Section 4
Assessment and Management of Key Environmental Issues

PREAMBLE

This section describes the specific environmental features of the Project Site and its surrounds that would or may be affected by the proposed Project. Information on existing conditions, proposed safeguards and controls and potential impacts the Project may have after implementation of these measures is presented for those issues identified in Section 3 as being of greatest significance.

Where appropriate, proposed monitoring programs are also described.

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4.1 BACKGROUND INFORMATION

4.1.1 The Existing Site

Figure 4.1 displays the existing layout of the Project Site, based on an aerial photograph taken on 4 August 2007. The principal features of the existing site are as follows.

- The Project Site is largely disturbed with only 8ha of the 60ha relatively undisturbed, ie. principally around the perimeter of the Project Site.
- A series of bund walls varying in height from 5m to 19m and totalling approximately 1 900m in length are located around the perimeter of the Project Site.
- Two principal extraction areas are located on site, namely the northwestern clay/shale extraction area and the southwestern clay extraction area.
- Five dams are currently located on the Project Site.
  - Dam 1: A 30ML dam constructed principally to store water pumped for a nearby groundwater bore.
  - Dam 2: A sediment retention dam adjacent to the northwestern extraction area – used principally as a stilling basin for water pumped from the sump in the northwestern extraction area before being discharged to Blaxland Creek.
  - Dam 3: A former farm dam now used as a sediment retention dam adjacent to the northern boundary of the Project Site. This dam previously received runoff from the clay/shale stockpile area discharged via a pipe beneath the northeastern bund wall.
  - Dam 4: A water storage dam for containment of water from the clay/shale stockpile area and overflow from Dam 5. This dam is also used for dosing/flocculating water pumped from the sump in the northwestern extraction area.
  - Dam 5: A water storage dam collecting runoff from the southwestern extraction area. This dam overflows via a channel to Dam 4.
- The site infrastructure remaining on site from the previous owners includes a site office, weighbridge (x2) and equipment compound.
- Various stockpiles of clay/shale products.
- The Project Site is fenced with a standard rural fence and has a locked gate.

Since the Proponent purchased the Project Site on 19 August 2008, the site has been managed on a care-and-maintenance basis. The principal maintenance activities have centred upon upgrading on-site drainage structures to better manage the surface water and to progressively de-water the northwestern extraction area.

Base Photo Source: Geo-spectrum (Australia) Pty Ltd - Date of Photo: 4 August 2007

Figure 4.1
EXISTING SITE

4.1.2 Topography

Regionally, the Project Site is located approximately 10.8km east of the Nepean River, which marks the eastern extent of the foothills of the Great Dividing Range and the beginning of the gently undulating topography that characterises the western Sydney Basin. Between the Project Site and the steep slopes of the Nepean Gorge (maximum 243m AHD, approximate slope 1:1.7 (V:H), elevations range from 25m AHD to 60m AHD, with slopes of approximately 1:23 (V:H) or less. To the north, east and south of the Project Site, the topography is similarly flat to gently undulating. The highest point in close proximity to the Project Site is 92m AHD, 4.2km to the southwest. **Figure 4.2** displays the topography surrounding the Project Site.

Within the Project Site itself, the existing topography displays a general grade from southeast to northwest for almost 80% of the Project Site (50m AHD to 35m AHD), with slopes of 1:10 (V:H) in the vicinity of Blaxland Creek. The remaining 20% of the site drains to the southeast with slopes ranging from 1:8 (V:H) to 1:20 (V:H).

Since commencement of clay/shale extraction on the Project Site in 1981, the natural topography has been substantially modified. Contours on the Project Site are superimposed in **Figure 4.1**.

Elevations range from 65m AHD at the top of the southern bund wall to approximately 17m AHD at the base of the northwestern clay/shale extraction area. The maximum slopes occur on the batter slopes of the perimeter bund walls. These slopes typically vary from 24º to 38º.

The eastern and northeastern bund walls vary in height from 50m AHD to 58m AHD in an area where the ground level is approximately 40m AHD to 45m AHD and the clay/shale stockpiles are between 5m and 10m high. The southwestern bund wall is the highest bund wall on site, reaching 19m in the southwestern corner of the Project Site. The void within the northwestern extraction area within the Project Site (in Cell 1) is up to 24m below the natural ground level.

4.1.3 Meteorology

4.1.3.1 Source of Data

Climatic data collected over a 39 year period are available from the Bureau of Meteorology monitoring station located at Orchard Hills Treatment Works (The Chase – Station Number 067084), approximately 3.6km west of the Project Site. Evaporation data was drawn from records collected at Badgerys Creek, 7.9km south of the Project Site.

Table 4.1 presents temperature and rainfall data collected at Orchard Hills Treatment Works. The temperature data covers a period of 19 years between 1970 and 1989 and the rainfall data covers a period of 39 years between 1970 and 2009. Temperature data is presented as monthly averages of 9:00am and 3:00pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data comprise mean and median monthly rainfall and the average number of raindays per month.

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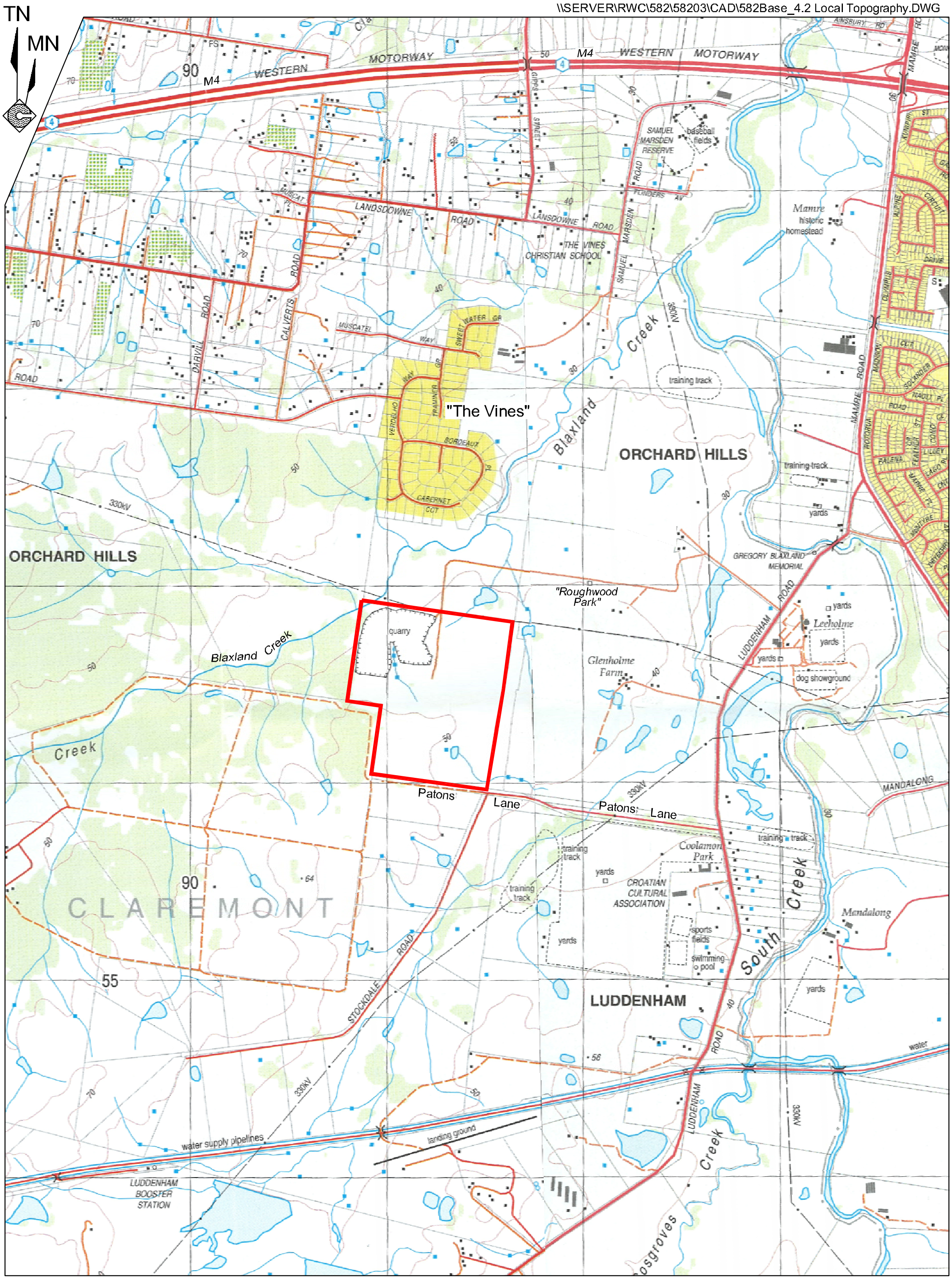

REFERENCE
Project Site Boundary

SCALE 1:30 000

500 0 500 1000 1500 m

Base Map Source: Prospect (2001) and Penrith (2001) 1:25 000 Topographic Maps

Figure 4.2
LOCAL TOPOGRAPHY

Table 4.1
Temperature, Humidity and Rainfall Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9am Mean Temperature (ºC) – Orchard Hills Treatment Works (The Chase)													
Mean	21.1	20.8	20.2	17.4	13.7	10.4	9.5	11.1	14.7	17.5	18.8	20.9	16.3
3pm Mean Temperature (°C) - Orchard Hills Treatment Works (The Chase)													
Mean	26.8	26.3	25.2	22.5	19.2	16.3	16.0	17.8	20.3	22.1	24.4	26.9	22.0
Daily Maximum Temperature (°C) - Orchard Hills Treatment Works (The Chase)													
Mean	28.3	27.8	26.5	23.8	20.4	17.3	17.2	18.9	21.8	23.9	25.8	28.5	23.4
Daily Minimum Temperature (°C) - Orchard Hills Treatment Works (The Chase)													
Mean	16.9	17.4	16.0	13.0	9.6	7.0	5.3	5.9	8.7	11.1	13.2	15.5	11.6
Rainfall (mm) - Orchard Hills Treatment Works (The Chase)													
Monthly mean -mm	103.6	110.6	90.2	65.7	65.4	51.4	38.3	40.7	38.1	59.0	78.2	70.9	812.8
Median -mm	96.0	99.2	72.9	43.0	46.6	31.8	21.0	17.0	31.9	44.2	61.9	50.0	743.5
Mean -days	8.4	8.7	7.8	6.1	5.9	4.8	4.4	3.8	5.2	6.8	7.8	7.0	76.7
Evaporation (mm) – Badgerys Creek McMasters F. Stn													
Mean monthly -mm	213.9	162	132	99	65.1	51	58.9	89.9	120	142.6	168	195	124.8
Orchard Hills Station number: 067084 Commenced 1970; Last record 2009; Elevation: 93m; Latitude:-33.80; Longitude: 150.71 Badgerys Ck Station number: 067068 Commenced 1936; 31 Dec 1996; Elevation 65m; Latitude: 33.87; Longitude: 150.73 Source: Bureau of Meteorology (2009).													

4.1.3.2 Temperature

The annual average maximum and minimum temperatures experienced at Orchard Hills Treatment Works are 23.4°C and 11.6°C respectively. On average, December is the hottest month with an average maximum temperature of 28.5°C. July is the coldest month, with average minimum temperature of 5.3°C.

4.1.3.3 Rainfall and Evaporation

Rainfall data collected at the Orchard Hills Treatment Works site shows that February is the wettest month, with an average rainfall of 110.6mm. The driest month is September with average monthly rainfall of 38.1mm. The average annual rainfall is 802mm whereas the 90th percentile rainfall year (a wet Year) is 1 147mm and 10th percentile rainfall year (a dry year) is 485mm. The rainfall for the 90th percentile 5 day storm event used to calculate preferred dam sizes across the Project Site is 47.6mm.

Table 4.1 presents the average monthly evaporation data recorded between 1936 and 1996. The highest rate of evaporation (213.9mm) occurs during January and the lowest evaporation in June (51mm). Rainfall and evaporation are comparable in May and June whereas evaporation exceeds rainfall during all other months.

4.1.3.4 Wind

Figure 4.3 shows the annual and seasonal wind roses compiled from the St Marys data for the period January 2007 to December 2007. On an annual basis, the data show a high frequency of winds from the south-southwest and to a lesser extent the south. In the summer, winds are predominantly from the south-southwest and south with a relatively even portion of winds ranging from east-northeast through to the south-southeast. In autumn and winter, the dominant wind occurs from the south-southwest, with minor winds from other directions. Winds during the winter months are from the south and south-southwest. On an annual basis, the mean wind speed for the St Marys site is 1.87m/s and the percentage of calms (wind speeds less than 0.5m/s) is 15.9 percent.

4.1.4 Surrounding Land Ownership, Land Uses and Residences

Figure 4.4 presents the land ownership details surrounding the Project Site. This information has been sourced from the publicly available Land Ownership Register maintained by the Department of Lands.

The Project Site is located largely within a rural landscape comprising open grazing land, pockets of established tree canopy and low density housing. Immediately to the west of the Project Site is land owned by the Commonwealth which is used by the Australian Defence Force. This land is heavily vegetated and represents one of the more significant areas of Cumberland Plain Woodland remaining in Western Sydney.

Located between approximately 0.5km and 1.5km to the north of the Project Site is a relatively recent residential subdivision, referred to as “The Vines”, comprising large detached housing. The Project Site is separated from this residential area by open grazing land and the tree-lined Blaxland Creek. Further, to the north (approximately 2km to 3km), the land also comprises low density residential dwellings on large allotments, with this area extending up to and bounded by the M4 Motorway.

Land to the immediate east of the Project Site consists of open grazing land and ancillary buildings on the “Roughwood Park” and “Glenholme Farm” including rural housing. The owner of “Roughwood Park” maintains and trains race horses on the property. The “Glenholme Park” property is largely used for grazing cattle. Between South Creek and Mamre Road to the east of the Project Site, a new rural-residential subdivision has been developed. Further to the east (approximately 3km) are the established residential suburbs of St Clair and Erskine Park as well as the Erskine Park industrial estate. The Erskine Park industrial estate currently incorporates the Enviroguard Waste Disposal Facility, a facility located on the site of the former Erskine Park hard rock quarry. To the south of the Project Site and Patons Lane, the land accommodates buildings and other facilities associated with an existing horse stud. A small well-established rural-residential subdivision is located adjacent to Luddenham Road, immediately south of Patons Lane.

Table 4.2 lists the distance between a number of components on the Project Site and a range of the residences surrounding the Project Site.

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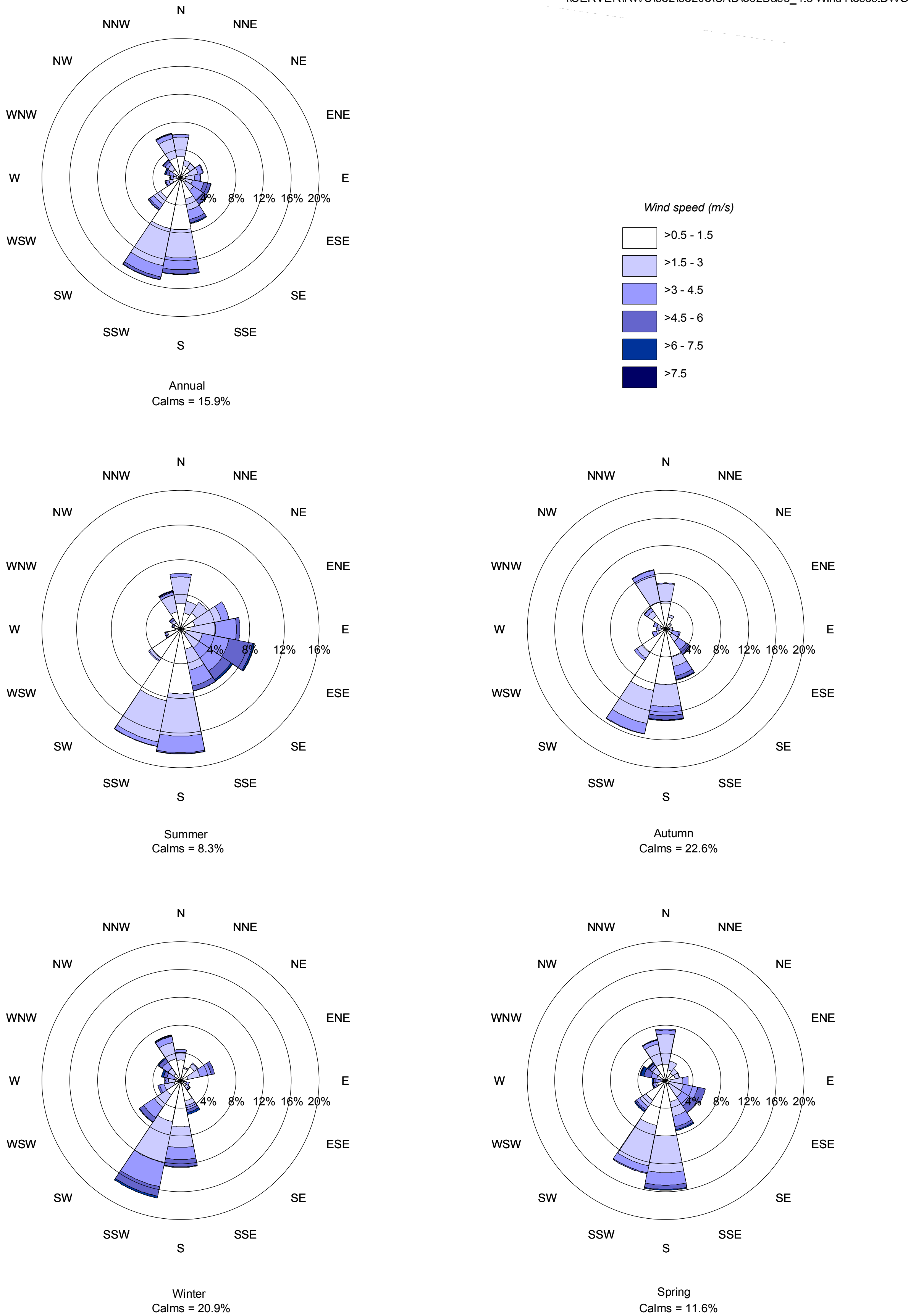

Source: PAEHolmes (2010) - Figure 3

Figure 4.3
ANNUAL AND SEASONAL WIND ROSES

Table 4.2
Distances from Representative Surrounding Residences to Project Site Components

Residence	Distance (m) from		
	Project Site Boundary	**Closest Cell**	**Recycling Area**
A	650	720	1 330
B	630	640	1 110
C	1 180	1 260	1 600
G	1 430	1 580	1 860
I	1 540	1 660	1 970
O	1 390	1 470	1 820
T	1 250	1 310	1 680
U	990	1 090	1 670
V	490	590	1 190
W	480	570	1 140
X	660	730	1 320
Y	880	970	1 530
Z	490	570	1 140

4.2 GROUNDWATER

The nature and characteristics of the groundwater beneath and surrounding the Project Site and the assessment of impacts of the Project on the groundwater is drawn from a report prepared by Aquaterra Consulting Pty Ltd. This section provides a summary of the report by Aquaterra Consulting Pty Ltd (2010) which is included in full as Part 2 of the Specialist Consultant Studies Compendium (Volume 1).

4.2.1 Introduction

Based upon the risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential groundwater impacts requiring assessment and their **unmitigated** risk rating are as follows.

- Contamination by leaking /spilt hydrocarbons requiring minor or major recovery works (low risk).
- Reduced groundwater levels with the Bringelly Shale and Hawkesbury Sandstone (low risk).
- Impact on groundwater dependent ecosystems, if present (moderate risk).

It is noted that most groundwater-related issues attract only a low to moderate risk as it is recognised, based upon over 100 years of waste placement (including putrescibles wastes) in former clay/shale quarries in the Sydney area and studies by Dupen (1993), that there is very little groundwater in the clay/shales and what is present is highly saline and of little value.

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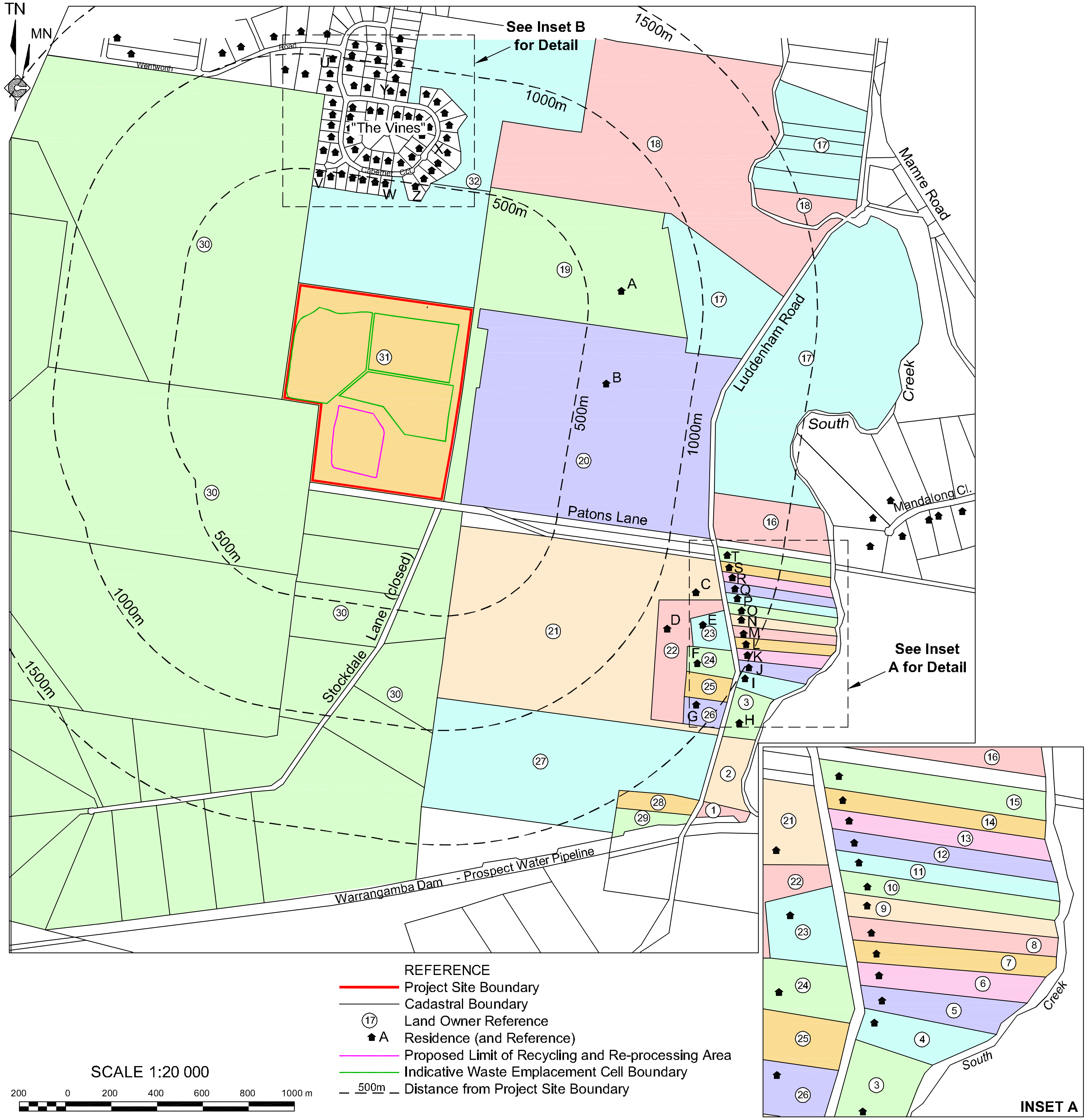

Land Owner Reference Schedule

No.	Owner
1	A.J. & A.L. Carroll
2	Mandalong Investments Pty Limited
3	B.G. & L. Diggins
4	I. Ovchinnikov
5	P.J. & J.A. Rapa
6	C.J. Sultana & C.P. Taylor
7	M.A.G. Bell
8	W.R. & M.R. Brown
9	J. & D.L. Ormshaw
10	A.P. Owen
11	N.P. & D.M. Burgess
12	R.A. & M.C. Robinson, J.F. & M.A. Doyle
13	J. & B. Van Schelven
14	J.J. & K. Mifsud, W.A. & K.A. Burgess
15	J. & K. Mifsud
16	J. & S. Balkema
17	Minister Administering the EP & A Act 1979
18	Associated Dairies (St Marys) P/L
19	V.W. & Y.D. Bates
20	Eric Newham Holdings Pty Limited
21	Darley Australia Pty Limited
22	Croatian Culture Association
23	E. Nahlous
24	N.E. & B.L. Middlebrook
25	M. & S. Cassar
26	S. & S. Nahlous
27	The Trustees of the Lebanese Maronite Missionary
28	J. & J.R. Dimech
29	H.L. Kennett
30	The Commonwealth of Australia
31	Dellara Pty Ltd
32	Vacik Pty Limited

(Source: NSW Department of Lands)

Figure 4.4
LAND OWNERSHIP AND SURROUNDING RESIDENCES

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No substantive groundwater pollution has been identified in former quarries. Notwithstanding these observations, the DGRs and requirements nominated by former DECC and DWE require particular attention to be paid to the following.

- Management of leachate on site, including from the construction and demolition waste in the perimeter bund walls.
- Commitments to prepare nominated documentation when seeking an environmental protection licence. (It is likely that there will be more than one application tailored to specific components of the project. The detail of the relevant components of the project would be provided to the DECCW when applying for approval for each component to be incorporated within the relevant Environment Protection Licence).
- Details of the emplacement cell designs.
- Details of the proposed groundwater usage and methods to be used to protect groundwater.

This section commences with a review of the groundwater occurrences regionally and on the Project Site. The quality of the groundwater beneath the Project Site is reviewed together with the relevant data collected on the parameters used in the design of the waste emplacement cells on site. The section includes a review of the proposed design and operational safeguards and residual impacts after those safeguards are adopted. The section concludes with the proposed groundwater monitoring program.

4.2.2 Occurrence

4.2.2.1 Regional Setting

The regional groundwater table occurs at depth within the Hawkesbury Sandstone which, in the vicinity of the Project Site, is typically 70m to 90m below the land surface. The groundwater is contained in both pores and joints within the sandstone and is pressurised, as groundwater levels in bores intersecting the aquifer rise in the order of 50m or 60m above the level of water intersection as evidenced by the existing groundwater abstraction bore on the Project Site.

The Ashfield Shale and Bringelly Shale units contain limited (and localised) quantities of groundwater, although technically they are aquitards not aquifers, with groundwater flow restricted to occasional horizontal bedding planes or discontinuous carbonaceous lenses within the shales. Groundwater movement in the shale aquitard is very minor and is overwhelmingly within these horizontal zones of slightly higher permeability. The groundwater chemistry data (see Section 4.2.3) confirms there is negligible recharge of groundwater within the shales, and negligible downward leakage from the shale units into the underlying Hawkesbury Sandstone.

4.2.2.2 Project Site

Groundwater levels have been recorded at three locations on the Project Site, namely at the northwest piezometer, northeast piezometer and the abstraction bore (near Dam 1). The occurrences of groundwater beneath the Project Site are depicted schematically on **Figure 4.5**. The two piezometers record the groundwater levels in the Bringelly Shale whereas the water level in the abstraction bore (27.8m AHD) principally reflects the hydrostatic pressure in the Hawkesbury Sandstone, with minimal influence from the overlying shale.

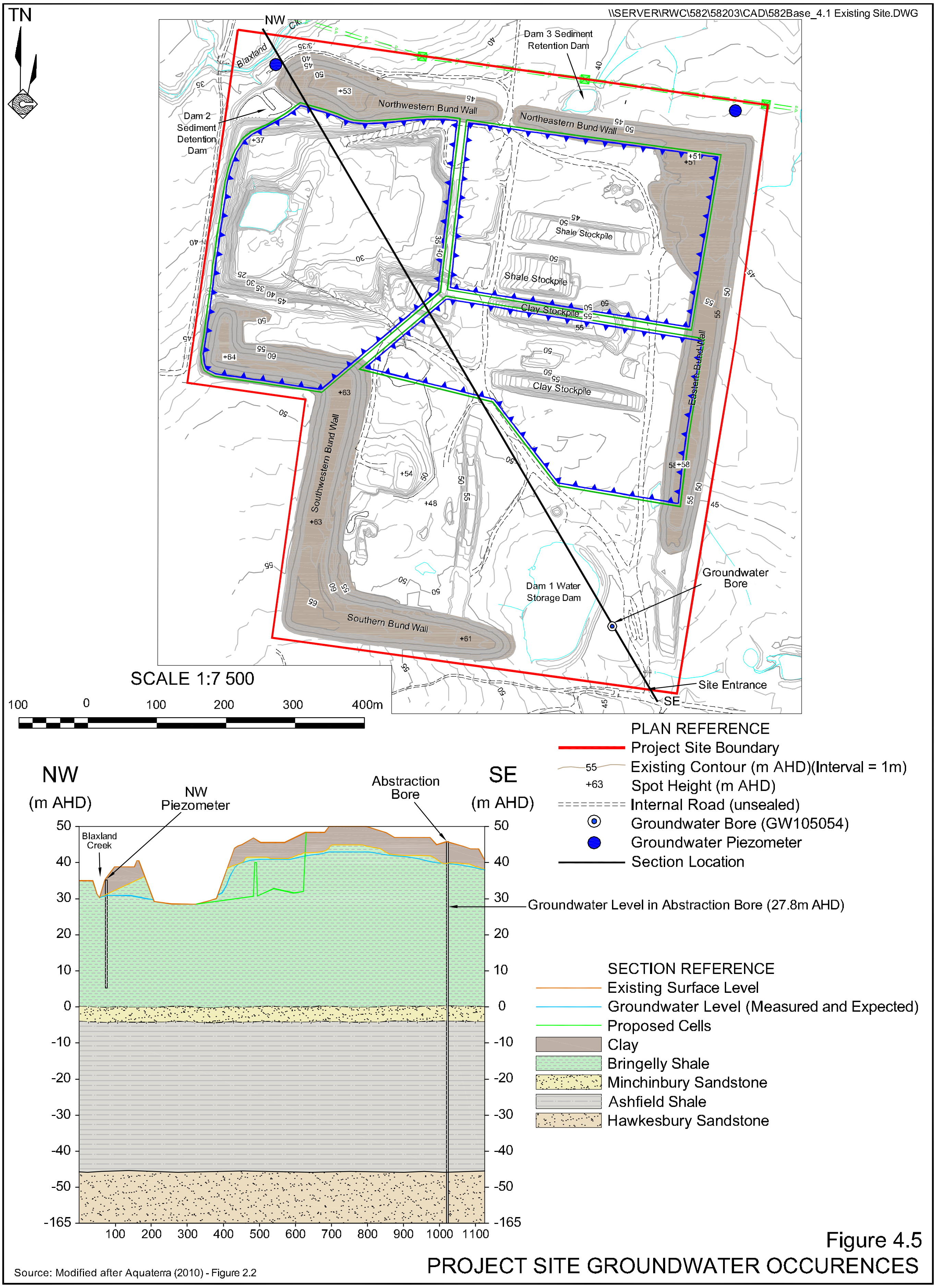


Figure 4.5
PROJECT SITE GROUNDWATER OCCURENCES

The groundwater levels recorded in the Bringelly Shale are about 4m to 5m below the land surface generally at the base of the clay.

Groundwater within the Bringelly Shale typically occurs beneath the Project Site in one of two forms.

1. The groundwater encountered within the upper 4m to 5m of the shale is understood to reflect seepage from the surface which accumulates locally in joints in the weathered zone. The quantity of water "perched" on top of the fresh shale is invariably limited and when exposed during extraction quickly disappears. This feature is supported from the significant quantity of drilling on site that did not intersect groundwater within 25m of the land surface. This form of groundwater is likely to persist throughout the life of the Project with the voids created by on-going extraction causing the small quantity of groundwater that is present to flow/seep towards and into the voids. In reality, and based on observations in the existing extraction areas, little if any water would flow/seep into the void as it would simply evaporate on the exposed side walls of the extraction void.
2. Groundwater can occur at depth in the Bringelly Shale generally within the more horizontal bedding planes and horizontal carbonaceous and often coaley lenses. This water is in fact connate water trapped in the shale from when it was deposited in an estuarine environment over 220 million years ago. Again, the quantities of water trapped are small and when encountered during extraction rarely "flow" for more than 1 or 2 hours.

The groundwater present within the Hawkesbury Sandstone is the regional groundwater resource, and is much deeper than, and disconnected from, the proposed depth of the waste emplacement cells on the Project Site.

4.2.2.3 Groundwater Bores

A search of the DWE groundwater database has revealed the presence of three licensed groundwater bores within approximately 3km of the centre of the Project Site (see **Figure 4.6**). One of these licensed bores is located on the Project Site and accesses groundwater predominantly in the Hawkesbury Sandstone, as it is cased to 59.5m and is an open hole to 210m (base of bore at -165m AHD). This bore is licensed to abstract up to 32ML/year. The other two bores within 3km of the Project Site are able to abstract water from the Hawkesbury Sandstone, with one bore extending to 366m in depth.

Access to the licensed bore nearest to the Project Site located on the "Coolamon Park" property (GW105382) was unable to be obtained. However, it is understood that this bore is currently not being utilised to access groundwater, but when it is used it is pumped at the rate of 1L/s.

4.2.3 Groundwater Quality

Bringelly Shale

The quality of the groundwater within the Bringelly Shale generally reflects the estuarine origin of the unit. Although quantities of groundwater present are low, it is always saline. Measurements taken from the two recently drilled groundwater bores on site revealed total dissolves solids ranging from 8 930mg/L in the northwest piezometer to 13 000mg/L in the northeast piezometer. This variability in salinity (over a distance of only 0.75km) is consistent with groundwater contained in a low porosity rock matrix with occasional discontinuous fractured and carbonaceous lenses. Detailed chemical tests of groundwater samples from the northwest and northeast piezometers revealed the following.

- The major anion was chloride, which is indicative of old groundwater which is not readily recharged and/or is remote from recharge zones.
- Natural levels of some dissolved metals were equal to or exceeded the freshwater ecosystem protection guideline levels as recorded by ANZECC (2000).

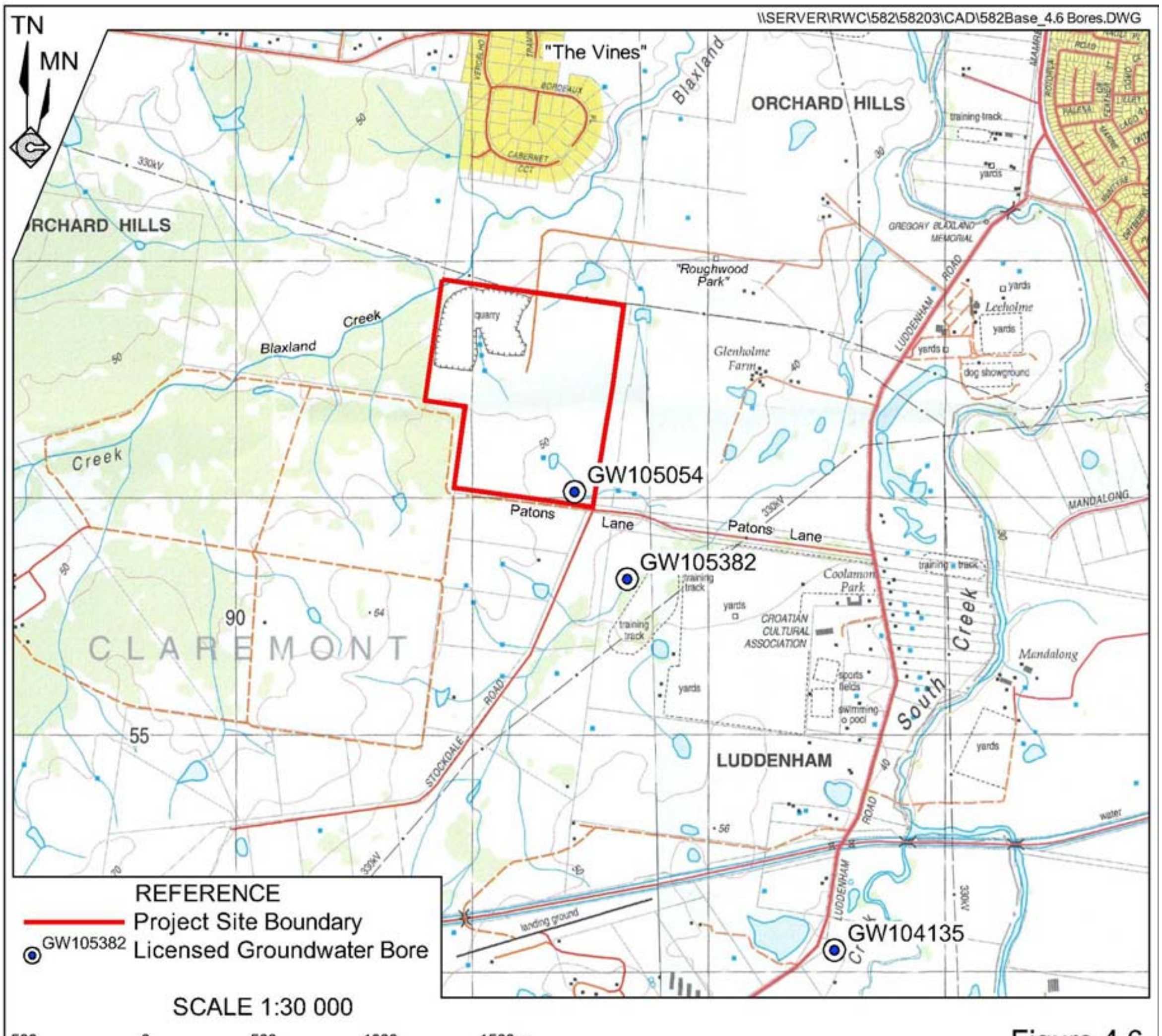


Figure 4.6
LICENSED GROUNDWATER BORES

- Natural ammonia concentrations were above the freshwater ecosystem protection guideline levels, a feature known for many years (Old, 1942).
- No pesticides or polycyclic aromatic hydrocarbons were detected.

Aquaterra (2010) notes that, given the low permeability groundwater environment beneath the Project Site and the lack of interaction between these groundwaters and surface water, the saline groundwater presents a negligible risk to freshwater ecosystems. Aquaterra (2010) also notes that the groundwater quality data for the northwest and northeast piezometers includes no evidence that groundwater seeping into the piezometers has been contaminated by any leachate which may have been generated from the construction and demolition waste in the existing perimeter bund walls on site.

Hawkesbury Sandstone

The quality of the water within the Hawkesbury Sandstone beneath the Project Site has been established through the testing of water from the on-site abstraction bore. Chemical tests of the water from the abstraction bore revealed that the water tested had a slightly lower salinity level than the water present in the Bringelly Shale suggesting same saline water from the Bringelly Shale was present, particularly since the bore has not been pumped for some time (Aquaterra, 2010). It is expected based upon knowledge of water quality elsewhere in the Hawkesbury Sandstone around Sydney that the quality of water from the abstraction when it is pumped for longer periods would be comparable with quality of water in Dam 1. Although water was last pumped into Dam 1 in early 2006, this salinity level, reflecting both effects of evaporation and local runoff inflows, was substantially lower than the groundwater from the abstraction bore (by a factor of at least seven).

4.2.4 Hydrogeological Parameters

In order to design the cells for the emplacement of waste and to understand the subsurface movement of the groundwater beneath the Project Site, Aquaterra (2010) conducted a number of tests on site, principally within the two bores drilled, namely the northwest and northeastern bores.

Testing undertaken on the two bores determined horizontal hydraulic conductivity values of 1×10^{-6} m/s and 1×10^{-9} m/s. Aquaterra noted that the vertical permeability would be orders of magnitude less than horizontal permeability, and likely to be less than 1×10^{-9} m/s.

Laboratory testing was also conducted upon a representative set of clay samples to establish the permeability of re-moulding clay to replicate the proposed use of compacted clay on site to horizontally contain the emplaced wastes. The results established that the re-moulded clay would have permeability values of between 4.4×10^{-10} m/s and 7.3×10^{-10} m/s. All results demonstrate a superior level of performance compared to the benchmark level of 1×10^{-9} m/s.

4.2.5 Design and Operational Safeguards

The design and operational safeguards to be adopted throughout the life of the Project to protect the quality of groundwater beneath and surrounding the Project Site focus upon the adoption of the benchmark techniques (or an acceptable alternative technique) required by the DECCW and documented in DECC (1996). The methods by which each of the benchmark techniques or alternative techniques would be adopted are outlined as follows.

Benchmark Technique No. 1: Leachate Barrier

Reliance is being placed on the following barriers to contain leachate within the emplacement cells.

i) At least 10m of clay/shale would be maintained between the external boundary of each emplacement cell and the Project Site boundary. In fact, on the northern down-gradient side of the Project Site, the boundaries of emplacement Cells 1 and 2 are almost 90m from the boundary of the Project Site.

ii) Clay would be positioned and compacted around the external boundaries of each emplacement cell or an alternative engineered liner installed up to the elevation of the land's natural surface.

iii) At least 0.4m of re-compacted clay would be placed on the floor of each cell to achieve a permeability of less than 7.3×10^{-10} m/s. An alternative engineered liner achieving an equal or lower permeability may instead be utilised for the cell floor barrier, with approval from DECCW.

Details of each of the barriers are presented in Aquaterra (2010).

Benchmark Technique No's 2 and 3: Leachate Collection, Extraction and Disposal, and Surface Water Controls

The Proponent would adopt a comprehensive surface water and leachate management system designed by GSS Environmental/BMT WBM and Aquaterra to satisfy the requirements of these benchmark techniques. The following are components of the system to satisfy these benchmark techniques.

i) All delivered waste would be isolated from run-on water by the construction of protective bunds around active waste placement areas.

ii) The area of uncovered waste exposure to rainfall would be minimised through placement (and compaction) of at least 150mm of daily cover.

iii) A leachate collection system would be installed on the floor of each cell incorporating HDPE collection pipes (at 50m spacings) within a leachate drainage layer. The floor of each cell would be constructed to achieve the required fall to the leachate riser in each cell.

iv) A leachate pumping system would be used to pump the leachate from the base of each cell to the on-site lined evaporation pond. The pump would be automated and would commence pumping when the leachate level in the riser reaches a pre-determined level, currently planned to be 0.3m above the cell floor in the vicinity of the riser. Interlocks would be fitted to ensure that leachate is not pumped to the leachate evaporation pond in the highly unlikely event that the leachate level in the pond exceeds the nominated maximum level.

v) A HDPE-lined Initial Leachate Evaporation Pond with a capacity of 12ML to be constructed in the western section of Cell 3 to accept leachate during operations within Cells 1 and 2. A HDPE-lined Long-Term Leachate Evaporation Pond with a capacity of approximately 12ML would also be constructed within the southern section of the existing Dam 1 in the southeastern corner of the Project Site following the commencement of operations in Cell 3 and prior to decommissioning of the Initial Leachate Evaporation Pond. The Long-Term Leachate Evaporation Pond would involve the construction of a dividing wall within the existing dam and reshaping all side walls to achieve the optimum slopes for installation of a 1.0mm thick HDPE liner.

Aquaterra (2010) has determined that the capacities of the leachate ponds would be sufficient to manage the quantity of leachate forecast to be produced throughout the life of the facility. **Figure 4.7** displays predicted cumulative leachate volumes Aquaterra (2010) predicts would be produced throughout the life of the Project. A maximum volume of less than 12ML is predicted by Year 30 based on a series of conservative assumptions. Therefore, it is likely the 12ML Long-Term Leachate Evaporation Pond would never be full.

vi) It is noted from **Figure 4.7** that Aquaterra (2010) predicts leachate needing to be stored in the evaporation pond for approximately 8 years after the completion of waste emplacement activities reducing gradually throughout that period to zero.

vii) A program of leachate re-injection would be adopted to achieve the recommended water absorptive capacity of 0.03m^3/tonne of waste. This would be achieved during the drier months through the re-injection of leachate from the leachate evaporation ponds for absorption by the waste. A site procedure would be developed to establish how much leachate needs to be re-injected based upon the quantity of waste received and the rainfall during the previous month.

viii) During the periods when the Proponent is moving some of the construction and demolition waste remaining in the perimeter bund walls, a procedure would be adopted to ensure all runoff from the exposed waste is directed into the adjoining lined cell.

Details of each of the above controls and the leachate modelling are included in Aquaterra (2010).

It is noted that small quantities of low strength leachate would be generated from the temporary storage of wood waste within the Recycling and Re-processing Area. This leachate would be collected in a small pond adjacent to the wood waste storage area and pumped to the Initial Stormwater Leachate Dam in Cell 3 and then into Dam 1 following the construction of the Long-Term Leachate Evaporation Pond and lining of the remaining Dam 1 area (the Final Stormwater Leachate Dam) with HDPE.

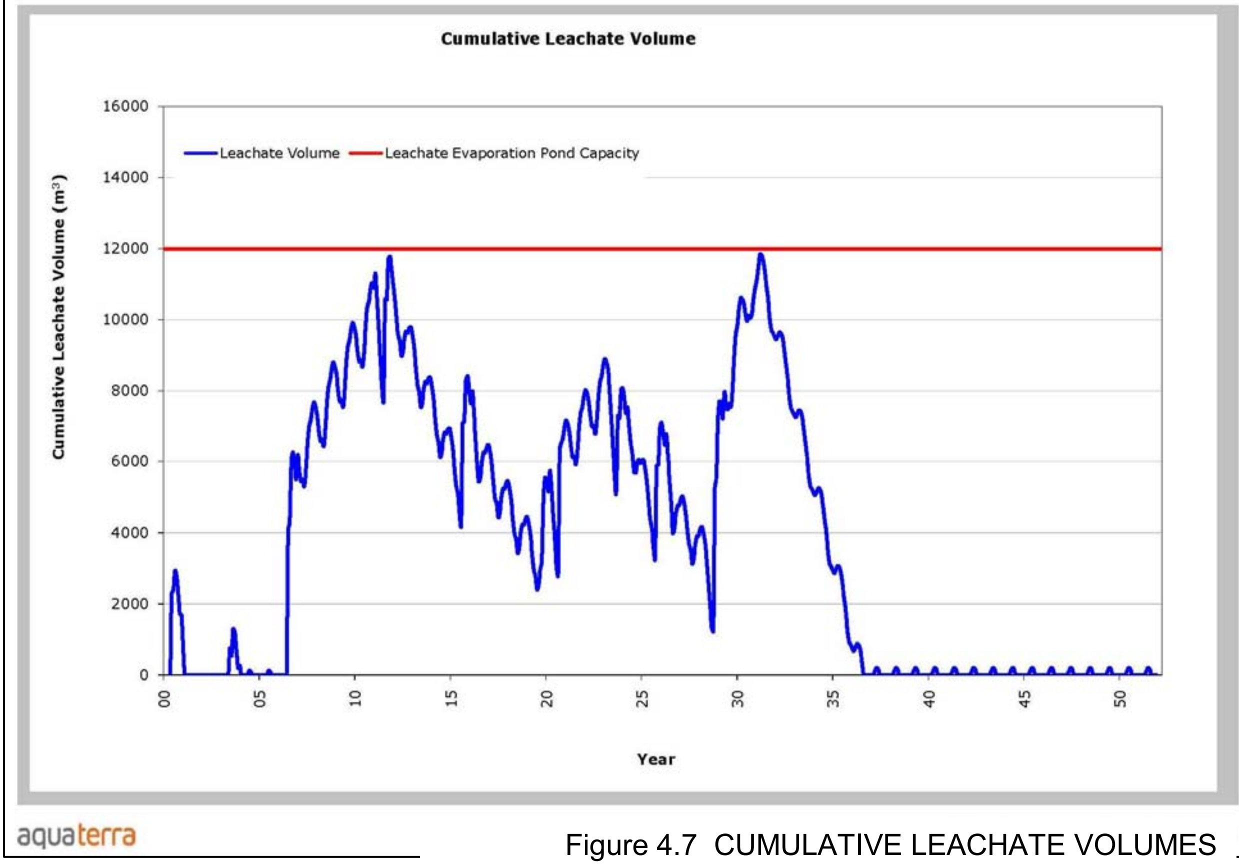


Figure 4.7 CUMULATIVE LEACHATE VOLUMES

Source: Aquaterra (2010) – Figure 4.2.

Benchmark Technique No. 33: Covering of Waste

A program of covering the active waste placement area at the end of each operational day with at least 150mm of ripped shale or clay.

Benchmark Technique No.s 10 and 11: Gas Containment System

Whilst it is recognised that the Proponent would not accept putrescible wastes, a small proportion of organic material is invariably incorporated in construction and demolition waste and commercial and industrial waste. Hence, it is likely that very small quantities of gas containing mainly methane may need to be managed. In the event that sufficient methane is generated to warrant collection, the Proponent would install a gas collection distribution system in the final capping (see Section 2.14.5). Details of a system, including the use of "perimeter chimneys" are incorporated in Aquaterra (2010). The Proponent would closely evaluate all potential gas collection systems prior to installing any system for use on site.

Benchmark Technique No. 28: Capping and Rehabilitation

Section 2.14.5 has previously described the proposed final capping and rehabilitation of the final surface above the emplacement cells. Aquaterra (2010) acknowledges that the proposed method differs from the requirements of the benchmark technique, however, demonstrates how the proposed cap would meet the environmental performance requirements of the benchmark technique.

In addition to the above design and operational safeguards, the Proponent would prepare and implement a hydrocarbon management plan to ensure that spillage and leaks of hydrocarbons are avoided. Should any spillages or leaks occur, the affected material would be remediated on site and placed in an active emplacement area on site. All containment of spills and leaks would be undertaken in accordance with the technical guidelines section "*Bunding and Spill Management"* (EPA 1995).

4.2.6 Assessment of Impacts

Aquaterra (2010) concludes that, with the adoption of the benchmark or alternative techniques, the groundwater beneath and surrounding the Project Site would be protected. Any seepage from the seepage layer in the weathered shales would continue to seep towards the emplacement voids. Any groundwater present in the carbonaceous or coaley layers would be fully drained throughout the period of extraction and would be covered by the engineered barrier constructed on the external perimeter of each cell.

Aquaterra concludes that the risk of leachate impacting on groundwater quality in the Hawkesbury Sandstone beneath or surrounding the Site is considered to be negligible for the following reasons.

- Up to 64m of shale is present beneath the base of the lowest emplacement cell (approximately 17m AHD) and the Hawkesbury Sandstone.
- The vertical permeability of the shale is confidently expected to be very low (less than 1×10^{-9} m/s). This natural barrier offers further protection in addition to the proposed engineered liner which would also be installed in accordance with DECCW requirements.
- Groundwater flow in the shale is governed by discontinuous, predominantly horizontal flow, with a very low bulk permeability.
- Any groundwater from the shale that seeps into the emplacement cells would be managed with the leachate.

The salinity of the groundwater in the Hawkesbury Sandstone is approximately an order of magnitude lower than the salinity in the overlying shale. This provides evidence that the shale is not significantly recharging groundwater within the Hawkesbury Sandstone.

The pumping of up to 32ML of groundwater from the on-site abstraction bore would have negligible impact upon the two bores 0.4km and 2.3km from the on-site abstraction bore.

4.2.7 Monitoring

The Proponent would undertake a monitoring program to demonstrate the effectiveness of the proposed design and operational safeguards. The following program would be evaluated and reviewed annually to ensure that only meaningful data is being collected. **Table 4.3** lists the proposed parameters and frequency of measurement for samples collected from the two existing piezometers, the abstraction bore and any other piezometers constructed throughout the life of the Project.

Also the volume of leachate which is generated (by each cell), stored and disposed of would be continuously monitored and compared to the model predictions. This data would be collated and reported to demonstrate that the Site continuously has sufficient storage capacity.

Table 4.3
Proposed Groundwater Monitoring Program

Frequency	Parameter
Quarterly	Total dissolved solids, pH, Standing water level, Nitrogen – Ammonia, Calcium, Magnesium, Potassium, Sodium, Chloride, Sulfate, Alkalinity (as HCO_3 and CO_3^{2-}), Total Organic Carbon
Annually	Nitrogen – Nitrate, Nitrogen – Nitrite, Aluminium, Arsenic, Barium, Cadmium, Chromium (total), Chromium (hexavalent), Cobalt, Copper, Mercury, Manganese, Lead, Zinc, Fluoride, Benzene, Toluene, Ethylbenzene, Xylene, Total Phenolics, Total Petroleum Hydrocarbons, Organochlorine Pesticides, Organophosphate Pesticides, Polycyclic Aromatic Hydrocarbons
Source: Modified after Aquaterra (2010) – Table 5.3	

4.3 SURFACE WATER

The surface water assessment of the Project was undertaken by GSS Environmental (GSSE) and BMT WBM (WBM). The full surface water assessment is presented as Part 3 of the Specialist Consultant Studies Compendium, with the relevant information from the assessment summarised in the following subsections. The assessment is referred to as GSSE/WBM (2010) throughout this document.

4.3.1 Introduction

Based on the risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential surface water impacts requiring assessment and their **unmitigated** risk rating are as follows.

- Discharge of sediment-laden or turbid water from the Project Site (moderate risk).
- Temporary degradation of downstream water quality through discharge/spill of contaminated water (moderate risk).
- Long term contamination of downstream water quality through major or repeated discharge/spill of contaminated water (high risk).
- Altered flooding patterns and indirect impacts on native vegetation communities and ecosystems (low risk).
- Erosion of rehabilitated final landform (moderate risk).
- Reduced flows to downstream agricultural land (low risk) and native vegetation (low risk).

In addition, the Director-General's requirements and requirements of other government agencies nominate that the *Environmental Assessment* include:

- detailed modelling of the potential surface water impacts of the Project, paying particular regard to Blaxland Creek and other nearby watercourses and associated riparian corridors;

- a site water balance for the Project, including a description of the measures that would be implemented to minimise water use on site and any water licensing requirements for the Project; and
- details of the proposed erosion and sediment controls (during construction), the stormwater and leachate management system (during operations), flooding, potential off-site drainage impacts, and water supply and efficiency measures.

The following sub-sections describe and assess the existing drainage and surface water environment, identify the surface water management issues, proposed surface water controls, safeguards and mitigation measures and an assessment of the residual impacts following the implementation of these safeguards and mitigation measures.

4.3.2 Drainage Network

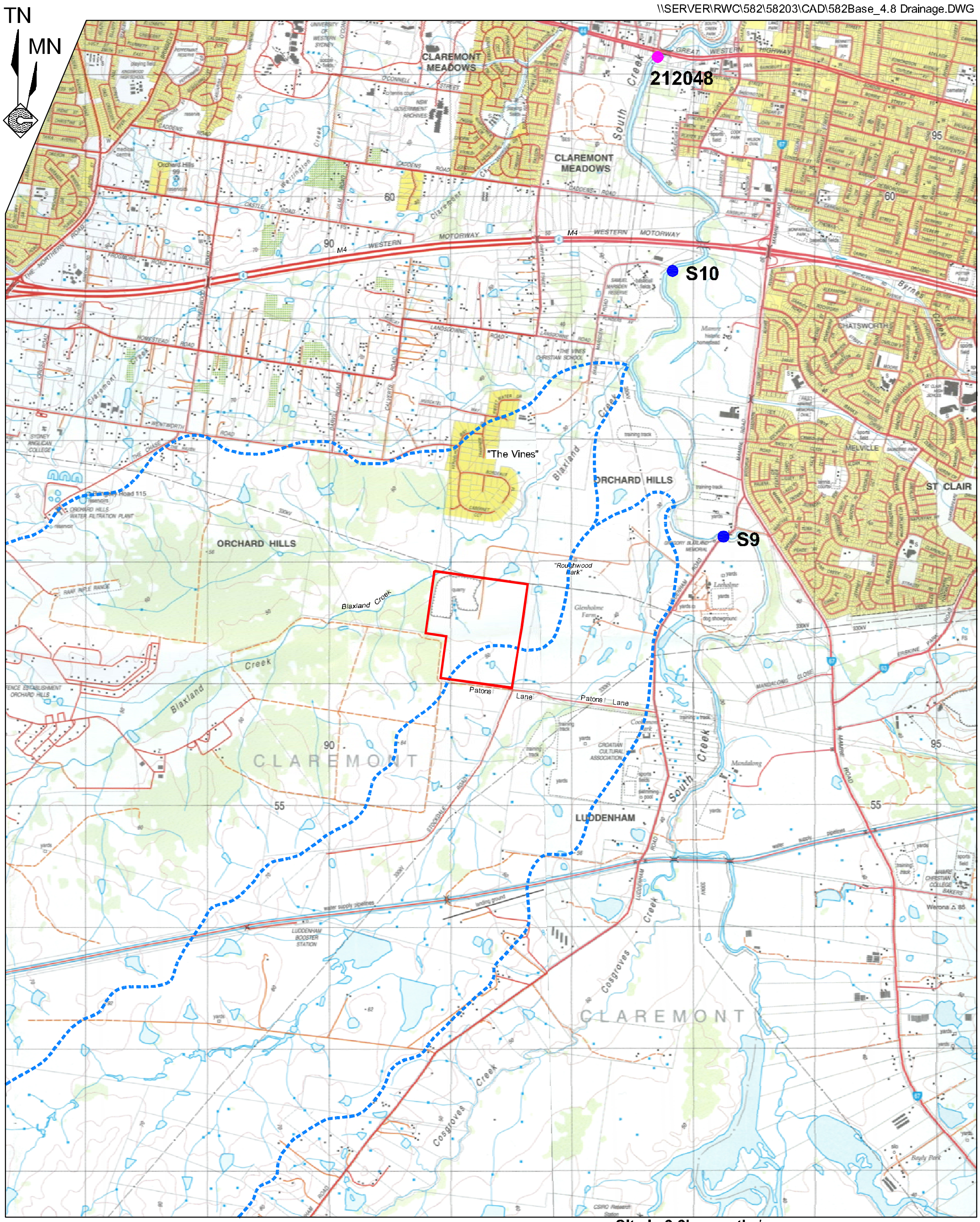
4.3.2.1 Regional and Local Network

The Project Site is located within the catchment of Blaxland Creek, which flows in a northeasterly direction to South Creek, a tributary of the Hawkesbury-Nepean River system. Blaxland Creek is a fourth order creek according to the Strahler System of stream classification. South Creek is a much larger creek system with its headwaters starting near Harrington Park, approximately 24km south of the Project Site. The majority of the upstream catchment of South Creek has been cleared for agricultural and residential purposes. The southeastern section of the Project Site reports to a small tributary which enters South Creek approximately 1.4km to the northeast of the Project Site and 1km upstream from the Blaxland Creek junction. **Figure 4.8** displays the local drainage network around the Project Site. South Creek continues to flow northward and enters the Hawkesbury River near Windsor, approximately 23km north of the Project Site.

Prior to the disturbance associated with past quarry operations, the majority of the Project Site naturally drained to the northwest and Blaxland Creek. Perimeter bund walls, extractive processes and diversion channels related to the operation of the quarry have since changed the drainage patterns on the Project Site. As a result, the Project Site can be divided into six catchment areas, five of which are located within the Blaxland Creek catchment.

Two watercourses on the Project Site were identified by the former Department of Water and Energy (DWE) during a desktop stream categorisation assessment and identification of minimum riparian corridor widths along watercourses. The two watercourses were identified on the Project Site (from 1:25 000 topographic mapping (dated 2001) namely one Category 1 stream and one Category 3 stream.

1. The 100m length section of Blaxland Creek flowing through the northwestern corner of the Project Site is a Category 1 watercourse according to the former Department of Infrastructure, Planning and Natural Resources (DIPNR) stream classification system.
2. The Category 3 "stream" was originally present on site but has been removed through the approved clay/shale extraction on site.



REFERENCE

- Project Site Boundary
- Catchment Boundary
- S9 ● Surface Water Quality Sampling Site
- 212048 ● South Creek Stream Gauges

SCALE 1:50 000

0.5 0 0.5 1.0 1.5 2.0 2.5 km

Source: Modified after GSS Environmental & BMT WBM (2010) - Figure 4.4

Figure 4.8
LOCAL DRAINAGE NETWORK

Blaxland Creek is currently moderately disturbed within the Project Site, with past grazing activities causing degradation of the riparian zone and associated bank erosion. There is an existing low flow pipe outlet from an existing dam (Dam 2) where water has been historically released into the creek under the existing quarry development consent. Since this section of creek has been classified as a Category 1 stream, a minimum core riparian zone of 40m is required along both sides of the watercourse along with a 10m vegetative buffer. A section of both the northwestern perimeter bund wall and Dam 2 are located within this core riparian zone and additional vegetative buffer.

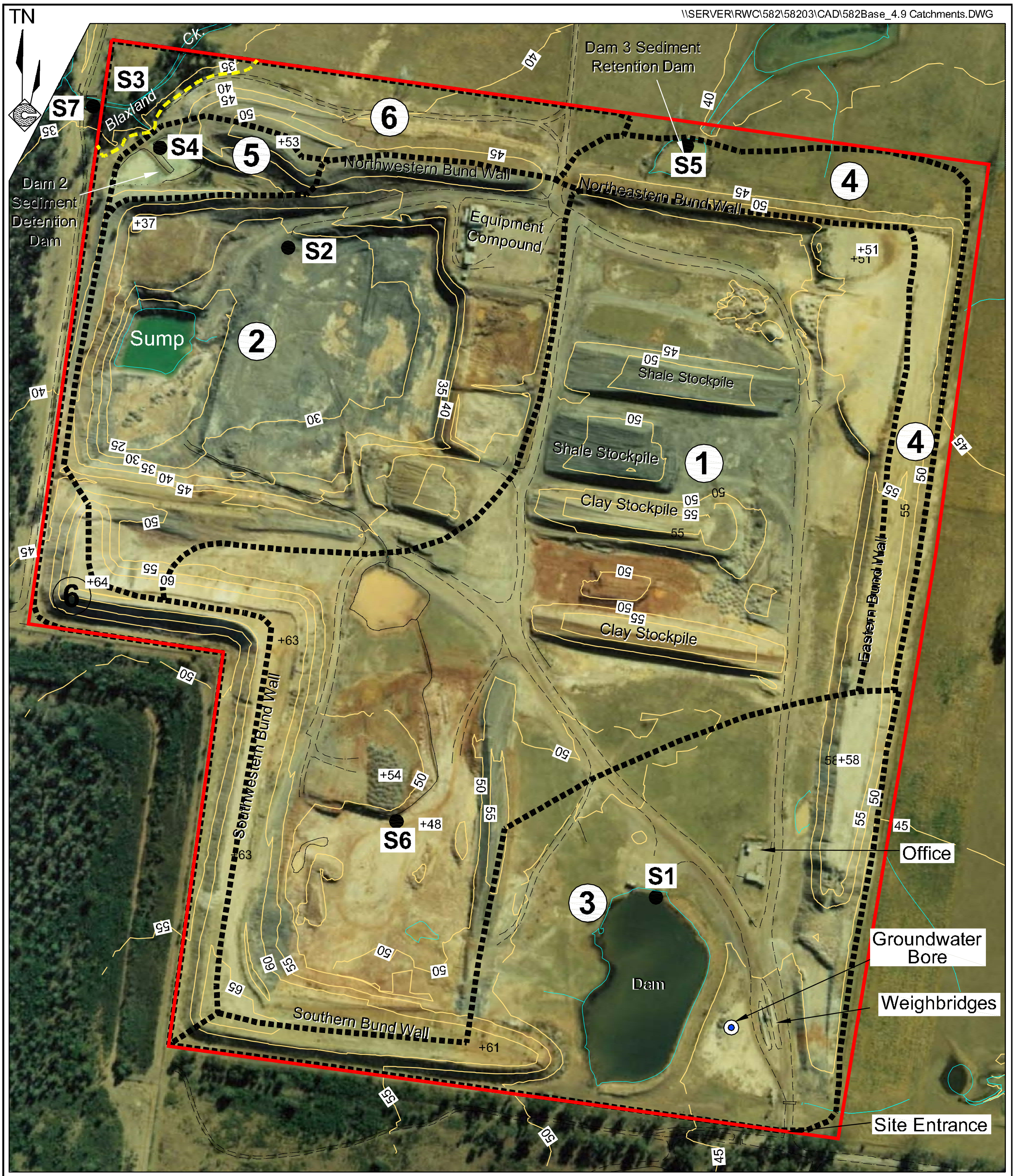
Immediately upstream of the Project Site, Blaxland Creek flows through three box culverts under a bridge which is located on the land owned by the Commonwealth and used by the Australian Defence Force. Litter racks and security fences are installed on the downstream side of the culverts which have debris built up behind them. Gabion baskets have also been installed along the channel banks on both the upstream and downstream side of the culverts for approximately 5m as scour protection for the creek banks adjacent to the bridge. The scouring within Blaxland Creek within the Project Site is largely attributed to the stream dynamics created by these culverts. A more stable section of the creek with well vegetated creek banks is located immediately downstream of the Project Site.

4.3.2.2 On-site Drainage Network

Surface water flows on the Project Site are currently confined to six localised catchments, five of which are located in the Blaxland Creek catchment and one located within the South Creek catchment. **Figure 4.9** displays the locations of each catchment on the Project Site and **Table 4.4** provides a brief description of each catchment.

Table 4.4
Project Site – Internal Catchments

Catchment	Area 1 (ha)	Description
1	24.7	This central catchment incorporates Dams 4 and 5, the southwestern extraction area and most of the clay/shale stockpile areas. Hence, there is a considerable sediment load generated following rainfall, particularly into Dam 5. Dam 4 is currently used for the coagulation of water from the sump within the northwestern extraction area (prior to discharge through Dam 2).
2	13.0	This catchment is centred on the northwestern extraction area (encompassing the proposed Cell 1) and incorporates the entire extraction area and surrounding excavated/constructed slopes.
3	11.3	This catchment covers the southeastern corner of the Project Site incorporating the site entrance, weighbridge/office, groundwater bore, Dam 1 and a small area of stockpiles. Dam 1 was used by the former owner to store water pumped from the nearby groundwater bore. A considerable proportion of the catchment is vegetated.
4	3.4	This catchment essentially incorporates the outer section of the northeastern and eastern bund walls that ultimately flow into Dam 3 near the northern boundary of the Project Site.
5	1.0	This catchment is centred on Dam 2 at the northwestern corner of the Project Site. This dam has historically been used to contain sediment-laden runoff pumped from the extraction void prior to discharge (via a pipe through the dam wall). This dam is also used by the Proponent during the program to release water from the site into Blaxland Creek.
6	5.5	This catchment incorporates the external areas of the southwestern and northwestern bund walls runoff from which effectively flow directly towards Blaxland Creek.
Notes: 1. Catchments as shown on **Figure 4.9**.		



REFERENCE

Project Site Boundary

55 Existing Contour (m AHD)(Interval = 5m)

+63 Spot Height (m AHD)

Internal Road (unsealed)

S1 Surface Water Quality Sampling Site

3 Catchment Boundary (and reference)

1% AEP Flood Level (35.6m AHD)

SCALE 1:5 000

50 0 50 100 150 200 250 m

Source: Modified after GSS Environmental & BMT WBM (2010) - Figure 4.2

Figure 4.9
PROJECT SITE CATCHMENTS

4.3.3 Water Quality

4.3.3.1 Introduction

Water quality has been measured within the Project Site and nearby creeks on several occasions since February 2009. On-site measurements were taken and samples collected from the existing dams within the Project Site and from Blaxland Creek and South Creek and tested for a range of water quality parameters. A number of parameters measured in the laboratory were found to be below detection limits. A complete summary of the on-site measurements and laboratory testing results is provided in GSSE/WBM (2010).

The presence of existing dams within the Project Site that intercept runoff from the current operations assists to provide an indication of the future water quality throughout the Project life. Water monitoring sites within the Project Site and surrounding area are shown in **Figures 4.8** and **4.9**.

4.3.3.2 Water Quality Results

- Electrical Conductivity (EC) – The monitoring results indicate that sodium and chloride are the dominant ions within the water on the Project Site, Blaxland Creek and South Creek. The concentrations of these ions follow a similar trend as EC for each site. EC is also currently recorded continuously by DECCW within South Creek at gauged Site 212048 approximately 2.5km downstream of the confluence of Blaxland Creek and South Creek (ie. approximately 4km downstream of the Project Site). EC has been recorded at this gauge since September, 2003. Measured EC levels within the existing dams within the Project Site are lower than observed within South Creek and are similar to the Blaxland Creek levels. The results indicate that rainfall and surface runoff within the Project Site may be assisting to maintain EC levels within the lower range of values recently observed in South Creek. The available data indicates that the EC within the Project Site and surrounding creeks lies within the higher range of default ANZECC trigger values (125-2200µS/cm) for low land rivers in slightly disturbed ecosystems in south-east Australia.
- pH – Measured pH levels of water in dams on the Project Site are typically in the range of 8.0 to 8.5. This is in contrast to the pH values in Blaxland Creek (7.0 to 7.5). The measured total alkalinity within the dams is dominated by bicarbonate ions for all sampling sites (where measured) with the exception of sites S1 and S5, for which 10% to 20% of the alkalinity is due to carbonate ions. The existing surface waters in the Project Site typically have high alkalinity and therefore a higher buffering capacity potential and would be less susceptible to pH changes.
- Total suspended solids (TSS) and Turbidity – The monitoring results for the Project Site indicate that all samples analysed from on-site dams are below the ANZECC guideline trigger value of 50mg/L. The TSS concentrations measured within the Project Site are similar to those recorded in South Creek, although these are elevated above the concentrations observed in Blaxland Creek. Although the TSS concentrations are significantly below the trigger value, the turbidity

monitoring results for the existing quarry sump (S2) indicate the presence of a higher proportion of finer dispersible particles. Turbidity levels in the existing quarry void approach 100NTU which exceed levels in Blaxland Creek, which has a turbidity level less than 15NTU over the typically ambient conditions monitored.

- Total nitrogen (TN) – Concentrations of TN are significantly higher in South Creek than within the waters of the Project Site and Blaxland Creek, which generally have similar concentrations. All monitored sites exceed the ANZECC guideline trigger values. Monitoring sites within the Project Site that incorporate vegetation or have partially vegetated sub-catchments (S1 and S5) generally provided higher TN concentrations. Ammonia concentrations within the Project Site and Blaxland Creek are below the ANZECC guideline trigger value. Ammonia levels in South Creek are significantly elevated above the ANZECC guideline levels. Total oxidised nitrogen levels are generally low across the monitoring sites and are dominated by nitrate. Organic nitrogen comprises the largest component of the nitrogen species.
- Total Phosphorus (TP) – TP concentrations within the Project Site and Blaxland Creek are typically lower than the ANZECC trigger value. Observed TP concentrations at S2 were the lowest observed and are similar to the Blaxland Creek concentrations. TP concentrations observed in South Creek slightly exceed the trigger value.
- Dissolved oxygen (DO) – DO was measured on one occasion for each monitoring site within the Project Site. The results indicate that DO concentrations typically exceed the minimum default ANZECC trigger concentration within the Project Site. Observed DO concentrations in Blaxland Creek are slightly lower than those observed within the Project Site.
- Hardness – Water within the Project Site is typically moderate to hard. Water within the existing flooded void (S2) generally has lower hardness (approximately 90mg/L of $CaCO_3$) than other sites. Observed hardness in Blaxland Creek and South Creek generally exceeds 150mg/L and would be categorised as hard to very hard.

4.3.4 Existing Flow Regimes

Two existing stream gauges are located along South Creek in the vicinity of the Project Site, 212320 South Creek at Mulgoa Road (Elizabeth Drive) and 212048 South Creek at Great Western Highway (see **Figure 4.8**).

Stream Gauge 212320 has recorded stream flow since 1970 and is located approximately 10km upstream of the confluence with Blaxland Creek. The South Creek catchment draining to this gauge comprises 88km^2 of primarily rural and rural residential land uses. Stream Gauge 212048 was established in 1986 and has recorded stream flow since this date. The gauging site is located approximately 2.5km downstream of the confluence with Blaxland Creek. The South

Creek catchment draining to this gauge comprises 250km^2 of rural, rural residential and urban land uses. Suburbs including Claremont Meadows, Erskine Park, St Clair and North St Marys drain into South Creek upstream of this gauge.

Daily flow data from these two gauges was utilised to prepare the specific flow duration curves shown in **Figure 4.10.**

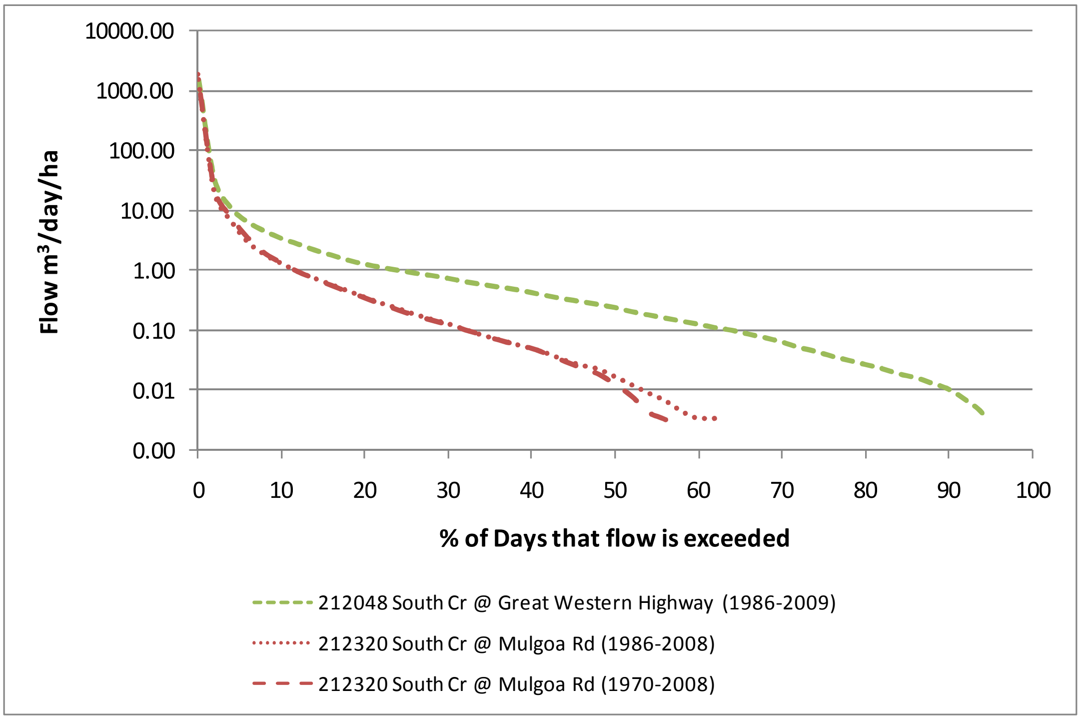


Figure 4.10 South Creek Daily Flow Duration Curves

The flow duration curves represent the typical flows along South Creek. The flow regime for any discharges from the Project Site should seek to achieve a flow duration curve that falls between the flow duration curves for 212048 and 212320 shown on **Figure 4.10**. It is considered that the flow regime for Blaxland Creek is likely to be ephemeral and closer to 212320.

Both Blaxland Creek and South Creek have extensive flood-prone areas. It is known that during substantial flood events, South Creek backs up Blaxland Creek. The 1% AEP flood, ie. the one in 100 year flood level adjacent to the Project Site is 35.6m AHD. This level extends for distances of 8m to 30m south of the Blaxland Creek southern bank to the base of Dam 2 and the western section of the northwestern bund wall (see **Figure 4.9**).

4.3.5 Design and Operational Safeguards

The design and operational safeguards discussed in this subsection focus on those relating to stormwater. Discussions relating to the leachate management system are presented in Section 4.2.5. For discussions relating to stormwater, distinction is made between sediment-laden water and clean water.

Sediment-laden water includes runoff from:

- clay/shale extraction areas;
- internal and perimeter bund walls;
- rehabilitated areas prior to the successful establishment of vegetation;
- access roads;
- runoff from the daily waste emplacement cover; and
- areas of the waste emplacement cells yet to be filled.

Clean water is that runoff from undisturbed catchments or catchments relatively undisturbed by clay/shale extraction, waste emplacement or related activities.

The principal objectives of surface water management for the Project are to both ensure that all surface water is managed appropriately to enable the efficient operation of clay/shale extraction and waste emplacement activities, to ensure that any water leaving the Project Site is discharged at an appropriate rate that meets appropriate quality standards and retains downstream riparian values. The key surface water management strategies to be adopted across the Project Site to ensure these objectives are satisfied are as follows.

1. Clean water runoff unaffected by the operations would be directed away from disturbed areas and off site.
2. A series of sediment dams and in-cell sumps would be constructed around the site.
3. All sediment-laden runoff that is not leachate would be directed into the sediment dams and in-cell sumps.
4. As much of the water as possible collected in the sediment dams would be re-used for dust suppression purposes.
5. When surplus, water which is collected in the sediment dams, could be discharged from the Project Site via licenced discharge points. If necessary, the water would be treated (eg. via coagulation) to ensure the appropriate water quality standards are met.
6. Temporary erosion and sediment control devices would be installed during the construction phase of the Project (eg. sediment fences and straw bales) to minimise the discharge of sediment-laden water from newly disturbed areas.
7. Sediment control structures would be maintained to ensure that the designed capacities are maintained for optimum settling of sediments.
8. An effective revegetation and maintenance and monitoring program would be implemented for the site.

GSSE/WBM (2010) identify a range of design and operational safeguards which collectively would assist to manage surface water on site such that, if discharges are required, water quality objectives would be satisfied and flow regimes in local creeks not substantially changed. The safeguards include the following.

Source Controls

Source controls are measures designed to collect sediment and minimise erosion at the source which in turn reduces the quantity of sediment transported and collected in the sediment dams on site. These controls include silt-stop fencing, straw bale barriers, rock groynes, diversion banks and level spreaders.

The Proponent would position these controls in the appropriate locations on site and relocate them, as required, throughout the life of the Project.

All source controls would be inspected monthly or following periods experiencing > 25mm of rainfall in 24 hours.

Sumps

The Proponent would excavate sumps within the active extraction areas to contain all stormwater, preferably away from the operational areas. Where appropriate, diversion banks would be constructed to divert stormwater to the sumps and avoid any mixing of stormwater and leachate.

Sediment Dams

GSSE/WBM (2010) consider the sediment dams on the Project Site as either “internal” or “external”. **Figure 4.11** displays the various sediment dams on the Project Site.

The internal sediment dams are or would be constructed within the perimeter bund walls. These dams (Dams 4 and 5) would have no gravity outlet and discharges would be controlled by pumping/syphoning etc. The approach to discharging from these dams to the external sediment dams would be established for high and low flow scenarios during the early stages of operation. However, emphasis would be upon the use of water from these dams for dust suppression.

The external sediment dams (Dams 2, 3 and 6) are outside the existing perimeter bund walls and are, or would be, able to overflow off site via a controlled pipe or high flow weir or spillway. The external dams would collect sediment from the external slopes of the existing perimeter bund walls when they are disturbed and from the long-term final landform. In time, as the final slopes are vegetated, less sediment would be generated for collection in these sediment dams.

Dam 2 would continue as the intermediate dam receiving water from Dams 4 and 5 that is surplus to site requirements and has been treated with coagulant for ultimate discharge off site from licenced discharge point (LDP) 1.

It is noted that all dams on the Project Site would have a pollution control function. Consequently, they would not need to be licenced in accordance with the Maximum Harvestable Right Dam Capacity policy.

The characteristics of the key sediment dams in use for each of these three scenarios are listed in **Table 4.5.** All sediment dams have been sized to ensure they contain up to the 90^{th} percentile 5 day duration rainfall event.

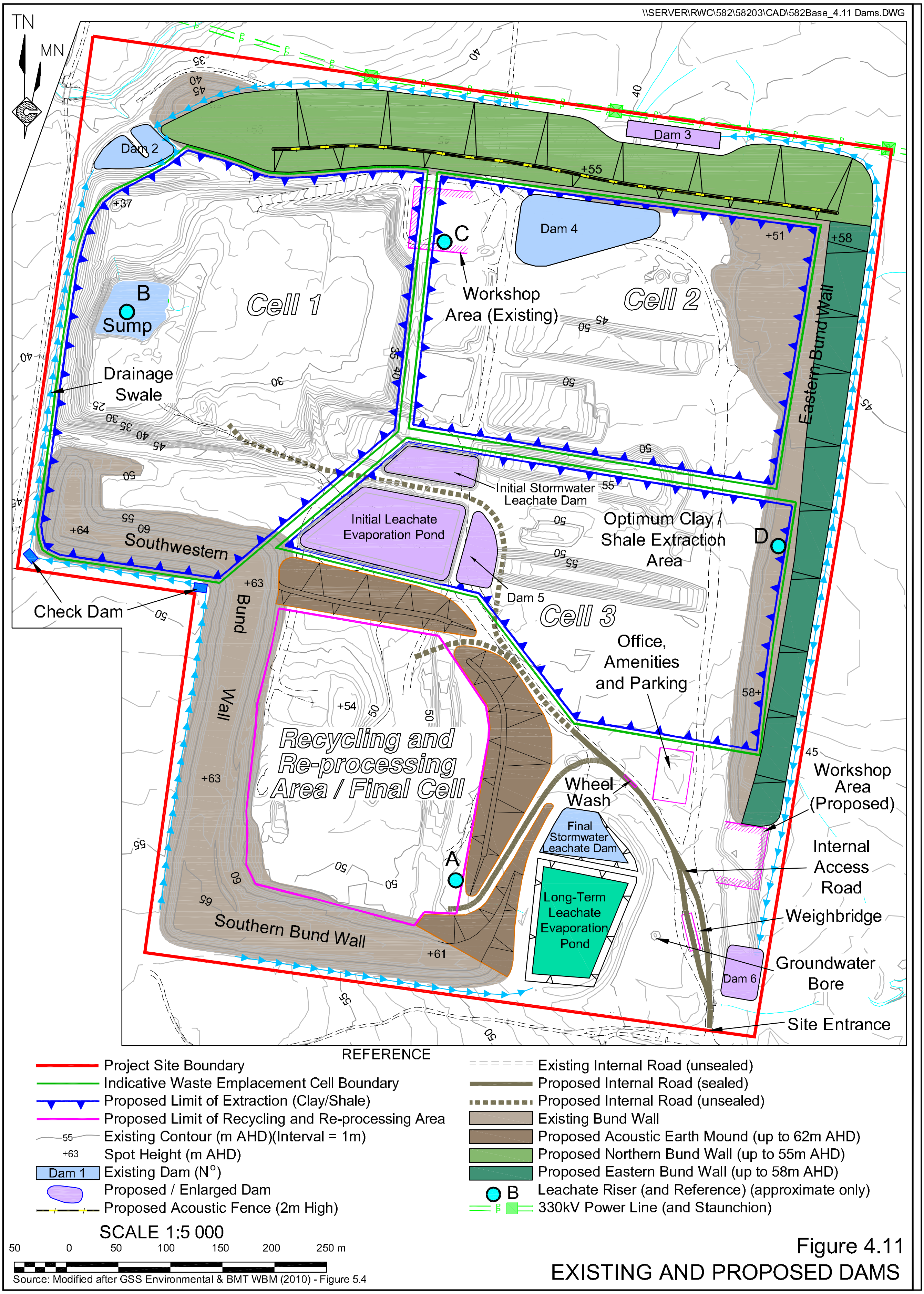


Figure 4.11
EXISTING AND PROPOSED DAMS

It is noted that the increased capacity in Dam 2 would be achieved by excavating material solely from the western two-thirds of the existing dam and retaining the eastern third of the dam with its aquatic vegetation to contribute to polishing the quality of water being discharged to Blaxland Creek from Dam 2.

GSSE/WBM (2010) present three representative operational scenarios for the management of surplus water throughout the operational life of the Project, namely for Year 1, Year 13 and the final landform.

Table 4.5
Sediment Dam Characteristics

Storage ID	Characteristic	Year 1	Year 13	Final
Dam 2	Catchment Area (ha)	6.3	15.4	18.8
	Surface Area (m^2)	2600	2600	2600
	Permanent Storage (m^3)	2600	2600	2600
Dam 3	Catchment Area (ha)	4.8	5.1	26.2
	Surface Area (m^2)	1250	1250	1700
	Permanent Storage (m^3)	2300	2300	3100
Dam 4 / Cell 2 Sump	Catchment Area (ha)	16.4	10.7	-
	Surface Area (m^2)	3000	2000	-
	Permanent Storage (m^3)	15000	3700	-
Dam 5 / Recycling and Re-processing Area/Final Cell Sump	Catchment Area (ha)	8	15.2	-
	Surface Area (m^2)	1800	1800	-
	Permanent Storage (m^3)	5300	5300	-
Dam 6	Catchment Area (ha)	9.5	9.5	12.3
	Surface Area (m^2)	1800	1800	1800
	Permanent Storage (m^3)	3300	3300	3300
Cell 1 Sump	Catchment Area (ha)	11.1	-	-
	Surface Area (m^2)	2300	-	-
	Permanent Storage (m^3)	4500	-	-
Source: GSSE/WBM (2010) – Table 5-3				

GSSE/WBM (2010) set out an approach that the Proponent would adopt, and modify based on site experience if necessary, for the discharge of water from the Project Site. The approach to discharging from the Project Site is predicated upon two factors.

a) the need to contribute to add some water to flows in Blaxland Creek during periods of low flow, i.e. to assist in maintaining environmental flows.

b) The need to reduce storage capacity of on-site sediment dams to ensure sufficient capacity is present to contain subsequent runoff events.

Based on these two factors, it is proposed to discharge water from the sediment dams under scenarios relating to either low or high storage levels.

Firstly, discharge would only occur when the storage level exceeds 10% of the total maximum storage capacity, i.e. up to a level of 50%. Low flow discharge would be up to $50m^3$ /day. Secondly, when the storage level exceeds 50% of the total maximum storage capacity, the excess water would be discharged to Blaxland Creek at a rate of up to 64L/s.

When surplus water is collected in the sediment dams, this water could be discharged from the site via licenced discharge points. If required, the water would be treated (e.g. via coagulation) to ensure the appropriate water quality standards are met.

Revegetation

The revegetation of disturbed areas, even temporarily with an interim cover crop, is a useful method to reduce sediment runoff. The Proponent is committed to the revegetation of completed surface areas on the final landform in areas of no more than 0.5ha at a time.

Conveyance Controls

Two forms of conveyance controls would be used on site, namely grassed swales and bioretention swales.

Grassed swales would be used to filter runoff being discharged to Blaxland Creek. The existing overflow from Dam 2 would be upgraded and maintained with a fully turfed swale.

The installation of bioretention swales would be investigated and installed, when practical to further improve the quality of water being discharged from the Project Site.

Water Treatment Processes

Observations and laboratory measurements of water accumulating within the sump in the northwestern extraction area and Dams 4 and 5 reveals that the dispersive nature of the clays onsite results in elevated turbidity levels, even when the total suspended solids concentrations are less than 50mg/L.

The Proponent has already used flocculants (polyaluminium chloride) to reduce the turbidity level in the water being discharged from the site to Blaxland Creek. Tests upon water being discharged from site have established that use of flocculants has reduced turbidity levels by 55% to 75% and total suspended solids concentration by approximately 50%, i.e. to levels similar to the natural levels in Blaxland Creek. The use of the flocculants would continue, as required throughout the life of the Project when it is necessary to discharge surplus water from sediment dams within the Project Site.

4.3.6 Site Water Balance

4.3.6.1 Introduction

GSSE/WBM (2010) have undertaken a detailed assessment of quantities of water required on site and those that are or would be available on site throughout the life of the Project. This has been achieved through a site water balance for operation in Year 1 and Year 13 based upon dry, median and wet rainfall conditions i.e. with annual rainfalls of 485mm, 805mm and 1147mm.

4.3.6.2 Water Sources

The Proponent has two sources of water on site, namely surface runoff and the on-site abstraction bore.

For the two scenarios in Year 1 and Year 13, the available total storage of sediment dams on site would be 33ML and 17.4ML respectively. It is noted that the existing Dam 1 has not been included as it would effectively only receive water pumped from the on-site groundwater bore with run-on water diverted to Dam 6. The total storage is therefore approximately 22% and 13% of the estimated annual runoff volume in a median year.

The other water source the Proponent would be able to draw upon throughout the life of the Project would be the on-site abstraction bore located adjacent to Dam 1. This bore (Licence No 10BL161098) is licenced for the recovery of up to 32ML per year.

4.3.6.3 Water Requirements and Losses

The site water requirements during Year 1 and Year 13 would be 37ML/year and 34ML/year respectively. This water would be required principally for dust suppression with small quantities used for vegetation establishment and to achieve optimum moisture content when compacting clays, if required.

The water would preferentially be drawn for dust suppression from Dams 4 and 5, however, additional water could be drawn from Dams 1, 2, 3 and 6.

The principal losses considered in the water balance relate to evaporation and site discharges.

Evaporation considered in the site water balance would occur from the upper soil layers, daily cover layer, surface depression storage and the surface of all sumps and sediment dams.

4.3.6.4 Site Water Balance Results

Table 4.6 presents a summary of the water balance results for the Year 1 and Year 13 scenarios.

Table 4.6
Summary of Water Balance Results

Input/Output	Input/Output Description	Dry Year (ML/yr)	Median Year (ML/yr)	Wet Year (ML/yr)
	Year 1			
Sources (1)	Surface water runoff	45	136	270
Losses (2)	Evaporation losses from storages	13	14	15
	Low and high flow site discharge	21	102	222
Supply (1) – (2)	Surface water available for re-use	11	20	33
Demand	Demand for internal site re-use	37	37	37
Deficit	Alternative water source	26	17	4
	Year 13			
Sources (1)	Surface water runoff	31	120	241
Losses (2)	Evaporation losses from storages	9	11	12
	Low and high flow site discharge	15	99	214
Supply (1) – (2)	Surface water available for re-use	7	10	15
Demand	Demand for internal site re-use	34	34	34
Deficit	Alternative water source	27	24	19

Source: GSSE/WBM (2010) – Table 7-1

The water balance effectively identifies that during Year 1 the calculated water deficit would vary between 19 and 27ML. For both scenarios, the deficit would be drawn from the on-site abstraction bore. GSSE/WBM (2010) does, however, suggest that it would be appropriate to review/optimise the approach to discharging from the sediment dams to retain additional quantities of water for on-site use.

Measures to be implemented to minimise water use on site, and in turn reduce the dependence on the groundwater bore include:

- undertaking progressive rehabilitation of the Project Site to minimise dust suppression requirements for disturbed areas;
- minimising the need for dust suppression water use via the implementation of dust mitigation measures, as recommended in the Air Quality and Greenhouse Gas Assessment (refer to Volume 2, Part 5 of the Specialist Consultant Studies Compendium); and
- preferential use of water collected in the sediment dams to meet water operational requirements.

4.3.7 Assessment of Impacts

4.3.7.1 Surface Water Quantity Assessment

Surface water quantity modelling was undertaken by BMT WBM to assist with water balance calculations, flow regime evaluation and the water quality assessment. The modelling was undertaken using the **M**odel for **U**rban **S**tormwater **I**mprovement **C**onceptualisation (MUSIC) model for Year 1, Year 13 and the Final Landform. Key meteorological inputs to the MUSIC model include rainfall and potential evapotranspiration (PET) data.

The MUSIC model was applied to complete continuous simulation rainfall-runoff modelling for the Project Site to assist with evaluating flow regimes. **Figure 4.12** displays the flow duration curves for Project Site discharges for Year 1, Year 13 and from the final landform.

Year 1

During Year 1 operations surface water discharges to Blaxland Creek would be managed primarily through a series of interconnected internal sediment dams that would capture and treat runoff prior to discharge to Blaxland Creek. The majority of site discharge during Year 1 would be actively managed by pumping from Dam 4.

The Year 1 scenario represents the Project Site in a condition which has the highest potential to generate runoff. The Year 1 flow regime modelling results shown in **Figure 4.12** indicate that during Year 1 operations the flows discharged from the site would be within the range of flows typical of an equivalent area in the South Creek catchment. Flows in the 10%ile to 70%ile range are likely to be of importance to the stream ecology and in this range it is expected that the Project would discharge flows on a similar flow regime as South Creek. It may also be important for the stream ecology to maintain ephemerality within the stream. The modelling results indicate that discharge flow from the site would not occur above the 55%ile (i.e. for 45% of time no flow would discharge from the site). This is consistent with the South Creek data where flow ceases above the 55%ile for Stn. 212320 (primarily rural catchment).

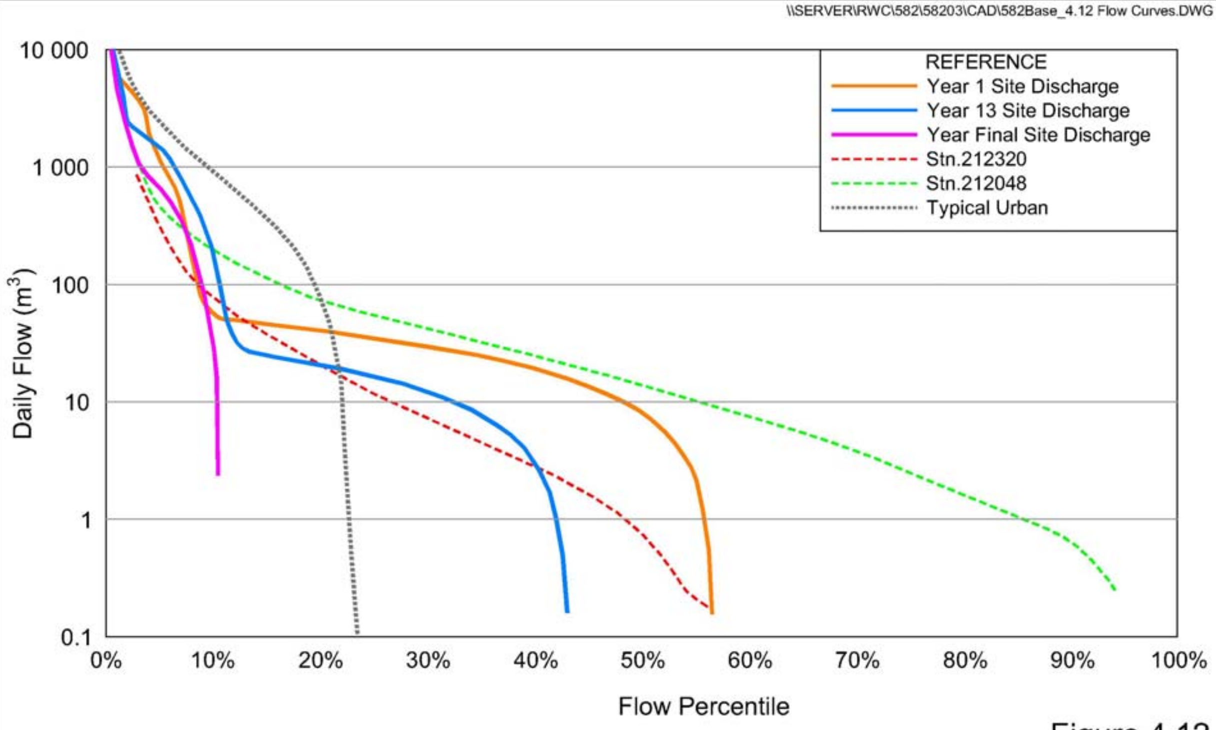


Figure 4.12
FLOW DURATION CURVES FOR PROJECT SITE DISCHARGES

Source: Modified after GSS Environmental & BMT WBM (2010) - Figures 5.5 to 5.7

Year 13

During Year 13 operations, surface water discharges to Blaxland Creek would also primarily be managed through a series of interconnected internal sediment dams capturing runoff for treatment, with the majority of internal dam discharge during Year 13 actively managed by pumping from Dam 5 to Blaxland Creek.

The Year 13 scenario represents the Project Site in a condition with less soil area disturbed than Year 1 and a reduced potential to generate runoff due to the progressive rehabilitation. The Year 13 flow regime modelling results shown in **Figure 4.12** indicate that during Year 13 operations, the flows discharged from the site are likely to be similar to those for an equivalent area in the South Creek catchment (Stn. 212320). Infrequent higher flows above the 1%ile flow (>1yr ARI flow) would be most relevant for stream forming and are likely to be of similar magnitude from the site as the existing South Creek flows. A key difference between discharges from the site and the observed flow characteristics in South Creek is within the 2% to 10% range where temporary storage and retention of flows within the site would result in this flow range being elevated above typical conditions. Whilst the flows would be elevated in this range, it is considered that this is a reasonable compromise to ensure that potential impacts on water quality are minimised.

Similarly to Year 1, flows in the 10%ile to 70%ile range are likely to be of importance to the stream ecology and in this range. It may also be important for the stream ecology to maintain ephemeral flows. The modelling results indicate that discharge flow from the site would not occur above the 45%ile flow. Similarly to Year 1, this is consistent with the South Creek data, although for Year 13 it is considered that the reduction in duration of flow discharges from the site would be approaching the characteristics of a first order stream in a natural situation.

Final Landform

At Final Landform stage, surface water discharges to Blaxland Creek would also be managed passively through Dam 2, Dam 3 and Dam 6 prior to discharge through low flow outlet structures into Blaxland Creek and a smaller tributary located south-east of the site boundary. The models incorporate modified outlets for Dam 2, Dam 3 and Dam 6 to achieve a nominal 72 hour extended detention for storage levels above the permanent water level. This has the effect of extending the period of discharge following runoff events.

The Final Landform scenario represents the Project Site in a fully rehabilitated condition. The Final Landform flow regime modelling results shown in **Figure 4.12** indicate that, following rehabilitation of the site, the duration of flow discharges from the site would be significantly reduced. Within the 0 to 5%ile flow range discharge from the site is expected to be similar to South Creek. It is expected that following completion of the site rehabilitation, the proposed 1m deep subsoil/topsoil layer and planted vegetation would intercept a significant proportion of rainfall.

Whilst the flow duration for the Final Landform scenario is significantly reduced, it is considered that this would be more representative of natural flows within first order streams in the South Creek catchment prior to development. It is considered that under natural conditions, surface discharge from the Project Site would have been ephemeral and occurred only following high rainfall periods that would result in surface flow to Blaxland Creek for less than 10% of time.

4.3.7.2 Surface Water Quality Assessment

GSSE/WBM (2010) reviews the likely changes in water quality in recognition of the proposed design and operational safeguards for the proposed discharge regime. The existing water quality data presented in Section 4.3.3.2 already provides a good appreciation of the impact site operations have had and would continue to have on surface water quality.

- Electrical Conductivity – No substantial changes to the salinity of the water on site is predicted. Whilst some groundwater is likely to either seep or flow into the extraction voids, its volume would be minimal and substantially diluted by the surface water accumulating on site.
- pH – the pH of surface water accumulating in the Project Site would continue to have a slightly higher pH range (pH 8.0 to 8.5) than Blaxland Creek (pH 7.0 to 7.5). The existing and proposed water accumulating on site would continue to have a high buffering potential recognised by GSSE/WBM (2010) as beneficial in terms of reducing potential for heavy metal dissolution in the water on the Project Site.
- Total Suspended Solids (TSS) and Turbidity – Experience to date confirms that both suspended solids concentration and turbidity levels need to be, and can be controlled for water discharged from site. The Proponent would adopt strict procedures to ensure that all water discharged from the Project Site satisfies the EPL discharge criteria.

- Total Nitrogen – No changes are predicted to occur in the nitrogen concentrations in Blaxland or South Creeks as a result of discharge from the Project Site.
- Total Phosphorus (TP) – Based upon measured concentration in the existing sump in the northwestern extraction area it is unlikely TP would vary from the existing low levels.

4.3.7.3 Blaxland Creek Core Riparian Zone

The Project would involve the removal of section of the northwestern bund wall from the existing Blaxland Creek Core Riparian Zone and the reduction in slope of the bund wall itself. No works would involve direct disturbance of the creek bed or banks. This work combined with the proposed planting of trees and shrubs in the core riparian zone and its buffer would have beneficial impacts on the area adjacent to Blaxland Creek.

It is also noted the proposed works would also not exacerbate any flooding characteristics of Blaxland Creek.

4.3.8 Monitoring

The Proponent is committed to a program of surface water monitoring to assist to understand the quality of water accumulating on site and to demonstrate the discharges of water from the Project Site comply with the criteria identified by GSSE/WBM (2010) and set out in **Table 4.7**.

Table 4.7
Surface Water Quality Assessment Criteria

Parameter	Recommended Criteria
pH	-
Total Suspended Solids (mg/L)	50
Turbidity (NTU)	6 - 50
Total Ammonia (mg/L)	0.9[1]
Dissolved Oxygen (mg/L)	7.7 – 9.0[2]
Electrical Conductivity (µS/cm)	125 - 2200

Note 1: Value established under the DGRs and the Blue Book Volume 2B.
Note 2: Range based on lower 85% saturation limit and typical water temperature range 13 – 20oC.
Source: GSSE/WBM (2010) – Table 9-2

The proposed monitoring program would review the water quality on site, during discharge periods and upstream and downstream locations in Blaxland Creek – see **Figure 4.13.** The frequency of monitoring is displayed in **Table 4.8**.

Table 4.8
Surface Water Quality Monitoring

Monitoring Location	Frequency	Parameters Measured
All internal and external dams	Quarterly	All listed in **Table 4.7**
Licensed Discharge Points (ie. Dam 2 and Dam 6)	Daily during active discharge	Turbidity
	Weekly during active discharge	All listed in **Table 4.7**
Blaxland Creek (Upstream and Downstream of the Licensed Discharge Point)	Quarterly	All listed in **Table 4.7**

Source: Modified after GSSE/WBM (2010) – Table 9-1

Additional prudent water quality monitoring would also be undertaken within Dams 2 and 6 during stages of the Project where the leachate evaporation pond and stormwater leachate dam are located within their respective catchments. Monitoring parameters, frequencies, criteria and triggers for response would be developed as part of the formal monitoring program to be established for the site.

All monitoring results would be presented in the Proponent's Annual Returns for its environmental protection licences and each AEMR. The presentation of the results would be accompanied by an evaluation of the results and review of the appropriateness of the monitoring program.

This section presents relevant information on the existing noise environment, environmental noise criteria, proposed operational safeguards and mitigation measures for the Project and an assessment of the residual impacts following the implementation of these safeguards and mitigation measures.

4.4 NOISE

The noise assessment was undertaken by Wilkinson Murray Pty Ltd. The full assessment (hereafter Wilkinson Murray, 2010) is presented as Volume 1, Part 4 of the Specialist Consultant Studies Compendium, with the relevant information from the assessment summarised in the following subsections.

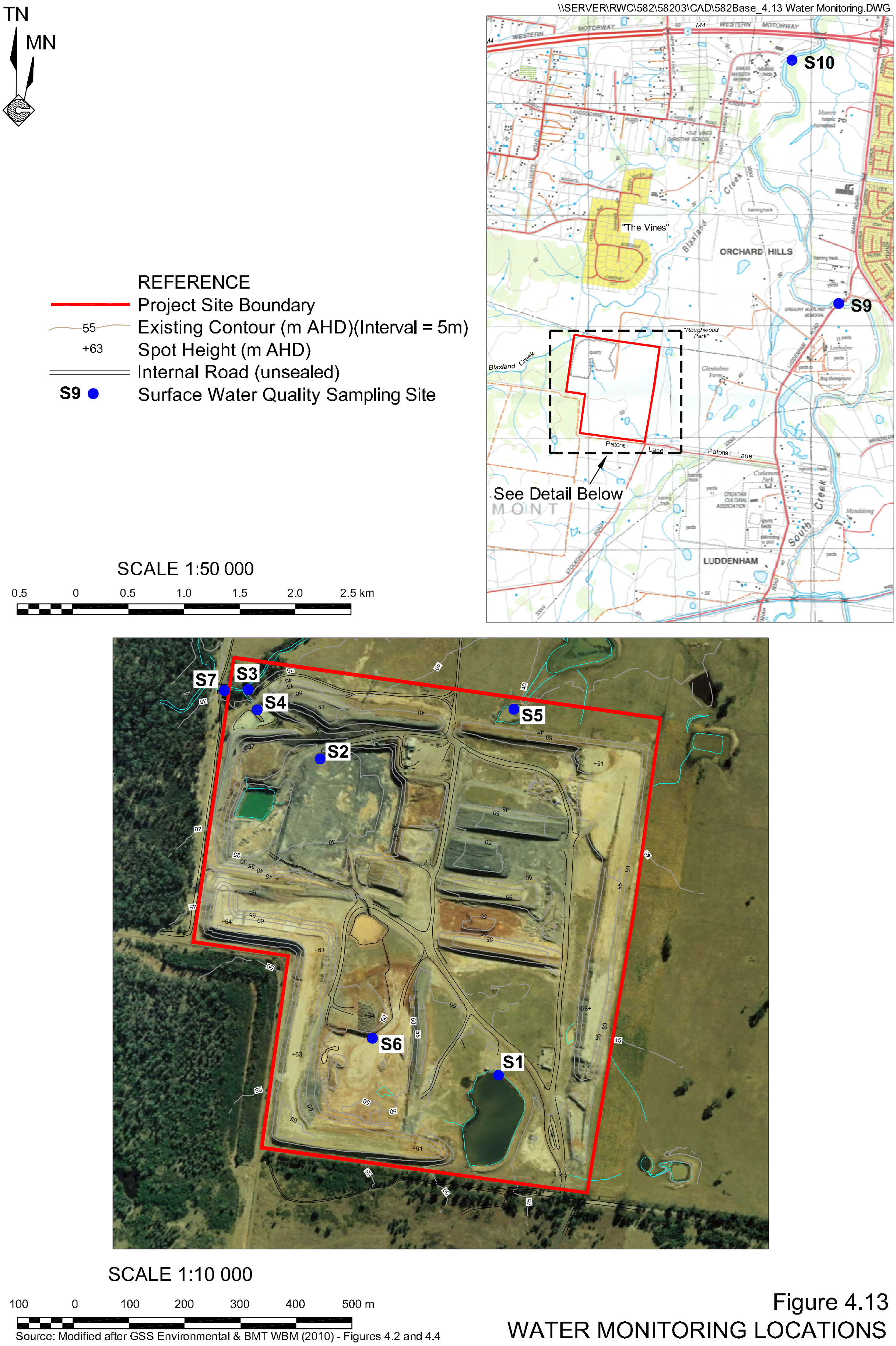
4.4.1 Introduction

Based on the risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential environmental noise impacts requiring assessment and their unmitigated risk rating are as follows.

- Increased noise levels associated with Project Site activities causing annoyance, distractions, ie. amenity impacts (low to high risk depending on noise level).
- Increased noise levels associated with road traffic causing annoyance, distractions, ie. amenity impacts (low to high risk depending on noise level).

Maximum noise levels causing sleep disturbance (high risk).

In addition, the Director-General's requirements issued by DoP and the requirements of the former DECC require that the assessment of noise and noise impacts include a quantitative assessment of the potential construction, operational and traffic noise impacts of the Project, in particular the staged removal of the bund walls. The *Environmental Assessment* needs to refer to the *NSW Industrial Noise Policy*, *Environmental Criteria for Road Traffic Noise* (EPA, 1999), *Environmental Noise Control Manual* (EPA, 1994)) and Draft Construction Noise Guideline 2008 (DECC).



Source: Modified after GSS Environmental & BMT WBM (2010) - Figures 4.2 and 4.4

Figure 4.13
WATER MONITORING LOCATIONS

4.4.2 Existing Noise Environment

Long-term, unattended noise monitoring was undertaken adjacent to the following three residences during the monitoring periods indicated.

Site 1 Vacant lot adjacent to 15 Cabernet Circuit, The Vines, Orchard Hills (28 May – 8 June, 2009).

Site 2 Bates' residence on the "Roughwood Park" property, via Luddenham Road, Orchard Hills (18 June to 28 June, 2009);

Site 3 216 Luddenham Road, Luddenham (28 May – 8 June, 2009).

The locations of all three monitoring locations are shown on **Figure 4.14**. These monitoring locations were chosen on the basis of representing those residences potentially most affected by noise from the Project.

The data collected from the noise loggers enabled the calculation of the Assessed Background Level (ABL), which is a single figure measure of the otherwise varying background noise during each day, evening and night periods respectively. The median of these values at each monitoring site is the Rating Background Level (RBL), which is taken to be the value which defines the background noise level to be used for assessing the Project. Notably, the calculation of the RBLs excludes any noise data collected during periods of rain or high winds (>5m/s) in accordance with the Industrial Noise Policy (INP). Detailed results of the noise monitoring – including periods of weather-excluded data - are shown graphically in Wilkinson Murray (2010).

Table 4.9 indicates the calculated RBL levels over the time periods relevant to this assessment. Notably, the Project would not operate during night periods other than between 6:00am and 7:00am (the "morning shoulder period") when trucks delivering waste and passenger traffic would arrive on site and truck-loading of recycled materials is undertaken within the bunded south-western cell of the site. Notably, **Table 4.9** indicates that RBLs during morning shoulder period are higher than their corresponding daytime RBL, which is due to the concentration of early morning traffic volumes on the M4 Motorway to the north. Notably, even notwithstanding the exclusion of this weather-affected data, more than a week's worth of valid monitoring data was obtained at each of the three sites monitored.

As is relevant for developing the Project's noise *amenity criteria*, on-site surveys indicated that the existing (pre-Project) level of "industrial" noise is negligible.

Table 4.9
Summary of Background Noise Levels at Sites 1 to 3

Site	Monitoring Period	Assessment Background Level (dB(A))	
		Morning Shoulder	Day
1	28/05/09 to 08/06/09 Range	31.6 to 43.2	29.2 to 37
	RBL	37	34
2	18/06/09 to 28/06/09 Range	33.9 to 46.1	32.1 to 40.5
	RBL	43	34
3	28/05/09 to 07/06/09 Range	37.5 to 47.6	35 to 39.5
	RBL	41	37

Note: Morning Shoulder Period: 6:00am-7:00am, Daytime 7.00am-6.00pm
Source: Wilkinson Murray (2010) – Modified after Tables 3.1 to 3.3.

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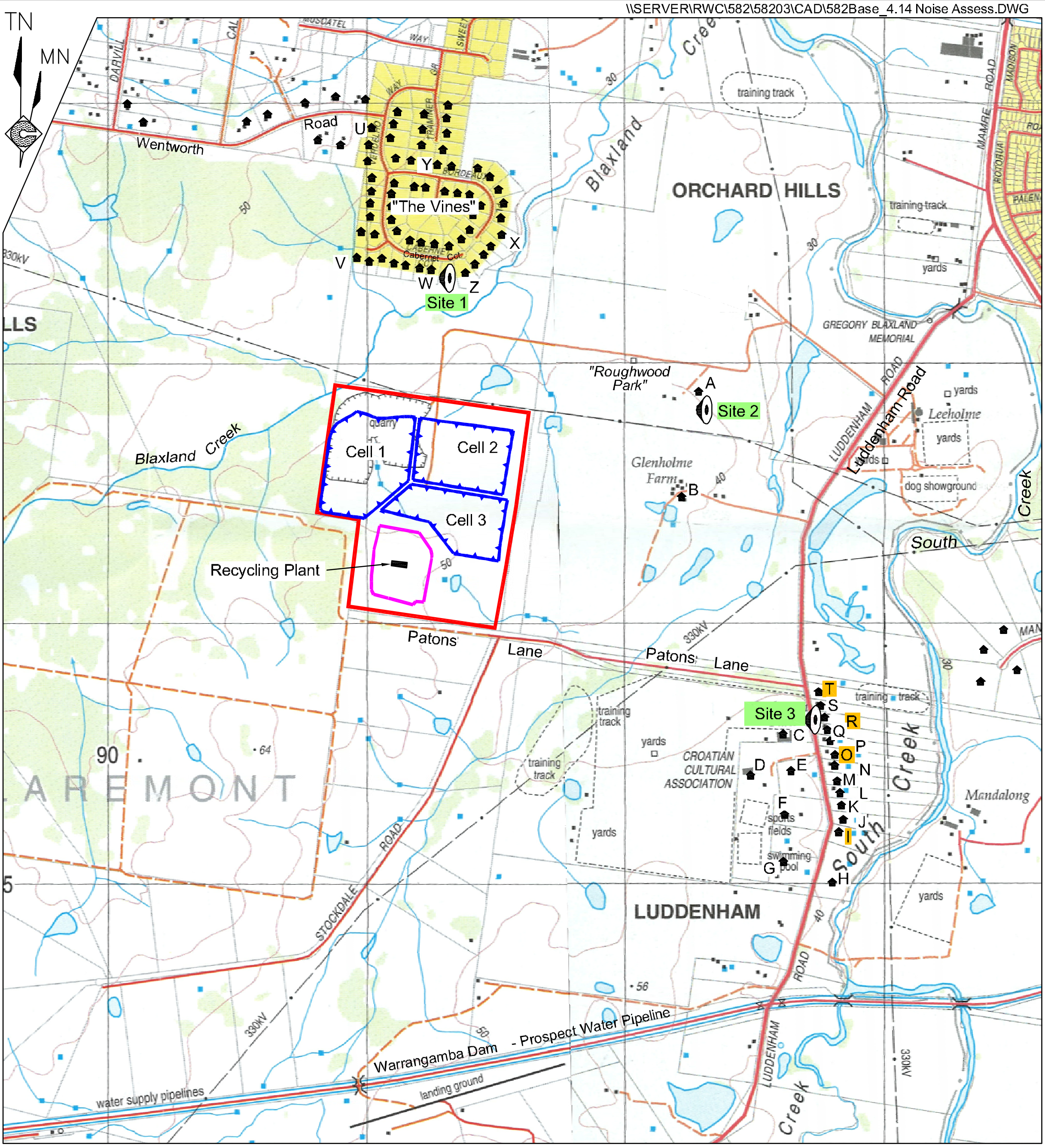

No.	Distance (m) to: Recycling Plant	Nearest Waste Cell	No.	Distance (m) to: Recycling Plant	Nearest Waste Cell
A	1330	720	N	1840	1500
B	1110	640	O	1820	1470
C	1600	1260	P	1780	1430
D	1570	1250	Q	1760	1400
E	1700	1370	R	1730	1370
F	1760	1450	S	1700	1340
G	1860	1580	T	1680	1310
H	2060	1760	U	1670	1090
I	1970	1660	V	1190	590
J	1960	1640	W	1140	570
K	1930	1600	X	1320	730
L	1900	1570	Y	1530	970
M	1870	1540	Z	1140	570

REFERENCE
- Project Site Boundary
- Residence
- Proposed Limit of Recycling and Re-processing Area
- Proposed Limit of Extraction
- A — Noise Assessment Location
- Site 1 — Noise Measurement Location

SCALE 1:25 000

250 0 250 500 750 1000 1250 m

Base Map Source: Prospect (2001) and Penrith (2001) 1:25 000 Topographic Maps

Figure 4.14
NOISE MEASUREMENT AND ASSESSMENT LOCATIONS

4.4.3 Project Noise Criteria

4.4.3.1 Introduction

The assessment of the Project's potential to create noise may be separated into two broad considerations, ie. for *on-site* and *off-site* related activities.

- Noise from *on-site* operations directly involved with the construction of noise-reduction components, eg. the northern bund wall are assessed in accordance with the *Interim Construction Noise Guideline* (DECC, 2009)
- Noise from *on-site* operations (including any on-site traffic) which is assessed under the DECCW's *Industrial Noise Policy (INP);* and
- Noise from *off-site* traffic associated with the Project which is assessed under the NSW *Environmental Criteria for Road Traffic Noise (ECRTN)* (EPA 1999).

4.4.3.2 Noise Criteria for Site Establishment and Construction

It is proposed that two criteria apply to the site establishment and construction period.

1. For the activities involved in the earthmoving component of the re-configuration and construction of the northern bund wall and raising of the eastern bund wall, it is proposed the relevant criterion is the noise management level specified for major construction projects in the *Interim Construction Noise Guideline* (DECC, 2009).

   This requirement specifies that the $L_{Aeq15min}$ does not exceed the background noise level by 10 dB(A) within the recommended hours:

   Monday to Friday 7:00am to 6:00pm
   Saturdays 8:00am to 1:00pm
   No work on Sundays or public holidays.

   It is proposed that this criterion applies to the earthmoving activities involved in these site establishment components which are planned to be completed over a 3 month period.

2. For the activities involved in the site establishment activities elsewhere on the Project Site and of a Saturday afternoon between 1:00pm and 5:00pm, the relevant criterion adopted would be the same as those for on-site operations throughout the operational life of the Project. It is programmed that all other site establishment and construction activities would occur for a period of approximately 6 months.

   Table 4.10 presents the proposed noise criteria for the site establishment and construction activities discussed in 1. above.

Table 4.10
Site Establishment and Construction Noise Criteria

Time Period	"The Vines"	Bates' Residence	Luddenham Road Residences
7:00am – 6:00pm Monday to Friday	44 dB(A)	44 dB(A)	47 dB(A)
8:00am – 1:00pm Saturday			
Source: Wilkinson Murray (2010) – Modified after Table 4.2.			

4.4.3.3 Noise Criteria for On-Site Operations

The *INP* identifies two noise criterion considered appropriate for operational noise. The criteria adopted for assessment purposes is the more stringent of the Intrusiveness or Amenity criteria.

The intrusiveness criterion specifies that the L_{Aeq} noise level from the Project's on-site noise sources should not exceed the Rating Background Level (RBL) by more than 5 dB(A).

The second consideration is the amenity criterion, which seeks to ensure that the L_{Aeq} noise contribution from the Project would not combine with existing *industrial* noise sources to exceed levels considered acceptable for the area. For residences in a rural setting, the relevant recommended "acceptable" levels are:

- Daytime (7:00am-6:00pm) 50 dB(A) L_{Aeq}
- Evening (6:00pm-10:00pm) 45 dB(A) L_{Aeq}
- Night (10:00pm-7:00am) 40 dB(A) L_{Aeq}

In this case, there is very little pre-existing "industrial" noise (eg, noise from stationary sources such as factories or plant) in the area surrounding the Project Site. The existing ambient noise of the area is dictated by regional traffic (on the M4 Motorway and Mamre Road in particular) which is NOT an industrial noise source. Thus, due to the absence of other competing industrial sources in the area, the level of "industrial" (which, in this case, is to say operational) noise from the Project Site is permitted up to the acceptable levels presented above.

Table 4.11 presents the derivation of the Project's operational noise criteria, which culminate as the product of whichever is the more stringent of the intrusiveness or amenity criteria.

Table 4.11
Summary of Intrusiveness and Amenity Noise Criteria

Time Period	Intrusiveness Criteria, $L_{Aeq,15min}$ (dB(A))			Amenity Criteria, $L_{Aeq,period}$ (dB(A))		
	"The Vines"	Bates Residence	Luddenham Road Residences	"The Vines"	Bates Residence	Luddenham Road Residences
Day	39	39	42	50	50	50
Morning Shoulder	42	48	46	40	40	40
Note: Daytime: 7.00am-6.00pm, Morning Shoulder period: 6:00am-7:00am						
Source: Wilkinson Murray (2010) – Table 4.3.						

Table 4.11 reveals that for day periods, it is the intrusiveness criterion that governs the Project's overall operational noise criteria. For sources such as those considered here, $L_{Aeq,15min}$ noise levels would be approximately 2 dB(A) above $L_{Aeq,Period}$ levels, and hence the "morning shoulder" amenity criteria are equivalent to approximately 42 dB(A) $L_{Aeq,15min}$. These are the most critical criteria for that period. **Table 4.12** summarises the overall criteria that control the total noise emissions from the Project Site, in terms of $L_{Aeq,15min}$.

Table 4.12
Criteria for Operational Noise at Residences from On-Site Activities

Time Period	Project Noise Criteria, $L_{Aeq,15min}$ (dB(A))		
	"The Vines"	Bates Residence	Luddenham Road
Day	39	39	42
Morning Shoulder	42	42	42

Note: Daytime 7.00am-6.00pm, Morning Shoulder period 6.00am-7.00am.
Source: Wilkinson Murray (2010) – Table 4.4.

4.4.3.4 Criteria for Noise from Off-Site Traffic

Approach to Setting Criteria

DECCW's *Environmental Criteria for Road Traffic Noise (ECRTN)* sets out criteria for assessment of noise from Project vehicles on public roads before they arrive at the Project Site ie. when travelling on Mamre Road, Luddenham Road and Patons Lane.

The *ECRTN* sets out noise criteria for "Arterial", "Collector" and "Local" roads. The classification of roads included in the Project's proposed transportation network are listed below:

Local Roads	Patons Lane, Luddenham Road
Collector Roads	Mamre Road
Freeway/Arterial Roads	M4 Motorway, Great Western Hwy, Elizabeth Dr, Westlink M7.

Based on the criteria specified in the *ECRTN*, it is likely that the potential for traffic noise impacts from the Project would be greatest on the local roads of Patons Lane and, in particular, Luddenham Road, where several residences are located.

The *ECRTN* traffic noise criteria for "land use developments with potential to create additional traffic on local roads" are that noise from traffic associated with the Project should not exceed:

For Local Roads

- Daytime (7.00am-10.00pm) $L_{Aeq,1hr} = 55$ dB(A)
- Night Time (10.00pm-7.00am) $L_{Aeq,1hr} = 50$ dB(A)

These criteria relate to the level of noise from Project traffic as measured external to the most affected building façade of the nearest affected residence.

Where existing traffic noise levels already exceed these values, the *ECRTN* indicates that:

> *"Where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments.*
>
> *In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB."*

4.4.3.5 Criteria for the Prevention of Sleep Disturbance

Given that the Project includes heavy vehicle and passenger vehicle movements between 6:00am and 7:00am which falls within the night time period (as defined by DECCW), there is potential for the components of the Project occurring during that period to cause sleep disturbance.

The *ECRTN* includes a methodology for the assessment of sleep disturbance arising from traffic. In summary, the *ECRTN* concludes that:

- Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions.
- One or two noise events per night, with maximum internal noise levels of 65-70 dB(A), are not likely to affect health and wellbeing significantly.

For this assessment, a maximum internal L_{Amax} noise level of 55 dB(A) has been adopted as the primary test for the potential for sleep disturbance. This corresponds to a noise level of 65 dB(A) L_{Amax} *external* to the residential façade, if windows are open as may be required for ventilation during summer. Wilkinson Murray (2010) consider the residences in this assessment are of a construction such that an open window would provide approximately 10 dB noise reduction.

On the same basis, the secondary goal above can also be re-expressed as an *external* goal such that "one or two noise events per night, with maximum *external* (to the building facade) noise levels of 75-80 dB(A) are not likely to affect health and wellbeing significantly".

4.4.4 Design and Operational Safeguards

The Proponent would adopt a range of design and operational safeguards to ensure that the various noise criteria are satisfied at all surrounding residences or the extent and duration of any exceedance are minimised. The various safeguards were compiled in an iterative manner to identify the safeguards that would be appropriate to attenuate or limit noise propagation from the Project Site. All safeguards would be incorporated in a noise management plan that would be prepared / reviewed prior to site establishment stage and receipt of wastes in Cell 1, Cell 2 and Cell 3.

4.4.4.1 Northern and Eastern Bund Wall Construction

Given the exposed area of activity on the northern, and at times elevated, sections of the northern bund wall, the Proponent would ensure that the following safeguards are adopted throughout its construction.

1. All activities on the northern external side of the northern bund wall would be undertaken only between the hours of 7:00am to 6:00pm, Monday to Friday and 8:00am to 1:00pm Saturdays, public holidays excluded.
2. Earthmoving equipment operating on the northern bund wall would be sequenced such that only nominated mobile equipment, eg. trucks/scrapers can be on the northern side of the northern bund wall at any one time.
3. A 4m high mobile acoustic barrier (between 100m and 150m in length) positioned, as required, during the site establishment stage to shield residences from earthmoving equipment.
4. A program of monitoring would be initiated during the first week of construction to assist the Proponent to fully understand the sequencing of equipment needed to contain the noise levels at "The Vines" to the nominated 44 dB(A) noise level.
5. All earthmoving equipment would be checked prior to use on the northern bund wall to ensure that its sound power level is equal to or less than the noise level nominated in **Table 4.13**. Any equipment not satisfying this requirement would not be allowed to operate on the northern side of the northern bund wall. Only broadband reversing alarms would be permitted on mobile equipment used on site.
6. All equipment operators would be requested to operate the earthmoving equipment in the most noise efficient means possible, eg. bulldozers would only be operated in first gear when in reverse.
7. All efforts would be made to operate at the topographically lower levels of a morning between 7.00am and 9.00am to limit noise during that period although it is acknowledged this period is often the period with highest background noise level attributed to traffic on the M4 Motorway.

Similar safeguards would be applied by the Proponent when deconstructing / reshaping and increasing the elevation of the eastern bund wall during the site establishment period.

Table 4.13
Modelled Equipment and Sound Power Levels

Equipment	Source Description	LAeq,15min SWL (dB(A)
Truck	Truck in motion	107
	Truck Idling	102
	Water Truck	107
Compactor	Compacting earth on rehab mounds	110
FEL	Earthworks & loading trucks	111
Scraper	Earthworks	107
Excavator	Earthworks	107
Crusher	Processing recyclable materials	121
Trommel	Processing recyclable materials	110
Shredder	Processing recyclable materials	112
Picking Stn	Small conveyor used for sifting	100

Note: Crusher and Trommel SWLs are as given by the manufacturer of units to be used on the Project Site.
Source: Wilkinson Murray (2010) – **Table 5.2**

4.4.4.2 Remaining Site Establishment and Construction Operations

The following safeguards are proposed during the site establishment and construction operations throughout the remainder of the Project Site during the period whilst the northern bund wall is being constructed and following its construction until the site is established and ready to accept waste.

1. All earthmoving activities would be undertaken only between the hours of 7:00am to 6:00pm, Monday to Friday and 8:00am to 1:00pm Saturdays, public holidays excluded.
2. Activities undertaken between 1:00pm and 5:00pm of a Saturday would be those generating lower noise levels at surrounding residences given the applicability of the more stringent noise criterion during that period.
3. All equipment would be checked prior to use on site to ensure its sound power level is equal to or less than the noise level nominated in **Table 4.13**. Any equipment not satisfying this requirement would not be allowed to operate on site.
4. The level of mobile equipment operating on the site would generally be limited to that listed in the scenarios for the site establishment period.
5. A program of monitoring would be undertaken following the completion of construction on the northern bund wall to demonstrate the remainder of the activities on site also satisfy the operational noise criteria specified in **Table 4.13**.

4.4.4.3 Ongoing Site Operations

Throughout the site establishment period, the Proponent would construct the following acoustic barriers to reduce noise associated with the ongoing operation of the site.

1. The northern bund wall would be constructed to an upper elevation of 55m AHD. Whilst the external batters would be comparatively gentle to support vegetation growth, the internal batters would be steeper, that is, approaching angle of repose, to maximise the effectiveness of the bund wall to limit noise propagated from the Project Site.
2. A 2m high wooden fence would be erected on top of the 55m AHD section of the northern bund wall to raise the effective barrier height at that location to 57m AHD.
3. The upper surface of the eastern bund wall would be raised to a constant elevation of 58m AHD with VENM from Cell 1 and capped within on-site derived clay. The external surface of the placed material would be covered with soil material and vegetated.
4. The northern and eastern earth mounds would be constructed adjacent to the Recycling and Re-processing Area with an upper elevation of 62m AHD. The external visible section of the mounds would be covered with soil material and spray grassed.

Throughout the operational life of the Project, a range of operational procedures would be adopted to contain noise within the nominated criteria or the extent and duration of any exceedance are minimised.

1. All activities would be undertaken only between the hours of 7:00am to 6:00pm, Monday to Friday and 8:00am to 5:00pm Saturdays, public holidays excluded.
2. During the period when the mobile recycling and re-processing plant is operating, stockpiles of materials would be placed on eastern and northern sides of the plant to attenuate noise from the operation of the mobile plant.
3. Following the erection of the long term recycling and re-processing facility, a set of barriers/partial enclosures would be erected on the northern and eastern sides of the plant to attenuate noise from the operation of the long-term plant. The exact form of the barriers/enclosures would be established in conjunction with an acoustic consultant following the placement of the equipment and prior to the completion of the commissioning period. If necessary, some of the equipment would be partially enclosed.
4. It is proposed to construct the waste emplacements in Cells 1 and 2 by commencing on the northern side of each cell to provide the maximum acoustic protection. This approach would be maintained once the waste emplacement surface rises above the natural land surface. The wastes would be emplaced on the northern side first to create a barrier of typically 3m to 4.5m behind which ongoing waste emplacement can proceed.
5. The northern bund wall and wooden fence would provide attention for most of the activities within Cell 1. However, for those sections of Cell 1 where activities would not be fully shielded, the Proponent would place the 4m-high mobile noise barriers referred to in Section 4.4.4.1 to shield the earthmoving equipment operating in those areas.
6. The Proponent would operate the waste emplacements in a manner that would ensure that activities are undertaken in the lowest parts of each cell during those periods when noise levels may be enhanced when operating at higher levels eg. early mornings/ gentle breezes to the north.
7. The rehabilitation activities on the final landform, particularly on the northern slopes, would require earthmoving equipment to operate in locations and at elevations that require shielding using the 4m-high mobile noise barrier. The 4m barrier would be relocated every 2m vertically as the landform rises to retain effective shield of noise.
8. Only the nominated number of items of earthmoving equipment would be operating behind the 4m-high barrier and all equipment operators would be requested to operate the earthmoving equipment in the most noise-efficient means possible.

In addition to the above safeguards, the Proponent recognises that there would be sufficient flexibility with on-site operations to ensure that noise levels from earthmoving equipment is minimised, wherever possible. This would be achieved by operating at the topographically lower areas when localised background levels are comparatively low and vice versa. An appreciation of the wind direction would also be reflected in the selection of operating locations on any given day. Earthmoving activities would have less impact at "The Vines" when operating during periods when the wind direction is within the Sector 300° to 100°. It is noted that no reliance has been placed upon this management practice when assessing impacts from noise. Rather, it simple demonstrates the Proponent's commitment to operate as much as possible below the nominated criteria.

Table 4.14 lists the proportion of time each month that winds are blowing from the 300º to 100º sector.

Table 4.14
Frequency of Winds Blowing Away from "The Vines" Estate.*

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
57.8	44.8	39.2	32.0	59.5	24.2	36.3	56.8	39.4	47.8	39.4	50.1

* Based on 7.00am to 6.00pm and originating within the sector 300o to 100°
Source: Bureau of Meteorology (2009).

Effectively, this data indicates the proportion of time each month that the Proponent could undertake the rehabilitation activities in exposed locations.

4.4.5 Assessment of Impacts

4.4.5.1 Introduction

The assessment of impacts upon the noise climate around the Project Site has been assessed through the use of computer modelling undertaken by Wilkinson Murray (2010). The inputs to the modelling included the noise sources/levels (see **Table 4.13**) and their location, surrounding topography, the on-site topographic barriers and the various meteorological conditions experienced in the Orchard Hills area.

The *INP* requires that in predicting operational noise levels, wind speed and direction should be taken into account if wind speeds of up to 3m/s in the source to receiver direction occur more than 30% of the time in any season.

Records of wind speed and direction were obtained from DECCW's meteorological station at St Marys, approximately 3km northeast of the Project Site, for the year January 2006 to December 2006. Records show that during the daytime periods over the entire year, winds of between 0.5m/s and 3m/s occur for over 30% of the time only from the north and northwest during autumn and from the northeast during summer.

In cases where consideration of meteorological conditions is required, a procedure has been developed for addressing meteorological conditions which is considered to be consistent with the intent of the *INP*, and is more realistic than the procedure of adopting a single condition for assessment (although more difficult to implement) (Wilkinson Murray, 2009). This procedure has been accepted by DECCW in previous assessments, and is used in this report to calculate noise levels from the Project Site.

Five operational scenarios were considered by Wilkinson Murray (2010) for this noise assessment. These represent the typical *worst case* operating conditions during each of the phases of the Project. Given that, during these operating scenarios, there would be significant periods during which not all plant is operating concurrently or at their most exposed locations, noise emissions from the site would most often be lower than is represented by each scenario.

The five operational scenarios assessed were as follows.

Scenario 1: Site Establishment and Construction – involving principally the construction of the northern bund wall; excavation activities in the Recycling and Re-processing Area and Cell 1; construction of various water management structures and installation of components of the leachate management system.

Scenario 2: Initial Waste Placement and Recycling – involving principally the delivering of waste to the Recycling and Re-processing Area and Cell 1A; excavation of clay/shale in Cell 1B and stockpiling above Cell 2; operation of the mobile recycling and re-processing plant and despatch of clay/shale and recycled and re-processed products.

Scenario 3: Stage 2A Waste Operations – involving principally the delivery of waste to Cell 2A; excavation of clay/shale in Cell 2B and stockpiling above Cell 3; final rehabilitation on the upper stages above Cell 1; operation of the long-term recycling and re-processing plant and despatch of clay/shale and recycled and re-processed products.

Scenario 4: Stage 3B Operations – involving principally the delivery of waste to Cell 3B; excavation of clay/shale in Cell 3C; finalisation of the upper slopes above Cell 3A; operation of the long-term recycling and re-processing plant and despatch of clay/shale and recycled and re-processed products.

Scenario 5: Early Morning Operations (6:00am – 7:00am) – involving only delivery of waste to the Recycling and Re-processing Area and Cell 1A and loading/despatch of recycling and re-processed products. (All other activities would commence after 7:00am).

Details of each of the above scenarios are provided in Section 5.3 of Wilkinson Murray (2010). For Scenarios 1, 3 and 4, an additional option was modelled reflecting the presence of "favourable winds", ie. winds blowing away from the residences in "The Vines", ie. when blowing in the direction of 300º to 100º.

4.4.5.2 Predicted Operational Noise Levels from On-Site Activities

Tables 4.15 to **4.17** present the noise levels predicted at a representative set of potentially affected surrounding residences under all relevant meteorological conditions for site establishment, daytime operations and early morning activities (6:00am to 7:00am).

For daytime calculations, 41 separate meteorological conditions were considered – wind speed of 0.5-3m/s in each of eight directions, and zero wind speed (representing both zero wind and wind speeds above 3m/s). Noise levels were calculated under each of these conditions, and the probability of occurrence of each condition for daytime periods in each season was then used to calculate the L_{Aeq} noise level which would be exceeded for 10% of 15-minute periods. **Tables 4.15** to **4.17** show the predicted noise level exceeded for 10% of 15 minute periods during the worst case season for daytime meteorological conditions. These predictions are inclusive of the consideration of the effects of temperature inversions which occur at the site.

It is noted that multiple results are presented for Scenarios 1, 3 and 4, ie. 1a, 3a and 4a in order to distinguish the noise emissions of the Project during these stages from noise resulting for the relatively small proportion of time for which plant would be operating on the northern or eastern slopes of the final landform. Noise from earthmoving equipment working on exposed (to residences) slopes of the final landform would be minimised by developing the edge of the landform nearest the residences first and having equipment work behind it wherever possible.

Table 4.15
Predicted Noise Levels Exceeded for 10% of 15 Minute Periods During Site Establishment and Construction

Residence Address	ID[1]	Criterion	Scenario 1
9 Verdelho Way	Y	44	35
3 Chablis Pl	V	44	39
15 Cabernet Cct	W	44	39
11 Cabernet Cct	Z	44	39
Bates Residence	A	44	36
Newham Residence	B	44	35
210 Luddenham Rd	T	47	31
216 Luddenham Rd	R	47	31
230 Luddenham Rd	O	47	30
262 Luddenham Rd	I	47	29
Notes: 1 – Residence location shown on **Figure 4.14**			
Source: Modified after Wilkinson Murray (2010) – Table 5.3			

Table 4.16
Predicted Noise Levels Exceeded for 10% of 15 Minute Periods During Daytime Operations

Residence Address	ID[1]	Criterion	Scenario		
			2	3	4
9 Verdelho Way	Y	39	37	38	37
3 Chablis Pl	V	39	38	38	37
15 Cabernet Cct	W	39	38	39	38
11 Cabernet Cct	Z	39	39	39	39
Bates Residence	A	39	39	38	38
Newham Residence	B	39	39	39	39
210 Luddenham Rd	T	42	37	37	36
216 Luddenham Rd	R	42	37	37	36
230 Luddenham Rd	O	42	36	36	36
262 Luddenham Rd	I	42	36	36	37
Notes: 1 – Residence location shown on **Figure 4.14**					
Source: Modified after Wilkinson Murray (2010) – Table 5.4					

Table 4.17
Predicted Noise Levels Exceeded for 10% of 15 Minute Periods During Early Morning Operations (6:00am to 7:00am)

Residence Address	ID[1]	Criterion	Scenario 5
9 Verdelho Way	Y	42	38
3 Chablis Pl	V	42	37
15 Cabernet Cct	W	42	39
11 Cabernet Cct	Z	42	39
Bates Residence	A	42	35
Newham Residence	B	42	34
210 Luddenham Rd	T	42	29
216 Luddenham Rd	R	42	29
230 Luddenham Rd	O	42	29
262 Luddenham Rd	I	42	29

Notes: 1 – Residence location shown on **Figure 4.14**

Source: Wilkinson Murray (2010) – Table 5.5

Notably, the noise levels presented in **Table 4.15** to **Table 4.17** represent emission levels from typical worst case conditions (ie. plant operating in those locations most exposed to residences in worst case wind conditions – wind blowing toward residences.) At many times, noise levels from the site would be less than the presented levels. Further, at times of favourable winds (blowing away from, rather than toward residences), noise would be much reduced from these levels. The Noise Management Plan to be developed for the Project would seek to optimise the operational flexibility of the site in order to take advantage of these opportunities to reduce noise from the site to residences.

4.4.5.3 Evaluation of Predicted Operational Noise Levels

Table 4.15 indicates that noise generated during the northern bund wall construction and at other times during the site establishment period would comply with the criteria relevant to that period of operations. It is acknowledged that for the closest residences within "The Vines" estate, the predicted noise level would equal the criteria which would require dedicated adherence of the Proponent and the earthmoving operator to the specific safeguards for that period.

The predicted elevated noise levels during the initial 3 months of the site establishment period are considered appropriate given the outcome of the northern bund wall construction would be creation of the principal long term audio-visual control for the entire estate.

Daytime Operations

Table 4.16 indicates that for the operational Scenarios 2, 3 and 4, full compliance would be achieved at all residences for Scenario 2, and all residences except the Newham Residence (Residence B) for Scenarios 3 and 4. The recorded predicted exceedance of 1 dB is minor and attributable to circumstances where the Proponent has the ability to adjust operations slightly to achieve compliance. In any event, the Proponent would consult with the occupiers of the Newham residence during the predicted period of potential exceedances to discuss the potential exceedance.

Table 4.16 identifies that not withstanding the considerable design and operational safeguards proposed, the presence of earthmoving equipment on the northern and eastern slopes of the final landform would cause noise exceedances of up to 6dB(A) at residences in the south-western sector of "The Vines" estate and the Newham residence. Given the presence of equipment on the upper slopes of the final landform is fundamental to the successful rehabilitation of the site, it is concluded that such exceedances are unavoidable for the periods during which they occur.

It is appropriate to place the predicted exceedances in perspective to support the Proponent's position that the rehabilitation activities should proceed in the manner proposed. Reference to the background noise measurements recorded in **Appendix 3** of Wilkinson Murray (2010) regularly shows L_{eq} noise levels attributable to M4 Motorway traffic in excess of 45 dB(A) of a morning and then periodically throughout the day.

It is further noted that many of the subject residences are not occupied on most weekdays and consequently the opportunities exist through consultation with the occupants of those potentially affected residences to undertake the proposed rehabilitation activities without impacts.

It is the Proponent's intention in conjunction with a detailed monitoring program to regularly review the approach to rehabilitation activities in consultation with the occupants of nearby residences.

Early Morning Operations

Table 4.17 indicates that noise from early morning (6am to 7am) on-site operations would comply with all relevant noise criteria for all prevailing meteorological conditions including temperature inversions.

4.4.5.4 Noise from the Project's Off-Site Traffic

L_{Aeq} noise levels over a 1 hour period associated with existing traffic, and the proposed additional traffic, were calculated using the CoRTN prediction procedure. Worst-case assumptions were made regarding traffic generated by the Project. For existing traffic, the maximum traffic volume in any hour was recorded as 300 per hour, with a lower volume of 250 per hour assumed for a typical hour during the daytime.

The receivers potentially most affected by traffic noise from the Project are located adjacent to Luddenham Road. The most potentially affected residence is located approximately 60m from the nearest point of the route taken by trucks arriving to the site from the north.

Other parameters used in the calculation of road traffic noise levels are shown in **Table 4.18**.

Table 4.18
Calculation of Noise Levels from Road Traffic

Parameter	Existing Traffic	Additional Project Traffic
Vehicles Per Hour	250	45 (30 heavy + 15 light)*
Percentage Heavy Vehicles	7%	67%
Road Surface Correction	+1 dB	+1 dB
Distance to facade	21 m	60 m
Percentage Soft Ground	50%	50%
Calculated $L_{Aeq,1hr}$	60.6 dB(A)	53.4 dB(A)
Source: Wilkinson Murray (2010) – Table 6.2		* Movements

Table 4.18 indicates that a typical existing hourly traffic noise level of 60.6 dB(A) can be expected at the worst-case receiver, and additional traffic from the Project, under worst-case conditions, would create 51.8 dB(A). The total traffic noise level is then calculated to be 61.1 dB(A), or an increase of 0.5 dB over the existing level, which is within the allowance criterion of +2 dB(A). Thus, it is expected that the Project would not give rise to any operational traffic noise impacts.

The potential for sleep disturbance from the Project's traffic is contained to the consideration of noise to residences from trucks as they approach the site prior to 7:00am. Based on the sound power level of a truck pass-by being 108 dB(A) L_{Amax}, the (façade-corrected) noise levels external to the most potentially affected residences is predicted to be 66 dB(A) L_{Amax}.

The predicted truck passby noise levels at the most affected residences would be greater than the primary noise goal of 65 dB(A) L_{Amax}, by 1 dB, which is an insignificant exceedance level.

On this basis, it is expected that early morning truck movements to the Project Site would not give rise to sleep disturbance for those residents in close proximity to the transport route.

4.4.6 Monitoring

The Proponent recognises that there would be considerable benefit in undertaking targeted noise monitoring programs to assist in the validation of the modelling undertaken by Wilkinson Murray (2010) and, demonstration of compliance.

It is proposed to initially undertake monitoring of site establishment and daytime operational noise at the rear of Residences V, W and Z to identify which of these residences should be the location of long term monitoring. Monitoring of operational noise is also proposed at Residences A and B. Monitoring of traffic-related noise is proposed to be undertaken at Residence T, the closest residence to the intersection of Luddenham Road and Patons Lane.

The monitoring program would be regularly reviewed (at least every 3 years) to ensure only meaningful data is being collected.

All monitoring results would be discussed with the respective owners and included in each Annual Environmental Management Report.

4.4.7 Conclusion

The noise generated on site would periodically be audible at surrounding residences, however, it is predicated that the noise levels generated would comply with the site specific noise criteria at the respective residences.

The Proponent recognises that noise would potentially be most audible at "The Vines" estate when earthmoving equipment is constructing the northern bund wall during the initial 3 months of the site establishment phase. With such a recognition, the Proponent would regularly consult with surrounding residents in order to minimise the noise impacts on these residents during that period.

With respect to road-traffic noise, compliance under all circumstances has been predicted, however, the Proponent accepts that it has a responsibility to ensure that drivers travelling to and from the Project Site do so in a manner that minimises traffic noise-related impacts.

4.5 AIR QUALITY

The air quality and greenhouse gas assessment for the Project was undertaken by PAEHolmes (2010). The full assessment is presented in Volume 2, Part 5 of the Specialist Consultant Studies Compendium, with the relevant information summarised in the following subsections.

4.5.1 Introduction

Based on the risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential air quality impacts requiring assessment and their **unmitigated** risk ratings are as follows.

- Deposited dust levels attributable to the Project are unlikely to exceed the DECC guideline level, (low risk).
- PM_{10} levels may occasionally (once every 1 to 2 years) rise above the Project goal (only on those days when background levels attributable to other sources are high) (low risk).
- Greenhouse gas emissions (moderate risk).
- Detection of odour at surrounding non-Project related residences (low to high risk).
- Impacts extend beyond the Project Site or impact on extensive areas of native vegetation (low risk).

The Director-General's requirements issued by the DoP require that the *Environmental Assessment* include the following.

- Quantitative assessment of the potential air quality impacts of the Project.
- Quantitative assessment of the potential odour impacts of the Project.
- Quantitative assessment of the Scope 1, 2 and 3 greenhouse gas emissions of the Project.

- A qualitative assessment of the potential impact of these emissions of the environment.
- An assessment of all reasonable and feasible measures that could be implemented to minimise the generation of greenhouse gas emissions associated with the Project.

The following subsections describe the existing air quality environment, identify the air quality management issues and the proposed air quality controls, safeguards and mitigation measures. Additionally, the assessment also presents the residual impacts upon air quality following the implementation of these safeguards and mitigation measures.

4.5.2 Existing Air Quality

4.5.2.1 PM_{10} Concentration

Existing sources of particulate matter in the vicinity of the Project Site include traffic on unsealed roads, local building and construction activities, animal grazing and stabling activities and to a lesser extent traffic from the M4 motorway.

There has been no air quality monitoring undertaken at the Project Site, however, there is a DECCW monitoring site that measures particulate matter (PM_{10}) concentrations at St Marys (Mamre Road), approximately 2.5km northeast of the Project Site using a Tapered Element Oscillating Microbalance (TEOM). Dust monitoring has also been undertaken approximately 8km east-northeast of the Project Site at a quarry formerly owned by Hanson Construction Materials Pty Limited.

From the monitoring data available, it has been assumed that the following background concentrations apply at the nearest residences surrounding the Project Site.

- Annual average TSP of 42.5µg/m3.
- Annual average PM10 of 17µg/m3.
- Annual average dust deposition of 1.9g/m^2/month.

4.5.3 Air Quality Guidelines

4.5.3.1 Dust Assessment Criteria

Air quality standards or goals are used to assess the potential for ambient air quality to give rise to adverse health or nuisance effects. In its modelling and assessment guidelines, the DECCW specifies air quality assessment criteria relevant for assessing impacts from dust generating activities (DEC, 2005).

These criteria are consistent with the National Environment Protection Measures for Ambient Air Quality (referred to as the Ambient Air-NEPMs (see NEPC, 1998)). However, the NSW DECCW's criteria include averaging periods, which are not included in the Air-NEPMs, and references to other measures of air quality, namely dust deposition and total suspended particulate matter (TSP).

Table 4.19 summarises the air quality goals for dust that are relevant to the Project.

Table 4.19
Air Quality Impact Assessment Criteria for Particulate Matter Concentrations

Pollutant	Standard / Goal	Averaging Period	Agency
Total suspended particulate matter (TSP)	90 $\mu g/m^3$	Annual mean	NSW DECCW
Particulate matter < 10 μm (PM_{10})	50 $\mu g/m^3$	24-hour maximum	NSW DECCW
	30 $\mu g/m^3$	Annual mean	NSW DECCW
Source: PAEHolmes (2010) – Table 3.1			

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces and possibly on vegetation/crops.

Table 4.20 shows the dust deposition criteria set out in the DECCW Approved Methods for modelling and assessment (NSW DEC, 2005).

Table 4.20
NSW DECCW Criteria for Dust (insoluble solids) Fallout

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month
Source: PAEHolmes (2010) – Table 3.2			

4.5.3.2 Odour Assessment Criteria

Measuring Odour Concentration

There are no instrument-based methods that can measure an odour response in the same way as the human nose. Therefore “dynamic olfactometry” is typically used as the basis of odour management by regulatory authorities.

Dynamic olfactometry is the measurement of odour by presenting a sample of odorous air to a panel of people with decreasing quantities of clean odour-free air. The panellists then note when the smell becomes detectable. The correlations between the known dilution ratios and the panellists’ responses are then used to calculate the number of dilutions of the original sample required to achieve the odour detection threshold. The units for odour measurement using dynamic olfactometry are “odour units” (ou) which are dimensionless and are effectively “dilutions to threshold”.

The draft Committé Européen de Normalisation (CEN) odour measurement standard (CEN, 1996) is a performance based standard with strict criteria for repeatability and reproducibility. The Australian standard AS4323.3 (introduced in September 2001) (Standards Australia, 2001) is based upon the CEN standard.

Relevant odour data has been obtained from odour testing conducted on a Class 2 landfill similar to the Project (Holmes Air Sciences, 2007).

Odour Performance Criteria

The DECCW has developed odour goals and the way in which they should be applied with dispersion models to assess the likelihood of nuisance impact arising from the emission of odour. There are two factors that need to be considered, namely:

- what "level of exposure" to odour is considered acceptable to meet current community standards in NSW; and
- how can dispersion models be used to determine if a source of odour meets the goals which are based on this acceptable level of exposure.

The term "level of exposure" has been used to reflect the fact that odour impacts are determined by several factors the most important of which are:

- frequency of the exposure;
- intensity of the odour;
- duration of the odour episodes; and
- offensiveness of the odour.

In determining the offensiveness of an odour, it needs to be recognised that for most odours the context in which an odour is perceived is also relevant. Some odours, for example the smell of sewage, hydrogen sulfide, butyric acid, landfill gas etc., are likely to be judged offensive regardless of the context in which they occur. Other odours such as the smell of jet fuel may be acceptable at an airport, but not in a house, and diesel exhaust may be acceptable near a busy road, but not in a restaurant.

Complex Mixtures of Odorous Air Pollutants

The DECCW Approved Methods include ground-level concentration (glc) criterion for complex mixtures of odorous air pollutants. They have been refined by the DECCW to take account of population density in the area. **Table 4.21** lists the odour glc criterion to be exceeded not more than 1% of the time, for different population densities.

The difference between odour goals is based on considerations of risk of odour impact rather than differences in odour acceptability between urban and rural areas. For a given odour level, there would be a wide range of responses in the population exposed to the odour. In a densely populated area, there would therefore be a greater risk that some individuals within the community would find the odour unacceptable than in a sparsely populated area. The Project Site is considered urban. Therefore, as shown in **Table 4.21**, the relevant impact assessment criterion for the Project Site is 2 ou which is the strictest criterion possible (DEC, 2005).

Peak-to-Mean Ratios

It is common practice to use dispersion models to determine compliance with odour goals. This introduces a complication because Gaussian dispersion models are only able to directly predict concentrations over an averaging period of 3-minutes or greater. The human nose, however, responds to odours over periods of the order of a second or so. During a 3-minute period, odour levels can fluctuate significantly above and below the mean depending on the nature of the source.

Table 4.21
Odour Performance Criteria for the Assessment of Odour

Population of affected community	glc criterion for complex mixtures of odorous air pollutants (ou)
≤ ~2	7
~10	6
~30	5
~125	4
~500	3
Urban (2000) and/or schools and hospitals	2
Source: PAEHolmes (2010) – Table 3.3	

To determine more rigorously the ratio between the one-second peak concentrations and three-minute and longer period average concentrations (referred to as the peak-to-mean ratio) that might be predicted by a Gaussian dispersion model, the DEC commissioned a study by Katestone Scientific Pty Ltd (1995, 1998). This study recommended peak-to-mean ratios for a range of circumstances. The ratio is also dependent on atmospheric stability and the distance from the source. For area sources in the near-field, as applies in this case, the peak to-mean ratio is 2.5 for neutral conditions (stability class A-D) and 2.3 for stable conditions (stability class E-F). A summary of the factors is provided in PAEHolmes (2010).

The DECCW Approved Methods take account of this peaking factor and the goals shown in **Table 4.21** are based on nose-response time.

4.5.4 Approach to Air Quality Assessment

4.5.4.1 Dust Assessment

The approach taken for the dust assessment involved the following.

- The assembly of estimated annual dust emissions of each activity associated with the operations.
- Provision of emissions and meteorological information for inclusion in a computer-based dispersion model used to predict dust concentrations in the region and at nearest residences; and
- A comparison of predicted concentrations with relevant air quality criteria.

Off-site dust levels due to the proposed Project have been predicted using AUSPLUME. AUSPLUME (Version 6.0) is an advanced Gaussian dispersion model developed on behalf of the Victorian EPA (VEPA, 1986) and is based on the United States Environmental Protection Agency's Industrial Source Complex (ISC) model. It is widely used throughout Australia and is regarded as a "state-of-the-art" model. AUSPLUME is the model required for use by the DECCW unless Project characteristics dictate otherwise (NSW DEC, 2005).

The modelling has been based on the use of three particle-size categories (0 to 2.5 µm - referred to as FP (fine particulate matter), 2.5 to 10 µm - referred to as CM (coarse matter) and 10 to 30 µm - referred to as the Rest). Mass emission rates in each of these size ranges have been determined using the factors derived from the SPCC (1986) study and TSP emission rates calculated using emission factors derived primarily from US EPA (1985) work. The distribution of particles in each particle size range is as follows:

- $PM_{2.5}$ (FP) is 4.7% of the TSP;
- $PM_{2.5-10}$ (CM) is 34.4% of TSP; and
- PM_{10-30} (Rest) is 60.9% of TSP.

Modelling was completed using three AUSPLUME source groups with each group corresponding to a particle size category. Each source in the group was assumed to emit at the full TSP emission rate and to deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mean of the limits of the particle size range, except for the $PM_{2.5}$ group, which was assumed to have a particle size of 1 µm. The predicted concentrations in the three plot output files for each group were then combined according to the weightings above to determine the concentration of PM_{10} and TSP.

The AUSPLUME model also has the capacity to take into account dust emissions that vary in time, or with meteorological conditions. This has proven to be particularly useful for simulating emissions for operations where wind speed is an important factor in determining the rate at which dust is generated.

For the Project, six operational scenarios were modelled with the operations represented by a series of volume sources located according to the positions of the dust sources as they would be for the scenario being modelled. The location of the modelled dust sources for each of the scenarios modelled are presented in PAEHolmes (2010). Estimates of emissions for each source were developed on an hourly time step taking into account the activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. It is important to do this in the AUSPLUME model to ensure that long-term average emission rates are not combined with worst-case dispersion conditions which are associated with light winds. Light winds at a Project Site such as this would correspond with periods of low dust generation (because wind erosion and other wind dependent emissions rates would be low) and also correspond with periods of poor dispersion. If these measures are not adopted then the model has the potential to significantly overstate impacts.

It has been assumed that each activity would occur between 7:00am and 6:00pm every day, except for wind erosion sources which have been modelled for 24-hours per day. Model predictions have been made at 195 discrete receptors (including nearest residences) located in the study area. The location of these receptors has been chosen to provide finer resolution closer to the dust sources and nearby receptors. The AUSPLUME model input files can be provided in electronic form on request.

4.5.4.2 Odour Assessment

The odour assessment was undertaken with the use of odour emissions and the meteorological information in the dispersion model AUSPLUME (Version 6.0) to predict off-site odour levels from the facility. Model predictions were then compared with the DECCW's odour assessment criteria.

The 99th percentile nose-response 1-hour average ground-level odour concentrations have been predicted at a set of receptors arranged in a grid of 100m spacing. Additional discrete receptors have been placed at nearby residences to determine the impact at these locations.

4.5.4.3 Greenhouse Gas Assessment

CO_2 would be the most significant gas for the Project which would be formed and released during the combustion of diesel fuel. It would be liberated when fuels are burnt in diesel powered equipment and in the generation of the electrical energy that would be used at the site. There would be no residual CH_4 emissions due to proposed collection and oxidation of the small quantities of CH_4 likely to be generated, N_2O emissions would be minimal, and there would be no release of HFCs or PFCs.

Inventories of greenhouse gas emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (referred to as warming potentials) and emission factors take into account the global warming potentials of the gases created during combustion.

The estimated emissions are referred to in terms of CO_2-equivalent (CO_2-e) emission by applying the relevant global warming potential.

The following formula (DCC, 2009a) was used to estimate the greenhouse gas emissions from fuel usage:

$$\textit{GHG Emissions } (tC0_2 - e) = \frac{Q \times EC \times EF}{1000} \qquad \text{Equation 1}$$

Where:

Where:	Q	=	quantity of fuel in tonnes or thousands of litres
	EC	=	energy content of the fuel in GJ/tonne or GJ/kL
	EF	=	relevant emission factor in kg CO_2-e/GJ

To calculate emissions from electricity usage, the following equation was used:

$$\textit{GHG Emissions } (tC0_2 - e) = Q \times \frac{EF}{1000} \qquad \text{Equation 2}$$

Where:	Q	=	electricity consumed in GJ
	EF	=	relevant emission factor in kg CO_2-e/GJ

Emission Factors

Data provided in the National Greenhouse Accounts (NGA) Factors, published by the Department of Climate Change (DCC, 2009a) were used. DCC defines three 'scopes' (or emission categories).

- Scope 1 covers direct emissions from sources within the Project Site, such as fuel combustion and manufacturing processes.
- Scope 2 covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation.
- Scope 3 includes all other indirect emissions that are a consequence of the organisations activities but are not from sources owned or controlled by the organisations, for example, production of diesel fuel, off-site transport of the product, or staff travel etc.

For the purposes of this assessment, a full fuel cycle emission factor (that is the sum of Scope 1, Scope 2 and Scope 3 emission factors, where applicable) has been used. **Table 4.22** provides a summary of the emission factors used.

Table 4.22
Summary of Emission Factors for Greenhouse Gas Assessment

Type of Fuels and Electricity	Emission factor		Scope	Source
Diesel - Non-transport activities	69.5	kg CO_2-e/GJ	1	Table 3 (DCC, 2009a)
	5.3	kg CO_2-e/GJ	3	Table 38 (DCC, 2009a)
Diesel - Transport activities	69.9	kg CO_2-e/GJ	1	Table 3 (DCC, 2009a)
	5.3	kg CO_2-e/GJ	3	Table 38 (DCC, 2009a)
Electricity	0.89	kg CO_2-e/kWh	2	Table 39 (DCC, 2009a)
	0.18	kg CO_2-e/kWh	3	Table 3 (DCC, 2009a)
Source: PAEHolmes (2010) – Table 10.1				

4.5.5 Estimated Dust Emissions

Dust emissions would arise from various activities at the Project Site. Total dust emissions have been estimated by analysing the activities taking place in the Project during six stages of proposed operations.

- Scenario 1: Site establishment
- Scenario 2: Initial waste placement and recycling – typical operations
- Scenario 3a: Stage 2A waste operations – typical operations
- Scenario 3b: Stage 2A waste operations – worst case operations
- Scenario 4: Stage 3B operations – typical operations
- Scenario 5: Early morning operations

For the purposes of this assessment, typical and worst case operations have been defined as follows.

	Waste Received	Waste Emplaced	Recycled/Re-processed Products Despatched	Clay/Shale Despatched
Typical:	300 000tpa	200 000tpa	100 000tpa	200 000tpa
Worst Case:	600 000tpa	450 000tpa	150 000tpa	Nil*

* Although no clay/shale would be despatched off site, allowance has been made for extraction of clay/shale for capping material and creation of airspace.

For Scenario 1, operations would occur over a six month period. However, to ensure the worst-case impacts are captured, it has been assumed that these activities occur for an entire year, and as such all emission estimations have been doubled.

Scenario 3b was chosen to represent the impacts when worst case operations (ie. receipt of 600 000tpa) are active. Activities occurring in this scenario predominantly take place within the northern side of the site, closest to the worst-case scenario for worst case operations and therefore should worst case operations occur during other scenarios these predictions would be considered conservative.

The operations which apply in each case have been combined with emission factors developed, both locally and by the US EPA, to estimate the amount of dust produced by each activity. The emission factors applied are considered to be the most up-to-date methods for determining dust generation rates. The fraction of fine, inhalable and coarse particles for each activity has been taken into account for the dispersion modelling.

The plans for the Project have been analysed and detailed emissions inventories have been prepared for the five scenarios considered.

The most significant dust generating activities from the proposed operations were identified and the dust emission estimates for each scenario modelled (details of the calculations of the dust emissions are presented in PAEHolmes, 2010). The estimated emissions take account of proposed air pollution controls including active controls such as watering of haul routes to minimise dust emissions.

The four most significant dust generating activities for each scenario are presented in **Table 4.23**. For each of the scenarios wind erosion was the primary contributor, accounting for between 56% and 79.9% of total estimated dust emissions. Removing and unloading material with scrapers was estimated to be the second largest contributor to dust emissions in Scenarios 1, 2 and 3 where Scraper activity accounted for 33.2%, 22.3% and 21.6% of annual site activity emissions respectively.

Table 4.23
Estimated Dust Emission due to Proposed Operations

Page 1 of 2

Activity	TSP emission (kg/year)	% of Annual Site Activity Emissions
Scenario 1		
Wind erosion from exposed areas	94,608	61.5
Scraper (Cell 1A) unloading material	24,960	16.2
Scraper (Cell 1A) removing material	18,096	11.8
Scraper travelling	8,069	5.2
Scenario 2		
Wind erosion from exposed areas	77,088	56
Scraper (Cell 1A) removing material	18096	13.2
Scraper (Cell 1A) unloading material	12480	9.1
FEL (Perimeter bund walls in Cell 2)	8307	6
Scenario 3a		
Wind erosion from exposed areas	87,600	62.1
Scraper (Cell 2A) removing material	18,096	12.8
Scraper (Cell 2A) unloading material	12,480	8.8
Scraper travelling	7,773	5.5

Table 4.23 (Cont'd)
Estimated Dust Emission due to Proposed Operations

Page 2 of 2

Activity	TSP emission (kg/year)	% of Annual Site Activity Emissions
Scenario 3b		
Wind erosion from exposed areas	87,600	58.8
Scraper (Cell 2A) removing material	18,096	12.1
Scraper (Cell 2A) unloading material	12,480	8.4
Scraper travelling	7,773	5.2
Scenario 4		
Wind erosion from exposed areas	49,056	70
Dozer (Cell 3)	5538	8
Dozer (Cell 3)	5538	8
FEL (Recycling plant in Recycling and Re-processing Area)	2003	2.9
Dumping waste for recycling (Recycling and Re-processing Area)	2003	2.9
Scenario 5		
Wind erosion from exposed areas	38,544	79.9
Dumping waste for recycling (Recycling and Re-processing Area)	2,003	4.15
Dumping waste for recycling (Cell 1A)	2,003	4.15
FEL (Recycled product)	2,003	4.15

Source: PAEHolmes (2010) – Tables 7.1-7.6

4.5.6 Estimated Odour Emissions

The emplacement of wastes on the Project Site would be categorised as a "Class 2 landfill", signifying that no putrescible waste would be accepted. Nevertheless, odours can be produced over time from very small biodegradable material that is inextricably included in the solid general waste. In practice, Class 2 landfills have historically accepted a wider range of materials than those proposed to be accepted as part of this Project. However, it has been assumed, for the purposes of this assessment, that odour emissions for historical Class 2 landfills are relevant. These emissions would be referred to as "standard" Class 2 odour emissions.

There are limited odour emissions data available for Class 2 landfills. Measurements made for a non-putrescible landfill site after six months (CEE, 1994) have indicated levels of approximately 0.5 ou.m^3/m^2/min (certainty units). Odours from the Project Site would reach their maximum after a number of years (perhaps 4 years), when it is estimated that emissions may increase by a factor of 14. That is, to model for a worst-case scenario it is necessary to take into account the potential increase in odour over time to approximately 7 ou.m^3/m^2/min (or 0.117 ou.m^3/m^2/s). These worst-case emissions however, would not occur over the whole area. As the waste emplacement progresses, emissions from the previously capped cells would rise to a peak and then fall again.

Assuming that the peak for the proposed waste emplacement operation would be approximately 0.117 ou.m3/m^2/s, the profile of this gas model was used to estimate the emissions for the time period specified on the graph (30 years). An average emission rate was then taken to apply for the waste emplacement area.

As the proportion of biodegradable material accepted to landfill for this Project would be low (and substantially lower than that accepted by Class 2 landfills in the 1990s), a proportionate reduction to the standard "Class 2" odour emissions is considered to be appropriate. At a similar facility operated by Dial-a-dump Industries in Alexandria, the total amount of organic or biodegradable material received in 2006 was 5,282 tonnes (Holmes Air Sciences, 2007). In the past, all of this would have been landfilled at a standard Class 2 operation. However, under the current operating conditions most of the materials were recovered or recycled and, of the 5,282 tonnes of organic and potentially biodegradable materials, only 32 tonnes actually went to landfill. Thus, less than 1% was landfilled (32 / 5282 = 0.6%). As a conservative approach, odour emissions from capped areas have therefore been taken to be 5% of the standard historical Class 2 odour emissions.

In addition to odours from capped areas, there may be small quantities of odour emitted from the active tipping face and the initial leachate evaporation pond and initial stormwater leachate dam. Odour measurements from the covered active tipping face and leachate pond at the Englands Road Waste Management Facility in Coffs Harbour (Holmes Air Sciences, 2008) were used to estimate the odour impact for Dial-a-dump Industries, Alexandria site have been collected by The Odour Unit (2006). Odour emissions from two different active tipping surfaces were measured; no cover and temporary cloth cover. The cloth cover has been assumed as a suitable representation of the Virgin Excavated Natural Material cover that would be used on site.

The odour sources within the initial leachate evaporation pond and initial stormwater leachate dam (located in Cell 3) would be removed once the long-term leachate evaporation pond and final stormwater leachate dam become operational mid way through the operational life of Cell 3.

Once the long-term leachate evaporation pond and final stormwater leachate dam are in operation, the odour sources from the pond and dam will be located further from the sensitive receptors in "The Vines" estate, thus reducing the overall odour impact at these locations.

Preliminary odour modelling (completed as part of sensitivity testing undertaken to ensure assessment of the worst-case operations) confirmed that operation of the long-term leachate pond and final stormwater leachate dam has lower odour impacts at the sensitive receptors to the north within "The Vines" estate. It is unlikely that odour generated from the pond and dam would have significant odour impacts, regardless of their location.

Table 4.24 provides the quantitative information on each odour source used in the dispersion modelling. Odour emissions in the dispersion model have been multiplied by the recommended peak-to-mean ratios for different source types to predict odour levels for nose response times. Peak-to-mean factors for the near-field have been applied for the purposes of this assessment. For area sources, these factors have numerical values of 2.5 for unstable and neutral atmospheric conditions and 2.3 for stable conditions in the near field.

The odour emissions shown in **Table 4.24** have been taken to represent the "upper limit" of emissions from the landfill activities, given the tight controls on incoming wastes that would be accepted on the Project Site, the low proportion of biodegradable materials and the assumed maximum extents of odour emitting surfaces.

Table 4.24
Odour Sources and Emissions used in the Dispersion Modelling

Source	Area (m^2)	SOER ($ou.m^3/m^2/s$)	SOER with peak-to-mean ($ou.m^3/m^2/s$)	
			Neutral (2.5)	Stable (2.3)
Capped areas – Cell 1	118,363	0.00255*	0.00637	0.00586
Capped areas – Cell 2A	44,104	0.00255*	0.00637	0.00586
Active Tipping (Daily Cover) – Cell 2B	44,363	0.062	0.155	0.1426
Active Tipping (No Cover)– Cell 2B	1,600	0.428	1.07	0.9844
Leachate Pond	9,337	0.022	0.055	0.0506

* 5% of estimated average odour emissions from standard Class 2 landfills
SOER = Specific Odour Emission Rate. Actual areas may be smaller than modelled
Source: PAEHolmes (2010) – Table 7.7

This assessment has considered that Cells 1 and 2A have been filled and capped and Active waste emplacement is underway in Cell 2B with an active tipping face of 1,600 m^2 located at the northern end of the cell. The remainder of the cell is assumed to be covered daily with a temporary cover as the cell is progressively filled. It is anticipated that this scenario would represent a possible worst-case impact from the Project at the sensitive receptors located to the north and is applicable to both typical and worst case operations.

4.5.7 Design and Operational Safeguards

Dust from the proposed Project would be generated from two primary sources, namely:

- wind-blown dust from exposed areas; and
- dust generated by operational activities.

The following mitigation measures are proposed to manage dust emissions from the Project. The aim of these measures would be to minimise the emission of dust from the various dust generating activities taking place. The effect of these measures has been included in the model simulations undertaken by PAEHolmes (2010).

In order to manage/minimise wind blown dust from exposed areas, the Proponent would firstly minimise the area of disturbance at one time, particularly in exposed areas and either cover temporarily or habilitate permanently. Areas of temporary cover would be watered to promote crusting on clay/shale materials and limit wind-blown dust lift-off. It is acknowledged that the bund walls around the perimeter of the Project Site would also assist to limit dust lift off given the considerable shielding these bund walls offer.

The Proponent has estimated that in the order of 34ML to 37ML of water would be used annually for the suppression of dust using both a water cart to water the internal unsealed access roads and on the crushing and conveying circuits in the Recycling and Re-processing Area. It is also noted that the Proponent has committed to the cessation of earthmoving operations on those days when high wind speeds and temperatures occur.

The water balance conducted for the Project (Section 4.3.6) identified sufficient water would be available from both on-site sediment dams and the abstraction bore to supply the Project's dust suppression requirements.

4.5.8 Assessment of Impacts

4.5.8.1 Assessment of Dust Impacts

The following subsections provide a summary of the modelling results for each year at a representative number of residences surrounding the Project Site. The results include predicted impacts from the Project itself and cumulative impacts from the Project plus existing background levels.

Dust concentrations due to operations on site have been presented in isopleth diagrams showing the following.

1. Predicted maximum 24-hour average PM_{10} concentration.
2. Predicted annual average PM_{10} concentration.
3. Predicted annual average TSP concentration.
4. Predicted annual average dust deposition.

In order to assess predicted concentrations over a 24-hour period, it is more complicated than simply adding a constant average 24-hour background concentration to the model results. PM_{10} averages vary considerably from day to day as they are subject to the local meteorological conditions at the time. Adding the maximum measured 24-hour average PM_{10} concentration to the predicted maximum 24-hour average concentration over a year would represent a very conservative approach as it is unlikely that the worst-case emissions from the Project would occur at the same time as the highest background concentrations.

The predicted 24-hour PM_{10} cumulative impacts have been modelled with concurrent PM_{10} and meteorological data from the DECCW monitoring station at St Marys.

PAEHolmes (2010) notes that the maximum 24-hour average contour plot does not represent the dispersion pattern for any particular day, but shows the highest predicted 24-hour average concentrations that occurred at each location for the worst day in the year. The maxima are used to show concentrations which can possibly be reached under the modelled conditions.

It is important to note that the isopleth figures are presented to provide a visual representation of the predicted impacts. To produce the isopleths, it is necessary to make interpolations, and as a result the isopleths would not always match exactly with predicted impacts at any specific location. The actual predicted impacts at the residences are presented in tabular form.

Scenario Modelling Predictions

PAEHolmes (2010) includes figures that illustrate the predicted 24-hour and annual average PM_{10}, annual average TSP and dust deposition levels for the Project alone and the 24-hour and annual average PM_{10}, annual average TSP and dust deposition including background impacts during each of the six scenarios. For the purposes of providing an overview of the key outcomes from the assessment of dust impacts, the outcomes of two modelling scenarios are provided. These two scenarios have been selected as they incorporate the highest predicted PM_{10} 24-hour emissions attributable to the Project. The remaining four scenarios are described in PAEHolmes (2010). **Table 4.25** and **Figures 4.15** and **4.16** present a summary of the predicted concentrations at eight representative nearby residences for Scenario 1 and 3b.

Modelling results for Scenario 1 show marginal exceedances of the DECCW PM_{10} 24-hour average goal at two representative residences, "V" (3 Chablis Place) and "W" (15 Cabernet Circuit). Further analysis of the impacts at residences "V" and "W" is included in PAEHolmes (2010) which shows that there are no predicted exceedances due to the operation of the Project alone and that exceedance of the 24-hour average goal is only predicted to occur on one occasion throughout the year at both receptors "V" and "W" when background levels attributable to other sources are high.

Modelling results for Scenario 2, 3a, 3b, 4 and 5 show no exceedances of the NEPM and DECCW goals at any of the residences.

Table 4.25
Dispersion Modelling Predictions for Scenarios 1 and 3

Residences ID	PM_{10} 24-hour (µg/m^3)		PM_{10} Annual (µg/m^3)		TSP Annual (µg/m^3)		Dust Deposition (g/m^2/month)	
	Project only	Cumulative	Project only	Cumulative	Project only	Cumulative	Project only	Cumulative
	Criteria 50		*Criteria 30*		*Criteria 90*		*Criteria 2.0*	*Criteria 4.0*
Scenario 1								
A	12.3	47	0.6	18	0.7	43	0.1	2
B	16.2	47	0.6	18	0.8	43	0.1	2
D	4.8	47	0.3	17	0.3	43	0.0	2
H	3.1	47	0.2	17	0.2	43	0.0	2
I	3.6	47	0.2	17	0.2	43	0.0	2
T	4.2	47	0.2	17	0.3	43	0.0	2
U	14.2	48	1.5	18	1.8	44	0.2	2
V	32.5	51	3.2	20	4.1	47	0.4	2
W	33.5	51	4.6	22	6.0	48	0.5	2
X	23.9	50	2.7	20	3.4	46	0.3	2
Scenario 3b								
A	8.2	47	0.5	18	0.6	43	0.1	2.0
B	11.8	47	0.7	18	0.9	43	0.1	2.0
D	4.2	47	0.3	17	0.4	43	0.1	2.0
H	2.3	47	0.2	17	0.2	43	0.0	1.9
I	2.7	47	0.2	17	0.3	43	0.0	1.9
T	5.7	47	0.3	17	0.4	43	0.1	2.0
U	8.5	48	0.7	18	0.9	43	0.1	2.0
V	11.6	48	1.3	18	1.7	44	0.3	2.2
W	18.4	49	2.1	19	2.8	45	0.3	2.2
X	13.3	48	1.8	19	2.3	45	0.2	2.1

Source: PAEHolmes (2010) – Table 8.1 and 8.6

4.5.8.2 Assessment of Odour Impacts

Odour modelling results are shown in **Figure 4.17**. The contour plot presented shows the 99th percentile odour levels averaged over 1-hour periods. At the 99th percentile, the model results show that the 2ou criterion does not extend into any residential areas. As a conservative assessment, the model output has not considered the progressive filling sequence of each cell. It is therefore assumed that the whole Project Site would be emitting odour at the maximum rate. With this taken into consideration the impact would be further reduced.

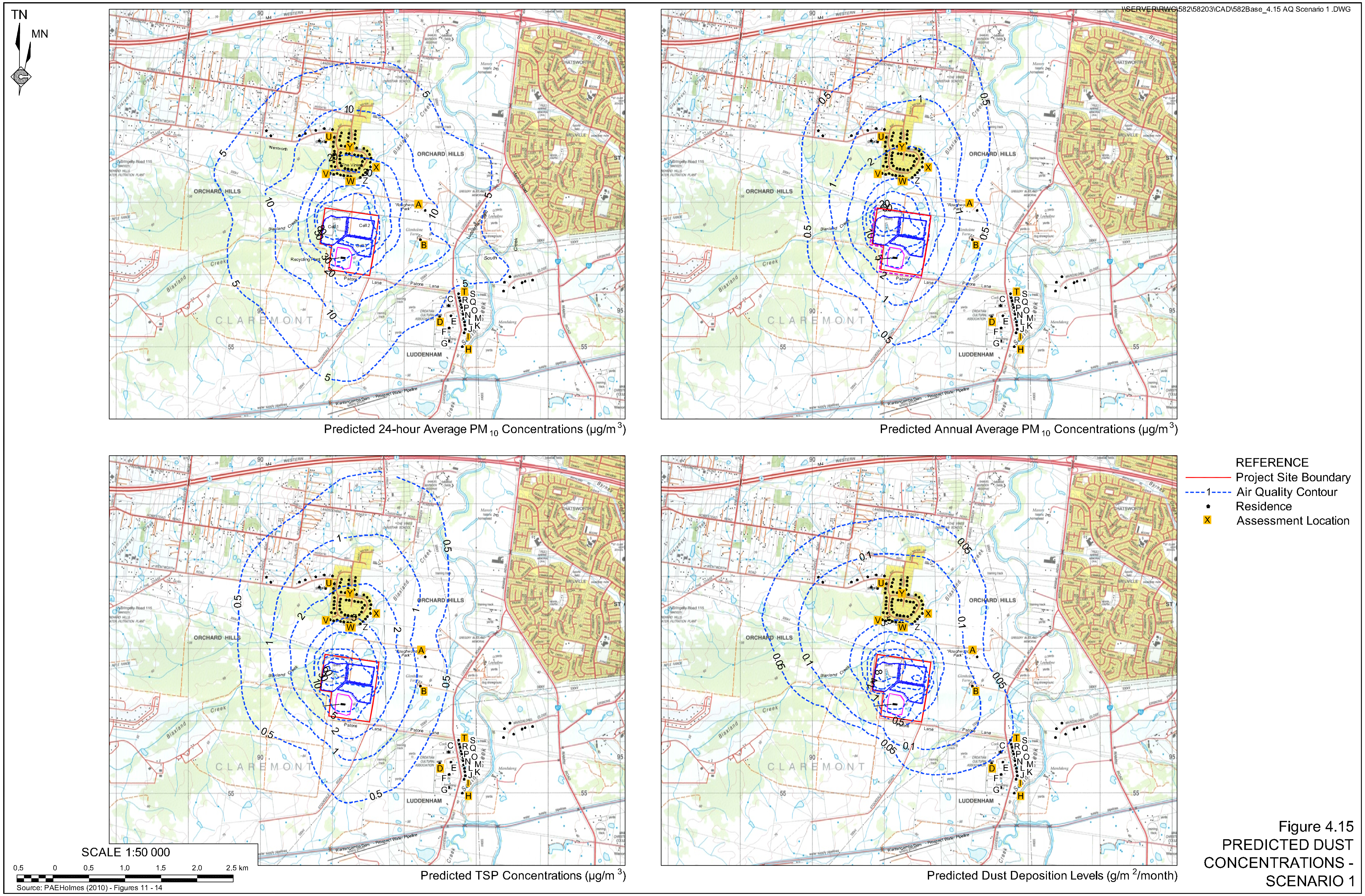

Figure 4.15
PREDICTED DUST CONCENTRATIONS - SCENARIO 1

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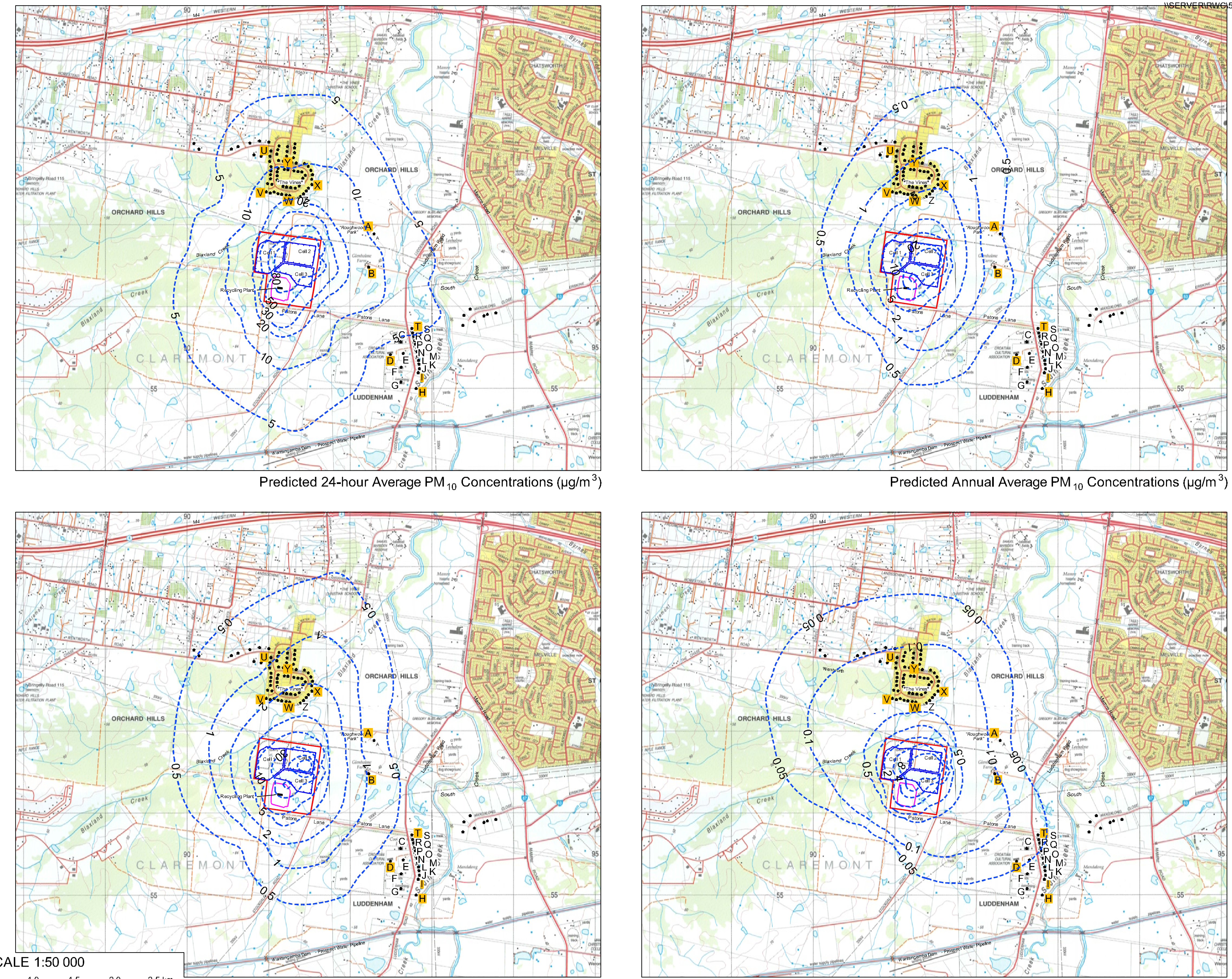

Predicted 24-hour Average PM $_{10}$ Concentrations (µg/m ^{3})

Predicted Annual Average PM $_{10}$ Concentrations (µg/m ^{3})

Predicted TSP Concentrations (µg/m ^{3})

Predicted Dust Deposition Levels (g/m ^{2}/month)

REFERENCE
- Project Site Boundary
- 1 Air Quality Contour
- Residence
- X Assessment Location

SCALE 1:50 000

0.5 0 0.5 1.0 1.5 2.0 2.5 km

Source: PAEHolmes (2010) - Figures 35 - 38

Figure 4.16
PREDICTED DUST CONCENTRATIONS - SCENARIO 3B

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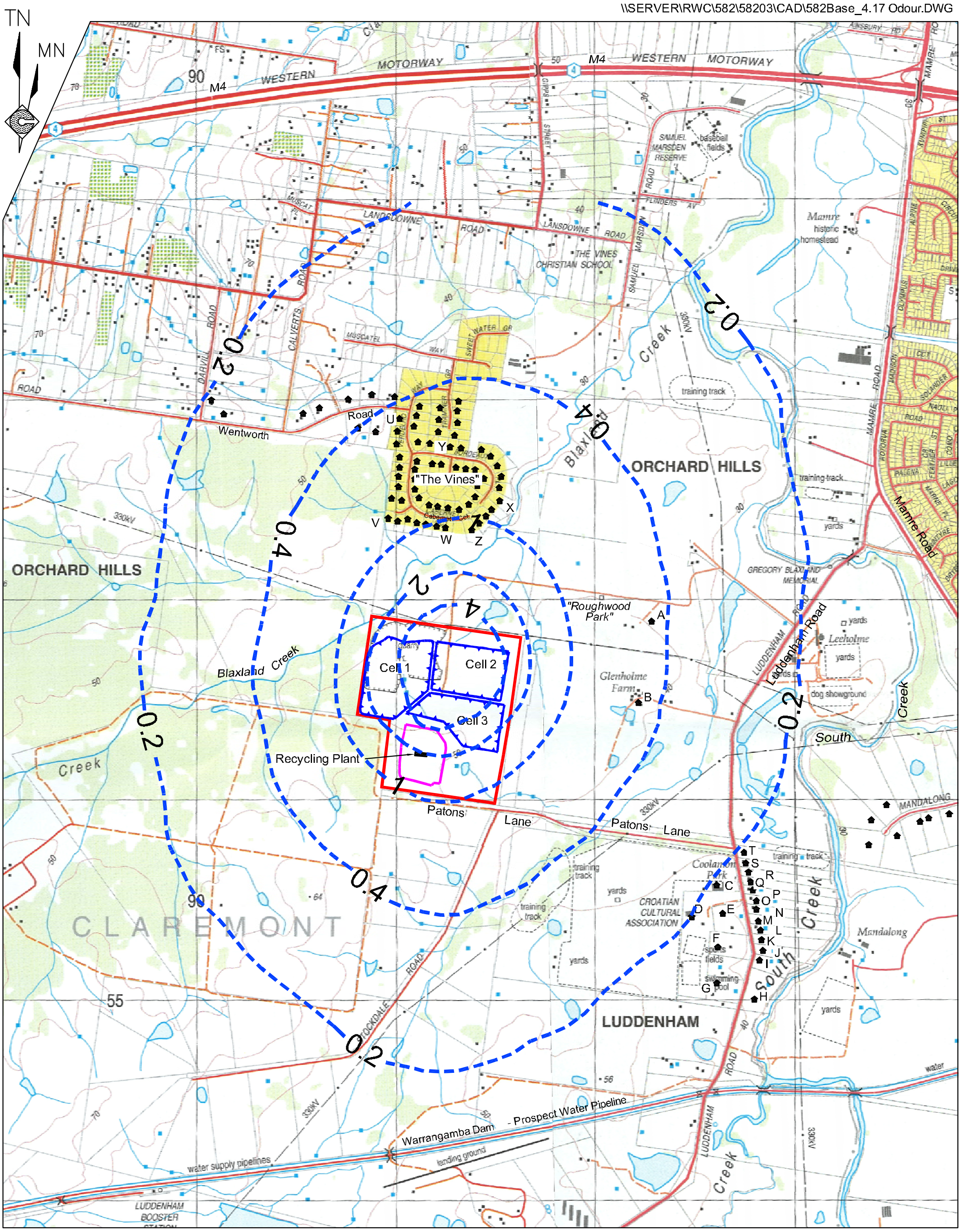
\\SERVER\RWC\582\58203\CAD\582Base_4.17 Odour.DWG



REFERENCE
- Project Site Boundary
- Residence
- Proposed Limit of Recycling and Re-processing Area
- Proposed Limit of Extraction
- 0.1 Predicted Odour Contour

SCALE 1:30 000

500 0 500 1000 1500 m

Source: PAEHolmes (2010) - Figure 59

Figure 4.17
99^{th} PERCENTILE PREDICTED ODOUR CONCENTRATIONS FOR THE PROJECT

The type of odour likely to be generated from the Project would smell significantly different to the odour generated from a putrescible waste landfill due to the lack of organic material emplaced. It is anticipated that the presence of methanethiol, the pungent odour reminiscent of bad eggs, would be minimal (Young and Parker, 1984).

4.5.8.3 Assessment of Greenhouse Gas Emissions

4.5.8.3.1 Fuel and electricity usage

Based on information provided by the Proponent, **Table 4.26** presents a summary of annual on-site diesel fuel usage.

Table 4.26
Summary of on-site diesel usage (L/yr)

Equipment type	No. in use	Fuel consumption rate (L/hr)	Equipment usage per day (hours)	Diesel usage per year (L/yr)
D9 Bulldozer	1	25	5	39,000
Excavator	1	17	5	26,520
Compactor	1	36	5	56,160
Utility	1	1	12	3,744
Articulated truck	2	23	3	43,056
Generator	1	5	10	15,600
Impact crusher	1	45	4	56,160
Trommel	1	17	5	26,520
Jaw crusher	1	30	3	28,080
			Total per year (L/yr)	294,840
Source: Dellara Pty Ltd				

There would also be diesel consumption in the transport action of the product clay / shale to customers. Based on the assumption that 200 000tpa of product would be transported from the site in 30t trucks with an average return travel distance of 24km per load and the average fuel consumption of articulated trucks being 54.6 litres per 100 kilometres (ABS, 2007), the annual fuel usage to transport the product is 87 360L/yr ((200,000 [t/y] / 30 [t/trip]) * 24 [km/trip] * 0.546 [L/km]).

The energy content of diesel was taken to be 38.6GJ/kL (DCC, 2009a).

Hours of operation for the Project are assumed to be 65 hours per week and 52 weeks per year. Recycling equipment usage is estimated at 60% of the hours of operation. **Table 4.27** presents a summary of annual on-site electricity usage.

Table 4.27
Summary of on-site electricity usage (kWh/y)

Equipment type	No. in use	Power rating (kWh)	Power usage per year (kWh/y)
Shredder	1	264	535,392
Picking Station	1	15	30,420
Secondary Shredder	1	110	223,080
		Total per year (kWh/y)	788,892
Source: Dellara Pty Ltd			

Therefore, based on the information provided by the proponent, electricity consumption onsite would be approximately 790MWh/y.

4.5.8.3.2 Gas Generation

There is potential for the site to generate a small proportion of methane from the decomposition of biodegradable material emplaced on site. Estimations of the amount of methane generated from the waste emplaced has been calculated in Aquaterra (2010). Method 1 of the National Greenhouse and Energy Reporting System Measurement Technical Guidelines was used as it does not require any field data.

It has been estimated that over the life of the Project, methane generation would start at 220 t in Year 1 of the Project and would gradually increase to a peak of 6,500 t in Year 31 before quickly declining as no more waste is emplaced.

In order to manage the amount of methane released from the Project, the waste emplacement cells would incorporate a gas collection layer. As the generated methane makes its way to the surface, the gas would be directed to a gas distribution layer within the vegetation layer. It is estimated that 40% methane oxidation via natural processes can be achieved with this technique (Aquaterra, 2010).

The amount of methane generated has been converted to a carbon dioxide equivalent amount by multiplying by a factor of 21 (DCC, 2009).

4.5.8.4 Greenhouse gas emissions results

Based on the usage fuel and electricity usage and methane generated, the annual CO_2-e emissions for Year 1 are summarised in **Table 4.28**. The annual CO_2-e emissions for Year 31 are summarised in **Table 4.29** assuming 40% methane oxidation.

Table 4.28
Summary of estimated CO_2-e emissions (t CO_2-e/y) – Year 1

Type of fuel	Scope 1	Scope 2	Scope 3	TOTAL (t CO2-e)
Diesel – non-transport	791	-	60	851
Diesel – transport	6,106	-	463	6,569
Electricity usage	-	702	142	844
Methane generation	4,620	-	-	4,620
Total	11,517	702	665	12,885
Source: PAEHolmes (2010) – Table 10.4				

Note: some figures not exact due to rounding

Table 4.29
Summary of estimated CO_2-e emissions (t CO_2-e/y) – Year 31

Type of fuel	Scope 1	Scope 2	Scope 3	TOTAL (t CO2-e)
Diesel – non-transport	791	-	60	851
Diesel – transport	6,106	-	463	6,569
Electricity usage	-	702	142	844
Methane generation	81,900	-	-	81,900
Total	**88,797**	**702**	**665**	**90,165**
Source: PAEHolmes (2010) – Table 10.5				

Note: some figures not exact due to rounding

On an annual basis, it has been estimated that the development would release approximately 0.013Mt008Mt/y CO_2-e. The annual greenhouse emissions in NSW for 2007 were 162.7Mt (DCC, 2009b). Therefore, the proposed development represents approximately 0.008005% of the total NSW greenhouse gas emissions. At the peak in Year 31, it has been estimated that the release would reach 0.09Mt/y CO_2-e. Comparing to emissions in NSW for 2007, the proposed development would represent 0.055% of the total NSW greenhouse gas emissions. The majority of these emissions (approximately 80%) are associated with transportation wastes and clay/shale.

It is recommended that when the Project is operational, methane emissions are recalculated using actual emission measurements taken onsite as the actual amount of biodegradable material emplaced may differ.

4.5.9 Monitoring

The Proponent proposes to establish a network of deposited dust gauges around the Project Site. This network would enable the Proponent to validate the predicted modelled impacts presented in this assessment.

In total, seven gauges are proposed near the Residences A, B, C, T, V, W, and Y (see **Figure 4.18**). The exact location of the gauges would be established in consultation with the respective landowners.

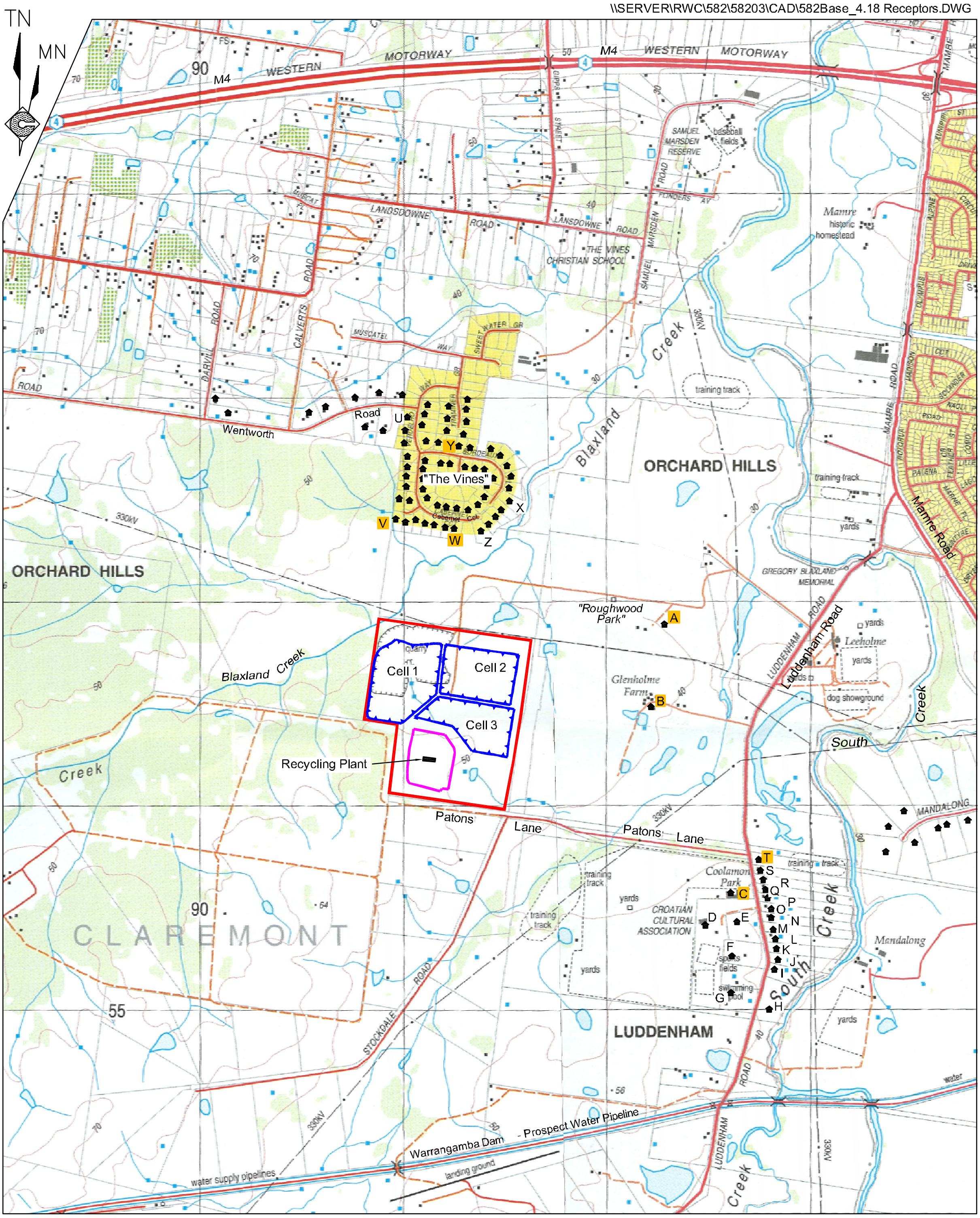
In the unlikely event that the deposited dust gauges identify incremental deposited dust levels attributed to the facility approaching 1 g/m^2/month or 50% of the criteria value, the Proponent would install a high volume air sampler to record PM_{10} concentrations in the vicinity of the gauge(s) with elevated levels.

The proposed air quality monitoring network would be reviewed throughout the life of the Project to ensure that meaningful data is collected. All results of the dust monitoring program would be provided to the respective land owners, and presented in full with an evaluation of the results in each AEMR.

4.5.10 Conclusion

The dispersion modelling used to predict off-site dust and odour levels due to the proposed activities at the Project Site showed that, with one exception, all modelled air quality scenarios the predicted 24-hour and annual average PM_{10}, TSP and deposition levels at surrounding residences would be below the DECCW's assessment criteria, even when existing background levels are included. The dust modelling is conservative and impacts are likely to be less than predicted. The predicted 24-hour average PM_{10} concentrations for the modelled Scenario 1 showed marginal exceedances at residences "V" and "W" attributed mainly to high background levels from other dust sources.

Odour levels at the nearest residences were predicted to be below the most stringent assessment criterion noted by the DECCW. The results therefore suggest that there would be no adverse odour impacts associated with the Project.



REFERENCE

- Project Site Boundary
- Residence
- Proposed Limit of Recycling and Re-processing Area
- Proposed Limit of Extraction
- Air Quality Monitoring Location

SCALE 1:30 000

500 0 500 1000 1500 m

Base Map Source: Prospect (2001) and Penrith (2001) 1:25 000 Topographic Maps

Figure 4.18
AIR QUALITY MONITORING LOCATIONS

4.6 TRAFFIC AND PARKING ASSESSMENT

This section provides a summary of the traffic and parking assessment completed by Traffic Solutions Pty Ltd (Traffic Solutions, 2010), which is reproduced in full as Part 6, Volume 2 of the Specialist Consultant Studies Compendium.

4.6.1 Introduction

Based on the risk analysis (see Section 3.3 and **Table 3.5**), the potential environmental impacts related to traffic and transport requiring assessment and their unmitigated risk rating are as follows.

- Increased traffic congestion (low risk).
- Road pavement deterioration (moderate risk).
- Elevated risk of accident/incident on local roads (low to high risk).

In addition, the Director-General's requirements issued by the DoP and requirements issued by the Roads and Traffic Authority (RTA) identified the following key issues for consideration within the *Environmental Assessment:*

- Accurate predictions of the traffic volumes likely to be generated during construction and operation;
- A detailed assessment of the potential impacts of this traffic on the capacity, efficiency and safety of the surrounding road network, including modelling of the intersections at Luddenham Road/Patons Lane, and Luddenham Road/Mamre Road;
- Details of any proposed road upgrade works, and the measures that would be implemented to ensure that the relevant road network is appropriately maintained during the life of the Project; and
- Details of the proposed access and parking arrangements on the Project Site.

The following subsections assess the existing road and traffic environments, the proposed changes generated by the Project, relevant design features, operational safeguards and ongoing management to mitigate the risks posed and an assessment of residual impacts.

4.6.2 Existing Traffic Conditions

4.6.2.1 Road Hierarchy

Mamre Road is classified as a "State Road" under the RTA's "Sydney and Surrounding State and Regional Roads Plan – 1993" and Luddenham Road is classified a "Regional Road".

Vehicle access to the Project Site is proposed directly onto Patons Lane, which serves a local road function. Patons Lane is a public road, however, it is fitted with a locked gate near its intersection with Luddenham Road with the agreement of all five adjoining landowners. The Proponent intends that this status would remain after its re-construction and throughout the life of the Project.

A review of the RTA's approved B-Double route plans reveals that Luddenham Road and Patons Lane are not approved B-Double roads at present. In recognition of this, the Proponent intends to lodge an application to the RTA for approval to operate B-Doubles on the relevant sections of these roads for consideration.

4.6.2.2 Traffic Controls

The main features of the existing traffic controls in the vicinity of the Project Site are as follows.

- Mamre Road and Luddenham Road generally have an 80 km/h speed limit in the vicinity of the Project Site, however, Luddenham Road, reduces to 60 km/h in the vicinity of Patons Lane.
- The intersection of Mamre Road and Luddenham Road is controlled by seagull linemarking.
- The intersection of Luddenham Road and Patons Road has been reconstructed by the former owner of the Project Site to provide a right turn treatment with a minor holding area in Luddenham Road for right-turning vehicles entering Patons Lane. Stop restrictions exist in Patons Lane at the intersection.
- Mamre Road and Luddenham Road generally have double white centre line marking, however, intermittent overtaking areas are provided.
- Patons Lane has double white centreline provided approaching its intersection with Luddenham Road.
- Mamre Road and Luddenham Road provide one lane in each direction in the vicinity of the Project Site.

4.6.2.3 Existing Pavement Condition

The pavement along Mamre Road and Luddenham Road in the vicinity of the Project Site is of a very high standard.

4.6.2.4 Existing Traffic Flows

Data on traffic movements in the vicinity of the Project Site were collected by Curtis Traffic Surveys from 6:30am to 9:30am and 3:00pm to 6:00pm on Tuesday 16 June 2009 at the intersections of:

- Mamre Road and Luddenham Road, Orchard Hills; and
- Luddenham Road and Patons Lane, Orchard Hills.

Detailed results of the surveys are included in Traffic Solutions (2010). A summary of the peak hour flows at the survey locations is depicted in **Figure 4.19**.

A closer review of the intersection count at Luddenham Road and Patons Lane during the morning and evening peak hours revealed greater detail on the existing peak hour heavy vehicle trips. The recorded peak hour car and truck flows in Luddenham Road during the peak hours are outlined in **Table 4.30**.

Table 4.30
Peak Hour Car and Truck Flows

Peak Hour	Luddenham Road Vehicle Direction and Breakdown				
	Northbound		Southbound		Total
	Cars	Trucks (>3t)	Cars	Trucks (>3t)	
AM Peak Hour (7.30am to 8.30am)	207	5	60	3	275
PM Peak Hour (3.15pm to 4.15pm)	102	5	178	16	301
Source: Traffic Solutions (2010) – Table 3.1					

The existing heavy vehicle volumes represent 2.9% and 6.9% in the morning and evening peak hours respectively. In addition, tube counters were placed on Luddenham Road north of Patons Lane (at the 60 km/h sign at No. 182 Luddenham Road) from 18 to 25 June 2009. The tube surveys have recorded every vehicle travelling along Luddenham Road over 24hrs/day over a 7-day period. The automatic counter recorded the number of vehicle in each direction, speed and classification of all vehicles. The key data collected is set out in **Table 4.31**.

Table 4.31
Existing Luddenham Road Traffic Volume Data

Location	AADT	Average Weekday peak hours		85th % speed (km/h)	Percentage of heavy vehicles
		AM	PM		
Northbound	1554	258	310	84	5%
Southbound	1608	7:00am – 8:00am	5:00pm – 6:00pm	88	5%
Total	3162	568		84	5%
Source: Traffic Solutions (2010) – Table 3.2					

It is apparent from the road hierarchy that Luddenham Road serves an important link, however, the overall traffic flows are considered low.

An indication of the growth of traffic volumes on Luddenham and Mamre Roads in the vicinity of the Project Site are provided by the Roads and Traffic Authority publication *'Traffic Volume Data 2002, Sydney Region – Volume 1'*. Daily traffic flows on Luddenham Road have gradually increased from 2,017 in 1993 to 2,977 in 2005. Daily traffic volumes on Mamre Road increased from 9,676 in 1993 to 14,074 in 2005.

The data reveals that the traffic volumes on Luddenham Road have increased by 15% (5% p.a average) in the most recent three year period up to 2005 while traffic volumes on Mamre Road have increased by 13.1% (4.36% p.a. average) during the most recent three year period. Accordingly, to assess the impact of the proposed waste and resource management facility when at full production in three years the flows along Mamre Road and Luddenham Road in the peak hours would be increased by 15% and 13.1% (respectively) or three years growth in the intersection modelling for the post development scenario.

4.6.2.5 Midblock Roadway Capacity

Using the RTA's *Guide to Traffic Generating Developments*, the existing operation of Luddenham Road with 301 vehicles in the peak hours and 5% heavy vehicles operates at a very good level of service 'A'.

4.6.2.6 Existing Intersection Operation

Figure 4.19 depicts the existing traffic flows at the intersections of Luddenham Road with Mamre Road and Patons Lane. The existing operation of these intersections were assessed using INTANAL 2008, a software program developed by Sims Varley Traffic Systems Pty Ltd for the purpose of analysing signalised, roundabout and sign-controlled intersections.

The results of the modelling reveal that the intersections of Mamre Road and Luddenham Road currently operate at a good level of service with minimal delays and spare capacity.

4.6.3 The Project's Traffic Components

4.6.3.1 Patons Lane

Patons Lane is currently an unsealed road with an engineering construction certificate in place for the construction and sealing of the road. All clearing for the road has been undertaken and it remains for the road to be constructed following the receipt of Project approval for the waste and resource management facility.

4.6.3.2 Site Entrance

The existing site entrance from Patons Lane onto the Project Site is currently 10m wide. Traffic Solutions (2010) recommend this opening is enlarged to 12.5m wide to allow the safe ingress/egress of B-doubles. The Proponent would reconstruct the site entrance to this standard following the receipt of approval from the RTA that the relevant sections of Luddenham Road and Patons Lane are approved to carry B-doubles.

4.6.3.3 Vehicle Parking

It is proposed that parking would be required for typically 20 light vehicles with short term parking for 10 additional vehicles. No parking is planned on site for any heavy vehicles as those would all be kept off site.

Geometric design requirements for car park layouts are specified in the '*Australian/New Zealand Standards, Parking Facilities Part 1; Off Street Car Parking (AS/NZS 2890.1)* of 2004. This standard classifies this development as a Class 1A off-street car parking facility requiring a category 1 driveway. Given that this site has a total area of 60ha, ample area would be available for parking of cars and compliance with this standard can be achieved. The Proponent would provide for 25 lined car parking spaces on a sealed area adjacent to the re-furbished office with a further five un-marked spaces adjacent to the workshop. Accordingly, this Project adheres to the above Australian Standard requirements.

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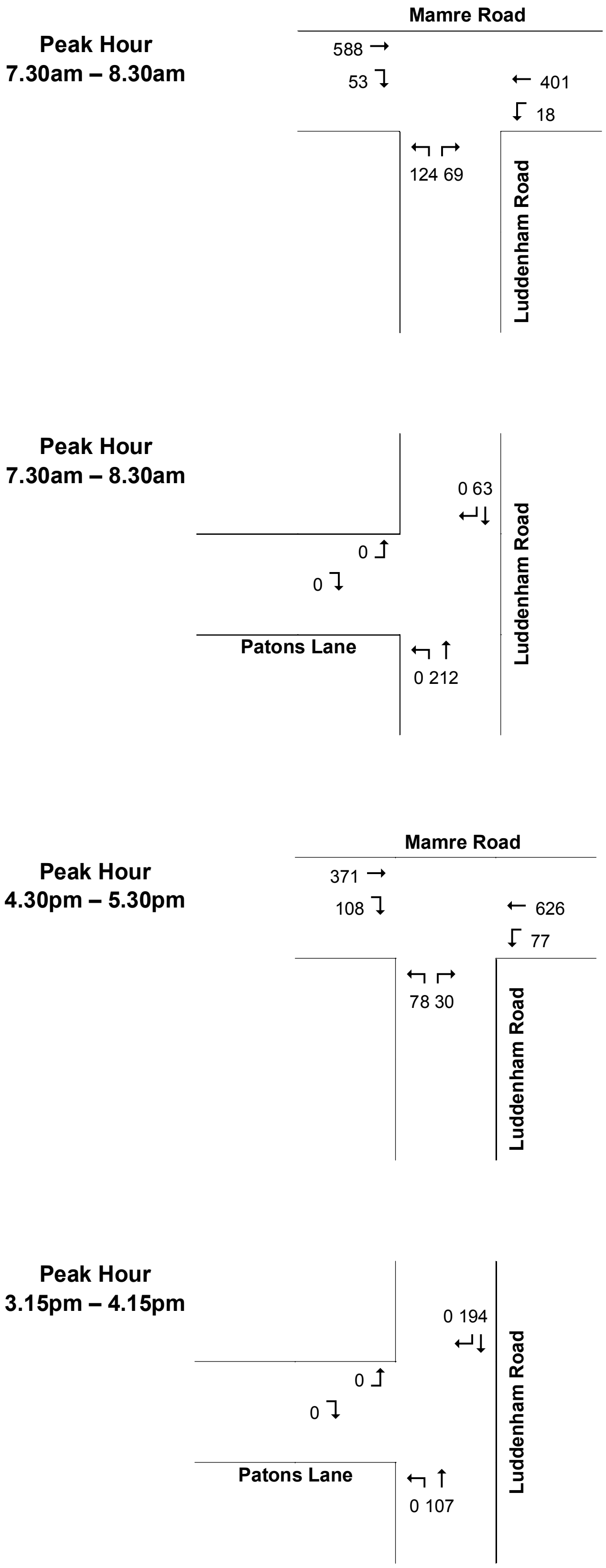

Figure 4.19
EXISTING PEAK HOUR FLOWS

Source: Traffic Solutions (2010) - Figure 2 & 3

Penrith City Council's "*Penrith Development Control Plan 2006 – Part 2 Section 2.11 Car Parking"* has no requirements applicable to this Project. However, given the size of the site, ample area is available to cater for the parking of staff cars, as required.

4.6.3.4 Project-related Heavy and Light Vehicle Movements

During site establishment, up to approximately 102 vehicle movements per day could be expected during the initial 6 months ie. comprising low loaders, table-top trucks, tri-axle truck and dog trailers and light vehicles. It is estimated that during the peak hours approximately 30 vehicle movements could be generated in the morning and evening peak hours respectively (27 in and 3 out in the morning and reverse in the evening).

During operations, the number of heavy and light vehicles travelling to and from the Project Site would reflect the quantity and type of wastes received and quantities of recycled / re-processed products and clay / shale despatched from the site. Estimates of the range of vehicles are provided in Section 2.9.3.2 and 2.9.3.3. In summary, the Proponent has placed an upper limit on the combined number of heavy vehicles travelling to the Project Site daily, ie. 158 truck loads (in or out) or 316 truck movements. Light vehicle movements are expected to vary from 40 to 60 per day, again with the bulk of those travelling to and from site near the start and end of the day's operations.

4.6.4 Design and Operational Safeguards

The assessment by Traffic Solutions (2010) has identified that the proposed transport route from the main road network (Mamre Road) to the Project Site is of a high standard with efficient intersections and good mid-block capacity. As such, there are no specific roadworks required other than the erection of suitable advisory signs of "Trucks Entering".

Given the duration of the Project over a period of 30 years, the Proponent anticipates that the pavement along Luddenham Road would require periodic rehabilitation and/or repair. Accordingly, it is proposed to enter into an agreement with Penrith City Council for the maintenance of Luddenham Road between Mamre Road and Patons Lane. The Proponent intends to set aside funds in a trust account at a rate of \$0.033 per tonne of materials imported and exported from the Project Site along the 1.9km section of Luddenham Road to Mamre Road. This amount, which would be CPI adjusted annually, has been calculated by Traffic Solutions based upon the following assumptions.

- Road reconstruction costs = \$109/m^2 (\$2009).
- Road pavement = 1.9km x 7m = 13300m^2.
- Pavement life = 20 years.
- Road reconstruction of a regional road attracts 50% contribution from the RTA.
- 600 000t of materials (in and out).
- Project related trucks = 60.5% of total trucks.

The Proponent would be fully responsible for all costs associated with the maintenance of Patons Lane throughout the life of the Project.

An important component of heavy vehicle movements travelling to and from the Project Site would be the behaviour of the drivers of the heavy vehicles. The Proponent recognises this fact and intends to introduce a Driver's Code of Conduct for all drivers travelling to and from the Project Site to ensure all issues related to unacceptable driver behaviour would not be tolerated. The code of conduct would cover such issues as the following.

i) Strict adherence to the approved hours of operation.

ii) Avoidance of use of exhaust brakes on Luddenham Road within 500m of the intersection with Patons Lane.

iii) Avoidance of parking along Luddenham Road.

iv) Avoidance of speeding on roads approaching the Project Site.

v) The need for courteous driving habits.

vi) The requirement for all rubbish to be properly disposed of i.e. no roadside litter would be tolerated.

It is proposed that the content of the Code of Conduct would be prepared in consultation with the residents near the intersection of Patons Lane and Luddenham Road to ensure that appropriate limitations/expectations are placed on drivers travelling to and from the Project Site. The Code of Conduct would incorporate a penalty clause for the re-offending drivers, ie. three substantiated offences and they would be banned from travelling to the Project Site.

It is noted that in order to avoid heavy vehicles parking at the entrance gate on Patons Lane, the Proponent intends to engage a security firm to open the gate at 5:30am of a weekday and 7:30am of a Saturday (excluding public holidays) to allow trucks arriving early to travel westward along Patons Lane to the gate at the entrance to the Project Site. The entrance gate into the Project Site would be opened at 6:00am of a weekday and 8.00am of a Saturday (excluding public holidays).

4.6.5 Assessment of Impacts

4.6.5.1 Impacts on Midblock Capacity

The existing operation of Luddenham Road with up to 301 vehicles (including 5% heavy vehicles) in the peak hours would operate at a very good level of service 'A'.

The existing heavy vehicle volumes represent 2.9% and 6.9% in the morning and evening peak hours respectively. **Table 4.32** provides a comparison between the existing and potential flows along Luddenham Road with an additional 20 heavy vehicle trips and 15 light vehicle trips in the peak hours.

Table 4.32
Luddenham Road Peak Hour Vehicle Volume, Direction and Classification

Peak Hour	Existing			Post Development		
	Cars	Trucks (>3t)	Total	Cars	Trucks (>3t)	Total
AM Peak hour 7:30am – 8:30am	267	8	275	282	37	319
PM Peak hour 3:15pm – 4:15pm	280	21	301	295	50	345
Source: Traffic Solutions (2010) Table 4.5.						

The post development heavy vehicle volumes would represent 11.6% and 14.5% in the morning and evening peak hours respectively. Using the data in **Table 4.33**, the post development operation of Luddenham Road with up to 345 vehicles in the peak hours and 14.5% heavy vehicles would still fall into the very good level of service ‘A’ category and is therefore considered satisfactory.

4.6.5.2 Impacts upon Key Intersections

For the purposes of this assessment, the 89 estimated morning and evening peak hour approach and departure vehicle trips have been assigned proportionally to the adjacent road system on the basis of existing flows at Mamre Road assuming 80% of approaching and departing truck traffic travels to/from the M4 Motorway and no truck traffic travels south along Luddenham Road. **Figure 4.20** depicts the potential additional morning and afternoon peak hour traffic volumes for the intersections based upon the forecast flows.

As noted, the traffic volumes on Luddenham Road have increased by 15% (5% p.a average) in the most recent three year period up to 2005 and Mamre Road has increased by 13.1% (4.36% p.a. average) during the most recent three year period. Accordingly, to assess the impact of the proposed Project when at full production in three years the flows along Mamre Road and Luddenham Road in the peak hours would be increased by 15% and 13.1% (respectively) or three years growth in the intersection modelling for the post development scenario.

A comparison of intersection performance between the existing and projected traffic demands during the morning and evening peak hours upon the intersections Luddenham Road with Mamre Road and Patons Lane has been conducted. **Tables 4.33** and **4.34** display the results of intersection modelling.

Table 4.33
Mamre Road and Luddenham Road, Orchard Hills (Give Way control seagull intersection)

	Existing		Proposed	
	AM	PM	AM	PM
Level of Service	B	B	B	B
Degree of Saturation	0.24	0.18	0.32	0.34
Total Average Delay (sec/veh)	12.2	11.4	13.2	13.5
Source: Traffic Solutions (2010) Table 4.6.				

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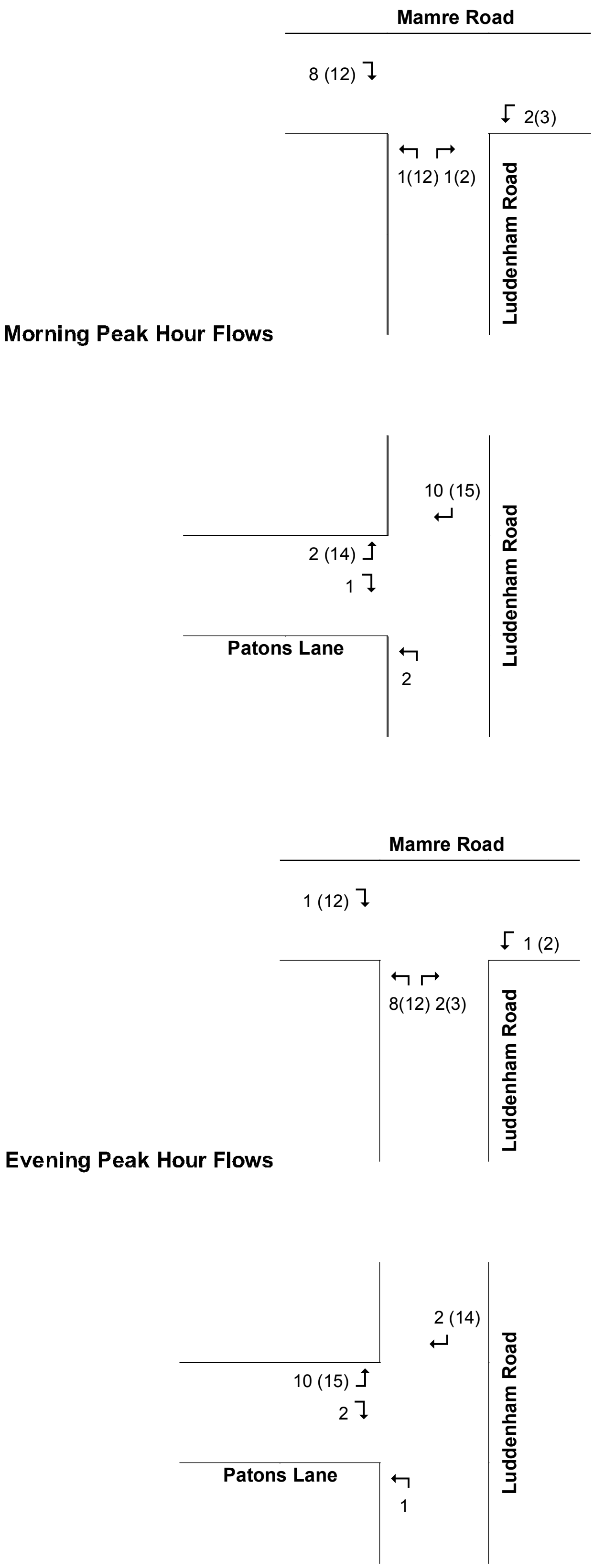

Source: Traffic Solutions (2010) - Figure 4 & 5

Figure 4.20
POTENTIAL ADDITIONAL PEAK HOUR FLOWS

Table 4.34
Luddenham Road and Patons Lane, Orchard Hills (Stop sign control)

	Existing		Proposed	
	AM	PM	AM	PM
Level of Service	A	A	A	A
Degree of Saturation	0.0	0.0	0.04	0.08
Total Average Delay (sec/veh)	0.0	0.0	5.8	5.5
Source: Traffic Solutions (2010) Table 4.6.				

The results of the modelling reveal that:

- the good Level of Service at the intersections modelled would not change with the estimated additional traffic generation of the proposed development;
- the additional traffic demand on the intersections modelled as a consequence of the proposed development would only alter the Degree of Saturation and Total Average Delays minutely; and
- the proposed driveway would operate at a very good level of service with minimal delays.

4.6.5.3 Heavy Vehicle Manoeuvring

As stated previously, Patons Lane is not an approved B-Double route. Accordingly, the maximum vehicle to be catered for on site is currently a 19m articulated vehicle. However, the Proponent would be lodging a 26m B-Double route assessment application under separate cover.

In order to determine if this size vehicle can access the Project Site, AUSTROADS B-Double turning template has been over laid upon the site access survey plan at scale. This procedure has revealed that a 26m B-Double vehicle would be able to enter the Project Site from both Luddenham Road into Patons Lane and from Patons Lane into the Project Site. The ability for the AS 2890.2 – 2002 articulated (19m) vehicle to enter the Project Site has also been assessed using the turning and templates, revealing sufficient driveway width for this size vehicle also.

Consequently, the Project would be able to cater for all heavy vehicles up to 26m B-Doubles, should the B-Double route be approved by the Roads and Traffic Authority.

4.6.5.4 Road Pavement

The high standard of the road pavement along the transport route between Mamre Road and the Project Site would provide for considerable traffic movements without substantial deterioration. Notwithstanding this, the Proponent's contribution to long term road maintenance would ensure the Project does not have an adverse impact on the road pavement.

4.7 VISIBILITY

This subsection provides an assessment of visibility issues relevant to the Project both throughout its operational life and following its completion. The subsection incorporates information drawn from the visual assessment completed by Design Collaborative Pty Ltd whose report is reproduced in full as Part 7, Volume 2 of the Specialist Consultant Studies Compendium.

4.7.1 Introduction

Based on the risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential visibility-related impacts on visual amenity requiring assessment and their **unmitigated** risk rating are as follows.

- Periodic visibility of operational activities (high risk).
- Marginally identifiable change to the landscape created by the final landform (high risk).
- Highly identifiable change to the landscape created by the final landform (moderate risk).

In addition, the Director-General's requirements issued by the Department of Planning identified the following visibility-related issues for consideration in the *Environmental Assessment.*

- An assessment of the potential visual impacts of the Project on the amenity of the surrounding area, including photomontages from sensitive receivers, with particular attention to the adjoining residential areas.
- A detailed description of the measures that would be implemented to minimise the potential visual impacts of the Project, including the proposed landscaping to screen the proposed works.
- Details of proposed lighting and signage.

The following subsections describe the existing visual amenity around the Project Site and the range of visibility-related safeguards to be adopted throughout the life of the Project. The subsection incorporates an assessment of the effectiveness of the rehabilitation process aimed at re-instating both the topography and landscape so that it is consistent with the relevant objectives of current and proposed land zoning.

4.7.2 Planning Context

Creating an acceptable visual outcome for the Project Site through progressive rehabilitation is a fundamental objective under the current Penrith Local Environmental Plan No. 201 – Rural Lands (PLEP-RL) and draft Penrith Local Environmental Plan 2008 (draft PLEP 2008). In terms of visual impact, the relevant objectives of the Project Site's current 1(a) (Rural "A" Zone-General) zoning are to:

- *protect and enhance the scenic quality and rural character of the locality;*
- *ensure that the form, siting and colours of buildings, building materials and landscaping complement the natural scenic quality of these localities; and to*
- *ensure that the views from main roads and the rural character of the locality would not be adversely affected.*

Similarly, the Project Site's proposed zonings of predominantly RU2 and part E2 under draft PLEP 2008 also provides the following relevant objectives:

- *maintain the rural landscape character of the land; and*
- *protect views and vistas from main roads and other vantage points.*

4.7.3 Existing Visual Amenity

The visual catchment of the Project Site has been defined by Design Collaborative (2010) based largely on the distance at which the perimeter bund walls around the Project Site are discernible. Observations towards the Project Site have established that the perimeter bund walls are discernible at a distance of approximately 1km (see **Plates 4.1** to **4.2**). A descriptive summary of the views towards the Project Site are provided as follows.

Views from the North

Views of the Project Site from the north are from private rural holdings and the relatively recent rural-residential estate known as "The Vines", where the closest property is approximately 500m from the northwestern and northeastern bund walls. Only glimpses of these bund walls are possible from those closest residential properties in "The Vines" estate (**Plates 4.1** and **4.2**). This is attributed to two factors, the first being that an extensive tree corridor exists along Blaxland Creek between the Project Site and these residences, which provides effective screening of the bund walls. Secondly, the topography of the "The Vines" estate rises up from south to north and, as a consequence, the screening provided by the tree canopy is further enhanced as those closest residential properties to the Project Site are located at elevations lower than the perimeter bund walls.

For those topographically higher residences within "The Vines" estate, views of the Project Site's bund walls become more prominent as the sight line is above the Blaxland Creek tree canopy (**Plate 4.3**).

Views from the East

The catchment area to the east of the Project Site is generally bounded by Luddenham Road and includes the residences on "Roughwood Park" and "Glenholme Farm". Public views of the Project Site from Luddenham Road are limited in some parts, as a result of existing vegetation and the natural topography of the land. Furthermore, given the distance (approximately 1km at its closest point), it is difficult to distinguish the bund walls from the natural topography of the landscape (**Plate 4.4**).

Closer to the Project Site, where views are from private rural holdings, the eastern bund wall becomes more prominent where it is not impeded by existing an intervening tree canopy. It is not until within approximately 500m from the Project Site that the bund walls become more visually prominent.

From Patons Lane, public views are generally limited due to the dense vegetation skirting the northern side of the carriageway. The eastern bund wall and the Project Site entrance is not readily viewed until within close proximity to its boundaries.

Views from the West

Views of the Project Site from the west are from the Australian Defence Force land. This adjoining land comprises a dense tree canopy, which effectively screens any long distance views of the Project Site from this direction. Glimpses of the western bund wall, therefore, are limited to areas within approximately 300m to 400m from the western boundary of the Project Site.

4.7.4 Mitigation Measures

4.7.4.1 Throughout the Project Life

The Proponent would adopt the following mitigation measures to minimise the visual impacts of all activities throughout the Project life.

1. **Northern Bund Wall**

   The existing northwestern bund wall would be reshaped on its western end to create lower slopes and the remainder of the bund and the nearby northeastern bund wall would be enlarged to provide a substantial visual barrier to the north approximately 55m high, referred to as the northern bund wall. It is acknowledged (as discussed in Section 4.4.4) that the proposed height of the northern bund wall has been dictated by the noise assessment requiring a sufficient height (together with a 2m fence – see below) to attenuate noise levels).

   The northern bund wall would be created with slopes varying from 1:3 (V:H) (18º) to 1:5 (V:H) (11º). These slopes are conducive for revegetation and, with ripping generally parallel to contour, would be vegetated on the northern slopes of the bund wall with a range of tree and shrub species (see Section 2.14.6).

   The construction and initial revegetation of the northern bund wall would itself be visible with equipment operating often on the northern exposed face. Such observations are unavoidable, however, the Proponent intends to program the works required to construct the northern bund to limit the period during which the bund is constructed.

   Once constructed and revegetated, the northern bund would be an important control in limiting visibility of the activities within the Project Site. Over time, as the trees on the outer fence of the bund wall increase in height, the proportion of the elevated sections of the landform being developed would diminish. Trees with a height of 5m to 6m within 5 years would restrict views from the north to that section of the final landform generally above 60m AHD.

2. **Northern Acoustic Fence**

   The noise assessment has established that a 2m high acoustic fence is required along the top of the northern bund wall to provide additional acoustic protection for mobile earthmoving equipment operating on site. This fence would also provide additional visual protection to a height of 57m.

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Plate 4.1 : View southwards from Cabernet Circuit towards the Project Site and intervening vegetation located along Blaxland Creek (Ref: DC-1)

Plate 4.2 : View southwards from Cabernet Circuit towards the Project Site and intervening vegetation located along Blaxland Creek (Ref: DC-2)

Plate 4.3 : View to the southeast from Verdelho Way towards the Project Site. Clay / Shale stockpiles on site are visible in the distance. (Ref: DC-3)

Plate 4.4 : View to the west from Luddenham Road towards the eastern bundwall. (Ref: DC-4)

It is proposed the fence is constructed with wooden panelling painted in a green/grey hue to minimise the visual impact of the fence itself. It is, however, likely that the proposed vegetation on the slopes and top of the northern bund wall would shield the fence within 3 or 4 years.

Figure 4.21 displays the anticipated form and extent of vegetation and acoustic fence on the northern bund wall.

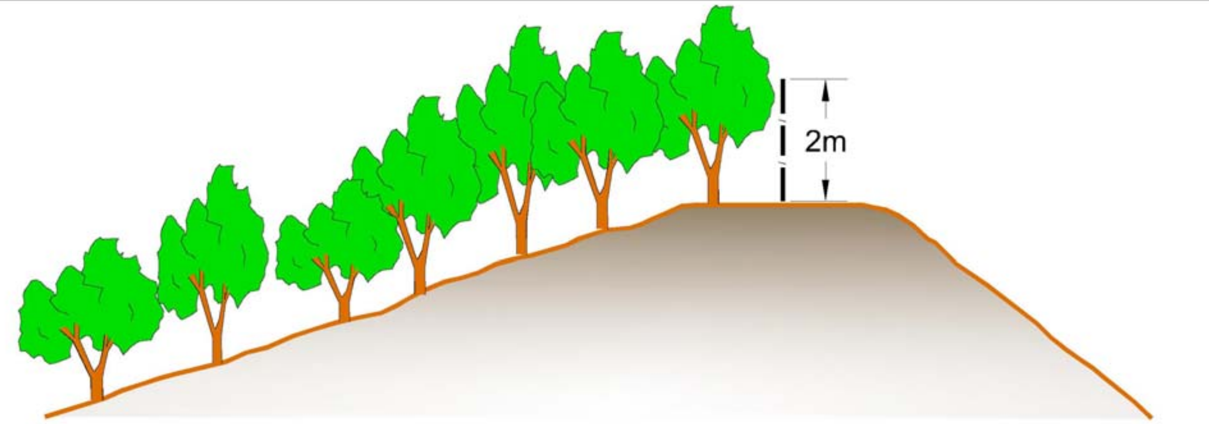

Figure 4.21
VEGETATED NORTHERN BUND WALL AND FENCE

3. **Eastern Bund Wall**
The crest of the eastern bund wall currently varies from approximately 52m AHD to 58m AHD and the outer eastern slope of the bund wall is comparatively steep but well vegetated. It is proposed, from a principally acoustic perspective, to raise the level of the bund wall to 58m through the placement of on the existing wide crest of the bund and re-shaping and revegetating the outer final slope. The final form and height of the eastern bund wall would assist to limit views of activities within the Project Site from the residences on "Roughwood Park" and "Glenholme Farm".

4. **Progressive Rehabilitation of Final Landform**
Emphasis would be placed upon progressively rehabilitating the final landform in sections no larger than 0.5ha at a time. This approach would ensure that the area of exposed unvegetated surface is minimised and the area revegetated is increased gradually.

5. **Elevations of Operating Equipment**
The Project has been intentionally designed with long term components operating in areas of least elevation (and hence greatest topographic shielding) or in areas where acoustic shielding can be constructed. Examples of these practices are as follows.
   – The recycling and re-processing plant would be positioned on a platform within the Recycling and Re-processing Area at an elevation of 46m AHD to 48m AHD. This elevation, combined with the nearby acoustic mounds would ensure the plant is not visible from any residence.

– All stockpiles for clay/shale products set aside for brick manufacture would be located in areas that would ensure that earthmoving equipment used to construct the stockpiles (eg. scrapers) are not visible from any residence.

6. **Mobile Barrier to Shield Equipment Operating in Elevated Areas**

   In order to create the proposed final landform (**Figure 2.18**), it would be necessary for equipment to operate on or near the surface of the waste emplacements. The extent of visibility of equipment operating on the elevated areas would be limited through the use of a 4m-high mobile acoustic barrier.

7. **High Standard of Housekeeping**

   The Proponent would ensure that the entire facility is operated with a high standard of housekeeping. This would involve the implementation of procedures with all site personnel, particularly to avoid wind-blown litter. Additional practices, eg. litter fences would be used when the waste emplacement activities are elevated should they be necessary.

8. **Lighting**

   The proposed lighting on site is described in Section 2.12.2.1 with emphasis placed upon its use for an hour of a morning (6:00am to 7:00am) and afternoon (5:00pm to (6:00pm) during the period May to August each year. All on-site lighting would be positioned such that it would not be visible from surrounding residences.

9. **Signage**

   The waste and resource management facility would operate with minimal signage, particularly given the facility would not be open to the general public and its location would be circulated and/or known to all haulage contractors travelling to and from the facility. A small sign, satisfying the requirements of Penrith City Council would be positioned at the entrance of the facility off Luddenham Road.

4.7.5 Assessment of Impacts

A qualitative assessment of the existing and proposed visual impacts of the Project was undertaken by Design Collaborative (2010).

4.7.5.1 Introduction

The visual impacts of the Project have been assessed throughout and at the end of the life of the Project, that is, from the existing landform, through the operational stages and the final landform from within the defined visual catchment area detailed in **Figure 4.22**. To assist with this assessment, four visibility cross sections have been prepared, all of which are included in Design Collaborative (2010). Each of these cross sections has been illustrated at four separate stages of the Project, which include:

- Existing Landform
- Early Operational Stages (Approximately Years 1-5)
- Operational Stages (Approximately Years 6 -27)
- Final Landform (Approximately Years 28-30)

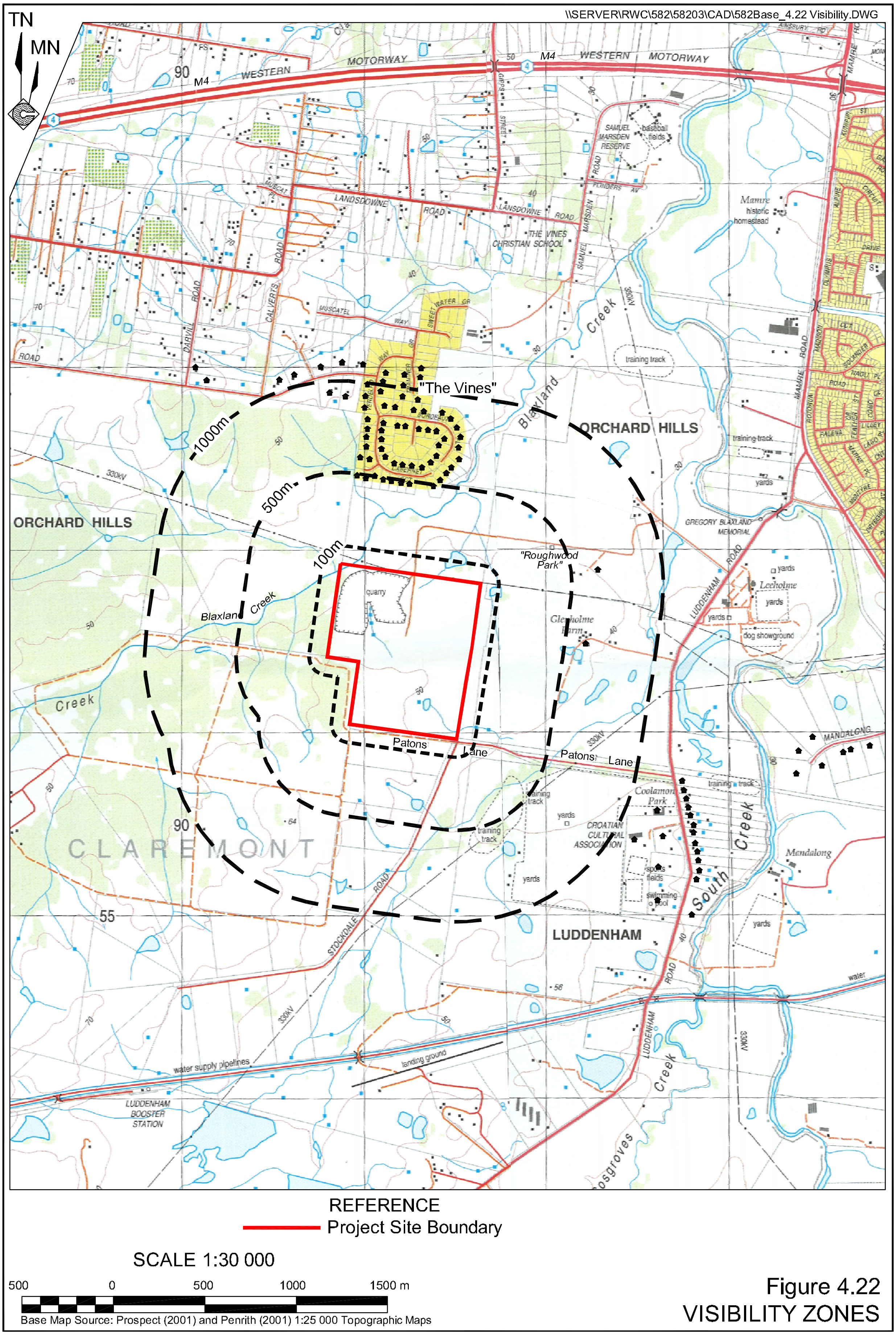

Figure 4.22
VISIBILITY ZONES

The visual impacts upon the defined visual catchment area throughout the life of the Project have been assessed on a qualitative basis as either being negligible, minor, moderate, severe or devastating. Each of these qualitative impact levels are defined as follows:

Negligible – When the Project Site is viewed from within the defined catchment, it upholds the local planning objectives of enhancing the scenic quality and the rural character of the surrounding landscape.

Minor – When the Project Site is viewed from within the defined catchment, it presents some discrete signs that the natural topography of the land has been altered, however, not in a manner that would impede the local planning objectives of enhancing the scenic quality and the rural character of the locality.

Moderate – When the Project Site is viewed from within the defined catchment, it presents more obvious signs that the natural topography of the land has been altered and, therefore, presents some unsatisfactory impact on upholding the local planning objectives of enhancing scenic quality and the rural character of the locality.

Severe – When the Project Site is viewed from within the defined catchment, it presents obvious signs that the natural topography of the land has been disturbed, which results in a failure to achieve the local planning objectives of enhancing the scenic quality and the rural character of the locality.

Devastating – When the Project Site is viewed from within the defined catchment, it presents a landform that has been significantly disturbed to such a high degree that it is unlikely that any rehabilitation could ever reduce the level of adverse impacts to achieve the local planning objectives of enhancing the scenic quality and rural character of the locality.

The assessment has been undertaken for the life of the Project from three defined distances of approximately 1km (at the edge of the defined visual catchment), 500m and 100m from the Project Site's boundaries, which are otherwise known as the outer, middle and inner rings. This assessment which has been undertaken from all directions describes the current visual impacts and the likely resultant visual impacts that may occur as a result of the progressive rehabilitation of the Project Site. A summary of the impacts is provided below in **Table 4.35**.

Table 4.35
Existing, Operational and Final Landform Visual Impacts

Distance	1000m (Outer Ring)				500m (Middle Ring)				100m (Inner Ring)			
Project Stage	Existing	Operational (Early)	Operational	Final	Existing	Operational (Early)	Operational	Final	Existing	Operational (Early)	Operational	Final
North	M	M	N	N	M	M	N	N	S	S	M	M
South	N	N	N	N	M	N	N	N	Md	Md	Md	N
East	N	N	N	N	Md	N	N	N	S	M	M	M
West	N	N	N	N	M	N	M	N	M	M	Md	N
Key: N – Negligible; M – Minor; Md – Moderate; S – Severe; D – Devastating												
Source: Design Collaborative (2010) – Table 1												

4.7.5.2 Visual Impact Assessment

The visual impact assessment outlined in detail below describes how the Project Site would be viewed from the three established distances from all directions within the defined visual catchment area. An assessment is provided for each of the stages in the life of the Project Site.

4.7.5.2.1 Views from the North

Existing Landform

Views of the Project Site from the north, particularly from the closest residential properties within "The Vines" estate, currently incur moderate to minor view impacts as a result of the 10m to 13m high bund wall along its north-western and north-eastern boundaries. The severity of these existing views is reduced by the existing non-deciduous tree canopy located along Blaxland Creek that screens the Project Site from this area. Views of the Project Site from other and/or the southern side of Blaxland Creek where there is no vegetation screening however, accentuates the appearance of the bund walls in comparison to the surrounding topography.

Early Operation Stages

As illustrated in **Figure 4.23** and **Figure 4.24,** the early operation procedures would involve constructing two audio-visual earth mounds that would shield the activities within the Recycling and Re-processing Area.

The new earth mounds to be constructed around the Recycling and Re-processing Area would ensure that noise generated from the recycling and re-processing plant is maintained at appropriate levels, and that the associated plant cannot be viewed from outside the Project Site's boundaries.

The early operational stages would also see the commencement of waste emplacement in the northwestern part of Cell 1. The existing northern bund wall towards the western side of the Project Site is at its highest at this point (53m AHD). The height of this existing northern-western bund wall would be increased to 55m AHD across the bulk of the northern bund wall.

As illustrated in **Figure 4.23** the combined northwestern and northeastern bund walls would be reshaped and battered in order to provide a gradual slope up away from the northern boundary as opposed to the steep walls of the bunds at present. The reshaped bund wall would also elevate the sight lines from those properties at a higher elevation within "The Vines" estate to the top of what would be the eventual height of the final landform was well as to contain any adverse noise spill from the Project Site.

The view impacts of the Project Site from the north that would be incurred from "The Vines" estate in the outer and middle rings of the visual catchment would remain minor. Similarly, when the site is viewed from the inner ring, the visual impact would remain severe.

Operational Stages

Once the activity on the Project Site has significantly increased, the waste emplacement along the western and in the north-western corner of Cell 1 would have reached the final landform level and capped. The northern bund wall that is constructed during the site establishment stage would blend into the background of the final landform and would read like a gradual slope up from the northern boundary of the Project Site (see **Figure 4.23**).

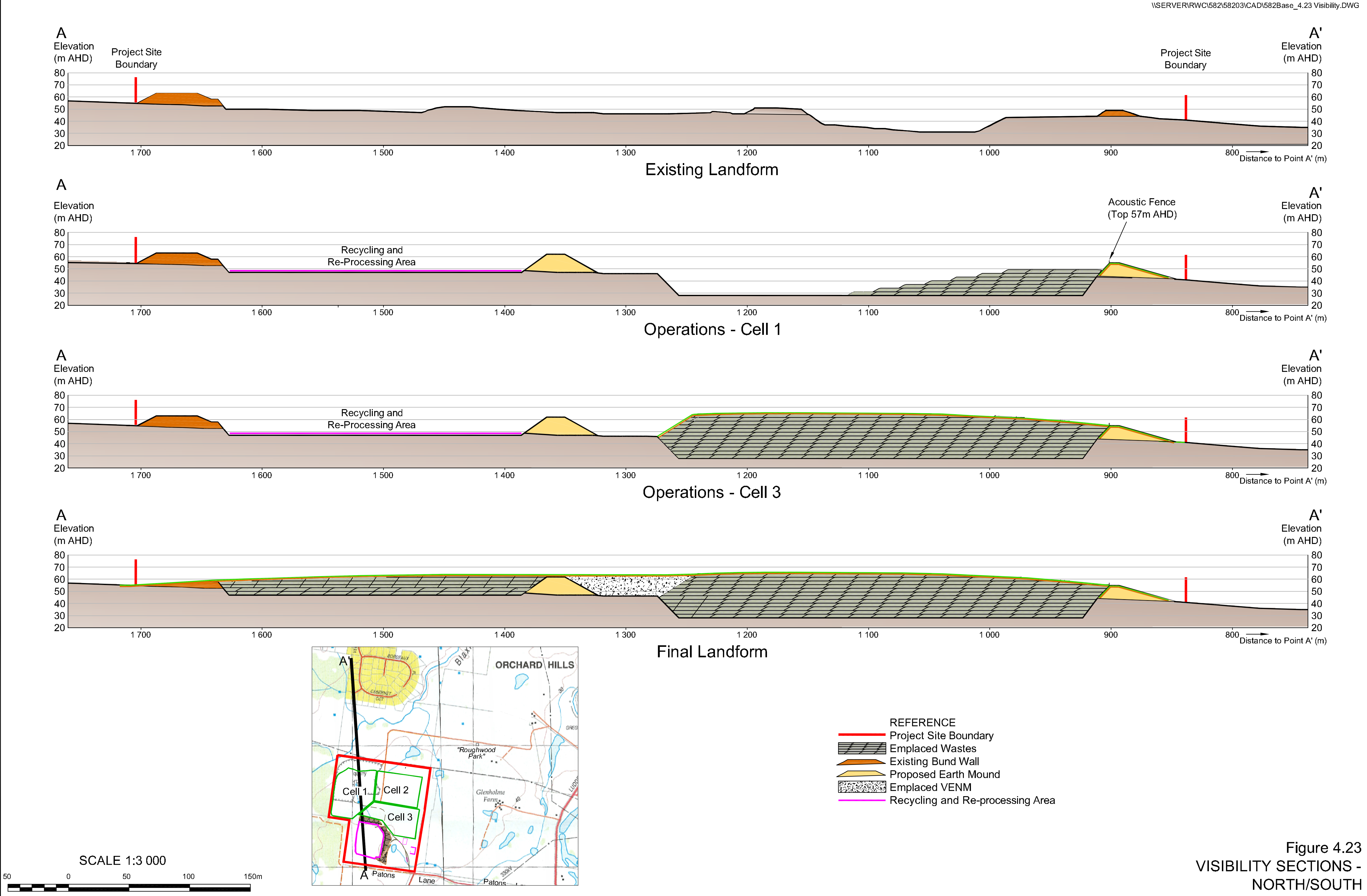

Figure 4.23
VISIBILITY SECTIONS - NORTH/SOUTH

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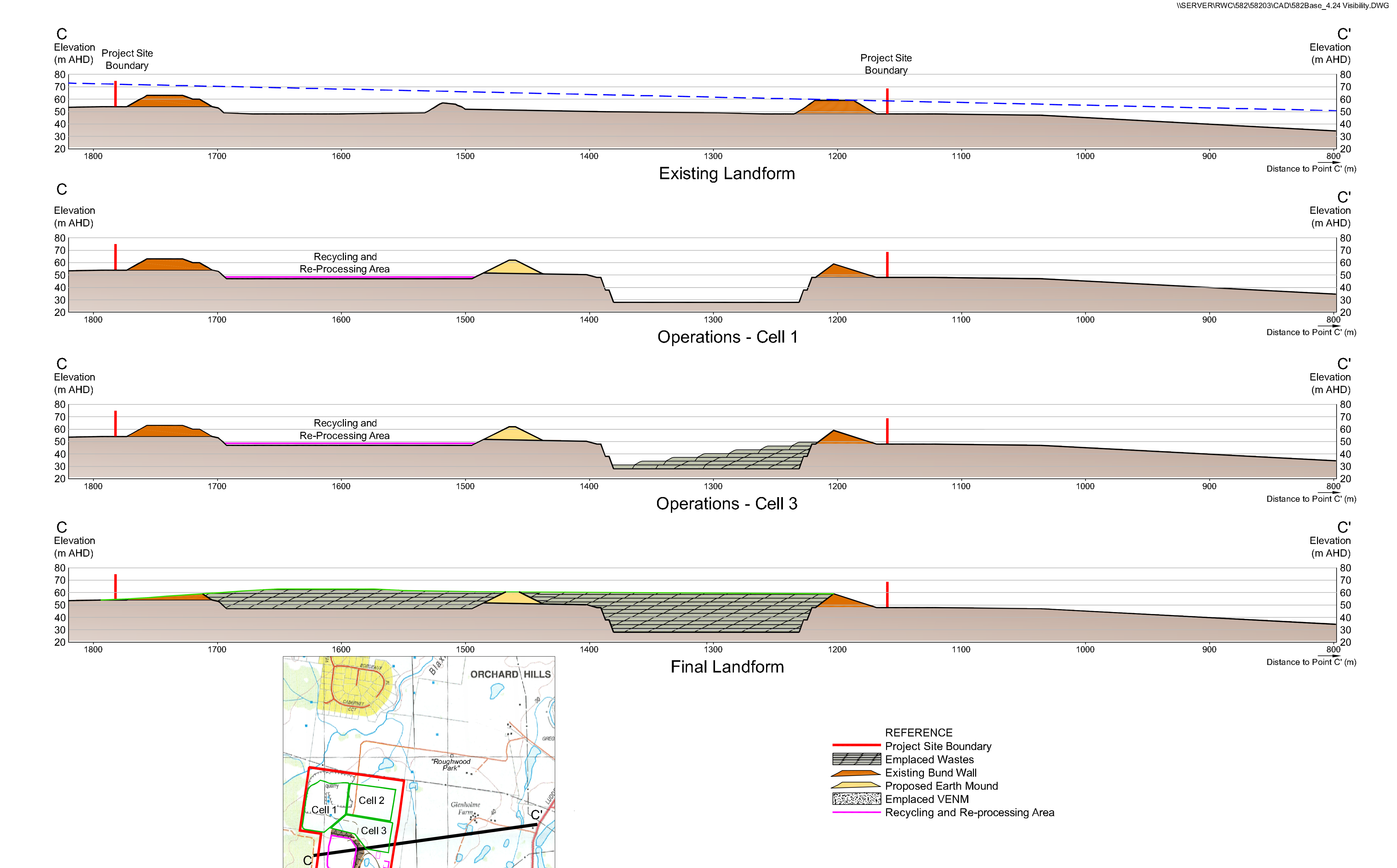

Figure 4.24
VISIBILITY SECTIONS - EAST/WEST

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Further toward the centre of the Project Site, along its northern boundary, **Figure 4.24** illustrates that the elevated northern bund wall would assist to shield much of the activities on site. The landform would rise gradually towards the centre of the site as the waste emplacement increases to its capacity in Cells 1 and 2.

Therefore, the view impacts of the Project Site from the north that would be incurred from the outer and middle rings of the visual catchment would be reduced to negligible and to minor from the inner ring.

Final Landform

The rehabilitation would result in the visual impact of the majority of the northern and eastern bund walls being progressively reduced as they blend into the gradual slope towards the centre of the Project Site approximately 350m from its northern and eastern boundaries. The views from the north would be significantly improved and when combined with the existing tree canopy located along Blaxland Creek, the visual impact would be reduced to negligible from outer and middle rings, which comprise “The Vines” estate. **Plates 4.5** and **4.6** present photomontages of the landform at the end of the site establishment period and at the end of the Project life when viewed from “The Vines” estate and the “Roughwood Park” residence. Design Collaborative (2010) includes further photomontages for review.

Closer to the Project Site, the visual impact would be reduced from severe to minor as a result of the redefined landform, particularly with the reshaping and revegetation of the northern bund wall. In this regard, it is important to note that those views of the Project Site from the north and east would be one of the first aspects that would be improved as a result of the Project’s progressive rehabilitation program in order to provide some visual amenity relief to a number of the residents within “The Vines” estate.

4.7.5.2.2 Views from the South

Existing Landform

Views of the Project Site from the south include an existing bund wall, which is approximately 10m high (see **Figures 4.23** and **4.24**). This bund wall occupies over half of the length of the Project Site’s southern boundary. The existing landform for the remainder of the Project Site’s southern boundary is generally flat and at the natural ground level.

The existing visual impacts of the Project Site, when viewed from the outer and middle rings from the south, are barely discernable given the extent of existing vegetation that exists within this visual catchment area. From the inner ring, the existing visual impact of the Project Site is best described as moderate.

Early Operational Stages

The early operational stages would not see any changes to the existing landform along the site’s southern boundary and, therefore, the view impacts would be unchanged in the early stages of the operations.

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Existing View

View after Construction of Visual Bund

View of the Final Landform

Plate 4.5
Photomontage of the landform at the end of the site establishment period and at the end of the Project life when viewed from the "The Vines".

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Existing View

View after Construction of Visual Bund

View of the Final Landform

Plate 4.6
Photomontage of the landform at the end of the site establishment period and at the end of the Project life as viewed from “Roughwood Park”.

Views of the site would only slightly change when viewed from the south east and from the inner ring of the visual catchment. The changes that would be viewed would include the new audio visual earth mounds that would be constructed around the Recycling and Re-processing Area. The visual impact of these changes would not change the moderate rating.

Operational Stages

When the Project is in the peak of its operations, the existing bund wall located along the site's southern boundary would be retained. The main purpose of this is that it forms part of the audio-visual shielding around the Recycling and Re-processing Area in order to assist with minimising any adverse noise spill and to also screen the associated plant from the public domain. The view impact from the southern outer and middle rings would, therefore, remain unchanged for the majority of the Project's life.

From the inner ring, some changes to the Project Site's landform when viewed from the south-east would be evident and would consist of the commencement of the final landform being created in Cell 1. However, this landform would be over 400m away from the Project Site's southern boundary and, therefore, is unlikely to significantly change the visual impact from moderate.

Final Landform

The removal of the southern perimeter bund walls as well as encompassing existing internal bunds within the overall final landform would result in a negligible visual impact when the Project Site is viewed from the south.

4.7.5.2.3 Views from the East

Existing Landform

Three quarters of the Project Site's eastern boundary is occupied by an existing 10m high bund wall. The remainder of the area along the Project Site's eastern boundary is at the natural ground level.

The Project Site is difficult to differentiate from the surrounding rural landscape at the outer ring of the visual catchment area and, therefore, the impact is negligible. From the middle ring, the visual impact of the existing bund walls are moderate increasing to severe when viewed from the inner ring.

Early Operational Stages

The height of the eastern bund wall would be increased marginally (to 58m AHD) in the early operational stages principally to attenuate noise levels. As a result of the increase in the bund wall height, the visual impact from the middle ring would be reduced to negligible and to minor from the inner ring.

Operational Stages

The Project Site's landform would not dramatically change from that displayed during the early operational stages. The eastern bund wall would be reshaped towards the end of the operation in Cells 2B and 3A which, in turn, would blend with the overall slope of the final landform. The visual impact from within the eastern catchment area would, therefore, not change during the majority of the life of the Project, which is predominantly negligible.

Final Landform

As illustrated in **Figure 4.23** the views from within the catchment area from the east would generally not change from the early stages of the operations. The visual impact status from within the catchment area would, therefore, also remain unchanged once the final landform is in place.

4.7.5.2.4 Views from the West

Existing Landform

The Project Site is not viewed from the outer ring in the western part of the visual catchment area given the extent of tree canopy on the adjoining land owned by the Commonwealth of Australia. Only glimpses of the Project Site's existing 13m high bund wall located along the southern half of its western boundary are possible in the middle and inner rings. Overall, the existing visual impact of the Project Site when viewed from the west is negligible and minor.

Early Operational Stages

The early operational stages would result in no changes to the visual impacts from the west given that the existing western bund wall would not be altered. This bund wall is being retained to screen and mitigate noise impacts from operations within the Recycling and Re-processing Area.

Operational Stages

Once the operations have significantly progressed, some changes to the visual characteristics of the site that would be noticeable from the inner ring and to a lesser degree the middle ring would be the waste emplacement and the associated establishment of the final landform in Cell 1. As this situation arises, the visual impacts are likely to change from negligible to minor for the middle ring and from minor to moderate for the inner ring.

Final Landform

The bund wall skirting the western boundary of the Project Site would predominantly be removed as part of the final rehabilitation process. The bund wall would be battered down and form part of the final landform. The benefit of this would be that the visual impacts when the Project Site is viewed from the middle and outer rings would be reduced back to negligible and minor.

4.7.6 Conclusion

The Project would achieve the visibility-related objectives of the local planning framework for its rural context via its proposed progressive rehabilitation of the Project Site through residual non-putrescible waste emplacement and VENM within its cells and landscaping.

During the site establishment phase of the Project, the existing perimeter northern and eastern bund walls would be altered and used to provide both visual and acoustic barriers, in particular, with respect to those closest residential properties in "The Vines" estate to the north and also residences to the east.

The progressive rehabilitation would move generally from north to south in order to enable the recycling and reprocessing plant to continue to operate even at the end of the residual waste emplacement capacity of the Project Site's main cells. By this stage, the visual impacts of the site from the north and east within the visual catchment area would, overall, be categorised as minor.

At the end of the life of the Project Site, the final landform would be a landscaped, gently sloping knoll that would be consistent with the surrounding rural character and the objectives of the relevant local environmental planning instruments.

4.8 FLORA

This section provides a summary of the flora assessment completed by Geoff Cunningham Natural Resource Consultants Pty Ltd (GCNRC, 2009a), which is reproduced in full as Part 8, Volume 2 of the Specialist Consultant Studies Compendium.

4.8.1 Introduction

Based on the environmental risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential threatened flora and fauna impacts requiring assessment and their **unmitigated** risk rating are as follows.

- Disturbance to native vegetation within nominated areas (Low Risk).
- Disturbance to native vegetation outside nominated areas (Low Risk).
- Disturbance to threatened flora and endangered ecological communities (Low Risk).
- Disturbance leading to local population reduction (Low Risk).
- Reduced local biodiversity (Low Risk).
- Reduced regional biodiversity (Low Risk).

In addition, the Director-General's requirements issued by the Department of Planning identified key issues relating to flora and biodiversity, including:

- an assessment of the potential impacts of the Project on threatened species and Endangered Ecological Communities (EECs); and
- details of the proposed measures to enhance biodiversity.

Further, the DECC and other relevant government agencies (including DWE) nominated that the *Environmental Assessment* also provide details relating to:

- field surveys;
- likely impacts on threatened species, populations, ecological communities and their habitat;

- potential off-site impacts onto adjacent areas;
- mitigation measures to prevent impacts on threatened species and/or EECs; and
- possibilities for riparian zone revegetation.

The following subsections describe and assess the existing native/exotic vegetation and the presence of threatened flora species and communities, identify flora management issues, proposed, safeguards and management measures for threatened species.

4.8.2 Study Methodology

The desktop component of the flora assessment involved:

- the review of any previous flora assessments undertaken within and surrounding the Project Site;
- review of available aerial photography; and
- a web-based search of the documented records held on the DECC Atlas of NSW Wildlife Database and the Environment Australia Protected Matter Search Tool.

A field survey of the Project Site was then carried out on 4 February 2009 which involved describing and mapping the vegetation communities and preparing a comprehensive plant species list for the Project Site. Particular attention was given to the identification, location and assessment of threatened and rare plants and communities.

In total, nine quadrat sites were selected for field investigation. At each site, a 20m x 20m quadrat (or a rectangular quadrat of equivalent area) was examined and the species present were recorded.

4.8.3 Previous Flora Studies

No detailed flora studies have previously been undertaken within the Project Site and it is noted that the land within the Project Site was fully cleared and used for grazing at least since 1980, i.e. at the time when the Environmental Impact Statement for existing clay/shale quarry was prepared (RWC, 1980).

There are, however, a number of studies which provide descriptions of the vegetation within the adjacent Department of Defence lands and therefore provide an indication of the likely original vegetation cover on the Project Site. These studies indicate that prior to the Project Site being cleared it is likely to have contained Grey Box Woodland (Benson 1992 and James 1997) or the endangered Shale Plains Woodland (Tozer 2003), both dominated by *Eucalyptus moluccana* (Grey Box) and *Eucalyptus tereticornis* (Forest Red Gum). Tozer (2003) also described the vegetation along Blaxland Creek as Alluvial Woodland, part of the endangered Sydney Coastal River Flat Forest community. Sydney Coastal River Flat Forest is usually dominated by *Eucalyptus amplifolia* (Cabbage Gum) and *Eucalyptus tereticornis* (Forest Red Gum) with some *Angophora floribunda* (Rough-barked Apple).

A full summary of these studies is provided in GCNRC (2009a).

4.8.4 Field Survey Results

As a result of the field survey two vegetation communities were identified within the Project Site, namely:

- Community 1 - Weed Invaded Disturbed Lands; and
- Community 2 - Vegetation Along Blaxland Creek.

A description of each community is provided as follows (note: species marked with an '*' are introduced species.

Community 1 – Weed Invaded Disturbed Lands

This community is treeless although a few small seedlings of *Casuarina glauca* (Swamp Oak) were noted in scattered locations. Shrubs are also generally absent although the weedy species *Lycium ferrocissimum** (African Boxthorn) (Noxious weed) and *Ricinus communis* (Castor Oil Plant) (poisonous) were recorded.

Groundcover species were almost entirely introduced and included *Bothriochloa macra* (Red Grass), *Chloris gayana** (Rhodes Grass), *Chloris truncata* (Windmill Grass), *Chloris virgata** (Feathertop Rhodes Grass), *Cirsium vulgare** (Spear Thistle), *Conyza bonariensis** (Flaxleaf Fleabane), *Cynodon dactylon* * (Couch Grass), *Cyperus sp., Ditttrichia graveolens** (Stinkwort), *Einadia nutans* (Climbing Saltbush), *Eragrostis leptostachya* (Paddock Lovegrass), *Eragrostis curvula** (African Lovegrass), *Hypochaeris radicata** (Flatweed), *Juncus sp*. (Rush), *Pennisetum clandestinum** (Kikuyu Grass), *Senecio madagascariensis** (Fireweed), *Setaria pumila** (Pale Pigeon Grass), *Solanum sisymbriifolium** (Sticky Nightshade), *Sporobolus africanus** (Parramatta Grass), *Themeda australis* (Kangaroo Grass), *Typha sp*. (Cumbungi) and *Verbena bonariensis** (Wild Stattice).

By far the most obvious species over many parts of this community is Sticky Nightshade.*

Community 2 – Vegetation along Blaxland Creek

Tree species occurring along this short length of Blaxland reek include *Eucalyptus amplifolia* (Cabbage Gum), *Casuarina glauca* (Swamp Oak) and *Angophora floribunda* (Rough-barked Apple). Shrubs recorded include *Melaleuca stypheloides* (Prickly Paperbark) and *Bursaria spinosa* (Native Blackthorn).

This community contains a number of native groundcover species that do not occur on the disturbed areas. Recorded groundcover species include *Austrodanthonia racemosa* var. *racemosa* (Wallaby Grass), *Chloris gayana** (Rhodes Grass), *Cirsium vulgare** (Spear Thistle), *Cynodon dactylon* * (Couch Grass), *Echinopogon ovatus* (Forest Hedgehog Grass), *Eragrostis curvula** (African Lovegrass), *Glycine* sp. (Glycine), *Paspalum dilatatum** (Paspalum), *Setaria pumila** (Pale Pigeon Grass), *Sida rhombifolia** (Paddy's Lucerne) and *Themeda australis* (Kangaroo Grass).

In total, seven tree/shrub species and 27 groundcover species were recorded by GCNRC (2009a) within the Project Site. Of these species two of the tree/shrub and 16 of the groundcover species are introduced / exotic species.

4.8.5 Noxious Weed Considerations

Groundcover within the Project Site is almost totally invaded by introduced weed and pasture species. However, of these species, only African Boxthorn (*Lycium ferocissimum*) is listed as noxious for the Penrith City Local Government Area (DPI, 2009). African Boxthorn was recorded near Blaxland Creek and, as a Class 4 weed, the growth and spread of the species needs to be controlled. All occurrences of this species would be eradicated as soon as possible.

4.8.6 Flora of Conservation Significance

4.8.6.1 NSW Threatened Species Conservation Act 1995

Threatened Species

The 'Atlas of NSW Wildlife' contains records of the following 10 threatened flora species within a targeted 20km x 20km square surrounding the Project Site.

- *Cynanchum elegans* - White-flowered Wax Plant.
- *Pultenaea parviflora* -
- *Acacia pubescens* - Downy Wattle.
- *Eucalyptus benthamii* - Camden White Gum.
- *Eucalyptus scoparia* - Wallangarra White Gum (***an unusual record***).
- *Syzygium paniculatu* - Magenta Lilly Pilly.
- *Genoplesium baueri* - Bauer's Midge Orchid.
- *Pterostylis saxicola* - Sydney Plains Greenhood.
- *Pomaderris brunnea* - Brown Pomaderris.
- *Pimelea spicata* - Spiked Rice-flower.

GCNRC (2009a) assessed that none of these species is present within the Project Site and that suitable habitat is either not present or restricted only to that adjacent Blaxland Creek. None of these species were detected during the field survey.

Endangered and Critically Endangered Ecological Communities

One critically endangered ecological community, the *Blue Gum High Forest in the Sydney Basin Bioregion* and 44 endangered ecological communities, are predicted to occur within the boundaries of the Penrith 1: 100 000 Map Sheet Area. However, of these, only the following two communities were recorded as being ‘present’.

- Sydney Coastal River-Flat Forest.
- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.

The field survey recorded that a remnant of “River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions” is present as a narrow ribbon stand along Blaxland Creek beyond the proposed areas of planned disturbance.

Endangered Flora Populations

One Endangered Flora Population is recorded within the Penrith 1: 100 000 Map Sheet Area. This population is *Marsdenia viridiflora* R. Br. subsp. *viridiflora* recorded in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas. This population does not occur within the Project Site.

Critical Habitat

There is no Critical Habitat recorded within the Project Site or the 20km x 20km targeted square surrounding the Project Site.

4.8.6.2 Commonwealth Environment Protection and Biodiversity Conservation Act 1999

Threatened Species

The Environment Australia Protected Matters Report indicates that the following threatened species (which were also recorded by the 'Atlas of NSW Wildlife') have been recorded or are predicted to occur within a 5km radius of the Project Site.

- *Cynachum elegans* - White-flowered Wax Plant.
- *Pomaderris brunnea* - Brown Pomaderris.
- *Pultenaea pariflora*.

GCNRC (2009a) assessed the likely occurrence of these three species and concluded that none are present within the Project Site. None of these species were detected during the field survey.

Threatened Ecological Communities

Cumberland Plain Woodland is the only threatened ecological community recorded, or predicted to occur within the area surrounding the Project Site. This community was note recorded within the Project Site.

Nearby World Heritage Properties

No World Heritage Properties are recorded nearby.

Associated Wetlands of International Significance

No wetlands of international significance are recorded nearby.

4.8.6.3 Koala Habitat

Schedule 1 of State Environmental Planning Policy No 44 - Koala Habitat Protection (SEPP 44) contains a list of Local Government Areas to which the SEPP 44 applies. The Project Site is located within Penrith City Local Government Area. Schedule 1 of the Policy does not list the Penrith City Local Government Area and consequently this Policy does not apply.

4.8.6.4 ROTAP Species

No Rare or Threatened Australian Plants (ROTAP) species were recorded within the Project Site.

4.8.7 Operational Safeguards and Management Measures

The primary management measure that would be required is control of weed species. The Project Site is so highly invaded by introduced weed species that, if the current weed crop and the potential weed crop contained in the soil seed bank was to be sprayed with herbicides, the result would be a 'moonscape'. This would effectively remove any protective cover and result in erosion, particularly of the existing bunding, and potential sediment laden discharge to Blaxland Creek and surrounding landholdings.

Based on the recommendations of GCNRC (2009a) the following weed control process would be implemented.

- Immediate and continual targeted control of African Boxthorn (Noxious Weed) and Castor Oil Plant (Poisonous).
- Removal of grazing sheep and goats from the Project Site to allow what native species are present to regenerate.
- Retention of areas currently vegetated with weed cover until the rehabilitation phase.
- Cultivation and sowing of a suitable perennial grass pasture mix during rehabilitation and regular fertilising and control of broadleaf weed species.
- Strategic rotational grazing of the pasture on a conservative basis to ensure the maintenance of a strong and competitive perennial grass cover on rehabilitated areas.

It is considered that this would be the most effective approach to reduce the weed component of the pasture and the size of the soil weed seed bank to more manageable levels.

Other management measures that would be implemented to minimise potential impacts upon native vegetation would include the following.

- Rehabilitation of the northern face of the northern bund wall, the entire northern fence and the riparian zone adjoining Blaxland Creek would be undertaken using native trees and shrubs (see Section 2.14.6).
- To assist in revegetation, in all areas, except where native trees and shrubs are to be planted, appropriate levels of fertiliser would be applied.
- The Blaxland Creek riparian zone would be securely fenced from the remainder of the Project Site, which is to be grazed, in order to prevent stock damaging the planted native species.

4.8.8 Impact Assessment

In accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC 2005) and *Threatened Species Assessment Guidelines* (DECC 2007), a ‘seven-part test’ under Section 5A of the EP&A Act was completed by GCNRC (2009a) for the threatened species, endangered ecological communities and populations occurring or with potential to occur within the Project Site.

The test found that there would be no significant impacts from the Project upon any threatened species, endangered ecological communities or populations or their habitat. It was also assessed that the vegetation within the adjacent Department of Defence land would not be adversely affected in any significant way.

In view of the lack of any significant impact on threatened flora species, Endangered Ecological Communities, Endangered Flora Populations or Critical Habitat, GCNRC (2009a) concluded that a Referral under the EPBC Act relating to flora would not be required.

4.8.9 Conclusion

Most of the Project Site is highly modified from its original condition. There is no suitable habitat present at the Project Site for many of the threatened flora species likely / predicted to occur there and field observations failed to record any threatened flora species. There area no endangered flora populations or occurrences of Critical Habitat within the Project Site although a remnant of the *River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* community occurs in a narrow ribbon stand along Blaxland Creek.

With the implementation of the proposed management measures, it is assessed that there would be no significant impacts relating to flora.

4.9 FAUNA

This section provides a summary of the fauna assessment completed by Aquila Ecological Surveys (AES, 2009) which is reproduced in full as Part 9, Volume 2 of the Specialist Consultant Studies Compendium.

4.9.1 Introduction

Based on the risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential impacts upon threatened flora and fauna that require assessment and their **unmitigated** risk rating are as follows.

- Disturbance to native habitat within nominated areas (low risk).
- Disturbance to native habitat outside nominated areas (low risk).
- Disturbance to threatened fauna and endangered ecological communities (low risk).
- Disturbance leading to local population reduction (low risk).
- Disturbance leading to local extinction(s) (low risk).
- Reduced local biodiversity (low risk).
- Reduced regional biodiversity (low risk).

In addition, the DECC and other relevant government agencies (including DWE and Penrith City Council) nominated that the *Environmental Assessment* provide details relating to:

- field surveys undertaken on site;
- likely impacts on threatened species, populations, communities and their habitat;
- potential off-site impacts onto adjacent areas; and
- mitigation measures to prevent impacts on threatened species and/or endangered ecological communities.

The following subsections describe the existing fauna habitats and species that occur within and surrounding the Project Site and consider their conservation significance. The potential impacts that the Project would have on identified fauna species and habitat are also described.

4.9.2 Study Methodology

4.9.2.1 Background Research

Records of both terrestrial and aquatic fauna species recorded since 1980 within a 5km radius of the Project Site were obtained from the DECCW Atlas of NSW Wildlife. Similarly, records were also obtained from the Bionet Database using a 10km by 10km grid centred on the Project Site. Other literature and databases reviewed included the following.

- Vegetation mapping of the western Sydney area (NPWS, 2002).
- Western Sydney Urban Bushland Biodiversity Survey report (NPWS, 1997).

The schedules of the TSC Act, EPBC Act and the *Fisheries Management Act 1994* were also reviewed.

4.9.2.2 Field Survey

A field survey of the Project Site was undertaken on 12 and 13 January 2009.

A diurnal survey was undertaken which recorded the presence/absence of specific native food and shelter, such as dense shrubs, flowering trees, standing water, tree hollows, caves and rock outcrops. The surrounding habitat was also evaluated to gain an appreciation of the relative importance of that which occurs within the Project Site. All fauna species noted during the diurnal survey were recorded. Conditions during the diurnal survey were warm (around 27^{o}C) with not wind or cloud.

A nocturnal survey was also completed to detect arboreal mammal and nocturnal bird species. The survey comprised foot-based spotlighting over a period of approximately one hour after dusk each evening. Insectivorous (microchiropteran) bat detection was undertaken using an Anabat II Bat detector with an internal recording device which was left overnight at two locations within the Project Site. Conditions during the nocturnal survey were warm (around 24^{0}C) with light to moderate winds and no cloud.

In addition to these surveys, a brief inspection of the Blaxland Creek downstream of the Project Site was undertaken where public access was available. The inspection was undertaken to generally assess the aquatic habitat provided by Blaxland Creek.

Whilst the fauna survey does not meet all the requirements of fauna surveys published in the draft DEC (2004) guidelines, AES considers that, given the highly modified nature of the Project Site and the completion of a database review, the level of survey is sufficient.

4.9.3 Significant Fauna Species Previously Recorded

During the literature review and database search, a total of nine threatened fauna species listed under the TSC Act were recorded within 5km of the Project Site whilst two threatened fauna species listed under the EPBC Act were recorded. **Table 4.36** lists these species and outlines their habitat requirements.

Table 4.36
Locally Occurring Threatened Fauna Species

Species	EPBC Act	TSC Act	Habitat (DECC 2009b)
Bush Stone-curlew *Burhinus grallarius*		E	Open forests and woodlands with a sparse grassy ground layer and fallen timber. Known from woodland in the Commonwealth land used by the Australian Defence Force to the west of the Project Site (author's field notes; NPWS, 1997).
Speckled Warbler *Pyrrholaemus sagittatus*		V	A wide range of *Eucalyptus* dominated communities that have a grassy understorey, often on rocky ridges or in gullies.
Diamond Firetail *Stagonopleura guttata*		V	Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum *Eucalyptus pauciflora* Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities.
Spotted-tailed Quoll *Dasyurus maculatus*	E	V	A range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individuals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites.
Grey-headed Flying-fox *Pteropus poliocephalus*	V	V	Subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops.
Eastern Freetail-bat *Mormopterus norfolkensis*		V	Dry sclerophyll forest and woodland east of the Great Dividing Range. Roosts mainly in tree hollows but would also roost under bark or in man-made structures.
Eastern Bentwing-bat *Miniopterus schreibersii oceanensis*		V	Forages in forested areas, catching moths and other flying insects above the treetops. Caves are the primary roosting habitat, but the species also uses derelict mines, storm-water tunnels, buildings and other man-made structures.
Large-footed Myotis *Myotis adversus*		V	Roosts close to water in caves, mineshafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forages over streams and pools.
Cumberland Land Snail *Meridolum corneovirens*		E	Vegetation remnants with intact soils on the Cumberland Plain.

Source: AES (2009) - Table 1 E – Endangered V – Vulnerable.

One aquatic fauna species, the Macquarie Perch (*Macquaria australasica*), was also listed under the *Fisheries Management Act 1994* as occurring within the Hawkesbury-Nepean River catchment. The Macquarie Perch occurs in relatively clean streams and requires gravel beds for breeding. It is known from Glenbrook Creek and the upper Nepean where these conditions exist.

4.9.4 Fauna Survey Results

4.9.4.1 Terrestrial Fauna

Fauna habitat on the Project Site is highly modified, consisting of large areas of bare ground as a result of past quarrying activities with little subsequent regeneration. The few shrubs and grasses that are present are generally introduced species that are of little value to native fauna. Native fauna species detected within this habitat type included Australian Magpie (*Gymnorhina tibicens*) and Masked Plover (*Vanellus miles*).

The riparian woodland that borders Blaxland Creek within and adjacent to the northwestern corner of the Project Site provides habitat for a range of native fauna species adapted to the edges of woodlands. Species detected here included the Common Brushtail Possum (*Trichosurus vulpecula*), Eastern Grey Kangaroo (*Macropus giganteus*), Red-rumped Parrot (*Psephotus haematonotus*) and Superb Fairy Wren (*Malurus cyanea*).

4.9.4.2 Aquatic Fauna

The existing Dam 2 is vegetated with sedges and rushes such as Cumbungi (*Typha orientalis*), Spike-rush (*Typha orientalis*) and Common Rush (*Juncus usitatus*) providing a ‘wetland’ type habitat. Species detected here included Black-fronted Dotterel (*Elseyornis melanops*), Clamorous Reed-warbler (*Acrocephalus stentoreus*), Spotted Marsh Frog (*Limnodynastes tasmaniensis*) and Eastern Common Froglet (*Crinis signifera*).

The vegetated perimeter of the Dam 1 provides habitat for waterfowl including the Chestnut Teal (*Anas castanea*), Grey Teal (*A. Gracilis*), Pacific Black Duck (*A.superciliosa*), Australasian Grebe (*Tachybaptus novaehollandiae*) and White-faced Heron (*Egretta novaehollandiae*).

AES (2009) notes that both of these habitats are typical of farm dams which are common and widespread in the local area.

Blaxland Creek itself is an ephemeral stream discharging into South Creek some 2.3km to the northeast of the Project Site. Downstream of the Project Site, the riparian zone of Blaxland Creek is characterised by a narrow strip of woodland generally less than 20m wide dominated by Cabbage Gum (*Eucalyptus amplifolia*) to 22m tall with Swamp Oak (*Casuarina glauca*) and *Melaleuca decora* to 8m and Blackthorn (*Bursaria spinosa*) to 2m. The surrounding land use is mostly grazing land. Upstream of the Project Site, Blaxland Creek is surrounded by a large area of remnant Cumberland Plain Woodland and is relatively undisturbed.

Habitat features influencing the type of aquatic fauna along Blaxland Creek include pools, snags and woody debris, sandy/alluvial substrates, stands of macrophytes such as Cumbungi (*Typha orientalis*), floating water plants, undercut banks and a mix of shaded and unshaded areas. It is noted that the F4 Motorway under which South Creek flows would act as a barrier to fish passage.

Table 4.37 presents a classification system for fish habitat developed by NSW Fisheries. Under this system, Blaxland Creek would qualify as "moderate fish habitat." Based on other studies in the South Creek catchment (eg Connell Wagner 2002), fish species likely to be present are the native Long-finned Eel (*Anguilla reinhardtii*), Striped Gudgeon (*Gobiomorphus australis*) and the introduced Mosquito Fish (*Gambusia holbrookii*).

Table 4.37
Classification Scheme for Waterway Crossings over Different Fish Habitat Types

Classification	Characteristics Of Waterway
Class 1 – Major Fish Habitat	Major permanently or intermittently flowing waterway (eg. River or major creek), habitat of a threatened fish species.
Class 2 – Moderate fish habitat	Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi – permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and/or fish observed inhabiting the area.
Class 3 – Minimal fish habitat	Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (eg. Fish, yabbies). Semi – permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.
Class 4 – Unlikely fish habitat	Named or unnamed watercourse with intermittent flow during rain events only, little or no defined drainage channel, little or no free standing water or pools after rain event finishes (eg. dry gully, shallow floodplain depression with no permanent wetland aquatic flora present).
Source: Fairfull and Witheridge (2003)	

4.9.4.3 Threatened Species

Only one threatened fauna species, the Eastern Freetail-bat, was recorded during the field survey by the Anabat detector when it was set near the Southern Water Storage Dam. Based on habitat within the Project Site, the following threatened fauna species listed in **Table 4.36** are also considered likely to occur.

- Eastern Bentwing-bat.
- Large-footed Myotis.

The Eastern Freetail-bat and Eastern Bentwing-bat would forage at the edges of the woodlands that abut the Project Site whilst the Large-footed Myotis is likely to forage over Southern Water Storage Dam. Due to the lack of tree hollows, caves or similar structures on the Project Site, none of these species would roost on the Project Site.

None of the other threatened species listed in **Table 4.36** are likely to occur due to the lack of intact woodland.

In relation to aquatic fauna, given the disturbance to Blaxland and South Creeks it is unlikely that the Macquarie Perch (*Macquaria australasica*) occurs in the area that would potentially be affected by the release of water from the Project Site (ie. within Blaxland Creek downstream of the Project Site).

4.9.5 Operational Safeguards

Other than avoiding any disturbance of the riparian woodland adjacent Blaxland Creek and the implementation of appropriate water management measures to prevent ‘polluted’ discharge, no further safeguards are considered necessary.

4.9.6 Impact Assessment

4.9.6.1 Habitat Removal and Impact on Fauna

The Project would result in the removal and modification of habitat at the Project Site, however, the habitat within the Project Site is already highly modified and generally only suitable for a narrow range of native fauna species, all of which are common in similar habitat in the surrounding region. Additionally, whilst the Dam 1 would largely be removed, the loss of this habitat area for waterfowl is not considered significant, as this artificial habitat type is abundant in nearby areas.

Similarly, a proportion of the small ‘wetland’ area contained within Dam 2 would be disturbed as a result of desilting and deepening of section of this dam. However, this habitat type is also artificial and common in shallow farm dams and dam fringes in the locality. It is noted that the final landform for the Project provides for a number of dams for ongoing water management which would provide, to some degree, similar habitat.

It was also assessed that it is unlikely there would be any significant impacts on surrounding fauna or its habitat as a result of dust settling. Potential impacts from traffic resulting in roadkill have also been assessed as not being significant, particularly when compared to that caused by the movement of traffic elsewhere in the surrounding region.

4.9.6.2 Threatened Species Conservation Act 1995 Matters

In accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC 2005) and *Threatened Species Assessment Guidelines* (DECC 2007), a ‘seven-part test’ under Section 5A of the EP&A Act has been completed for threatened species either recorded or with potential habitat within the Project Site. A summary of the outcomes from the tests is provide below whilst a copy of the comprehensive seven-part test is included in full in AES (2009).

Eastern Freetail Bat

The test found that the Project is unlikely to have a significant impact on the Eastern Freetail Bat, or its habitat. This species is highly mobile and unlikely to be affected in its local movements by the minor modifications to habitat that would occur. Habitat for the species (wooded areas with tree hollows) is widespread in the locality, particularly in the adjoining Department of Defence land.

Eastern Bentwing Bat

The Project is unlikely to have a significant effect on the Eastern Bentwing Bat or its habitat. Very little potential foraging habitat would be affected by the Project and the species is unlikely to roost anywhere within the Project Site.

Large-footed Myotis

The Project is unlikely to have a significant effect on Large-footed Myotis, or its habitat. It is considered that the Project Site is unlikely to be used for roosting by the Large-footed Myotis and the type of foraging habitat available within the Project Site is well represented in surrounding areas.

4.9.6.3 Environment Protection and Biodiversity Conservation Act 1999 Matters

No threatened or migratory species listed under the EPBC Act were recorded within the Project Site, nor are any considered likely to occur. Furthermore, the activities to be undertaken on the Project Site throughout the operational life of the facility are predicted not to have any adverse impact on fauna or fauna habitat on the adjoining Commonwealth Department of Defence land. Therefore, referral under the EPBC Act is not required in relation to impact upon on fauna.

4.9.7 Conclusion

The habitat types represented within Project Site are either highly modified and/or well represented in the locality. Whilst three fauna species listed as vulnerable on the TSC Act occur or are likely to occur, the Project is unlikely to have a significant effect on any of these species or their habitats. AES (2009) concludes that there would be no fauna related constraints on the development and operation of the Project.

4.10 HERITAGE

This section provides a summary of the Aboriginal and European Heritage Assessments completed by Archaeological Surveys & Reports Pty Ltd (ASR, 2009), which are reproduced in full as Part 10 and Part 11, Volume 2 of the Specialist Consultant Studies Compendium.

4.10.1 Introduction

Based on the risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential impacts upon Aboriginal and European heritage requiring assessment and their **unmitigated** risk ratings are as follows.

- Impact on identified sites and/or artefacts of Aboriginal cultural heritage as a result of the proposed activity and without the permission of Aboriginal stakeholders or DECCW (high risk).

- Impact on unidentified sites and/or artefacts of Aboriginal cultural heritage as a result of the proposed activity and without the permission of Aboriginal stakeholders or DECCW (high risk).
- Impact on unidentified sites and/or artefacts of European heritage as a result of the proposed activity and without permission of the NSW Heritage Office (low risk).

In addition, the Director-General's Requirements issued by the Department of Planning require that the *Environmental Assessment* refer to the draft *Guidelines of Interim Community Consultation Requirements for Applicants* (DEC, 2005).

The following subsections describe the consultation process undertaken, the methods of the investigations and the outcomes of the archaeological investigation of the Project Site.

4.10.2 Method of Investigation

4.10.2.1 Aboriginal Consultation

In accordance with the *Guidelines of Interim Community Consultation Requirements for Applicants* (DEC, 2005), an advertisement was placed in the 'Penrith City Star' on 21 April 2009, inviting all Aboriginal stakeholders with an interest in the Project to register their interest. During the extended 19 day response period, one expression of interest was received from Deerubbin Local Aboriginal Land Council.

A list of local registered stakeholders was also requested from The Metropolitan Branch and DECC. The following stakeholders were listed in the reply.

- Deerubbin Local Aboriginal Land Council (DLALC): Kevin Cavanagh.
- Darug Custodial Aboriginal Corporation (DCAC): Leanne Watson.
- Darug Tribal Aboriginal Corporation (DTAC): Sandra Lee.
- Darug Aboriginal Cultural Heritage Assessments (DACHA): Gordon Morton.
- Muru Mittigar Aboriginal Cultural & Education Centre (MMACEC): Lesley Edwards.
- Darug Land Observations (DLO): Gordon Workman.

Representatives from the various organisations and stakeholder groups were contacted and advised of the Project. Each organisation / group, with the exception of MMACEC, said they would send a Sites Officer to assist in the field investigation. However, only representatives from DLALC, DACHA and DCAC arrived at the Project Site for the field investigation. Subsequent to the field investigation, further correspondence was received from DLALC and DACHA.

In relation to Native Title, correspondence with the Office of the Registrar indicated that there was no Land Claim over the Project Site.

A copy of the newspaper advertisement and all relevant correspondence is included in ASR (2009a).

4.10.2.2 Background Research

As part of the background research for the Aboriginal heritage assessment, a search of the DECCW Aboriginal Heritage Information Management System (AHIMS) was undertaken and available mapping, relevant literature and reports and the environmental context of the site were reviewed.

In relation to European heritage the following database / register searches were conducted.

- A search of the Heritage Branch Website - the State Heritage Register.
- A search of the National Trust Register - the Register of the National Estate.
- A search of the Draft Penrith Local Environmental Plan 2008 for places of heritage interest.

4.10.2.3 Development of a Predictive Model and Field Survey

A predictive model was developed by ASR (2009a) to consider the existing archaeological record, resource availability, knowledge of the habitation and land use patterns of the Aboriginal people of the region (and generally) and factors affecting identification. The objective of the predictive model was not to determine where the investigation should be conducted, rather to establish a theoretical model for the distribution of archaeological material against which the effectiveness and subsequent analysis of the survey results can be tested, compared and reasoned.

Due to significant disturbance of the Project Site it was considered unlikely that there would be any places where PADs (potential archaeological deposits) would occur. While Blaxland Creek was a potential source of potable water, and of useful stone material, it appeared unlikely that there would be a large enough surviving area to have supported a camp site. Considering this, the following model for site distribution was proposed for the Project Site.

- Isolated artefacts may be present and visible in erosion features.
- Low-density artefact scatters may be present and visible in erosion features, but it is unlikely that any debitage would be visible.
- It is unlikely that there are any surviving trees of more than 150 years old on which there would be deliberately scarred surfaces.
- It is unlikely that there are any surviving trees of more than 150 years old on which there would be deliberately carved surfaces.
- It is unlikely there would be any engravings, and/or grinding grooves, which if present, would be in the creek bed.
- It is unlikely there would be any PADs given that there are so few undisturbed areas.
- In the absence of shelters or overhangs there is no potential for shelters to exist and therefore no potential for art sites, and therefore no potential for undisturbed occupation deposits.

- There would be no Aboriginal stone quarries.
- There would be no shell middens.
- There would be no visible evidence of burials.
- There would be no surviving Bora rings.
- There would be no stone arrangements.
- There are no known cultural associations with the area.

4.10.2.4 Field Survey

A comprehensive survey of the bund walls and outer perimeter of the bund walls was undertaken on 29 June 2009 by John Appleton (ASR), assisted by Steve Randall (DLALC), Justine Coplin (DCAC) and Gordon Morton (DACHA). The survey was made on foot in dry, sunny conditions in light ideal for observing any artefactual material present. All areas shaded in blue in **Figure 4.25** were surveyed on foot. There was easy access to all parts of the survey area, and so the only constraint to an effective survey was the groundcover and it's effect on archaeological visibility.

The investigators walked in a clockwise direction around the outer perimeter of the bund walls as well as the top of the bund walls. An attempt was also made to survey the banks of Blaxland Creek, but the dense grass cover totally concealed the ground surface. All relevant observations eg. topography, vegetation cover, and conditions, were recorded in a field-log and photographs were taken with an Olympus Camedia SP-510UZ Zoom Digital Camera. The photographic record included in ASR (2009) provides a visual reference for the survey conditions and various aspects of past impacts to the Project Site.

The effectiveness of the survey in identifying scarred or carved trees was comprehensive, but groundcover in many places along the perimeter was a constraint. There was no archaeological visibility on the western bank of Blaxland Creek, a location in which artefactual material might have been present.

During the survey for Aboriginal heritage, ASR also completed an inspection for any items of European heritage significance with relevant observations photographed.

4.10.3 Summary of Results

4.10.3.1 Aboriginal Heritage – Results Summary

The search of AHIMS found no record of Aboriginal sites within and in the vicinity of the Project Site. During the field inspection, however, two isolated artefacts were recorded. Site Recording Forms prepared by ASR (2009a) describe the sites as follows whilst their locations are shown on **Figure 4.25**.

Base Photo Source: Geo-Spectrum (Australia) Pty Ltd - Date of Photo: 4 August 2007

Figure 4.25
PLAN SHOWING EFFECTIVE SURVEY COVERAGE AND ABORIGINAL SITE LOCATIONS

Orchard Hills ISO 1

- Location GDA: 56H E.0291170 N.6256869 ± 5m
- Map Penrith 9030-3N, 1: 25,000 scale Topographic map
- Site type Isolated artefact
- Land use: Fallow
- Distance from water: 100m (Blaxland Creek)
- Archaeological visibility: 85%
- Artefact description:
  - Mudstone or tuff proximal fragment of a flake, 33 x 22 x 8mm.
  - Split cone 8 x 4mm.
  - O cortex

Orchard Hills ISO 2

- Location: GDA: 56H E.0291576 N.6256440 ± 5m
- Map: Penrith 9030-3N, 1: 25,000 scale Topographic map
- Site type: Isolated artefact
- Land use: Fallow
- Distance from water: 350m (Blaxland Creek)
- Archaeological visibility: 85%
- Artefact description:
  - Quartzite Backed blade (Bondi Point), 24 x 7 x 4mm.
  - O cortex

The extreme northwestern corner of the Project Site was also assessed to be a PAD, but as the location would not be impacted upon by the Project no further investigation was considered necessary by ASR (2009a).

ASR (2009a) noted that the existence of artefactual material in the Project Site was surprising given there was such a small area that remained relatively undisturbed. However, the Aboriginal representatives advised that they had personally seen many stone artefacts while performing other surveys in the surrounding area, and particularly on the Defence Force land adjacent to the Project Site.

4.10.3.2 European Heritage – Results Summary

No items or places of European heritage significance were identified within Project Site on any registers or databases. The field inspection confirmed that there were no structures within the Project Site other than the office at the entrance to the Project Site, a weighbridge and temporary buildings and sheds in the Equipment Compound. No structures or relics of European heritage interest were observed in the Project Site.

4.10.4 Significance Assessment

4.10.4.1 Aboriginal Heritage - Significance

The DECCW policy to safeguard all sites, Aboriginal places, and archaeological material of significance wherever possible requires that some means of assessing the significance of the sites is necessary. This is not only for the purpose of determining whether the Project can proceed, but also to provide Cultural Resource Managers with the information for future management of the area.

Cultural significance

The Aboriginal or cultural significance of Aboriginal relics and sites can only be assessed by the Aboriginal community, and in particular, the Elders. It is the responsibility of the archaeologist to ensure that the Elders or elected representatives of the Aboriginal community are advised of the survey results, and are consulted as to their knowledge and opinion of the significance of the area, and to transcribe and present those expressions in report form.

In this instance the only written recommendations received were from DLALC; and from DACHA. Neither of the organisations recommended any further investigation, and both agreed that there were no constraints on cultural grounds to the Project.

Research potential

As only two artefacts were recorded on degrading surfaces during the investigation the two locations are assessed to be of no research potential.

4.10.4.2 European Heritage - Significance

In 2001, The NSW Heritage Office issued revised Guidelines for Assessing Heritage. However, in the absence of any structures or relics of European heritage interest on the Project Site a Heritage Assessment is not required.

4.10.5 Management Measures

4.10.5.1 Aboriginal Heritage

The two Aboriginal stakeholder organisations that provided written recommendations stated that the two artefacts were not a constraint to the Project. Therefore, based on the recommendation of ASR (2009a), following grant of Project approval, the Proponent would contact the three Aboriginal organisations that participated in the survey to request they return to the Project Site to salvage the identified artefactual material. No subsurface investigation is considered necessary as the artefacts occur on degrading surfaces of weathered B Horizon soils/rock.

ASR (2009a) considers that the salvage would not require an archaeologist to be present, however, once the salvage has been completed the Proponent would advise DECCW in writing that "Orchard Hills ISO 1" and "Orchard Hills ISO2" have been salvaged, who took part in the salvage, and the names of the Aboriginal organisations they represented. In the event that the Aboriginal organisations choose not to take the opportunity to salvage the artefacts, the

Proponent would inform DECCW in writing that the company had invited the Aboriginal organisations to salvage the artefacts, and that they had chosen not to. The DECCW would also be requested to provide written confirmation that the two site locations could then be disturbed.

In addition to these measures, the Proponent would ensure that its employees are aware of their obligations under the *National Parks and Wildlife Act 1974.* Should any relic be uncovered during Project-related activities, work in the area surrounding the relic would cease and the DECCW, the three Aboriginal organisations that participated in the survey and the Police (if bone is discovered and not clearly identified as being of animal remains) would be informed of the find. Work would not recommence in the area immediately surrounding the find until those officials have inspected the material and permission has been given to proceed.

4.10.5.2 European Heritage

In the absence of any structures or relics of heritage interest on the Project Site ASR (2009b) concludes that there are no constraints on heritage grounds to the Project and provides no specific management recommendations.

4.11 SOILS, LAND CAPABILITY AND AGRICULTURAL SUITABILITY

This section provides a summary of the soils assessment completed by Geoff Cunningham Natural Resource Consultants Pty Ltd (GCNRC, 2009b), which is reproduced in full as Part 12, Volume 2 of the Specialist Consultant Studies Compendium.

4.11.1 Introduction

Based on the risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential soil impacts and changes to land capability and agricultural land suitability requiring assessment and their **unmitigated** risk ratings are as follows.

- Insufficient soil quantities for rehabilitation (low risk).
- Temporary disturbance to soil quality (moderate risk).
- Degradation of soil quality (moderate risk).
- Elevated erosion or erosion potential (moderate risk).
- Decreased land and agricultural capability of the final landform (low risk).

The Director-General's Requirements issued by the Department of Planning require that the assessment of soils and land capability / agricultural land capability should refer to *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004).

The following subsections describe the soils within the Project Site, identify the soil and land management issues and the proposed soil-related management measures. The subsection concludes with an assessment of the residual impacts upon the soil resources and land capability following the implementation of these safeguards and mitigation measures.

4.11.2 Regional Setting

The Project Site is located within the boundaries of the Penrith 1:100 000 scale Soil Landscapes map sheet, published by the former Soil Conservation Service of NSW (Hazelton, Bannerman and Tille, 1989). The map shows the Project Site comprises soils typical of the Blacktown Soil Landscape with a small section associated with Blaxland Creek being described as South Creek Soil Landscape.

The Blacktown Soil Landscape typically occupies gently undulating rises on Wianamatta group shales with gently inclined slopes and broad rounded crests and ridges.

Soils of the South Creek Soil Landscape typically occupies floodplains, valley flats and drainage depressions of the channels of the Cumberland Plain, gently undulating rises on Wianamatta group shales with gently inclined slopes and broad rounded crests and ridges.

4.11.3 Project Site Soils

4.11.3.1 Soil Mapping Units

Four soil profiles were exposed in pits dug across the Project Site to characterise the soils with respect to soil mapping units and chemical and physical characteristics. Each pit was dug to a depth of at least 2.5m, or the depth of backhoe refusal if rock was closer to the surface. It is noted that, past clay/shale extraction has removed soils from much of the Project Site and that only a limited area of natural soils remain on the Project Site. The location of each soil pit is shown on **Figure 4.26**.

Based on the information from the soil profiles and analyses, the following two distinct soil mapping units (SMUs) were identified across the Project Site (**Figure 4.26**). Technical descriptions of each of the SMUs are included in GCNRC (2009b).

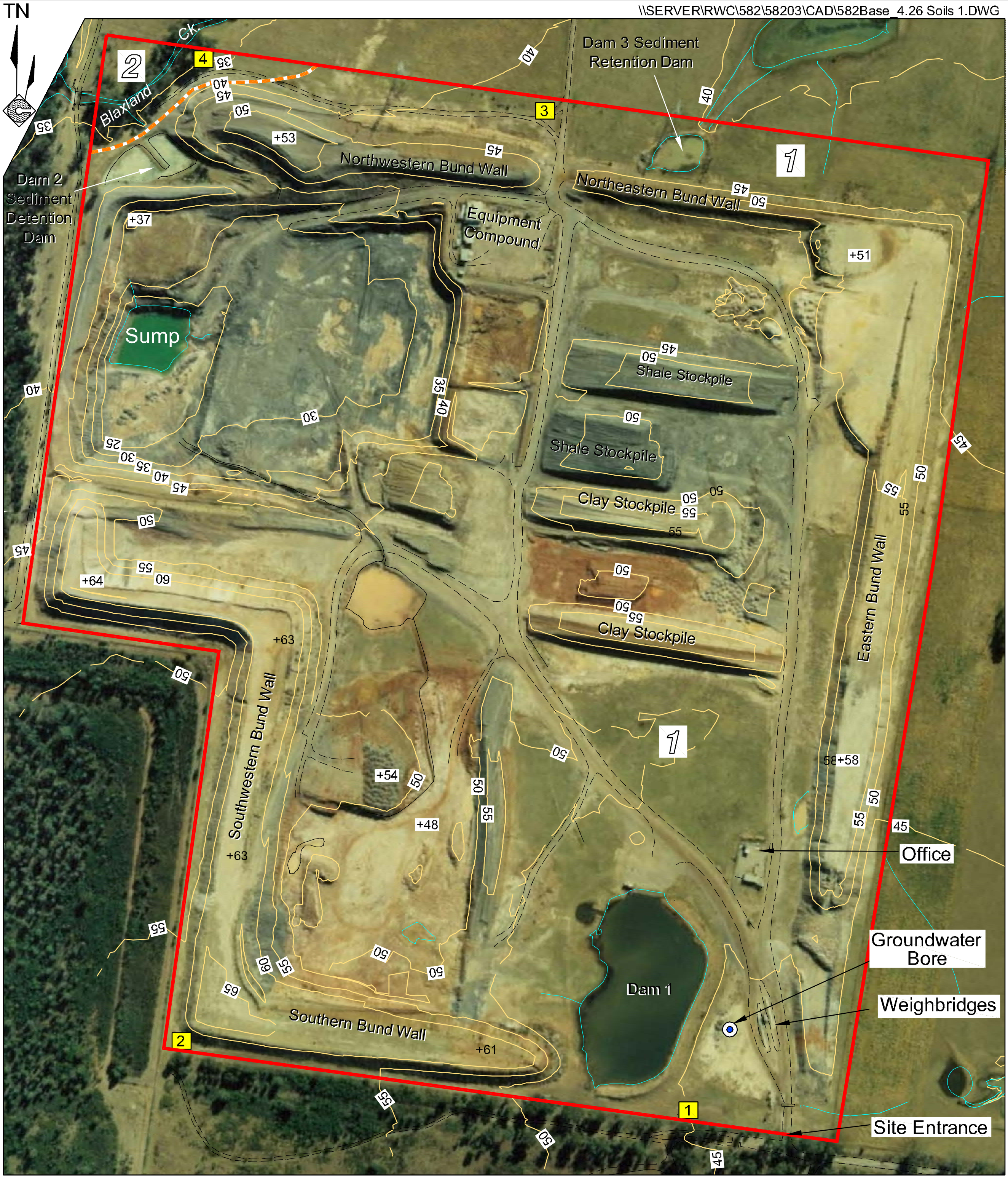
Soil Mapping Unit 1 – Soils of the Upper Slopes and Crest

The soils of this SMU are classified as Brown and Black Kurosols under the Australian Soil Classification. The soil generally has a loose to firm or hard surface which is sometimes cracked. Surface stone is absent. Excavated to a maximum of 270cm depth, sometimes encountering bedrock but the lower horizon continued below excavation depth in some profiles.

The soil layers are described as follows.

- Topsoil – clay loam; light to medium clay; many roots; no lime present; no manganese present; pH 5.5 to 6.0, gravel and stones generally absent; sometime some small gravel to 5mm, occasional angular gravel to 3cm present; not mottled; not bleached; brown dark yellowish brown dry, dark brown, very dark greyish brown moist; well structured, often hydrophobic. Sometimes up to two additional relatively coarse textured A horizon layers may also be present.
- Subsoil – up to four subsoil horizons identified; texture generally clayey; many roots in the upper sections but few to absent at depth; recorded pH 4.5 to 5.0; gravel and stones absent or gravel present in varying amounts; usually whole coloured or mottled at depth in colours of white, red, grey, brown and yellow; commonly well structured, usually not hydrophobic.

\\SERVER\RWC\582\58203\CAD\582Base_4.26 Soils 1.DWG



REFERENCE
Project Site Boundary
55 Existing Contour (m AHD)(Interval = 5m)
+63 Spot Height (m AHD)
Internal Road (unsealed)
1 Soil Test Pit
1 Soil Mapping Unit Boundary (and reference)

SCALE 1:5 000
50 0 50 100 150 200 250 m

Base Photo Source: Geo-Spectrum (Australia) Pty Ltd - Date of Photo: 4 August 2007

Figure 4.26
SOIL SAMPLING SITES AND SOIL MAPPING UNITS

Soil Mapping Unit 2 – Soils of the Blaxland Creek Floodplain

The soils of this SMU are classified as Yellow Chromosol under the Australian Soil Classification. The soil generally has a firm surface absent of stone. Excavated to a maximum of 260cm depth.

The soil layers are described as follows.

- Topsoil – a silty clay to light clay; many roots; no lime present; no manganese present; pH 6.0; gravel and stones absent; not mottled; not bleached; pale brown dry, very dark greyish brown moist; well structured; not hydrophobic.
- Subsoil – (as excavated) comprised of four layers over bedrock or a continuation of the lowest horizon; generally medium or heavy clay textured, roots many near the surface but decreasing with depth; no visible lime present; no manganese present; pH 6.0 to 8.0 at depth; gravel and stones usually absent not bleached; some horizons mottled in colours of grey, brown and yellow; when whole coloured, the colours are brown and yellow; well structured; not hydrophobic.

4.11.3.2 Soil Physical Attributes

Nine samples from two representative soil profiles were selected for laboratory analysis to further characterise the physical and chemical attributes. The results for the physical attributes of SMU 1 and 2 are provided in **Table 4.38**.

Particle Size Analysis

The Particle Size Analysis (PSA) results in **Table 4.38** indicate the proportions of gravel, clay, silt, fine sand and coarse sand contained within each sample. From this data it is evident that most soil horizons analysed contain variable, but usually small, levels of gravel. With the amount generally associated with distinct separate horizons. Only one horizon (Pit 4, horizon 4) contained a significant gravel content.

The texture class of each soil layer calculated from the laboratory analysis is also shown in **Table 4.38**. The texture class generally ranges between loamy sand and clay. It is noted that the field textures of almost all layers of the four profiles that were examined indicate that the soils were generally more clayey than was shown in the laboratory analyses.

Table 4.38
Physical Laboratory Analysis Data for Selected Soil Profiles
(Whole Soil Particle Size Analysis)

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SMU / Pit No.	Layer	Texture (fine earth)#	Depth (cm)	PSA % Clay	PSA % Silt	PSA % Fine Sand	PSA % Coarse Sand	PSA % Total Sand	PSA % Gravel
SMU 1 Pit 2	1	clay loam	0-24	28	18	33	13	46	8
	2	clay	24-68	44	14	23	10	33	9
	3	clay/silty clay	68-154	61	18	16	4	20	1
	4	clay	154-270	54	20	17	6	23	3
SMU 2 Pit 4	1	loam	0-12	13	25	56	6	62	<1
	2	loamy sand	12-34	9	21	63	7	70	0
	3	clay loam	34-100	28	17	51	4	55	<1
	4	clay loam	100-222	22	10	24	26	50	18
	5	silty clay	222-250	43	34	22	1	23	<1

Table 4.38 (Cont'd)
Physical Laboratory Analysis Data for Selected Soil Profiles
(Whole Soil Particle Size Analysis)

Page 2 of 2

SMU/ Pit No.	Layer	Texture (fine earth)#	Depth (cm)	D%	D% Level of Dispersion	EAT	EAT Level of Dispersion
SMU 1 Pit 2	1	clay loam	0-24	16	slight	3(3)	moderate
	2	clay	24-68	24	slight	3(2)	slight
	3	Clay / silty clay	68-154	63	high	2(3)	very high
	4	clay	154-270	76	very high	2(3)	very high
SMU 2 Pit 4	1	loam	0-12	19	slight	8/3(1)	negligible to slight
	2	loamy sand	12-34	13	slight	8/3(1)	negligible to slight
	3	clay loam	34-100	12	slight	5	slight
	4	clay loam	100-222	74	very high	2(3)	very high
	5	silty clay	222-250	87	very high	1	very high

Source: GCNRC (2009b) – Table 2
D = Dispersion, EAT = Emerson Aggregate Test, PSA = Particle Size Analysis
# texture based on laboratory measurements

Dispersion Percentage

The Dispersion Percentage (D%) test indicates the proportion of the soil material less than 0.005mm in size that would disperse on wetting (ie. the clay and some of the silt fractions). The D% values shown in **Table 4.38** indicate that:

- the topsoil of SMU 1 showed slight dispersibility;
- the subsoil of SMU 1 showed high to very high dispersibility;
- the topsoil of SMU 2 showed slight dispersibility; and
- the subsoil of SMU 2 showed slight to very high dispersibility.

The subsoils generally contain moderate levels of clay and this fact may make them more dispersive than the analyses indicate. Given these indications of dispersibility, the erosion potential is undoubtedly high for any areas of exposed subsoil.

Emerson Aggregate Test

The Emerson Aggregate Test (EAT) provides a measure of the coherence of soil aggregates when they are immersed in water. The EAT data in **Table 4.38** indicated that:

- the topsoil of SMU 1 showed slight dispersibility;
- the subsoil of SMU 1 showed very high dispersibility;
- the topsoil of SMU 2 showed slight dispersibility; and
- the subsoil of SMU 2 showed slight to very high dispersibility.

The topsoils of both SMUs show only slight dispersibility as indicated by the EAT but the subsoils in both units are generally highly dispersible reflecting the results the D% test.

4.11.3.3 Soil Chemical Attributes

Laboratory testing of the samples included the examination of the electrical conductivity whilst soil pH was measured in the field using the Raupach method. The results of the soil chemical tests are provided in **Table 4.39.**

Soil pH

Perusal of the data in the pH column in **Table 4.39** indicates that all of the topsoils and subsoils tested showed pH levels within the 4.0 to 8.5 range. This was also the case in the other profiles that were not laboratory tested. It is considered that soil pH would not be a constraint to the use of the existing soils for rehabilitation of the Project Site.

Electrical Conductivity

Electrical conductivity (EC) is a measure of the presence of water-soluble salts, mainly of sodium, calcium and magnesium, in the soil. Based upon the results presented in **Table 4.39** the topsoils of both SMUs were found to be non-saline. However, the subsoils of both SMUs are slightly-to-moderately saline.

Table 4.39
Chemical Analyses Laboratory Analysis Data for Selected Soil Profiles

SMU / Pit No.	Layer	Texture (fine earth)#	Depth (cm)	pH *	EC (dS/m)
SMU 1 Pit 2	1	clay loam	0-24cm	5.5	0.03
	2	clay	24-68cm	5.5	0.34
	3	clay / silty clay	68-154cm	4.5	0.91
	4	clay	154-270cm	4.5	1.02
SMU 2 Pit 4	1	loam	0-12cm	6.0	0.03
	2	loamy sand	12-34cm	6.0	<0.01
	3	clay loam	34-100cm	6.0	0.04
	4	clay loam	100-222cm	7.0	0.28
	5	silty clay	222-250cm	8.0	0.65

Source: GCNRC (2009b) – Table 3
texture based on laboratory measurements *Raupach field measurement

4.11.3.4 Soil Erodibility and Erosion Potential

The soils within the Project Site are generally unaffected by soil erosion although removal of vegetation cover would result in these currently stable soils being predisposed to erosion.

GCNRC (2009b) also undertook an assessment using the SOILOSS computer program which determines erosion hazard.

The soils (topsoil and subsoil combined) from SMU 1 were allotted a MODERATE erodibility by the SOILOSS model based on their physical characteristics, while the soils from SMU2 had a combined rating of HIGH.

The elevated erodibility ratings are exacerbated for the subsoils of both SMUs when the salinity levels of these subsoils are considered in terms of their possible negative impact on the establishment of protective living vegetative cover. These two factors make it imperative that stockpiles and rehabilitated areas are at all times properly protected against soil erosion.

4.11.4 Soil Management Measures

Based on the interpretation of results from the soil assessment, the following soil management procedures would be implemented.

- Disturbance to soils from SMU 2 would be avoided wherever possible with no soil stripping proposed.
- The topsoil layer from SMU 1 would be stripped to a depth of approximately 25cm in all areas of disturbance.
- The subsoil layer from SMU 2 would be stripped to a total depth of approximately 100cm in any areas of deeper disturbance (ie. extraction or emplacement areas).
- Soil would be handled (disturbed) as little as possible to minimise mechanical damage to soil structure that would be detrimental to rapid establishment of groundcover once rehabilitation works commence.
- Soils would not be worked when the soil moisture content is too high (which may result in compaction and damage to soil structure).
- Topsoil and subsoil unable to be directly placed would be stockpiled separately from each other and to heights no greater than 2m and 3m respectively.
- Stockpiles would be formed neatly so as to avoid double handling.
- Driving of machinery on the topsoil and subsoil stockpiles would be avoided.
- Stockpiles would be constructed with a slope no greater than 1:2 (V:H) and the surface left ‘rough’, in a micro sense, to assist in runoff control, seed retention and germination.
- Stockpiles would be preferentially positioned to minimise runoff water from upslope areas.
- Stockpiles would be stabilised rapidly using a suitable pasture cover (as recommended by local DII officers).
- Additional measures to minimise loss of soil material from the stockpiles before they are stabilised, such as using sediment fencing or hay bales, would be implemented as required.
- If establishment of a suitable plant cover on the subsoil stockpiles proves to be difficult then alternative stabilising techniques such as application of hay / bitumen mulches etc may be used

4.11.5 Land Capability and Agricultural Land Suitability

4.11.5.1 Existing Land Capability

Land Capability is "the ability of land to accept a type and intensity of use permanently, or for specified periods under specific management, without permanent damage."

The 1:100 000 scale Land Capability mapping shows the Project Site lies mainly within and area mapped as having a Class III land capability with the land along Blaxland Creek mapped as Class VI land. The map does not differentiate between the existing quarried area and stockpile areas and surrounding agricultural land.

Class III *land is suitable for regular cultivation on a rotational basis with the land protected by structural soil conservation works such as graded banks, waterways and diversion banks, together with soil conservation practices such as conservation tillage.*

Class VI *land is suitable for grazing with no cultivation. Soil conservation practices including limitation of stock, broadcasting of seed and fertiliser, prevention of fire and destruction of vermin and possibly some isolated structural works are required.*

4.11.5.2 Agricultural Land Suitability Classification

"Agricultural land suitability" is based on land capability, but with the incorporation of other factors, such as closeness to markets and availability of water or processing facilities, in order to provide an indication of its suitability with respect to agriculture (Cunningham *et al.,* undated).

NSW Department of Primary Industries (Agriculture) has prepared a series of maps showing the Agricultural Land Suitability Classification of the land in the Sydney Basin (NSW Agriculture, 1995). Map Penrith 9030-3 – N in this series shows the land surrounding the Project Site as Class 3 land. The map does not differentiate between the quarried area and stockpile areas and the surrounding agricultural land. Similarly the map does not separate the land suitability of the area associated with Blaxland Creek from that of the areas away from the creek.

Class 3 land is *'grazing land that is well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture. The overall level of production is moderate as a result of edaphic (soil related) or environmental constraints. Erosion hazard or soil structural breakdown limit the frequency of ground disturbance, and conservation or drainage works may be required.'*

4.11.6 Assessment of Impacts

It is assessed that adherence to the proposed soil management measures would result in a minimal impact from a soils viewpoint on the land within the Project Site.

It is also assessed that, if the rehabilitation and soil management measures proposed are adhered to and additional soil material is obtained through the proposed recycling activities, the lands within the Project Site would be able to be returned to a Class III Land Capability status. As the land along Blaxland Creek would not be disturbed the Land Capability of this area would not change. Additionally, it is assessed that the post-use agricultural land suitability classification would remain as **Class 3** with the provision that any future occasional cultivation is limited to work required to establish or renovate perennial pastures rather than crop production.

4.12 SOCIO-ECONOMIC SETTING

4.12.1 Existing Setting

The local community within 3km of the Project Site comprises a range of sectors from: the long standing agricultural sector, eg. on the adjoining "Glenholme Farm" and "Roughwood Park"; rural-residential properties fronting Luddenham Road; the recent large block residential subdivision for "The Vines" estate, and densely populated suburbs such as St Clair.

From a local government perspective, the Project Site is located in the suburb of Orchard Hills, ie. within the southeastern side of Penrith LGA. The suburbs of St Clair and Erskine Park border the suburb to the east. Kingswood and Claremont Meadows are northern neighbours and Glenmore Park, South Penrith and the rural areas of Wallacia and Mulgoa comprise the western boundary of the LGA.

A profile of the surrounding communities is gained though a review of statistics drawn from the Australian Bureau of Statistics (ABS).

Table 4.40 presents a summary of the 2006 population statistics for the Orchard Hills State Suburb (referred to hereafter as "Orchard Hills"), the surrounding suburbs of St Clair, Luddenham and Glenmore Park (referred to here after as "Surrounding Districts") and for NSW as a whole.

The Census data indicate that within Orchard Hills and the surrounding districts, the proportion of persons aged 14 years and younger (26% and 23% respectively) were higher than for NSW as a whole.

The percentage of people aged 15 years to 24 years was comparable in each of the three categories, accounting for 14% to 17% of the total population. The percentage of people between the ages of 25 and 54 was also comparable between the three categories, accounting for 40%, 46% and 42% of the populations of Orchard Hills, the surrounding districts and NSW respectively.

This data indicates that both Orchard Hills and the surrounding districts have a similar population distribution to NSW as a whole. The greatest variation between the three categories is the 65+ age group, where the population in the surrounding districts is 10% less than NSW as a whole. This may be the result of relatively new, family-sized housing in new housing estates in surrounding suburbs including Glenmore Park.

Table 4.40
Population Statistics

		Orchard Hills		**Surrounding Districts**		**NSW**	
	Age groups	Persons	Percentage	Persons	Percentage	Persons	Percentage
Children	0-4 years	94	5%	3,359	8%	420,431	6%
	5-14 years	345	18%	7,111	18%	878,483	13%
Studying or Working	15-19 years	151	8%	3,624	9%	439,863	7%
	20-24 years	139	7%	3,138	8%	431,854	7%
	25-54 years	765	40%	18,660	46%	2,753,219	42%
Approaching Retirement or Retired	55-64 years	231	12%	3,108	8%	719,551	11%
	65+ years	185	10%	1,629	4%	905,778	14%
	Total persons	1,911		40,630		6,549,178	
Source: Australian Bureau of Statistics – 2006 Census							

Industry employment statistics are summarised in **Table 4.41**. The three primary industries of employment in Orchard Hills and the surrounding districts were “Construction”, “Retail Trade” and “Manufacturing” (employing 34.5% of the workforce in both categories). The biggest employer across NSW was “Retail trade” (11.1%), followed by “Health care & social assistance” (10.5%) and “Manufacturing” (9.6%).

Table 4.41
Industry Employment Statistics

	Orchard Hills		**Surrounding Districts**		**NSW**	
	Persons	Percentage	Persons	Percentage	Persons	Percentage
Agriculture, forestry & fishing	32	3.4%	111	0.5%	78,661	2.7%
Mining	3	0.3%	53	0.2%	20,318	0.7%
Manufacturing	91	9.8%	2877	13.4%	277,986	9.6%
Electricity, gas, water & waste services	15	1.6%	290	1.3%	29,184	1.0%
Construction	134	14.4%	1850	8.6%	212,729	7.3%
Wholesale trade	50	5.4%	1262	5.9%	136,761	4.7%
Retail trade	97	10.4%	2699	12.5%	323,929	11.1%
Accommodation & food services	33	3.5%	1179	5.5%	190,454	6.5%
Transport, postal & warehousing	62	6.6%	1538	7.1%	145,518	5.0%
Information media & telecommunications	11	1.2%	378	1.8%	68,976	2.4%
Financial & insurance services	24	2.6%	1168	5.4%	144,867	5.0%
Rental, hiring & real estate services	24	2.6%	336	1.6%	50,588	1.7%
Professional, scientific & technical services	58	6.2%	926	4.3%	213,247	7.3%
Administrative & support services	12	1.3%	593	2.8%	90,431	3.1%
Public administration & safety	50	5.4%	1626	7.6%	174,915	6.0%
Education & training	61	6.5%	1227	5.7%	219,679	7.6%
Health care & social assistance	74	7.9%	1792	8.3%	304,335	10.5%
Arts & recreation services	6	0.6%	229	1.1%	39,574	1.4%
Other services	40	4.3%	870	4.0%	110,094	3.8%
Inadequately described/Not stated	56	6.0%	512	2.4%	77,194	2.7%
Total	933		21516		2909440	
Source: Australian Bureau of Statistics – 2006 Census						

Table 4.42 presents a summary of income statistics. Median individual, family and household incomes in Orchard Hills and the surrounding districts exceeded the NSW medians.

Table 4.42
Income Statistics

	Orchard Hills	Surrounding Districts*	NSW
Median individual income ($/weekly)	541	571	461
Median family income ($/weekly)	1,554	1,433	1,181
Median household income ($/weekly)	1,477	1,393	1,036

Source: Australian Bureau of Statistics – 2006 Census
* Average of three surrounding districts

Table 4.43 displays housing statistics for Orchard Hills, Surrounding Districts and NSW. Median monthly housing loan repayments in Orchard Hills and the Surrounding Districts exceeded the NSW median by $650 and $421 respectively. The average household is also significantly larger, with an average of 3.5 people per household in Orchard Hills compared with 2.6 people in the average NSW household.

Table 4.43
Housing Statistics

	Orchard Hills	Surrounding Districts*	NSW
Median housing loan repayment ($/monthly)	2,167	1,746	1,517
Median rent ($/weekly)	235	242	210
Average number of persons per bedroom	1.1	1	1.1
Average household size	3.5	3.3	2.6

Source: Australian Bureau of Statistics - 2006 Census
*Average of three surrounding districts

From a social capital perspective, the local communities are understood to have some areas of mutual interest whereas many rely upon the social and sporting networks across a wider area.

4.12.2 Design and Operational Safeguards and Impacts

Whilst the Proponent recognises the Project Site is comparatively isolated with respect to the surrounding communities, it none-the-less recognises its corporate responsibility to participate/recognise local community events and activities.

The community consultation process established concerns that the Project could have adverse impacts on both local amenity and real estate values. It remains the Proponent’s objective through operating a State-of-the-art facility that issues relating to amenity and in turn real estate value would remain unchanged. The Proponent acknowledges that from both a visual and noise perspective, the surrounding community would be aware of the Project, however, the activity is recognised as a “means to an end” of rehabilitating the existing quarry and returning the land for grazing purposes.

The Proponent is fully supportive of the formation of a Community Consultative Committee for the Project involving local community representatives to keep local residents informed about the Project’s progress and to provide a forum for regular discussion.

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