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Tweed Shire Council

Report for Quirks Quarry Landfill

Concept Design Report (Revised)

October 2011

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction

1.1 General

GHD Pty Ltd (GHD) was commissioned by Tweed Shire Council (Council) to undertake the concept design for the proposed Quirks Quarry Landfill. The work is part of the Environmental Assessment for the proposed Eviron Road Quarry and Landfill site.

1.2 Scope of Report

The purpose of this report is to:

- Detail the information used to produce the concept design;
- Outline the assumptions used to produce the concept design; and
- Document the methodology adopted to produce the concept design.

GHD notes that this report was reviewed and updated on a continuous basis as data was received from Council and assumptions agreed by Council.

1.2.1 Version Control

This version of the report (Rev 3 October 2011) incorporates revised waste acceptance data and forecasts, together with achieved compaction rates provided by Council. This data has increase the forecast operational life of Quirks Quarry Landfill. Consequently, the following sections of the report have been amended:

- 3.7 Void Capacity

  Section rewritten to account for new waste acceptance data and compaction rates.
- 3.8.1 Leachate Quantity

  Revision to parameters of leachate treatment and irrigation to account for new waste acceptance data.
- 3.8.2 Results of Leachate Generation

  Leachate model rerun to account for new waste acceptance data.
- Appendix B Concept Leachate Generation Calculations

  Leachate model rerun to account for new waste acceptance data.

1.3 Background Information

1.3.1 Survey Data

The development of concept design was based on the following survey data provided to GHD:

- Existing site survey provided by Council in February 2009;
- 3D digital terrain model triangles provided by Council in February 2009;

- 2D design data of proposed final Quarry design levels, 'Figure 4 – Final Quarry Landform' produced by Ray Sargent and Associates and located in Report 'Plan Management of Quirks Quarry'. The Autocad drawing was provided by Council to GHD. This data was then manipulated into a 3D format by GHD; and
- Datum assumed for the concept design:
  - Horizontal Datum – MGA 94; and
  - Height Datum – AHD.

1.3.2 Documentation

The development of the concept design was based on the following documentation:

- Plan of Management of Quirks Quarry – November 2006, Quirks Quarry V3.0;
- Botanic Garden – Master Plan Report, Tweed Shire Council, September 1998;
- Silo Patched Point Dataset:
  - Site name – Tyalgum (Wanungara View) and Site number – 058057 (Bureau of Meteorology, 2008).
- Australian Rainfall Intensity Data – IFD for Murwillumbah, NSW;
- MS09002 – All Groundwater Bores.xls. Excel spreadsheet of all bore hole location and levels for Quirks Quarry provided by Tweed Shire Council, February 2009;
- Environmental Guidelines: Solid Waste Landfills, EPA NSW, January 1996;
- Draft Environmental Guidelines: Landfilling, Department of Environment and Conservation NSW, August 2007;
- Managing Urban Stormwater: Soils and Construction, Volume 1, NSW Landcom, March 2004;
- Managing Urban Stormwater: Soils and Construction – Waste Landfills, Volume 2B, NSW Landcom, March 2004;
- Tweed Urban Stormwater Management Plan, Tweed Shire Council; and
- Tweed Shire Council Development Control Plan – Development of Flood Liable Land, Map 2 – Mid Tweed, Draft V2.3, 09 November 2005.

2. Site Overview

2.1 Site Location

The proposed Quirks Quarry Landfill site falls within the Tweed Shire Council Shire adjacent to the Pacific Motorway at Eviron. The council owned site is situated south of Chinderah, approximately 11.3 Kilometres northeast of Murwillumbah and 22 kilometres south of Tweed Heads. The site is shown on drawing number 41-20806-FIG 01 (located in Appendix A).

2.2 Site History

Quirks Quarry has been operating since the 1950's. An Environmental Impact Statement (EIS) was prepared in 1996 to assess proposed extensions for the 'continued operation' of the existing quarry. Prior to 1996, the quarry had a threshold annual extraction rate of 50,000 tonnes (Brian J. Mackney & Associates, 1996).

TSC purchased the quarry in 1996 and at this time the quarry began operating under the current quarry management plans.

The TSC Development Assessment Unit issued a deferred commencement Development Application on the 15th of December 1999 for the continuation and expansion of Quirks Quarry. The commencement was deferred with respect to obtaining an approved Plan of Management and provision of a description of an access route to the site. The Plan of Management was approved on the 16th of June 2000 (PF1960/540 Pt2).

2.3 Land Use

The site has been used as a quarry since the 1950's. A description of the quarry operations is provided in the Quirks Quarry Plan of Management V3.0 (TSC, 2006).

The quarry covers an area of approximately 3.82 ha and straddles the border of two lots, being predominantly located on Lot 602 DP 1001049, with a small portion falling within Lot 1 1159352. Most of the site is zoned 5(a) – Special Uses (Garbage Depot) under the Tweed Shire Local Environmental Plan (2000). In addition, the northern most portion of Lot 602 DP 1001049 and the eastern portion of Lot 1 DP1159352 are zoned 1(b) Agricultural Protection.

2.4 Land Ownership

TSC owns both Lot 1 DP1159352 and Lot 602 DP 1001049 on which the site is located.

2.5 Topography

The existing quarry site is located on a low relief, westerly tending spur of the Condong Range. The spur protrudes onto the flatter cane lands between the coastal ranges and the Tweed River.

Runoff from the extraction area drains to a small stream south-west of the site. This stream enters a series of cane drains to the north of the site which eventually flow into the main trust canal. This canal enters the Tweed River approximately 3.5 km north of the quarry site.

2.6 Geology

Regional scale geological mapping (1:250,000-scale map for Tweed Heads, Sheet 56-03) shows Quaternary-age deposits (river gravel, alluvium, sand and clay) outcrop along the River Tweed and other low lying areas in the vicinity of the site. Isolated outcrops of Tertiary age volcanic rock (predominantly basalt) are mapped south west and south east of the site. The regionally extensive Silurian-age Neranleigh–Fernvale beds (greywacke, slate, phyllite and quartzite) are mapped at ground surface in the west. South of the site these beds are shown to dip towards the south west at around 45° on a regional scale and may be folded, as indicated by the regional geological cross section (NSW Department of Mines 1967).

2.7 Soils

The predominant soil type within the region comprise of massive black and grey coastal (alluvial) clays. These soils are found in the coastal areas and the Tweed River flood plain, and are prone to localised acidification subject to draining / desaturation. The alluvial deposits can be up to 20 m in depth. Soils located within the rocky subcrop generally comprise clayey residual soils, being formed by weathering of the underlying basement sequences.

2.8 Groundwater

It is currently understood that groundwater at the site flows from the south west to the north east. However, during initial concept design, GHD used groundwater monitoring data from August 2008. Further preliminary analysis, using result in Table 1, verified that the initial concept design level of RL 2 m (located at the lowest point of the landfill area, Stage 2) was suitable for sub-grade base levels. Table 1 shows the historical range of standing water levels recorded for the monitoring wells within the proposed landfill area to date.

It is recommended that during detailed design or at the construction phase, further geological and hydrogeological investigations and assessments should be carried out within the proposed landfill area to further understand the local groundwater conditions.

Table 1 Groundwater Levels

Ground water ID	Top Casing (RL)	Standing Water Level (RL)[1]	Date of Sample
GW4	1.15	0.101 to 0.095	04 Sep 07 to 02 Jul 09
GW7	2.18	0.701 to 0.561	04 Sep 07 to 02 Jul 09
GW8	2.04	0.822 to 0.625	04 Sep 07 to 02 Jul 09
GW9	2.81	-0.09 to 0.14	05 Aug 08 to 02 Jul 09
GW10	3.94	0.11 to -0.19	05 Aug 08 to 02 Jul 09
GW11	9.17	5.85 to 6.26	05 Aug 08 to 02 Jul 09
GW23	3.66	0.62 to 0.57	21 Apr 09 to 02 Jul 09
GW24	36.49	9.39 to 8.89	21 Apr 09 to 02 Jul 09

2.9 Surface Hydrology

Existing surface water drainage at the site comprises a number of small drainage channels which flow north/north east into a larger un-named channel which flows from south east to north west through the site. This larger channel continues to the north close to the edge of the Tweed River floodplain at the break in slope and discharges to Leddays Creek, eventually discharging into the Tweed River to the north of the site.

2.10 Climate

Climate data gathered from the Bureau of Meteorology Murwillumbah (Bray Park) Site shows that the area has an average annual rainfall of 1518.4 mm. Mean annual temperatures range from 14.4°C to 25.8°C. Mean monthly maximum temperatures range from 21.0°C in July to 29.6°C in January. Mean monthly minimum temperatures range from 8.5°C in July to 19.7°C in January (BOM 2008).

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[1] Standing water levels provided by Council

3. Concept Design Basis

3.1 General

This chapter outlines the basis for the concept design and the assumptions and constraints incorporated into the concept design.

3.2 Existing Services & Site Infrastructure

As part of the development of the concept design Council verified the following services or infrastructure that would be affected or impacted on:

- Overhead or underground electric cables:
  - no services on site;
- Other underground services:
  - no other services on site;
- Existing leachate and gas lines:
  - no items on site;
- Existing leachate wells and groundwater wells:
  - groundwater wells are located around the quarry area. Refer to Figure 02, Appendix A, for further details;
- Flooding of the site:
  - the site is prone to flooding refer section 3.4;
- Quarry Office:
  - to be removed by the Quarry Contractor following completion of the quarrying works;
- Bitumen access haul road to Eviron Road:
  - to be replaced by a haul road connection to Stotts Creek landfill which will become the sole access point to the landfill and quarry at Eviron Road/Quirks;
- Dam located at the south west end of the site and associated stormwater drainage:
  - all existing stormwater to be utilised where possible until requiring removal during the staging of the landfill works;
- Sediment basins located at the north west and west end of site and associated stormwater drainage:
  - all existing stormwater to be utilised where possible until requiring removal during the development stages of the landfill works.
- Open drain located on the north east edge of the site:
  - to remain and be utilised throughout the life of the landfill.
- Dial before you dig (DBYD):
  - A search was not completed as part of the concept design;
  - GHD recommend this be performed as part of the detailed design.

Council verified that there would be no requirements for a gatehouse, weighbridge, workshop, site office and wheelwash, as the existing infrastructure at Stott Creek would be utilised for this site.

3.3 Groundwater

In March 2009, GHD assumed a base level for the landfill cell using ground water (GW) standing water level data collected and supplied by Council. From the data range September 2007 to November 2008, the highest standing water level (August 2008) was utilised in the base level assumptions.

Since carrying out the concept design, Council have installed additional GW monitoring wells around the Quirks Quarry area. At time of concept design no monitoring data for the new wells had been provided by Council. GW data for these new wells should be used during detailed design to verify the base level used in the concept design.

To assess the GW levels and direction of flow the following was assumed:

- No GW level data for GW24 was made available by Council during the design stages of these works, therefore ground water flow in the south east corner of the site could not be calculated;
- The ground water appeared to be flowing from the south west (GW8) to the north east (GW10 and GW9) of the site;
- The average current base level within the quarrying area was 2 m AHD; and
- A visual assessment of the quarry area in March 2009 showed no obvious signs of groundwater lying above the ground surface at RL 2 m.

The concept design has therefore used a level of RL 2 (located at the lowest point of the landfill area, Stage 2) for design of the subgrade base levels. A preliminary analysis of data regarding standing water levels for groundwater monitoring wells in the vicinity of the future landfill confirms that the water table is at an approximate RL of 0.5 m to 1 m. Therefore the concept design clay liner level of RL 2.9 m (located at the lowest point of the landfill area, Stage 2) will allow a minimum attenuation layer of approximately 1.9 m above the groundwater table. In accordance with the data provided by Council, it is presently assumed that a ground water attenuation system will not be required within the concept design.

However, it is recommended that prior to detailed design or at the construction phase, further analysis of the future groundwater level data should be undertaken and if required geotechnical and hydrogeological investigations should be carried out within the proposed landfill area to gain more accurate groundwater level information.

3.4 Surface Hydrology

Based upon Flood Map 2 for Mid Tweed, Quirks Quarry is in an area predicted to be inundated in an ARI 100 year flood. The flood level for this area is 3.9 RL.

Council verified that the sugar cane fields located north west of the proposed landfill area could potentially be susceptible to flooding.

As a result of the above information, the following was included in the concept design:

- A perimeter bund has been proposed along the northern and western edges of the proposed landfill area at an average level of 6.5 RL; and

- In the concept design, the current low lying areas of the site (Stage 3 area) will be raised above current surface levels along the northern and western edges of the perimeter bund to approximately 1 m to 3 m. The base of the landfill will then fall towards the eastern edge of the proposed landfill area. This should potentially reduce stormwater from the surrounding site overflowing the perimeter bund and entering the landfill area.

3.5 Geotechnical

The concept design only allows for general landfill cell arrangement and morphology. No slope or liner stability assessment has been included as part of the approved scope of works. GHD recommends that prior to construction a review of slope stability be undertaken.

This is particular important for the steep batter located along the north east edge of the site. The batter face is approximately 1:1 and could pose potential problems due to health and safety when constructing the cell liner.

Additional geotechnical and hydro geological investigations and assessments will need to be carried out within the proposed landfill footprint area prior to commencement of detailed design.

3.6 Site Access

A site access track for the leachate riser pipe in Stage 2 and maintenance of the sediment basin has been included. The following assumptions have been made:

- The site access track will commence from the existing bitumen access road;
- The site access track will have a minimum width of 4 m;
- The site access track is assumed to be of a temporary nature, unsealed, will require continuous maintenance and where possible be constructed using recycled materials; and
- No haul routes into waste cells have been included as part of the concept design:
  - GHD note that these are to be included in the detailed design.

3.7 Void Capacity

In April 2011, Council provided revised waste acceptance and operational data for the Stotts Creek Landfill, which has altered the calculations for the void capacity and the likely life of the Quirks Quarry Landfill.

3.7.1 Waste Compaction Data

Monthly compaction testing between December 2009 and September 2011 indicates that an average waste compaction rate of 1211 kg/m^3 has been achieved at Council's Stotts Creek Landfill (as shown in Council records provided in Appendix E). In the previous version of the concept design a waste compaction rate of 750 kg/m^3 was adopted. However based on the newly provided data, a revised compaction rate of 1000 kg/m^3 has been adopted for the concept design. This is lower than the average currently being achieved and is therefore considered to remain a conservative estimate of achievable compaction based on current standing operating procedures and equipment which will be carried over as minimum requirements at the establishment of Quirks Quarry Landfill.

3.7.2 Forecasted Waste Acceptance

Council provided GHD with revised and updated waste acceptance forecasts for 2012 onwards in April 2011. The forecasts are based upon actual wastes received at Stotts Creek Landfill and are lower than that adopted in the previous version of the concept design.

It is noted that Council has committed to establishing and AWT facility by 2016 with the aim of diverting up to 66% of the waste currently disposed to landfill. However given that planning for this is in the very early stages, this diversion and reduction of waste to landfill has not been factored into the concept design.

Construction and Demolition waste will continue to be landfilled at Stotts Creek Landfill until the end of 2019, as was the case in the previous version of the concept design.

3.7.3 Revised Void Capacity

Based on the revised data and the void capacity estimated in the previous design, GHD have updated the estimate of the operating life for the landfill. The following assumptions were utilised in calculation of the landfill life capacity and the results are shown in Table 2:

- Assumed 2012 yearly waste tonnage = 47,893 tonnes;
- Assumed increase in yearly waste volumes for each consecutive year = average 3% ;
- Waste compaction rate: 1 m^3 = 1 tonne; and
- Estimated yearly daily cover placed = 20% of yearly waste volume.
- Void capacity (waste only) = 580,000 m^3
- Void capacity (waste and daily cover) – 696,300 m^3

On the basis of the revised calculations, summarised in Table 3 below it is estimated that Quirks Quarry Landfill will an operational life of approximately 10 years.

Table 2 Life Expectancy of Quirks Quarry Landfill

Year	Annual Waste tonnage	Waste volume @ 1000kg/m3	Daily Cover Volume (20%)	Total Volume of Waste and Daily Cover (m^3)	Cumulative Volume of Waste and Daily Cover
2012	47,893	47,893	9,579	57,472	57,472
2013	48,851	48,851	9,770	58,621	116,093
2014	50,316	50,316	10,063	60,380	176,472
2015	51,826	51,826	10,365	62,191	238,663
2016	53,381	53,381	10,676	64,057	302,720
2017	54,982	54,982	10,996	65,978	368,699
2018	56,632	56,632	11,326	67,958	436,656
2019	58,330	58,330	11,666	69,997	506,653

Year	Annual Waste tonnage	Waste volume @ 1000kg/m3	Daily Cover Volume (20%)	Total Volume of Waste and Daily Cover (m^3)	Cumulative Volume of Waste and Daily Cover
2020	75,030[1]	75,030	15,006	90,036	596,689
2021	77,131	77,131	15,426	92,557	689,246
Total	574,371	574,371	114,874	689,246	**689,246**

1 Inert landfill at Stotts Creek closes in 2019, inert waste accepted at Quirks Quarry Landfill from 2020 onwards.

3.8 Leachate

As the proposed landfill is not yet operational there is no actual data on landfill leachate generation rates or quality at the site. Consequently, water balance modelling has been undertaken to estimate the quantities of leachate that will be generated by the landfill during median and wet weather conditions. To obtain an understanding of the likely characteristics of the leachate generated at the site, data on leachate quality at other similar landfills has been considered.

3.8.1 Leachate Quantity

A water balance model was undertaken to provide an estimate of the quantity of leachate generated during operation and post closure of the landfill. The modelling was conducted as per the Draft Environmental Guidelines: Landfilling (DECC 2007), which specifies that leachate generation be modelled for a heavy rainfall year (10% Annual Exceedance Probability) in the initial year and median rainfall years (50% AEP) for the next 9 years. This process is to be completed for each decade of operation until closure.

The modelled leachate generation rates were developed using the USEPA's Hydrological Evaluation of Landfill Performance (HELP) model based on the following assumptions:

- Daily rainfall data was taken from weather station 'Tyalgum (Wanungara View), site number 058057[2], for the period 1950 to 2008. The 10% AEP was in 1972 and the 50% AEP was in 1991;
- The soil characteristics for total porosity, field capacity, wilting point, and saturated hydraulic conductivity were selected from the HELP model default values based on the type of material anticipated on site;
- No absorption of rainfall infiltration by the landfill waste;
- Three capping scenarios as outlined in Section 4.7 for daily cover, intermediate cover and final capping layer;
- Staging and sequencing of the works in accordance with Section 4.3;
- Intermediate cover placed any area that will be left standing for greater than 28 days.;

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[2] 'Murwillumbah (Bray Park)', site number 058158, the closest weather station site to Quirks Quarry was unable to be used due to an inadequate data set

- Filled areas / stages are progressively capped as the final landform is achieved;
- Leachate is to be stored with in the cell;
- A leachate treatment and irrigation scheme is to be developed in year 2, to be online by December of that year with a capacity ~25 m^3/day, this will stay in place for the life of the landfill.

It should be noted that it is GHD's experience that the HELP model is generally conservative in nature (over estimates leachate generation) but all modelling should be verified based on actual data collected during operation.

3.8.2 Results of Leachate Generation

The results of the water balance modelling are summarised in Table 3 (rounded). Copies of the model outputs are provided in Appendix C.

Table 3 Summary of Leachate Generation Modelling Results

Scenario	Estimated Leachate Generation for 10% AEP Rainfall year			Estimated Leachate Generation for 50% AEP Rainfall year		
	Average Monthly (kL/month)	Peak Month (kL/month)	Total for Year (kL)	Average Monthly (kL/month)	Peak Month (kL/month)	Total for Year (kL)
Stage 1A	420	1,100	5,020	260	660	3,060
Stage 1B	910	2,660	10,950	570	1,570	6,880
Stage 2	1,530	4,060	18,310	970	3,740	11,630
Stage 3	2,120	5,660	25,480	1,350	5,180	16,240
Final Landform	220	290	2,630	200	290	2,400

The results in Table 3 demonstrate that leachate generation will vary significantly over the life of the landfilling operation and during different climatic conditions.

The maximum peak monthly leachate generation will occur during Stage 3 of the landfilling operation with approximately 5,180 kL of leachate generated during a 50% AEP rainfall year and approximately 5,660 kL during the a 10% AEP rainfall year. By contrast, the highest average leachate generation during a median (50% AEP) rainfall year will be approximately 1,350 kL/month (or ~40 kL/day), which will also occur in Stage 3. During a 10% AEP rainfall year, the average monthly leachate generation in Stage 3 will rise to approximately 2,120 kL.

The modelled cumulative leachate generation for the life of the landfill is provided in Figure 1.

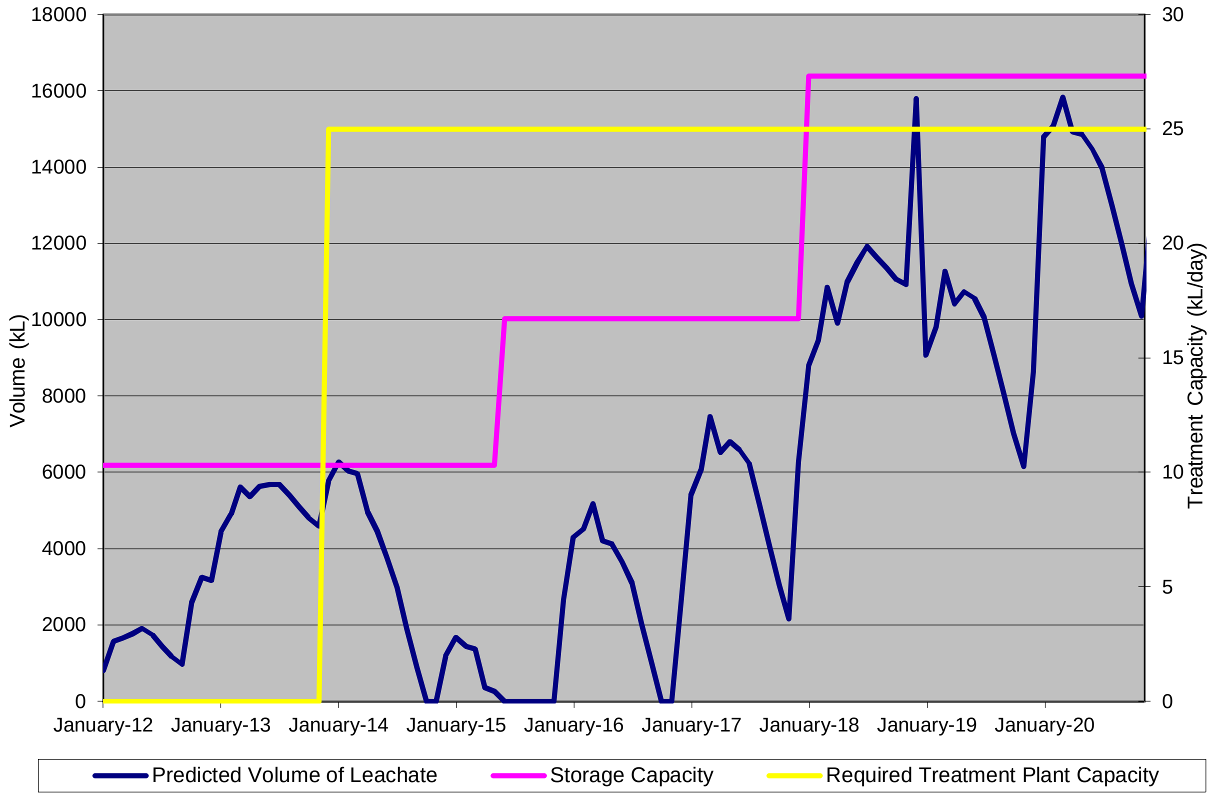

Figure 1 Cumulative leachate generation

3.8.3 Leachate Disposal Options

Based on the leachate generation rates modelled the following options for leachate disposal were considered:

- Option 1: Evaporation from the leachate storage dam;
- Option 2: Injection into the landfilled waste;
- Option 3: Irrigation on the active landfilling area;
- Option 4: Irrigation to a dedicated and contained irrigation area;
- Option 5: Irrigation of leachate on a developed but inactive landfill cell i.e. develop Stage 2 cell and irrigate leachate on the cell before landfilling commences;
- Option 6: Treatment of leachate and discharge to a local water course; and
- Option 7: Pretreatment of leachate on site and tanker off site for disposal at a local sewage treatment plant.

The issue of leachate treatment has also been considered as part of Options 4, 6, and 7 as it impacts on the requirements for irrigation.

Option 1 - Evaporation from a leachate dam

This option would involve transferring leachate from the landfill cell to an onsite leachate storage / evaporation dam for disposal. As rainfall at the site is greater than potential evaporation this option was not further investigated.

Option 2 – Injection into landfilled waste

This option would involve transferring leachate from the landfill cell to a leachate storage dam / tank and then injection of the leachate into the landfilled waste once a sufficiently large quantity of waste had been landfilled at the site.

It should be noted that this option does not provide a long-term mechanism for disposal of leachate. Some of the injected leachate would be absorbed by the landfilled waste, but this would not be sufficient for disposal of all leachate generated at the site. Typically the former DECC Guideline allows 30L of water absorption per tonne of landfilled waste, which would amount to 2,600 kL per year (for 70,000 tonnes of waste per year), which is substantially less than the estimated leachate generation (3,060 – 16,240 kL/yr in a 50% AEP rainfall year, refer to Table 3).

Option 3 – Irrigation onto active landfilling area

This option would involve extracting leachate from the landfill cells, storing the leachate in a dam / tank on the site, and then irrigating the leachate over the active landfilling area.

It should be noted that this option does not provide a long-term mechanism for disposal of leachate. Some of the injected leachate would be absorbed by the landfilled waste, but this would not be sufficient for disposal of all leachate generated at the site. Typically the this method would allow for 60L of water absorption per tonne of landfilled waste, which would amount to 5,200 kL per year (for 70,000 tonnes of waste per year), which is at the lower end of the estimated leachate generation (3,060 – 16,240 kL/yr in a 50% AEP rainfall year, refer to Table 3). This option could therefore be used in the interim to manage leachate until a suitable leachate disposal system is in place.

It should be noted that that any infiltration / percolation of the irrigated leachate on the active landfilling area will simply become leachate again. Thus, the irrigation practice needs to achieve nil infiltration / percolation.

Treatment of the leachate prior to irrigation is not commonly undertaken for this type of operation, however, as a result, all runoff from the irrigation area would need to collected and managed as potentially contaminated i.e. as leachate. This increases the quantity of the leachate requiring management and increases the size of the irrigation area.

Advantages

- Simple and robust system;
- Little risk of groundwater contamination;
- Little risk of soil contamination;
- May not require leachate treatment plant, however this depends on risks / impacts on site staff / users of the facility.

Issues

- Irrigation would need to be undertaken in a careful, well-managed manner. Over irrigation of the landfilled area simply creates runoff, which must be managed as leachate, or infiltrates into the landfilled waste, increasing the quantity of leachate requiring management / disposal;
- Stormwater runoff from the irrigation area must be managed as leachate if the leachate is not treated;
- Potential impacts on landfilling operation: regularly moving leachate irrigation activities and associated stormwater management measures;
- Some risk of surface water contamination – depends on measures to manage surface water at irrigation area. Treatment of leachate prior to irrigation would reduce risks of surface contamination;
- Some risk of spray drift from irrigation options. More of a risk to site staff and users of the site.

Option 4 – Irrigation to a dedicated and contained irrigation area

This option would involve extracting leachate from the landfill cells, storage of the leachate in a dam / tank on the site, treating the leachate in a suitable leachate treatment plant, and irrigation of the treated leachate over a dedicated and contained leachate irrigation area.

Advantages

- Incorporating a leachate treatment plant will provide a number of benefits:
  - Reduced potential for odour nuisance from the storage dam (no need for surface aerators) and irrigation operation;
  - Reduced risk of surface water and groundwater contamination;
  - Reduced surface water management requirements at the irrigation area; and
  - Reduced risk of soil contamination.
- Reduced risk of spray drift from irrigation - if leachate is treated;
- No impact on landfilling operation; and
- Probable high acceptability to OEH and Public – if the leachate is treated prior to irrigation. The OEH do not favour irrigation of untreated leachate.

Issues

- Leachate management system is more complex;
- Irrigating untreated leachate has the following implications:
  - Destruction of vegetation on the irrigation area;
  - Increased potential for odour nuisance from the storage dam and irrigation operation;
  - Increased risk of surface water and groundwater contamination;
  - Increased surface water management requirements at the irrigation area; and
  - Increased risk of soil contamination.

Option 5 – Irrigation of leachate on a developed but inactive landfill cell

This option would involve extracting leachate from the landfill cells, storing the leachate in a dam on site, and irrigating the leachate on a developed and lined empty landfill cell.

As this proposal is essentially an evaporation option and rainfall at the site is greater than potential evaporation this option was not further investigated.

Option 6 – Treatment of leachate and discharge to a local water course

This option would involve extracting leachate from the landfill cells, storing the leachate in a dam on the site, treating the leachate in a suitable leachate treatment plant and discharging the treated leachate to the local watercourse. Due to the risks involved in terms of contamination of the water course should the system fail this option was not further investigated.

Option 7 – Pretreatment of leachate on site and tanker off site for disposal at a local sewage treatment plant

This option would involve extracting leachate from the landfill cells, storing the leachate in a dam on the site, treating the leachate in a suitable leachate treatment plant (if required) and trucking the treated leachate to a suitable location for discharge into the local sewerage system.

Advantages

- Simple and robust system;
- Reduced risks of odour impacts – no leachate storage dam;
- No risk of surface water or groundwater contamination;
- No risk of soil contamination;
- No risk of spray drift (no irrigation occurs);
- No impact on landfilling operation;

Issues

- Leachate pre-treatment plant required – but less complex than treatment plant for irrigation or discharge to water course;
- Traffic impacts of trucking operations – 10 trucks of 20 kL capacity per day for a peak month 10% AEP rainfall year (5,660 kL/month).

3.8.4 Leachate Treatment

As discussed in Section 3.8.3, disposal options 4, 6 and 7 require treatment of the landfill leachate prior to disposal. The following criteria would be considered when choosing a treatment option for the landfill leachate:

- The variability of leachate generation i.e. variations in leachate quantity and characteristics over the life of the landfilling operation;
- The characteristics of the leachate i.e. high ammonia / TKN, high level of degradable organic matter, and moderate salinity;
- Performance of the treatment process i.e. quality of the effluent;
- Operational reliability;
- Operation and monitoring requirements i.e. labour resources and technical knowledge;
- Availability of operational technical support;
- Minimisation of impacts on the local community (odour, noise, visual amenity, and availability of buffer zone);

- Minimisation of impacts on the environment (surface water/ groundwater/ soil contamination, clearing of land etc); and
- Construction and operating costs.

A general treatment process for landfill leachate would normally include:

- Preliminary treatment;
- Carbonaceous Biological Oxygen Demand (BOD) and nutrient reduction;
- Polishing; and
- Residuals management.

It should be noted that as the site is not yet constructed and operational, the characteristics of the leachate to be generated are uncertain and it is very risky to design and construct a leachate treatment plant based in estimates / predictions. It is recommended, and common, for a staged approached to be undertaken that involves the following steps:

- Implementing temporary leachate storage and management measures;
- Monitoring leachate generation (quantities and quality) for a suitable period of time e.g. 1 - 2 years; and
- Designing and constructing the leachate treatment plant based on the actual field data.

The following sections provide a discussion on leachate treatment options and describes the recommended approach to establishing a leachate treatment plant at the site.

Options

The primary contaminants of concern in landfill leachate are generally ammonia-nitrogen and degradable organic matter. A range of treatment methods have successfully been used to treat landfill leachate including:

- Aerobic biological processes, including aerated lagoons, activated sludge processes, trickling filters, rotating biological contactors (RBC), sequencing batch processes eg. SBR;
- Anaerobic biological processes including anaerobic filters and anaerobic sludge bed reactors (UASB); and
- Physical / chemical processes including precipitation, coagulation, filtration, chemical oxidation, ion exchange, and more recently membrane technologies (micro and nanofiltration and reverse osmosis).

However, most commonly aerobic biological treatment processes are used in combination with a simple polishing process, e.g wetlands, depending on the ultimate disposal method. Aerobic biological processes can typically remove 85% to > 90% of the degradable organic matter (BOD_5 and COD) and heavy metals, as well as substantially reduce nitrogen levels (ammonia to nitrate and then to nitrogen gas by means of nitrification and denitrification).

Consequently there is a wide range of treatment processes that could be used to successfully treat leachate generated at the site. There are also a range of methods for developing a leachate treatment plant at the site including:

1. Engage a consultant to design the leachate treatment plant and then engage a suitable contractor to construct the plant; or

2. Engage a contractor that specialises in the design and construction of package wastewater treatment plants suitable for treating leachate. There are a large number of such contractors in Australia that could provide a suitable leachate treatment plant.

Treatment Capacity

The capacity of the leachate treatment plant will be dependent on leachate generation at the site, the amount of storage available, and the capacity of the leachate disposal system.

As discussed previously, as the site is not yet constructed son no actual leachate quantity data is available. Consequently, a water balance model was developed to estimate leachate generation and the results used to model the various leachate treatment and disposal options. The results are provided in Appendix C. From the results it can be seen that the treatment capacity required will vary depending on the Stage of landfilling and the climatic conditions, which affect both leachate generation and disposal. Assuming the leachate is irrigated in site, during Stage 2 and 3 of landfilling a treatment plant with a minimum capacity of 25 kL/day will be required to cater for leachate generated during a 10% AEP rainfall year.

3.8.5 Recommended Approach

Based on the modelling performed and previous experience GHD recommend Council:

- Store leachate within the cells, that is, do not construct a leachate pond; and
- Adopt a disposal option that is a combination of:
  - Option 3 – Irrigation onto active landfilling area, to control leachate levels in the interim period until a leachate treatment plant and irrigation area is established; and
  - Option 4 – Irrigation to a dedicated and contained irrigation area, using treated leachate.

Further, due to the high rainfall and low comparative evaporation at the site the construction of an external leachate pond would lead to excessive amounts of leachate generation due to rainfall on the cell. GHD therefore recommended that Council store leachate within the landfill cell. Council should note that the OEH is unlikely to approve this without additional measures to ensure leachate does not leach from the basal lining system including:

- A HDPE liner above the proposed compacted clay liner; and
- Monitoring of landfill leachate levels; and
- Leachate quantity and quality.

Due to the uncertainty regarding the quantity and quality leachate that will be generated at the site and to avoid over sizing the leachate treatment plant, the following approach to leachate treatment is recommended:

- Monitor leachate generation (quantity and quality) for a suitable period of time e.g. 1 – 2 years;
- Irrigate leachate on the active landfilling area to control leachate levels in the interim period until a leachate treatment plant and irrigation area is established.
- Review and verifying leachate generation at the site e.g. during median and 10% AEP rainfall years;
- Review and confirm the preferred leachate management strategy;

- Prepare tender documentation for the design and construction of a suitable leachate treatment plant, based on the outputs of the previous tasks. This would include a performance based specification for a leachate treatment plant that would produce an effluent suitable for the selected leachate disposal option i.e. irrigation;
- Call tenders and construct a suitable leachate treatment plant at the site; and

Monitor and optimise the performance of the leachate treatment plant.

4. Concept Design

4.1 General

The landfill footprint will be split into cells / stages to allow efficient management of disturbed areas and minimisation of rainfall infiltration in to landfill waste filling area and thus generation of leachate.

4.2 Cell Life Requirements

The following assumptions were utilised in calculation of the life expectancy of each landfill cell / stage and the results are shown in **Table** 4:

- Minimum of 2 years filling before construction of next stage; and
- Requirements detailed in section 3.7.

Table 4 Life Expectancy of Each Landfill Cell

Cell /Stage	**Void Capacity (m^3)**	**Approximate Cell Life (Months)**	**Comments**
1	206,500	41	Intermediate Cover to RL 30
2	263,500	46	Intermediate Cover to RL 25
3	171,100	36	Final Capping
2 & 3	109,000	13	Final Capping
Total	**750,000**	**136**	Approximate Landfill Life

As detailed in **Table** 4 the concept design of the cell base and final waste profile, refer to Figure 03 and Figure 04, Appendix A, a void capacity of approximately 750,000 $m^{3,}$ which equates to a landfill life of approximately 10 years has been provided.

4.3 Sequencing of Stages

The sequencing of the cell construction and subsequent landfilling operations in all stages will enable progressive capping to be undertaken as each stage is completed. This will allow efficient management of the disturbed areas and minimisation of rainfall infiltration into the landfill and thus generation of leachate.

The initial development sequence will be as follows:

- Development of Stage 1
  - Cells split into Stage 1A and 1B by internal bund;
  - Lining placed to an RL 15 m.
- Landfilling of waste in Stage 1A:
  - Management of leachate in Stage 1A only, stored within cell;
  - Rainfall on Stage 1B treated as stormwater and pumped to natural drainage.

- Landfilling of waste in Stage 1B:
  - Management of leachate in Stage 1A & 1B, stored within Stage 1 (combined);
  - Management of stormwater from cell to sediment basin once waste reaches RL 15 m;
  - Development of leachate disposal infrastructure, treatment plant and irrigation area, based on collection of leachate quality and quantity data.
- Development of Stage 2 with landfilling of waste continuing in Stage 1 (1A and 1B) to a level of approximately RL 30 m;
  - Leachate disposed by treatment and irrigation stored within Stage 1.
- Intermediate capping of Stage 1 (1A and 1B) and establishment of temporary vegetation to a level of approximately RL 30 m;
- Landfilling of waste in Stage 2;
  - Management of leachate in Stage 1 and 2 and disposal by treatment and irrigation;
  - Excess leachate stored within Stage 1 and 2.
- Development of Stage 3 with landfilling of waste continuing in Stage 2 to a level of approximately RL 25 m;
- Intermediate capping of Stage 2 and establishment of adequate ground cover to a level of approximately RL 25 m;
- Landfilling of waste in Stage 3;
  - Management of leachate in Stages 1 to 3, and disposal by treatment and irrigation;
  - Excess leachate stored within Stage 1 and 2.
- Final capping of Stage 3 and establishment of adequate ground cover to a final design level of approximately RL 20;
- Landfilling of waste in Stage 2 and Stage 3 to final design levels and management of leachate in Stages 1 to 3;
- Final capping of Stage 2 and 3 and establishment of adequate ground cover to a final design levels; and
- Continue management of leachate in Stages 1 to 3 based on recommendations of closure plan (closure plan to be developed a minimum 6 months prior to final placement of waste).

4.3.1 Cell Subgrade Profile Requirements

The concept design for leachate barrier systems has been developed in accordance with the environmental goals of the NSW EPA Environmental Guidelines: Solid Waste Landfills.

The cell subgrade was designed in accordance with the final subgrade contours of 'Figure 4 – Final Quarry Landform' produced by Ray Sargent and Associates, refer to Appendix D. This design is more than adequate to provide suitable falls on the cell base. To accommodate compaction machinery during installation of the cell liner to the batters, the liner will be overfilled (width direction), installed to a height of approximately 3 m and then the surplus clay material cut back to the required perpendicular depth. The concept cell design is as follows:

- Longitudinal grade: 2%;

- Transverse grade: 2%;
- Minimum base level at Stage 2 sump (top level): 2 m AHD;
- No further excavation below current surface levels; and
- Internal batter slopes at 1:3 in areas outside of the final quarry landform and 1:2 in accordance with the final quarry landform design.

4.4 Final Waste Profile

The final landform of the landfill was designed to ensure that the landfill was restored to a similar profile to that of the surrounding landscape. The external batters were designed to be constructed at a maximum grade of 25% (1 in 4) with a minimum top surface grade of 5% (1 in 20). The minimum grade of 5% should be maintained to ensure that rain falling on the site is able to drain away freely, thus minimising infiltration into the waste.

4.5 Cell Liner Details

The cell liner will be designed in accordance with the NSW, EPA guidelines as follows:

- 0.9 m thick compacted clay liner placed vertical to the base and perpendicular to internal batters;
- The liner will need to achieve a permeability of less than 1×10^{-9} m/s;
- 1.5 mm thick high density polyethylene (HDPE) liner to the base of the landfill only, to an approximate RL 7 m (for leachate storage refer to Section 4.8);
- 0.3 m leachate drainage aggregate layer over the base of the liner to achieve a permeability of greater than 1×10^{-3} m/s and associated leachate collection pipework.
- Excavated internal batter slopes will were possible be ≤ 1:3 for constructability of the liner; and
- For slopes > 1:3, the liner will need to be placed in lifts.

4.5.1 Leachate Collection System within the Landfill

In accordance with the former DECCW Guidelines, the leachate collection system must incorporate ‘a drainage layer capable of maintaining the level of leachate over the uppermost layer of the liner at not greater than 300 mm’.

Leachate is currently proposed to be managed via a network of perforated pipes which will discharge to a leachate sump located at the lowest point of each stage. The leachate will be conveyed from the sump by use of pumps via a leachate riser pipe which will then be tankered off site, irrigated or treated.

A leachate sump will be located at the low point of each stage. The sump will be recessed below the level of the liner to ensure the leachate collection pumps are always covered with some liquid to prevent them from becoming damaged.

A full drainage layer and pipework across the base of the landfill has been incorporated into the concept design. During detailed design these pipes will need to be spaced (using Giroud’s equation) and sized (using Manning’s equation) to ensure that the level of leachate over the uppermost layer of the liner is not greater than 300 mm.

4.6 Capping Details

Throughout the waste filling process GHD have assumed that Council will progressively cover the waste using the following techniques:

- Daily Cover:
  - 150 mm minimum of soil material over exposed waste at the end of each working day.
- Intermediate Cover:
  - 300 mm minimum of well compacted soil material to achieve a suitable permeability as final waste landform profiles are achieved.
- Final Capping (maximum requirement):
  - Linear low density polyethylene (LLDPE) liner to achieve a permeability of less than 1×10^{-8} m/s;
  - 500 mm revegetation layer which will be suitable for plant growth; and
  - 100 mm of mulch or topsoil.

The final capping option detailed above, exceeds requirements and environmental goals of the NSW EPA Guidelines. Once landfilling has commenced and Council have collected actual leachate generation figures and actual landfill gas production figures, the final capping system will be reassessed and detail designed. The following layers have currently not been included in this concept design, but may be required in the detailed design:

- A 500 mm compacted clay cap to achieve a permeability of less than 1×10^{-8} m/s. A LLDPE liner is presently recommended following analysis of leachate generation rates, refer to Section 4.9. Once Council obtain actual leachate generation data, as discussed below, it will be assessed whether a clay cap is a viable option;
- A 300 mm drainage layer is recommended above the compacted clay cap. Throughout the Stage 1 waste filling period, Council are advised to carry out weekly monitoring to record the volume of leachate collected and disposed off site, the rainfall and the approximate % of the landfilling area which has exposed waste, daily cover, intermediate cover and final cap. This will provide a more accurate assessment of leachate generation and allow the water balance modelling to be reviewed and revised if required, refer to Section 4.9 for further details. Dependent upon the outcome of the actual leachate generation data, it will be assessed whether this drainage layer will be required;
- A 300 mm gas drainage layer is recommended below the compacted clay cap. This layer may not be required due to the nature and volume of the waste. Landfill gas assessments to calculate gas generation rates should be carried out by a qualified LFG Contractors / Engineers. An active gas system has been allowed for as part of the concept design; and
- An additional 200 mm of revegetation layer has been included in the above assumes to ensure a suitable depth is available for plant growth.

Failure to progressively cap the landfill using the 3 scenarios above may increase infiltration of rainfall into the landfill which will therefore affect sizing of the leachate generation and stormwater infrastructure.

4.7 Material Balance

In accordance with the assumptions listed above in Sections 4.5 and 4.6, the material balance required for each Stage is outlined in Table 5. These volumes are an estimate only and may vary during the design and construction phases of the landfill.

Table 5 Material Balance Summary

Cell Staging	Void Capacity Volume (m^3)	Cut Volume (m^3)	Fill Volume (m^3)	Assumed Daily Cover Volume[3] (m^3)	Slope Area of Cell (m^2)	Cell Liner - Clay Layer 0.9m thick Volume (m^3)	Cell Liner – HDPE Liner Area (m^2)	Cell Liner - Leachate Aggregate Layer 0.3m thick Volume (m^3)	Final Cap – LLDPE Liner Area (m^2)	Final Cap - Vegetation Layer 0.6m thick Volume (m^3)
1	206,500	245,000	800	41,300	27,500	25,100	11,800	3,200	27,800	16,700
2	263,500	62,000	400	52,700	17,400	16,400	13,500	3,700	17,600	10,500
3	171,000	8,000	32,200	34,200	14,700	14,100	13,500	3,200	14,900	8,900
2 to 3	109,000			21,800						
Total	**750,000**	**315,000**	**33,400**	**150,000**	**59,500**	**55,600**	**38,800**	**10,100**	**60,300**	**36,100**

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[3] Assumes 20% of void capacity will be consumed by daily cover

4.8 Concept Leachate Infrastructure

4.8.1 Leachate Management within Cells

Leachate will be managed by a herringbone arrangement of leachate collection points which discharge to a leachate sump located at the lowest point of each cell.

The leachate will be conveyed from the sump by use of pumps via a leachate riser pipe which will then be gravity fed (where ever possible) to the leachate treatment plant for disposal by irrigation.

The concept design will show indicative locations with typical details and assumes the following:

- Sump top area: 6 m by 6 m;
- Sump depth: 0.5 m;
- Leachate collection pipes: 160 mm diameter HDPE perforated (minimum); and
- Leachate riser pipe: 450 mm diameter HDPE perforated and solid.

4.9 Concept Stormwater Infrastructure

4.9.1 Existing Stormwater Infrastructure

The current stormwater drainage system, consisting of a dam, sediment basins and perimeter stormwater drains, will be retained where possible throughout the development stages of the proposed landfill. These systems have not been sized as part of the concept design and may require further design analysis during the construction phases of the landfill.

The current perimeter drain and stormwater culverts located along the boundary of the eastern and southern edge of the site will be retained to collect stormwater runoff from the current vegetated ground cover areas not associated with the proposed landfill area.

The sediment basin and culverts located at the western edge of the existing access track will be retained to collect stormwater runoff from current vegetated ground cover areas not associated with the proposed landfill area.

Refer to Figure 09, Appendix A, for locations of the current stormwater infrastructure.

4.9.2 Proposed Sediment Basin

A sediment basin will be required to intercept and retain sediment laden stormwater runoff from disturbed areas of the site following a rainfall event.

- The sediment basin has been sized in accordance with ‘Managing Urban Stormwater: Soils and Construction’ Volume 1, NSW Landcom, March 2004.

The following assumptions have been made to size the pond:

- As Quirks Quarry will consist of an open rock pit, with large levels of rock dust and rubble, it has been assumed that the total area for Stages 1-3 will be disturbed at commencement of landfilling in Stage

1. The total disturbed catchment area of 5.7 Hectares (Ha) has therefore been used for sizing the sediment basin;

- Filled cells will be progressively capped as the final landform is achieved. Therefore stormwater will be diverted away from the sediment basin;
- A type D / F sediment basin has been classified in this design;
- The settling zone has been designed to contain all runoff expected from the 90th percentile, 5 day rainfall depth;
- The storage zone has been designed as 50% of the capacity of the settling zone;
- As a result of the nature of the rock material a soil hydrology of Group D, and thereby a runoff coefficient (Cv) of 0.9 has been assumed; and
- Refer to Appendix C for stormwater design calculations.

Based upon the assumptions listed above, the sediment basin has been sized to contain a maximum volume of 9,000 m^3 before overflow via a spillway. The final sizing of the sediment basin has assumed the following:

- Freeboard – 0.5 m from top of storage zone to spillway outlet;
- Embankment Height – 0.3 m from spillway outlet to top of embankment;
- Internal slope at 1 vertical to 3 horizontal; and
- Length to width of pond: 2 to 1 approximately.

Concept Design Size of Sediment Basin

The total surface area of the sediment basin (assuming top of embankment area) using the above assumptions will be as follows:

- Length: 85 m;
- Width: 55 m;
- Depth: 2.8 m; and
- Vol Capacity to spillway outlet only: 9,000 m^3.

Initial concept design of this sediment basin indicates that it can be located outside of the landfill area and can control stormwater runoff for a catchment area of 5.7 Ha. Refer to Figure 09, Appendix A, for assumed location of the sediment basin.

4.9.3 Proposed Landfill Stormwater Drains

Stormwater drains will be required to intercept sediment laden stormwater runoff from disturbed areas of the site and convey into a sediment basin prior to release from off site into the current stormwater infrastructure.

A perimeter landfill drain or diversion drain will be required around the perimeter of the landfill area as each Stage of the landfill is developed. This drain will be required to:

- Potential reduce the volume of stormwater runoff from disturbed areas (inside and outside of the landfill footprint) from entering the current landfill waste filling area and thereby increasing the leachate generation volume;
- Intercept stormwater runoff from the current landfill waste filling area, where waste batters have been intermediately covered or where the final cap has been installed but inadequate ground cover has yet established; and
- Intercept stormwater runoff from perimeter access tracks.

Temporary stormwater drains will be required along the boundary of each of the temporary intercell bunds. These drains will be removed as development of each cell / stage occurs. This drain will be required to:

- Intercept stormwater runoff from the perimeter drain installed during each Stage development to ensure this runoff is discharged into the sediment basin;
- Intercept stormwater runoff from disturbed undeveloped areas within the landfill footprint, (staged areas where waste has not been landfilled);
- Intercept runoff from stockpiled material used for daily cover, intermediate cover and final cap which have not been vegetated; and
- Intercept stormwater runoff from the current landfill waste filling area, where waste batters have been intermediately covered or where the final cap has been installed but inadequate ground cover has yet established.

A temporary stormwater drain will be required within Stage 1, excavated into the south and west batters, at a level of RL 15 m. This drain will be required to:

- Reduce leachate generation during Stage 1 waste filling operations. The drain will intercept stormwater runoff from the batter areas over the RL 15 m. This stormwater runoff will be diverted to the perimeter landfill drain or to the temporary drains located along the intercell bund.
- A subcell bund will be constructed between Stage 1A and Stage 1B. This bund will be required to:
  - Reduce leachate generation during Stage 1A waste filling operations. This bund will ensure that stormwater collected in Stage 1B (no waste filling has occurred in Stage 1B) remains uncontaminated. This stormwater will collect at the lowest point of Stage 1B and then be pumped into the nearest temporary stormwater drain. Council will be required to continuously manage the pumping operations.

As each landfill cell / stage has final cap installed and adequate ground cover has established, the stormwater runoff from these areas can be diverted away from the landfill perimeter drain and discharge directly off site.

The stormwater drains has been sized in accordance with ‘Managing Urban Stormwater: Soils and Construction’ Volume 1, NSW Landcom, March 2004.

The following assumptions have been made to size the drains:

- As Quirks Quarry will consist of an open rock pit, with large levels of rock dust and rubble, it has been assumed that the total area for Stages 1-3 will be disturbed at commencement of landfilling in Stage 1. The total disturbed catchment area required for each perimeter landfill drain located along the eastern and western edges of the landfill is 2.8 Ha.

- The landfill drains have been sized to contain a 1 in 20 year storm event without overflowing.
- As a result of the nature of the rock material a soil hydrology of Group D, and thereby a runoff coefficient (Cv) of 0.9 has been assumed.
- Refer to Appendix C for stormwater design calculations.

Concept Design Size for Landfill Stormwater Drains

Based upon the assumptions listed above the landfill stormwater drains have been sized accordingly:

- Bed Width: 1.5 m;
- Depth: 0.5 m;
- Bank Slopes: 1:2 m; and
- Flow Capacity: 1.4 m^3/s.

Initial concept design of these landfill drains indicates that they will need to be sized to contain a flow capacity of 1.4 m^3/s for a catchment area of 2.8 Ha. Refer to Figure 09 and Figure 10, Appendix A, for assumed location of the stormwater drains.

4.10 Concept Landfill Gas Infrastructure

4.10.1 Introduction

Landfills produce landfill gas (LFG) as organic waste material decompose under anaerobic conditions. LFG contains approximately equal parts of methane and carbon dioxide by volume. Other gases such as volatile organic compounds and hydrogen sulphide may also be present in LFG in trace concentrations from time and time.

LFG can move through the ground either to the surface or towards the perimeter of the landfill. The main potential hazard associated with off-site migration of LFG is the possibility of flammable gas entering structures and being ignited, or an asphyxiation risk due to gas entering confined spaces through cracks in foundations or via utility services.

4.10.2 LFG Monitoring Wells

The geology of the site as documented in ‘Plan of Management Quirks Quarry’, (Author unknown), V3, is described as ‘The gravel resources primarily are chert, the geology of which has its origins in the Palaeozoic Neranleigh-Fernvale group. This group consists of a series of thinly bedded shale, mud stones and sandstones with occasional massive greywackes, volcanic types, agglomerates, cherts and quartzites. These rocks have all undergone extensive deformation and exhibit a closely spaced jointing or cleavage pattern which, together with the weathering characteristics, make them particularly useful as road construction material.’

Based on the above description, it is presently assumed the excavated surfaces of the quarry walls could potentially be fractured and could potentially provide a pathway for landfill gas to escape if the landfill liner system was to become damaged during the landfilling stages. On the assumptions above it is recommended that LFG monitoring wells are installed around the full perimeter of the site to detect any potential off-site migration. This is an assumption only and is recommended that further geotechnical investigations are carried out within the proposed area of Quirks Quarry prior to development of the landfill. The exact location will need to be assessed during a site gas risk assessment and recommendations from this investigations detailed within the LEMP.

As recommended by NSW EPA ‘Environmental Guidelines: Solid Waste Landfills’, ‘monitoring wells should be installed around the perimeter of the site, at a depth equal to the minimum groundwater level, the greatest depth of refuse, or 10 m metres below underground utilities or manholes within 50 m of the landfill. These wells should be placed at intervals sufficiently small to be able to detect any potential off-site migration’.

Refer to Figure 11, Appendix A, for approximate locations of the LFG monitoring wells.

4.10.3 LFG Active Extraction Infrastructure

The requirement for installation of a LFG active extraction system will be dependent upon the type and quantity of waste landfilled, and the requirements of the landfill license. Based upon various LFG assessments carried out by GHD it is expected that at a minimum, gas extraction wells and a flare will be required.

For assumed gas extraction infrastructure locations, refer to Figure 11 ,Appendix A. The gas extraction system is assumed to consist of:

- LFG extraction wells spaced at approximately 50 m centres;
- Gas manifold pipework systems from each of the staged area;
- A gas ring main located along the landfill perimeter;
- Condensate traps located along the gas ring main to collect condensate produced as the gas moves through the pipework; and
- Gas extraction flare (initial installation), with the potential for construction of an energy recovery plant depending upon the gas extraction volumes. A compound area of 20 m by 30 m has been allowed. This compound will not be located within the landfill footprint to prevent potential movement of the compound area during settlement of the waste.

The exact number of gas extraction wells, lengths of pipework and type of extraction system will be designed by an experienced LFG Contractor who will carry out site investigations and gas modelling to calculate gas generation.

TSC has indicated a commitment to sustainable LFG management and has identified a potential alternative to onsite LFG infrastructure at this site. Further investigation of the costs, benefits and logistics of tapping into or expanding (replicating) the existing infrastructure at the Stotts Creek Landfill Facility will be undertaken to determine whether this is a more advantageous solution to the provision of a flare at Quirks Quarry LFG management for this landfill.

Appendix A

Figures

DRAWING NUMBER	**TITLE**
Figure 01	LOCALITY PLAN AND DRAWING LIST
Figure 02	EXISTING SITE PLAN
Figure 03	CELL ARRANGEMENT AND PROPOSED EXCAVATION CONTOURS
Figure 04	FINAL WASTE FILL CONTOURS AND CAP DETAILS
Figure 05	CUT AND FILL PLAN
Figure 06	LEACHATE ARRANGEMENT AND DETAILS
Figure 07	TYPICAL CROSS SECTIONS
Figure 08	TYPICAL DETAILS
Figure 09	STORMWATER ARRANGEMENT AND DETAILS
Figure 10	STORMWATER AND SEDIMENT CONTROL DETAILS
Figure 11	TYPICAL GAS EXTRACTION AND INFRASTRUCTURE

TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN
41-20806

LOCALITY PLAN

FIGURE LIST

FIG No.	DRAWING TITLE
41-20806-FIG 01	LOCALITY PLAN AND DRAWING LIST
41-20806-FIG 02	EXISTING SITE PLAN
41-20806-FIG 03	CELL ARRANGEMENT
41-20806-FIG 04	CAP ARRANGEMENT AND DETAILS
41-20806-FIG 05	CUT AND FILL PLAN
41-20806-FIG 06	LEACHATE ARRANGEMENT AND DETAILS
41-20806-FIG 07	TYPICAL CROSS SECTIONS
41-20806-FIG 08	TYPICAL DETAILS
41-20806-FIG 09	STORMWATER ARRANGEMENT AND DETAILS
41-20806-FIG 10	STORMWATER AND SEDIMENT CONTROL DETAILS
41-20806-FIG 11	TYPICAL GAS EXTRACTION INFRASTRUCTURE

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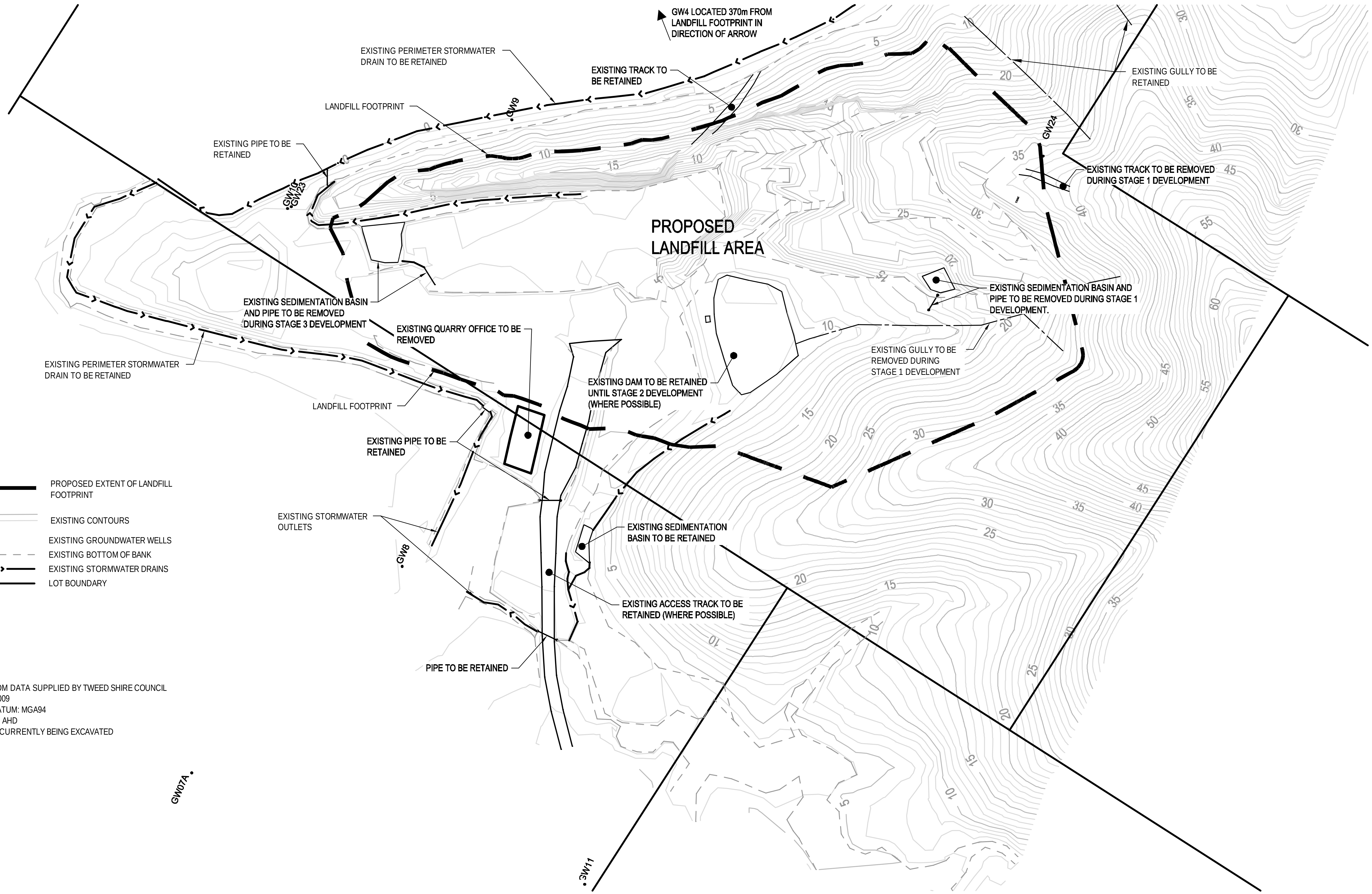
QUIRKS QUARRY CONCEPTUAL DESIGN

LOCALITY PLAN AND
DRAWING LIST

Job Number 41-20806
Revision B
Date SEPT 2009

Figure 01

Plot Date: 9 June 2011 - 4:24 PM Plotted by: Emma Cornelius/GoldCoast/GHD/AU , Hervey Bay Cad File No: N:\AU\Brisbane\Projects\41\20806\CADD\Drawings\41-20806-FIG 01 - Standard\41-20806-FIG 01.dwg



LEGEND

▬ ▬	PROPOSED EXTENT OF LANDFILL FOOTPRINT
—— 10 ——	EXISTING CONTOURS
GW	EXISTING GROUNDWATER WELLS
– – – –	EXISTING BOTTOM OF BANK
—›—›—	EXISTING STORMWATER DRAINS
———	LOT BOUNDARY

NOTES:

1. PREPARED FROM DATA SUPPLIED BY TWEED SHIRE COUNCIL IN FEBRUARY 2009
2. HORIZONTAL DATUM: MGA94
   HEIGHT DATUM: AHD
3. QUARRY AREA CURRENTLY BEING EXCAVATED

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE (A3)

TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

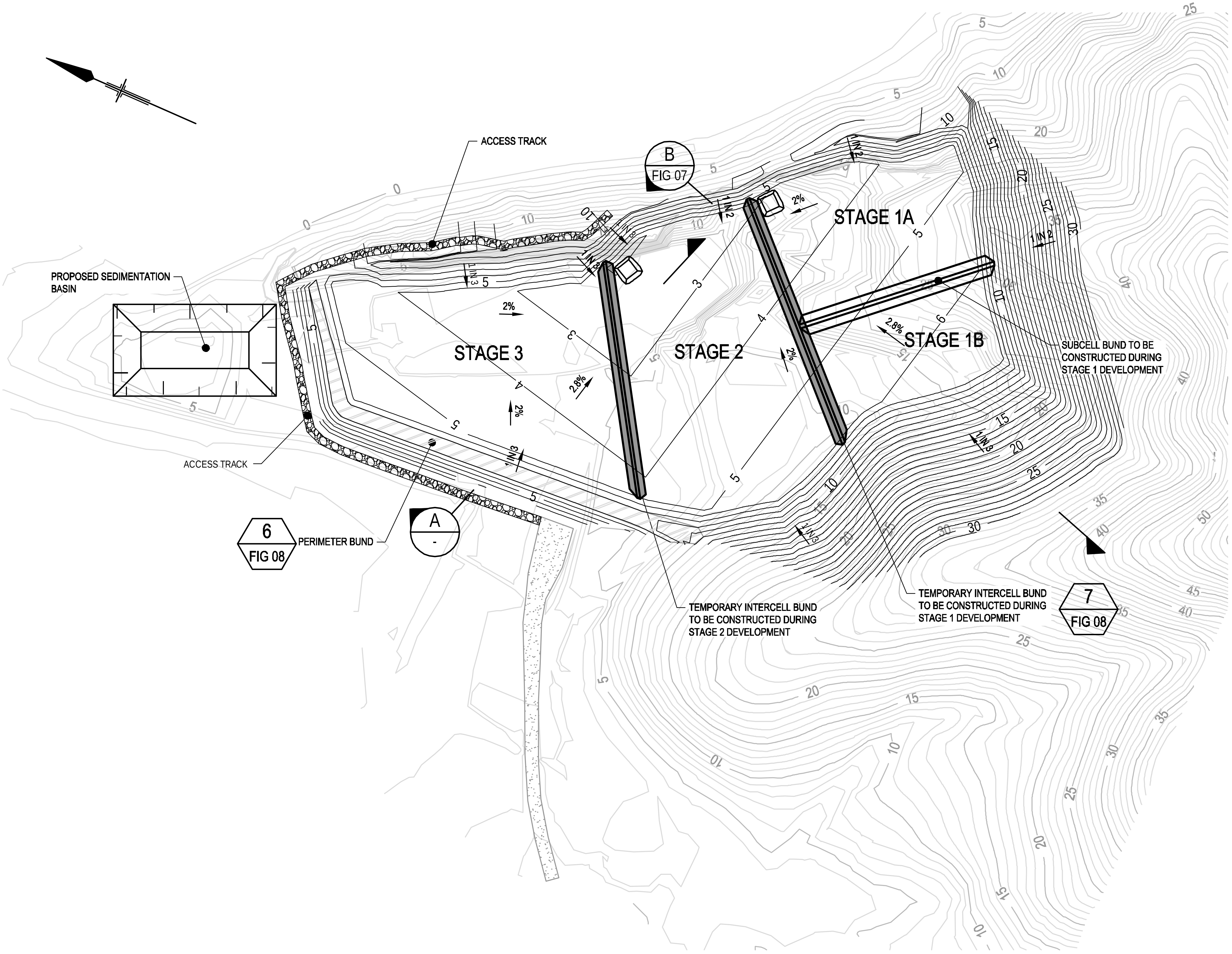
EXISTING SITE PLAN

Job Number	41-20806
Revision	C
Date	OCT 2009

Figure 02

Level 4, 201 Charlotte St Brisbane QLD 4000 Australia **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

Plot Date: 26 October 2010 - 2:54 PM Plotted by: Nicola Hankin/Brisbane/GHD/AU Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 02-RC.dwg



NOTES:

1. THIS DESIGN ONLY ALLOWS FOR GENERAL LANDFILL CELL/ CAP ARRANGEMENT & MORPHOLOGY. NO SLOPE OR CELL/ CAP LINER STABILITY ASSESSMENT WAS INCLUDED AS PART OF THE APPROVED SLOPE OF WORKS. GHD RECOMMENDS THAT PRIOR TO CONSTRUCTION A REVISION OF SLOPE STABILITY BE UNDERTAKEN.
2. GROUND WATER INVESTIGATION TO BE CARRIED OUT PRIOR TO CONSTRUCTION WORKS
3. EXISTING QUARRY AREA CONTOURS IN ACCORDANCE WITH RAY SARGENT & ASSOCIATES - APRIL 2000
   - INTERNAL BATTER SLOPES 1 IN 2
   - BASE CONTOURS : 2.8%
4. REMAINING INTERNAL BATTERS AT 1 IN 3
5. VOLUMES CALCULATED FROM DATA SUPPLIED BY TWEED SHIRE COUNCIL IN FEBRUARY 2009
6. PROGRESSIVE QUARRYING WITHIN EXISTING QUARRY AREA WILL VARY CUT & FILL VOLUME

VOLUME CALCULATIONS

VOLUME CALCULATIONS TO SUBGRADE PROFILE

STAGE 1	
PLAN AREA	26,100 m²
CUT VOLUME	245,000 m³
FILL VOLUME	800 m³
STAGE 2	
PLAN AREA	17,000 m²
CUT VOLUME	62,000 m³
FILL VOLUME	400 m³
STAGE 3	
PLAN AREA	14,400 m²
CUT VOLUME	8,000 m³
FILL VOLUME	32,180 m³
TOTAL	
PLAN AREA	57,500 m²
CUT VOLUME	315,000 m³
FILL VOLUME	33,380 m³

LEGEND

▨	TEMPORARY INTERCELL BUND
—— 5 ——	PROPOSED SUBGRADE CONTOURS
—— 10 ——	EXISTING CONTOURS

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE (A3)

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TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

CELL ARRANGEMENT AND PROPOSED SUBGRADE CONTOURS

Job Number	41-20806
Revision	C
Date	OCT 2009

Figure 03

Unit 2, 8 Neils St Hervey Bay QLD 4655 Australia T 61 7 4191 2000 F 61 7 4191 2099 E hvbmail@ghd.com.au W www.ghd.com.au

Plot Date: 26 October 2010 - 2:57 PM Plotted by: Nicola Hankin/Brisbane/GHD/AU , Hervey Bay Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 03-RC.dwg

NOTES

1. VOLUMES CALCULATED FROM DATA SUPPLIED BY TWEED SHIRE COUNCIL IN FEBRUARY 2009
2. PROGRESSIVE QUARRYING WITHIN EXISTING QUARRY AREA WILL VARY CUT & FILL VOLUME

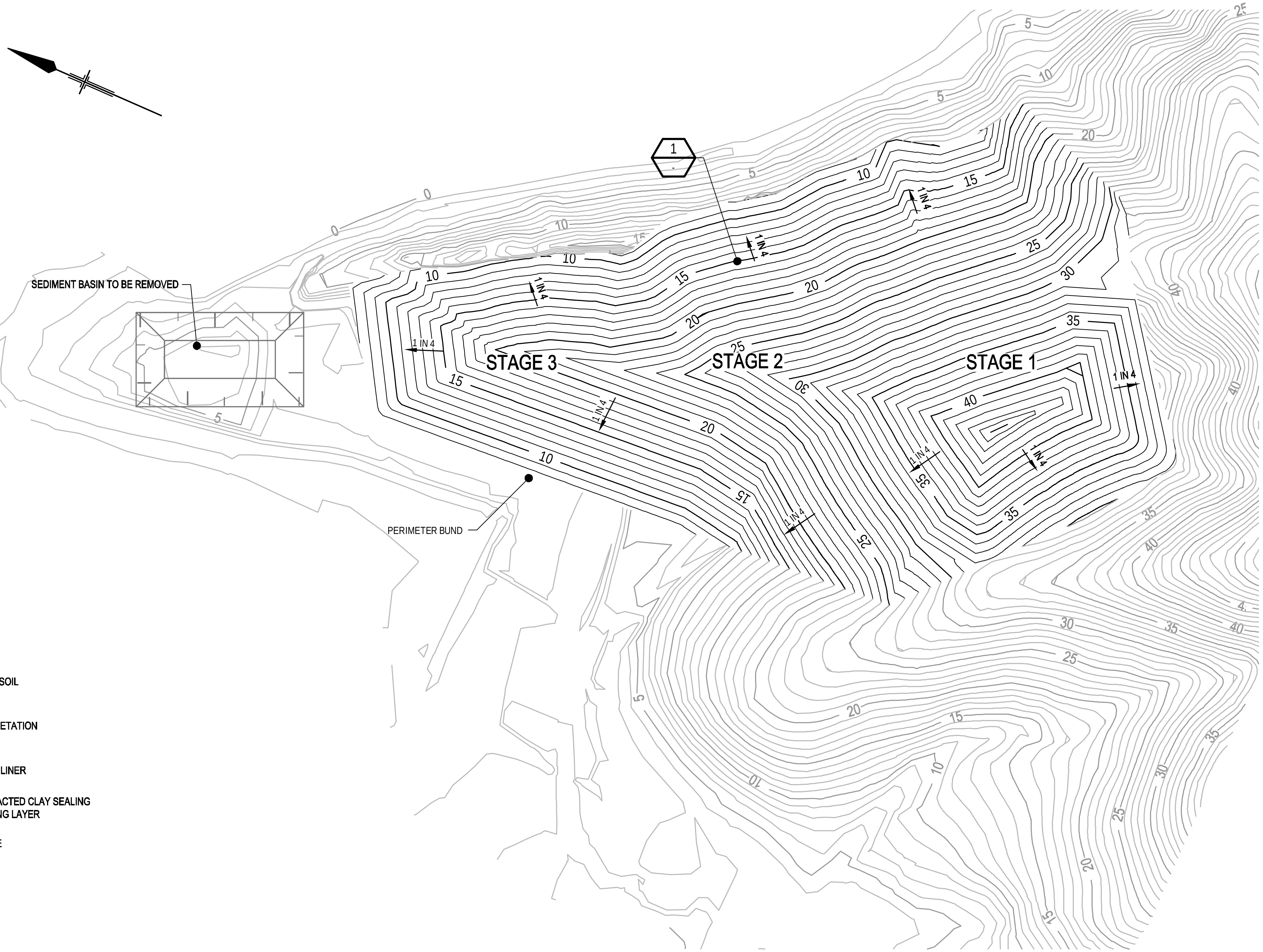
VOLUME CALCULATIONS

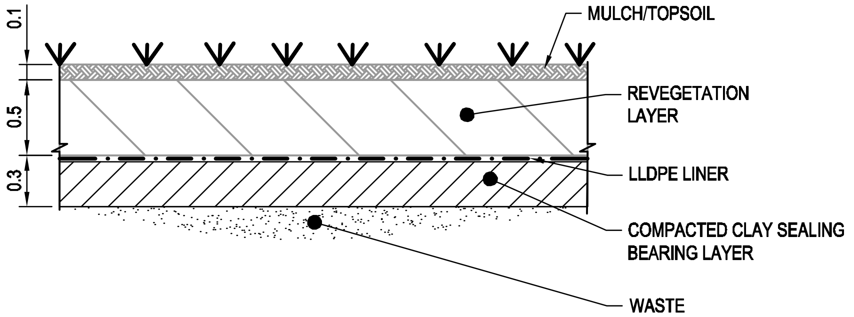
VOLUME CALCULATIONS FOR WASTE / DAILY COVER VOID CAPACITYTO SUBGRADE PROFILE

STAGE 1	
PLAN AREA	26,100 m²
VOID CAPACITY	273,000 m³
STAGE 2	
PLAN AREA	17,000 m²
VOID CAPACITY	306,000 m³
STAGE 3	
PLAN AREA	14,400 m²
VOID CAPACITY	171,000 m³
TOTAL	
PLAN AREA	57,500 m²
VOID CAPACITY	750,000 m³

LEGEND

—— 10 ——	EXISTING CONTOURS
—— 5 ——	PROPOSED WASTE CONTOURS





TYPICAL FINAL CAPPING LAYER PROFILE

1 DETAIL
-
SCALE 1 : 50

0 0.5 1.0 1.5m
SCALE 1:50 AT ORIGINAL SIZE (A3)
0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE (A3)

GHD

TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

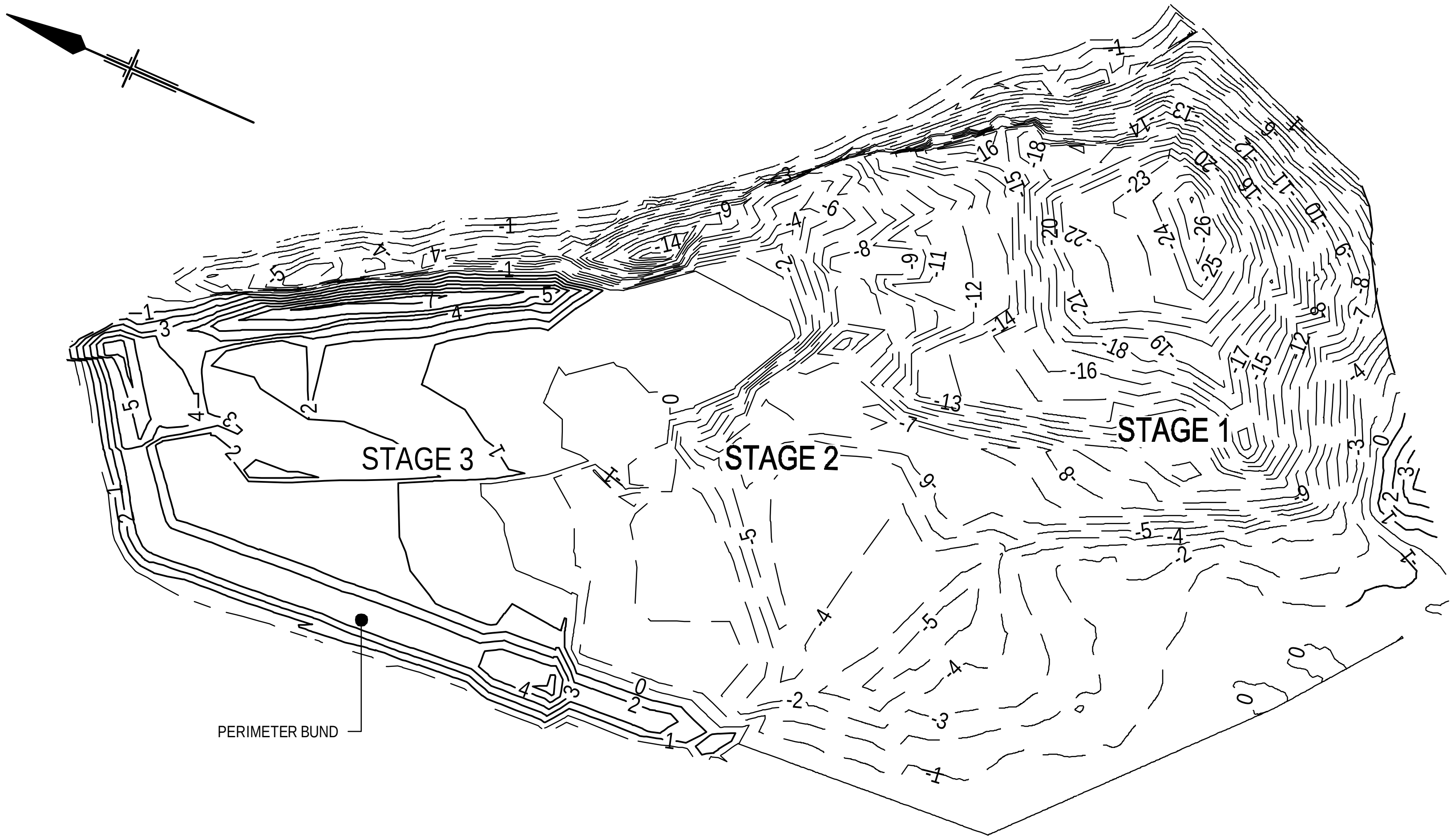
FINAL WASTE FILL CONTOURS
AND CAP DETAILS

Job Number	41-20806
Revision	C
Date	OCT 2009

Figure 04

Level 4, 201 Charlotte St Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Plot Date: 26 October 2010 - 2:58 PM Plotted by: Nicola Hankin/Brisbane/GHD/AU Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 04-RC.dwg



NOTES:

1. VOLUMES CALCULATED FROM DATA SUPPLIED BY TWEED SHIRE COUNCIL IN FEBRUARY 2009
2. PROGRESSIVE QUARRYING WITHIN EXISTING QUARRY AREA WILL VARY CUT & FILL VOLUME

VOLUME CALCULATIONS

PLAN AREA OF LANDFILL FOOTPRINT	57,500 m^2
TOTAL CUT TO SUBGRADE PROFILE	315,00 m^3
TOTAL FILL TO SUBGRADE PROFILE	33,000 m^3
TOTAL VOID CAPACITY	750,000 m^3
TOTAL CLAY LINER MATERIAL	55,600 m^3
TOTAL HDPE LINER	38,800 m^2
TOTAL LEACHATE AGGREGATE	10,100 m^3
TOTAL SEPARATION GEOTEXTILE	60,000 m^2
TOTAL PROTECTION GEOTEXTILE	60,000 m^2
TOTAL LLDPE LINER	60,300 m^3
TOTAL VEGETATIVE MEDIUM	36,100 m^3

LEGEND

—— 1 ——	DEPTH CONTOUR - FILL TO SUBGRADE PROFILE
— -1 - —	DEPTH CONTOUR - CUT TO SUBGRADE PROFILE

0 20 40 60m

SCALE 1:2000 AT ORIGINAL SIZE (A3)

TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

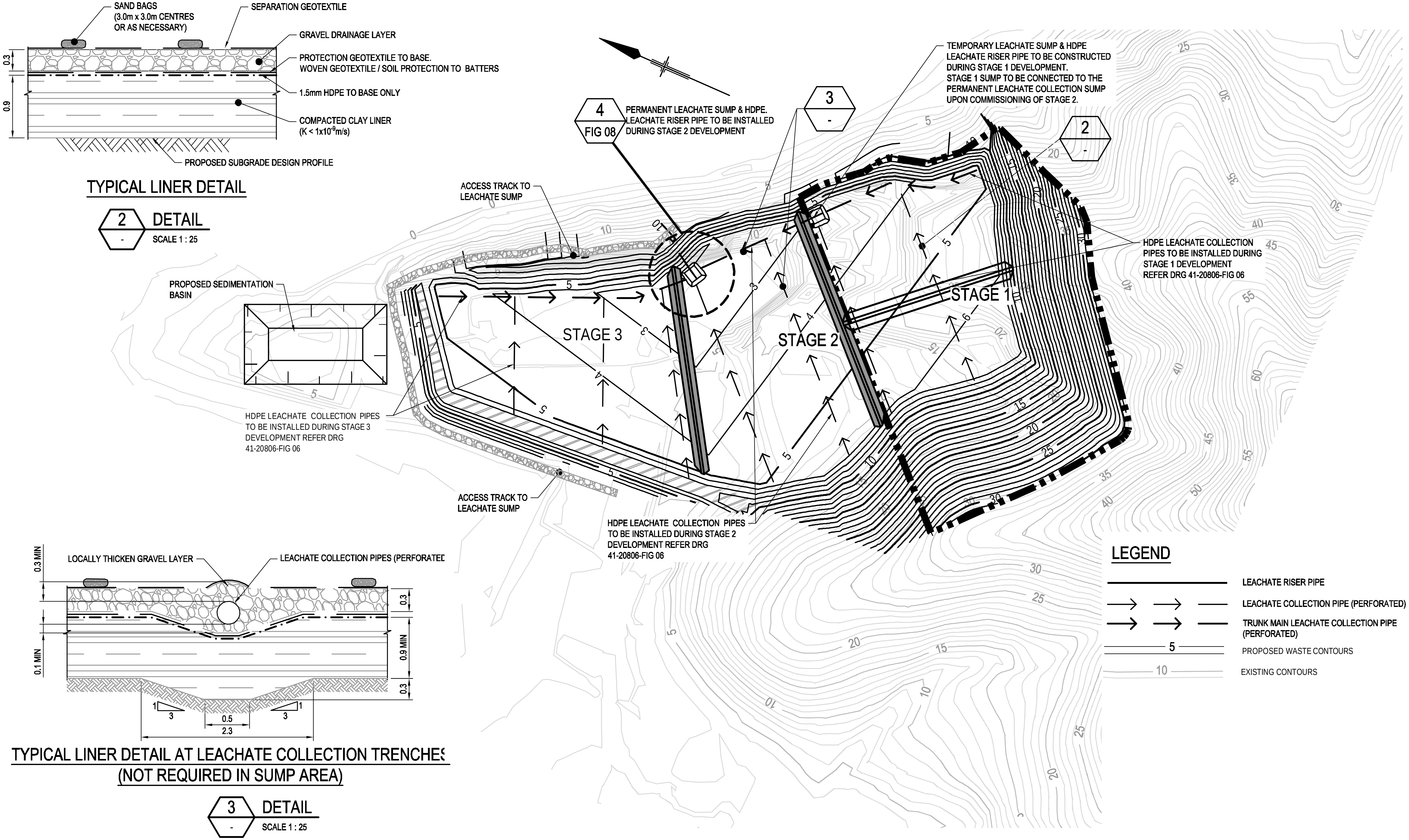
CUT AND FILL PLAN

Job Number 41-20806
Revision C
Date OCT 2009

Figure 05

Level 4, 201 Charlotte St Brisbane QLD 4000 Australia **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

Plot Date: 26 October 2010 - 3:41 PM Plotted by: Nicola Hankin/Brisbane/GHD/AU Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 05-RC.dwg



TYPICAL LINER DETAIL

2 - DETAIL
SCALE 1 : 25

LEGEND

▬	LEACHATE RISER PIPE
→ → —	LEACHATE COLLECTION PIPE (PERFORATED)
→ → —	TRUNK MAIN LEACHATE COLLECTION PIPE (PERFORATED)
—— 5 ——	PROPOSED WASTE CONTOURS
—— 10 ——	EXISTING CONTOURS

TYPICAL LINER DETAIL AT LEACHATE COLLECTION TRENCHES (NOT REQUIRED IN SUMP AREA)

3 - DETAIL
SCALE 1 : 25

0 0.25 0.5 0.75m
SCALE 1:25 AT ORIGINAL SIZE (A3)

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE (A3)

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TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

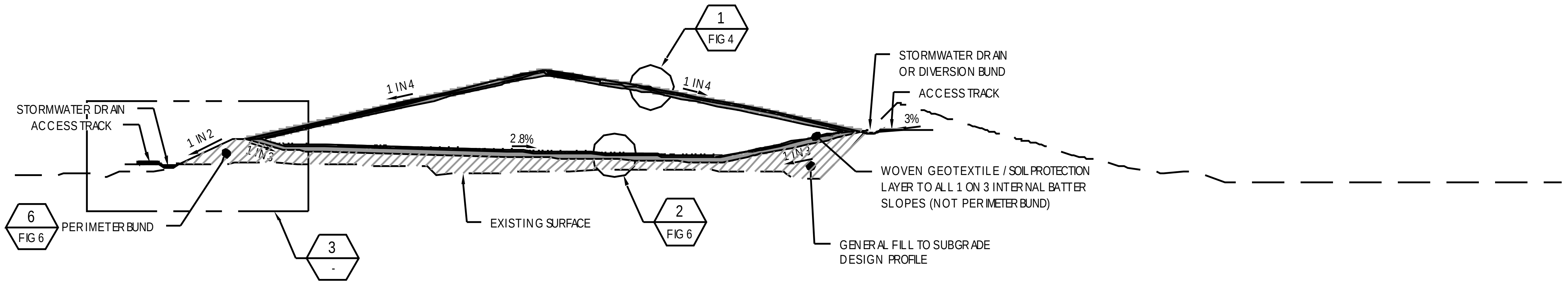
LEACHATE ARRANGEMENT
AND DETAILS

Job Number 41-20806
Revision C
Date OCT 2009

Figure 06

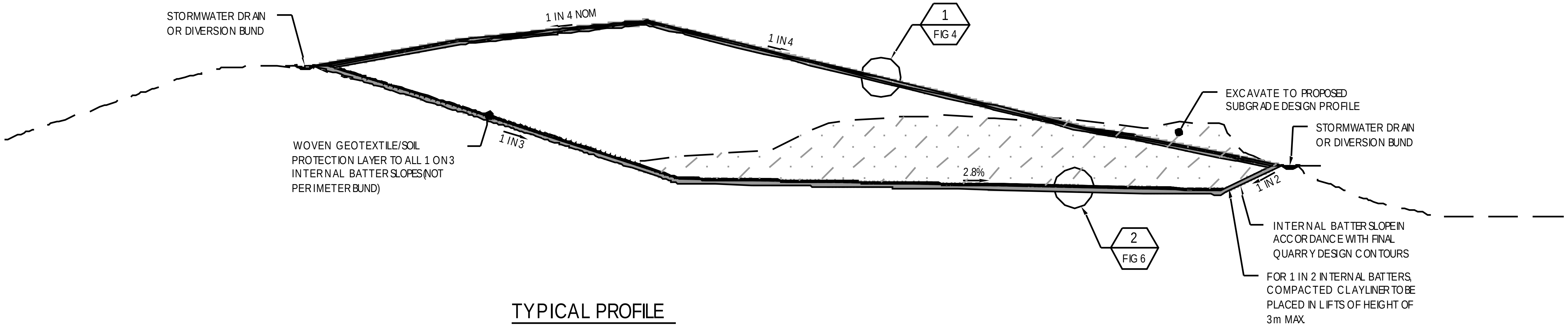
Level 4, 201 Charlotte St Brisbane QLD 4000 Australia **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

Plot Date: 26 October 2010 - 3:43 PM Plotted by: Nicola Hankin/Brisbane/GHD/AU Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 06-RC.dwg



TYPICAL PROFILE

A SECTION
FIG 3 SCALE 1 : 1000



TYPICAL PROFILE

B SECTION
FIG 3 SCALE 1 : 1000

0 10 20 30m
SCALE 1:1000 AT ORIGINAL SIZE (A3)

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TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

TYPICAL CROSS SECTIONS

Job Number	41-20806
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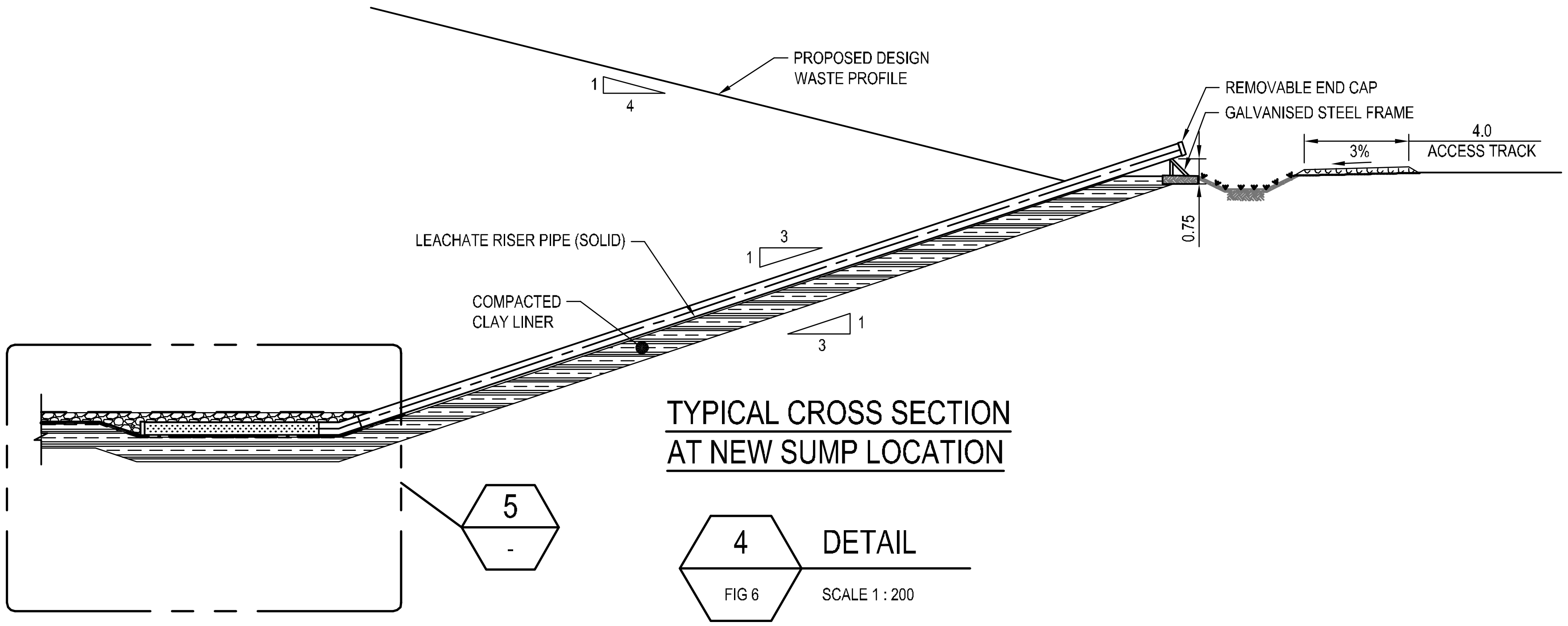
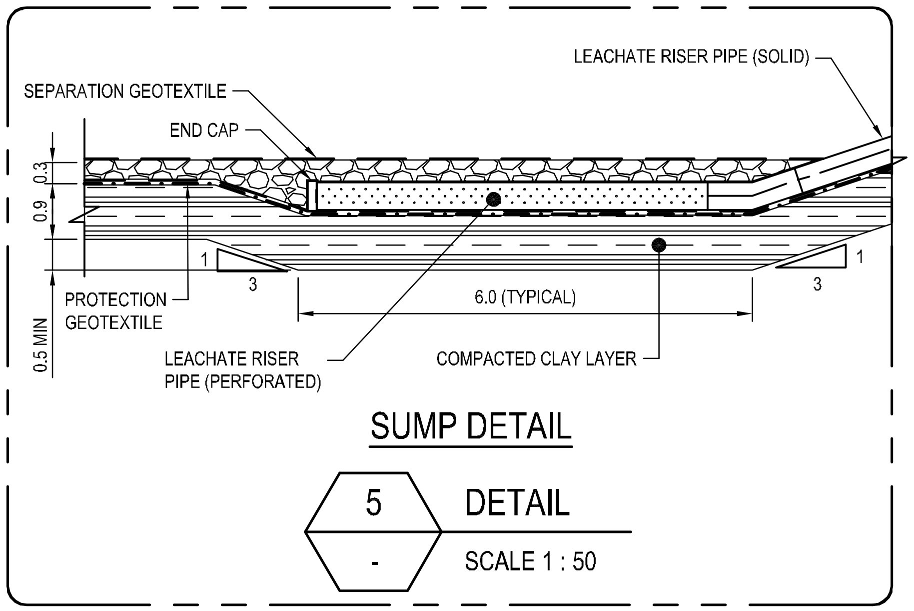
Figure 07

[redacted]



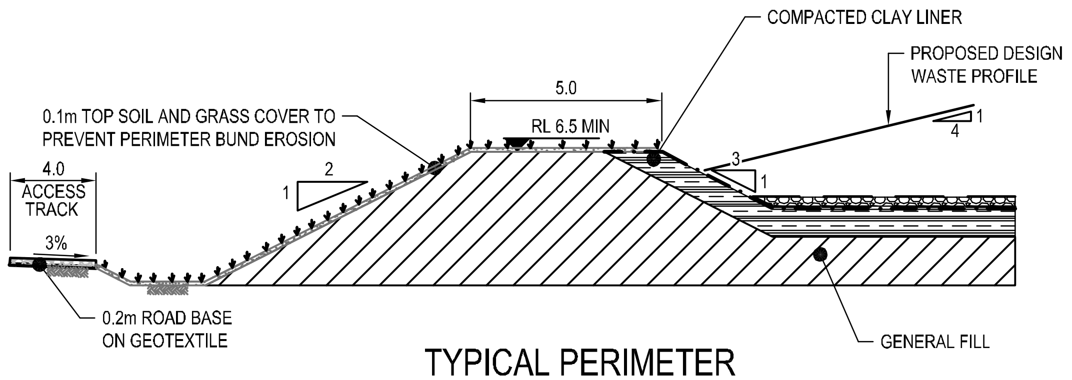
TYPICAL CROSS SECTION AT NEW SUMP LOCATION

4 DETAIL
FIG 6 SCALE 1 : 200



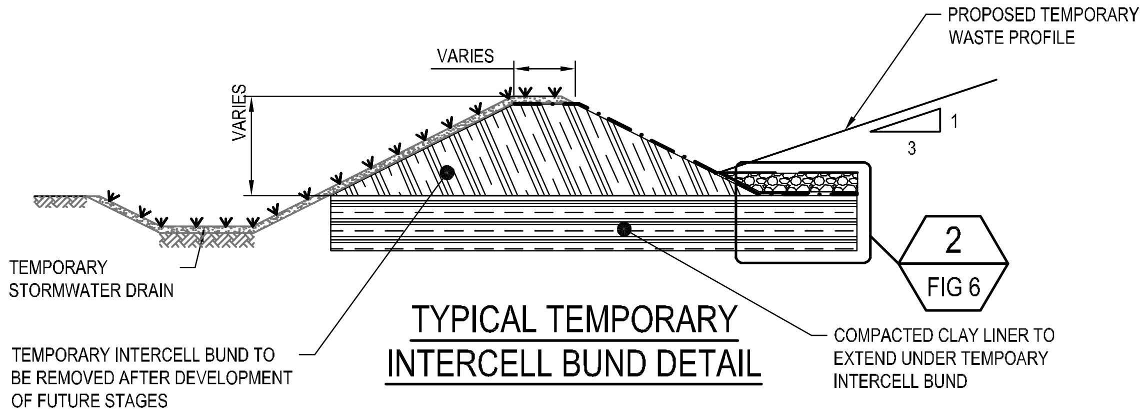
SUMP DETAIL

5 DETAIL
- SCALE 1 : 50



TYPICAL PERIMETER BUND DETAIL

6 DETAIL
FIG 3 SCALE 1 : 200



TYPICAL TEMPORARY INTERCELL BUND DETAIL

7 DETAIL
FIG 3 SCALE 1 : 100

0 1 2 3m
SCALE 1:100 AT ORIGINAL SIZE (A3)

0 2 4 6m
SCALE 1:200 AT ORIGINAL SIZE (A3)

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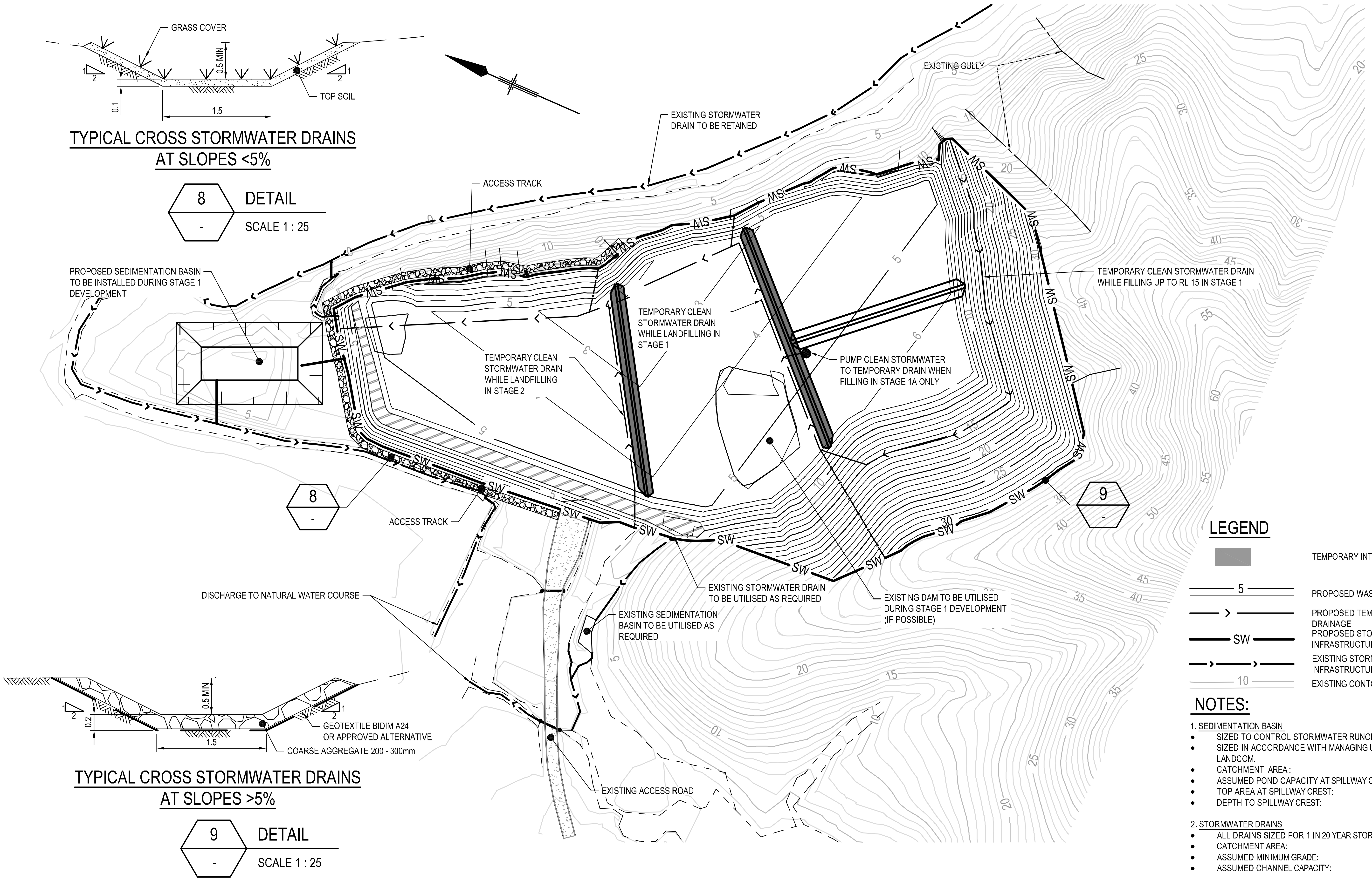
TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

TYPICAL DETAILS

Job Number 41-20806
Revision B
Date OCT 2009

Figure 08

Plot Date: 21 October 2009 - 12:45 PM Plotted by: Nicola Hankin, Brisbane Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 08.dwg



TYPICAL CROSS STORMWATER DRAINS AT SLOPES <5%

8 DETAIL
-
SCALE 1 : 25

TYPICAL CROSS STORMWATER DRAINS AT SLOPES >5%

9 DETAIL
-
SCALE 1 : 25

LEGEND

▨	TEMPORARY INTERCELL BUND
——— 5 ———	PROPOSED WASTE CONTOURS
——— > ———	PROPOSED TEMPORARY STORMWATER DRAINAGE
——— SW ———	PROPOSED STORMWATER INFRASTRUCTURE
—>——>	EXISTING STORMWATER INFRASTRUCTURE
——— 10 ———	EXISTING CONTOURS

NOTES:

1. SEDIMENTATION BASIN
- SIZED TO CONTROL STORMWATER RUNOFF FOR STAGES 1 & 3
- SIZED IN ACCORDANCE WITH MANAGING URBAN STORMWATER, LANDCOM.
- CATCHMENT AREA : 5.7 Ha
- ASSUMED POND CAPACITY AT SPILLWAY CREST: 0.9 ML
- TOP AREA AT SPILLWAY CREST: 85m x 55m
- DEPTH TO SPILLWAY CREST: 2.5 m

2. STORMWATER DRAINS
- ALL DRAINS SIZED FOR 1 IN 20 YEAR STORM EVENT
- CATCHMENT AREA: 2.8 Ha
- ASSUMED MINIMUM GRADE: 0.5 %
- ASSUMED CHANNEL CAPACITY: 1.4 m^3/s

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE (A3)

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TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

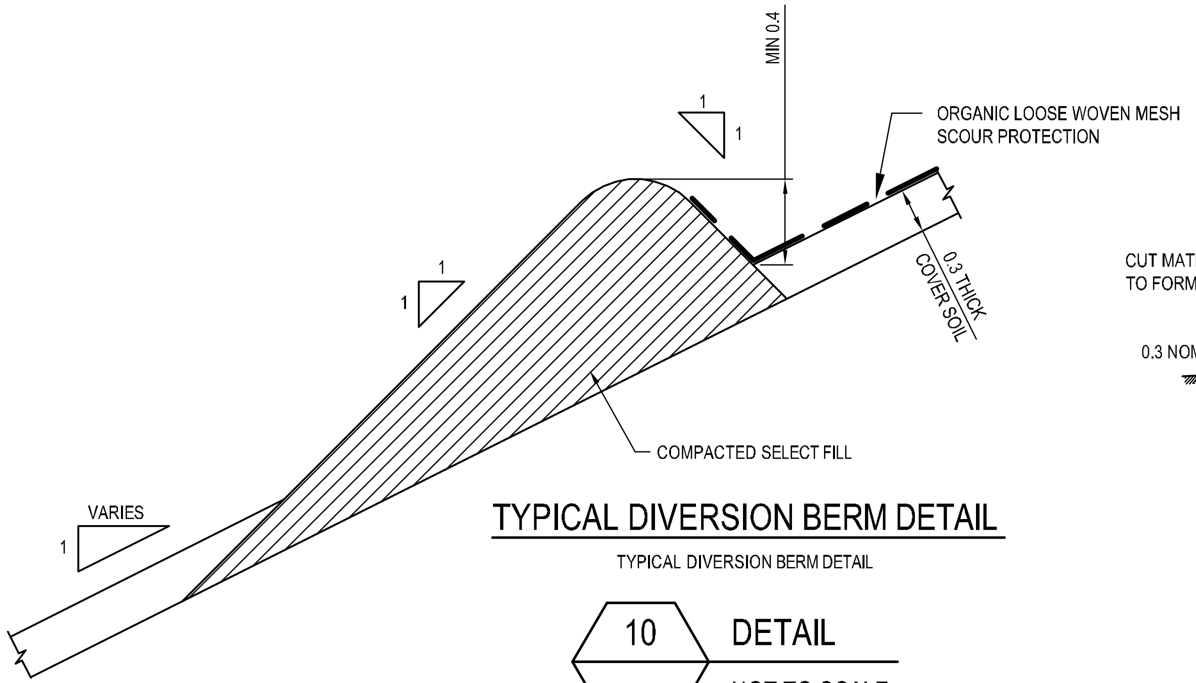
STORMWATER ARRANGEMENT
AND DETAILS

Job Number 41-20806
Revision B
Date OCT 2009

Figure 09

Unit 2, 8 Neils St Hervey Bay QLD 4655 Australia T 61 7 4191 2000 F 61 7 4191 2099 E hvbmail@ghd.com.au W www.ghd.com.au

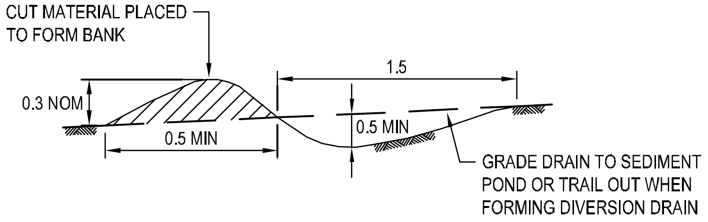
Plot Date: 21 October 2009 - 12:55 PM Plotted by: Nicola Hankin, Brisbane Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 09.dwg



TYPICAL DIVERSION BERM DETAIL

TYPICAL DIVERSION BERM DETAIL

10 DETAIL
- NOT TO SCALE



TYPICAL DIVERSION DRAIN DETAIL

NOT TO SCALE

11 DETAIL
- NOT TO SCALE

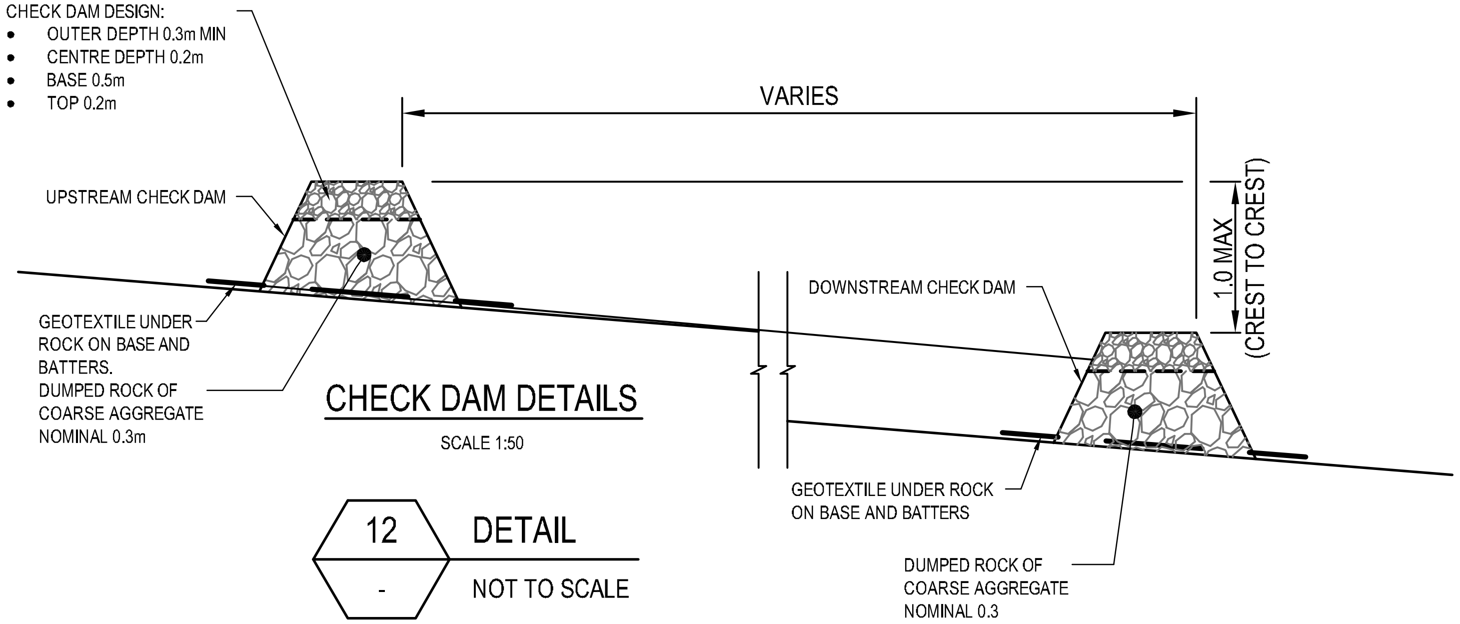
NOTES:

1. SEDIMENT AND EROSION
1.1 ALL EROSION AND SEDIMENT CONTROL MEASURES ARE TO BE INSTALLED PRIOR TO SITE DISTURBANCE.
1.2 TOPSOIL FROM ALL AREAS THAT WILL BE DISTURBED TO BE STRIPPED AND STOCKPILED SEPERATE FROM ROCK AT NOMINATED LOCATIONS.
1.3 ALL EROSION AND SEDIMENT CONTROL STRUCTURES MUST BE INSPECTED AFTER EACH RAINFALL EVENT FOR STRUCTURAL DAMAGE AND ALL TRAPPED SEDIMENT TO BE REMOVED TO THE SOIL STOCKPILE LOCATIONS.
1.4 DISTURBED AREAS ARE TO BE REVEGETATED WITHIN 14 DAYS OF THE COMPLETION OF EARTHWORKS.
1.5 CHANNELS AND BERMS DESIGNED FOR 20 YEAR ARI EVENT.
1.6 LOCATE AND PROTECT ALL SERVICES PRIOR TO THE START OF CONSTRUCTION.

2. DIVERSION BERM CONSTRUCTION:
2.1 COMPACTED SELECT FILL SHALL BE KEYED INTO COVER SOILS.
2.2 DIVERSION BERM LONGDITUDINAL FLOWLINE SHALL BE MINIMUM 1%.
2.3 ORGANIC LOOSE WOVEN MESH TO BE INSTALLED AS PER MANUFACTURER'S GUIDELINES.

3. STOCKPILE CONSTRUCTION
3.1. LOCATE STOCKPILE AT LEAST 5m FROM EXISTING VEGETATION, CONCENTRATED WATER FLOWS, ROADS, HAZARD AREAS AND LANDFILL STAGE BATTERS.
3.2 CONSTRUCT ON THE CONTOUR AS A LOW, FAT, ELONGATED MOUND.
3.3 WHERE THERE IS SUFFICIENT AREA TOPSOIL STOCKPILES SHALL BE LESS THAN 2m IN HEIGHT

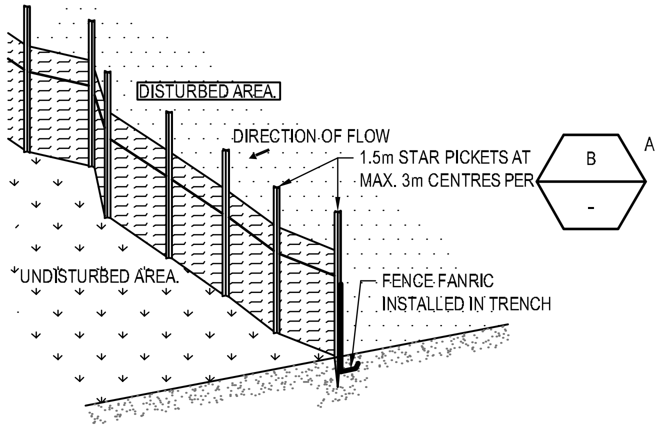
4.SILT FENCE CONSTRUCTION
4.1 CONSTRUCT SEDIMENT FENCE AS CLOSE AS POSSIBLE TO PARALLEL TO THE CONTOURS OF THE SITE.
4.2 DRIVE 1.5m LONG STAR PICKETS INTO GROUND 3m APART.
4.3 DIG A 0.15m DEEP TRENCH ALONG THE UPSIDE LINE OF THE FENCE FOR THE BOTTOM OF THE FABRIC TO BE ENTRENCHED.
4.4 BACKFILL TRENCH OVER BASE OF FABRIC.
4.5 FIX SELF-SUPPORTING GEOTEXTILE TO UPSLOPE SIDE OF POST WITH WIRE TIES OR PER SILT FENCE AS PER MANUFACTURER'S GUIDELINES. JOIN SECTIONS OF FABRIC AT A SUPPORT POST WITH A 0.15m OVERLAP.



CHECK DAM DETAILS

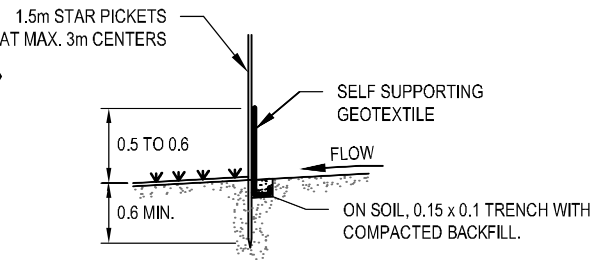
SCALE 1:50

12 DETAIL
- NOT TO SCALE



TYPICAL SILT FENCE

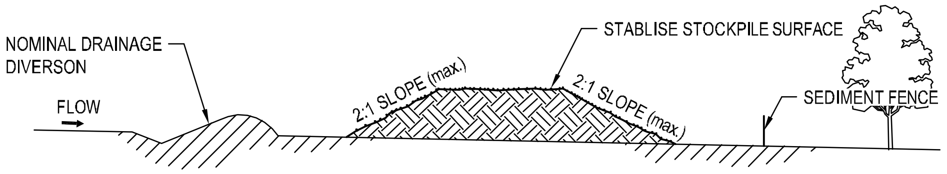
NOT TO SCALE



B SECTION
- NOT TO SCALE

TYPICAL SILT FENCE SECTION

NOT TO SCALE

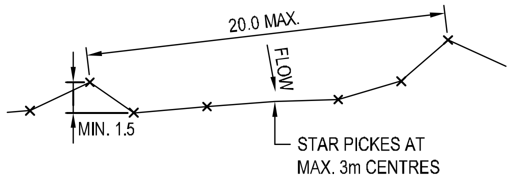


TYPICAL STOCKPILE SECTION DETAIL

NOT TO SCALE

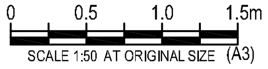
13 DETAIL
- NOT TO SCALE

14 DETAIL
- NOT TO SCALE



SILT FENCE PLAN

NOT TO SCALE



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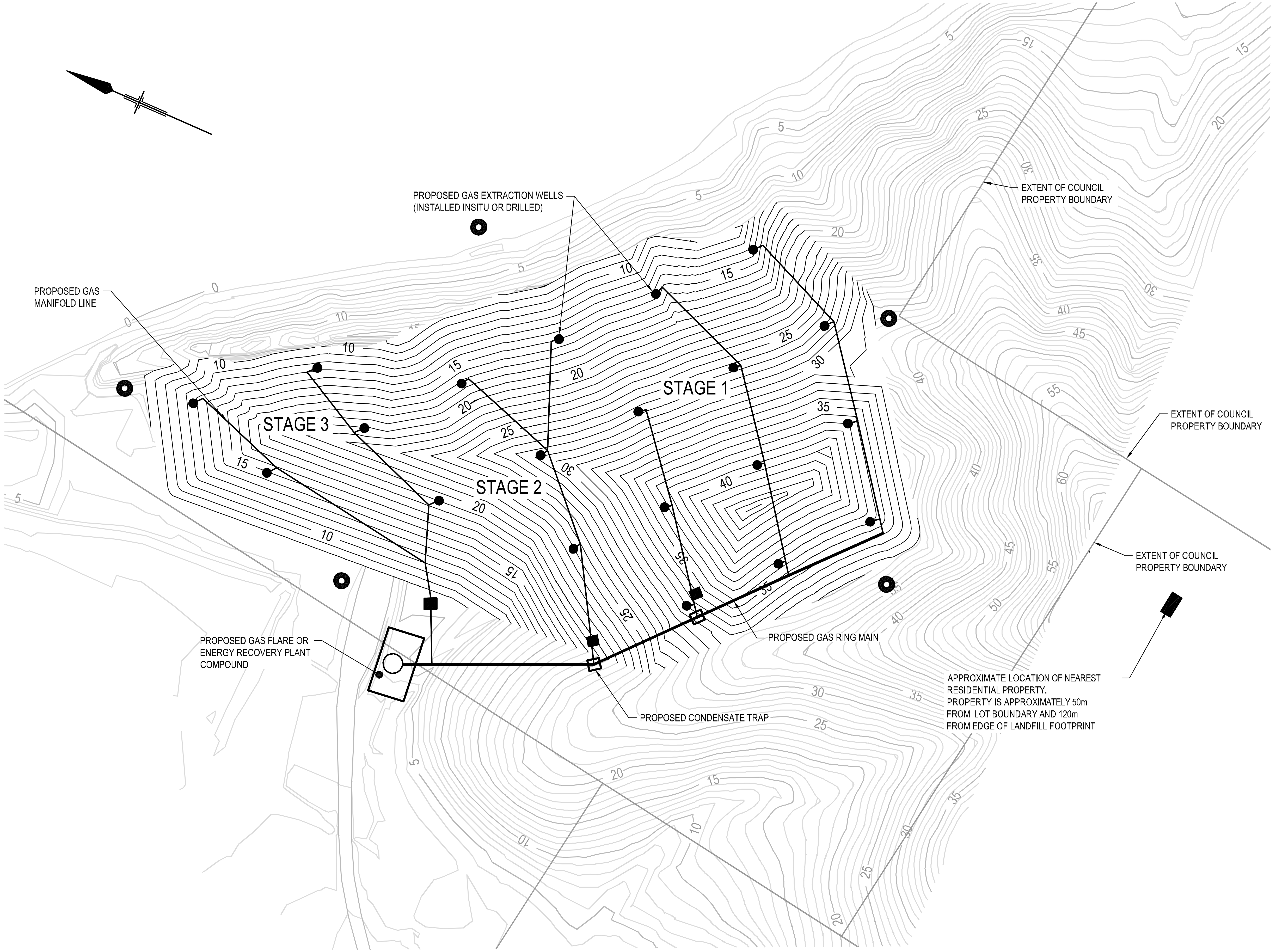
TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

STORMWATER AND SEDIMENT
CONTROL DETAILS

Job Number 41-20806
Revision B
Date OCT 2009

Figure 10

Plot Date: 16 October 2009 - 2:16 AM Plotted by: Nicola Hankin, Brisbane Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 10.dwg



NOTES:

1. LOCATION OF GAS EXTRACTION INFRASTRUCTURE IS INDICATIVE ONLY AND MUST NOT BE USED FOR CONSTRUCTION WORKS.
2. ASSESSMENT OF GAS PRODUCTION AND GAS INFRASTRUCTURE TO BE CARRIED OUT BY AN EXPERIENCED LANDFILL GAS CONTRACTOR / ENGINEER.
3. GAS INFRASTRUCTURE WILL BE PROGRESSIVELY INSTALLED DURING THE DEVELOPMENT OF EACH STAGE AND IN ACCORDANCE WITH LICENSE CONDITIONS.
4. GAS EXTRACTION WELLS MAY BE INSTALLED AT 50m CENTRES, OR AS STIPULATED FOLLOWING A LANDFILL GAS ASSESSMENT.

LEGEND

— 20 —	PROPOSED WASTE CONTOURS
—	ASSUMED EXTENT OF COUNCIL PROPERTY BOUNDARY
◉	PROPOSED GAS MONITORING WELL LOCATIONS
●	PROPOSED GAS EXTRACTION WELL LOCATIONS
—	PROPOSED GAS RING MAIN
━	PROPOSED GAS MANIFOLD LINES FOR EACH STAGE
○	PROPOSED GAS FLARE OR ENERGY RECOVERY PLANT COMPOUND
■	PROPOSED CONDENSATE TRAP

0 20 40 60m
SCALE 1:2000 AT ORIGINAL SIZE (A3)

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TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

TYPICAL GAS
EXTRACTION INFRASTRUCTURE

Job Number 41-20806
Revision B
Date OCT 2009
Figure 11

Plot Date: 16 October 2009 - 2:54 AM Plotted by: Nicola Hankin , Brisbane Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 11.dwg

Appendix B

Concept Leachate Generation Calculations

Year	Waste Acceptance (tonnes)				
2012	47,893	Waste filling rate	57400	m^3/year	(waste only)
2013	48,851		160	m^3/day	
2014	50,316				
2015	51,826	Waste lift height	2	m	
2016	53,381				
2017	54,982	Waste open area	80	m^2/day	(Daily Cover)
2018	56,632				
2019	58,330	Days until Intermediate Cover Placed	28	days	
2020	75,030				
2021	77,131				

Maximum Daily cover area 2200 m^2

Cell	Total Area m^2	Daily Cover Area %	Inter Cover Area %	Daily Cover Area m^2	Inter Cover Area m^2			
1A	8190	27	73	2200	5990	Half Cell Up to RL 15 - 6 months filling	40200m3 of void	Area = 8190m2
1B	17900	12	88	2200	15700	Full Cell up to RL 15 - 15 months	95000m3 of void	Area = 15820m2
2	17000	13	87	2200	14800	Full Cell up to RL 10 - 3 months	27300m3 of void	Area = 12850m2
3	14400	15	85	2200	12200			
Total Area	**49300**							

Leachate Storage Volumes Within Cell

Cell	Area RL4 m^2	Vol RL4 m^3	Storage Vol RL4 m^3	Area RL5 m^2	Vol RL5 m^3	Storage Vol RL5 m^3	Area RL6 m^2	Vol RL6 m^3	Storage Vol RL6 m^3	Area RL7 m^2	Vol RL7 m^3	Storage Vol RL7 m^3	Area RL8 m^2	Vol RL8 m^3	Storage Vol RL8 m^3
1A	47	2	1	1930	800	400	5830	4500	2250	9820	12400	6200	11660	23400	11700
1B															
2	2950	1350	675	7160	6370	3185	11060	15570	7785	12940	27800	13900	13400	41050	20525
3	1500	560	280	5860	3980	1990	10900	12700	6350	12400	24500	12250	13480	37490	18745
Total Area			**956**			**5575**			**16385**			**32350**			**50970**

Storage Volume - assume 50% porosity of waste

Quirks Quarry - Tweed Shire Council

Daily Cover Area	2200	m2
Intermediate Cover Area	5990	m2
Final Capping Area	0	m2
Storage Capacity	6200	m3
Initial Storage Volume	0	v/v
Leachate Absorbed by Waste	0	l/m3
Leachate Disposal per Day	0	m3
Sump Pump Rate	5	L/s

(Treatment plant and disposal by irrigation)

(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter		January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
														mm	m3	
		31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)																
		495.9	507.6	168.7	171.4	141.4	56.2	8.4	18.5	46.1	546.1	148.7	71.2	2380	19494	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)																
Actual Evaporation		192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	12760	65%
Runoff - Calculated using HELP (mm)																
Daily Cover Area		221.9	224.6	53.0	94.1	18.2	2.5	0.0	0.1	8.5	310.2	32.6	10.8	976	2148	41%
Intermediate Cover Area		306.1	366.2	97.2	99.0	50.4	5.6	0.0	0.7	4.0	411.3	47.4	16.3	1404	8410	59%
Final Capping Area		414.6	454.1	119.1	140.8	79.5	12.8	0.0	0.0	0.4	482.5	81.8	11.4	1797	0	75%
Total Runoff	**(m3)**	**2321**	**2687**	**699**	**800**	**342**	**39**	**0**	**4**	**42**	**3146**	**356**	**121**		**10558**	
Evapotranspiration - Calculated using HELP (mm)																
Daily Cover Area		65.8	50.4	54.4	26.7	40.2	38.6	12.2	19.3	9.8	51.0	63.1	43.8	475	1045	20%
Intermediate Cover Area		66.6	50.6	55.0	28.9	39.5	38.4	7.9	19.8	11.0	48.6	62.5	43.7	473	2831	20%
Final Capping Area		66.8	50.6	56.4	42.3	39.8	38.3	19.9	19.3	13.0	59.6	70.2	51.4	528	0	22%
Total Evapotranpiration	**(m3)**	**544**	**414**	**449**	**232**	**325**	**315**	**74**	**161**	**88**	**403**	**513**	**358**		**3876**	
Leachate - Calculated using HELP (mm)																
Daily Cover Area		198.9	229.9	77.1	52.3	76.7	13.3	0.0	3.2	10.9	189.5	54.7	17.5	924	2033	39%
Intermediate Cover Area		110.8	91.1	35.1	48.2	44.3	13.5	0.0	3.9	10.9	82.9	47.4	9.8	498	2982	21%
Final Capping Area		5.9	3.8	4.5	5.4	3.7	4.8	4.6	4.0	4.3	3.3	4.5	4.6	53	0	2%
Total Leachate Generated	**(m3)**	**1,101**	**1,052**	**380**	**404**	**434**	**110**	**0**	**30**	**90**	**913**	**404**	**97**		**5,015**	
Leachate Absorbed by Waste	**(m3)**	0	0	0	0	0	0	0	0	0	0	0	0		0	
Leachate Disposal	**(m3)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		0	
Cumulative Volume	**(m3)**	**1,101**	**2,153**	**2,533**	**2,936**	**3,371**	**3,481**	**3,481**	**3,511**	**3,601**	**4,514**	**4,918**	**5,015**			
Storage Volume Exceeded		**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation	**(Hrs/Day)**	**1.97**	**2.09**	**0.68**	**0.75**	**0.78**	**0.20**	**0.00**	**0.05**	**0.17**	**1.64**	**0.75**	**0.17**			

Quirks Quarry - Tweed Shire Council

Daily Cover Area	2200	m2
Intermediate Cover Area	17900	m2
Final Capping Area	0	m2
Storage Capacity	6200	m3
Initial Storage Volume	0	v/v
Leachate Absorbed by Waste	0	l/m3
Leachate Disposal per Day	0	m3
Sump Pump Rate	5	L/s

(Treatment plant and disposal by irrigation)

(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
													mm	m3	
	31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)															
	495.9	507.6	168.7	171.4	141.4	56.2	8.4	18.5	46.1	546.1	148.7	71.2	2380	47842	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	31316	65%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	221.9	224.6	53.0	94.1	18.2	2.5	0.0	0.1	8.5	310.2	32.6	10.8	976	2148	41%
Intermediate Cover Area	306.1	366.2	97.2	99.0	50.4	5.6	0.0	0.7	4.0	411.3	47.4	16.3	1404	25133	59%
Final Capping Area	414.6	454.1	119.1	140.8	79.5	12.8	0.0	0.0	0.4	482.5	81.8	11.4	1797	0	75%
Total Runoff (m3)	**5967**	**7048**	**1857**	**1978**	**943**	**106**	**0**	**13**	**89**	**8044**	**920**	**315**		**27281**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	65.8	50.4	54.4	26.7	40.2	38.6	12.2	19.3	9.8	51.0	63.1	43.8	475	1045	20%
Intermediate Cover Area	66.6	50.6	55.0	28.9	39.5	38.4	7.9	19.8	11.0	48.6	62.5	43.7	473	8459	20%
Final Capping Area	66.8	50.6	56.4	42.3	39.8	38.3	19.9	19.3	13.0	59.6	70.2	51.4	528	0	22%
Total Evapotranpiration (m3)	**1337**	**1017**	**1105**	**576**	**796**	**772**	**167**	**397**	**219**	**982**	**1257**	**879**		**9505**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	198.9	229.9	77.1	52.3	76.7	13.3	0.0	3.2	10.9	189.5	54.7	17.5	924	2033	39%
Intermediate Cover Area	110.8	91.1	35.1	48.2	44.3	13.5	0.0	3.9	10.9	82.9	47.4	9.8	498	8912	21%
Final Capping Area	5.9	3.8	4.5	5.4	3.7	4.8	4.6	4.0	4.3	3.3	4.5	4.6	53	0	2%
Total Leachate Generated (m3)	**2,421**	**2,137**	**797**	**977**	**962**	**272**	**0**	**76**	**220**	**1,901**	**968**	**213**		**10,945**	
Leachate Absorbed by Waste (m3)	0	0	0	0	0	0	0	0	0	0	0	0		0	
Leachate Disposal (m3)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		0	
Cumulative Volume (m3)	**2,421**	**4,558**	**5,355**	**6,333**	**7,295**	**7,567**	**7,567**	**7,643**	**7,863**	**9,764**	**10,732**	**10,945**			
Storage Volume Exceeded	**NO**	**NO**	**NO**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**			
Sump to Pond Pump Operation (Hrs/Day)	**4.34**	**4.24**	**1.43**	**1.81**	**1.72**	**0.50**	**0.00**	**0.14**	**0.41**	**3.41**	**1.79**	**0.38**			

Quirks Quarry - Tweed Shire Council

Daily Cover Area	2200	m2	
Intermediate Cover Area	32700	m2	
Final Capping Area	0	m2	
Storage Capacity	6200	m3	
Initial Storage Volume	0	v/v	
Leachate Absorbed by Waste	0	l/m3	
Leachate Disposal per Day	0	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
													mm	m3	
	31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)															
	495.9	507.6	168.7	171.4	141.4	56.2	8.4	18.5	46.1	546.1	148.7	71.2	2380	83069	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	54374	65%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	221.9	224.6	53.0	94.1	18.2	2.5	0.0	0.1	8.5	310.2	32.6	10.8	976	2148	41%
Intermediate Cover Area	306.1	366.2	97.2	99.0	50.4	5.6	0.0	0.7	4.0	411.3	47.4	16.3	1404	45913	59%
Final Capping Area	414.6	454.1	119.1	140.8	79.5	12.8	0.0	0.0	0.4	482.5	81.8	11.4	1797	0	75%
Total Runoff (m3)	**10496**	**12468**	**3296**	**3443**	**1689**	**189**	**0**	**23**	**148**	**14132**	**1622**	**556**		**48061**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	65.8	50.4	54.4	26.7	40.2	38.6	12.2	19.3	9.8	51.0	63.1	43.8	475	1045	20%
Intermediate Cover Area	66.6	50.6	55.0	28.9	39.5	38.4	7.9	19.8	11.0	48.6	62.5	43.7	473	15453	20%
Final Capping Area	66.8	50.6	56.4	42.3	39.8	38.3	19.9	19.3	13.0	59.6	70.2	51.4	528	0	22%
Total Evapotranpiration (m3)	**2323**	**1766**	**1920**	**1004**	**1381**	**1340**	**283**	**690**	**382**	**1702**	**2182**	**1525**		**16499**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	198.9	229.9	77.1	52.3	76.7	13.3	0.0	3.2	10.9	189.5	54.7	17.5	924	2033	39%
Intermediate Cover Area	110.8	91.1	35.1	48.2	44.3	13.5	0.0	3.9	10.9	82.9	47.4	9.8	498	16281	21%
Final Capping Area	5.9	3.8	4.5	5.4	3.7	4.8	4.6	4.0	4.3	3.3	4.5	4.6	53	0	2%
Total Leachate Generated (m3)	**4,061**	**3,486**	**1,316**	**1,690**	**1,619**	**472**	**0**	**134**	**382**	**3,128**	**1,669**	**357**		**18,314**	
Leachate Absorbed by Waste (m3)	0	0	0	0	0	0	0	0	0	0	0	0		0	
Leachate Disposal (m3)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		0	
Cumulative Volume (m3)	**4,061**	**7,547**	**8,863**	**10,553**	**12,172**	**12,644**	**12,644**	**12,777**	**13,159**	**16,287**	**17,956**	**18,314**			
Storage Volume Exceeded	**NO**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**			
Sump to Pond Pump Operation (Hrs/Day)	**7.28**	**6.92**	**2.36**	**3.13**	**2.90**	**0.87**	**0.00**	**0.24**	**0.71**	**5.61**	**3.09**	**0.64**			

Quirks Quarry - Tweed Shire Council

Daily Cover Area	2200	m2
Intermediate Cover Area	47100	m2
Final Capping Area	0	m2
Storage Capacity	6200	m3
Initial Storage Volume	0	v/v
Leachate Absorbed by Waste	0	l/m3
Leachate Disposal per Day	0	m3
Sump Pump Rate	5	L/s

(Treatment plant and disposal by irrigation)

(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**Annual Total**		**Percent**
													mm	**m3**	
	31	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**			
Precipitation (mm)															
	495.9	507.6	168.7	171.4	141.4	56.2	8.4	18.5	46.1	546.1	148.7	71.2	2380	117344	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	76809	65%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	221.9	224.6	53.0	94.1	18.2	2.5	0.0	0.1	8.5	310.2	32.6	10.8	976	2148	41%
Intermediate Cover Area	306.1	366.2	97.2	99.0	50.4	5.6	0.0	0.7	4.0	411.3	47.4	16.3	1404	66132	59%
Final Capping Area	414.6	454.1	119.1	140.8	79.5	12.8	0.0	0.0	0.4	482.5	81.8	11.4	1797	0	75%
Total Runoff (m3)	**14904**	**17741**	**4696**	**4868**	**2416**	**269**	**0**	**33**	**205**	**20054**	**2304**	**790**		**68280**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	65.8	50.4	54.4	26.7	40.2	38.6	12.2	19.3	9.8	51.0	63.1	43.8	475	1045	20%
Intermediate Cover Area	66.6	50.6	55.0	28.9	39.5	38.4	7.9	19.8	11.0	48.6	62.5	43.7	473	22259	20%
Final Capping Area	66.8	50.6	56.4	42.3	39.8	38.3	19.9	19.3	13.0	59.6	70.2	51.4	528	0	22%
Total Evapotranpiration (m3)	**3283**	**2496**	**2712**	**1420**	**1950**	**1892**	**397**	**975**	**541**	**2402**	**3082**	**2155**		**23304**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	198.9	229.9	77.1	52.3	76.7	13.3	0.0	3.2	10.9	189.5	54.7	17.5	924	2033	39%
Intermediate Cover Area	110.8	91.1	35.1	48.2	44.3	13.5	0.0	3.9	10.9	82.9	47.4	9.8	498	23451	21%
Final Capping Area	5.9	3.8	4.5	5.4	3.7	4.8	4.6	4.0	4.3	3.3	4.5	4.6	53	0	2%
Total Leachate Generated (m3)	**5,656**	**4,799**	**1,821**	**2,384**	**2,257**	**667**	**0**	**189**	**539**	**4,322**	**2,351**	**498**		**25,483**	
Leachate Absorbed by Waste (m3)	0	0	0	0	0	0	0	0	0	0	0	0		0	
Leachate Disposal (m3)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		0	
Cumulative Volume (m3)	**5,656**	**10,455**	**12,276**	**14,660**	**16,917**	**17,584**	**17,584**	**17,773**	**18,312**	**22,634**	**24,986**	**25,483**			
Storage Volume Exceeded	**NO**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**			
Sump to Pond Pump Operation (Hrs/Day)	**10.14**	**9.52**	**3.26**	**4.41**	**4.05**	**1.24**	**0.00**	**0.34**	**1.00**	**7.75**	**4.35**	**0.89**			

Quirks Quarry - Tweed Shire Council

Daily Cover Area	0	m2	
Intermediate Cover Area	0	m2	
Final Capping Area	49300	m2	
Storage Capacity	6200	m3	
Initial Storage Volume	0	v/v	
Leachate Absorbed by Waste	0	l/m3	
Leachate Disposal per Day	0	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
													mm	m3	
	31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)															
	495.9	507.6	168.7	171.4	141.4	56.2	8.4	18.5	46.1	546.1	148.7	71.2	2380	0	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	0	65%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	221.9	224.6	53.0	94.1	18.2	2.5	0.0	0.1	8.5	310.2	32.6	10.8	976	0	41%
Intermediate Cover Area	306.1	366.2	97.2	99.0	50.4	5.6	0.0	0.7	4.0	411.3	47.4	16.3	1404	0	59%
Final Capping Area	414.6	454.1	119.1	140.8	79.5	12.8	0.0	0.0	0.4	482.5	81.8	11.4	1797	88589	75%
Total Runoff (m3)	**20439**	**22389**	**5873**	**6941**	**3918**	**631**	**0**	**0**	**20**	**23785**	**4034**	**561**		**0**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	65.8	50.4	54.4	26.7	40.2	38.6	12.2	19.3	9.8	51.0	63.1	43.8	475	0	20%
Intermediate Cover Area	66.6	50.6	55.0	28.9	39.5	38.4	7.9	19.8	11.0	48.6	62.5	43.7	473	0	20%
Final Capping Area	66.8	50.6	56.4	42.3	39.8	38.3	19.9	19.3	13.0	59.6	70.2	51.4	528	26010	22%
Total Evapotranpiration (m3)	**3293**	**2495**	**2781**	**2087**	**1964**	**1886**	**980**	**949**	**640**	**2937**	**3462**	**2535**		**26010**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	198.9	229.9	77.1	52.3	76.7	13.3	0.0	3.2	10.9	189.5	54.7	17.5	924	0	39%
Intermediate Cover Area	110.8	91.1	35.1	48.2	44.3	13.5	0.0	3.9	10.9	82.9	47.4	9.8	498	0	21%
Final Capping Area	5.9	3.8	4.5	5.4	3.7	4.8	4.6	4.0	4.3	3.3	4.5	4.6	53	2634	2%
Total Leachate Generated (m3)	**291**	**187**	**220**	**267**	**182**	**238**	**226**	**199**	**214**	**162**	**222**	**228**		**2,634**	
Leachate Absorbed by Waste (m3)	0	0	0	0	0	0	0	0	0	0	0	0		0	
Leachate Disposal (m3)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		0	
Cumulative Volume (m3)	**291**	**478**	**698**	**965**	**1,147**	**1,385**	**1,610**	**1,809**	**2,023**	**2,185**	**2,407**	**2,634**			
Storage Volume Exceeded	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation (Hrs/Day)	**0.52**	**0.37**	**0.39**	**0.49**	**0.33**	**0.44**	**0.40**	**0.36**	**0.40**	**0.29**	**0.41**	**0.41**			

Quirks Quarry - Tweed Shire Council

Daily Cover Area	2200	m2	
Intermediate Cover Area	5990	m2	
Final Capping Area	0	m2	
Storage Capacity	6200	m3	
Initial Storage Volume	0	v/v	
Leachate Absorbed by Waste	0	l/m3	
Leachate Disposal per Day	0	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
													mm	m3	
	31	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**			
Precipitation (mm)															
	177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	12233	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	12760	104%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	1442	44%
Intermediate Cover Area	53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	5106	57%
Final Capping Area	113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	0	71%
Total Runoff (m3)	**423**	**1537**	**220**	**11**	**81**	**148**	**181**	**0**	**0**	**0**	**19**	**3930**		**6548**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	707	22%
Intermediate Cover Area	54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	1924	22%
Final Capping Area	62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	0	26%
Total Evapotranpiration (m3)	**446**	**409**	**319**	**239**	**228**	**223**	**151**	**0**	**0**	**36**	**46**	**535**		**2631**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	1139	35%
Intermediate Cover Area	76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	1921	21%
Final Capping Area	4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	0	3%
Total Leachate Generated (m3)	**655**	**359**	**409**	**13**	**253**	**147**	**119**	**0**	**0**	**0**	**33**	**1,070**		**3,060**	
Leachate Absorbed by Waste (m3)	0	0	0	0	0	0	0	0	0	0	0	0		0	
Leachate Disposal (m3)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		0	
Cumulative Volume (m3)	**655**	**1,015**	**1,424**	**1,437**	**1,689**	**1,837**	**1,956**	**1,956**	**1,956**	**1,956**	**1,990**	**3,060**			
Storage Volume Exceeded	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation (Hrs/Day)	**1.17**	**0.71**	**0.73**	**0.02**	**0.45**	**0.27**	**0.21**	**0.00**	**0.00**	**0.00**	**0.06**	**1.92**			

Quirks Quarry - Tweed Shire Council

Daily Cover Area	2200	m2
Intermediate Cover Area	17900	m2
Final Capping Area	0	m2
Storage Capacity	6200	m3
Initial Storage Volume	0	v/v
Leachate Absorbed by Waste	0	l/m3
Leachate Disposal per Day	0	m3
Sump Pump Rate	5	L/s

(Treatment plant and disposal by irrigation)

(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
													mm	m3	
	31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)															
	177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	30021	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	31316	104%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	1442	44%
Intermediate Cover Area	53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	15258	57%
Final Capping Area	113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	0	71%
Total Runoff (m3)	**1065**	**3912**	**555**	**30**	**218**	**396**	**462**	**0**	**0**	**0**	**53**	**10011**		**16700**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	707	22%
Intermediate Cover Area	54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	5748	22%
Final Capping Area	62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	0	26%
Total Evapotranpiration (m3)	**1098**	**1019**	**781**	**585**	**572**	**546**	**351**	**0**	**0**	**81**	**107**	**1317**		**6455**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	1139	35%
Intermediate Cover Area	76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	5740	21%
Final Capping Area	4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	0	3%
Total Leachate Generated (m3)	**1,570**	**728**	**1,006**	**36**	**575**	**341**	**294**	**0**	**0**	**1**	**68**	**2,261**		**6,879**	
Leachate Absorbed by Waste (m3)	0	0	0	0	0	0	0	0	0	0	0	0		0	
Leachate Disposal (m3)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		0	
Cumulative Volume (m3)	**1,570**	**2,297**	**3,304**	**3,339**	**3,914**	**4,256**	**4,550**	**4,550**	**4,550**	**4,551**	**4,619**	**6,879**			
Storage Volume Exceeded	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**			
Sump to Pond Pump Operation (Hrs/Day)	**2.81**	**1.44**	**1.80**	**0.07**	**1.03**	**0.63**	**0.53**	**0.00**	**0.00**	**0.00**	**0.13**	**4.05**			

Quirks Quarry - Tweed Shire Council

Daily Cover Area	2200	m2	
Intermediate Cover Area	32700	m2	
Final Capping Area	0	m2	
Storage Capacity	6200	m3	
Initial Storage Volume	0	v/v	
Leachate Absorbed by Waste	0	l/m3	
Leachate Disposal per Day	0	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
													mm	m3	
	31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)															
	177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	52127	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	54374	104%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	1442	44%
Intermediate Cover Area	53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	27873	57%
Final Capping Area	113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	0	71%
Total Runoff (m3)	**1862**	**6863**	**971**	**53**	**388**	**705**	**811**	**0**	**0**	**0**	**95**	**17566**		**29316**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	707	22%
Intermediate Cover Area	54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	10501	22%
Final Capping Area	62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	0	26%
Total Evapotranpiration (m3)	**1909**	**1776**	**1356**	**1015**	**1000**	**947**	**599**	**0**	**0**	**137**	**182**	**2288**		**11208**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	1139	35%
Intermediate Cover Area	76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	10486	21%
Final Capping Area	4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	0	3%
Total Leachate Generated (m3)	**2,706**	**1,185**	**1,748**	**64**	**975**	**582**	**512**	**1**	**0**	**1**	**110**	**3,740**		**11,625**	
Leachate Absorbed by Waste (m3)	0	0	0	0	0	0	0	0	0	0	0	0		0	
Leachate Disposal (m3)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		0	
Cumulative Volume (m3)	**2,706**	**3,891**	**5,640**	**5,704**	**6,679**	**7,261**	**7,773**	**7,774**	**7,774**	**7,775**	**7,885**	**11,625**			
Storage Volume Exceeded	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**			
Sump to Pond Pump Operation (Hrs/Day)	**4.85**	**2.35**	**3.13**	**0.12**	**1.75**	**1.08**	**0.92**	**0.00**	**0.00**	**0.00**	**0.20**	**6.70**			

FILE: Copy of Water Balance_Quirks Quarry_Cell1_S1_Split- RB.xls

50% AEP - Stage 2

4/10/2011

Quirks Quarry - Tweed Shire Council

Daily Cover Area	2200	m2	
Intermediate Cover Area	47100	m2	
Final Capping Area	0	m2	
Storage Capacity	6200	m3	
Initial Storage Volume	0	v/v	
Leachate Absorbed by Waste	0	l/m3	
Leachate Disposal per Day	0	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter		January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
														mm	m3	
		31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)																
		177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	73634	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)																
Actual Evaporation		192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	76809	104%
Runoff - Calculated using HELP (mm)																
Daily Cover Area		45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	1442	44%
Intermediate Cover Area		53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	40148	57%
Final Capping Area		113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	0	71%
Total Runoff	**(m3)**	**2638**	**9735**	**1377**	**76**	**553**	**1006**	**1151**	**0**	**0**	**0**	**137**	**24918**		**41590**	
Evapotranspiration - Calculated using HELP (mm)																
Daily Cover Area		53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	707	22%
Intermediate Cover Area		54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	15125	22%
Final Capping Area		62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	0	26%
Total Evapotranpiration	**(m3)**	**2697**	**2513**	**1915**	**1433**	**1416**	**1338**	**840**	**0**	**0**	**192**	**255**	**3233**		**15832**	
Leachate - Calculated using HELP (mm)																
Daily Cover Area		88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	1139	35%
Intermediate Cover Area		76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	15103	21%
Final Capping Area		4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	0	3%
Total Leachate Generated	**(m3)**	**3,812**	**1,630**	**2,471**	**91**	**1,365**	**817**	**723**	**1**	**0**	**1**	**152**	**5,179**		**16,243**	
Leachate Absorbed by Waste	**(m3)**	0	0	0	0	0	0	0	0	0	0	0	0		0	
Leachate Disposal	**(m3)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		0	
Cumulative Volume	**(m3)**	**3,812**	**5,442**	**7,913**	**8,004**	**9,369**	**10,186**	**10,909**	**10,910**	**10,910**	**10,912**	**11,063**	**16,243**			
Storage Volume Exceeded		**NO**	**NO**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**			
Sump to Pond Pump Operation	**(Hrs/Day)**	**6.83**	**3.23**	**4.43**	**0.17**	**2.45**	**1.51**	**1.30**	**0.00**	**0.00**	**0.00**	**0.28**	**9.28**			

Quirks Quarry - Tweed Shire Council

Daily Cover Area	0	m2	
Intermediate Cover Area	0	m2	
Final Capping Area	49300	m2	
Storage Capacity	6200	m3	
Initial Storage Volume	0	v/v	
Leachate Absorbed by Waste	0	l/m3	
Leachate Disposal per Day	0	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter		January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
														mm	m3	
		31	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**			
Precipitation (mm)																
		177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	0	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)																
Actual Evaporation		192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	0	104%
Runoff - Calculated using HELP (mm)																
Daily Cover Area		45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	0	44%
Intermediate Cover Area		53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	0	57%
Final Capping Area		113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	52416	71%
Total Runoff	**(m3)**	**5600**	**11011**	**3451**	**0**	**1083**	**1555**	**940**	**0**	**0**	**0**	**0**	**28776**		**0**	
Evapotranspiration - Calculated using HELP (mm)																
Daily Cover Area		53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	0	22%
Intermediate Cover Area		54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	0	22%
Final Capping Area		62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	18901	26%
Total Evapotranpiration	**(m3)**	**3082**	**2757**	**2502**	**1437**	**1421**	**1878**	**1623**	**0**	**0**	**300**	**411**	**3488**		**18901**	
Leachate - Calculated using HELP (mm)																
Daily Cover Area		88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	0	35%
Intermediate Cover Area		76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	0	21%
Final Capping Area		4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	2401	3%
Total Leachate Generated	**(m3)**	**217**	**234**	**241**	**263**	**102**	**206**	**293**	**180**	**183**	**120**	**208**	**155**		**2,401**	
Leachate Absorbed by Waste	**(m3)**	0	0	0	0	0	0	0	0	0	0	0	0		0	
Leachate Disposal	**(m3)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		0	
Cumulative Volume	**(m3)**	**217**	**451**	**691**	**954**	**1,056**	**1,262**	**1,555**	**1,735**	**1,918**	**2,038**	**2,246**	**2,401**			
Storage Volume Exceeded		**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation	**(Hrs/Day)**	**0.39**	**0.46**	**0.43**	**0.49**	**0.18**	**0.38**	**0.53**	**0.32**	**0.34**	**0.21**	**0.38**	**0.28**			

Year	Waste Volume (tonnes)				
2012	47,893	Waste filling rate	57400	m^3/year	(waste only @ 1t/m3)
2013	48,851		160	m^3/day	
2014	50,316				
2015	51,826	Waste lift height	2	m	
2016	53,381				
2017	54,982	Waste open area	80	m^2/day	(Daily Cover)
2018	56,632				
2019	58,330	Days until Intermediate Cover Placed	28	days	
2020	75,030				
2021	77,131				

Maximum Daily cover area 2200 m^2

Cell	Total Area m^2	Daily Cover Area %	Inter Cover Area %	Daily Cover Area m^2	Inter Cover Area m^2	ell 1 staging		
1A	8190	27	73	2200	5990	Half Cell Up to RL 15 - 9 months filling	40200m3 of void	Area = 8190m2
1B	17900	12	88	2200	15700	Full Cell up to RL 15 - 19 months	95000m3 of void	Area = 15820m2
2	17000	13	87	2200	14800	Full Cell up to RL 10 - 5 months	27300m3 of void	Area = 12850m2
3	14400	15	85	2200	12200			
Total Area	**49300**							

Leachate Storage Volumes Within Cell

Cell	Area RL4 m^2	Vol RL4 m^3	Storage Vol RL4 m^3	Area RL5 m^2	Vol RL5 m^3	Storage Vol RL5 m^3	Area RL6 m^2	Vol RL6 m^3	Storage Vol RL6 m^3	Area RL7 m^2	Vol RL7 m^3	Storage Vol RL7 m^3	Area RL8 m^2	Vol RL8 m^3	Storage Vol RL8 m^3
1A	47	2	1	1930	800	400	5830	4500	2250	9820	12400	6200	11660	23400	11700
1B															
2	2950	1350	675	7160	6370	3185	11060	15570	7785	12940	27800	13900	13400	41050	20525
3	1500	560	280	5860	3980	1990	10900	12700	6350	12400	24500	12250	13480	37490	18745
Total Area			**956**			**5575**			**16385**			**32350**			**50970**

Storage Volume - assume 50% porosity of waste

Quirks Quarry - Tweed Shire Council

	0-9 months		10 -12 months		
Daily Cover Area	2200	m2	2200	m2	
Intermediate Cover Area	5990	m2	17900	m2	
Final Capping Area	0	m2	0	m2	
Storage Capacity	6200	m3	6200	m3	
Initial Storage Volume	0	v/v	0	v/v	
Leachate Absorbed by Waste	60	l/m3	60	l/m3	
Leachate Disposal per Day	0	m3	0	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
													mm	m3	
	31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)															
	495.9	507.6	168.7	171.4	141.4	56.2	8.4	18.5	46.1	546.1	148.7	71.2	2380	28617	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	19549	65%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	221.9	224.6	53.0	94.1	18.2	2.5	0.0	0.1	8.5	310.2	32.6	10.8	976	2148	41%
Intermediate Cover Area	306.1	366.2	97.2	99.0	50.4	5.6	0.0	0.7	4.0	411.3	47.4	16.3	1404	14067	59%
Final Capping Area	414.6	454.1	119.1	140.8	79.5	12.8	0.0	0.0	0.4	482.5	81.8	11.4	1797	0	75%
Total Runoff (m3)	**2321**	**2687**	**699**	**800**	**342**	**39**	**0**	**4**	**42**	**8044**	**920**	**315**		**16215**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	65.8	50.4	54.4	26.7	40.2	38.6	12.2	19.3	9.8	51.0	63.1	43.8	475	1045	20%
Intermediate Cover Area	66.6	50.6	55.0	28.9	39.5	38.4	7.9	19.8	11.0	48.6	62.5	43.7	473	4675	20%
Final Capping Area	66.8	50.6	56.4	42.3	39.8	38.3	19.9	19.3	13.0	59.6	70.2	51.4	528	0	22%
Total Evapotranpiration (m3)	**544**	**414**	**449**	**232**	**325**	**315**	**74**	**161**	**88**	**982**	**1257**	**879**		**5720**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	198.9	229.9	77.1	52.3	76.7	13.3	0.0	3.2	10.9	189.5	54.7	17.5	924	2033	39%
Intermediate Cover Area	110.8	91.1	35.1	48.2	44.3	13.5	0.0	3.9	10.9	82.9	47.4	9.8	498	4650	21%
Final Capping Area	5.9	3.8	4.5	5.4	3.7	4.8	4.6	4.0	4.3	3.3	4.5	4.6	53	0	2%
Total Leachate Generated (m3)	**1,101**	**1,052**	**380**	**404**	**434**	**110**	**0**	**30**	**90**	**1,901**	**968**	**213**		**6,683**	
Leachate Absorbed by Waste (m3)	298	269	298	288	298	288	298	298	288	298	288	298		3,504	
Leachate Disposal (m3)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		0	
Cumulative Volume (m3)	**804**	**1,587**	**1,669**	**1,784**	**1,921**	**1,743**	**1,446**	**1,178**	**980**	**2,583**	**3,263**	**3,179**			
Storage Volume Exceeded	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation (Hrs/Day)	**1.97**	**2.09**	**0.68**	**0.75**	**0.78**	**0.20**	**0.00**	**0.05**	**0.17**	**3.41**	**1.79**	**0.38**			

Quirks Quarry - Tweed Shire Council

	12-24 months		
Daily Cover Area	2200	m2	
Intermediate Cover Area	17900	m2	
Final Capping Area	0	m2	
Storage Capacity	6200	m3	
Initial Storage Volume	0.51	v/v	
Leachate Absorbed by Waste	60	l/m3	
Leachate Disposal per Day	25	m3	(Treatment plant and disposal by irrigation) From December
Sump Pump Rate	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
													mm	m3	
	31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)															
	177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	30021	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	31316	104%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	1442	44%
Intermediate Cover Area	53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	15258	57%
Final Capping Area	113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	0	71%
Total Runoff (m3)	**1065**	**3912**	**555**	**30**	**218**	**396**	**462**	**0**	**0**	**0**	**53**	**10011**		**16700**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	707	22%
Intermediate Cover Area	54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	5748	22%
Final Capping Area	62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	0	26%
Total Evapotranpiration (m3)	**1098**	**1019**	**781**	**585**	**572**	**546**	**351**	**0**	**0**	**81**	**107**	**1317**		**6455**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	1139	35%
Intermediate Cover Area	76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	5740	21%
Final Capping Area	4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	0	3%
Total Leachate Generated (m3)	**1,570**	**728**	**1,006**	**36**	**575**	**341**	**294**	**0**	**0**	**1**	**68**	**2,261**		**6,879**	
Leachate Absorbed by Waste (m3)	298	269	298	288	298	288	298	298	288	298	288	298		3,504	
Leachate Disposal (m3)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**775**		775	
Cumulative Volume (m3)	**4,451**	**4,910**	**5,619**	**5,366**	**5,644**	**5,697**	**5,694**	**5,396**	**5,108**	**4,811**	**4,591**	**5,779**			
Storage Volume Exceeded	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation (Hrs/Day)	**2.81**	**1.44**	**1.80**	**0.07**	**1.03**	**0.63**	**0.53**	**0.00**	**0.00**	**0.00**	**0.13**	**4.05**			

Quirks Quarry - Tweed Shire Council

	24-36 months		
Daily Cover Area	2200	m2	
Intermediate Cover Area	17900	m2	
Final Capping Area	0	m2	
Storage Capacity	6200	m3	
Initial Storage Volume	0.93	v/v	
Leachate Absorbed by Waste	60	l/m3	
Leachate Disposal per Day	25	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
													mm	m3	
	31	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**			
Precipitation (mm)															
	177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	30021	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	31316	104%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	1442	44%
Intermediate Cover Area	53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	15258	57%
Final Capping Area	113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	0	71%
Total Runoff (m3)	**1065**	**3912**	**555**	**30**	**218**	**396**	**462**	**0**	**0**	**0**	**53**	**10011**		**16700**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	707	22%
Intermediate Cover Area	54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	5748	22%
Final Capping Area	62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	0	26%
Total Evapotranpiration (m3)	**1098**	**1019**	**781**	**585**	**572**	**546**	**351**	**0**	**0**	**81**	**107**	**1317**		**6455**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	1139	35%
Intermediate Cover Area	76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	5740	21%
Final Capping Area	4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	0	3%
Total Leachate Generated (m3)	**1,570**	**728**	**1,006**	**36**	**575**	**341**	**294**	**0**	**0**	**1**	**68**	**2,261**		**6,879**	
Leachate Absorbed by Waste (m3)	298	269	298	288	298	288	298	298	288	298	288	298		3,504	
Leachate Disposal (m3)	775	700	775	750	775	750	775	775	750	775	750	775		9,125	
Cumulative Volume (m3)	**6,277**	**6,035**	**5,969**	**4,967**	**4,469**	**3,772**	**2,994**	**1,922**	**884**	**0**	**0**	**1,188**			
Storage Volume Exceeded	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation (Hrs/Day)	**2.81**	**1.44**	**1.80**	**0.07**	**1.03**	**0.63**	**0.53**	**0.00**	**0.00**	**0.00**	**0.13**	**4.05**			

50% AEP - Year 3

Quirks Quarry - Tweed Shire Council

	37-41 months		42-48 months		
Daily Cover Area	2200	m2	2200	m2	
Intermediate Cover Area	17900	m2	32700	m2	
Final Capping Area	0	m2	0	m2	
Storage Capacity	6200	m3	10035	m3	
Initial Storage Volume	0.19	v/v	0	v/v	
Leachate Absorbed by Waste	60	l/m3	60	l/m3	
Leachate Disposal per Day	25	m3	25	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
													mm	m3	
	31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)															
	177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	30021	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	31316	104%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	1442	44%
Intermediate Cover Area	53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	15258	57%
Final Capping Area	113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	0	71%
Total Runoff **(m3)**	**1065**	**3912**	**555**	**30**	**218**	**705**	**811**	**0**	**0**	**0**	**95**	**17566**		**16700**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	707	22%
Intermediate Cover Area	54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	5748	22%
Final Capping Area	62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	0	26%
Total Evapotranpiration **(m3)**	**1098**	**1019**	**781**	**585**	**1000**	**947**	**599**	**0**	**0**	**137**	**182**	**2288**		**6455**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	1139	35%
Intermediate Cover Area	76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	5740	21%
Final Capping Area	4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	0	3%
Total Leachate Generated **(m3)**	**1,570**	**728**	**1,006**	**36**	**975**	**582**	**512**	**1**	**0**	**1**	**110**	**3,740**		**9,261**	
Leachate Absorbed by Waste **(m3)**	298	269	298	288	298	288	298	298	288	298	288	298		3,504	
Leachate Disposal **(m3)**	**775**	**700**	**775**	**750**	**775**	**750**	**775**	**775**	**750**	**775**	**750**	**775**		9,125	
Cumulative Volume **(m3)**	**1,685**	**1,444**	**1,378**	**376**	**278**	**0**	**0**	**0**	**0**	**0**	**0**	**2,667**			
Storage Volume Exceeded	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation **(Hrs/Day)**	**2.81**	**1.44**	**1.80**	**0.07**	**1.75**	**1.08**	**0.92**	**0.00**	**0.00**	**0.00**	**0.20**	**6.70**			

Quirks Quarry - Tweed Shire Council

	49-60 months		
Daily Cover Area	2200	m2	
Intermediate Cover Area	32700	m2	
Final Capping Area	0	m2	
Storage Capacity	10035	m3	
Initial Storage Volume	0.27	v/v	
Leachate Absorbed by Waste	60	l/m3	
Leachate Disposal per Day	25	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
													mm	m3	
	31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)															
	177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	52127	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	54374	104%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	1442	44%
Intermediate Cover Area	53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	27873	57%
Final Capping Area	113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	0	71%
Total Runoff (m3)	**1862**	**6863**	**971**	**53**	**388**	**705**	**811**	**0**	**0**	**0**	**95**	**17566**		**29316**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	707	22%
Intermediate Cover Area	54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	10501	22%
Final Capping Area	62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	0	26%
Total Evapotranpiration (m3)	**1909**	**1776**	**1356**	**1015**	**1000**	**947**	**599**	**0**	**0**	**137**	**182**	**2288**		**11208**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	1139	35%
Intermediate Cover Area	76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	10486	21%
Final Capping Area	4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	0	3%
Total Leachate Generated (m3)	**2,706**	**1,185**	**1,748**	**64**	**975**	**582**	**512**	**1**	**0**	**1**	**110**	**3,740**		**11,625**	
Leachate Absorbed by Waste (m3)	298	269	298	288	298	288	298	298	288	298	288	298		3,504	
Leachate Disposal (m3)	**775**	**700**	**775**	**750**	**775**	**750**	**775**	**775**	**750**	**775**	**750**	**775**		9,125	
Cumulative Volume (m3)	**4,301**	**4,517**	**5,193**	**4,219**	**4,122**	**3,666**	**3,105**	**2,033**	**995**	**0**	**0**	**2,667**			
Storage Volume Exceeded	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation (Hrs/Day)	**4.85**	**2.35**	**3.13**	**0.12**	**1.75**	**1.08**	**0.92**	**0.00**	**0.00**	**0.00**	**0.20**	**6.70**			

Quirks Quarry - Tweed Shire Council

	61-72 months		
Daily Cover Area	2200	m2	
Intermediate Cover Area	47100	m2	
Final Capping Area	0	m2	
Storage Capacity	10035	m3	
Initial Storage Volume	0.27	v/v	
Leachate Absorbed by Waste	60	l/m3	
Leachate Disposal per Day	25	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
													mm	m3	
	31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)															
	177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	73634	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	76809	104%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	1442	44%
Intermediate Cover Area	53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	40148	57%
Final Capping Area	113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	0	71%
Total Runoff **(m3)**	**2638**	**9735**	**1377**	**76**	**553**	**1006**	**1151**	**0**	**0**	**0**	**137**	**24918**		**41590**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	707	22%
Intermediate Cover Area	54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	15125	22%
Final Capping Area	62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	0	26%
Total Evapotranpiration **(m3)**	**2697**	**2513**	**1915**	**1433**	**1416**	**1338**	**840**	**0**	**0**	**192**	**255**	**3233**		**15832**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	1139	35%
Intermediate Cover Area	76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	15103	21%
Final Capping Area	4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	0	3%
Total Leachate Generated **(m3)**	**3,812**	**1,630**	**2,471**	**91**	**1,365**	**817**	**723**	**1**	**0**	**1**	**152**	**5,179**		**16,243**	
Leachate Absorbed by Waste **(m3)**	298	269	298	288	298	288	298	298	288	298	288	298		3,504	
Leachate Disposal **(m3)**	**775**	**700**	**775**	**750**	**775**	**750**	**775**	**775**	**750**	**775**	**750**	**775**		9,125	
Cumulative Volume **(m3)**	**5,407**	**6,068**	**7,466**	**6,520**	**6,812**	**6,591**	**6,242**	**5,170**	**4,132**	**3,061**	**2,174**	**6,281**			
Storage Volume Exceeded	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation **(Hrs/Day)**	**6.83**	**3.23**	**4.43**	**0.17**	**2.45**	**1.51**	**1.30**	**0.00**	**0.00**	**0.00**	**0.28**	**9.28**			

Quirks Quarry - Tweed Shire Council

	73-84 months		
Daily Cover Area	2200	m2	
Intermediate Cover Area	47100	m2	
Final Capping Area	0	m2	
Storage Capacity	16385	m3	
Initial Storage Volume	0.37	v/v	
Leachate Absorbed by Waste	60	l/m3	
Leachate Disposal per Day	25	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
													mm	m3	
	31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)															
	177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	73634	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	76809	104%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	1442	44%
Intermediate Cover Area	53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	40148	57%
Final Capping Area	113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	0	71%
Total Runoff (m3)	**2638**	**9735**	**1377**	**76**	**553**	**1006**	**1151**	**0**	**0**	**0**	**137**	**24918**		**41590**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	707	22%
Intermediate Cover Area	54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	15125	22%
Final Capping Area	62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	0	26%
Total Evapotranpiration (m3)	**2697**	**2513**	**1915**	**1433**	**1416**	**1338**	**840**	**0**	**0**	**192**	**255**	**3233**		**15832**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	1139	35%
Intermediate Cover Area	76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	15103	21%
Final Capping Area	4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	0	3%
Total Leachate Generated (m3)	**3,812**	**1,630**	**2,471**	**91**	**1,365**	**817**	**723**	**1**	**0**	**1**	**152**	**5,179**		**16,243**	
Leachate Absorbed by Waste (m3)	298	269	298	288	298	288	298	298	288	298	288	298		3,504	
Leachate Disposal (m3)	**775**	**700**	**775**	**750**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**		3,000	
Cumulative Volume (m3)	**8,802**	**9,463**	**10,861**	**9,915**	**10,982**	**11,511**	**11,937**	**11,640**	**11,352**	**11,056**	**10,920**	**15,801**			
Storage Volume Exceeded	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation (Hrs/Day)	**6.83**	**3.23**	**4.43**	**0.17**	**2.45**	**1.51**	**1.30**	**0.00**	**0.00**	**0.00**	**0.28**	**9.28**			

Quirks Quarry - Tweed Shire Council

	85-90 months		90-96 months		
Daily Cover Area	2200	m2	2200	m2	
Intermediate Cover Area	47100	m2	30500	m2	
Final Capping Area	14400	m2	14400	m2	
Storage Capacity	16385	m3	16385	m3	
Initial Storage Volume	0.38	v/v	0	v/v	
Leachate Absorbed by Waste	60	l/m3	60	l/m3	
Leachate Disposal per Day	25	m3	25	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter		January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
														mm	m3	
		31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)																
		177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	58665	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)																
Actual Evaporation		192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	60492	104%
Runoff - Calculated using HELP (mm)																
Daily Cover Area		45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	1442	44%
Intermediate Cover Area		53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	30696	57%
Final Capping Area		113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	15310	71%
Total Runoff	**(m3)**	**4274**	**12951**	**2385**	**76**	**870**	**1460**	**1034**	**0**	**0**	**0**	**89**	**24848**		**32139**	
Evapotranspiration - Calculated using HELP (mm)																
Daily Cover Area		53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	707	22%
Intermediate Cover Area		54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	12680	22%
Final Capping Area		62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	5521	26%
Total Evapotranpiration	**(m3)**	**3598**	**3318**	**2646**	**1853**	**1831**	**1886**	**1036**	**0**	**0**	**216**	**291**	**3163**		**18908**	
Leachate - Calculated using HELP (mm)																
Daily Cover Area		88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	1139	35%
Intermediate Cover Area		76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	12432	21%
Final Capping Area		4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	701	3%
Total Leachate Generated	**(m3)**	**3,876**	**1,698**	**2,541**	**168**	**1,395**	**877**	**565**	**53**	**53**	**36**	**165**	**3,565**		**14,992**	
Leachate Absorbed by Waste	**(m3)**	298	269	298	288	298	288	298	298	288	298	288	298		3,504	
Leachate Disposal	**(m3)**	**775**	**700**	**775**	**750**	**775**	**750**	**775**	**775**	**750**	**775**	**750**	**775**		9,125	
Cumulative Volume	**(m3)**	**9,084**	**9,814**	**11,282**	**10,412**	**10,734**	**10,573**	**10,065**	**9,046**	**8,061**	**7,025**	**6,151**	**8,644**			
Storage Volume Exceeded		**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation	**(Hrs/Day)**	**6.95**	**3.37**	**4.55**	**0.31**	**2.50**	**1.62**	**1.01**	**0.10**	**0.10**	**0.06**	**0.30**	**6.39**			

Quirks Quarry - Tweed Shire Council

	97-108 months	
Daily Cover Area	2200	m2
Intermediate Cover Area	32700	m2
Final Capping Area	14400	m2
Storage Capacity	16385	m3
Initial Storage Volume	0.80	v/v
Leachate Absorbed by Waste	60	l/m3
Leachate Disposal per Day	25	m3 (Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s (Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
													mm	m3	
	31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)															
	177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	52127	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	54374	104%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	1442	44%
Intermediate Cover Area	53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	27873	57%
Final Capping Area	113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	15310	71%
Total Runoff (m3)	**3498**	**10079**	**1979**	**53**	**704**	**1159**	**1086**	**0**	**0**	**0**	**95**	**25972**		**29316**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	707	22%
Intermediate Cover Area	54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	10501	22%
Final Capping Area	62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	5521	26%
Total Evapotranpiration (m3)	**2809**	**2581**	**2087**	**1435**	**1415**	**1496**	**1073**	**0**	**0**	**225**	**302**	**3307**		**16729**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	1139	35%
Intermediate Cover Area	76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	10486	21%
Final Capping Area	4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	701	3%
Total Leachate Generated (m3)	**2,770**	**1,253**	**1,819**	**141**	**1,005**	**642**	**597**	**53**	**53**	**36**	**171**	**3,785**		**12,326**	
Leachate Absorbed by Waste (m3)	298	269	298	288	298	288	298	298	288	298	288	298		3,504	
Leachate Disposal (m3)	**775**	**700**	**775**	**750**	**775**	**750**	**775**	**775**	**750**	**775**	**750**	**775**		**9,125**	
Cumulative Volume (m3)	**14,805**	**15,090**	**15,836**	**14,938**	**14,871**	**14,475**	**14,000**	**12,981**	**11,996**	**10,960**	**10,093**	**12,805**			
Storage Volume Exceeded	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation (Hrs/Day)	**4.96**	**2.49**	**3.26**	**0.26**	**1.80**	**1.19**	**1.07**	**0.10**	**0.10**	**0.06**	**0.32**	**6.78**			

50% AEP - Year 9

Quirks Quarry - Tweed Shire Council

	109-120 months		
Daily Cover Area	2200	m2	
Intermediate Cover Area	32700	m2	
Final Capping Area	49300	m2	
Storage Capacity	16385	m3	
Initial Storage Volume	0.53	v/v	
Leachate Absorbed by Waste	60	l/m3	
Leachate Disposal per Day	25	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**Annual Total**		**Percent**
													mm	**m3**	
	31	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**			
Precipitation (mm)															
	177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	52127	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)															
Actual Evaporation	192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	54374	104%
Runoff - Calculated using HELP (mm)															
Daily Cover Area	45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	1442	44%
Intermediate Cover Area	53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	27873	57%
Final Capping Area	113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	52416	71%
Total Runoff (m3)	**7462**	**17874**	**4422**	**53**	**1471**	**2261**	**1751**	**0**	**0**	**0**	**95**	**46342**		**29316**	
Evapotranspiration - Calculated using HELP (mm)															
Daily Cover Area	53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	707	22%
Intermediate Cover Area	54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	10501	22%
Final Capping Area	62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	18901	26%
Total Evapotranpiration (m3)	**4991**	**4533**	**3858**	**2452**	**2421**	**2825**	**2222**	**0**	**0**	**437**	**593**	**5776**		**30109**	
Leachate - Calculated using HELP (mm)															
Daily Cover Area	88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	1139	35%
Intermediate Cover Area	76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	10486	21%
Final Capping Area	4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	2401	3%
Total Leachate Generated (m3)	**2,924**	**1,419**	**1,989**	**327**	**1,077**	**788**	**805**	**181**	**183**	**121**	**318**	**3,895**		**14,026**	
Leachate Absorbed by Waste (m3)	298	269	298	288	298	288	298	298	288	298	288	298		3,504	
Leachate Disposal (m3)	775	700	775	750	775	750	775	775	750	775	750	775		9,125	
Cumulative Volume (m3)	**10,495**	**10,945**	**11,861**	**11,150**	**11,155**	**10,905**	**10,637**	**9,745**	**8,890**	**7,938**	**7,218**	**10,041**			
Storage Volume Exceeded	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation (Hrs/Day)	**5.24**	**2.81**	**3.56**	**0.61**	**1.93**	**1.46**	**1.44**	**0.32**	**0.34**	**0.22**	**0.59**	**6.98**			

Quirks Quarry - Tweed Shire Council

	121-132 months		
Daily Cover Area	0	m2	
Intermediate Cover Area	0	m2	
Final Capping Area	49300	m2	
Storage Capacity	16385	m3	
Initial Storage Volume	0.78	v/v	
Leachate Absorbed by Waste	0	l/m3	
Leachate Disposal per Day	25	m3	(Treatment plant and disposal by irrigation)
Sump Pump Rate	5	L/s	(Pump rate needs to be high enough so only operates 24hrs / day. If restricted to 8hrs/day will need to be 8)

Parameter		January	February	March	April	May	June	July	August	September	October	November	December	Annual Total		Percent
														mm	m3	
		31	28	31	30	31	30	31	31	30	31	30	31			
Precipitation (mm)																
		177.4	287.0	98.0	29.4	75.7	56.0	55.1	0.0	0.0	18.8	16.9	679.3	1494	0	100%
Average Monthly Class A Pan Evaporation - Taken from Tweed Urban Stormwater Management Plan (mm)																
Actual Evaporation		192.0	149.0	134.0	100.0	65.0	51.0	73.0	97.0	127.0	165.0	179.0	226.0	1558	0	104%
Runoff - Calculated using HELP (mm)																
Daily Cover Area		45.5	155.5	23.2	0.8	5.4	10.5	17.9	0.0	0.0	0.0	0.6	396.4	656	0	44%
Intermediate Cover Area		53.9	199.4	28.2	1.6	11.5	20.9	23.6	0.0	0.0	0.0	2.9	510.5	852	0	57%
Final Capping Area		113.6	223.3	70.0	0.0	22.0	31.6	19.1	0.0	0.0	0.0	0.0	583.7	1063	52416	71%
Total Runoff	**(m3)**	**5600**	**11011**	**3451**	**0**	**1083**	**1555**	**940**	**0**	**0**	**0**	**0**	**28776**		**0**	
Evapotranspiration - Calculated using HELP (mm)																
Daily Cover Area		53.7	46.6	39.1	29.6	24.7	27.4	22.9	0.0	0.0	5.8	7.3	64.4	321	0	22%
Intermediate Cover Area		54.8	51.2	38.8	29.1	28.9	27.1	16.8	0.0	0.0	3.8	5.1	65.6	321	0	22%
Final Capping Area		62.5	55.9	50.8	29.2	28.8	38.1	32.9	0.0	0.0	6.1	8.3	70.8	383	18901	26%
Total Evapotranpiration	**(m3)**	**3082**	**2757**	**2502**	**1437**	**1421**	**1878**	**1623**	**0**	**0**	**300**	**411**	**3488**		**18901**	
Leachate - Calculated using HELP (mm)																
Daily Cover Area		88.8	79.2	49.4	0.7	41.2	22.7	14.0	0.0	0.0	0.1	7.4	214.4	518	0	35%
Intermediate Cover Area		76.8	30.9	50.1	1.9	27.1	16.3	14.7	0.0	0.0	0.0	2.9	99.9	321	0	21%
Final Capping Area		4.4	4.7	4.9	5.3	2.1	4.2	6.0	3.6	3.7	2.4	4.2	3.1	49	2401	3%
Total Leachate Generated	**(m3)**	**217**	**234**	**241**	**263**	**102**	**206**	**293**	**180**	**183**	**120**	**208**	**155**		**2,401**	
Leachate Absorbed by Waste	**(m3)**	0	0	0	0	0	0	0	0	0	0	0	0		0	
Leachate Disposal	**(m3)**	775	700	775	750	775	750	775	775	750	775	750	775		9,125	
Cumulative Volume	**(m3)**	**12,247**	**11,781**	**11,246**	**10,759**	**10,086**	**9,542**	**9,061**	**8,466**	**7,898**	**7,243**	**6,701**	**6,081**			
Storage Volume Exceeded		**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**			
Sump to Pond Pump Operation	**(Hrs/Day)**	**0.39**	**0.46**	**0.43**	**0.49**	**0.18**	**0.38**	**0.53**	**0.32**	**0.34**	**0.21**	**0.38**	**0.28**			

Appendix C

Concept Stormwater Calculations

Sediment Basin Calculations

Stormwater Drain Calculations

Concept Design Sedimentation Basin Calculation

1. Site Data Sheet

Site name: **Tweed Shire Council**

Site location: **Quirks Quarry**

Description: **Conceptual Sedimentation Basin Sizing**

Weather Station: **Murwillumba**

Note: These "Standard Calculation" spreadsheets relate only to low erosion hazard lands as identified in figure 4.6 where the designer chooses to not use the RUSLE to size sediment basins. The more "Detailed Calculation" spreadsheets should be used on high erosion hazard lands as identified by Figure 4.6 or where the designer chooses to run the RUSLE in calculations.

Site area	**Site**						**Remarks**
	1	2	3				
Total catchment area (ha)	2.61	1.70	1.44				Whole area will be disturbed as is currently a quarry
Disturbed catchment area (ha)	5.75						

Soil analysis

Soil landscape							DIPNR mapping (if relevant) Sections 6.3.3(c), (d) and (e)
Soil Texture Group	D/F	D/F	D/F	D/F	D/F		

Rainfall data

Rainfall Data for Settling Zone							
Design rainfall depth (days)	5	5	5				See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	90	90	90				See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	82.5	82.5	82.5				See Section 6.3.4 (h)
Rainfall intensity: 2-year, 6-hour storm	16.8	16.8	16.8				See IFD chart for the site
Rainfall erosivity (R-factor)	6590	6590	6590				Automatic calculation from above data

Concept Design Sedimentation Basin Calculations

2. Volume of Sediment Basins, *Type D* and *Type F* Soils

Type D Basin	**Soils that contain significant proportion of fine (<0.005 mm) "dispersible" materials that will never settle unless flocculated.**
Type F Basin	**Soils, the bulk of which are fine grained, (> 33% finer than 0.02 mm) and will require much longer 'residence' time to settle in a sediment retention basin.**

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$Vs = 10 \times C_v \times A \times R_{y\text{-}\%ile,x\text{-}day} \ (m^3)$$

where:

10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

R = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See sections 6.3.4(d), (e), (f), (g) and (h)

A = total catchment area of the basin (ha)

Sediment Storage Zone Volume

In the standard calculation, the sediment storage zone is 50 percent of the setting zone. However, designers can work to capture the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)), in which case the "Detailed Calculation" spreadsheets should be used.

Total Basin Volume

Site	C_v	R x-day y-%ile	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
1	0.90	82.5	5.75	4269.82	2134.91	6405
2	0.90	82.5	0.00	0.00	0.00	0.00
3	0.90	82.5	0.00	0.00	0.00	0.00

3. Sizing of Sedimentation Basin

TOP DIMENSIONS - Up to Storage and Sedimentation Zone Volume

Length	80.00
width	50.00
depth	2.00
internal slopes	3.00

Max depth =	**8.33**		
Base =	**68.00**	x	**38.00**
Top area =	**4000.00**		
Base area =	**2584.00**		
VOLUME	**6,536.000**		

TOP DIMENSIONS - Up to Spillway Crest Volume

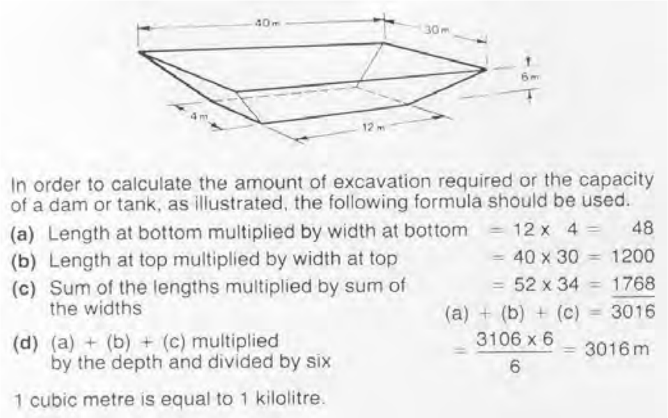
Length	83.00
width	53.00
depth	2.50
internal slopes	3.00

Max depth =	**8.83**		
Base =	**71.00**	x	**41.00**
Top area =	**4399.00**		
Base area =	**2911.00**		
VOLUME	**9,077.500**		

TOP DIMENSIONS - Up to Top of Embankment Volume

Length	84.80
width	54.80
depth	2.80
internal slopes	3.00

Max depth =	**9.13**		
Base =	**72.80**	x	**42.80**
Top area =	**4647.04**		
Base area =	**3115.84**		
VOLUME	**10,800.832**		



In order to calculate the amount of excavation required or the capacity of a dam or tank, as illustrated, the following formula should be used.

(a)	Length at bottom multiplied by width at bottom	= 12 x 4 = 48
(b)	Length at top multiplied by width at top	= 40 x 30 = 1200
(c)	Sum of the lengths multiplied by sum of the widths	= 52 x 34 = 1768
		(a) + (b) + (c) = 3016
(d)	(a) + (b) + (c) multiplied by the depth and divided by six	$= \frac{3106 \times 6}{6} = 3016\,m$

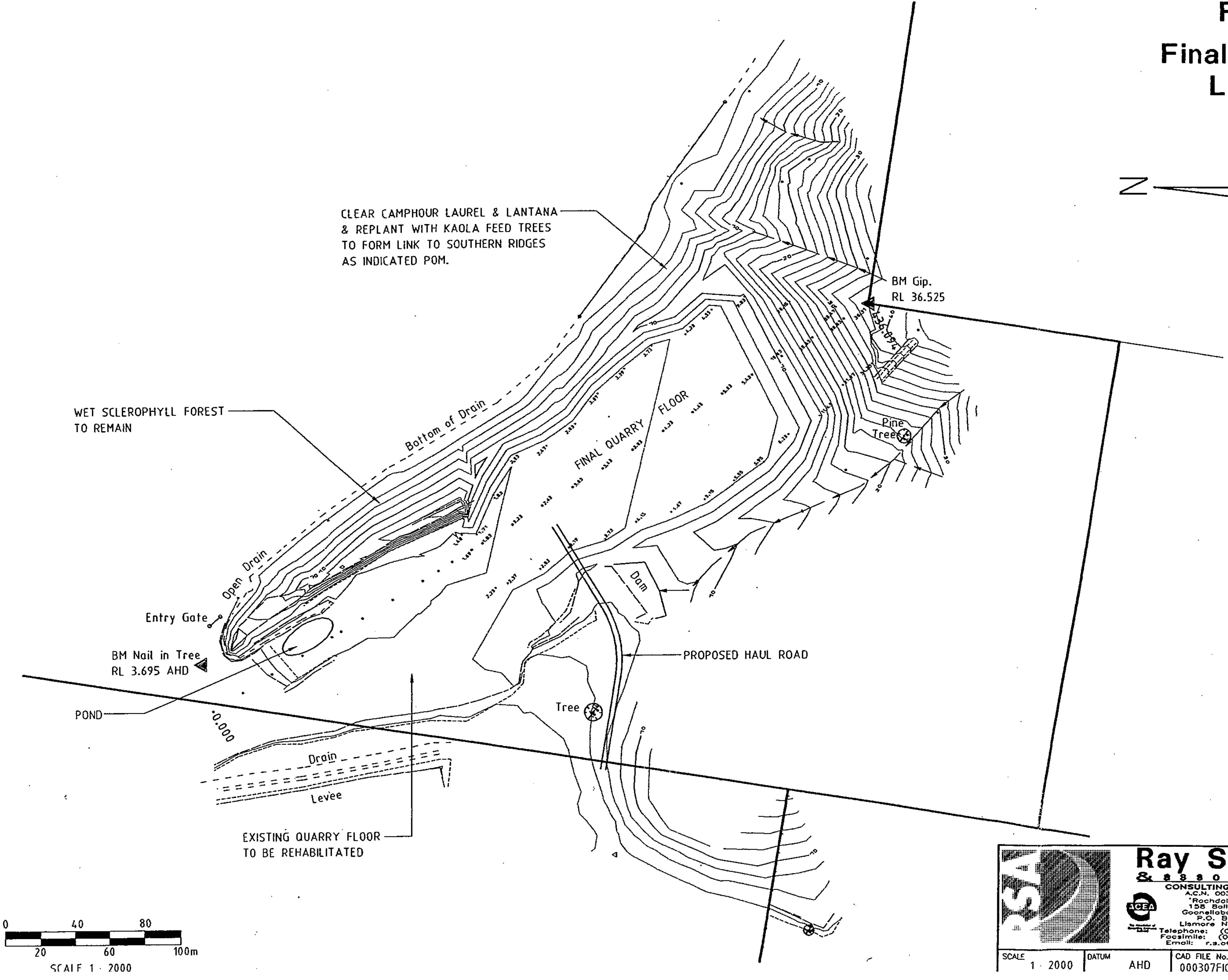
1 cubic metre is equal to 1 kilolitre.

Appendix D

Fig 4 – Final Quarry Landform

Figure 4

Final Quarry Landform



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SCALE	DATUM	CAD FILE No.	DATE
1 : 2000	AHD	000307FIG4	APR.00

Appendix E

Stotts Creek Waste Compaction Data and Testing Procedure

Stotts Creek RRC - Testing of compaction procedure

Extracted from EC2011-049 Contract for Management of Stotts Creek Landfill

Testing of Compaction

The compacted waste shall be tested for compaction at monthly intervals by an independent N.A.T.A. registered laboratory at the Contractor’s expense.

The Superintendent shall select the site for the tests provided that it is located in the material deposited in the preceding month and if the target density is achieved then compaction is considered to be satisfactory.

The method of testing for compaction is to be approved by the Superintendent in writing prior to the undertaking of the tests. Should there be disagreement over the method of testing then the following method shall be the one utilised.

> Testing shall be carried out by excavating a trench of approximately two cubic metres (2cu. m) volume and 2 metres depth in the compacted fill by backhoe and loading the excavated material into a truck. The volume excavated shall be measured and the weight of the material excavated determined by weighing at the nearest public weighbridge. The density will then be calculated by dividing the weight of the material in kilograms by the volume in cubic metres.
>
> In supervising the tests the Superintendent will examine the material as it is excavated and if he considers that an excessive amount of cover material is present in the sample, additional trenches shall be excavated until excessive cover material is eliminated.

Should the density reported be less than the minimum density of 750kg/m^3 then a further test shall be carried out at the Contractor’s expense. If the second test achieves the minimum density then compaction is considered satisfactory. If the densities from the second test are not considered satisfactory by the Superintendent then the Contractor will be required to rework the areas filled since the previous compaction tests were undertaken to achieve the minimum compaction required by the contract.

After completion of each test, the excavated waste material shall be replaced in the hole and recompacted at the Contractor’s expense.

The Superintendent may also require the testing of the density of the compacted fill by any other method that has been proved to give accurate results.

FORM NO: QAF0015

ISSUE 1

SOLO RESOURCE RECOVERY
RICHMOND WASTE SERVICES
RICO RECOVERY SYSTEMS

STOTT'S CREEK LANDFILL COMPACTION TESTING

Compaction Test - Stotts Creek Resource Recovery Centre

		WEIGHT				VOLUME	COMPACTION DENSITY	TEST SAMPLE LOCATION
	TEST DATE	GROSS tonnes	TARE tonnes	NET tonnes	WEIGHBRIDGE DOCKET NO.	M^3	Kg / M^3	
DEC	07/12/2009	20.66	19.04	1.62		2	810	Excavated from south west corner of tip face
JAN	27/01/2010	21.68	19.00	2.68		2	1340	Excavated from south west corner of tip face
FEB	10/03/2010	22.06	19.26	2.80		2	1400	Excavated 30m in from cell #1
MAR	06/04/2010	14.42	12.40	2.02		2	1010	Excavated on boundry of cels 3 & 4, 15 mtrs east of cell 2
APR	06/05/2010	15.3	13.5	1.8	SOM628	2	900	Excavated from 30m south of wet cell tip face
MAY	27/05/2010	22.66	20.04	2.62	SI56057	2	1310	Excavated from centre of tip to north end of cell
JUN	05/07/2010	22.82	19.56	3.26	SI62413	2	1630	Excavated 25m west of cell 1, 30m south of tip face
JUL	02/08/2010	15.78	12.92	2.86	SI67080	2	1430	Excavated 30m south of cell 4 and 20m west of cell 1
AUG	31/08/2010	12..36	9.96	2.4	SI71948	2	1200	Excavated 50m west of cell 1 and 30m south of cell 4
SEP	20/10/2010	12.92	10.16	2.76	SI80662	2	1380	Excavated 100 m north of cell 1 and 10 m west of cell 2
OCT	01/11/2010	12.94	10.22	2.72	SI82919	2	1360	Excavated 8m west of cell 2 and 130m north of cell 3
NOV	02/12/2010	12.52	10.3	2.22	SI88307	2	1110	Excavated from centre of cell 3
DEC	07/12/2009	20.66	19.04	1.62		2	810	Excavated from south west corner of tip face
JAN	31/01/2011	12.06	10.06	2.00	SI99283	2	1000	Excavated 30 m west of cell 2 and 150 m south of cell 4
FEB	01/03/2011	13.1	10.08	3.02	SI105002	2	1510	Excavated 40 m south of cell 4 and 18 m west of cell 1
MAR	31/03/2011	13.06	10.28	2.78	SI110621	2	1390	Excavated 30 m west of cell 1 and 10 m south of cell 4
APR	29/04/2011	12.38	10.62	1.76	SI115415	2	880	Excavated 60 m south of cell 4 and 30 m west of cels 1 & 2
MAY	31/05/2011	13.7	10.48	3.22	SOO198	2	1610	Excavated 30 m west of cell 1 and 5 m south of north wall
JUN	01/07/2011	12.56	10.62	1.94	SI124377	2	970	Excavated 10 m from west wall and 30 m from south wall in cell 3
JUL	29/07/2011	13.48	10.88	2.6	SOO399	2	1300	Excavated 15 m east of west wall on boundary of cels 3 & 4
AUG	05/09/2011	13.6	11.4	2.2	SOO514	2	1100	Excavated 30 m east of cell 2 and 50 m north of cell 3

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