# Mt Piper Power Station Ash Placement Project

## ENVIRONMENTAL ASSESSMENT

## CHAPTER 7 – WATER MANAGEMENT

August 2010

# Contents

# 7. Water Management

*This chapter provides an assessment of the key environmental issue of water management. The Director-General's requirements specific to water management are:*

- *For Neubecks Creek and Ivanhoe No 4 sites (concept plan application only) include an analysis of potential surface water, hydrology, groundwater and water supply constraints to the development of these sites including available mitigation and/or management options that may be applied to achieve acceptable environmental outcomes, with consideration of cumulative impacts from the project and other existing or proposed activities in close proximity to the project site. The assessment must demonstrate sufficient water supply availability to accommodate the requirements of the concept plan as a whole and that these sites can be developed without significant risks to hydrology or groundwater resources, with consideration to cumulative impacts. Key water related risk factors and/or design criteria that would require further detailed investigation prior to the development of these sites must be identified.*
- *For the Lamberts North and Lamberts South sites the Environmental Assessment must characterise and assess site hydrology and water management including drainage, stormwater, flooding and water supply and provide an assessment of potential risks to surface water and groundwater quality with consideration of relevant State policies and ANZECC water quality guidelines. The water quality investigations must address the cumulative impacts on water of the proposal in conjunction with other activities in the area such as power generation, coal mining and a landfill, in particular the potential impact on the Coxs River system, Huon Creek and Neubecks Creek. The Environmental Assessment must provide details of proposed water quality monitoring during construction and operation so as to assess changes to the quality of receiving waters and the groundwater table.*

## 7.1. Introduction

A technical paper on hydrology and water quality was prepared and is provided as **Appendix D** to the EA. This chapter summarises the paper and provides:

- A review of surface water hydrology and identification of potential for water quality impacts due to surface run-off in Neubecks Creek and Coxs River. A water management system is described for the Lamberts North and Lamberts South sites to demonstrate that sufficient water would be available for site usage without any requirement to extract water from any new sources, and how water on the sites would be managed to minimise the risk of water pollution in Neubecks Creek;

- Information on groundwater quality and movement, using existing bore hole data collected for the on-going monitoring of the existing ash storage area (Area 1) and data from new bore holes drilled in Lamberts North and Lamberts South as part of this study. Based on data collection and modelling undertaken for Area 1 an assessment is made of the potential for groundwater impacts to result from new ash storage areas;
- A review of available water quality data from Neubecks Creek and an assessment of it against ANZECC/ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. It also provides an assessment of the contribution to the existing water quality from groundwater inflow from mine workings and the existing ash placement Area 1. Cumulative effects from other developments within the Neubecks Creeks catchment are also considered;
- An assessment of the impacts on receiving water quality and identifies the measures needed to mitigate any potential impacts on water quality during the life of the facility. Monitoring plans are proposed in the context of identifying impacts on water quality in Neubecks Creek from the placement of ash at Lamberts North and Lamberts South and providing a baseline for assessing potential impacts from Neubecks Creek and Ivanhoe No 4 sites.

## 7.2. Hydrology

### 7.2.1. Drainage Catchments

A detailed hydrological study was undertaken in the Lamberts Gully area to assess issues associated with surface runoff from the proposed ash placement areas of Lamberts North and Lamberts South.

The area contains two waterways referred to as Huons Gully and Lamberts Gully. These two gullies or waterways appear to have derived from the original Lamberts Creek which was present when the Western Main Colliery holding was active. The waterways have been disturbed by previous mining activities in the catchment. The location of the original Lamberts Creek alignment is unclear but the existing drainage elements comprise Huons Gully (known previously as Eastern Drain and more recently as Huons Creek) and Lamberts Gully which both drain from south to north, with the headwaters of both waterways in the Ben Bullen State Forest (see **Figure 7-1**). Huons Gully drains to a large pond known as Huons Pond or Groundwater Collection basin (GCB), an impoundment which is not connected to Neubecks Creek, rather it is pumped to settlement ponds and reused on site. Lamberts Gully drains through the existing Lamberts Gully Coal Mine and then into Neubecks Creek. The Lamberts Gully area lies within the Western Main Colliery and since the 1940s this area has been worked by shallow underground and open cut mining.

The Ivanhoe No. 4 area includes a number of drainage lines. The catchment for these drainage lines in the drain from the ridge that is on the western and southern sides of the Ivanhoe No. 4 Concept Area. The drainage lines drain from this ridge north and east through the Ivanhoe No. 4 Concept Area. The drainage lines combine and continue to drain north-east to the western arm of Neubecks Creek.

The Neubecks Creek area includes a number of drainage lines and the northern arm of Neubecks Creek. The catchment for these drainage lines and Neubecks Creek drain from North to South. The drainage lines combines with Neubecks Creek, which continues to flow east.

The catchments for Neubecks Creek and Ivanhoe No 4 are illustrated in **Figure 7-2.**

### 7.2.2. Water Management Strategy

Water would be used within the proposed ash placement areas for dust management and for progressive rehabilitation through capping and revegetation. The water management within the proposed ash placement areas is discussed below.

Water for ash conditioning prior to placement in the ash area is derived from the reuse water within the power station operation. The ash is treated within the power station area and the treated ash is then transported to the ash placement areas. This same process will operate for the new ash placement area. Should Mt Piper Extension be constructed as a coal fired plant, the ash conditioning processes are also planned to be undertaken within the existing Mt Piper Power Station. The water requirements for the Mt Piper Extension were addressed in the EA undertaken for the concept approval for that project (SKM, 2009). Accordingly, water used for ash conditioning is not addressed in this EA.

#### Lamberts Gully

The objective of the water management strategy is to provide adequate water to the proposed ash storage facility to operate successfully while minimising environmental impacts by collecting and managing dirty runoff water. Delta has managed the existing ash placement area at Mt Piper since plant operations commenced in the early 1990s and the water management techniques developed at that site will be applied to the proposed sites at Lamberts North and Lamberts South.

On this basis a water management strategy for the two sites would be developed with the following key principles:

- Stormwater runoff from undisturbed areas surrounding the Project site to be diverted away from disturbed areas and released directly into adjacent waterways;
- Design of any drainage systems operating for the life of the project to ensure erosion is minimised;

- Staging ash placement to minimise the operational area exposed at any one time to reduce the potential for erosion;
- Separating sediment-containing stormwater from other sources of water on the site such as the ash placement area;
- Incorporating the reuse of contaminated stormwater into the overall water management strategy for the project to meet the demands for rehabilitation and dust suppression;
- Minimising the extent and duration of disturbed areas by implementing a progressive rehabilitation strategy including prompt stabilisation of landforms; and
- Modifying water usage and ash placement activities in times of very low water availability to continue to meet dust suppression and rehabilitation objectives.

The key elements of the water management system are sediment dams and water storages (which collect water from capped and rehabilitated areas), Dirty Water Area Storage Area[1] (which collects run-off from the on-going ash placement activities) and diversion drains. Water management in very low water availability conditions would comprise:

- Controlling dust by minimising work areas and using DUSTEX instead of water. The most distant and least used areas (about 40%) would be capped with a thin layer of overburden. The remaining areas would be capped with sealant such as DUSTEX, thus allowing the sprinklers to be turned off as no water would be required, with labour and time dedicated to keeping the temporary capping intact. The working areas would be minimised and rotated to allow continued placement without affecting production. The method would involve a small area or pad for ash placement and ash would be progressively placed until the pad reaches optimum height. The pad would then be coated with DUSTEX and the placement moved to a different working area. Working areas could be rotated indefinitely by placing temporary capping and placing ash over previously capped areas;
- The use of water only for the management of roads and some working areas. Water carts would be used to supply about 40 kL/hr for 3 hours per day (120 kL/day or less than half of the nominated daily volume of water required). It should be noted that about 20% of the water cart water is sourced from dirty water ponds and surface drains and, although this will reduce demand on water by minimising usage, while maintaining an effective system for gathering all water from the site.

[1] The Dirty Water Storage Area would be required to have a storage capacity of about 500 ML and would move with the progression of the active ash placement areas.

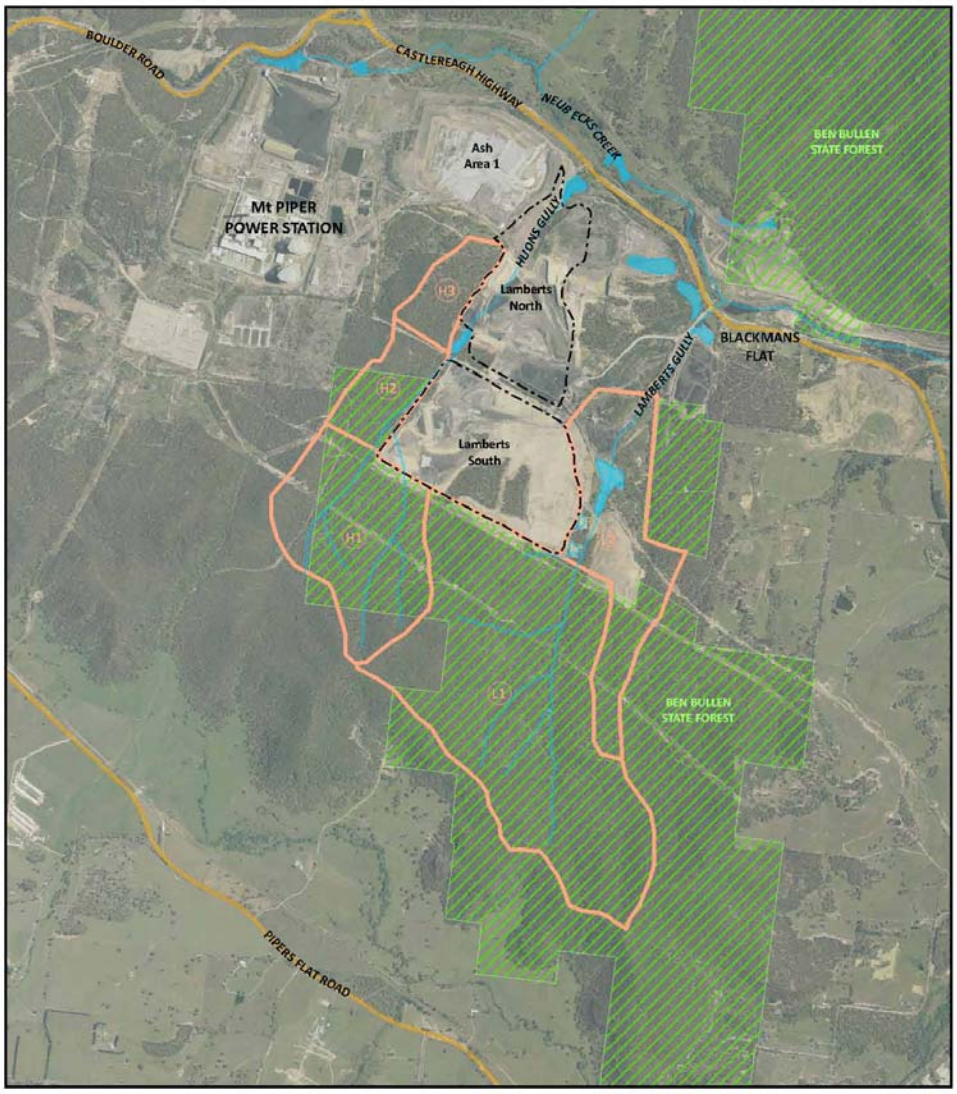


Figure 7-1 Catchment Plan - Project Approval Areas

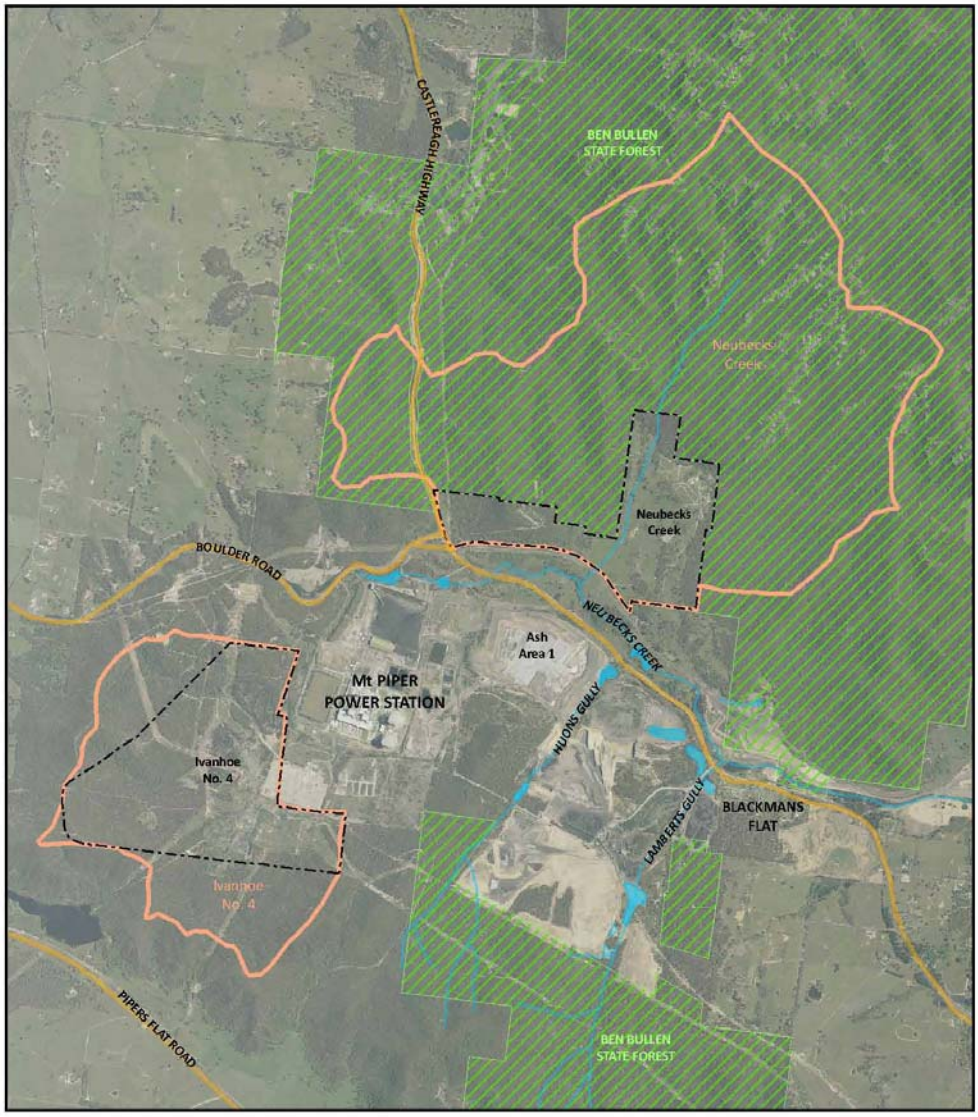


Figure 7-2 Catchment Plan - Concept Approval Areas

Water requirements for rehabilitation are minimised by the use of native plants of local provenance, ie species which are hardy and drought tolerant. In the case of extreme conditions, no water would be available but these plants would be no worse off than the surrounding flora.

All of these activities form part of the current water management strategy for ash placement at Mt Piper Power Station and reflect the local water situation. Should the Mt Piper Power Station and Mt Piper Extension be operating together during very low availability conditions, the water management procedures for ash placement and the minimum water requirements of 120 kL/day would be the same. Work face areas and access roads for the two plants operating would be similar, although the placement rate would be higher.

Water collected in the water storage areas would be used for rehabilitation and dust suppression. As the ash placement areas are progressively capped and rehabilitated, the runoff from these areas would be directed to sediment dams. The diversion drains would be designed to convey the 100 year ARI flood event from the external catchments.

The performance of the water management system for Lamberts North and Lamberts South was assessed using the modelling software program GoldSim to model continuous systems. The modelling was undertaken for the placement of ash generated from the existing Mt Piper Power Station and for the option of the existing plant plus Mt Piper Extension operation as a coal fired plant. The water balance model was used to predict the reliability of the water for the rehabilitation and dust suppression demands. The maximum daily water demand for Mt Piper would be 250 kL/day, and for Mt Piper plus Mt Piper Extension 450 kL/day. The rehabilitation and dust suppression water demand would vary, however, depending on the amount of rainfall received at the site and the amount of ash to be placed. More rainfall means less watering for both dust suppression and rehabilitation. The water balance modelling assumes a constant daily demand of 250 kL/day for Mt Piper Power Station alone and a daily demand of 450 kL/day for Mt Piper and Mt Piper Extension Power Stations together, regardless of ash production and local rainfall.

The water balance modelling results are presented in two ways:

- The overall project reliability – which calculates the total number of days in the 30 year project life in which demand is fully satisfied; and
- The annual reliability – which assesses the number of days per year that the demand is fully supplied. This provides an added level of detail to assess which specific phase of the project may have the potential for water storage.

For overall project reliability the water balance model predicts the average dust suppression and rehabilitation reliability for the project life is 80-82%. This means that, on average over the life of the project, daily dust suppression and rehabilitation demand is predicted to be satisfied for 80-82%

of the days of the project life, assuming maximum daily water usage. On the other 18-20% of days the water available would be less than the maximum requirement (250 or 450 kL/day).

For annual reliability the water supply reliability was assessed for a range of different likelihoods ie the chance of the risk of water shortage occurring. The aim of this type of assessment is to look at the results with the potential for water shortage and determine how likely that is to occur. This water balance modelling predicts there will be suitable water availability to supply the rehabilitation and dust suppression demand for the proposed ash placement facility. The consequence of a shortfall of water to supply dust suppression and rehabilitation is minor in that during periods of median rainfall the shortfall from 250 kL/day would occur on no more than 19% of days of the year for Mt Piper operating and from 450 kL/day it would occur on no more than 23% of days of the year for Mt Piper and Mt Piper Extension both operating at full output.

When rainfall is significantly below average, for half of the year the full quota of 250 kL/day or 450 kL/day is able to be supplied; for the other half of the year there is only a 10% chance that the full quota will be provided or a 90% chance that the rainfall will be less than the full quota. As discussed below the minimum requirement for dust management on the site is 120 kL/day. There would be a substantially reduced risk of being able to provide 120 kL/day compared with 250 kL/day indicating, when linked to strict management of water storages, a moderate to high likelihood that the 120 kL/day would always be available.

The reliability of water supplied for dust suppression and rehabilitation is regarded as moderate to high but, in the event of a significantly below average period of rainfall and a shortfall occurring, alternative management processes exist for water management. The management processes were described above and form part of the current water management strategies which reflect the local water situation. As noted, the minimum water requirement for ash placement is 120kL/day and when that number is set as the requirement for water supply, there is a substantially reduced risk of a shortfall occurring. The management of water on the site is based on timing for the adjustment of water extraction from the on-site storages (which collect rainfall). This allows the water extracted to be reduced to a maximum of 120 kL/day as early as practicable, thus ensuring the maintenance of water in the storages for much longer periods during times of low or no rainfall.

The water balance model predicts that the maximum volume of water to be stored in the Dirty Water Storage Area, as a result of a major rainfall event, is 200 ML. This maximum volume is less than the volume of the dirty water storage area. Therefore, the model predicted there would be no releases from Dirty Water Storage Area of the proposed ash placement facility for the simulated project life.

The sediment dams and existing water storages on the site will manage the runoff containing sediment from the capped and rehabilitated areas. There would be no planned releases from this

system and the final retention dam would overflow to the waterway after the runoff has been treated appropriately. The frequency of the overflows from the sediment dams system was determined from the water balance model in terms of Average Recurrence Interval. This assessment equates to an ARI of approximately 1 in 5 years and therefore, on average, the site would be predicted to have an overflow from the sedimentation dams in six years of the 30 year project life.

This result represents the maximum likely overflows from the sediment dams over the life of the proposed ash placement facility.

### Neubecks Creek and Ivanhoe No 4

To manage the potential impacts of the development of the areas of Ivanhoe No. 4 and Neubecks Creek, a site water management system at each site would need to be developed.

The philosophy of the water management strategy would be to provide adequate water to the proposed ash placement facility to operate successfully while minimising environmental impacts by collecting and managing dirty runoff water. A water management system developed for each area would have the following key principles:

- Stormwater runoff from undisturbed areas surrounding the site would be diverted away from disturbed areas and released directly into adjacent waterways;
- Design of any drainage systems operating for the life of the site to ensure erosion minimised;
- Staging ash placement to minimise the operational area exposed at any one time to reduce the potential for erosion;
- Separating sediment-containing stormwater from other sources of polluted water on the site such as the ash placement area;
- Incorporating the reuse of contaminated stormwater into the overall water management strategy for the project to meet the demands for rehabilitation and dust suppression;
- Minimisation of extent and duration of disturbed areas by implementing a progressive rehabilitation strategy including prompt stabilisation of landforms; and
- Modifying water usage and ash placement activities in times of very low water availability to continue to meet dust suppression and rehabilitation objectives.

In the process of developing the water management system, a number of studies would need to be undertaken for water management and to assess flooding. The development of the water management for the site would require the development of a water balance model. The objectives of the water balance model would be to:

- Control the release of water from the storages so that that releases occur in a manner that minimises impacts upon downstream users and the environment;

- Manage dam storages so as to have enough water to adequately supply to demands for rehabilitation and dust suppression;
- Control and manage the separation and use of clean and dirty water.

### 7.2.3. Water Availability

The project investigation area for the Lamberts North and Lamberts South ash placement facilities is only a very small portion of the Upper Coxs River Catchment, and development of the ash placement area would have no impact on the water catchment in terms of water availability. As the Lamberts Gully project investigation area has been previously disturbed by mining, the runoff from the water has already been removed from the Upper Coxs River Catchment.

Similarly, the Neubecks Creek and Ivanhoe No. 4 sites are only very small portions of the Upper Coxs River Catchment and would have no impact on the Sydney drinking water catchments in terms of water availability.

The development of the ash placement facilities require water to be used for rehabilitation and dust suppression to supply to the operation. The water for the demands of the proposed ash placement would be sourced from water harvested from the disturbed areas of the proposed ash placement facility and would not require water to be derived from the Coxs River system.

### 7.2.4. Flooding Impacts

The development of the ash disposal facility has the potential to affect the flooding regime of the local creeks by modifying the landform of the area to include the proposed ash placement facility. The potential for flooding impacts would be managed by the use of diversion drains to separate clean water from undisturbed catchments upstream of the proposed ash placement facility. The diversion drains would be designed to convey the 100 year ARI flood event.

### 7.2.5. Water Quality

As the proposed ash placement facilities would have the potential to affect the water quality of Neubecks Creek and consequently the Coxs River the system would be designed to manage the contaminated water from the site and minimise the risk of affecting the water quality by:

- Separating clean water from undisturbed catchments and dirty water on the site;
- Managing the dirty water generated on site by use of sediment dams for runoff containing sediment laden water and a dirty water area for water containing runoff from the exposed ash placement areas;
- Designing for no regular controlled releases from the site;

- Reusing the water generated on site to satisfy the demands for rehabilitation and dust suppression;
- Designing the sedimentation dams to release water in large rainfall events after the water has been treated through the dams;
- Incorporating the reuse of contaminated stormwater into the overall water management strategy for the project to meet the demands for rehabilitation and dust suppression; and
- Minimising the extent and duration of disturbed areas by implementing a progressive rehabilitation strategy including prompt stabilisation of landforms.

## 7.3. Groundwater

### 7.3.1. Geology and Mining Activities

The Mt Piper area is located at the western edge of the Sydney geological basin, within rocks of the Illawarra Coal Measures. The geological sequence in the vicinity of Mount Piper is as follows, in descending order: Lidsdale Seam (1-1.5m): interbedded high ash coal and shale; Blackmans Flat Conglomerate (up to 20m, but probably only a few metres here): coarse sandstone and conglomerate; Lithgow Seam (2-3m); Marrangaroo Conglomerate (about 20m) massive sandstone and conglomerate, with some boulders; Shoalhaven Group (>20m): marine sandstone, siltstone and mudstone, sulphide-bearing and acid-generating in places. Coal mining commenced in the Wallerawang and Mount Piper district in about 1873 and it is likely that the miners were initially drawn by the presence of the thick Lithgow Seam at shallow depth.

The Lamberts Gully area lies within the Western Main Colliery holding, which occupies the land immediately east of the power station. Since the 1940s the Lithgow Seam here has been worked by shallow underground bord and pillar methods and subsequently by open cut, the latter being generally ‘roof lifting’ exercises to extract pillar remnants. Underground mining ceased in the 1990s and open pit extraction has continued.

The Ivanhoe No 4 area is known to be extensively underlain by shallow bord and pillar workings of the former Ivanhoe No 4 colliery. The condition of these workings is likely to be similar to those beneath the Lamberts Gully site, except that no open cut “roof lifting” has been carried out there.

The proposed Neubecks Creek ash placement area appears to be partly within the Neubecks Creek mining lease (eastern side) and partly on the Ivanhoe colliery holding (western side). Bord and pillar mining and open cut mining have been carried out in this area (Huon Colliery and Huon Extended Colliery, plus No 3 and 5 open cuts). The mined areas are separated by undisturbed portions of the Lithgow Seam, and workings extend to at least 500m north of the Mudgee Road. The condition of these workings is likely to be similar to that of the Lamberts Gully area.

Undisturbed coal measures rocks in the Sydney Basin are generally considered poor groundwater prospects because of low bore yields and water quality that is only fair to poor – that is, of stock quality but non-potable. The seams themselves act as semi-confined aquifers of low hydraulic conductivity and moderate to high salinity. The underlying Shoalhaven Group rocks contain small but significant amounts of fine-grained sulphide minerals.

### 7.3.2. Groundwater Bores

Connell Wagner (2007) and Aurecon (2009) reported on the use of groundwater bores in the area of the existing ash placement area at Mt Piper Power Station. Some bores were located up-gradient of the existing ash placement area (MPGM4/ D4 and D5). Others were placed inside the ash placement area to monitor the effects of normal ash placement, although some (including B904 at the southern part of the ash placement area) were located to sample underground mine (goaf) workings. Borehole locations are shown in **Figure 7-3.**

A Statement of Environmental Effects (SEE) for the extension in 2007 of the brine placement area includes a summary of groundwater monitoring results obtained from the borehole sites (D10 – D14) in and around the operating ash emplacement area (Connell Wagner, 2007). Surface monitoring data from the groundwater collection basin (GCB), known as Huons Pond or Dam, at the end of Huons Gully are also provided. The GCB is the former Huon Mine No 6 void. Connell Wagner (2007) indicated that groundwater seepage at the ash placement locality is generally to the east to Huons Gully and the GCB due to the gradient of the strata at this location. Any seepage that reaches Huons Gully is contained within the basin and is reused, thus avoiding discharge to Neubecks Creek.

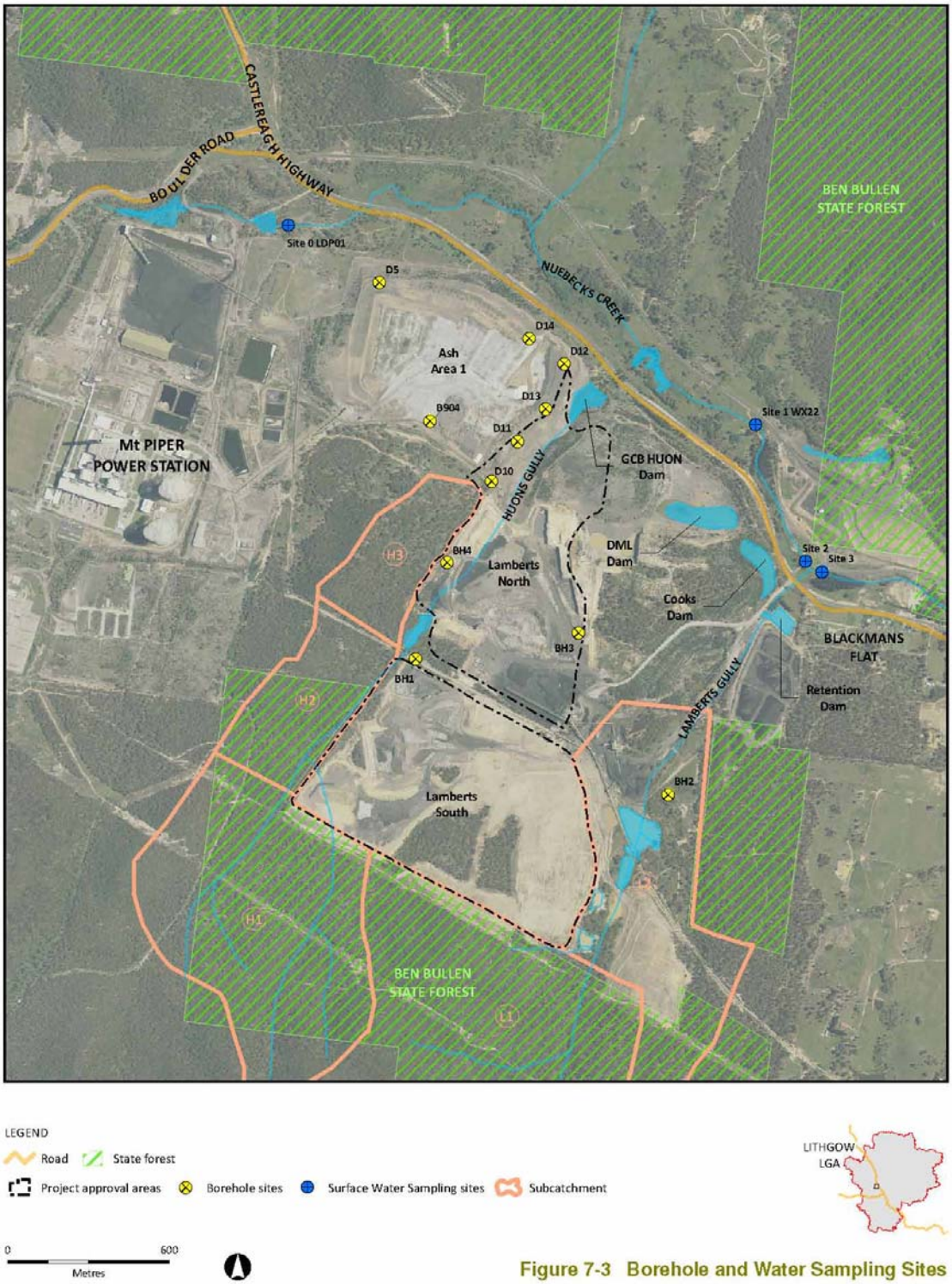


Figure 7-3 Borehole and Water Sampling Sites

The Protection of the Environment Operations Act requires consideration of the ANZECC (2000) guidelines when assessing effects on ambient water quality in receiving waters. The wider context of the ANZECC (2000) guideline was used to define acceptable ambient water quality. The guidelines used are for protection of freshwater aquatic life. Where appropriate other guidelines used were for protection of livestock, irrigation water or drinking water.

Aurecon (2009) updated these data and provided a comparison with upstream site D5. These data are summarised in **Table 7-1**.

**Table 7-1 Average Groundwater Concentrations in Monitoring Bores and GCB**

| Parameter (mg/L) (sampling time) | MPG M4 / D10 (2001-2009) | B0904 (1997-2000) | MPG M4 /D11 (2001-2009) | MPGM4 /D12 (2001-2006) | MPG M4 /D13 (2001-2005) | MPG M4 /D14 (2001-2003) | MPG M4/D 5 | GCB (2001-2008) | Guideline (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| **Cond-ivity (uS/cm)** | 1618 | - | 2076 | 1263 | 1245 | 1209 | 1098 | 1554 | 30-350 |
| **TDS** | 1374 | 1384 | 1390 | 960 | 982 | 865 | 879 | 1216 | 1500** |
| **Mn** | 3.16 | 9.2 | 2.4 | 6.9 | 1.46 | 1.35 | 8.35 | 4.26 | 1.9 |
| **Cl** | 44 | 22 | 229 | 29 | 68 | 26 | 26 | 41 | 350 * |
| **$SO_4$** | 864 | 892 | 228 | 624 | 418 | 356 | 583 | 791 | 1000 # |
| **B** | 1.8 | 1.5 | 0.3 | 0.7 | 0.04 | 0.02 | 0.15 | 0.893 | 0.37 |
| **Fe** | 1.26 | 10.6 | 6.37 | 13.63 | 0.16 | 3.66 | 49.9 | 0.103 | 0.3 ## |
| **F** | 0.34 | 5.3 | 0.46 | 0.1 | 0.2 | 0.14 | 0.181 | 0.089 | 1.0## |
| **Ni** | 0.372 | 0.84 | 0.047 | 0.672 | 0.055 | 0.458 | 0.066 | 0.313 | 0.011 |
| **Zn** | 0.458 | 2.6 | 0.104 | 0.524 | 0.03 | 0.02 | 0.077 | 0.073 | 0.008 |

ANZECC (2000) guidelines for protection of freshwaters, livestock or irrigation waters ( # Livestock water; * Irrigation water for moderately tolerant crops; ## drinking water; ** conductivity conversion applied by Connell Wagner (2007))

The summarised groundwater results show:

- Sulphate, boron, nickel, manganese and iron are naturally elevated in the area due to the local mineralisation associated with groundwater from the coal mining workings;
- Elevated trace elements concentrations are particularly evident at bores B904 and D10 which are adjacent to areas of mine coal pillars (goaf);
- The effect of the underground mine water quality (as indicated from B904 and D10) is reflected in the values for the groundwater collection basin, notably in the higher sulphate and boron compared to the D11 to D14 bores. Trace elements such as nickel and zinc are also elevated in these areas.

Chloride is regarded as an indicator of brine leachates, although no criterion is available for ecosystems. As a guideline an indicator of 350 mg/L is used for moderately tolerant crops. The low chloride concentrations in the groundwater bores (except for D11), indicate no significant effects on the local groundwater from the existing brine conditioned ash. The elevated chloride concentrations at D11 indicate a separate localised source of chlorine in the mine goaf water (Merrick, 2007).

Aurecon (2009) looked at long term trends for chloride since 1993 in the GCB, compared with chloride trends in Neubecks Creek and showed that the goaf chloride has not affected the creek concentrations.

A new groundwater drilling program was carried out at Lamberts Gully Colliery on 10-11 December 2009. Four boreholes were drilled (BHs 1-4) and two of these (BH2 and BH4) were completed as groundwater observation wells (piezometers). Full analytical results from testing of groundwater samples drawn from BH 1 and BH 2 in January 2010 are given in **Appendix D**, and are compared with earlier testing from observation wells MPGM4/ D10 to D14) in the NW corner of Lamberts North. The principal differences arising from this comparison are that:

- The groundwater salt level (TDS) in BH 1 and BH 2 is very low; and
- Sulphate, manganese and iron are also much lower.

The existing groundwater in the Lamberts South area falls within ANZECC guidelines in many respects. Note, however, that nickel (Ni) and zinc (Zn) at BH1 are above criteria. As noted above, underground mine water quality is reflected as trace element levels for Ni and Zn.

No groundwater investigations are known to have been carried out in the Ivanhoe No 4 area. The potential ash placement area is more elevated than the Lamberts Gully site, but the abandoned mine workings appear to be at least partially saturated. This was deduced from iron stained groundwater discharge in gutters adjacent to the access road to Mt Piper Power Station. Groundwater flow in this area appears to be generally to the east or north east, consistent with the fall of surface topography and the dip of the Lithgow Seam.

No information is available on the groundwater at Neubecks Creek site. It is presumed, however, that the groundwater generally moves towards discharge points along the main watercourse (Neubecks Creek) and the extent of flooding in the abandoned colliery workings will be dependent on topography.

### 7.3.3. Groundwater Modelling at Existing Ash Storage Area

Connell Wagner (2007) reported on groundwater modelling undertaken in 1999 and 2006/7 to assess the potential impacts associated with brine co-placement in the ash storage area 1.

Groundwater flows were shown to be from west of the ash placement area to the drain which enters the groundwater collection basin (GCB). The model also showed a limited connection between the GCB and Neubecks Creek.

Modelling undertaken in 1999 by Merrick and Tammetta (1999) for brine production and co-placement predicted an insignificant increase in salts and trace elements in the groundwater seeping into the GCB and from there to Neubecks Creek. The modelling showed:

- Water conditioned ash and brine conditioned ash contributed evenly to concentrations of groundwater discharging into Huons Gully and the GCB (Huons Pond);
- The stable background concentrations of major ions throughout the area are not related to the ash deposit. It appeared that the mine goaf zones were bleeding continuously into the spoil material under the attraction of the groundwater sink at the pond;
- There is a low risk that any trace elements generated from ash disposal would increase background levels by more than ANZECC guidelines at Huon Gully or the GCB. There would be no risks at Neubecks Creek, with extremely low concentrations predicted.

The results confirmed that the brine constituents were essentially immobilised in the pores of the water conditioned fly ash and brine conditioned fly ash. Overall the ash had a low rainfall infiltration rate, so the passage of the infiltration through the existing ash deposit was very slow.

Further modelling was undertaken in 2006/7 to predict the potential impacts of the proposed expansion of the brine co-placement area on the GCB and Neubecks Creek (Merrick, 2007). The modelling results showed that the extended area for placement of brine conditioned ash was not expected to cause a significant increase in the concentrations of water quality parameters in the local groundwater or in Neubecks Creek.

The minimal effects of leachates from the ash deposits were due to the slow rate at which leachates from the brine conditioned ash entered the groundwater and the mixing of this with the background groundwater under the ash deposit. The groundwater then flows to the GCB with some possibly reaching Neubecks Creek. The predicted values did not exceed the ANZECC (2000) criteria.

The modelling also noted that the predicted increases in water quality parameters due to inputs from the underground mine areas were also below the ANZECC guidelines, with the exception of boron, nickel and zinc which were naturally elevated. Most of the predicted increases were assessed as being due to poor water quality in the underground mine workings moving toward the GCB and are unrelated to the brine placement area or water conditioned ash placement.

### 7.3.4. Neubecks Creek and Ivanhoe No 4

To assess the potential impacts of ash placement at these sites a detailed groundwater study would be required for each site. A bore hole monitoring program will be required for each new ash placement site. Given the timeframe and uncertainty of whether these sites would be used for ash placement a limited monitoring program should be established to provide preliminary information on the hydrogeological conditions in the project area and provide a basis for planning a future monitoring network. The information to be collected from any new bore holes established would include water levels, seasonal fluctuations and water quality test results.

## 7.4. Surface Water Quality

Neubecks Creek is the primary potential receiving water for any discharges from the existing and proposed ash placement areas, which can in turn influence the quality of water feeding into the Coxs River and Sydney's drinking water system.

The assessment of existing water quality conditions within the study area has been made through interpretation of existing water quality data and review of existing reports. Generally water quality information is available for Neubecks Creek at a number of locations, although collection dates vary. Sampling locations are shown in **Figure 7-3**. Data are summarised in **Appendix D**.

## 7.5. Summary of Impacts

The Director-General's requirements require the Environmental Assessment to assess the impacts on Neubecks Creek, Coxs River and Huons Creek of the proposal at Lamberts North and Lamberts South and the cumulative impacts from other activities such as the operation of the Mt Piper Power Station, its current ash placement Area 1, coal mining in the area and the proposed Lithgow Council Waste Management Facility (not part of this assessment).

The impacts of coal mining and the existing power station operations are included in the assessment. The proposed waste facility has yet to begin operation. The EIS prepared for the waste facility project (HLA Envirosciences 2005) indicated potential water quality impacts from contaminants associated with leaching of land fill material as well as pollution from leaks and spills. Management measures are proposed within the EIS, including a comprehensive leachate management system.

The impacts on receiving waters will focus on Neubecks Creek. Coxs River is downstream of Neubecks Creek, and any cumulative impact within Coxs River would only be evident if a significant impact due to the proposal was noted in Neubecks Creek.

As indicated in the chapters above, the status of Huons Creek as a waterway is unclear. It is described as Huons Gully in the area associated with the existing coal mining activities, as it

appears for some time to have functioned as a gully or drainage line, receiving groundwater drainage from the existing ash placement area and from the operating open cut coal mine, and is not connected to Neubecks Creek. The drainage above the coal mine activities functions as a dry creek drainage area in catchment without any obvious disturbance. The project proposes to cover Huons Gully with ash to provide the necessary volume for ash and to divert any drainage from the undisturbed areas upstream to Lamberts Gully and thence to Neubecks Creek.

The direct and cumulative impacts of the proposal on Neubecks Creek and Coxs River are summarised below.

### 7.5.1. Impacts on Surface Water Hydrology

The development of the proposed ash placement facility has the potential to affect the water availability of the Upper Cox River Catchment in two ways, by:

- Reducing the volume of runoff to the Coxs River by reducing the catchment area; and
- Requiring external water sources to supply water demands at the proposed ash placement facility.

The project investigation area for the Lamberts North and Lamberts South ash placement facilities is approximately 0.4% of the Upper Coxs River Catchment. Similarly, the Ivanhoe No. 4 area and the Neubecks Creek area equate to approximately 0.4% and 0.3% of the Upper Coxs River Catchment respectively and represent less than 0.01% of the Warragamba (Lake Burragarang) catchment. These are only very small portions of the Upper Coxs River Catchment and would have no impact on the water catchment in terms of water availability.

The proposed ash placement facilities would not require water allocations or licences to operate, as the facilities would be supplied by the water harvested from the disturbed areas of the sites. The water would be used for rehabilitation and dust suppression to supply to the operation. The water sourced from the disturbed areas of the proposed ash placement facility would be achieved by the development of a site water management system for each site.

The development of the ash disposal facility has the potential to affect the flooding regime of the local creeks by modifying the landform of the area to include the proposed ash placement facility. The potential for flooding impacts is mostly likely due to the upstream catchments of the ash placement facility. The development of the site water management system would include diversion drains to separate clean water from undisturbed catchments upstream of the proposed ash placement facility. The diversion drains would be designed to convey the 100 year ARI flood event.

The proposed ash placement facility would have the potential to affect the water quality of the receiving waters. The proposed ash placement facility would generate water contaminated by

sediment and the site water management system would be designed to manage the water from the site and minimise the risk of affecting the water quality of Neubecks Creek and Coxs River by:

- Separating clean water from undisturbed catchments and dirty water on the site;
- Managing the dirty water generated on site, based on the contaminants including sediment dams for runoff containing sediment laden water and a dirty water area for water containing runoff from the exposed ash placement areas;
- Allowing no regular controlled releases from the site;
- Reusing the water generated on site to satisfy the demands for rehabilitation and dust suppression; and
- Allowing water releases from sedimentation dams only in large rainfall events after the water has been treated through the dams.

### 7.5.2. Impacts on Groundwater

The findings from the 2009 groundwater drilling, and from the review of other sources, show that:

- Water quality is the groundwater is due primarily to the existing water quality from coal mine workings. Sulphate, boron, nickel, manganese and iron are naturally elevated in the area due to the local mineralisation. Elevated trace elements concentrations are particularly evident at bores which are adjacent to areas of mine coal pillars (goaf). The effect of the underground mine water quality is reflected in the values for the groundwater collection basin, notably in the higher sulphate and boron. Trace elements such as nickel and zinc are also elevated in these areas;
- Chloride is regarded as an indicator of brine leachates, and the low chloride concentrations in the groundwater bores indicate no significant effects on the local groundwater from the existing brine conditioned ash;
- Modelling undertaken showed that water conditioned ash and brine conditioned ash contributed evenly to concentrations of groundwater discharging into Huons Gully and the GCB (Huons Pond). The stable background concentrations of major ions throughout the area are not related to the ash deposit and it appeared that the mine goaf zones were bleeding continuously into the spoil material under the attraction of the groundwater sink at the pond. The results confirmed that the brine constituents were essentially immobilised in the pores of the water conditioned fly ash and brine conditioned fly ash. Overall the ash had a low rainfall infiltration rate, so the passage of the infiltration through the existing ash deposit was very slow. The minimal effects of leachates from the ash deposits were due to the slow rate at which leachates from the brine conditioned ash entered the groundwater and the mixing of this with the background groundwater under the ash deposit. The groundwater then flows to the GCB, with some possibly reaching Neubecks Creek. There is a low risk that any trace

elements generated from ash disposal would increase background levels by more than the water quality guidelines at Huons Gully or the GCB;

- The main aquifer in the proposed Lamberts North and Lamberts South ash storage areas is the disturbed rock mass up to 50m thick lying between the base of the Lithgow Seam and the ground surface. This is unconfined and probably extremely permeable in places. It is only partly saturated, with standing water levels generally below RL 920m, discharging eastwards towards water courses such as Lamberts Gully;
- Present disposal practices require the brine conditioned ash to be placed 35-40m above the water table (at 946m AHD). Groundwater quality results and modelling discussed above suggest that this practice is sufficient to ensure brine does not leach through to the groundwater. Continuing this practice of placing brine conditioned ash at an appropriate height would allow for groundwater quality to be unaffected by ash placement in Lamberts North (at 946m AHD) and Lamberts South (956m AHD).

### 7.5.3. Surface Water Impacts

Based on the processes associated with ash placement the key indicators of concern with respect to water quality include electrical conductivity, total dissolved solids, chloride and trace metals.

Neubecks Creek is the primary potential receiving water for any discharges from the existing and proposed ash placement areas, which can in turn influence the quality of water feeding into the Coxs River. Overall, the Neubecks Creek monitoring results indicate that:

- Electrical conductivity can be elevated at all sites, although immediately downstream of the existing ash Area 1 it falls within guidelines;
- Chloride ion levels are consistently low where measured;
- Metal concentrations are often below criteria, but are shown to be elevated in Neubecks Creek immediately downstream of the existing ash area (particularly silver, arsenic, cadmium, chromium, copper and zinc), at the site upstream of the existing ash area (silver and aluminium) and at downstream sites associated with the existing mine operations (manganese and zinc). The increased manganese and zinc indicated that the flow in Neubecks Creek was dominated by groundwater inflows during the dry weather rather than catchment runoff. The local groundwater is elevated in these metals due to the acid sulphate conditions in the local underground mine waters.

### 7.5.4. Conclusion

There exists sufficient data from the on-going monitoring and the modelling studies undertaken (described above) to show that the main contribution to elevated water quality parameters in

Neubecks Creek is due to past, underground coal mining activities rather than the existing ash placement works at Area 1 or the operation of Mt Piper Power Station. The Council Waste Management Facility site has yet to begin operation so there is no suggestion of any existing cumulative impact from it.

The management of works at the existing Area 1 is appropriate to minimise the risk of a discharge from the construction and operation of the active ash placement areas. A continuation of these practices in the Lamberts North and Lamberts South areas, as well as similar practices at the Neubecks Creek and Ivanhoe No 4 sites would be enough to ensure that ash placement has limited if any effects on the water quality of Neubecks Creek.

The sections below discuss the mitigation measures necessary to minimise the risks.

## 7.6. Operational Mitigation and Monitoring

### 7.6.1. Site Surface Water

#### Mitigation

As the proposed ash placement facilities would have the potential to affect the water quality of Neubecks Creek and consequently the Coxs River, the system would be designed to manage the ash and sediment contaminated water from the site and minimise the risk of affecting the off-site water quality. This would be done by:

- Separating clean water from undisturbed catchments using catch drains and directing this clean water directly to waterways;
- Managing the water generated in the exposed ash areas to a Dirty Water Area (dams) and designing these dams to provide for no releases from these sites. This water will evaporate and/ or be used for dust suppression and rehabilitation sites;
- Reusing the water generated from capped and rehabilitated areas to satisfy the demands for rehabilitation and dust suppression. This will be done on site by use of sediment dams and water storages for runoff containing sediment laden water. The sedimentation dams will be designed to release water in large rainfall events after the water has been treated through the dams. Once the rehabilitation is established, the runoff would be allowed to return to the waterway without the need for any dams.

The management of potential for water runoff during ash placement would involve:

- Placement of ash in layers, with steps to produce a batter slope and bunds at batter extents to prevent discharge of water over the benches and down batter slopes to minimise scour and erosion; and

- Drainage of surface water runoff from permanent batters to flow along benches and/or formalised channels. It would be typically directed to the centre of the ash placement area and into dirty water storage areas.

### Monitoring

The adequacy of the structures to control water quality runoff will be monitored. This would include water quality testing of sedimentation dams and water storages to ensure any discharge is appropriate for release to the receiving waterways. The information from this monitoring would also provide advice as to when water from rehabilitated areas will be able to runoff directly to the environment, rather than through a sedimentation dam.

## 7.6.2. Groundwater

### Mitigation

The management of groundwater quality would be achieved by appropriate design and operation of the ash placement facilities. This would include:

- Regrading and profiling of storage areas to provide a base area above groundwater for the placement of ash materials;
- Placement of brine treated ash at defined heights above groundwater levels to minimise risk of seepage into the groundwater table;
- At Huons Gully the placement of a subsurface drainage at the gully invert to provide a discharge area for groundwater seepage from Area 1 as well as ground water movement from upstream in Huons Gully.

### Monitoring

The development consent of 1 April 1982 for the Mt Piper Power Station ash placement was modified in April 2000 to allow for brine conditioned ash placement at the site. The 2000 consent requested the preparation of a Water Monitoring Program which would include groundwater quality testing in monitoring bores on or in the vicinity of the Area 1 site. The most recent update to the plan is provided in Aurecon (2008). The results of this testing are reported in an annual Environmental Monitoring Report, the most recent being Aurecon (2009).

A bore hole monitoring program would be required for each new ash placement site. At Lamberts Gully the present two observation wells in Lamberts South, even supplemented by those installed in the NW corner of Lamberts North, are not sufficient for a groundwater monitoring network. They do, however, give preliminary information on the hydrogeological conditions in the project area and provide a basis for planning a future monitoring network. Further well installation would need to be delayed until after the mining activities cease, and until detailed planning for the ash storage areas is further advanced.

The information to be collected from any new bore holes established would include water levels, seasonal fluctuations and water quality test results. The water quality parameters would include pH, conductivity, ions (especially chloride) and trace metals. As with the previous consent for ash placement, the data from the monitoring sites would be reported in an annual Environmental Monitoring Report.

The annual Environmental Monitoring Report will include available results and analyses from the borehole monitoring and actions taken or intended to be taken, if any, to mitigate any adverse environmental impacts.

### 7.6.3. Off-site Surface Water

#### Management

Neubecks Creek is the primary potential receiving water for any discharges from the existing and proposed ash placement areas, which can in turn influence the quality of water feeding into the Coxs River. Overall, monitoring results from the four in-stream sites (at Mt Piper licensed discharge point and 3 sites downstream of the existing ash Area 1) indicate that the identified exceedances of water quality criteria within the receiving waters may be due to varied activities within the catchment, in particular disused mining works. The occasional elevated conductivity and trace metal results cannot be attributed to the existing ash Area 1.

The means of managing water runoff were described above and the maintenance of those processes is important to ensure that ash storage areas do not contribute to any water quality impacts within Neubecks Creek.

#### Monitoring

A monitoring plan would be developed for the project. The intent will be to identify sufficient sites in Neubecks Creek to:

- Provide background data showing the existing water quality impacts from the Neubecks Creek and Ivanhoe No 4 sites;
- Allow the possibility of separating out potential impacts from the Lamberts North and Lamberts South sites from the existing Area 1 site.

As noted above the development consent for the Mt Piper Power Station ash placement was modified in April 2000 to allow for brine conditioned ash placement at the site. The consent requested the preparation of a Water Monitoring Program which would include water quality testing in receiving waters (Aurecon, 2008). The results of this testing are reported in an annual Environmental Monitoring Report (see Aurecon, 2009).

Water quality monitoring would be based on existing monitoring undertaken in Neubecks Creek so that results between sites are comparable. Currently this involves monthly monitoring by Delta

Electricity in Neubecks Creek at the licensed discharge point LDP01 and at site WX22 approximately 400m upstream of Blackmans Flat. Other sites in Neubecks Creek would be selected that are representative of the proposed areas of work and that may identify any proposed impacts from the sites. Monitoring sites would take into consideration groundwater monitoring to ensure the source of any water quality issues may be identified ie groundwater seepage or surface runoff.

Water quality monitoring should consider the ANZECC/ARMCANZ (2000) guidelines and monitoring results should be compared against recommended trigger values for protection of upland river aquatic ecosystems. The recommended water quality monitoring parameters have been devised based on the likely pollutants of concern during the construction and operating stages of Lamberts North and Lamberts South. These parameters include:

- In situ**:** pH, electrical conductivity, total dissolved solids, alkalinity and turbidity;
- Total anions and cations: chloride, fluoride, sulphate, sodium, calcium, magnesium and potassium
- Trace elements/metals: Aluminium, arsenic, silver, barium, boron cadmium, chromium, copper, iron, mercury, manganese, lead, selenium, silica and zinc.

Concentrations would be in accordance with the ANZECC/ARMCANZ (2000) guidelines for protection of aquatic ecosystems.

The results from the monitoring would be reported in the annual Environmental Monitoring Report which will include all available results and analyses from the in-stream monitoring and actions taken or intended to be taken, if any, to mitigate any adverse environmental impacts.

### Cumulative Impacts

As forestry, mining and power generation have been the dominant land use practices for many years these practices have contributed to the existing water quality of surrounding creeks.

To assess the relative contributions from various sources to receiving water contribution, sampling design should consider a means by which various inputs can be separately identified. This would require an integrated sampling program to identify contribution from surface drainage from around and on the ash placement facility, ash placement seepage or leachate to groundwater, existing underground coal mine groundwater contribution, contribution from mine sites directly associated with Neubecks Creek and Ivanhoe No 4, contribution from Delta's existing licensed discharge and, should it proceed, from Mt Piper Extension. Cooperation would also benefit from any monitoring program required from Council's waste management site.

It is important that appropriate mitigation measures and a comprehensive monitoring and control program to identify water quality issues and sources of pollution be continued and expanded to enable assessment of any cumulative effects on surface water quality.

## 7.7. Construction Mitigation and Monitoring

### 7.7.1. Construction Impacts

There are a number of construction phase activities for the preparation of areas for ash storage which include:

- Clearing and grubbing. Areas for ash placement will be cleared of any vegetation and unsuitable founding materials;
- Re-grading/re-profiling of sites to control seepage and maintain uniform drainage;
- Earthworks and fill construction involving the construction of soil banks, filling of areas and spreading and compaction to achieved desired levels;
- Temporary rehabilitation and stockpile remediation of areas previously disturbed by mining activities to control surface flow and erosion. This may involve construction of sedimentation ponds, surface water diversion and revegetation of disturbed areas;
- Construction access and haul roads will be progressively created as ash placement continues;
- Construction of surface drainage works and sub-surface drainage which may include retention basins, sediment and erosion control measures, capping and re-vegetation of areas;
- Construction of rock drainage blanket in Huon Gully.

These construction activities may affect the water quality of Neubecks Creek in the following ways:

- The potential to generate sediments and pollutants such as nutrients to local waterways as the soil in cleared areas becomes exposed and the likelihood of erosion is increased;
- Increased vehicle movements in the area in and out of construction sites, increase the likelihood for hydrocarbons and chemicals to enter the surrounding waterways as a result of spills and leakages from construction vehicles;
- General litter and gross pollutants from construction materials;
- Contaminants such as nutrients, metals and other potential toxicants that attach to the sediment particles can be transferred to waterways if appropriate sediment and erosion control measures are not in place or working effectively.

As such the potential impacts to surface water quality of Neubecks Creek as a result of construction phase activities for the preparation for ash storage include:

- Increased salinity;
- Increased turbidity and sedimentation;
- Increased nutrients and risk of eutrophication;
- Increased metal concentrations which could be toxic to aquatic organisms.

All construction work would be undertaken so as to minimise environmental disturbance and mitigate risks associated with such construction activities.

### 7.7.2. Construction Environmental Safeguards

To reduce potential water quality impacts of the site during construction, general measures to control erosion of soil and sedimentation would be implemented prior to construction works. Such measures would be documented in a Construction Phase Soil and Water Management Plan (SWMP) prepared in accordance with the principles and practices in *Soil and Construction, Managing Urban Stormwater Handbook* (Landcom 2004).

More specifically, environmental safeguards will include:

- Vehicles to travel on designated access roads;
- Management of runoff to waterways and ensure additional impacts on groundwater and surface water quality do not occur;
- Regular site maintenance to be undertaken to ensure frequent dust suppression so that pollution of waterways does not occur;
- Ensuring that chemicals and fuels are appropriately stored and bunded;
- Installing erosion and sediment controls such as sediment basins and sediment fences;
- Ensuring construction workers/staff understand and maintain sediment and erosion control measures;
- Preparation and implementation of revegetation and rehabilitation plans for sites once ash is placed and the site capped.

The in-stream monitoring described above should be undertaken during construction to determine if sediment and erosion control measures and surface water diversion techniques are working effectively.