

Veolia Environmental Services (Australia) Pty Ltd.

Re: EPL– Annual Assessment of Woodlawn Bioreactor & Intermodal Facility Monitoring Data.

Report – 17 December 2008.

(Ref: E2W-083 R001)

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Client: Veolia Environmental Services (Australia) Pty Ltd

**Project: EPL - Annual Assessment of
Woodlawn Bioreactor and Intermodal Facility Monitoring Data**

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1.0 INTRODUCTION

Earth2Water Pty Ltd (E2W) was engaged by Veolia Environmental Services Pty Ltd (Veolia) to review and assess the annual monitoring data for the Woodlawn Bioreactor and Intermodal Facility sites in association with Environmental Protection Licence (EPL) requirements.

Veolia operates the Woodlawn Bioreactor site (WB) under EPL 11436, while the Intermodal Facility (IMF) falls under EPL 11455. These EPLs are dealt with in combination in this report, which marks the second annual monitoring report for the WB and IMF EPLs.

The site occupies approximately 3,000 hectares and also encompasses the Woodlawn Mine Lease, which is governed by SML20 (Figures 1 and 2).

This EPL report provides a review and assessment of the dust, air, surface and groundwater monitoring data obtained from Veolia's Bioreactor and Intermodal Facility for the 2007 to 2008 reporting period (i.e. 6 September 2007 to 5 September 2008). The report includes historic and recent monitoring data, conceptual models, data assessment, conclusions and where required, recommendations to improve future monitoring.

During the reporting period, which commenced on the 6th September 2007, the Woodlawn Bioreactor licence and associated monitoring requirements varied due to a change implemented by the NSW Department of Environment and Climate Change (DECC) in February 2008. These changes meant that half the monitoring was conducted under the old licence conditions and the later half of the year were conducted under the new conditions. Veolia has confirmed that an apparent non-compliance has been made based on that the site had been operating under two licence conditions, and an explanation of this can be found in Appendices C and L.

2.0 BACKGROUND

The NSW Department of Environment and Climate Change (DECC) regulates numerous waste management and disposal facilities in NSW. The DECC issues licenses which both permit and regulate waste disposal activities. Licence conditions typically include requirements to monitor leachate quality, surface and groundwater quality in and around landfill sites.

This report aims to provide Veolia with an independent review of the monitoring data and results obtained to date (2004 to 2008).

E2W's scope of work included the review of available technical reports, historic and current monitoring data (dust, air and water), well monitoring networks, surface water storages, hydrogeology and any other relevant environmental information. This scope of work has enabled an assessment of the monitoring data from the Woodlawn Bioreactor and Intermodal Facility.

E2W recently provided Veolia with a comprehensive assessment of the site's water monitoring systems, entitled *Status of Water Monitoring Systems at the Woodlawn Bioreactor Site* (November, 2007). This report sub-divided the site into ten 'systems' or sub-sites to simplify the large and complex site (e.g. mine void, South, North and West Tailing Dams, Evaporation Dams 1, 2 and 3, Waste Rock Dump, Plant Area and Intermodal Facility) based on the unique landform features (Figure 1).

3.0 LANDFILL DESIGN, OPERATIONS AND HISTORY

The Woodlawn Mine was a typical large-scale open cut and underground mine operation. The mine infrastructure included the construction, operation and maintenance of the following:

- Waste Rock Dump (WRD)
- Tailings Dams
- On-site ore processing facilities (Plant Area)
- Evaporation Dams (ED1, 2 and 3)
- Underground operations
- Open-pit operations

The former mining components at Woodlawn still exist and are illustrated on Figures 1 and 2. A summary of the site history is outlined in Table 3.1.

The Woodlawn Bioreactor occupies the mine void (to 200 mbgl) and comprises approximately 25 million cubic metres of landfill space. Landfilling and gas collection commenced in late 2004.

Table 3.1 Milestones and History

Date	Event
1978	Woodlawn open cut mine activities commence.
22.12.1982 (aerial)	Plant Area and dams present. North and South Tailings are constructed and used for tailings/water storage. West Tailings Dam is under construction, together with the Waste Rock Dump. Plant Collection Dam/Lagoon is full of water - irregular area.
9.06.1987 (aerial)	North and South Tailings Dams full of water, tailings comprising ~20% of available area. ED1 under construction, with Waste Rock Dam being raised (several benches visible) and includes leachate sump. Dolerite stockpile is visible on west side of mine void. Bunding structure visible at Plant Collection Dam with minor water. Raw Water Dam has been constructed and is full of water. The ED3 area comprises a series of small dams.
1989	Expansion and development of plant infrastructure. Open cut mine workings reach ~ 200 m depth, underground mining commenced.
15.07.1989 (aerial)	ED1 construction complete and full of water. Construction of ED3 South is a work in progress. Dolerite stockpile is increasing in size. West Tailings Dam has been constructed and is full of water. Plant Collection Dam is full of water.
11.09.1990 (aerial)	West Tailings Dam is larger and full of water and tailings occupy approx. 10% of available area. ED2 has been constructed and now full of water. ED3 construction practically completed (dry). Plant Collection Dam is enlarged and full of water.
30.09.1991	Tailings in the North and South Tailings Dams cover approx. 50% of the available surface area. A new section is being added to the SW corner of the West Tailings Dam. Lower benches of Waste Rock Dam appear revegetated. ED3 North is being constructed and nearly completed (dry).

11.09.1994 (aerial)	ED3 North and South are complete and full of water. New SW addition to West Tailings Dam is complete and full of water. North Tailings Dam is subdivided in smaller cells on west side and through centre. ED2 has a defined internal bund on the NW corner (visible from 1990). Waste Rock Dump is being rehabilitated and revegetated. Water visible at the bottom of the mine void.
5.10.1995 (aerial)	Rehabilitation/revegetation of Waste Rock Dump is nearing completion.
11.11.1996 (aerial)	ED1 and 2 have high water levels. ED3 is also full.
March 1998	Administrators appointed to Denehurst Ltd.
17.09.2004 (aerial)	Water in ED1, 2 and 3 at low levels. Tailings in North, South and West Tailings Dams have consolidated.
October 1999	Commission of Inquiry - Woodlawn Waste Management Facility.
November 2000	Minister grants consent for Woodlawn.
February 2002	Revised EIS prepared.
August 2002	Minister grants Development Approval for Clyde Transfer Terminal.
February 2003	Land and Environment Court Hearing into Clyde Transfer Terminal.
September 2003	Construction of Bioreactor and Intermodal Facility complete.
December 2003	Clyde Waste Transfer Terminal (Special Provisions) Act (2003) passed by State Government.
Jan - June 2004	Construction of the Clyde Transfer Terminal.
October 2004	Wind Farm DA and EIS lodged.
September 2004	Landfill gas collection system installed at base of void. First waste load delivered to site.
February 2005	Mining operations plan (MOP) approved.
May 2005	Planning focus meeting held on the Alternative Waste Technology proposal.
June 2005	First stage of gas extraction system and flaring initiated.
October 2005	Wind Farm DA approved.
November 2005	Mixing of acid mine drainage and landfill leachate in the void sump, discharged to ED3 North and South.
January 2006	Construction of first power generator hub commenced.
April 2006	Environment, Safety and Quality accreditation gained.
August 2006	Power generator hub completed.
July 2007	Application for temporary storage of leachate in ED3 from void. Construction of segregated dams (ED3 lagoons) within ED3 for temporary storage. Bioreactor has received 970,000 tonnes of waste since commencement.
September 2007	Approximately 40 m of waste placed in landfill since commencement. (pit base from 200 to 160 m below perimeter). Leachate level of approximately 10 - 15 m below waste level.
November 2007	Comprehensive assessment of water monitoring programs submitted by E2W. AWT DA Approved. Gold medal - WMAA National Landfill Excellence Awards.
February 2008	Commissioning of first landfill gas generator - power generation commenced.
April 2008	Woodlawn Bioreactor Energy official opening.

Note: aerial = historical information sourced from an aerial photograph.

4.0 ENVIRONMENTAL SETTING

The environmental setting of the site including, topography, soils, hydrology, geology and hydrogeology are described in the following subsections.

The main site features and hydrogeology are also included in Figures 1, 2, 3A, 4 and 5.

4.1 Site Location

Woodlawn Mine is located ~7 km west of Tarago, approximately 8.5 km south-west of Lake Bathurst and around 7.5 km east of Lake George. Situated 250 km south-west of Sydney, the mine site is approximately midway between Goulburn and Canberra. The land is situated within the Mulwaree Local Government Area (Woodward-Clyde, February 1999).

The Woodlawn Mine is situated on a property formerly owned by Denehurst Pty Ltd, which has a land area of approximately 3,000 hectares. The property includes the mine void, waste rock dump, tailings dams, evaporation ponds, disused mining infrastructure and surrounding rural land and pine forest. The area surrounding the property is characterised by large rural holdings which are lightly timbered with stands of woodland. A sewerage treatment plant is located on Collector Road adjacent to the site.

The closest township to the mine site is Tarago. It is a small rural service centre consisting of a railway station, school, hotel, small commercial centre and a number of residences.

4.2 Climate

The long-term climatic data at Woodlawn indicates that evaporation exceeds rainfall on an annual basis. The total rainfall recorded between July 2007 and June 2008 was 520 mm; which is considerably lower than the 22 year average for the July to June period of 642.4 mm. The total rainfall for 2007 was 649.6 mm.

The average evaporation (17 year average) at the site is 1420 mm/year (AEMR, 2003). The evaporation rates significantly exceed annual rainfall, making evaporation processes very effective for onsite water management.

4.3 Topography

The natural ground surface surrounding the mine void lies at an elevation of approximately 800 m AHD, with the base elevation of the mine void at approximately 630 m AHD. The landfill site is situated on a ridge which forms part of the Great Dividing Range (GDR). The topography of the surrounding area comprises rounded hills that rise up to approximately 1,000 m AHD, particularly to the north and south of the landfill site (Figures 1 and 3A).

The Woodlawn Mine property lies at the head of the Allianoyonyiga and Crisps Creek catchments. Allianoyonyiga Creek is upstream of the Lake George catchment, while Crisps Creek connects to the Mulwaree River.

4.4 The Landfill/Void Area

The Bioreactor lies within the former Woodlawn Mine site and is located ~500 m south of Collector Road on top of a ridge line which forms part of the Great Dividing Range (Figure 1).

The landfill site occupies an area of approximately 38 ha of Woodlawn's 3,000 ha. The landfill site comprises the open cut mine void, the access road into the site and an area to the north-east

of the void where the associated site facilities (i.e. weighbridge and site office) are located. A waste rock dump and a number of tailings dams are located to the south and south-east of the landfill site. Hickory's Paddock lies to the east and disused mine facilities are located to the north-east. Evaporation ponds are located to the north-west of the landfill site (Figure 1).

The open cut mine void, where landfilling has commenced, has an approximate volume of 25 million cubic metres and a depth of ~200 m. The void consists of several benches, a haul road and sediment ponds. The base of the void contains highly acidic sulphate-rich water.

The base of the void is at approximately 630 m relative to the Australian Height Datum (AHD), while the lowest point of the void rim is around 800 m AHD (Woodward-Clyde, February 1999).

4.5 Geology and Hydrogeology

The hydrogeology of the site is dominated by the hard rock geology and mine/landfill activities. The regional groundwater flow regime has been altered by the mine void, which induces large inward hydraulic gradients. The various water storages (i.e. Tailings and Evaporation Dams) also influence the flow regime by recharging and mounding the water table.

The inferred groundwater flow regime for the site is presented in Figure 1. The geology and hydrogeology is presented in Figures 1, 4 and 5.

The regional geological setting comprises volcanic rocks which form part of the Lachlan Fold Belt of south-eastern NSW. The geological sequence of the site itself includes Ordovician and Siluro-Devonian lithified volcanogenics, volcanoclastics, as well as sedimentary shales and sandstones. These units are regionally faulted and jointed with a synclinal-anticlinal fold pattern, which results in a significant lack of continuity in the horizontal plane (URS, November 2004).

The hydrogeology of the mine void and surrounding area is largely dominated by volcanic rocks within which the mineralised zone occurs. The rock mass is generally of low permeability but fractures and joints, where interconnected, create minor storage areas and some secondary permeability. These provide a modest water supply to horizontal drains drilled around the mine void and some exploration drill holes. Pre-mining regional groundwater gradients were not established, but investigations show the regional water table to be a subdued reflection of surface topography with gradients away from the GDR towards Crisps Creek and Lake George (Woodward-Clyde, February 1999).

The basement rocks generally exhibit low hydraulic conductivity. Rock permeability is due almost entirely to fractures. The low bedrock surrounding the mine void exhibits low bulk permeability due to the action of metamorphism and hydrothermal fluids, which have sealed the primary porosity of the bedrock. It has been observed that seepages from the base of the open cut primarily occur through two fault/fracture zones (the 690 etc.) located on opposite ends of the pit. Seepage is also known to occur via old exploration drill holes and horizontal drain holes, which were designed to relieve hydraulic pressures from the pit walls.

Secondary permeability potentially exists where the rocks have been sheared by faulting, or where the rock exhibits cooling fractures (dolerites). However, the secondary porosity has been

largely sealed by clays formed during the weathering of mineral compounds in the basement rocks.

Aquifer tests have been carried out in selected horizontal bores, piezometers and monitoring bores within the void and surrounding area to determine the permeability and transmissivity of the bedrock. The results indicate low to extremely low values of transmissivity, with some of the monitoring bores taking a week or more to fully recover after purging of a single bore volume (Woodward-Clyde, February 1999).

Despite the fact that the mine void is over 180 m deep and extends for at least 160 m below the natural water table, the total groundwater inflow into the mine void is approximately 1 - 2 L/sec. The main seepage locations are shown in Figure 1, together with the location of the fault zones through the void (i.e. 760 and 750/790).

The inferred directions of groundwater flow in the bedrock aquifer are presented in Figure 1. Dewatering associated with mining operations has created a steep cone of depression in the void area (Woodward-Clyde, February 1999). The steep hydraulic gradients into the void are indicative of the impervious bedrock and slow seepage velocities into it (Figure 5).

Overlying the basement fractured rock aquifer on some hill-sides, are recent deposits of hillwash (colluvium) sediments, which grade laterally into alluvial sediments in the valleys. This alluvial aquifer may form a conduit through which groundwater discharges to the downstream environment.

Figure 1 shows the inferred direction of groundwater flow within the alluvial aquifer in the Crisps and Allianoyonyiga Creek catchments, based on the surface water flow system. The approximate extent of the alluvial aquifer is also presented in Figure 1.

The sedimentary deposits show highly variable permeability and generally have confined conditions at the head of the catchment. Down catchment the aquifer becomes unconfined, with discharge to the creek surface water system and boggy areas adjacent to the streams. Relatively high permeability aquifers exist where sediments occur in valley bases, and to a lesser degree, on the slopes.

Figure 4 provides a schematic view of the aquifer units present at the site. At present, the void acts as a hydraulic trap due to the steep inward hydraulic gradients (Figure 5). As the void is filled with waste, there will be a reduction to the steepness of the inward hydraulic gradients. Once the waste produces a mound, the 'void' will no longer be a hydraulic trap and gradients no longer inward.

4.6 Groundwater Recharge and Discharge Areas

Groundwater recharge to the bedrock primarily occurs through direct rainfall infiltration to open fractures and joints in areas where bedrock is exposed at the ground surface. Enhanced recharge has been observed immediately south of the mine void (adjacent to the waste rock dump) and seeps after rainfall in the southern portal (Woodward-Clyde, February 1999).

Evidence of recharge in the void is illustrated with groundwater level changes in existing piezometers located on the batters and perimeter of the void. Several piezometers (i.e. 44A and

110A) are potentially located on a fault zone and show moderate fluctuations (~10 m) during rainfall recharge. These piezometers are also in proximity to seepage locations (Figure 1, Appendix D).

The low bulk permeability of the bedrock in the mine area means significant groundwater discharge will only occur where open fracture conduits exist and permeability is sufficient to produce a significant flow rate in the context of local catchment vegetation and hydrology.

E2W interpret that Crisps Creek (one of two primary receptors) is ephemeral and generally a losing stream (in text Figure 4.6 b) during dry seasons. The stream would revert to a gaining stream (in text Figure 4.6 a) during wet seasons. The type of creek system will determine the discharge regime, fate and transport of groundwater pollution.

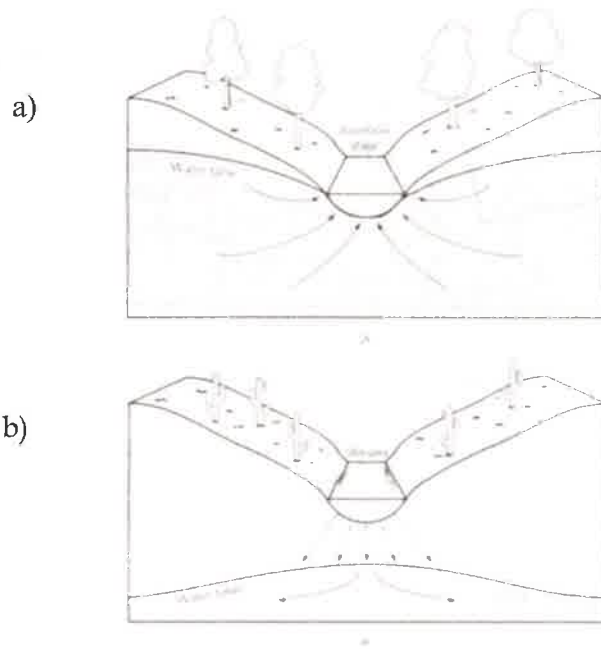


Figure 4.6: Gaining and losing streams typically associated with wet and dry seasons, respectively.

4.7 Hydrology

Allianoyonyiga and Crisps Creek are considered to be the primary receptors for discharges occurring from the Woodlawn site. The Great Dividing Range (GDR) bisects the void and diverts flows to south (via Allianoyonyiga Creek) to Lake George catchment and north (via Crisps Creek) to Wollondilly catchment (Figure 1 and in text Figure 4.7).