shallowest laterally extensive groundwater bearing unit.

Details of hydrogeological conditions encountered during this Phase 2 ESA are summarised in *Section 5.1*.

2.7 *GROUNDWATER USE*

A search of publically listed boreholes on the *NSW Natural Resource Atlas* (NSW Government) 27 registered groundwater bores were identified within a 3 km radius of the site. These bores are registered for monitoring, industrial, irrigation, domestic and stock uses. Details of these industrial, domestic and stock bores are listed below in *Table 2.3*.

Table 2.3 ***Registered Groundwater Bores in Proximity to the Site***

Bore ID	Distance from Power Station[1] (km)	Direction from site	Water Bearing Zone(s) (m)	Registered Use
GW053719	2.2km from Ash Repository	North East	-	Industrial
GW106737	2.5 km from Ash Repository	South East	84.0 – 84.5 5 (SWL - 33m)	Domestic
GW111942	2.9 km from Coal storage area	North	3-3.1 27-27.1 43-43.1	Industrial
GW802266	2.8 km from operational area	West	-	Domestic Stock

[1] Measured from the closest AEC

One groundwater bore is registered for domestic water supply purposes down-gradient of the site. This bore (GW106737) was installed across a shale water bearing zone at 84 m bgl and is considered to intersect the deeper aquifer. A second bore registered for industrial use (GW053719) appears to be installed within the Angus Colliery, owned by Centennial Coal. If groundwater flow in the area is dominated by local geology and flows in a north easterly direction, this bore may intersect the same water bearing unit which passes through the Mt Piper Power Station.

2.8 *HYDROLOGY*

The site is located within the Upper Cox's River Catchment. The main hydrological features in the area are shown on *Figure 1 of Annex A* and can be summarised as follows:

- Coxs River located approximately 2.5 km east from the site boundary. This is the main hydrological feature in the area. The Coxs River runs from north to south, and is dammed at Lake Wallace and Lake Lyell to provide water supply for the Delta Electricity Power Stations. The lakes are also used for other purposes including public recreation such as boating and fishing. The river ultimately flows to Lake Burragorang which stores much of Sydney's drinking water supply;

- Western Drain located within the site on the western boundary of the operational area. This diverts runoff from the hills above the site along the western boundary and into Neubecks Creek;

- Neubecks Creek (also known as Wangcol Creek) located immediately to the north of the site. Neubecks Creek drains from the area west and north of Mt Piper Power Station to join the Coxs River north of Lidsdale;

- Pipers Flat Creek located approximately 1.5 km south of the site boundary, running from west to east beyond the forested ridge behind the site; and

- Thompsons Creek Reservoir located approximately 8 km south-west from the site boundary of Mt Piper. This dam impounds Thompsons Creek to supply water to the Delta Electricity Power Stations. As the dam has a small catchment it is supplemented with water from Lake Lyell. It is used recreationally for trout-fishing. Thompsons Creek appears to run south to north joining Pipers Flat Creek (mentioned above).

- Hydrological features are presented in *Figure 1 of Annex A*.

- Surface water drainage has recently been diverted from the former Huons Gully located along the western edge of the area formerly mined by Centennial Coal in the recently purchased Lamberts North area. The drainage line formerly included a surface water pond known as Huons

Void, or the Groundwater Collection Pit which has now been filled and is understood to not directly discharge to Neubecks Creek.

2.8.1 *Lake Lyell*

The Coxs River was dammed downstream of Lake Wallace to form the Lake Lyell reservoir in 1982. Lake Lyell has an active capacity of approximately 31 GL, sourced from local runoff. The water is also pumped to off-stream storage at Thompsons Creek Reservoir, which supplies Mt Piper, or to Lake Wallace, which supplies Wallerawang Power Station.

At the time of preparation of the PESA three local farmers held agreements with Delta to agist stock within the buffer lands around Lake Lyell. It is further understood that these agreements were transferred to Energy Australia along with the sale of the Site. Lithgow City Council also owns a portion of lands adjacent to Lake Lyell, as well as leasing additional lands which are publicly accessible for camping and recreation areas.

2.8.2 *Thompsons Creek Reservoir*

Thompsons Creek Reservoir was constructed in 1992 on a small creek to provide off-stream storage for supply of the water to Mt Piper and Wallerawang. Although the surface runoff catchment of Thompson Creek is relatively small, Thompsons Creek Reservoir has a storage capacity of up to 27.5 GL with water routinely pumped from Lake Lyell.

The reservoir is also available to the public for recreational fishing, however other recreational activities (swimming / boating etc) are not permitted. Surrounding buffer lands are generally vacant vegetated lands, with some areas used for stock grazing by local farmers under agreements with Energy Australia.

2.9 *SENSITIVE RECEPTORS*

Sensitive receptors relevant to the Site identified as part of the *SAQP* (ERM, 2013a), included:

- indoor and outdoor human health receptors in the form of industrial workers;
- intrusive maintenance workers;
- residential receptors and potential groundwater users;
- recreational users of Lake Lyell (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 Lyell, the Neubecks Creek and the Coxs River.

2.10 *POTENTIAL AND KNOWN SOURCES OF CONTAMINATION*

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

- Former Mine and Backfilling of Operational Area (contamination of soil and groundwater from historical activities, or use or impacted fill material);
- Former Landfills (potential leaching from landfilled materials);
- Coal Storage Area (potential leaching from stockpiled coal);
- Electrical Transformers (potential leaks of transformer oil)
- Water Holding Ponds (potential leaks of ponds);
- Workshops (potential leaks of solvents);
- Mobile Plant Refuelling Area (potential fuel leaks);
- Operational USTs (potential fuel leaks);
- Operational ASTs (potential chemical and/or fuel leaks);
- Current Ash Repository (leachate);
- Lamberts North Ash Repository (leachate); and
- Lake Lyell and Thompsons Creek Reservoir (sediments may have accumulated contaminants from Mt Piper Power Station drainage and discharges).

Subsequent to the issue of the PESA (ERM, 2013b) the Site has self-notified groundwater contamination to NSW EPA under Section 60 of the CLM Act. The following details are listed on the NSW EPA register of contaminated sites:

Table 2.4 ***Mount Piper Notification to NSW EPA under the CLM Act***

Suburb/ City	Site description and address	Activity that caused contamination	s60 form received?	EPA initial assessment	EPA site management class
Portland	Mt Piper Power Station 350 Boulder Road	Other Petroleum	Yes	In progress	B - The EPA is awaiting further information to progress its initial assessment of this site.

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 National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC, 2013), 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 5.6* 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 in the following sections.

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 in *Sections 1* and *2* of this report, and via the conceptual site model (CSM) provided in *Annex C* which was developed as part of the *SAQP* (ERM, 2013a).

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 sale of the Mt Piper 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, surface water and groundwater impact on or beneath the Site?
- What is the nature and extent of sediment and surface water and impact to Lake Lyell and Thompsons Creek Reservoir?
- 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 notification and / or regulation under the *NSW Contaminated Land Management Act, 1997*?
- Is material remediation likely to be required?

Adopted screening values 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/sediment 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 screening values 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 Phase 2 ESA program within the study boundaries may include:

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

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 Phase 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. Deviations from the Phase 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.

The proposed Phase 2 program included soil samples from 183 locations and groundwater samples from 97 locations. The completed Phase 2 program included soil samples from 187 locations and groundwater samples from 77 locations. A detailed comparison of the proposed and completed investigation locations for each AEC along with explanations for changes is provided in *Table 8 of Annex B*.

Where access constraints were identified, boreholes and monitoring wells were moved (where possible to nearby locations) and where drilling was not feasible, surface soil samples were collected to assess direct contact pathways. In areas which could not be accessed for drilling, monitoring wells were located around the perimeter of the inaccessible area where possible. The distribution of monitoring wells around the perimeter provides an understanding of groundwater conditions up-gradient and down-gradient of the relevant AECs to assess the potential extent of contamination and identify potential for migration of contaminants. It is therefore considered that the number and distribution of completed boreholes and monitoring wells is sufficient for characterising soil and groundwater conditions for the purpose of this baseline assessment.

At the beginning of the Phase 2 program the conceptual site model (CSM) was revised in AECs MA (Former Landfills) and ML (non-operational areas) which resulted in changes to the SAQP in these AECs. The previous CSM for these AECs was based on a soil profile with capacity for shallow groundwater and potential contamination sources limited to surface activities such as maintenance and storage. Field observations indicated that the soil profile was shallow (<0.5 m bgl) or non-existent across most of the buffer lands on elevated terrain to the north and west of the main operational area. Initial drilling confirmed that groundwater was present at depths greater than 20 m bgl within rock strata. The density of monitoring wells was therefore reduced, as contamination, if present, would likely be present at the surface (<0.5 m bgl) and therefore is unlikely to migrate to groundwater at depths of greater than 20 m bgl. Access to areas within AECs MA (Former Landfills) and ML (non-operational areas) was also limited due to difficult access in terrain and dense vegetation, and the presence of overhead power lines restricting drilling locations. Irrespective of these constraints, it is considered that the number and distribution of completed boreholes and monitoring wells is sufficient for characterising soil and groundwater conditions for the purpose of this baseline assessment.

The main constraint on the implementation of the Phase 2 program within the main operational area (AEC MK and MI) was the presence of underground utilities and other operational hazards including traffic. It is considered that the number and distribution of completed boreholes and monitoring wells is sufficient for characterising soil and groundwater conditions for the purpose of this baseline assessment.

At the beginning of Phase 2 program the SAQP for the AECs MG (current ash repository) and MH (Lamberts North Ash Repository) were revised to account for the operational constraints at the time of sampling, however, it is considered that the number and distribution of completed boreholes and monitoring wells is sufficient for characterising soil and groundwater conditions for the purpose of this baseline assessment

Table 3.1 *Mt Piper Phase 2 Investigation Location Abandonment*

AEC	Location	Location Type	Comments
MA	MA_MW02	Monitoring Well	Monitoring well abandoned due to change in conceptual site model. *.
MA	MA_MW04	Monitoring Well	Monitoring well abandoned due to change in conceptual site model*.
MA	MA_MW06	Monitoring Well	Monitoring well abandoned due to change in conceptual site model*.

AEC	Location	Location Type	Comments
MA	MA_MW09	Monitoring Well	Monitoring well abandoned due to change in conceptual site model* and physical access constraints.
MA	MA_MW10	Monitoring Well	Monitoring well abandoned due to change in conceptual site model* and physical access constraints.
MA	MA_MW11	Monitoring Well	Serviceable existing well located nearby considered adequate for the purpose of this investigation.
MG	MG_SB01	Soil Bore	Proposed location was outside the site boundary. No suitable alternate locations.
MH	MH_SB05	Soil Bore	Soil bore location abandoned due to physical access constraints
MH	MH_SB06	Soil Bore	Soil bore location abandoned due to physical access constraints
MH	MH_SB07	Soil Bore	Soil bore location abandoned due to physical access constraints
MI	MI_SB01	Soil Bore	Soil bore location abandoned due to physical access constraints. Nearby monitoring wells installed in the sewerage treatment plant.
MK	MK_SB21	Soil Bore	Soil bore location abandoned due to physical access constraints.
MK	MK_SB23	Soil Bore	Soil bore abandoned due to physical access constraints (underground services). Located adjacent to proposed monitoring well - MD_MW01 - providing sufficient data.
MK	MK_SB29	Soil Bore	Soil bore abandoned due to physical access constraints (underground services). Located adjacent to proposed monitoring well - MD_MW02 providing sufficient data.
MK	MK_SB41	Soil Bore	Soil bore location abandoned due to physical access constraints (known subsurface utilities). Located adjacent to existing well MJ_X_MWMP5.
MK	MK_SB45	Soil Bore	Monitoring well location abandoned due to physical access constraints (known subsurface utilities).
MK	MK_SB53	Soil Bore	Sufficient soil bores along fence boundary.

AEC	Location	Location Type	Comments
MK	MK_SB60	Soil Bore	Soil bore location abandoned due to physical access constraints (known subsurface utilities and traffic). Located adjacent to proposed soil bore MK_SB61 which provides sufficient data.
MK	MK_SB63	Soil Bore	Soil bore location abandoned due to physical access constraints (known subsurface utilities).
MK	MK_SB64	Soil Bore	Soil bore location abandoned due to physical access constraints (known subsurface utilities).
MK	MK_SB66	Soil Bore	Soil bore location abandoned due to physical access constraints (known subsurface utilities).
MK	MK_SB67	Soil Bore	Soil bore location abandoned due to physical access constraints (known subsurface utilities).
MK	MK_SB69	Soil Bore	Soil bore location abandoned due to physical access constraints (known subsurface utilities).
MK	MK_SB70	Soil Bore	Soil bore location abandoned due to physical access constraints (known subsurface utilities).
MK	MK_SB72	Soil Bore	Soil bore location abandoned due to physical access constraints (known subsurface utilities).
MK	MK_SB73	Soil Bore	Soil bore location abandoned due to physical access constraints (known subsurface utilities).
MK	MK_SB74	Soil Bore	Soil bore location abandoned due to physical access constraints.
MK	MK_SB75	Soil Bore	Soil bore location abandoned due to physical access constraints (known subsurface utilities).
MK	MK_SB77	Soil Bore	Soil bore location abandoned due to physical access constraints.
MK	MK_SB80	Soil Bore	Soil bore location abandoned due to physical access constraints (heavy vehicle traffic).
MK	MK_SB83	Soil Bore	Soil bore location abandoned due to physical access constraints (known subsurface utilities).
MK	MK_SB85	Soil Bore	Soil bore location abandoned due to physical access constraints (heavy vehicle traffic).
ML	ML_MW01	Monitoring Well	Monitoring well abandoned due to change in conceptual site model*.

AEC	Location	Location Type	Comments
ML	ML_MW04	Monitoring Well	Monitoring well location abandoned due to physical access constraints (overhead transmission lines).
ML	ML_MW06	Monitoring Well	Monitoring well location abandoned due to physical access constraints.
ML	ML_MW09	Monitoring Well	Monitoring well abandoned due to change in conceptual site model*. Nearby locations MF_MW04 and MF_MW05 utilised.
ML	ML_MW11	Monitoring Well	Monitoring well location abandoned due to physical access constraints (overhead transmission lines).
ML	ML_MW13	Monitoring Well	Monitoring well abandoned due to change in conceptual site model*.
ML	ML_MW16	Monitoring Well	Monitoring well abandoned due to change in conceptual site model*. Sufficient investigation locations within the former Contractors Yard.

Notes:
* See discussion in text above. The SAQP was revised in the field at the beginning of the Phase 2 program and it is considered that sufficient coverage was achieved.

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 QC samples outlined in relevant guidelines made or approved under the *NSW Contaminated Land Management Act 1997*, including the *ASC NEPM* (NEPC, 2013). In the event that acceptable 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 5.9* 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 screening values.

Exceedence of adopted screening values 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 screening values, consideration of the extent of the impact, the potential for receptors to be exposed to the impact, and regulatory compliance was considered.

The adopted screening values have generally been sourced from guidelines made or approved under the *Contaminated Land Management Act 1997*, which includes the ASC NEPM (NEPC, 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 (NEPC, 2013);

- 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; and

- Where applicable, the guidance provided in the Western Australia Department of Health (2009) *Guidelines for the assessment, remediation and management of asbestos-contaminated sites in Western Australia* has been adopted in relation to asbestos as referenced by the ASC NEPM (NEPC, 2013). This included consideration of the site-specific circumstances and the likely management and/or remediation approach (where required).

Groundwater and Surface Water Screening Values

Water data will be assessed against investigation criteria published in NEPC (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 bioaccumulation of mercury and selenium); (ANZECC/ARMCANZ, 2000)

- National Health and Medical Research Council (NHMRC) and National Resource Management Ministerial Council (NRMMC) (2013) *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy*; (NHMRC, 2013)

- NHMRC (2008) *Guidelines for Managing Risks in Recreational Waters* (note that these will be applied with reference to NHMRC and NRMMC 2013 – referenced above); and (NHMRC, 2008)

- 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). (Friebel, 2011)

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 (DEWHA, 2009) *National Assessment Guidelines for Dredging*. (ANZECC/ARMCANZ, 2000)

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;

- PAHs in water, including Benzo(a) pyrene and Carcinogenic PAHs (as BaP TEQ), have LORs above the drinking water and recreational guidelines. The LORs are within the same order of magnitude as the recreational screening value and an order of magnitude above the drinking water guideline – noting that no drinking water receptors have been identified in the vicinity of the site. A detection of either of these compounds may require further investigation and / or explanation, and should take into consideration concentrations of other volatile TRH fractions.

- 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.

- Several PAHs in sediments have LORs marginally above the ISQG-Low, and on occasion, above the ISQG-High. However it is noted the LOR for total PAHs was below the ISQG-Low. The laboratory reported that standard LOR could not be achieved due to the moisture content of the samples.

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 Delta Electricity. 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 (eg buffer lands) or to fill material data gaps within the CSM. It is noted that intrusive investigations were limited to areas where access and site activities enabled 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 (refer to *Table 3.1*).

Given the scale of the site, different sampling densities were 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* (NSW EPA, 1995) which does not recommend a minimum number of sampling points for sites larger than 5.0 ha. The NSW EPA *Sampling Design Guidelines* (NSW EPA, 1995) recommends four sampling patterns; judgemental, random, systematic and stratified. As recommended in these guidelines, a stratified sampling pattern was adopted whereby the Site was divided into smaller areas of environmental concern (AECs) based on a review of historical activities and identified potentially contaminating activities.

A combination of systematic and judgemental sampling patterns was therefore adopted within each AEC to both target specific potential point sources (e.g. fuel storage tanks) and to provide sufficient lateral coverage. The exception to this was sampling within the operational area, for which a grid-based systematic approach was adopted. The sampling densities adopted are considered appropriate for the purpose of this assessment.

The sampling pattern and density was limited by the constraints on drilling (as discussed in *Section 3.3*), however a systematic approach was achieved with monitoring wells were located down-gradient of inaccessible areas where feasible. Whilst there remains potential for localised areas of contamination to exist, the network of monitoring wells is considered to be sufficient to establish the presence of potentially material contamination by delineating the maximum extent of potential impacts.

It is therefore considered that the number and distribution of completed boreholes and monitoring wells is sufficient for characterising soil and groundwater conditions for the purpose of this baseline assessment within the constraints previously discussed and identified within the SAQP (e.g. subsurface utilities).

Final investigation locations are presented in Figures 5.1 to 5.7 of Annex A.

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 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). The location and number of sampling locations are presented within *Figures 5.1 to 5.8* of *Annex A* and listed by AEC (Area MA – Area MM) in *Table 1* of *Annex B*. Where practicable, all boreholes were advanced to an initial depth of 1.5 m bgl using either hand augering or Non-Destructive Digging (NDD) 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 (eg 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* (Standards Association of Australia, 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
Sample taken from shallow hand auger soil bore or deeper soil bore, SB01 at depth of 0.5 m bgl, within work area MA	MA_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 MA	MA_MW07_5.0
Sediment samples taken from SS01 within work area MM at a depth of 0.25 m below the surface of the sediment.	MM_SS01_0.25
Surface water samples taken from SS01 within work area MG	MG_SS01

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 requirements of the *ASC NEPM* (NEPC, 2013) incorporating the WA DOH guidelines *(WA DOH, 2009)* and the ERM *Assessment of Asbestos Impacted Areas SOP* (ERM, 2012). No potential asbestos containing material (ACM) was identified at the surface or during the investigation works, and there were no ACM fragments submitted for analysis. Discrete 500 ml samples of soil were collected in snap lock bags during NDD for laboratory analysis for asbestos fibres. These samples were submitted to the laboratory for asbestos identification and (where identified) quantification (%w/w analysis) in accordance with the *ASC NEPM* (NEPC, 2013) and the WA DOH guidelines *(WA DOH, 2009)*.

4.3.2 *Decontamination Procedure*

Down-hole drilling and non-single use 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 were backfilled and the surface covering reinstated to match existing.

4.3.4 *Management of Waste Materials Generated During Drilling*

All non-liquid waste materials generated during drilling works were stored on-site in stockpiles inside a temporary bund in a designated area near the ash repository. If evidence of significant contamination was observed during drilling (e.g. staining or odour) potentially impacted wastes could be stored separately.

The soil will be beneficially re-used as capping material within the ash repository, in accordance with environmental licence conditions. The ash repository is currently managed by LendLease on behalf of Energy Australia.

Potentially contaminated PPE used during drilling including Tyvek suits and disposable P2 face masks were placed inside two 200 micrometre (µm) thick, asbestos labelled bags (i.e. double bagged) and then into labelled drums. The drums were collected by an appropriately licenced waste contractor (Environmental Treatment Services Pty Ltd - ETS) and transported to an appropriately licenced waste facility in accordance with NSW waste regulations. Relevant disposal documentation can be provided upon request.

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 5.1 to 5.7* 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 (NAPL);

- 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 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.

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. 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 low-flow 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 100 mL solvent washed amber bottles and one, 1 litre solvent washed amber bottle (for inter-laboratory duplicate samples);
- samples to be analysed for dissolved metals filtered through disposable 0.45 µm filters and placed in 60 mL plastic bottles preserved with nitric acid, or 60 mL unpreserved plastic bottles for ultra-trace metals;
- samples to be analysed for ferrous iron filtered through disposable 0.45 µm filters and placed in 60 mL plastic bottles preserved with hydrochloric acid; and
- samples to be analysed for major cations and anions placed in an unpreserved 250 mL plastic bottle.

Light Non-Aqueous Phase Liquid (LNAPL) was observed at three locations in area ME during the groundwater monitoring and sampling event. Where LNAPL was detected with an interface probe, a clear plastic bailer was used to confirm the presence, thickness and appearance of the LNAPL. No samples were collected or analysed from groundwater monitoring wells where LNAPL was detected.

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*

With approval from Delta Electricity and Energy Australia, waste water from development and purging of groundwater monitoring wells was disposed of via designated drains on-site which discharged to treatment systems.

4.5 *SURVEYING*

All soil bore 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 (Craven Elliston & Hayes) to AHD for elevation and MGA coordinates for location. Survey data is presented in *Annex J*. 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 7 sampling locations (as shown on *Figure 5.7, Annex A*).

Sediment samples were collected in general accordance with the methodologies outlined in CSIRO *Handbook for Sediment Quality Assessment* (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.

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 'snaplock' 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 (using the same procedures as those previously outlined for soil sampling equipment) between sampling locations.

4.7 *SURFACE WATER INVESTIGATION*

Surface water sample locations were co-located with sediment sample locations. Surface 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 Lake Lyell and Thompsons Creek Reservoir. Surface water samples were collected approximately 1.0 m above the sediment 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 relevant 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); and
- benzene, toluene, ethylbenzene and xylenes (BTEX);

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

- asbestos (presence / absence – soil only);
- polychlorinated biphenyls (PCBs) – related to use of PCB-containing transformer oils on site; and
- volatile organic compounds (VOCs in addition to BTEX).

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

- total organic carbon (TOC);
- particle size distribution (PSD);
- electrical conductivity (EC); and
- pH and cation exchange capacity (CEC).

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*. QA/QC information incorporating inter-laboratory and intra-laboratory duplicates, rinsate samples and trip spike/blank samples is also presented in *Tables F6* to *F13* of *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.

There were some instances where the adopted screening values were less than the laboratory LOR. These potential non-conformances are discussed in *Section 5.6* of this report.

5 RESULTS AND DISCUSSION

5.1 SITE GEOLOGY OBSERVATIONS

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

Backfilled former open-cut mine voids were present across the current operational areas of the Site. These appeared to have been backfilled with overburden at the end of mining operations. Within these disturbed portions of the Site, subsurface soil conditions encountered largely comprised fill materials in the form of reworked local soils and rock overlying natural bedrock. An example of mine overburden fill materials is shown in *Photograph 20, Annex G*. Within undisturbed areas, fill typically overlaid shallow natural bedrock generally within 1.5 m of the surface. The depth to bedrock varied across the Site corresponding with topography, with outcropping siltstone and sandstone observed in elevated areas to the west of the operational area. An outcrop of coal is shown in Photograph 14, Annex G and an outcrop of siltstone is shown in *Photograph 15, Annex G*.

Table 5.1 Generalised Field Lithology Descriptions

Lithological Unit	Description	Depth[1] (m bgl)
Hardstanding	Concrete generally in good condition. (present in locations within the operational area)	0 - 0.2
Fill - Mine Overburden	Sandy clay or gravelly clay with angular gravels, cobbles and boulders, brown or brown with orange, red and grey mottling, dry to moist, non-plastic, no odours or staining.	0.2 – up to 15 [2]
Natural Soil[3]		
Clay	Dark brown, becoming pale grey with orange mottling with depth, moist to wet, homogenous, high plasticity, organic matter (fibrous roots).	2.5 – bedrock
Clay	Yellow brown, becoming pale grey with depth, moist, homogenous, high plasticity, organic matter	2.5 – bedrock
Sandy Clay	Brown, wet, low plasticity	4.1- 5.0 (AEC MA)
Silt	Grey brown, slightly moist, homogenous, low plasticity, no staining, no odour, organic matter.	4.5-5. (AEC MB)

Lithological Unit	Description	Depth[1] (m bgl)
Bedrock	Interbedded siltstone, sandstone, shale and coal. Siltstone: pale to dark grey, generally dry Sandstone: pale grey to brown, medium to coarse grained, dry, at times - moist to wet; Shale: dark grey, very fine grained, generally dry; Coal: black, dry or wet.	1.5 – 30.0

1. Given the variation in topography and mining activities across the Site, depths and lithologies may vary across the site.
2. Depth of fill across the site varied significantly. Fill material was recorded up to 15 m bgl within former open cut mining areas and extending to 1.5 m within areas undisturbed by mining activities (generally the western portion of the main operational area (AEC MK))
3. Natural soils typically recorded in the buffer lands and around the former landfill area (AEC MA), coal storage area (AEC MB), and some portions of operational area (AEC MK)

5.2 *GROUNDWATER FIELD OBSERVATIONS*

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 for newly installed and existing monitoring wells between 3 October and 19 December 2013. During this time, a total of 90 mm of rain was recorded. Rain was largely recorded (31.6 mm) between 11 and 23 November, 2013.

Groundwater gauging data is presented in *Table 2 of Annex B*. Groundwater was encountered at depths ranging from 0.60 m bgl to 29.01 m bgl, or 904 m AHD to 970 m AHD.

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

5.3 *SEDIMENT AND SURFACE WATER SAMPLES*

A total of 7 sediment and surface water samples were collected to assess the baseline condition of Lake Lyell and Thompsons Creek Reservoir. One additional surface water sample was collected from the freshwater pond in AEC MH. Sampling locations were distributed around the AEC as presented in *Figures 5.7 of Annex A*. Further details of these works are presented in *Section 0* and *Section 5.4.8*.

5.4 *AREAS OF ENVIRONMENTAL CONCERN (AEC) SUMMARY*

5.4.1 *MA -Former Landfills*

Background

There are three closed landfills present on the Site, as shown in *Figure 5.1, Annex A,* which date from the early years of construction and operation of Mt Piper Power Station.

Whilst each landfill was intended for a specific purpose and such practices were not uncommon at that time, the disposal of waste was largely uncontrolled and a range of potential contaminants may therefore be present. The former construction waste landfill was used by contractors for disposal of building waste and materials from the construction of Mt Piper Power Station. The landfill is located in a gully in the western buffer land. Potential contamination concerns include impact from non-inert construction wastes (oils, solvents, paints). The former general waste landfill included putrescible waste and site management indicated that it was not used for disposal of restricted wastes (ash or related wastes). The landfill consisted of an unlined trench without controls on landfill gas or leachate. The landfill was reportedly used between 1993 and 1995, when the Power Station changed its policy and disposed of waste off-site. A relatively small proportion of the planned landfill was therefore filled. The landfill is located to the south-west of the main operational area in the western buffer land. Potential contamination concerns include impact from putrescible wastes (leachate).The 'chitter dam' landfill is located upgradient from the former putrescible waste dump and was constructed originally as a surface water dam but was never used for storage of water supplies. The dam was converted for use as a landfill for chitter, which is a coarse reject material from coal washing (PPK Environment & Infrastructure Pty Ltd, 2000) 'Hard' construction waste such as concrete was also disposed in this landfill (PPK Environment & Infrastructure Pty Ltd, 2000). Potential contamination concerns include impact from chitter (that is, coarse carbonaceous wastes) such as acidity, dissolved salts and heavy metals.

Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area.

AEC Methodology and Investigation Field Observations

A total of six soil investigation bores, three of which were completed as groundwater monitoring wells, were advanced within this AEC. One monitoring well was installed down- or cross- hydraulic gradient of each of the chitter dam, general and construction waste landfills. Three existing monitoring wells were also gauged and sampled as part of the ESA. The sampling locations within this AEC are presented on *Figure 5.1* 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 1.8 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 MA***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
MA_MW01	4.3	None	0- 0.1
MA_MW03	3	None	0-0.1
MA_MW05	0.3	None	n/a^
MA_MW07	8.2	None	0.0
MA_MW08	0.8	None	n/a^
MA_MW12	5	None	0.0-1.8

^ refusal encountered on sandstone. Insufficient sample for duplicate to measure with PID due to coarse fill material (gravel).

Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC. Electrical conductivity (EC) readings indicated fresh water conditions. EC readings in the southern part of the Site, both up-gradient of the chitter dam (2.6 µS/cm at MA_MW01) and down-gradient of the former general waste landfill (0.2 µS/cm at MA_MW07 and ML_MW12) were an order of magnitude lower than the typical EC readings across the Site (median EC 665 µS/cm).

No indications of contamination such as sheens or odours were observed during groundwater sampling within this AEC. As summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results have been 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 with the exception of various heavy metals, however all of these 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*. In addition to monitoring wells located within the designated AEC, monitoring well ML_MW10 is located upgradient of the former construction landfill and has been considered as part of this assessment. Exceedences of the adopted screening values are also graphically presented in *Figure 8.1 to 8.9 of 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.

Copper, manganese, nickel and zinc were detected at concentrations in excess of the adopted ecological screening values in groundwater samples collected from monitoring wells within this AEC. At ML_MW10 the measured concentration of lead also exceeded the adopted ecological screening values.

Manganese and nickel were detected in groundwater at concentrations in excess of the human health (drinking water) screening values in groundwater samples collected from monitoring wells within this AEC. Manganese was detected in groundwater in excess of the human health (recreational assessment) criteria in three groundwater monitoring wells.

Discussion

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

All groundwater monitoring wells in this AEC, including upgradient well ML_MW10, reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included copper, lead, manganese, nickel and zinc. Manganese 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 metals have been identified at concentrations exceeding the adopted screening criteria in groundwater within all AECs a consolidated discussion of this issue is presented in *Section 5.5.*

5.4.2 *MB - Coal Storage Area*

Background

The coal storage area is approximately 16 ha in area and is used for the stockpiling of coal prior to transfer via conveyor to the mill and crusher and then to the boilers. Potential contamination sources or activities include coal stockpiling, use and maintenance of conveyors, coal truck washdown bays and associated settling ponds, and seepage from contaminated stormwater settling ponds. Refuelling of mobile plant is discussed in *Section 5.4.5*.

It is recognised that the coal conveyor system and associated sediment ponds may represent an AEC (related to mechanical operations (oils) and coal fines that may migrate to Neubecks Creek), however these have not been considered to warrant targeted environmental investigation.

It was considered unlikely that coal storage would represent a significant contamination issue in the context of the site-wide assessment; however, given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area.

AEC Investigation Methodology and Field Observations

A total of five soil investigation bores, all of which were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the perimeter of the AEC as presented in *Figure 5.2 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 through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 2.1 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.7*.

Table 5.3 Field Observations Summary – AEC MB

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
MB_MW01	1.1	None	0
MB_MW02	13.8	None	0-2.1
MB_MW03	8	None	0-0.2
MB_MW04	8.2	None	0
MB_MW05	8	None	0-0.3

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3 of Annex B*. Field parameters were generally within the expected range in this AEC. Electrical conductivity readings indicated fresh water conditions.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC.

Soil Analytical Results

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

Measured concentrations of COPCs were below the adopted screening values in the 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 not detected in soils sampled within this AEC.

Groundwater Analytical Results

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

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

Manganese, nickel and zinc were detected at concentrations in excess of the adopted ecological screening values in groundwater samples collected from the wells within this AEC. The ecological screening values for groundwater were also exceeded for copper at MB_MW02, and cadmium and lead at MB_MW04.

Manganese and nickel were detected in groundwater at concentrations in excess of the human health (drinking water) screening values in groundwater samples collected from monitoring 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.

Samples collected from all monitoring wells within this AEC were reported with metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, manganese, nickel and zinc. Concentrations of manganese and nickel in excess of the adopted human health (drinking water) screening values were also detected in a number of samples.

As metals have been identified at concentrations exceeding the adopted screening criteria in groundwater within all AECs a consolidated discussion of this issue is presented in *Section 5.5.*

5.4.3 *MC - Electrical Transformers*

Background

Transformers and associated oil storage tanks are located on concrete within a contained area. In general, transformers are considered to be "PCB free", with transformers tested regularly to assess PCB concentrations. There was a marginal exceedence of the statutory limit under the Environmentally Hazardous Chemicals Act 1985 for the notification of PCBs (Unit 2B 11/3.3kV Auxiliary Transformer) of 2 ppm (mg/kg) with 3.1 ppm (mg/kg). Delta did not report any spills within the transformer area and given the general level of housekeeping and monitoring, it is considered unlikely that a release of significant quantity has occurred and not been reported.

This area was considered to represent a relatively low risk in the context of this assessment, given the absence of any known historical release and the low likelihood of a pathway to soil and groundwater. However, in the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline of soil and groundwater conditions in this area.

AEC Investigation Methodology and Field Observations

A total of four soil investigation bores, all of which were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the perimeter of the AEC as presented in *Figure 5.3 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 through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 1.1 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.7.*

Table 5.4 ***Field Observations Summary – AEC MC***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
MC_MW01	5.5	None	0.4- 2.0
MC_MW02	5	None	0.2-1.4
MC_MW03	5	None	0.1-0.6
MC_MW04	6.2	None	0.5-1.4

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC. Electrical conductivity readings indicated fresh water conditions.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

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

Measured concentrations of COPCs were below the adopted screening values in the soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR. TRH fractions were detected in soil collected from MC_MW04 at a depth of 0.15 m bgl. These concentrations did not exceed adopted screening values.

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 not detected in soils sampled from within this AEC.

Groundwater Analytical Results

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

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

Manganese, nickel, zinc were detected at concentrations in excess of the adopted ecological screening values in groundwater samples collected from the wells within this AEC. The ecological screening values for groundwater were also exceeded for copper and lead at MC_MW02 and ML_MW12, and arsenic and cadmium at MC_MW04 and ML_MW15. The concentration of arsenic reported at MC_MW04 exceeded human health (drinking water and recreational) screening values. The concentration of arsenic at ML_MW15 exceeded the human health (drinking water) screening values.

Manganese and nickel were detected in groundwater at concentrations in excess of the human health (drinking water) screening values in groundwater samples collected from monitoring wells within this AEC. Manganese was detected in groundwater at concentrations in excess of the human health (recreational) screening values at MC_MW03.

Discussion

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

Samples collected from all monitoring wells within this AEC were reported with metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included arsenic, cadmium, copper, lead, manganese, nickel, zinc. Concentrations of arsenic, lead, manganese and nickel in excess of the adopted human health (drinking water) screening values were also detected in a number of samples. Concentrations of arsenic in excess of human health (recreational) screening values were detected in one sample collected from MC_MW04.

As metals have been identified at concentrations exceeding the adopted screening criteria in groundwater within all AECs a consolidated discussion of this issue is presented in *Section 5.5.*

5.4.4 *MD - Workshops*

Background

Maintenance workshops are located within the main operational areas of the Site at:

- the western side of the main plant, behind Unit 2 (AEC MK);
- the south-east corner of the coal handling area (this is a combined workshop and mobile plant refuelling area (AEC ME)); and
- bulk chemical storage is located adjacent to the stores building (AEC MJ).

As the workshops are located within the main operational areas of the Site, potential contamination issues have been addressed in other AECs, including MK (Operational Areas), ME (Mobile Plant Refuelling Area) and MJ (Operational USTs) which are located adjacent to the stores building. Monitoring wells and soil bores in these areas are discussed in the relevant sections.

Site management indicated that the workshops have remained in the same location since plant operation commenced. Delta management reported that some chlorinated hydrocarbons such as "Dev-Tap" (1,1,1, Trichloroethane) have been used historically, but that such products are no longer used. A separate known issue relating to fuel storage is discussed in *Section 5.4.5*. Previous soil and groundwater investigations have been conducted around the underground fuel infrastructure, and did not include laboratory analysis of soils (as discussed in *Section 5.4.10*). Therefore further investigation was considered to be required to provide a baseline for soil and groundwater conditions in this area.

AEC Methodology and Investigation Field Observations

A total of four 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. In addition, soil bores and monitoring wells installed in AEC ME (Mobile Refuelling Plant) and MK (Operational Areas), and existing wells in AEC MJ (Operational USTs) also target the workshop areas. Sampling locations were distributed around the AEC as presented in *Figure 5.3* 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 typically did not to exceed 1.8 ppm v (isobutylene equivalent), with the exception of one sample from MD_MW04 which reported a concentration of 81.7 ppm v (isobutylene equivalent).

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

Table 5.5 ***Field Observations Summary - AEC MD***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
MD_MW01	7	None	0- 0.6
MD_MW02*	1.8	None	1.6-1.8
MD_MW03	4	None	0.8-1.7
MD_MW04	6	Hydrocarbon odour	1.1-81.7

Notes: * soil bore only as monitoring well could not be installed due to refusal at shallow depth and proximity to sub-surface utilities.

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 3* of *Annex B*. Field parameters were generally within the expected range in this AEC. Electrical conductivity readings indicated fresh water conditions.

A light oily sheen was observed during groundwater purging at MD_MW04. No indications of contamination, such as sheen or odours, were observed during groundwater sampling at MD_MW02 and MD_MW03. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B.*

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4d of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Figure 8.1 to 8.9 of 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 reported above the corresponding laboratory LOR in soil collected from 1.2 m bgl at MD_MW04. 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 however all concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled from within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented *in Table 5.d of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Figure 8.1 to 8.9 of 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.

Manganese, nickel and zinc were detected at concentrations in excess of the adopted ecological screening values in groundwater samples collected from all groundwater monitoring wells within this AEC. The ecological screening values for groundwater were also exceeded for arsenic at MD_MW04, cadmium at MK_MW01, chromium at MD_MW03, copper at MK_MW08 and lead at MD_MW03 and MK_MW08.

Manganese and nickel were detected in groundwater at concentrations in excess of the human health (drinking water) screening values in groundwater samples collected from monitoring wells within this AEC.

The concentration of lead reported at MD_MW03 exceeded human health (drinking water) 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 1.2 m bgl at MD_MW04 which exceeded the adopted ESLs. The hydrocarbon impacts identified at this location may be related to historical leaks or spills associated with workshop activities in this area. Area MD is largely covered in concrete hardstanding, with some grass areas around service easements. Area MD is not considered to have any significant ecological value and thus the application of the ESLs is considered to be overly conservative in this instance.

Samples collected from all monitoring wells within this AEC were reported with metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included arsenic, cadmium, chromium, copper, lead, manganese, nickel, zinc. Concentrations of manganese and nickel in excess of the adopted human health (drinking water) screening values were also detected in a number of samples. Concentrations of lead in excess of human health (drinking water) screening values were detected in one sample collected from MD_MW03. As metals have been identified at concentrations exceeding the adopted screening criteria in groundwater within all AECs a consolidated discussion of this issue is presented in *Section 5.5.*

5.4.5 *ME - Mobile Plant Refuelling Area*

Background

The mobile plant refuelling area is located adjacent to the coal storage area and is used by large mobile plant. The infrastructure consists of a shed, small workshop and a wash bay, with a diesel UST and bowser located on the southern side of the wash bay. A washdown pit and a "bobcat pit" are located adjacent to the day maintenance workshop and the integrity of this in-ground pit is unknown. The wash bay drains to an oil-water separator located on the northern side of the wash bay. The oil-water separator drains through an underground pipe in a north-easterly direction, discharging into an open surface water drain along the coal storage area boundary. The bobcat pit drains to an oil collection pit which is pumped out by a road tanker. Although a covered concrete platform is provided at the mobile plant yard, the ground immediately surrounding the mobile plant area is unsealed and there was staining observed on bare ground beneath the large mobile plant.

Light non-aqueous phase liquid (LNAPL) has been previously identified in a groundwater monitoring well (MWMP8) on the northern side of the wash bay, adjacent to the oil-water separator in October 2012 (SMEC, 2012). Further investigations were undertaken, including integrity testing and excavation to inspect the UST and lines, which indicated no issues with the UST. Hydrocarbon fingerprint analysis was undertaken on samples of the diesel from the UST and the LNAPL in March 2013. The LNAPL was weathered with an age estimate of 25 years and was hence considered to be unrelated to the diesel currently in the UST. Other potential sources of historical petroleum releases include an aboveground release (spill from tanker or unknown AST), linework failure, or potentially unknown USTs.

The PESA (ERM, 2013b) considered further investigation was warranted to assess the potential for soil and ground contamination.

AEC Methodology and Investigation Field Observations

Proposed investigation locations in this AEC, as stated in the SAQP (ERM, 2013a), included four soil investigation bores, all of which were proposed to be completed as groundwater monitoring wells. Sub-surface clearance was undertaken at the four proposed monitoring well locations, and NDD was completed on 14 November to a depth of 1.5 m bgl in preparation for drilling to the target depth, estimated at 6 m bgl. Drilling of these four locations was scheduled for 18 November 2013. On arrival at Site on 18 November a drill rig under the direction of another consultant, SMEC, had begun drilling of monitoring wells in this area under directions from Energy Australia. ERM therefore ceased work in this AEC until the SMEC investigation was completed.

SMEC installed five groundwater monitoring wells in this AEC on 18 and 19 November 2013, including four monitoring wells and one recovery well (SMEC, 2014). The findings of the SMEC investigation are reported in the report *Installation and Monitoring of Plume Delineation Groundwater Wells - Bulldozer Workshop - Mt Piper Power Station* (SMEC, 2014). The stated objectives of the SMEC investigation were to delineate the extent of the previously identified hydrocarbon plume, install a product recovery well within the area of the identified plume and advise Energy Australia of likely remedial actions and steps/obligations in relation to the identified hydrocarbon contamination (SMEC, 2014).

The scope of works completed by ERM in this AEC was modified following the completion of the five additional groundwater wells by SMEC described above. Of the proposed ERM soil investigation bores, three locations were abandoned following NDD, and one location (inferred up-gradient of the identified LNAPL plume) was completed as a groundwater monitoring well (ME_MW04). The three soil investigation bores (ME_SB01, ME_SB02 and ME_SB03) were completed to a depth of 1.5 m bgl and soil samples were analysed for the COPCs.

The scope of works for this AEC completed by ERM as part of this Phase 2 ESA included four soil investigation bores, one of which was completed as a groundwater monitoring well. Soil samples were collected from the four ERM soil bore locations (ME_SB01, ME_SB02, ME_SB03 and ME_MW04). The depth to groundwater was gauged at all nine groundwater wells, including the recovery well, and LNAPL was detected in four locations. For clarity, a summary of monitoring well installations in this AEC is provided in *Table 5.6* below.

Table 5.6 *Summary of Wells in AEC ME*

Borehole ID	Alternate Name	Well Depth (m bgl)	Location Relative to Source
ME_X_MW01	MWMP09#1	6	Up-gradient, to west of workshop.
ME_X_MW02	MWMP10#1	7.5	Cross-gradient of ME_X_MWMP8*
ME_X_MW03*	MWMP12#1	7.5	Down-gradient of ME_X_MWMP8*
ME_X_MW05	MWMP11#1	6	Cross-gradient of ME_X_MWMP8*
ME_X_MW06	MWMP14#1	6	Down-gradient of ME_X_MWMP8*
(Recovery Well)	MWMP13#1		Adjacent to ME_X_MWMP8*
ME_X_MWMP7*	MWMP07#2	6	Adjacent to UST & bowser
ME_X_MWMP8*	MWMP08#2	4	Adjacent to oil-water interceptor
ME_MW04	ERM1#3	7.8	Up-gradient of UST & bowser

1. Well installed by SMEC (Dec 2011); note the recovery well was not sampled by ERM.
2. Well installed by SMEC (Nov 2013)
3. Well installed by ERM (Nov 2013). SMEC (2014) used alternate name "ERM1".
* well detected LNAPL
^LNAPL detected during gauging in November 2013, prior to drilling works.

Monitoring wells were distributed with one up, one across and two on the down hydraulic gradient side of the existing groundwater monitoring well ME_X_MWMP8 where LNAPL had historically been reported. The sampling locations (both those installed by ERM and those installed by others) within this AEC are presented on *Figure 5.3* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

It was observed that the ground surface within this AEC was unsealed, with coal present at the surface, and staining evident on the ground surface.

During drilling by ERM no staining or unusual odours were detected at depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.7 ppm v (isobutylene equivalent) in any soil sample collected from this AEC. Borelogs from the investigation completed by SMEC (2014) indicate hydrocarbon odours and LNAPL sheen at 5 m bgl at MWMP10 and a hydrocarbon odour at MWMP12

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

Table 5.7 *Field Observations Summary – AEC ME - Soil*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
ME_SB01	1.5	None	0.1-0.2
ME_SB02	1.5	None	0–0.3
ME_SB03	1.5	None	0.3-0.6
ME_MW04	12.5	None	0.3-0.7

Groundwater samples were collected from the five monitoring wells located within this AEC, with no samples collected from three monitoring wells where LNAPL was detected, and no sample was collected from the recovery well. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC. Electrical conductivity readings indicated fresh water conditions.

LNAPL was detected during groundwater gauging in three groundwater monitoring wells within this AEC, as summarised in *Table 5.8* below. The presence of LNAPL was visually confirmed with a clear plastic bailer. 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 *Table 3 of Annex B*.

Table 5.8 *Field Observations Summary – AEC ME - Groundwater*

Borehole ID	LNAPL thickness (mm)	Depth to LNAPL (m bgl)
ME_X_MWMP7	2	5.377
ME_X_MWMP8	200	3.425
ME_X_MW03	5	5.154

Soil Analytical Results

The soil analytical results have been 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.

Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.e* of *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Figure 8.1 to 8.9 of Annex A*.

LNAPL was detected in three groundwater monitoring wells within this AEC. 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.

Manganese, nickel and zinc exceeded the adopted ecological screening values in groundwater samples collected from all groundwater monitoring wells within this AEC. At monitoring well ME_MW04 the measured concentration of copper also exceeded the adopted ecological screening values. Manganese exceeded the adopted human health screening values (drinking water and recreational) in groundwater samples collected from all groundwater monitoring wells within this AEC. Nickel exceeded the adopted human health screening values (drinking water) in groundwater samples collected from all groundwater monitoring wells within this AEC, and also exceeded the human health screening values (recreational) at ME_MW04.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC. However, LNAPL was detected in three groundwater monitoring wells. Further discussion on the issue of LNAPL in this AEC is provided in *Section 5.6.2*.

Samples collected from all monitoring wells within this AEC were reported with metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included copper, manganese, nickel, zinc. Concentrations of manganese and nickel in excess of the adopted human health (drinking water and recreational) screening values were also detected in a number of samples.

As metals have been identified at concentrations exceeding the adopted screening criteria in groundwater within all AECs a consolidated discussion of this issue is presented in *Section 5.5*.

5.4.6 *MF - Operational ASTs*

Background

Operational above-ground storage tanks at the Site include a 28 000 L diesel AST located near the ash repository; sulfuric, caustic and alum tanks at the demineralisation plant; and a refined recycled oil (RRO) installation on the south east corner of the operational area.

The demineralisation plant was assessed as part of the operational area (Area MK, see *Section 5.4.11*).

The fuel (RRO) installation investigated as part of this assessment was installed in 1990/91 and consists of two bunded 1.2 ML steel tanks, an unloading station for unloading two road tankers simultaneously and a small 36 kL overflow tank (Worley Parsons 2013). The ASTs are filled by road tankers, with gravity pipes (in concrete lined trenches) transporting fuel to dedicated duty and standby ignition oil pumps for each boiler (Worley Parsons 2013). There were no reported leaks or spills associated with the RRO. Potentially significant releases of fuel associated with the ASTs and/or pipework would likely be accounted for in the fuel reconciliations. Fuel is metered when delivered and when used, and the tanks are gauged periodically (Worley Parsons 2013). Fuel reconciliations are undertaken to account for any potential loss of fuel. Tank integrity tests are reported to be undertaken across the site on a routine basis. Documentation relating to the tank integrity testing and fuel reconciliations was not available at the time of the PESA, however was reported by Worley Parsons (2013).

It is considered unlikely that there have been potentially significant releases from the ASTs given that they are located within a concrete lined bunded area and any potential leaks or spills would be immediately evident, and would be contained within the bunded area. The potential for unknown leaks from the fuel oil pipeline is unlikely given that it is located within a concrete lined trench, which can be access via ground level covers for inspection and any potential leaks or spills would be evident from staining on the concrete.

A water retention pond is located approximately 60 m to the north and down-slope of the RRO ASTs. The pond receives discharge from an oil water interceptor which appears to collect water from inside the bund of the AST. The side walls of the pond were heavily stained black and the pond did not appear to be lined. A sheen was noted on the water in the pond. Maintenance works were carried out during the site investigation works, which involved pumping of water into a waste water truck.

Given the absence of previous environmental investigations the PESA concluded that further investigation was warranted to assess potential soil and groundwater contamination issues associated with the fuel (RRO) installation in this AEC.

Methodology and Investigation Field Observations

A total of five soil investigation bores were drilled and converted to monitoring wells within this AEC. One monitoring well was installed upgradient, and two downgradient of the RRO tank farm. Two additional monitoring wells were installed down-gradient of the water retention pond near the RRO.

A groundwater sample was collected from an existing monitoring well, MG_X_MP1, located near the diesel AST near the ash repository. No leaks or spills have been reported in this area, and the potential for unknown leaks from infrastructure is unlikely given that the infrastructure is above-ground, therefore no further investigations were targeted at this area.

The sampling locations within this AEC are presented on Figures 5.4 and 5.5 of Annex A. Relevant borehole logs are presented within Annex D.

With the exception of the observations of the water retention pond described above, no field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. Soil sampling was limited to less than 0.45 m bgl, with shale bedrock encountered in all locations at depths between 0.2 and 0.45 m bgl. No staining or unusual odours were detected at any depth through the sampled soil and rock profile. Measured concentrations of ionisable volatile compounds via headspace analysis sampled from surface soils did not exceed 0.2 ppm v (isobutylene equivalent).

A summary of the field observations from the drilling works are presented in *Table 5.9.*

Table 5.9 ***Field Observations Summary - AEC MF***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID (ppm v - isobutylene equivalents)
MF_MW01	16	None	0.2
MF_MW02	25	None	0.0
MF_MW03	13	None	0.0
MF_MW04	15.8	None	0.0
MF_MW05	27	None	0.0

Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B.* No evidence of contamination was reported during groundwater sampling.

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.f of Annex B.* Exceedences of the adopted screening values are also graphically presented in *Figure 7 of Annex A.*

Measured concentrations of all 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. Concentrations of TRH C_{16}-C_{34} and total PAHs were above the corresponding laboratory LORs in soil samples at 0.2 m bgl from MF_MW03 and total PAHs at 0.2 m bgl from MF_MW05 however all concentrations were below the adopted screening values.

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 not detected in soils sampled within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented *in Table 5.f of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Figure 8.1 to 8.9 of 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.

Copper, manganese, nickel and zinc were detected at concentrations in excess of the adopted ecological screening values in groundwater samples collected from all groundwater monitoring wells within this AEC. Lead was detected at concentrations in excess of the adopted ecological screening values in groundwater sampled from MF_MW03. Cadmium was detected at concentrations in excess of the adopted ecological and human health (drinking water) screening values in groundwater sampled from MG_X_MP1. Nickel and manganese also exceeded the human health (drinking water) screening values in all sampled groundwater monitoring wells in this AEC.

Discussion

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

Groundwater flow direction is variable within this AEC and appears to flow in a south-west and north-easterly direction. Based on the geology and water strike observed during well installation, a fault is inferred to run north-south through the centre of the AST farm which appears to influence groundwater flow. Groundwater is inferred to be present between 11 and 25 m bgl, under semi-confined conditions within coarse sandstone and a coal seam.

All six of the groundwater monitoring wells sampled reported metals concentrations greater than the adopted human health and ecological screening values. Metals exceeding the adopted ecological screening values included copper, lead, manganese, nickel and zinc. Manganese and nickel concentrations in excess of the adopted human health (drinking water) screening values were also reported in a number of samples. Elevated heavy metal concentrations in groundwater sampled from upgradient well MF_MW03 correlate with slightly acidic pH in this location.

As metals have been identified at concentrations exceeding the adopted screening criteria in groundwater within all AECs a consolidated discussion of this issue is presented in *Section 5.5.* The groundwater results do not indicate significant hydrocarbon impacts in groundwater relating to the fuel infrastructure in this AEC.

5.4.7 MG - Current Ash Repository

Background

The current ash repository is located directly to the north east of the Power Station, in the former Western Main open-cut mine void. The AEC MG refers to the ash repository currently in operation, as the recent extension to Lamberts North was completed in mid-2013, however was not yet in active operation at the time of completion of the investigation works described herein. The Lamberts North Ash Repository is discussed separately in *Section 5.4.8.*

The current ash repository covers an area of approximately 40 ha and has been operational since the first power generating unit came on-line at Mount Piper Power Station in 1993. The ash repository was designed for dry ash placement, with water addition being limited to water added for ash conditioning prior to disposal and dust suppression following disposal.

Brine conditioned ash is currently disposed in a designated area of the ash repository as permitted by the EPL (GHD, 2012). Seepage from the ash repository has the potential to be saline and contain heavy metals, and routine groundwater monitoring in compliance with the EPL is undertaken in accordance with the *Mt Piper Power Station Brine Conditioned Flyash Co-placement Extension Water Management and Monitoring Plan* (WMP) (Connell Wagner, 2008). The amended WMP, including the extension to Lamberts North, was approved by the NSW Department of Planning, with comments provided by NSW Office of Water and NSW EPA. The WMP includes guidelines for the receiving waters of Huons Pond and Neubecks Creek, and also locally derived ANZECC guideline trigger concentrations for groundwater. These guidelines and receiving water sites have been used for assessment of the Stage I and II brine placements since brine conditioned ash placement began at the Mt Piper Stage I site in 2000.

Recent earthworks have diverted surface water drainage away from the former Huons Gully which was located on the boundary between the existing ash repository and the extension in Lamberts North. Until 2013, surface water drainage along Huons Gully discharged into the Huon Pond (formerly known as the Groundwater Collection Basin), which was also reportedly in contact with groundwater at the base of the former Lamberts Gully Mine. Huon Pond subsequently discharged to Neubecks Creek.

The Huon Pond was filled as part of construction of the Lamberts North Ash Repository in 2013, and ERM understands that surface water drainage does not currently discharge directly to Neubecks Creek from the ash repository.

Annual groundwater monitoring is routinely undertaken at the repository for a range of potential constituents of concern including salinity, pH, heavy metals and chloride (used as tracer for brine mobilisation) (Aurecon, 2012). In previous investigations, elevated boron and sulfate concentrations have been attributed to historical coal mining operations, and a marked increase in chloride concentrations in monitoring bore MPGM4/D10 was considered to be caused by seepage from the coal washery rejects ponds (Aurecon, 2012). A groundwater quality review undertaken in 2011 further found that surface and groundwater quality guidelines (as defined in the Water Management and Monitoring Plan (Connell Wagner, 2008) in the receiving waters of the Neubecks Creek and Huon Pond continued to be met.

While considerable environmental assessment has been undertaken in this area, it was not considered that suitable characterisation of environmental conditions has been established for the purpose of establishing a baseline of conditions as at or near the time of the transaction. ERM also understands that samples collected during groundwater monitoring have been taken with bailers and that metal samples collected during groundwater monitoring in recent years have not been field-filtered (Aurecon, 2012). Purging and sampling using bailers for the full suite of PCOCs considered in the course of this assessment is not recommended due to the difficulty of obtaining a representative groundwater samples owing from potential degassing of samples and the potential introduction of high levels of turbidity (NEPC 2013).

The PESA therefore recommended further assessment of this area via sampling of existing wells (using low-flow sampling and in-field filtering), and some limited additional intrusive assessment for soil characterisation.

AEC Methodology and Investigation Field Observations

Two soil investigation bores were advanced within this AEC to characterise fill materials on the perimeter wall of the ash repository. Mine overburden was encountered in both locations, consistent with known construction of the ash repository, with refusal encountered at 0.45m bgl on boulders at both locations. Six existing groundwater monitoring wells on the boundary of the ash repository were additionally sampled as part of this ESA. The sampling locations within this AEC are presented on *Figure 5.5* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining or odours 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 in the two samples collected at 0.8 and 1.0 ppm v (isobutylene equivalent).

A summary of the field observations from the drilling works are presented within *Table 5.10* (below).

Table 5.10 ***Field Observations Summary – AEC MG***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
MG_SB01	0.45	None	0.8
MG_SB02	0.45	None	1.0

Groundwater samples were collected from the seven existing monitoring wells located within this AEC. Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range, with the exception of pH. EC readings indicated that groundwater conditions were fresh in wells on the northern perimeter of the ash repository and saline in wells on the eastern perimeter of the ash repository, adjacent to the Lamberts North Ash Repository. The measured pH was slightly acidic (5.32 to 6.15) in most locations, with the exception of MG_X_4/D4 which had an acidic pH of 3.31. The acidic conditions at MG_X_4/D4 are likely related to the presence of mine spoil indicated on historical drawings (PPK, 2000). Borelogs for existing well MG_X_4/D4 also indicate this well is screened in mine overburden.

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 have been compared to the adopted human health and ecological screening values as presented in *Table 4g of Annex B*.

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 not detected in soils sampled within this AEC.

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 *Figure 8.1 to 8.9 of Annex A*.

Measured concentrations of all COPCs were below the laboratory LOR in all groundwater samples analysed, with the exception of metals.

Arsenic, boron, cadmium, chromium, copper, lead, manganese, nickel and zinc were detected at concentrations in excess of the adopted ecological screening values in most groundwater samples within this AEC. Boron, cadmium, lead and manganese were detected at concentrations in excess of the adopted human health (drinking water) screening values. Arsenic and nickel were detected at concentrations in excess of the adopted human health (drinking water and recreational) screening values.

Discussion

Groundwater is inferred to flow in a north-easterly direction, consistent with previous investigations. Neubecks Creek is situated within 100 m of the northern boundary of the ash repository and is the nearest surface water body and potential ecological receptor.

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

All seven of the groundwater monitoring wells reported metals concentrations greater than the adopted human health and/or ecological screening values. Metals exceeding the adopted ecological screening values included arsenic, boron, chromium, cadmium, copper, lead, manganese, nickel and zinc. Arsenic, boron, chromium, cadmium, copper, lead, manganese 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. Arsenic and nickel concentrations also exceeded the adopted human health (recreational) screening values.

As metals have been identified at concentrations exceeding the adopted screening criteria in groundwater within all AECs a consolidated discussion of this issue is presented in *Section 5.5*. This discussion also includes consideration of groundwater salinity.

5.4.8 *MH - Lamberts North Ash Repository*

Background

The Lamberts North ash repository is an extension of the current ash repository located to the south-east and adjacent to the existing ash repository. The Lamberts North ash repository was constructed on former open cut mine workings which formerly extended to the base of the Lithgow Seam. The repository was constructed in 2013 with a 5 m fill layer above the base of the former mine, which was in direct contact with groundwater within the Lithgow Seam (SKM, 2010). The placement of fill material prior to ash deposition is intended to provide a barrier to groundwater infiltration of the ash, and prevent potential leaching of contaminants from the ash to groundwater. The repository receives dry ash with water used for dust control only.

It is noted that the construction of the Lamberts North Ash Repository was approved by the Minister for Planning and Infrastructure under the *Environmental Planning and Assessment Act 1979* (NSW). The conditions of approval include surface water and groundwater monitoring. A Water Management Plan (WMP, Connell Wagner, 2008) was approved as part of the planning approval. The WMP includes groundwater and surface water monitoring during construction and operation of the ash repository (as discussed in *Section 5.4.7*) along with a requirement to prepare and submit an annual report (including the results of monitoring) to NSW EPA.

Construction of was completed in May 2013 in the northern section of this AEC (see *Figure 5.6, Annex A*), with some ash placement, however this facility has not yet commenced full operations. The remainder of the Lamberts North AEC has not yet been developed for ash placement, and generally remains in the condition at the time of transfer from Centennial Coal at the closure of the former mine.

Two unlined coal washery reject ponds were constructed by Centennial Coal along the former drainage line (known as Huon's Gully). These were constructed on a disturbed creek bed and open cut mine filled with overburden, and are reportedly approximately 20 m deep from surface to former base level. Seepage from washery rejects ponds has the potential to enter groundwater. Potential contamination concerns to groundwater include impact from dissolved salts and heavy metals, and annual groundwater monitoring identified a marked increase in chloride concentrations in monitoring bore MPGM4/D10 which is considered to be caused by seepage from the coal washery rejects (CDM Smith, 2012).

A drainage channel was constructed in mid-2013 to divert current surface water flow away from Huon's Gully, and along the boundary between Lamberts North and the ridge to the west. The intent of the drainage channel is to divert up-gradient surface water runoff around the ash repository, and the rejects ponds. This diverts any further inflows of water to the extension to the ash repository and a fresh water pond located to the south of the second washery rejects pond. The fresh water pond is separated from the coal washery reject ponds by a poorly battered earthen dam wall.

Delta management reported that the freshwater pond was temporarily used to direct water from the Huon Void. The freshwater pond is blocked from down-gradient drainage, and the ultimate receiver of waters from this pond is unclear.

As discussed in *Section 5.4.7*, seepage from the ash repository has the potential to be saline and contain dissolved salts and heavy metals.

However, as noted previously, the facility has been designed and constructed in a manner that reduces the potential for these impacts to reach groundwater (ie by filling the base of the former mine with 5 m of fill prior to placement, thus elevating the ash above the water table). Former coal mining operations have also been noted to be potential sources of these contaminants. These include the underground mine workings (goaf), located along the western boundary of the AEC, and the coal reject ponds located adjacent to the western boundary.

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 provide a baseline assessment of soil and groundwater conditions.

AEC Methodology and Investigation Field Observations

Four soil investigation bores were drilled within this AEC. Three of these were converted into groundwater monitoring wells. A surface sediment sample was also collected from the coal washery rejects pond (MH_SS02). The sampling locations within this AEC are presented on *Figure 5.5* 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. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 1.5 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 5.11*.

Table 5.11 ***Field Observations Summary - AEC MH***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
MH_MW01	30	None	0.1- 2
MH_MW02	15.5	None	0.1-1.5
MH_MW03	28.5	None	0.1- 0.6
MH_SB04	0.65	None	0.4- 1.3

Six existing groundwater monitoring wells were additionally sampled as part of the ESA. A further three groundwater monitoring wells located on the boundary with the current ash repository, MG_X_4/D9, MG_X_4/D1 and MG_X_4/D10 are considered in this assessment. A surface water sample (MH_SS01) was collected from a pond located to the south of the coal washery ponds.

Groundwater parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range, with the exception of pH. pH was slightly acidic to neutral (5.32 to 6.91) in most locations, with the exception of MH_X_D15 which had an acidic pH of 4.24. The groundwater from MH_X_D15 is likely influenced by (or potentially representative of) water quality conditions in the up-gradient mine goaf areas adjacent to the west.

Electrical conductivity measurements indicated that groundwater conditions were saline in wells north of, and down-gradient of, the coal washery ponds. Corresponding sodium and chloride concentrations were higher in these wells than upgradient wells (MH_MW02, MH_X_D17, MH_X_D18) which also reported EC readings indicative of fresh water.

Evidence of hydrocarbon impact was observed in two wells in this AEC. A sheen was reported at MH_X_D15 after purging 3 L, and a strong hydrocarbon odour was noted at MH_X_D18 during purging.

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 5.h of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Figure 7 of Annex A*.

Measured concentrations of COPCs were below the adopted human health and ecological screening values in all soil samples collected from within this AEC. Hydrocarbon (TRH and PAH) compounds were detected above the laboratory LOR at a depth of 0.2 m bgl, 8 m bgl and 26 m bgl at MH_MW01, a depth of at 12 m bgl at MH_MW02, at a depth of 0.1 m bgl at MH_SB04, and in a surface sample collected from the coal washery ponds (MH_SS02). Concentrations of TRH and PAH compounds in all samples in this AEC were below the adopted screening values.

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 5.h of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Figure 8.1 to 8.9 of Annex A*.

Measured concentrations of the majority of the COPCs were below the adopted screening values in all groundwater samples analysed. The exceptions to this were some detections of metals within groundwater across this AEC. The measured concentrations of metals were below the adopted screening values in the surface water sample collected from MH_SS01.

The majority of measured concentrations were below or close to the corresponding laboratory LOR. Concentrations of TRH C_{16}-C_{34} and TRH C_{34}-C_{40} were above the corresponding laboratory LORs in groundwater at MH_X_D18; however all concentrations were below the adopted screening values. Monitoring well MH_X_D18 is located down-gradient of the coal washery ponds, and is screened at a depth of 37.5 – 43.5 m bgl in shale bedrock.

Arsenic, boron, cadmium, chromium, copper, lead, manganese, nickel, zinc were detected in groundwater at concentrations in excess of the ecological screening values. Arsenic, lead, manganese and nickel were detected in groundwater at concentrations in excess of the human health (drinking water) screening values. Manganese and nickel were detected in groundwater at concentrations in excess of the human health (recreational assessment) criteria.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC. The detection of TRH and PAH in soil and groundwater is likely associated with the presence of coal in the mine overburden used to backfill these areas.

All seven of the groundwater monitoring wells reported metals concentrations greater than the adopted human health and/or ecological screening values. Metals exceeding the adopted ecological screening values included arsenic, boron, cadmium, chromium, copper, lead, manganese, nickel, zinc. Arsenic, lead, manganese and nickel were detected in groundwater at concentrations in excess of the human health (drinking water) screening values. Manganese and nickel were detected in groundwater at concentrations in excess of the human health (recreational assessment) criteria.

As metals have been identified at concentrations exceeding the adopted screening criteria in groundwater within all AECs a consolidated discussion of this issue is presented in *Section 5.5* including consideration of groundwater salinity.

5.4.9 *MI - Water Holding Ponds*

Background

Open ponds used to store and treat wastewaters are located within the central portion of the operational area. These are lined with HDPE to reduce the potential for wastewater loss, and monitoring bores are located near the ponds to facilitate detection of potential leakages.

During the PESA (ERM, 2013a), site management reported that monitoring results indicate that leakage has not occurred.

While routine groundwater monitoring has been undertaken in this area, further investigation was considered to be required to provide a baseline for soil and groundwater conditions in this area.

AEC Methodology and Investigation Field Observations

A total of seven soil investigation bores were drilled within this AEC. Based on the presence of existing monitoring wells, and a relatively low risk of contamination, additional groundwater monitoring wells were not deemed necessary. However, as no soil was data available for existing monitoring wells within this area, four investigation points were located in proximity to existing monitoring wells. Remaining boreholes were distributed to provide coverage of the area. The sampling locations within this AEC are presented on *Figures 5.3 and 5.5* 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 0.6 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 5.12*.

Table 5.12 ***Field Observations Summary - AEC MI***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
MI_SB02	0.8	None	0.1-0.4
MI_SB03	3	None	0-0.4
MI_SB04	3	None	0.1
MI_SB05	0.8	None	0.3-0.6
MI_SB06	1.3	None	0-0.1
MI_SB07	0.8	None	n/a^
MI_SB08	0.6	None	n/a^

^ refusal encountered. Insufficient sample for duplicate to measure with PID due to coarse fill material (gravels and cobbles).

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC. Electrical conductivity readings indicated fresh water conditions.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.i 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, with the exception of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} and total PAH. Concentrations of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} were above the corresponding laboratory LOR in soil collected from 0.2 m bgl at MI_SB04, however all concentrations were below the adopted screening values. Concentrations of total PAHs were above the corresponding laboratory LOR in soil collected from 0.2 m bgl at MI_SB04 and at 0.2 m bgl at MI_SB06 however all concentrations were below the adopted screening values.

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 4.i of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Figure 8.1 to 8.9 of 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.

Cadmium, copper, manganese, nickel and zinc were detected at concentrations in excess of the adopted ecological in groundwater samples collected from all groundwater monitoring wells within this AEC. Manganese and nickel were detected at concentrations in excess of the adopted human health (drinking water and recreational) in groundwater samples collected from several groundwater monitoring 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 four of the groundwater monitoring wells reported metals concentrations greater than the adopted human health and ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, manganese, nickel and zinc. Manganese and nickel concentrations in excess of the adopted human health (drinking water and recreational) screening values were also reported in a number of samples.

As metals have been identified at concentrations exceeding the adopted screening criteria in groundwater within all AECs a consolidated discussion of this issue is presented in *Section 5.5*.

5.4.10 *MJ – Operational USTs*

Background

Four underground storage tanks (USTs) are present on site, containing diesel and petrol (E10), in the stores area, diesel generator and the mobile plant area. The USTs are understood to be approximately 20 years old and no information was available on their construction. Site management advised that tank integrity tests are undertaken routinely at the site and have not identified any issues. The USTs are located as follows:

- Petrol and diesel USTs near the main store (approx. 33 000L and 20 000L respectively);
- Diesel UST for the emergency generator (11 700L) and associated above ground day tank; and
- Diesel USTs at the mobile plant refuelling area (see *Section 5.4.5*).

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.

Soil and groundwater investigations to date have been conducted around the underground fuel infrastructure, and did not include laboratory analysis of soils. Therefore further investigation was considered to be required to provide a baseline for soil and groundwater conditions in this area.

AEC Methodology and Investigation Field Observations

Six existing monitoring wells were sampled within this AEC. A total of three soil investigation bores, one of which was completed as a groundwater monitoring well, were advanced within this AEC. This AEC falls within the operational area, and also overlaps with Area MD (Workshops), these investigation locations are therefore also discussed in the sections relevant to those AECs. Soil bores and monitoring wells were distributed around the perimeter of the AEC as presented in *Figure 5.3 of Annex A*. Relevant borehole logs are presented within *Annex D*.

Several proposed soil bores in Area MK adjacent to the diesel generator grid based locations were abandoned due to site infrastructure and the likely presence of underground services.

Monitoring well MK_MW09 (MK_SB42) was located presumed upgradient of the diesel UST. Soil bore MK_SB24 was located adjacent to existing monitoring well MJ_X_MWMP1 to assess soil conditions adjacent to the petrol UST. Soil bore MD_MW02 and monitoring well MD_MW01 were located cross-gradient of existing wells around the petrol USTs.

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 0.6 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 5.13*.

Table 5.13 Field Observations Summary - AEC MJ

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
MK_SB42	6	None	0.1-1.2
MK_SB24	3	None	0.2-1.7
MD_MW01	7	None	0- 0.6
MD_MW02	1.8	None	1.6-1.8

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC. Electrical conductivity readings indicated fresh water conditions.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4j 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, with the exception of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} and total PAH. Concentrations of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} were above the corresponding laboratory LOR in soil collected from 2.0 m bgl at MD_MW04, however all concentrations were below the adopted screening values. Concentrations of total PAHs were above the corresponding laboratory LOR in soil collected from 2.0 m bgl at MD_MW04 and at .04 m bgl at MK_SB42 however all concentrations were below the adopted screening values.

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 5j of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Figure 8.1 to 8.9 of Annex A*

Measured concentrations of the majority of the COPCs were below the laboratory LOR in all groundwater samples analysed, with the exception of metals, BTEX and TRH in groundwater. Concentrations of some TRH fractions were above the corresponding laboratory LOR in groundwater from monitoring well MJ_X_MWMP1 and MK_MW09, however all concentrations were below the adopted screening values.

The concentration of benzene in groundwater at MJ_X_MWMP1 was in excess of the human health (drinking water) screening values.

Arsenic, copper, manganese, nickel and zinc were detected at concentrations in excess of the adopted ecological screening values in groundwater samples collected from all groundwater monitoring wells within this AEC. Manganese and nickel were detected at concentrations in excess of the adopted human health (drinking water) screening values in groundwater samples collected from several groundwater monitoring 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 from most monitoring wells within this AEC reported metals concentrations greater than the adopted ecological screening values.

Metals exceeding the adopted ecological screening values included arsenic, copper, manganese, nickel and zinc. Magnesium and nickel concentrations in excess of the adopted human health (drinking water) screening values were also reported in a number of samples.

Benzene was detected at concentrations in excess of the adopted human health (drinking water) screening values in groundwater at MJ_X_MWMP1 adjacent to a UST and fuel bowsers. The benzene exceedence at this location is attributable to the UST and associated fuel lines or possible surface spills. It is recommended that the integrity of the UST and lines in this location be tested to assess the potential for sub-surface leaks. As groundwater in the vicinity of the Site is not extracted for drinking water, the presence of benzene in excess of the adopted human health (drinking water) screening values is not considered to represent a significant risk to humans under the ongoing use of the Site as a power station.

As metals have been identified at concentrations exceeding the adopted screening criteria in groundwater within all AECs a consolidated discussion of this issue is presented in *Section 5.5.*

5.4.11 MK - Accessible Operational Areas

Background

The main operational area of the Site was constructed on former open cut coal mine workings. Historical maps of the Site indicating the approximate location of former open cut mines and underground workings are provided in PPK (2000), and are represented in *Figure 4, Annex A*. The former open cut workings were reportedly filled with mine overburden and mine wastes. Although there are no available records of the material used for backfill, borelogs from installations of monitoring wells, and from previous investigations (PB, 2012) corroborate the use of mine overburden as backfill. Along with mine overburden, it is feasible that other smaller waste streams used as backfill may be contributing to elevated salt, metals and acidity in groundwater.

It is also feasible that isolated areas of contamination relating to previous mine operation may remain at the facility. Historical activities with the potential to cause isolated contamination issues include maintenance, chemical storage and refuelling. Targeted activities within the operational area include transformers (Area MC), fuel tanks (Area ME and MF) and workshops (Area MD).

Given the history of mining operations, and power station operations, and the lack of existing investigation data for this AEC, the PESA considered further investigation to be required to provide a baseline and to assess the potential for soil and groundwater contamination.

AEC Methodology and Investigation Field Observations

Seventy-three soil investigation bores were advanced across the operational area in a general grid pattern. Areas with high electrical hazards (i.e electrical transformers) and key operational areas of the plant (including the cooling towers) were excluded from the intrusive works, with sampling locations distributed around the perimeter of these areas. Several proposed grid based locations were abandoned due to physical access restraints from site infrastructure, the presence of underground services and areas where underground services were suspected and could not be confirmed. Several soil bores were terminated before the target depth of 3 m due to refusal on fill material (typically mine overburden). Nine soil bores were advanced beyond 3m and completed as groundwater monitoring wells to provide a general coverage of groundwater conditions within this area. The sampling locations within this AEC are presented on *Figures 5.3 and 5.4* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

Field indicators of contamination, such as staining, odours or visibly stressed vegetation were not typically noted within this AEC. The exception to this was an odour from 0.8-1.2m bgl within fill material at location MK_SB87, with no staining was evident at this location. No staining or unusual odours were detected at any depth through the sampled soil profile at other locations within this AEC. Measured concentrations of ionisable volatile compounds via headspace analysis did not generally exceed 4 ppm v (isobutylene equivalent) in soil samples collected from this AEC. The highest concentration of ionisable volatile compounds was measured at a depth of 1.4, bgl at MK_SB87 at 262.6 ppm v, associated with an odour detected at 0.8-1.6 m bgl.

A summary of the field observations from the drilling works are presented within *Table 5.14*.

Table 5.14 ***Field Observations Summary – AEC MK***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v)
MK_SB01	0.25	None	0-0.6
MK_SB02	2.35	None	0.2- 1.6
MK_SB03	1.1	None	0.3-0.6
MK_SB04	3	None	0.3-1.0
MK_SB05	1.5	None	0.1-0.5
MK_SB06	0.55	None	0-0.1
MK_SB07	1.6	None	0-0.6
MK_SB08	0.9	None	0.3-0.9
MK_SB09	1.25	None	0-0.5
MK_SB10	1.8	None	0-0.3
MK_SB11	1.7	None	0-0.5
MK_SB12	0.95	None	0-0.3
MK_SB13	1.6	None	0.3-1.1
MK_SB14	3	None	0-0.4
MK_SB15	1.2	None	0.1-0.4
MK_SB16	8.7	None	0.1-0.5
MK_SB17	1.7	None	0.1-0.3

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v)
MK_SB18	0.5	None	0-0.1
MK_SB19	0.7	None	0
MK_SB20	0.4	None	0
MK_SB22	7	None	0.1-3.5
MK_SB24	3	None	0.2-1.7
MK_SB25	22.6	None	0-0.1
MK_SB26	0.4	None	0
MK_SB27	0.55	None	0-1.9
MK_SB28	3	None	0-1.3
MK_SB30	3	None	0.1-0.5
MK_SB31	0.2	None	0-0.3
MK_SB32	0.5	None	0-0.3
MK_SB33	1.8	None	0.7-2.4
MK_SB34	3.9	None	0.2-2.8
MK_SB35	3.9	None	0.3-0.9
MK_SB36	0.5	None	0.5-0.7
MK_SB37	1.45	None	0.2-0.3
MK_SB38	3.8	None	0.1-3.9
MK_SB39	6	None	0.1-2.7
MK_SB40	3	None	0-3
MK_SB42	6	None	0.1-1.2
MK_SB43	1.7	None	0.1-1
MK_SB44	3	None	0-0.3
MK_SB45	0.1	None	0-0.3
MK_SB46	2.1	None	1.7-2
MK_SB47	3	None	0.7-2.2
MK_SB49	1.2	None	0-0.1
MK_SB50	0.45	None	0.1-0.2
MK_SB51	5	None	0.4-3.8
MK_SB52	0.65	None	0-0.1
MK_SB54	1.1	None	1.-2.4
MK_SB55	0.6	None	0-0.2
MK_SB56	0.9	None	0.1-0.2
MK_SB57	3.9	None	0-3.1
MK_SB58	3.9	None	0.3-2.2
MK_SB59	0.75	None	0-0.1
MK_SB61	0.55	None	0.2-0.3
MK_SB62	1.3	None	0.1-0.2
MK_SB63	0.1	None	0-1
MK_SB64	0.1	None	0-0.5
MK_SB65	5	None	0.1-0.6
MK_SB66	0.1	None	0-0.3
MK_SB67	0.1	None	0
MK_SB68	6.8	None	0-3.7
MK_SB69	0.1	None	0-0.9
MK_SB71	3	None	0.1-1.1
MK_SB72	1	None	0.1-0.3
MK_SB75	0.1	None	0-0.3
MK_SB76	5	None	0.2-3.3
MK_SB78	6.3	None	0.1-0.7
MK_SB79	3	None	0.1-0.9
MK_SB81	3.9	None	0.2-1.1
MK_SB82	3.9	None	0.1-1.6
MK_SB84	1.5	None	0-0.1
MK_SB86	3.9	None	0.3-2.3
MK_SB87	7	Odour at 0.8-1.6 m	0.2-262.6

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC. Electrical conductivity readings indicated fresh water conditions.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

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

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 0.2 m bgl at MK_SB62, 0.4 m bgl at MW_SB61, 1.0 m bgl at MK_SB35 and 1.0 m bgl at MK_SB87. All concentrations were below the adopted screening values with the exception of TRH C_{10}–C_{16} which exceeded the adopted ESLs at 1.0 m bgl at MK_SB87. Concentrations of xylene were above the corresponding laboratory LOR in soil collected from 3.9 m at MK_SB78 and 1.0 m bgl at MK_SB87, however all concentrations were below the adopted screening values.

Concentrations of various heavy metals were identified 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 copper in a sample collected from 1.5 m bgl at MK_SB33 which exceeded the adopted EIL.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 4k of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Figure 8.1 to 8.9 of Annex A*.

Measured concentrations of the majority of the COPCs were below the laboratory LOR in all groundwater samples analysed, with the exception of metals, PAH and TRH in groundwater. Concentrations of some TRH fractions were above the corresponding laboratory LOR in groundwater from monitoring well MK_MW05 and MK_MW09, however all concentrations were below the adopted screening values.

Concentrations of some PAHs were above the corresponding laboratory LOR in groundwater from monitoring well MK_MW05, however all concentrations were below the adopted screening values.

Arsenic, cadmium, copper, lead, manganese, nickel and zinc were detected at concentrations in excess of the adopted ecological screening values in groundwater samples collected from several groundwater monitoring wells within this AEC. Manganese and nickel were detected at concentrations in excess of the adopted human health (drinking water and recreational) screening values in groundwater samples collected from several groundwater monitoring wells within this AEC. The adopted human health (drinking water) screening values were also exceeded for arsenic at MK_MW06 and lead at MK_MW07.

Discussion

No exceedences of the adopted human health screening values were identified in soil samples collected from within this AEC. The ecological screening values were exceeded at MK_SB86 and MK_SB33.

The measured concentration of TRH C_{10}–C_{16} exceeded the adopted ESLs at 1.0 m bgl at MK_SB87, located on the western side of the main plant, behind Unit 2. Operational activities in this area include a washdown pit and day maintenance building. The concentration of TRH in soil was below the adopted human health screening values, TRH was not detected above the laboratory LOR in groundwater at this location (MK_MW04). It was noted that vegetation in this area is limited to grass on landscaped areas. Grasses have a shallow root zone and impacts at a depth of 1.0 m bgl are therefore considered unlikely to represent a significant risk to the terrestrial environment under the ongoing use of the Site as a power station.

Copper concentrations marginally exceeded ecological criteria in shallow soil sampled from 1.5 m bgl at MK_SB33. It is noted that the concentration of copper in the shallower sample at 1.0 m bgl at this location was below the adopted ecological criteria, with a concentration of 6 mg/kg which was marginally above the laboratory LOR of 5 mg/kg. This exceedence is likely attributed to the presence of fill materials sourced from mine overburden which is ubiquitous across the Site but heterogeneous in composition.

The copper concentrations in soils from 1.5 m bgl in Area MK were all <250% of the ecological screening criteria and the 95% UCL of the mean concentration 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.

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 arsenic, cadmium, copper, lead, manganese, nickel and zinc. Arsenic and lead, concentrations in excess of the adopted human health (drinking water) screening values and nickel concentrations in excess of the adopted human health (drinking water and recreational) screening values were also reported in a number of samples.

As metals have been identified at concentrations exceeding the adopted screening criteria in groundwater within all AECs a consolidated discussion of this issue is presented in *Section 5.5*.

5.4.12 *ML - Non Operational Areas (including Buffer Lands & Former Contractors Yard)*

Background

This AEC includes buffer lands outside of the fence operational area of the main Site which are largely un-used. Current infrastructure in these areas includes a Trans-grid substation and overhead transmission lines. There are three former landfills located in the buffer lands, which are addressed in AEC MA (*Section 5.4.1*). The buffer lands include areas which have been extensively mined. This includes underground mine workings and former open cut mines which have been partly or fully backfilled with mine overburden. The location and extent of former mine workings on- and off-site are illustrated in *Figure 4, Annex A*. Connell Wagner (2008) reported that groundwater associated with the underground mine goaf[1] has been characterised by elevated concentrations of sulfate, the metalloid boron, and the metals manganese, nickel and zinc.

The buffer lands are characterised by steep terrain with dense vegetation, and access to these areas was limited to areas immediately adjacent to roads and tracks. Former mine infrastructure may be present in inaccessible parts of the buffer lands. This includes structures which appear to be water treatment dams to the north of the Site. Interviews with site staff indicated that these areas are largely un-used, aside from access to transmission lines and sub-stations.

During construction of the power station, temporary contractors yards were established around the perimeter of the current operational area. Infrastructure associated with these areas likely included site sheds, workshops, machinery and parts maintenance, fuel and chemical storage and septic tanks.

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1 The goaf areas are the underground mine areas where coal pillars have been partially mined and the roof allowed to collapse.

Given the absence of previous environmental characterisation work, the PESA (ERM, 2013a) recommended that a broad-scale assessment of potential contamination be undertaken to provide a baseline and to assess the potential for soil and groundwater contamination within this AEC.

The former contractors yards to the north and east of the operational were assessed in *Section 5.4.11* (MK – Operational Areas) and *Section 5.4.6* (MF – Operational ASTs). The former contractors yards to the west of the operational area are outside of the boundary of the Site.

AEC Methodology and Investigation Field Observations

Seven soil bores were advanced within the formers contractors' yard; two of which were completed as groundwater monitoring wells. The contactors yard is situated on a hill approximately 20 m above the operational area and shale and coal was observed to outcrop at the surface. Due to the presence of shallow bedrock, surface soil was subsequently sampled at an additional 16 locations to provide an assessment of potential soil contamination within this area.

A total of seven soil investigation bores were advanced within the buffer areas of the site, and six completed as groundwater monitoring wells. One surface soil sample was additionally collected within the buffer area.

For the purpose of discussion of groundwater results, monitoring wells from Area MG and MA have been included where they are located within the buffer lands. The sampling locations within this AEC are presented on *Figures 5.1, 5.2 and 5.4* 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 3.3 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 5.15*.

Table 5.15 *Field Observations Summary – AEC ML*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
ML_MW02	0.6	None	0- 0.1
ML_MW03	24.5	None	n/a^
ML_MW05	18.1	None	0-0.2
ML_MW07	5.0	None	0.2-1.8
ML_MW10	16.0	None	1.3-1.8
ML_MW12	8.0	None	0-0.7
ML_MW14	0.2	None	0-0.2
ML_MW15	15.9	None	0-1.9
ML_MW17	0.4	None	n/a^
ML_MW18	0.75	None	n/a^
ML_MW19	0.25	None	n/a^
ML_MW20	24.0	None	n/a^
ML_MW21	30.0	None	n/a^
ML_SB22	0.1	None	0-1.1
ML_MW23	0.3	None	n/a^
ML_MW24	0.45	None	0.0
ML_SB25	0.1	None	0.0
ML_SB26	0.1	None	0.0
ML_SB27	0.1	None	0.0
ML_SB28	0.1	None	0.0
ML_SB29	0.15	None	0.0
ML_SB30	0.15	None	0.0
ML_SB31	0.15	None	0.6
ML_SB32	0.1	None	0.1
ML_SB34	0.1	None	3.3
ML_SB35	0.15	None	0.0
ML_SB36	0.1	Red sand	0.0
ML_SB37	0.1	None	0.0
ML_SB38	0.1	None	n/a^
ML_SB39	0.15	None	0.0
ML_SB40	0.15	None	0.0

^Insufficient sample for duplicate to measure with PID due to coarse fill material (gravels and cobbles) and/or refusal on bedrock.

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC. Electrical conductivity measurements indicated fresh water conditions in most locations, with the exception of ML_MW05 which indicated saline conditions. The saline conditions at ML_MW05 may be influenced by or potentially indicative of water quality in mine goaf areas located to the east. The measured pH was slightly acidic in most locations, with the exception of MG_X_4/D4 which had an acidic pH of 3.31. The acidic conditions at MG_X_4/D4 are likely related to the presence of mine spoil indicated on historical drawings. Borelogs for existing well MG_X_4/D4 also indicate this well is screened in mine overburden.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.1 of Annex B*.

Measured concentrations of COPCs were below the adopted screening values in the 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. All concentrations were below the adopted screening values, with the exception of copper, nickel and zinc in samples collected at 0.05 m bgl at ML_SB36 which exceeded the adopted EIL.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 4.1 of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Figure 8.1 to 8.9 of 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, and PAHs, TRH at MK_MW05. Concentrations of PAHs and some TRH fractions were above the corresponding laboratory LOR in groundwater from monitoring well MK_MW05, downgradient of the former contractors yard, however all concentrations were below the adopted screening values. Groundwater at MK_MW05 was encountered within shale with interbedded coal and the detection of TRH and PAH in this location can be attributed to the background concentrations of hydrocarbons present in coal. Arsenic, cadmium, copper, lead, manganese, nickel and zinc were detected at concentrations in excess of the adopted ecological screening values in groundwater samples collected from all groundwater monitoring wells within this AEC. At MG_X_4/D4 the measured concentration of chromium also exceeded the adopted ecological screening values. Arsenic, lead, manganese and nickel were detected at concentrations in excess of the adopted human health (drinking water) screening values in groundwater samples collected from several groundwater monitoring wells within this AEC. At MG_X_4/D4 the measured concentration of cadmium also exceeded the adopted human health (drinking water) screening values. Arsenic in groundwater at MG_X_4/D4 and manganese in groundwater from several groundwater monitoring wells within this AEC was detected at concentrations in excess of the human health (recreational) screening values.

Discussion

No exceedences of the adopted human health screening values were identified in soil samples collected from within this AEC. Copper, nickel and zinc concentrations exceeded ecological criteria in shallow soil sampled from 0.05 m bgl at ML_SB36.

The copper and nickel concentrations at ML_SB36 were >250% of the ecological screening criteria. Red sand was present at the surface at ML_SB36, extending from a nearby workshop building and covering an area of approximately 100 m^2. This sand is likely a product of grit blasting on open ground from historical operations relating to Site construction activities.

Shale bedrock outcrops were observed at the surface in this area, with shallow soils typically less than 0.5 m bgl in this area. Photographs of the ground conditions in this AEC are presented in *Annex G*. There is limited soil to support plant growth, and it is unlikely to represent an area of high ecological significance. These impacts are considered unlikely to represent a significant risk to the terrestrial environment under the ongoing use of the Site as a Power Station.

All groundwater monitoring wells reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included arsenic, cadmium, chromium, copper, lead, manganese, nickel and zinc. Arsenic, lead, manganese and nickel concentrations in excess of the adopted human health (drinking water) screening values were also reported in a number of samples. Manganese concentrations also exceeded the adopted human health (recreational) screening values in groundwater from several groundwater monitoring wells.

At MG_X_4/D4 the measured concentration of cadmium also exceeded the adopted human health (drinking water) screening values, and arsenic concentrations in groundwater at MG_X_4/D4 also exceeded the human health (recreational) screening values.

As metals have been identified at concentrations exceeding the adopted screening criteria in groundwater within all AECs a consolidated discussion of this issue is presented in *Section 5.5*.

5.4.13 *MM - Water Assets (Lake Lyell and Thompsons Creek Reservoir)*

Background

The Coxs River was dammed downstream of Lake Wallace to form Lake Lyell in 1982. Lake Lyell has an active capacity of approximately 31 GL, sourced from local runoff. The water is also pumped to off-stream storage at Thompsons Creek, which supplies Mt Piper, or to Lake Wallace, which supplies Wallerawang Power Station.

There are currently three local farmers with agreements to agist stock within the buffer lands around Lake Lyell. Lithgow City Council owns a portion of lands adjacent to Lake Lyell, as well as leasing additional lands which are publicly accessible for camping and recreation.

Thompsons Creek Reservoir is located approximately 8 km south-west of the operational area of Mt Piper Power Station. The reservoir was constructed in 1992 on Thompsons Creek to provide off-stream storage for supply of the water to Mt Piper and Wallerawang. Although the surface runoff catchment of Thompson Creek is relatively small, Thompsons Creek Reservoir has a storage capacity of up to 27.5 GL with water routinely pumped from Lake Lyell.

The reservoir is also available to the public for recreational fishing. Surrounding buffer lands are generally vacant vegetated lands, with some areas used for stock grazing by local farmers under agreements with Delta.

The Coxs River catchment includes several current and historical coal mine operations, the Mt Piper Power Station and Wallerawang Power Station, and is highly disturbed. The Coxs River runs from north to south, and is dammed at Lake Wallace and Lake Lyell to provide water supply for the Delta Electricity Power Stations and other uses.

The PESA (ERM, 2013) noted that selenium monitoring had been conducted in Lake Lyell. However, given the numerous potential sources of contaminants and the presence of recreational users of Lake Lyell, further investigation was considered warranted to provide a baseline assessment of conditions for this area.

The PESA (ERM, 2013) noted that there had been no surface water or sediment investigations undertaken at Thompsons Creek Reservoir, and further investigation was therefore considered warranted to provide a baseline assessment of conditions for this area.

AEC Methodology and Investigation Field Observations

Samples were collected between 21 November and 22 November, 2013 from a total of 7 sampling locations. Sampling locations were distributed around the AEC as shown in *Figure 5.6* of *Annex A*.

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 5m* of *Annex B*.

The depth to sediment in Lake Lyell ranged from approximately 1.0 m to 18.0 m and from approximately 7.5 m to 11.0 m in Thompson Creek Reservoir. Three of the four sediment samples collected in Lake Lyell were clay with trace to some silt.

The fourth consisted of silt with some gravel. Sediments in Thompsons Creek Reservoir were coarser and more variable, with sediments ranging from clay with some silt and gravel to gravel with some silt and clay.

No field indicators of contamination, such as staining, sheen, or odours were noted within this AEC.

Sediment Analytical Results

The sediments were analysed for grain size, phenols, TRH, BTEX, PAHs, 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 values are presented in *Table 4m of Annex B*.

Measured concentrations of COPCs were below the ISQG-High in all sediment samples, however, the concentrations of metals exceeded the ISQG-Low in some samples. The majority of measured concentrations were below or close to the corresponding laboratory LOR, with the exception of metals.

Phenol and BTEX concentrations were less than the laboratory LOR and the adopted screening values in all sediment samples. PAH concentrations were less than the laboratory LOR. However, it is noted that due to the moisture content of the samples the laboratory LOR were greater than the ISQG-Low for some of the PAHs in the analytical suite and, in a smaller subset, greater than the ISQG-High.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of sediment samples collected from within this AEC. All concentrations were below the adopted screening values in Lake Lyell, with the exception of copper, nickel and zinc concentrations at one location, MM_SS21, which exceeded the ISQG-Low; however all concentrations were below the ISQG-High. All concentrations were below the adopted screening values in Thompsons Creek Reservoir with the exception of copper and lead concentrations which exceeded the ISQG-Low in one location, MM_SS40; however all concentrations were below the ISQG-High.

For the purposes of this assessment, and given the small data set, the ISQG values have not been normalised to 1% TOC, as recommended in ANZECC (2000). The purpose of normalising to 1% TOC is to account for the reductions in bioavailability that can be associated with the presence of organic matter in sediment. As shown in *Table 5m of Annex B*, measured TOC values across the sampling area ranged between 0.7% and 5.44% TOC, with two samples in Thompsons Creek Reservoir having less than 1% TOC.

There were no applicable Australian screening values identified for selenium in sediments. The measured selenium concentrations were however less than the laboratory LOR (5 mg/kg) in all samples collected from Lake Lyell and Thompsons Creek Reservoir.

As there are no current applicable screening values for TRH in sediment in fresh water environments, the screening values for TRH in the Commonwealth of Australia (2009) *National Assessment Guidelines for Dredging* have been adopted for screening purposes. Measured concentrations of $TRHC_{10}$-C_{36} in Thompsons Creek Reservoir were below the adopted screening value. Measured concentrations of $TRHC_{10}$-C_{36} in sediments from Lake Lyell were below the adopted screening value, with the exception of the sample collected from MM_SS21. The concentration of $TRHC_{10}$-C_{36} at MM_SS21 marginally exceeded the adopted screening value, with a concentration of 590 mg/kg. It is noted that the adopted screening level is applicable to marine environments, and as such the marginal exceedences of this screening value is not considered to represent a significant issue and is considered unlikely to be attributable to site operations at Mt Piper.

Surface Water Analytical Results

The surface water samples were analysed for phenols, TRH, BTEX, PAHs, and metals. The surface water analytical results were compared to the adopted ecological and human health (drinking water and recreational) screening values, as discussed in *Section 3.5.2*. The surface water analytical results compared to the adopted screening values are presented in *Table 5m* of *Annex B*.

Measured concentrations of COPCs were below the adopted screening values in the surface water samples collected from within this AEC, with the exception of metals. The majority of measured concentrations were below or close to the corresponding laboratory LOR. Phenol, BTEX, and PAH concentrations were less than the laboratory LOR and the adopted ecological and human health (drinking water and recreational) screening values in all surface water samples, with the exception of benzo(a)pyrene for which all concentrations were less than the LOR, but the LORs were not always lower than the recreational screening value.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of surface water samples collected from within this AEC. All concentrations were below the adopted screening values, with the exception of copper and zinc. Copper concentrations exceeded the adopted ecological screening values in all surface water samples from Lake Lyell and Thompsons Creek Reservoir. However, all copper concentrations were below the human health (drinking water and recreational) screening values.

Zinc concentration exceeded the adopted ecological screening values in one sample from Thompsons Creek Reservoir. However, all zinc concentrations were below the human health (drinking water and recreational) screening values.

The mercury concentration was less than the laboratory LOR in all of the surface water samples collected; however, the LOR (0.1 µg/L) was greater than the ecological screening criteria (0.06 µg/L). There was a similar issue for selenium, but a lower laboratory LOR was obtained for a limited number of samples and there were no exceedences of the ecological screening criteria noted among those samples.

Discussion

Sediment

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.

The exceedences of the ISQG-Low for copper, nickel, and lead in sediments in Lake Lyell and Thompsons Creek Reservoir are likely representative of background conditions in the respective catchment(s).

The metal concentrations in sediments in Lake Lyell are generally consistent with those reported by Birch et al. (1999), with the exception of copper and nickel concentrations measured at MM_SS21, which were approximately two times the ISQG-Low. It is not possible to determine if the exceedences of the copper, nickel, and zinc ISQG-Low noted in Lake Lyell are due to natural variability in background concentrations or to a localised point source. Other contributing sources to Lake Lyell include the tributary Farmers Creek, which receives inputs from various industries and a sewage treatment plant. Birch et al (1999) also noted metals impacts in sediments in Farmers Creek.

Thompsons Creek Reservoir is located in the headwaters of the catchment, which include surface run-off from grazing lands, and is upgradient of power generation infrastructure. Although water is piped from Lake Lyell, the metal exceedences measured in sediment in the Reservoir are considered likely to be representative of background concentrations in the catchment rather than anthropogenic inputs.

Surface Water

Given that copper concentrations marginally exceeded the ANZECC (2000) trigger values for the protection of 95% of freshwater species at most locations, it is considered likely that the concentrations are representative of background conditions. The concentration of zinc at MM_SS40 only marginally exceeded the adopted screening values.

The surface water results do not suggest that there has been significant anthropogenic impact on surface water quality in Lake Lyell or Thompsons Creek Reservoir.

5.5 *METAL AND METALLOID CONCENTRATIONS IN GROUNDWATER*

5.5.1 *Assessment of Background Conditions*

Metals and metalloids can occur naturally in groundwater, and an assessment of background conditions forms an integral part of the evaluation of metal and metalloid concentrations reported. This is especially relevant where potential off-site sources of metals and metalloids exist, including historical and current underground coal mining works which occur extensively in the vicinity of the Site. Mining activities may alter the hydrological system and intensify surface water and groundwater connectivity. Increased interaction on freshly exposed rock in fractures and fracture zones has the potential to mobilise elements from the rock mass (Jankowski, 2007).

Given that metals concentrations in groundwater exceeded one or more of the adopted human health and/or ecological screening values in most monitoring wells across the Site, the results have also been assessed in the context of background conditions, taking into account results from available background monitoring wells.

The local geology and historical coal mining activities have impacted on the quality of groundwater at the Site. Connell Wagner (2008) reported that groundwater associated with the underground mine goaf[2] (located predominantly to the east of the main operational area of the Power Station and to the south of the current ash repository) has been characterised by elevated concentrations of sulfate, the metalloid boron, and the metals manganese, nickel and zinc. In addition to the former underground and open cut mine workings located on the Site, potential mining related sources of metals and metalloids (including arsenic and boron) include the up-gradient surrounding areas to the south-west and west of the Site. Further potential sources include the coal fines rejects emplaced on the western edge of the Lamberts North ash repository and the current ash repository.

The concentrations of metals in groundwater have been compared to these background wells (as applicable), and for the purposes of this assessment, concentrations equalling or exceeding the maximum background concentrations by a factor of two were considered as potentially indicative of concentrations above background values. Background monitoring wells have been selected from two sets of wells:

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[2] The goaf areas are the underground mine areas where coal pillars have been partially mined and the roof allowed to collapse.

- *Site Background Monitoring Wells* - these wells are located up-hydraulic gradient of all identified on-site sources at the site. These include MA_MW01, ML_MW05, ML_MW10 and ML_MW12. pH levels and ORP (two key controls on metal and metalloid solubility) in the aforementioned monitoring wells fell within the mid-range of measurements recorded across the monitoring well network at the Site, with pH measurements from the background monitoring wells varying between 6.1 to 6.9 and ORP between -85 mV and 75 mV. These monitoring wells were considered as the general background data points for the Site.

- *Ash Repository Background Monitoring Wells* - these wells are considered representative of background conditions in the north eastern section of the Site in the vicinity of the current ash repository where impact to groundwater from former mining activities have previously been reported (Connell Wagner, 2008; Aurecon, 2012). These include monitoring wells located upgradient from the current ash repository (MG_X_4/D5 and MG_X_MP1). Note that these monitoring wells were considered primarily for metal(liods) with elevated concentrations in the vicinity of the current ash repository.

It is noted that the a limited number of monitoring wells are available as background monitoring wells and that only one round of data is available for comparison of reported concentrations from these monitoring wells to the rest of the monitoring network established during the Stage 2 ESA. The evaluation of metal(loid) concentrations in relation to background conditions based on the approach outlined here should therefore be seen as a preliminary review of background conditions given the relatively limited nature of the background dataset. While the background dataset is limited, the approach does allow for the preliminary identification of potential background conditions.

The following discussion assesses the results for each metal(loid) initially in terms of exceedences of the adopted screening values; and secondly, where background concentrations exceed the adopted screening values, the data were then evaluated against the background concentrations. This is followed by a consolidated discussion on the overall distribution of metal(loid) concentrations across the Site.

Arsenic

The concentration of arsenic in groundwater exceeded the lowest adopted screening value (human health (drinking water)) in 13 of the 70 monitoring wells sampled, with the majority of these exceedences observed in monitoring wells located in the eastern area of the main operational area at the Power Station. Of these, the concentration of arsenic was above a factor of two of the maximum reported background concentration in five monitoring wells, indicating that the presence of arsenic in groundwater at these locations may represent a potential risk greater than that which can be attributed to local background conditions.

Generally, the highest arsenic concentrations were reported for monitoring wells located in the eastern area of the main operational area at the Power Station (MC_MW04, MW-MW04, MJ_X_MWMP5 and MK_MW11), and one monitoring well (MG_X_4/D4) located to the north east of the coal storage area and directly downgradient of a remnant mine spoil dump. No monitoring wells located in the vicinity of the current ash repository exceeded the maximum concentration from the Site Background Monitoring Wells.

Boron

Boron concentrations exceeded the lowest adopted screening value (ecological) in four monitoring wells (MG_X_4/D1, MG_X_4/D9, MG_X_4/D10 and MH_MW03) located directly to the east and downgradient of the current ash repository. The boron concentrations in these four monitoring wells were between a factor of seven and more than an order of magnitude above the maximum concentration reported for the Ash Repository Background Monitoring Wells.

The highest boron concentration of 4,150 µg/L was reported for MG_X_4/D10, a monitoring well that is located cross-gradient of the current ash repository and down-gradient of the underground mine goaf located directly to the south of the ash repository. The other locations with elevated boron concentrations, MG_X_4/D1, MG_X_4/D9 and MH_MW03 were located down-gradient of MG_X_4/D10 and the underground mine goaf areas.

Cadmium

Cadmium concentrations exceeded the lowest adopted screening value (ecological) in 19 of the 70 monitoring wells sampled, with exceedences of the adopted screening values in monitoring wells spread across the Site, including the main operational area of the Power Station, non-operational areas and the current ash repository area. Of these, the concentration of cadmium was a factor of two above the maximum reported background concentration in four monitoring wells. The highest reported cadmium concentrations were located directly downgradient of a remnant mine spoil dump to the north east of the coal storage area (MG_X_4/D4), upgradient of the current ash repository (MG_X_MP1), and adjacent to the underground mine goaf within the former Huons Gully (MG_X_4/D10 and MH_X_D15).

Copper

Copper concentrations in groundwater exceeded the lowest adopted screening values (freshwater) at 32 of the 70 monitoring wells sampled, with exceedences located across the Site, including the main operational area, non-operational areas and the current ash repository area. It is however noted that none of the samples exceeded the screening values for drinking water (2,000 µg/L). The concentration of copper was a factor of two above the maximum reported background concentration at ten monitoring wells, located between the coal storage area and the water holding ponds (MJ_X_MWMP6, MI_X_5/D8, MI_X_5/D5, MG_X_MP1), near the operational ASTs (MF_MW03), near a remnant mine spoil dump to the north east of the coal storage area (MG_X_4/D4, ML_MW07), and in the former Huons Gully adjacent to the current ash repository (MH_X_D15, MG_X_4/D10, MH_MW01).

The current ash repository does not appear to be a significant source of copper to groundwater given that the highest copper concentration was reported for monitoring well MG_X_MP1 located upgradient of the current ash repository.

Lead

Lead concentrations exceeded the lowest adopted screening values (freshwater) at 11 of the 70 monitoring wells sampled. Of these, the concentration of lead was a factor of two above the maximum reported background concentration at three monitoring wells. These three monitoring wells are located in the electrical transformers area (MC_MW02), adjacent to the coal conveyor and coal crushing area (MK_MW07) and to the north east of the coal storage area and directly downgradient of a remnant mine spoil dump (MG_X_4/D4).

Manganese

Manganese concentrations in groundwater in the majority of monitoring wells (59/70) exceeded the lowest adopted screening value (human health (drinking water)). The reported manganese concentrations were a factor of two above the maximum reported background concentration in one monitoring well (MI_X_5/D5) located directly downgradient of a wastewater pond.

Nickel

Nickel concentrations in groundwater in the majority of monitoring wells (66/70) exceeded the lowest adopted screening values (ecological). The reported concentrations were a factor of two above the maximum reported background concentration at four monitoring wells between the coal storage area and the water storage ponds (MI_X_5/D2, MK_MW02, MK_MW03, MK_MW06), and seven monitoring wells located downgradient of the underground mine goaf and the current ash repository. The concentration of nickel in monitoring wells downgradient of the current ash repository (MG_X_4/D1 and MG_X_4/D9) is within a similar range to monitoring wells in the former Huons Gully downgradient of the underground mine goaf (MH_MW01, MH_MW03, MH_X_D15, MH_X_D19).

All seven monitoring wells downgradient of the underground mine goaf and the current ash repository had reported concentrations greater than a factor of two of the maximum reported concentration for the Ash Repository Background Monitoring Wells.

Zinc

Zinc concentrations in the majority of monitoring wells (67/70) across the Site exceeded the adopted screening value (ecological). The reported concentrations were a factor of two above the maximum reported background concentration at 18 monitoring wells across the site, including the water holding pond area, operational ASTs area, the main operational area of the Power Station, the coal storage area and the area located to the east of the current ash repository and underground mine goaf.

Zinc concentrations exceeded the maximum reported concentration for the Ash Repository Background Monitoring Wells at to MH_X_D15 located downgradient and to the east of the underground mine goaf (and upgradient of the current ash repository), monitoring well MG_X_4/D10 located in the former Huons Gully downgradient of the underground mine goaf and monitoring well MI_X_5/D5 located downgradient of a wastewater holding pond.

The highest zinc concentrations were observed in monitoring well MH_X_D15, located in the former Huons Gully, downgradient of the underground mine goaf and upgradient of the current ash repository. The concentrations of zinc in groundwater decrease in a north easterly and downgradient direction from MH_X_D15 to MH_X_4/D9; downgradient of the former underground mine goaf area which suggests that the elevated zinc concentrations are likely to be associated predominantly with the historical mine workings. The concentrations of zinc in groundwater in the western areas of the Site were less than a factor of two above the maximum reported background concentration.

Summary

Metals and metalloid concentrations in groundwater exceeded one or more of the adopted human health and/or ecological screening values in most monitoring wells across the Site. However, in the majority of monitoring wells metals and metalloid results fall within concentration ranges within a factor of two of the maximum concentrations seen in background monitoring wells.

Overall, groundwater monitoring wells with concentrations of metal(loids) equal to or above a factor of two of the maximum background concentrations were distributed in several key areas of the Site, including:

- in the main operation area, particularly between the coal storage area and the water holding ponds (MJ_X_MWMP6, MI_X_5/D8, MI_X_5/D5, MG_X_MP1, MK_MW07 MI_X_5/D2, MK_MW02, MK_MW03, MK_MW06). The groundwater in this area may be affected by backfilled former open cut mine workings and underground mine goaf areas that underlie the site;

- near a remnant mine spoil dump to the north east of the coal storage area (MG_X_4/D4, ML_MW07). The sample taken from MG_X_4/D4 further had a significantly lower pH (pH 3.3) than the other monitoring wells affected by arsenic and it is probable that MG_X_4/D4 has been affected by leachate from the remnant mine spoil dump that may have undergone oxidation of sulfide material (resulting in the creation of acidic conditions) associated with mine spoil;

- downgradient of former underground mine goaf areas and the more recent former mine workings in Huons Gully, including the coal fines rejects (MH_X_D15, MG_X_4/D10, MH_MW01, MG_X_4/D1, MG_X_4/D9 and MH_MW03); and

- downgradient of the current ash repository and downgradient of former underground mine goaf areas and the more recent former mine workings in Huons Gully (MG_X_4/D1 and MG_X_4/D9).

5.5.2 *Groundwater Salinity Concentrations*

As discussed in *Section 5.4.7*, annual groundwater monitoring is undertaken in the vicinity of the ash repository. The results of previous groundwater monitoring have identified elevated boron and sulfate concentrations in the vicinity of the ash repository, as well as a marked increase in chloride concentrations in monitoring bore MPGM4/D10 (MG_X_4/D10) (Aurecon, 2012). Whilst salinity, heavy metals and chloride are considered to be tracers for potential brine mobilisation from the ash repository, previous reports have identified sources of these impacts which are unrelated to the contributions from the ash repository. These other sources include historical coal mining operations and seepage from the coal washery rejects ponds within the former mine workings in Huons Gully.

Generally the field measurements of EC and laboratory analytical results for sodium and chloride were higher in most monitoring wells within the vicinity of the ash repository AECs (MG and MH) compared to other areas of the Site. The gauging data from the baseline ESA indicates an overall groundwater flow towards the north-east. EC readings of less than 1000 µS/cm indicated that groundwater conditions were relatively fresh in wells up-gradient of the ash repository, on the northern perimeter (MG_X_MP1, MG_X_4/D4, MG_X_4/D5). Similar conditions were observed at monitoring well MH_MW02 located within the recent former mine workings in Huons Gully but up-gradient of the identified coal fines rejects.

Comparatively higher EC readings (100-2000 µS/cm) and/or sodium (128-262 mg/L) and chloride (68-147 mg/L) concentrations in groundwater were reported at monitoring wells:

- within the coal fines rejects area in Huons Gully (MH_X_D15, MH_MW01); and

- on the downgradient perimeter of the current ash repository and Lamberts North (MH_X_D19, MG_X_4/D1 and MG_X_4/D9).

The highest readings of EC and concentrations of sodium and chloride in groundwater in the baseline ESA were reported at MG_X_4/D10 and MH_MW03. These wells are located on the southern perimeter of the current ash repository and are both downgradient of the former underground mine goaf areas and the more recent former mine workings in Huons Gully, including the coal fines rejects.

With the exception of MG_X_4/D10 and MH_MW03 the concentrations of chloride and sodium in groundwater in the vicinity of the ash repository (AECs, MG and MH) were less than a factor of two of the maximum reported background concentration at ML_MW05 and are therefore considered to be indicative of local background conditions.

Based on the available data, whilst there are elevated concentrations of sodium and chloride concentrations in the vicinity of MG_X_4/D10 and MH_MW03, the groundwater quality on the down-gradient perimeter of the Site (based on groundwater sampling results from monitoring wells MH_X_D19, MG_X_4/D1 and MG_X_4/D9) is considered to be within the expected range for local background conditions.

Potential sources of the elevated sodium and chloride concentrations at MG_X_4/D10 and MH_MW03 include contributions from the up-gradient underground mine goaf areas, and the coal fines rejects within the recent former mine workings in Huons Gully. Based on the available data the contribution of sodium and chloride from the former mining activities cannot be distinguished from potential contributions from the current ash repository.

5.6 *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, these are not considered to have a material impact on the outcomes of this assessment.

A summary of the locations unable to be completed due to various reasons is provided in *Table 3.1*. In locations where soil bores could not be excavated to the target depth due to proximity to known or suspected sub-surface utilities, surface soil samples were collected using a hand trowel.

A discussion of the limitations and uncertainties associated with the investigation is included in *Section 3.5* and a discussion of the suitability of the data and the requirement for further investigation included in *Section 5.7.5*. The discussion of the CSM provided in the *Section 5.7.1* and *Section 5.7.2* and summarised in *Annex C* is based on the following assumptions:

- the understanding of the potential sources as detailed in *Section 5.4* and *Section 5.7.1*;
- potential receptors were identified in *Section 2.9* and *Section 5.7.1* based on publically available information; and
- potential exposure pathways to receptors are based on ongoing use of the Site as a Power Station in the same or similar configuration to that observed at the time of this assessment.

5.7 OVERALL DISCUSSION

The primary objective of this Phase 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 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 Site is likely to warrant notification /regulation under the *CLM 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 and the CSM. The CSM developed as part of the *SAQP* (ERM, 2013a) was revised to incorporate overall results of the assessment and is presented in the following *Sections 5.7.1 and 5.7.2* as well as graphically represented in *Annex C*.

5.7.1 *Summary – The Nature and Extent of Soil, Sediment, Groundwater and Surface Water Impact*

A CSM was developed and refined, which identified the following ecological and human receptors:

- onsite employees, including intrusive workers potentially labouring within shallow trenches/excavations;
- recreational users of Neubecks Creek, and Lake Lyell;

- terrestrial ecological receptors within the open space areas both on and surrounding the Site; and
- freshwater aquatic organisms within Lake Lyell, Thompsons Creek Reservoir, Neubecks Creek.

Soil, sediment, surface water and groundwater data were compared against published environmental quality levels to provide a screening level assessment of potential risks to these identified receptors. The findings of the screening process indicated that concentrations in soil, sediment, surface water and groundwater generally complied with the adopted screening values, with some exceptions as discussed in the following sections. Potential source-pathway-receptor linkages identified in the preliminary ESA were subsequently revised on the basis of the available data and the refinement of receptors, as discussed in *Section 5.6.2.*

Onsite Soil

- Copper, nickel and/or zinc were detected at concentrations in excess of the adopted ecological screening value for commercial/industrial sites in soil samples collected from MK (Operational Area) and ML (Buffer Lands and Former Contractors Yard).
- TRH was detected at concentrations in excess of the adopted ecological screening value for commercial/industrial sites in soil samples collected from MD_MW04 and MK_SB87.

Onsite Groundwater

- LNAPL was detected in three groundwater monitoring wells;
- Benzene was detected at concentrations in excess of the adopted human health (drinking water) screening values in groundwater samples collected from AECs MJ (Operational USTs).
- Metals and metalloid concentrations in groundwater exceeded one or more of the adopted human health and/or ecological screening values in most monitoring wells across the Site. Where metals were above background concentrations, impact generally appears to be related to contributions from former mine workings both on the Site and in surrounding areas.
- Overall, groundwater monitoring wells with concentrations of metal(loids) equal to or above a factor of two of the maximum background concentrations were distributed in several key areas of the Site, including:
- in the main operation area, particularly between the coal storage area and the water holding ponds (MJ_X_MWMP6, MI_X_5/D8, MI_X_5/D5, MG_X_MP1, MK_MW07 MI_X_5/D2, MK_MW02, MK_MW03, MK_MW06). The groundwater in this area may be affected by backfilled

former open cut mine workings and underground mine goaf areas that underlie the site;

- near a remnant mine spoil dump to the north east of the coal storage area (MG_X_4/D4, ML_MW07). The sample taken from MG_X_4/D4 further had a significantly lower pH (pH 3.3) than the other monitoring wells affected by arsenic and it is probable that MG_X_4/D4 has been affected by leachate from the remnant mine spoil dump that may have undergone oxidation of sulfide material (resulting in the creation of acidic conditions) associated with mine spoil;

- downgradient of former underground mine goaf areas and the more recent former mine workings in Huons Gully, including the coal fines rejects (MH_X_D15, MG_X_4/D10, MH_MW01, MG_X_4/D1, MG_X_4/D9 and MH_MW03); and

- downgradient of the current ash repository and downgradient of former underground mine goaf areas and the more recent former mine workings in Huons Gully (MG_X_4/D1 and MG_X_4/D9).

Onsite Sediments

- Copper, nickel and zinc concentrations exceeded the ISQG-Low in one sample from Lake Lyell; however all concentrations were below the ISQG-High.

- Copper and lead concentrations exceeded the ISQG-Low in one sample from Thompsons Creek Reservoir; however all concentrations were below the ISQG-High.

- There were no applicable Australian screening values identified for TRH in sediment in fresh water environments. It was noted that one sample from Lake Lyell marginally exceeded the adopted screening value, however the adopted screening level is applicable to marine environments.

Onsite Surface Water

- Concentrations of metals in surface water in Lake Lyell and Thompsons Creek Reservoir were below the adopted human health (drinking water and recreational) screening values in all samples.

- Concentrations of metals in surface water in Lake Lyell and Thompsons Creek Reservoir were below the adopted ecological screening values, with the exception of zinc and copper.

- Copper concentrations in surface water in Lake Lyell and Thompsons Creek Reservoir marginally exceeded the ecological screening values in the majority of surface water samples analysed. The prevalence of copper in all samples marginally above the adopted ecological criteria indicates that the concentrations are likely attributable to local background conditions in the catchment.

- Zinc concentrations in surface water marginally exceeded the ecological screening values in one sample from in Lake Lyell and one sample from Thompsons Creek Reservoir. This is likely attributable to local background conditions in the catchment, including discharges from Cox River and Farmers Creek.

General Observations

LNAPL was observed at three sampling locations within Area ME (Mobile Plant Refuelling Area).

Asbestos fibres were not detected within any soil samples analysed at the Site. It is however 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.

5.7.2 *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 to consider all potential receptors identified in the CSM (*Annex C*). The exceedences of the screening values outlined in *Section 3.5.2* 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 incorporated into the CSM as presented in the following sections and summarised in *Annex C*. Potential source-pathway-receptor linkages identified in the preliminary ESA were subsequently revised on the basis of the available data and the refinement of receptors.

Onsite Soil

The soil results from all AECs at the Site comply with the applicable human health and ecological criteria for the current and on-going land-use with some minor exceptions as outlined below.

Copper, nickel and/or zinc were detected at concentrations in excess of the EIL for commercial/industrial sites in soil samples collected from AECs MK (Operational Area) and ML (Buffer Lands and Former Contractors Yard).

Copper was detected above the adopted EIL in AEC MK at one location, MK_SB33 at a depth of 1.5 m bgl. Statistical assessment of copper concentrations in soils within AEC MK demonstrated that this exceedence is a localised hotspot, and is unlikely to represent a significant risk to the terrestrial environment under the ongoing use of the Site as a power station.

The copper and nickel concentrations at ML_SB36 were >250% of the ecological screening criteria. Red sand was present at the surface at ML_SB36, extending from a nearby workshop building and covering an area of approximately 100 m^2. The depth of the red sand is anticipated to be < 0.3 m bgl, based on the depth to bedrock (shale) encountered at ML_MW20 to the north. This sand is likely a product of grit blasting on open ground from historical operations relating to Site construction activities.

Current Site practices should be reviewed to ensure that such activities are currently carried out in appropriate areas where waste products can be managed accordingly.

Shale bedrock outcrops were observed at the surface in this area, with shallow soils typically less than 0.5 m bgl in this area. There is limited soil to support plant growth, and it is unlikely to represent an area of high ecological significance. These impacts are considered unlikely to represent a significant risk to the terrestrial environment under the ongoing use of the Site as a Power Station.

It is recommended that the red sand visible in the area to the south of the workshop building be removed from this area as part of general housekeeping.

Total Recoverable Hydrocarbons in the C10–C16 fraction were detected at a concentration in excess of the ESL for commercial/industrial sites in a soil sample collected from MK_SB87 at a depth of 1.0 m bgl, associated with an odour and an elevated PID reading. The measured concentration of TRH in the deeper soil sample collected at 3 m bgl was below the laboratory LOR and TRH concentrations were below the laboratory LOR in groundwater samples from this area (MK_SB87/MK_MW04).

Operational activities in this area include an ash washdown pit, miscellaneous pumps and the day maintenance building. Sub-surface infrastructure in this area includes stormwater, contaminated waste water and ash washwater drainage pipes. It is recommended that the integrity of the contaminated waste water drainage pipes be inspected to assess the potential for further impact. It was noted that vegetation in this area is limited to grass on landscaped areas. Grasses have a shallow root zone and impacts at a depth of 1.0 m bgl are therefore considered unlikely to represent a significant risk to the terrestrial environment under the ongoing use of the Site as a power station.

Total Recoverable Hydrocarbons in the C10-C16 fraction and C16-C34 fractions were detected at a concentration in excess of the ESL for commercial/industrial sites in a soil sample collected from 1.2 m bgl at MD_MW04. The hydrocarbon impacts identified at this location may be related to historical leaks or spills associated with workshop activities in this area. Area MD is largely covered in concrete hardstanding, with some grass areas around service easements. Area MD is not considered to have any significant ecological value and thus the application of the ESLs is considered to be overly conservative in this instance.

Based on the discussion provided herein, it is considered that whilst exceedences of the ecological screening levels in soils were identified, the relevant source-pathway-receptor linkages are incomplete.

On-site Groundwater

Sensitivity of Receiving Environments

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 highly disturbed nature of the region through coal mining reduces the potential for the potable or domestic use of groundwater in the vicinity of the Site to be approved in the future.

The groundwater beneath the Site could be considered to be an aquatic environment of significance. However, as discussed in *Section 5.5*, the regional groundwater has elevated concentrations of heavy metals which originate from the characteristics of the local geology, and also have been degraded by historical mining activities.

Based on the topography and available hydrological information, groundwater beneath the Site is considered to ultimately discharge to Neubecks Creek, a tributary of the Coxs River. The volume of flow in the upper reaches of Neubecks Creek adjacent to the Site are noted to be intermittent, with typically low volumes of flow of <1ML/day (BOM, 2014). It is further noted that groundwater may not be a major contributor to surface water in Neubecks Creek, as the connection between the groundwater on the Site and Neubecks Creek may not be complete. Reaches of Neubecks Creek have been defined as "losing" streams, whereby the base level of the creek is above the level of groundwater aquifer (R.W. Corkery & Co., 2010). It is important to note that the only direct discharges to surface water from the Site are stormwater drainage discharged from a holding pond at LDP1 on Neubecks Creek which is managed and regulated under the EPL.

The quality of the Coxs River catchment has been degraded by industrial activities in the broader catchment, including coal mining, mine discharges, sewage treatment, and the operation of two power stations (Mt Piper and Wallerawang further downstream) (Birch et al, 1999).

The Coxs River discharges into Lake Wallace, downstream of the Wallerawang Power Station. The quality of the surface water and sediments in Lake Wallace are discussed in *Project Symphony – Wallerawang Phase 2 Environmental Site Assessment* (ERM, 2014), and as such are not considered further here. In a study of sediments on the Coxs River catchment, Birch et al (1999) concluded that Lake Wallace impedes the migration of a large proportion of heavy metals, reducing the amounts of heavy metals entering Lake Burragorang, the main drinking water reservoir for Sydney.

The ANZECC (2000) *freshwater ecological trigger values* were adopted in this assessment 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 5.7.3*). However, it is noted that due to the degraded quality of the background groundwater and the receiving surface waters the adoption of a lower threshold of protection of species may be appropriate. 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) are considered the most appropriate for initial screening purposes in this assessment.

The NHMRC (2008) recreational screening values were adopted in this assessment adopted to evaluate potential risks to recreational users of Neubecks Creek, Coxs River, and Lake Wallace further downstream. There are no known recreational users of Neubecks Creek and the upper reaches of the Coxs River, however as public access cannot be precluded, these receptors have been considered for the purpose of this assessment.

The NHMRC (2013) drinking water screening values 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 5.7.3*).

Hydrocarbons in Groundwater

Potential Sources

As discussed in *Section 5.4.10*, benzene was detected at concentrations in excess of the adopted human health (drinking water) screening values in groundwater samples collected from AEC MJ (Operational USTs). It is noted that this is an existing well. The benzene exceedence at this location is attributable to the UST and associated fuel lines or possible surface spills. It is recommended that the integrity of the UST and lines in this location be tested to confirm the absence of sub-surface leaks.

As groundwater in the vicinity of the Site is not extracted for drinking water, the presence of benzene in excess of the adopted human health (drinking water) screening values is not considered to represent a significant risk to the humans under the ongoing use of the Site as a power station.

ERM understands that the current site operator (Energy Australia) (and prior to the transaction Delta Electricity) has been developing appropriate management approaches in relation to this issue alongside independent consultants and regulators. It is noted that Delta Electricity has previously notified this issue to NSW EPA. It is considered that the costs for management of this issue may be potentially material depending on the remediation / management option selected.

As discussed in *Section 5.4.5,* LNAPL was detected in three groundwater monitoring wells in Area ME. There have been no reported surface spills and integrity tests of the current UST near ME_X_MW7 have not identified any issues. The source of the LNAPL has not been definitively identified, and other underground infrastructure in this area has not been investigated to-date. The oil-water separator drains through an underground pipe in a north-easterly direction, discharging into an open surface water drain along the coal storage area boundary. The bobcat pit drains to an oil collection pit which is pumped out by a road tanker.

Groundwater flow direction across the Site is typically to the north-east, as indicated in *Figure 6.1, Annex A.* In the AEC ME, groundwater flow direction appears to be mounded in the area of ME_X_MWMP8, adjacent to the oil-water interceptor, as shown in *Figure 6.3, Annex A.*

Aside from an unknown historical surface spill, on-going leaks in underground infrastructure in the vicinity, including the bobcat pit, the oil-water separator or the drainage pipe from the oil-water interceptor are potential sources of contamination. Both the sewer main and the oil-water interceptor drainage pipe cross through the area of the LNAPL plume, and the service trenches around these pipes are considered potential preferential pathways for migration of contaminants.

Human Receptors - Exposure Pathways (Dermal, Ingestion, Inhalation)

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. Groundwater is present at depths greater than 3.5 m bgl, therefore there are no feasible direct contact exposure pathways (ingestion and/or dermal absorption) for human receptors to encounter LNAPL and/or potential dissolved phase hydrocarbons. Based on the available information this source-pathway-receptor linkage has been discounted.

There may be a risk to workers on-site from vapour intrusion inside the workshop buildings if the LNAPL plume extends beneath the building. There may also be a risk to intrusive maintenance workers from vapours when conducting excavation works in trenches for sub-surface utility maintenance or future construction; however it is noted that normal trench excavation is unlikely to encounter LNAPL present at depths of greater than 3.5 m bgl.

Vapour intrusion risks are considered to be unlikely given the current use of this area, however cannot be discounted on the basis of the current data. It is noted that the workshop buildings are well ventilated with roller door access and typically open to the outdoors. A potentially complete source-pathway-receptor linkage does however remain in relation to potential inhalation exposure for industrial workers and/or intrusive maintenance workers.

On the basis of the current data, the down-gradient extent of the plume appears to have been delineated to the south of the coal stockpile area, with a down-gradient monitoring well ME_X_MW06 located approximately 12 m to the north of ME_X_MW03.

However, it is noted that the existing monitoring wells in this area (including recently installed wells by SMEC) are not screened consistently, with groundwater intercepted in two different lithologies. LNAPL has been identified in monitoring wells screened in fill materials at depths of 3-6 m bgl at ME_X_MWMP7, and 1-4 m bgl at ME_X_MWMP8. LNAPL has also been identified in monitoring well ME_X_MWMP12 screened in sandstone, at a depth of 4-7 m bgl.

Ecological Exposure Pathways

On the basis of the current data, and the distance to the downgradient Site boundary being more than 750 m to the north-east, it is unlikely that the LNAPL plume will foreseeably impact on the closest ecological receptor, Neubecks Creek, located on the north-east boundary of the Site.

Metals in Groundwater

Potential Sources

Monitoring wells across the Site reported concentrations of a wide range of metals at concentrations exceeding the adopted human health and / or ecological screening values as discussed in *Section 5.5*.

The regional groundwater has elevated concentrations of heavy metals which originate from the characteristics of the local geology, and also have been degraded by historical mining activities. The concentrations of metals in groundwater across the Site are generally comparable to up-gradient background monitoring wells. Where metals are above background concentrations, the impacts appear to be associated with contributions from former mine workings both on the Site and in surrounding areas.

The contribution of the ash repository to metals concentrations in groundwater cannot be differentiated from the contribution of the former mine workings. However, it is noted that the concentrations of most metals in groundwater downgradient of the current ash repository (MG_X_4/D1 and MG_X_4/D9) is within a similar range to monitoring wells in the former Huons Gully downgradient of the underground mine goaf (MH_MW01, MH_MW03, MH_X_D15, MH_X_D19). It is further noted that the contribution of the current ash repository to metals concentrations in groundwater was considered in the approval for the Mt Piper Ash Placement Project, which was approved by the Minister for Planning and Infrastructure under the *Environmental Planning and Assessment Act 1979* (NSW), and measures were implemented to minimise potential additional metals loadings from the current ash repository, and the extension into Lamberts North.

Human Exposure Pathways

Based on the available information potential source-pathway-receptor linkages have been discounted. In summary, the CSM was revised to consider the following source-pathway-receptor linkages:

- Ingestion - groundwater in the vicinity of the Site is not extracted for drinking water.

- Dermal absorption - direct contact with groundwater is unlikely based on the depth to groundwater and the on-going operations at the Site. Based on the available information this source-pathway-receptor linkage has been discounted.

- Inhalation – there are no potential inhalation exposure risks associated with metals in groundwater. Based on the available information this source-pathway-receptor linkage has been discounted.

- Ecological exposure pathways

The significance of potential impacts to ecological receptors in both groundwater and surface water is unclear, given the degraded quality of background groundwater and surface water and the undetermined connection of groundwater to Neubecks Creek. Given that potential groundwater discharges to Neubecks Creek occur up-stream of a highly disturbed catchment, including mine discharges (under existing EPLs) downstream of the confluence with the Coxs River, and licenced discharges from Wallerawang Power Station, the cumulative impact of these off-site sources to ecological receptors must be considered.

The quality of groundwater in the vicinity of the current ash repository and Lamberts North have been considered by several regulatory agencies (including the Sydney Catchment Authority and NSW Office of Water) in the approval for the Mt Piper Ash Placement Project, which was approved by the Minister for Planning and Infrastructure under the *Environmental Planning and Assessment Act 1979* (NSW). Further consultation with the appropriate regulatory agencies, including NSW EPA, is recommended to assess the appropriate management of this issue under the CLM Act (1997) and/or the *POEO Act* (1997).

5.7.3 *Summary – Does the Impact Warrant Notification under the Contaminated Land Management Act 1997?*

Under section 60 of the *CLM Act 1997*, 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, **and** 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, **and** the contamination exceeds, or will foreseeably exceed, an appropriate published screening value and will foreseeably continue to remain above that level.

The soil and groundwater results obtained in this assessment have been compared against the screening values 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 values 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 5.6.2*, 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 do 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:

- LNAPL detected in groundwater in Area ME, which has previously been reported to NSW EPA under the CLM Act;
- benzene was detected at a concentration in excess of the adopted human health (drinking water) screening values in groundwater at MJ_X_MWMP1;
- heavy metals in groundwater detected at concentrations not attributable to natural background conditions in groundwater at various locations across the Site.

Each of these issues is discussed in further detail below.

LNAPL In Groundwater - AEC ME

LNAPL was detected in two groundwater monitoring wells on the northern side of the wash bay, adjacent to the oil-water separator (ME_X_MWMP8 and ME_MW03), and one monitoring well on the southern side of the wash bay, adjacent to the diesel UST and bowser (ME_X_MWMP7).

LNAPL was previously identified in one groundwater monitoring well (ME_X_MWMP8) in October 2012 (SMEC 2012). Subsequent fingerprinting analysis of the LNAPL identified this is most likely weathered diesel with an estimated age of 25 years (+/- 5 years). Based on the age of the weathered diesel, and the findings of the tank integrity tests for the diesel UST near ME_X_MWMP7 it was concluded that the LNAPL was related to an historical spill and not an underground release from the current UST.

The source of the LNAPL has not been definitively identified, and other underground infrastructure in this area has not been investigated to-date. The oil-water separator drains through an underground pipe in a north-easterly direction, discharging into an open surface water drain along the coal storage area boundary. The bobcat pit drains to an oil collection pit which is pumped out by a road tanker.

Aside from an unknown historical surface spill, on-going leaks in underground infrastructure in the vicinity, including the bobcat pit, the oil-water separator or the drainage pipe from the oil-water interceptor are potential sources of contamination.

Both the sewer main and the oil-water interceptor drainage pipe cross through the area of the LNAPL plume, and the service trenches around these pipes are potential preferential pathways for migration of contaminants.

Delta Electricity has previously reported the presence of LNAPL to NSW EPA in compliance with the requirements of the *Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008 (NSW)*. Concurrent investigations were undertaken by SMEC on behalf of Energy Australia in November 2013, and routine monitoring is undertaken in compliance with the *POEO (UPSS) Regulation 2008*.

Notification to NSW EPA has already been initiated by Delta Electricity/EnergyAustralia, and it is recommended that this additional information is communicated to NSW EPA by EnergyAustralia. It would be prudent to undertake an additional round of confirmatory groundwater sampling at the cross-gradient locations near ME_X_MWMP8, to confirm the delineation of LNAPL prior to reporting to NSW EPA. This may already be scheduled as part of the existing scheduled UPSS monitoring program.

Benzene in Groundwater AEC MJ

Benzene was detected at a concentration marginally above the adopted human health (drinking water) screening values in groundwater at MJ_X_MWMP1 adjacent to a UST and fuel bowsers. Given that the detection within of benzene AEC MJ (MJ_X_MWMP1) 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 considered 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, it's already degraded nature and the proximity of the result to the screening value.

Metals in Groundwater

Various metals were detected at concentrations above the human health (drinking water) and / or ecological screening values which were not attributable to background conditions in groundwater at a number of locations across the Site. The concentrations of metals in groundwater across the Site are generally comparable to up-gradient background monitoring wells. Where metals are above background concentrations, impact generally appears to be associated with former mine workings both on the Site and in surrounding areas.

The contribution of the ash repository to metals concentrations in groundwater cannot be differentiated from the contribution of the former mine workings. However, it is noted that the concentrations of most metals in groundwater downgradient of the current ash repository (MG_X_4/D1 and MG_X_4/D9) lie within a similar range to concentrations in monitoring wells in the former Huons Gully, downgradient of the underground mine goaf (MH_MW01, MH_MW03, MH_X_D15, MH_X_D19). It is further noted that the contribution of the current ash repository to metals concentrations in groundwater was considered in the approval for the Mt Piper Ash Placement Project, which was approved by the Minister for Planning and Infrastructure under the *Environmental Planning and Assessment Act 1979* (NSW), and measures were implemented to minimise potential additional metals loadings from the current ash repository, and the extension into Lamberts North.

A summary of metals exceeding screening values with regard to the duty to report is provided in *Table 5.16* (over).

Table 5.16 Groundwater Screening in Relation to Potential Duty to Report

Metal	Data Range (µg/L)	Data Average (µg/L)	Background* Maximum (µg/L) Site/Ash	WMP ANZECC (2000) Modified^	Exceedences of Human Health (Drinking Water) or Ecological Screening Value	Relevant AECs #
Arsenic	0.4 - 129	8	10	24	Yes, ecological, drinking water and recreational value exceeded. Arsenic concentrations were above a factor of two of the maximum reported background concentration in five monitoring wells, four (MC_MW04, MC_MW04, MJ_X_MWMP5 and MK_MW11) of which are located in the eastern area of the main operation area at the Power Station, and one monitoring well (MG_X_4/D4) located to the north east of the coal storage area and directly down-gradient of a remnant mine spoil dump. These five monitoring wells with exceedences higher than background in particular may warrant reporting.	MC, MG MJ, MK ML
Boron	16 - 4150	198	<50 (289)	370	Yes, ecological and drinking water value exceeded. Boron concentrations in monitoring wells MG_X_4/D1, MG_X_4/D9, MG_X_4/D10 and MH_MW03 were between a factor of seven and more than an order of magnitude above the maximum concentration reported for the Ash Repository Background Monitoring Wells. It should be noted that the majority of the noted exceedences are in the vicinity of the Ash Repository which is regulated under the Site EPL.	MG, MH
Cadmium	<0.05 – 7.4	0.37	0.5	1	Yes, both ecological and drinking water were exceeded. Reported concentrations a factor of two above the maximum reported background concentration were limited to four monitoring wells; MG_X_4/D4 located to the north east of the coal storage area and directly down-gradient of a remnant mine spoil dump, MG_X_MP1 located upgradient of the current ash repository, MG_X_4/D10 located down-gradient of both the underground mine goaf and the current ash repository, and MH_X_D15 located adjacent to the underground mine goaf. These four monitoring wells with exceedences higher than background in particular may warrant reporting.	MG, MH, ML
Chromium	<0.2-10	0.58	na	1	Yes, ecological value marginally exceeded in three locations.	MD, MG, MH
Copper	0.5-39.4	3.1	2	2.5	Yes, ecological value exceeded. Reported concentrations a factor of two above the maximum reported background concentration were limited to ten monitoring wells located in the water holding pond area, operational ASTs area, the main operational area of the Power Station, non-operational areas and the current ash repository. The results indicate that the presence of copper impact above background concentrations are relatively localised on site within distinct areas, and that the current ash repository is not a significant source of copper to groundwater given that the highest copper concentration was reported for monitoring well MG_X_MP1 located upgradient of the current ash repository. These ten monitoring wells with exceedences higher than background in particular may warrant reporting.	MF, MG, MH, MI, MK, ML
Lead	<0.1-47	3.3	13	5	Yes, both ecological and drinking water values were exceeded. Reported concentrations a factor of two above the maximum reported background concentration were limited to three monitoring wells located in the electrical transformers area, the operational area and to the north east of the coal storage area and	MC, MK, ML

Metal	Data Range (µg/L)	Data Average (µg/L)	Background* Maximum (µg/L) Site/Ash	WMP ANZECC (2000) Modified^	Exceedences of Human Health (Drinking Water) or Ecological Screening Value	Relevant AECs #
					directly downgradient of a remnant mine spoil dump (MG_X_4/D4). The results indicate that the presence of lead impact above background concentrations are highly localised in distinct areas on site, and that the current ash repository is not a significant source of lead to groundwater. These three monitoring wells with exceedences higher than background in particular may warrant reporting.	
Manganese	50-20,300	4420	9870	1900	Yes, ecological, drinking water and recreational value exceeded. Reported concentrations a factor of two above the maximum reported background concentration were limited to one monitoring well (MI_X_5/D5) located directly downgradient of a wastewater pond. The results therefore indicate that the presence of manganese impact above background concentrations is limited to a highly localised part of the water holding pond area. Monitoring wells MI_X_5/D5 with exceedence higher than background in particular may warrant reporting.	MI
Nickel	2-990	152	82 (172)	17	Yes, both ecological and drinking water values were exceeded. Reported concentrations a factor of two above the maximum reported background concentration were limited to three monitoring wells located at the water storage ponds (MI_X_5/D2, MK_MW03, MK_MW06), one in the main operational area at the Power Station (MK_MW02) and a further seven monitoring wells located downgradient of the underground mine goaf and the current ash repository. The monitoring wells downgradient of the underground mine goaf and the current ash repository had reported concentrations above a factor of two of the maximum reported concentration for the Ash Repository Background Monitoring Wells (MG_X_4/D1, MG_X_4/D10, MG_X_4/D9, MH_MW01, MH_MW03, MH_X_D15, MH_X_D19). These eleven monitoring wells with exceedences higher than background in particular may warrant reporting.	MG, MH, MI, MK,
Zinc	<5 – 2300	176	56 (427)	116	Yes, ecological water values were exceeded. Reported concentrations a factor of two above the maximum reported background concentration included samples taken from 18 monitoring wells spread across the site, including the water holding pond area, operational ASTs area, the main operational area of the Power Station, the coal storage area (MB_MW02, MB_MW03, MB_MW05, MF_MW03, MG_X_4/D4, MI_X_5/D2, MK_MW02, MK_MW03, MK_MW09, MK_MW11, ML_MW08). Monitoring wells exceeding the maximum reported concentration for the Ash Repository Background Monitoring Wells included MG_X_MP1 MG_X_4/D10, MH_MW01, MH_MW03, MH_X_4/D8, MH_X_D15 and MH_X_D19. These 18 monitoring wells with exceedences higher than background in particular may warrant reporting.	MB, MF, MG, MH, MI, MK, ML

Notes: * = Background values assessed as concentrations a factor of two above the maximum reported concentration in a background monitoring well.
^ Connell Wagner (2008). Mt Piper Power Station Brine Conditioned Fly ash Co-placement Extension Water Management and Monitoring Plan. Delta Electricity Western. May 2008.
# = AECs with concentrations above background values where background values exceed one or more of the screening values.

Whilst many of the metals exceedences can be related to background concentrations, some elevated concentrations appear to be related to contributions from former mine workings both on the Site and in surrounding areas.

Groundwater impacts related to activities undertaken within the ash repository (including the extension to Lamberts North) are already regulated and monitored under the Site EPL. It is noted that the construction of the Lamberts North Ash Repository was approved by the Minister for Planning and Infrastructure under the *Environmental Planning and Assessment Act 1979* (NSW).

In ERM's professional experience it is NSW EPA's preference to regulate issues such as these under either the *POEO Act* (1997) or the *CLM Act* (1997) rather than both, and, in the case of licensed premises, it is usually the *POEO Act* (1997) which is preferred.

Groundwater impacts above background conditions within the main operational areas of the Site, and on the down-gradient boundary can be attributed to contributions from former mine workings both on the Site and in surrounding areas. In this instance, groundwater impacts are not currently regulated under the Site EPL, however it is noted that any potential discharge to surface water in Neubecks Creek would occur up-stream of potential discharges from groundwater beneath the ash repository. Therefore, ERM therefore considers that NSW EPA would most likely continue to manage this issue under the *POEO Act* (1997) via the Site EPL (including the existing groundwater and surface water monitoring program), 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. Some modification to the existing groundwater and surface water monitoring program under the EPL may be required.

5.7.4 *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 on a per source basis is likely to be required relate to the LNAPL identified in groundwater at the Mobile Plant Refuelling Area (ME). This issue was identified by Delta Electricity previous to this assessment, and has been officially notified to NSW EPA under Section 60 of the CLM Act. Further investigations into the extent of the LNAPL plume were conducted by Energy Australia concurrent to this investigation.

Further assessment and remediation may be required to address the hydrocarbon impacts in the mobile plant refuelling area (AEC ME). It is possible that costs related to this work could exceed the material threshold. As further assessment of the source of the LNAPL, and further delineation of the extent of contamination is required, detailed costings for remediation have not been prepared based the current data.

The costs associated with the management and/or remediation of this issue have been estimated in the range of $M 0.3 - $M 0.8 based on ERM's professional judgement and experience of similar hydrocarbon issues on large industrial sites.

It is recommended that the grit blasting impacts in the former contractors yard (Area ML) to the south of the workshop building be removed from this area as part of general housekeeping. The costs associated with this issue are not anticipated to be material.

As discussed in *Section 5.6.3,* the exceedences of the adopted screening values for metals in groundwater would most likely continue to be managed by NSW EPA under the *POEO Act* (1997) via the Site EPL. Therefore, ERM considers that the costs associated with this issue are not anticipated to be material.

The data presented in the ESA was considered to generally be of a suitable quality and completeness to meet the objectives as stated in *Section 1.2,* including to inform future decisions on the management of contamination issues. It is noted that the costs associated with the management and/or remediation of the identified contamination issues described above are indicative and that further assessment may be required to delineate the extent of contamination which may require management and/or remediation.

5.7.5 *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 the time of the transaction. It is noted that the majority of the locations proposed in the Preliminary ESA were able to be advanced, with the exception of the locations listed in *Table 3.1*.

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.

Additional characterisation of the baseline conditions at the Site is not considered to be required on the basis of the outcomes of this investigation. It is noted that groundwater impacts associated with Underground Petroleum Storage System (UPSS) infrastructure at the Site were identified independently of this assessment and the current site operator (EnergyAustralia) has been developing appropriate management approaches alongside independent consultants and regulators. On the basis of the outcomes of this Phase 2 ESA, it is considered that further monitoring may be required in these areas as follows:

- Groundwater – It is recommended that the integrity of the UST and lines in the vicinity of MJ_X_MWMP1 be tested to assess the potential for sub-surface leaks. Additional confirmatory groundwater sampling is also recommended at this location 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* (1997).

- Groundwater – Additional groundwater monitoring and gauging in AEC ME (Mobile Plant Refuelling Area) is recommended at the cross-gradient locations near ME_X_MWMP8, to confirm the delineation of LNAPL prior to reporting of the most recent results to NSW EPA. This may already be scheduled as part of the existing scheduled UPSS monitoring program and/or separate investigations initiated by Energy Australia. It is recommended that the integrity of the oil pit and the adjacent oil-water interceptor in AEC ME is tested to investigate the potential source of LNAPL contamination in this area. It is further recommended that the sewer main and the drainage pipe from the oil-water interceptor be investigated to determine the potential for preferential migration pathways of LNAPL in this area.

6 CONCLUSIONS

ERM completed a Phase 2 ESA at Mt Piper 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, groundwater, surface water and sediment 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 hydrocarbons and LNAPL in groundwater in the Mobile Plant Refuelling Area, benzene in groundwater near a UST, and metals in groundwater (refer below).

- Various metals were identified at concentrations in excess of screening values across the Site, however the concentrations of metals in groundwater across the Site are generally comparable to background groundwater quality. Where metals were above background concentrations, impact generally appears to be related to contributions from former mine workings both on the Site and in surrounding areas.

- 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 hydrocarbon impacts in groundwater in the Mobile Plant Refuelling Area. On the basis of the data available to ERM at the time of this assessment, the potential for vapour inhalation risks to industrial workers and/or intrusive maintenance workers in this area could not be ruled out. However, ERM understands that the current site operator (Energy Australia) (and prior to the transaction Delta Electricity) has been developing appropriate management approaches in relation to this issue alongside independent consultants and regulators. It is noted that Delta Electricity has previously notified this issue to NSW EPA. It is considered that the costs for management of this issue may be potentially material depending on the remediation / management option selected.

- ERM considers that NSW EPA would most likely continue to manage the LNAPL issue under the existing notification of potential contamination under the CLM Act, however, the additional results should be provided to NSW EPA for review and consideration.

- ERM considers that NSW EPA would most likely continue to manage the metals in groundwater issue under the *POEO Act* (1997) via the Site EPL (including the existing groundwater and surface water monitoring and reporting required as part of the conditions of consent issued under the *EP&A Act*), and hence would not require formal notification under the *CLM Act* (1997), however this approach should be confirmed with NSW EPA to ensure strict adherence to the *NSW DECC (2009)* guidelines. It is noted that NSW EPA could potentially request some modifications to the existing groundwater and surface water monitoring program under the EPL.

- The data presented in this Phase 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. It is noted that groundwater impacts identified independently of this assessment and the current site operator (EnergyAustralia) has been developing appropriate management approaches alongside independent consultants and regulators. On the basis of the outcomes of this Phase 2 ESA, it is considered that further monitoring may be required in these areas as follows:

- Groundwater – It is recommended that the integrity of the UST and lines in the vicinity of MJ_X_MWMP1 be tested to confirm the absence of sub-surface leaks. Additional confirmatory groundwater sampling is also recommended at this location 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* (1997).

- Groundwater – Additional groundwater monitoring and gauging in AEC ME is recommended at the cross-gradient locations near ME_X_MWMP8, to confirm the delineation of LNAPL prior to reporting to NSW EPA. This may already be scheduled as part of the existing scheduled UPSS monitoring program and/or separate investigations initiated by Energy Australia with SMEC. It is recommended that the integrity of the oil pit and the adjacent oil-water interceptor in AEC ME is tested to investigate the potential source of LNAPL contamination in this area. It is further recommended that the sewer main and the drainage pipe from the oil-water interceptor be investigated to determine the potential for preferential migration pathways of LNAPL in this area.

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