8.1 Introduction

This Chapter describes the geology, soils, and groundwater of the proposed AWT and Composting Facility site and its vicinity. It also provides an assessment of the potential impacts of the proposed development on geology, soils and groundwater quality.

8.2 Geology and Soils

8.2.1 Regional

The Woy Woy Waste Management facility (WMF) is located within a gully that runs south to north. The general geology of the region has been interpreted based on a 1:500 000 scale geological map of the Sydney Basin prepared by the Geological Survey of New South Wales, Division of Regional Geology 1967. Based on this mapping and associated review, the WMF site is underlain by Hawkesbury Sandstone. Typically this formation comprises multi-coloured sandstone, quartzose sandstone, with some shale and mudstone interbedded.

The Groundwater Monitoring Review prepared by GHD (2006) describes soils at the site in reference to the Sydney 1:100,000 Soil Landscapes Sheet. A number of soil landscapes occur at the WMF, primarily the Hornsby, Hawkesbury, Lambert and Watagan. These Landscapes have been described by Chapman and Murphy (1989).

The Hornsby soil landscape which occurs at the floor of the gully is characterised by sandy loam and weathered volcanic breccia clay overlaying volcanic breccia bedrock. The side slopes of the gully are Hawkesbury and Lambert soil landscapes, which are characterised by medium to coarse grained Hawkesbury Sandstone with minor shale and laminate lenses. Shallow layers of loose quartz sand, sandy clay loam and weathered sandstone overlay the sandstone bedrock. The saddle feature near the southern end of the site can be most likely attributed to the sandstone bedrock associated with the Lambert soil landscape, which tends to outcrop as wide benches of length 10 -100m. At the northern end of the site, interbedded quartz sandstone and laminate and shale associated with the Watagan soil landscapes begins to slope down towards Brisbane Water.

8.2.2 Development Area

Five groundwater monitoring wells are currently located within the Woy Woy WMF site, as shown on **Figure 8-1**. Three of these monitoring wells are located within the proposed development area, namely WW3, WW6 and WW 7. Based on the drilling investigations carried out when the wells were installed in 1997 the following geological characteristics were identified:

- gravelly sand, typically medium to coarse grained sand, brown with some iron staining, typically encountered at 0.5m (WW6) above bedrock;
- fresh bedrock, Hawkesbury Sandstone, fine to medium grained, light grey with some iron staining, medium to high strength (at depth), slightly weathered, thinly laminated. Fresh bedrock was encountered at depths varying from 0.5 to 3.3 m;
- shale, typically fine grained, light grey, lightly foliated, low strength, highly weathered was also encountered within the sandstone layers at 5.4 m (WW6); and

- structural joint planes were logged in all core logged, however, in general, the bedrock obtained from subsurface investigations can be classed as medium to high strength.

Existing Soil Contamination

The area proposed for construction of the platform for the AWT and Composting Facilities has historically been used as a quarry. Based on surface site inspections and discussions with Council it appears unlikely that any burial of nightsoil or solid waste was carried out in the proposed development area. According to Council, only natural excavated soil was buried in this area when the site was used as a quarry. Investigations carried out during installation of the monitoring wells have shown no evidence of underlying soil contamination, however it is noted that the main objective of these studies was not to investigate soil contamination. Based on the above it is considered unlikely that any area underlying the proposed development will be contaminated with hazardous materials or substances.

8.2.3 Impacts on Geology and Soil

In general the geology underlying the proposed AWT and Composting Facility platform consists of Hawkesbury Sandstone of medium to high strength and is therefore considered suitable for the proposed development. Further geotechnical investigations will be carried out prior to construction of the facility to confirm the properties of the underlying soil and to ensure they are suitable for construction of the engineered platform.

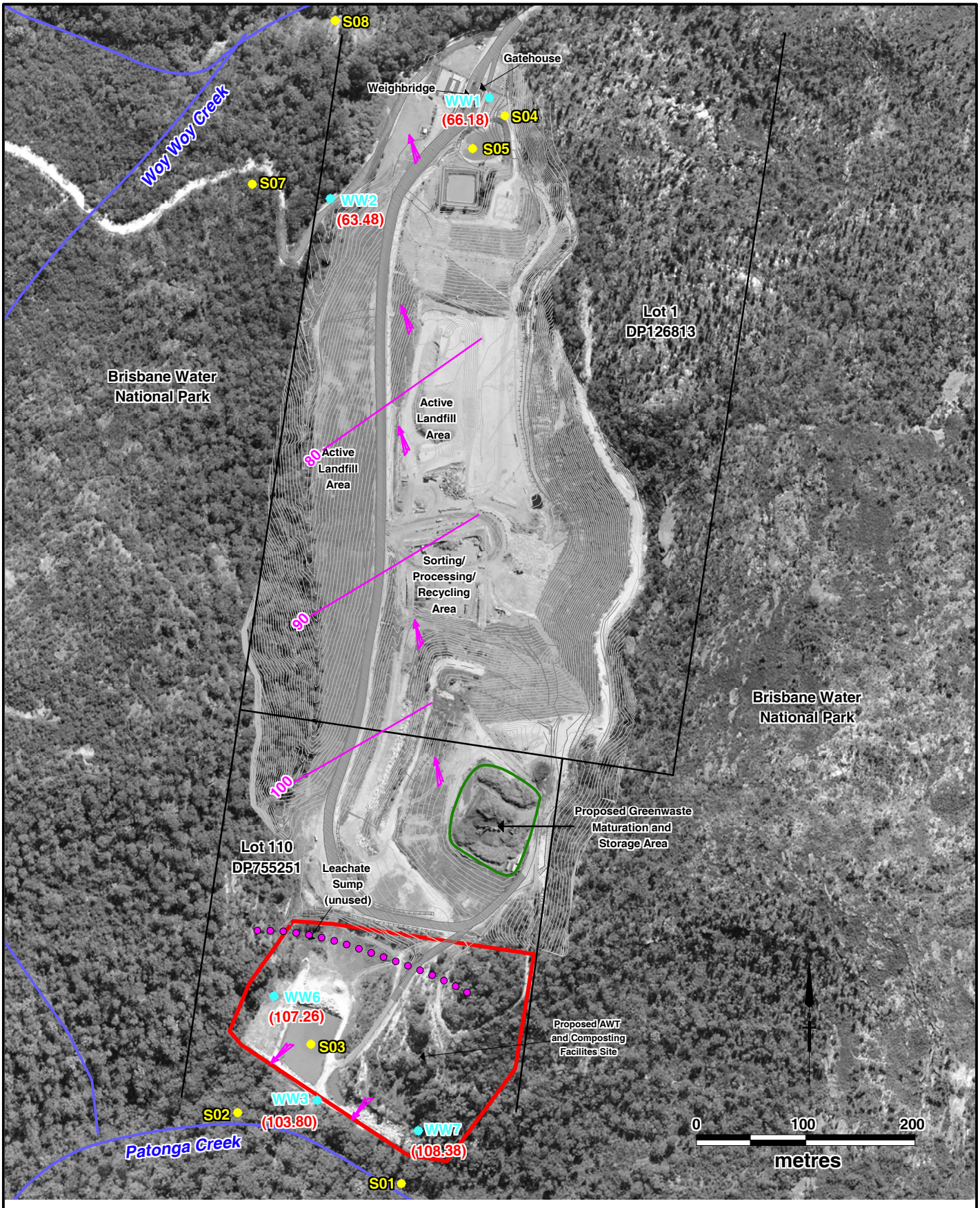
Construction of the platform for the proposed AWT and Composting Facilities will require excavation of the eastern section of the development area, and filling of the western section. This work will require the clearing of existing vegetation and soils, which has the potential to cause erosion to occur during rainfall events and loss of topsoil material. As described in Chapter 22, mitigation measures including stockpiling of topsoil for rehabilitation works, use of silt fences and early installation of temporary and permanent stormwater diversion structures, will minimise the impact on soils.

8.3 Hydrogeology

8.3.1 Existing Hydrogeological Conditions

Groundwater generally occurs within the Hawkesbury Sandstone at depths of up to about 10m. **Figure 8.1** displays the groundwater contours for the site based on water level monitoring in November 1998. In general, the contours show the existence of a northerly hydraulic gradient across the majority of the site towards Woy Woy Creek. However, a groundwater divide appears to exist at the saddle in the southern portion of the site, indicating that a minor component of groundwater flow also exists in a southerly direction towards Patonga Creek. Recent quarterly monitoring results (Golder, 2006) indicated groundwater depths ranging from 1.74 to 1.82m below ground level (BGL) in WW3, 0.05 to 0.70m BGL in WW6 and 2.49m to 4.72m BGL in WW7. Anecdotal evidence, based on observations by Council staff, indicate that the existing dam located within the footprint of the proposed AWT facility, may be recharged from groundwater underlying the site.

Permeability tests were performed on all monitoring wells during the 1998 investigations. Results from these tests indicate a generally low permeability, and are tabulated below:



Client	Project	Title
GOSFORD CITY COUNCIL	Environmental Assessment of Proposed Alternative Waste Technology and Composting Facilities at Woy Woy WMF	**WATER MONITORING LOCATIONS**
URS	Drawn: AJW | Approved: FINAL | Date: 21.08.06 Job No: **43177409** | File No: 43177409-023.wor	Figure: **8.1**

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Table 8-1 Permeability of Underlying Geology

Well (material)	WW1 sandstone	WW2 sandstone	WW3 sandstone	WW6 sandstone	WW7 sandstone
Characteristics	-	-	-	medium	low
K (m/s)	5.13e-08	1.2e-06	9.21e-08	3.64e-07	1.01e-07
K (m/day)	4.43e-03	1.04e-01	7.95e-03	3.14e-02	8.73e-03

Note: Characteristics indicates degree of weathering and joints within the screened area (low, medium and high).

The above results indicate a typically low permeability, however, monitoring well WW2 display medium permeability. During this investigation, the groundwater geochemistry was found to be slightly acidic with a high level of water oxygenation.

8.3.2 Existing Groundwater Usage

No groundwater extraction bores are located within the Woy Woy WMF site. A search of the Department of Natural Resources database revealed no licensed groundwater bores within a 500m radius of the proposed development area.

8.3.3 Groundwater Quality

In 2006, GHD undertook a review of the groundwater monitoring program and background groundwater quality for the landfill at the Woy Woy WMF.

Groundwater quality data was compared to accepted water quality criteria for groundwater, including the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000). These Guidelines are endorsed by the NSW EPA under s105 of the Contaminated Land Management Act (1997).

The results show a similarity between groundwater at WW2, WW3, WW6, WW7 and WW8, suggesting that the groundwater at these locations is from similar origin. GHD (2006a) found that sodium is the major cation and chloride is the dominant anion for groundwater at these locations. The Groundwater Monitoring Report by GHD (2006a) stated:

Based on groundwater data and other information available, it appears that there have been minimal landfill leachate impacts on groundwater around the perimeter of the landfilled area. Hence, the groundwater to date at WW2, WW3, WW6, WW7 and WW8 are of similar origin and can be considered to be representative of background (uncontaminated) groundwater at the site.

The groundwater at WW1 and WW4 exhibited some similarity to the landfill leachate water – based on analysis of major cations and anions – these locations were considered not to be representative of background groundwater.

The Groundwater Monitoring Report by GHD (2006a) found the following results:

- *pH* – Groundwater fields were generally acidic at WW1, WW2,WW3 and WW4 (mean pH 6) and moderately acidic at WW6, WW7 and WW8 (mean pH 4-5). These pHs are typical of the soil landscapes at the site (pH 4.5-5.8) as reported by Murphy (1993).

- *Redox Potential* – Mean redox potential readings taken form the site suggest that a more oxidising environment exists at WW6,WW7 and WW8 as compared to other wells. The most reducing environment is at WW4.
- *Ammonia* – Concentrations were almost consistently reported below the nominated fresh water and marine trigger values for all groundwater monitoring locations.
- *Reactive phosphorus* – Concentrations were reported be above the nominated fresh water and marine trigger values for less than 30% of sampling rounds at all locations.

8.3.4 Impacts on Hydrogeology

The proposed platform for the AWT and Composting Facilities will be constructed at a final level of approximately 115m AHD, well above the groundwater depth encountered in monitoring bores WW7, WW3 and WW6. Therefore the excavation works required in the eastern section of the proposed development area are unlikely to encounter groundwater. The filling of the western section of the proposed development area, where the dam is currently located, may encounter the shallow groundwater table. Therefore mitigation measures will need to be designed and installed during construction and operation of the proposed facilities to ensure that groundwater impacts are minimised. These measures, as summarised in Chapter 22, would include:

- Cut of drains to collect and redirect groundwater around the proposed construction areas; and
- Subsoil drains to collect and transport groundwater through the proposed platform area during operation.

Details of these mitigation measures will be provided in the Construction and Operational Environmental Management Plans to be prepared prior to construction of the works.