

Report for Eviron Road Quarry and Landfill Proposal Part 3A Environmental Assessment

Volume 2: Appendix A-H

November 2011

Appendix A

Director General's Requirements

Contact: Michael Young
Phone: 02 9228 6437
Fax: 02 9228 6466
Email: michael.young@planning.nsw.gov.au

Our ref: S07/01027

Mr David Hannah
Senior Environmental Scientist
Tweed Shire Council
PO Box 816
MURWILLUMBAH NSW 2484

Dear Mr Hannah

Director-General's Requirements
Eviron Road Quarry and Landfill Project
Application Numbers: 08_0067 and 08_0068

The Department has received your applications for the Environ Road Quarry and Landfill Project.

I have attached a copy of the Director-General's requirements for the project. These requirements have been prepared in consultation with relevant agencies, and are based on the information that you have provided to date. I have also attached a copy of the agencies' comments for your information.

Please note that the Director-General may alter these requirements at any time.

If your proposal is likely to have a significant impact on matters of National Environmental Significance, it will require an approval under the Commonwealth *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act). This approval is in addition to any approvals required under NSW legislation. It is your responsibility to contact the Department of Environment, Water, Heritage and the Arts in Canberra ((02) 6274 1111 or (http://www.environment.gov.au) and determine if the project requires an approval under the EPBC Act. The Commonwealth Government has accredited the NSW environmental assessment process, so if it is determined that an approval is required under the EPBC Act, please contact the Department immediately as supplementary Director-General's requirements may need to be issued.

I would appreciate it if you would contact the Department at least two weeks before you submit the Environmental Assessment of the project. This will enable the Department to determine the:

- applicable fees (see Division 1A, Part 15 of the *Environmental Planning & Assessment Regulation 2000)*; and
- number of copies (hard-copy or CD-ROM) of the Environmental Assessment that will be required for exhibition purposes.

Once it receives the Environmental Assessment, the Department will review it in consultation with the relevant agencies to determine if it adequately addresses the Director-General's requirements, and may require you to revise it prior to public exhibition.

The Department is required to make all the relevant information associated with the project publicly available on its website. Consequently, I would appreciate it if you would ensure that all the documents you subsequently submit to the Department are in a suitable format for the web, and arrange for an electronic version of the Environmental Assessment to be hosted on a suitable website during the exhibition period.

If you have any enquiries about these requirements, please contact Michael Young.

Yours sincerely

Chris Wilson
Executive Director
Major Project Assessment
As delegate of the Director-General

Director-General's Requirements

Section 75F and 75M of the *Environmental Planning and Assessment Act 1979*

Application Numbers	Concept Plan: 08_0067 Project Application: 08_0068
Concept Plan	Development of the following in two stages: • 2 quarries: North Valley and West Valley; • 3 landfills: Quirks Quarry, North Valley and West Valley; and • associated infrastructure.
Project Application	Development of Stage 1 of the proposed concept plan, which includes: • extracting, processing, and transporting up to 400,000 tonnes of extractive material a year from the North Valley Quarry; • disposing of up to 75,000 tonnes of putrescible waste a year at the existing Quirks Quarry and then at the North Valley Quarry; • developing a range of associated infrastructure; and • rehabilitating both sites.
Site	Lot 1 DP 34555, Lot 26 DP 615931, Lot 602 DP 1001049
Proponent	Tweed Shire Council
Date of Issue	31 July 2008
General Requirements	The Environmental Assessment of the project must include: • an executive summary; • a detailed description of the following: – historical extractive industry and landfill operations on the site and at the Stotts Creek landfill; – existing and approved extractive industry and landfill operations, including any statutory approvals that apply to these operations; and – existing environmental management and monitoring regime for the site; • a detailed description of the project, including the: – need for the project; – alternatives considered, including a justification for the proposed extractive industry and landfill operations on economic, social and environmental grounds; – likely staging of the project; and – plans of any proposed building works; • a risk assessment of the potential environmental impacts of the project, identifying the key issues for further assessment; • a detailed assessment of the key issues specified below and any other significant issues identified in the risk assessment (see above), which includes: – a description of the existing environment, using sufficient baseline data; – an assessment of the potential impacts of all stages of the project, including any cumulative impacts, taking into consideration any relevant guidelines, policies, plans and statutory provisions (see below); – a description of the measures that would be implemented to avoid, minimise, mitigate, rehabilitate/remediate, monitor and/or offset the potential impacts of the project, including detailed contingency plans for managing any potentially significant risks to the environment; • a statement of commitments, outlining all the proposed environmental management, mitigation and monitoring measures; • a conclusion justifying the project on economic, social and environmental grounds, taking into consideration whether the project is consistent with the objects of the *Environmental Planning and Assessment Act 1979*; and • a signed statement from the author of the Environmental Assessment certifying that the information contained in the report is neither false nor misleading.

Key Issues	• **Waste Management** – including: – accurate estimates of the quantity, nature and likely sources of the waste stream that is likely to be received at the facility; and – a comprehensive waste management strategy for the Tweed LGA as a whole, demonstrating that there is justifiable demand for the proposed landfill operations, and that all reasonable and feasible measures would be implemented across the LGA to maximise resource recovery from the waste stream and reduce the disposal of waste to landfill; • **Soil and Water** – including: – a detailed assessment of the potential impacts of the project on the quantity, quality and long-term integrity of the surface and ground water resources in the area, including any potential flooding impacts; – an assessment of the potential salinity and acid sulphate soil impacts; – a site water balance, including a detailed description of the measures that would be implemented on site to minimise the project's water use; • **Noise, Blasting & Vibration** – including the potential construction, operational and off-site road noise impacts; • **Air Quality & Odour**; • **Greenhouse Gas** – including: - a quantitative assessment of the scope 1 and 2 greenhouse gas emissions of the project; and - a detailed description of the measures that would be implemented to minimise the methane emissions of the proposed landfill operations and ensure that the project is energy efficient; • **Biodiversity** – including: – accurate estimates of any vegetation clearing associated with the project; – a detailed assessment of the potential impacts of the project on any threatened species, populations, endangered ecological communities or their habitats; and – a detailed description of the measures that would be implemented to maintain or improve the biodiversity values of the surrounding region in the medium to long term; • **Transport –** including a detailed assessment of the potential impacts of the project on the safety and performance of the road network; • **Heritage** - both Aboriginal and non-Aboriginal; • **Visual**; • **Hazards**; and • **Rehabilitation –** including: – a detailed description of how the site would be progressively rehabilitated, revegetated, and integrated into the surrounding landscape, including measures to ensure that the final landform is free draining; – a justification for the proposed final landform and use, taking into consideration any relevant strategic land use planning or resource management plans or policies; – a detailed description of the measures that would be put in place to ensure sufficient resources are available to implement the proposed rehabilitation measures, and the ongoing management of the site following the cessation of quarrying activities.
References	While not exhaustive, the following attachment contains a list of the guidelines, policies, and plans that may be relevant to the project.
Consultation	During the preparation of the Environmental Assessment, you should consult with the relevant local, State or Commonwealth Government authorities, service providers, community groups and affected landowners. In particular you must consult with the: • Department of Environment and Climate Change; • Department of Primary Industries; • Department of Water and Energy; • Roads and Traffic Authority; and • Tweed Shire Council.

	The consultation process and the issues raised during this process must be described in the Environmental Assessment.
Deemed refusal period	60 days

Guidelines, Policies & Plans

Aspect	Policy /Methodology
Risk	
	AS/NZS 4360:2004 Risk Management (Standards Australia)
	HB 203: 203:2006 Environmental Risk Management – Principles & Process (Standards Australia)
Waste	
	Waste Avoidance and Resource Recovery Strategy 2007 (DECC)
	Environmental Guidelines: Solid Waste Landfills (NSW EPA)
	Environmental Guidelines: Assessment Classification and Management of Non-Liquid and Liquid Waste (NSW EPA)
	Guideline for the Use and Disposal of Biosolids Products (NSW EPA)
Soil and Water	
Soil	Rural Land Capability Mapping (DLWC)
	Agricultural Land Classification (DPI)
	Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites (ANZECC & NHMRC)
	National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC)
	State Environmental Planning Policy No. 55 – Remediation of Land
	Managing Land Contamination – Planning Guidelines SEPP 55 – Remediation of Land (DOP)
	Design Manual for Soil Conservation Works - Technical Handbook No. 5 (DWE)
	Acid Sulfate Soil Manual (ASSMAC)
Surface Water	National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ)
	National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ)
	National Water Quality Management Strategy: Guidelines for Sewerage Systems – Effluent Management (ARMCANZ/ANZECC)
	National Water Quality Management Strategy: Guidelines for Sewerage Systems – Use of Reclaimed Water (ARMCANZ/ANZECC)
	Using the ANZECC Guideline and Water Quality Objectives in NSW (DEC)
	State Water Management Outcomes Plan
	NSW Government Water Quality and River Flow Environmental Objectives (DECC)
	Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC)
	Managing Urban Stormwater: Soils & Construction (Landcom)
	Managing Urban Stormwater: Treatment Techniques (DECC)
	Managing Urban Stormwater: Source Control (DECC)
	Technical Guidelines: Bunding & Spill Management (DECC)
	Environmental Guidelines: Use of Effluent by Irrigation
	Floodplain Management Manual (DNR)
	Floodplain Risk Management Guideline: Practical Consideration of Climate Change (DECC)
Groundwater	National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ/ANZECC)
	NSW State Groundwater Policy Framework Document (DWE)
	NSW State Groundwater Quality Protection Policy (DWE)
	NSW State Groundwater Quantity Management Policy (DWE) Draft
	NSW Salinity Strategy (DWE)

Noise & Blasting	
	NSW Industrial Noise Policy (DECC)
	Environmental Criteria for Road Traffic Noise (DECC – EPA)
	Environmental Noise Control Manual (DECC)
	Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (ANZECC)
	Assessing Vibration: A Technical Guideline (DECC)
	Explosives—Storage, Transport and Use, Part 2: Use of Explosives (Standards Australia AS 2187.2)
Air Quality & Odour	
	Protection of the Environment Operations (Clean Air) Regulation 2002
	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DECC)
	Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DECC)
	Assessment and Management of Odour from Stationary Sources in NSW (DECC)
Greenhouse Gas	
	National Greenhouse Accounts (NGA) Factors
	Guidelines for Energy Savings Action Plans (DEUS)
Biodiversity	
	Draft Guidelines for Threatened Species Assessment under Part 3A of the *Environmental Planning and Assessment Act 1979* (DECC)
	Policy & Guidelines - Aquatic Habitat Management and Fish Conservation (DPI Fisheries)
	Policy & Guidelines for Fish Friendly Waterway Crossings (DPI Fisheries)
	Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (DPI Fisheries)
	The NSW State Groundwater Dependent Ecosystem Policy (DWE)
	State Environmental Planning Policy No. 44 – Koala Habitat Protection
Transport	
	Guide to Traffic Generating Development (RTA)
	Road Design Guide (RTA)
Heritage	
Aboriginal	Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC)
	Aboriginal Cultural Heritage Standards and Guidelines Kit (NSW EPA)
Non-Indigenous	NSW Heritage Manual (NSW Heritage Office & DUAP)
	The Burra Charter (The Australia ICOMOS charter for places of cultural significance)
Visual	
	Control of Obtrusive Effects of Outdoor Lighting (AS 4282)
Hazards	
	State Environmental Planning Policy No. 33 – Hazardous and Offensive Development
	Applying Sepp 33: Hazardous And Offensive Development Application Guidelines (DUAP)
	Hazardous Industry Planning Advisory Paper No. 6 (HIPAP No 6): *Guidelines for Hazardous Analysis*, (DUAP)
	Multi-Level Risk Assessment (DUAP)
	Planning for Bush Fire Protection (NSW Rural Fire Service)
Strategic Plans	
	Far North Coast Strategy
	North Coast Regional Environmental Plan
	Tweed Local Environmental Plan 2000

Consultation	
	Guidelines for Major Project Community Consultation (DoP)
Industry	
	EIS Guideline – Extractive Industries Quarries (DOP)

Appendix B

Quirks Quarry Landfill Concept Design

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council

Report for Quirks Quarry Landfill

Concept Design Report (Revised)

October 2011



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

Contents

1. Introduction 1

1.1 General 1
1.2 Scope of Report 1
1.3 Background Information 1

2. Site Overview 3

2.1 Site Location 3
2.2 Site History 3
2.3 Land Use 3
2.4 Land Ownership 3
2.5 Topography 3
2.6 Geology 4
2.7 Soils 4
2.8 Groundwater 4
2.9 Surface Hydrology 5
2.10 Climate 5

3. Concept Design Basis 6

3.1 General 6
3.2 Existing Services & Site Infrastructure 6
3.3 Groundwater 7
3.4 Surface Hydrology 7
3.5 Geotechnical 8
3.6 Site Access 8
3.7 Void Capacity 8
3.8 Leachate 10

4. Concept Design 19

4.1 General 19
4.2 Cell Life Requirements 19
4.3 Sequencing of Stages 19
4.4 Final Waste Profile 21
4.5 Cell Liner Details 21
4.6 Capping Details 22

4.7 Material Balance 23
4.8 Concept Leachate Infrastructure 25
4.9 Concept Stormwater Infrastructure 25
4.10 Concept Landfill Gas Infrastructure 28

Table Index

Table 1 Groundwater Levels 5
Table 2 Life Expectancy of Quirks Quarry Landfill 9
Table 3 Summary of Leachate Generation Modelling Results 11
Table 4 Life Expectancy of Each Landfill Cell 19
Table 5 Material Balance Summary 24

Figure Index

Figure 1 Cumulative leachate generation 12

Appendices

A Figures
B Concept Leachate Generation Calculations
C Concept Stormwater Calculations
D Fig 4 – Final Quarry Landform
E Stotts Creek Waste Compaction Data and Testing Procedure

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).

[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.;

[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.

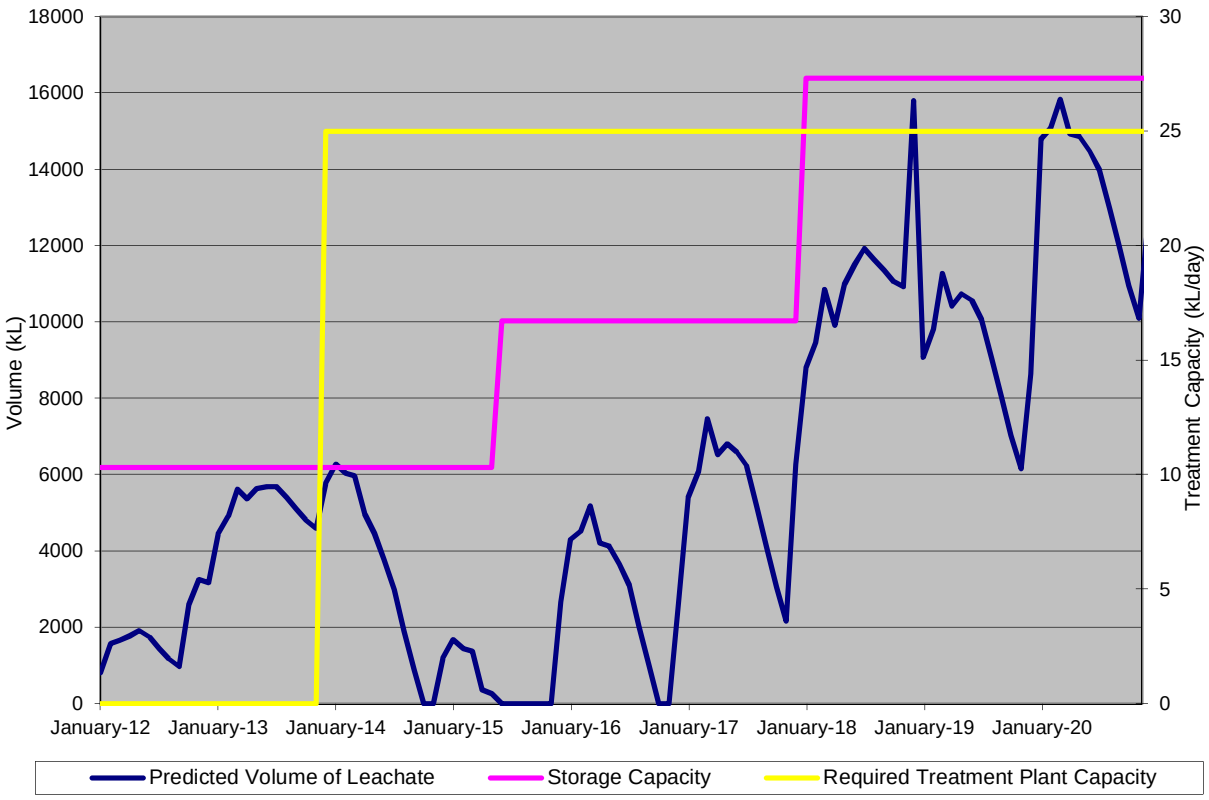


Figure 1 Cumulative leachate generation

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**

[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

CLIENTS | PEOPLE | PERFORMANCE

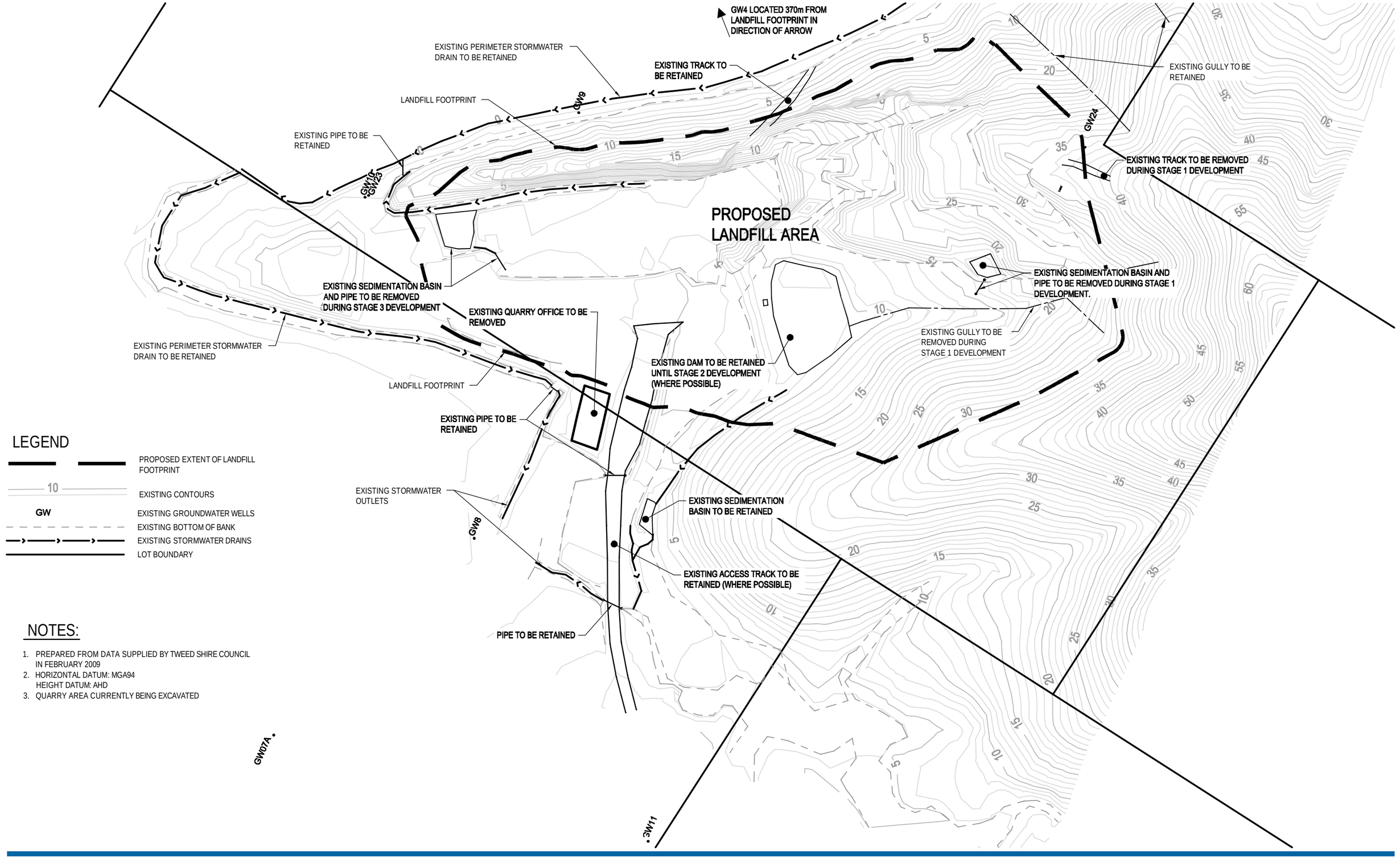
TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

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



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

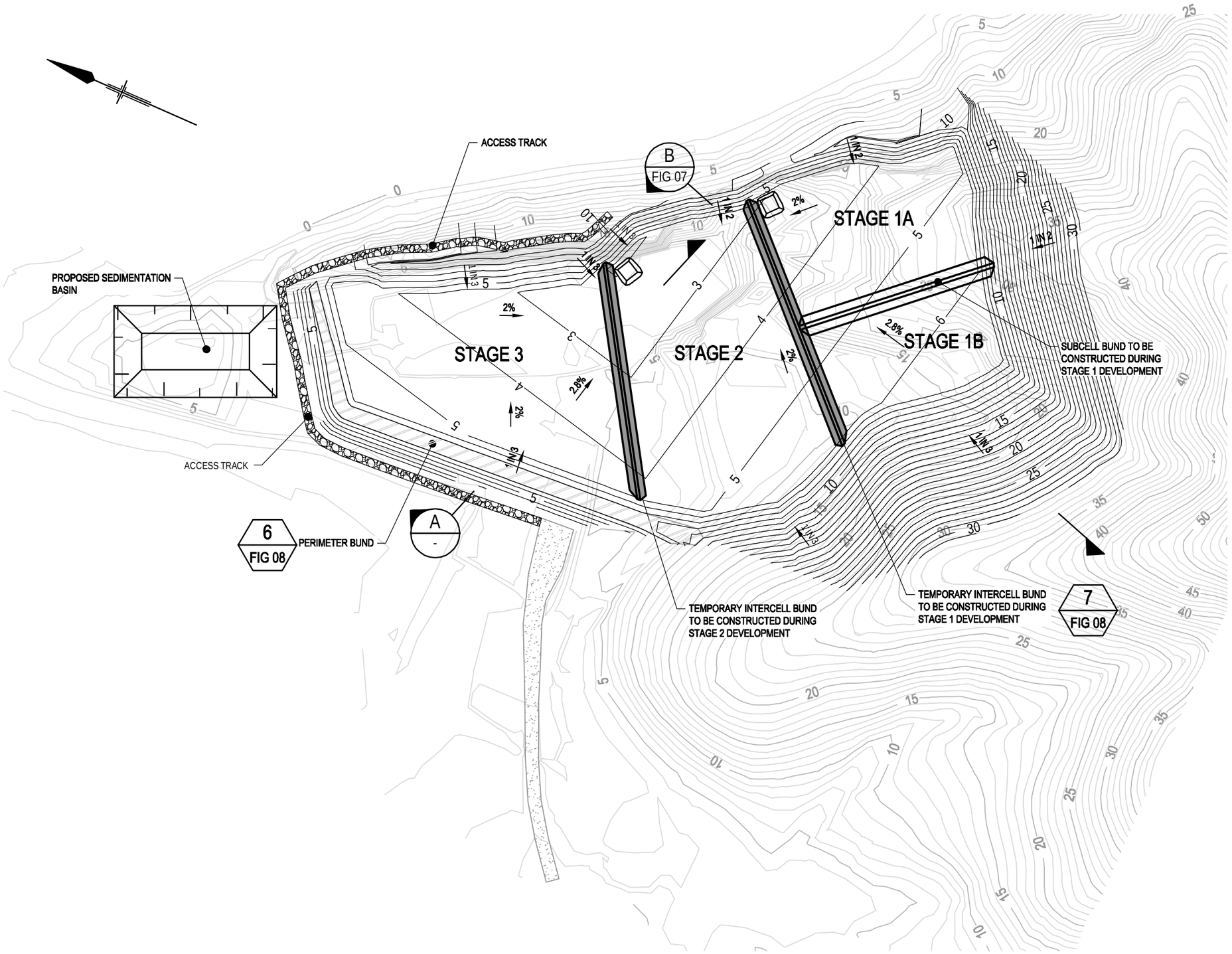
EXISTING SITE PLAN

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)

CLIENTS | PEOPLE | PERFORMANCE

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

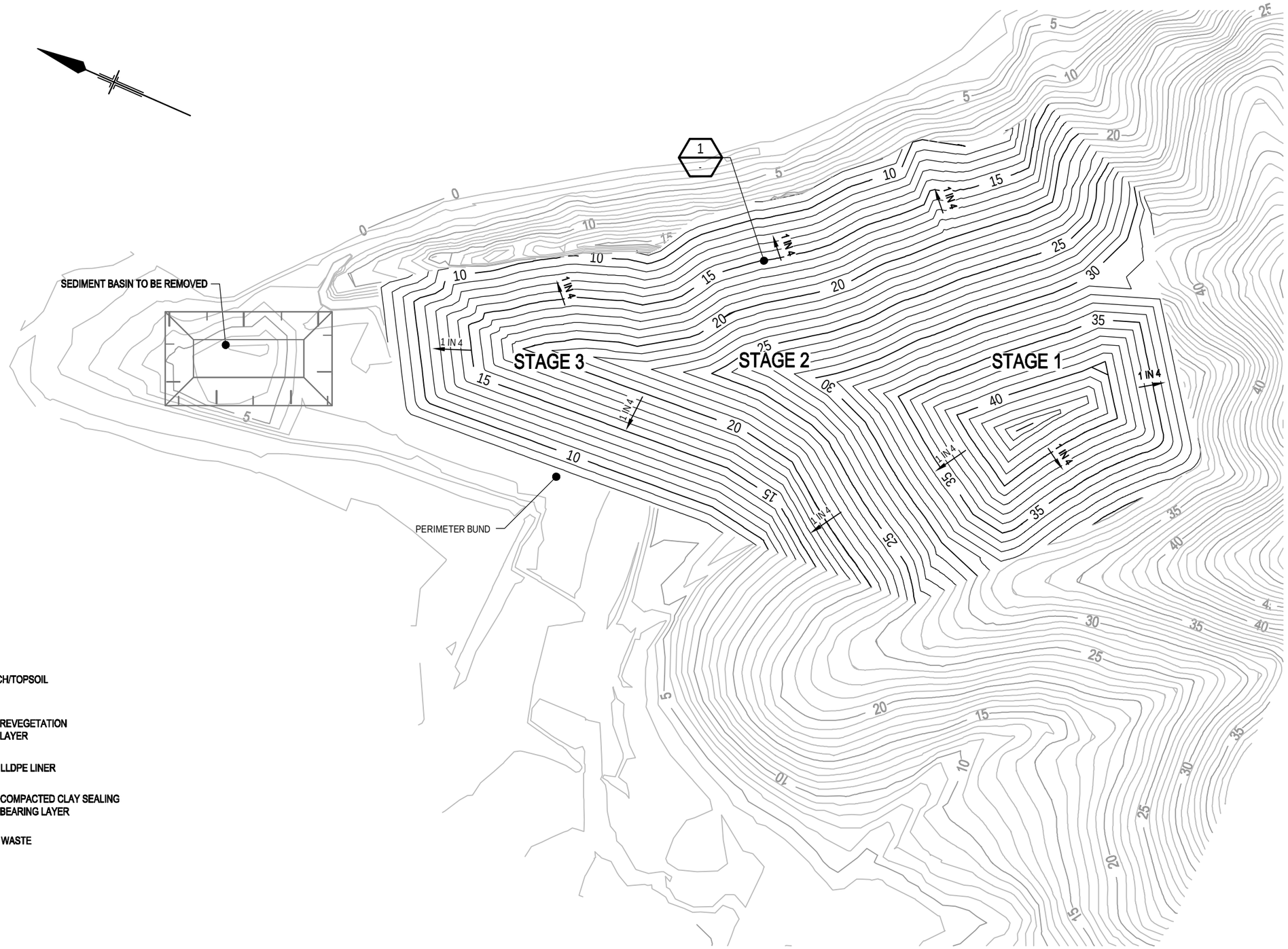
VOLUME CALCULATIONS FOR WASTE / DAILY COVER VOID CAPACITYTO SUBGRADE PROFILE

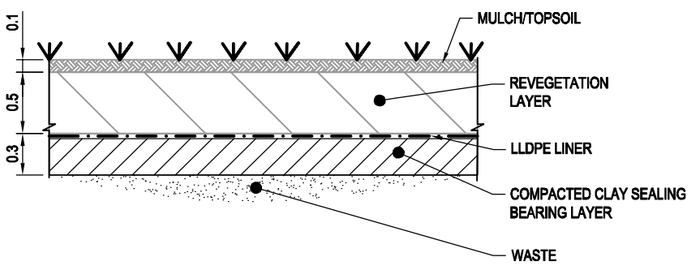
STAGE 1	
PLAN AREA	26,100 m²
VOID CAPACITY	273,000 m³
STAGE 2	
PLAN AREA	17,000 m²
VOID CAPACITY	306,000 m³
STAGE 3	
PLAN AREA	14,400 m²
VOID CAPACITY	171,000 m³
TOTAL	
PLAN AREA	57,500 m²
VOID CAPACITY	750,000 m³

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)

TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

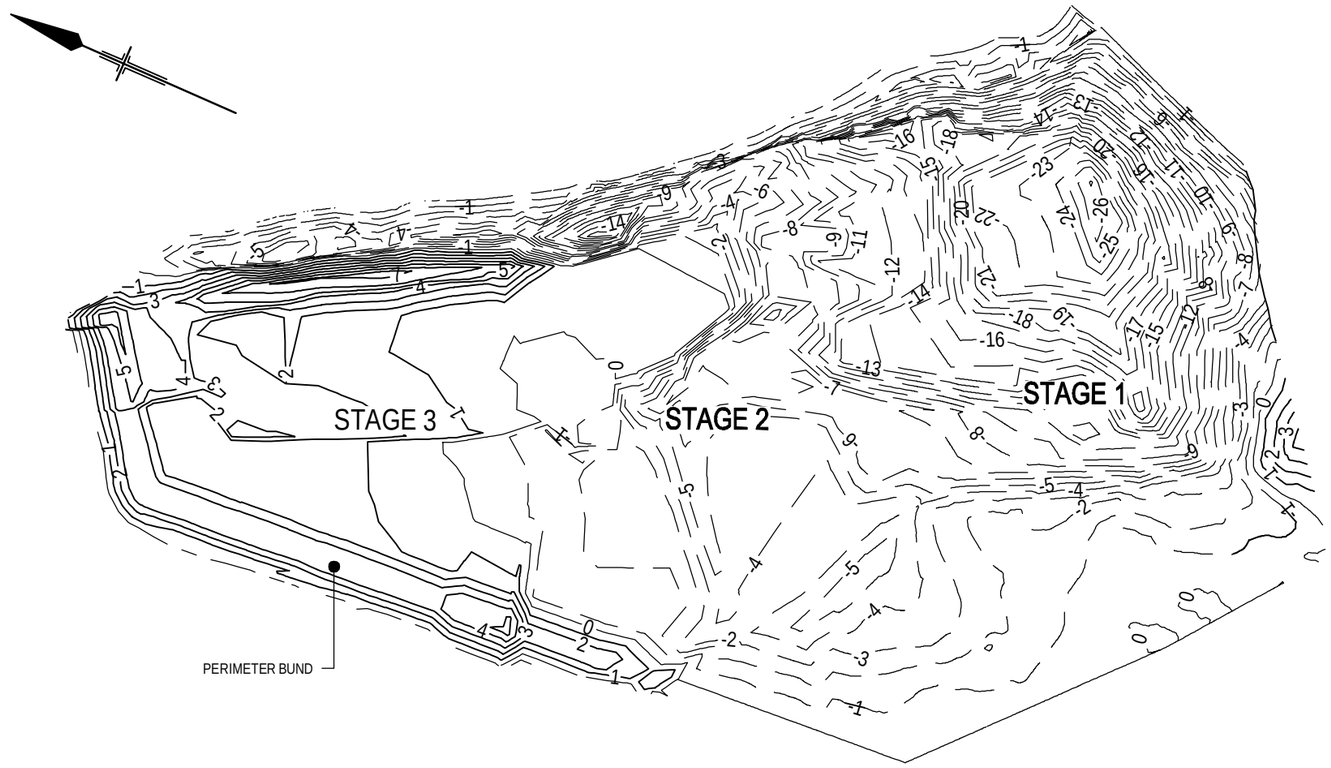
FINAL WASTE FILL CONTOURS AND CAP DETAILS

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

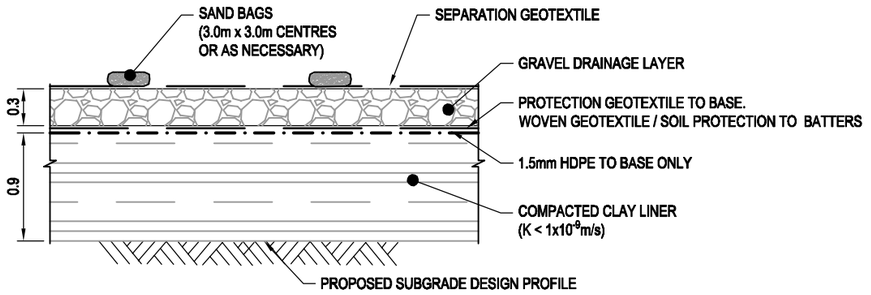
CUT AND FILL PLAN

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

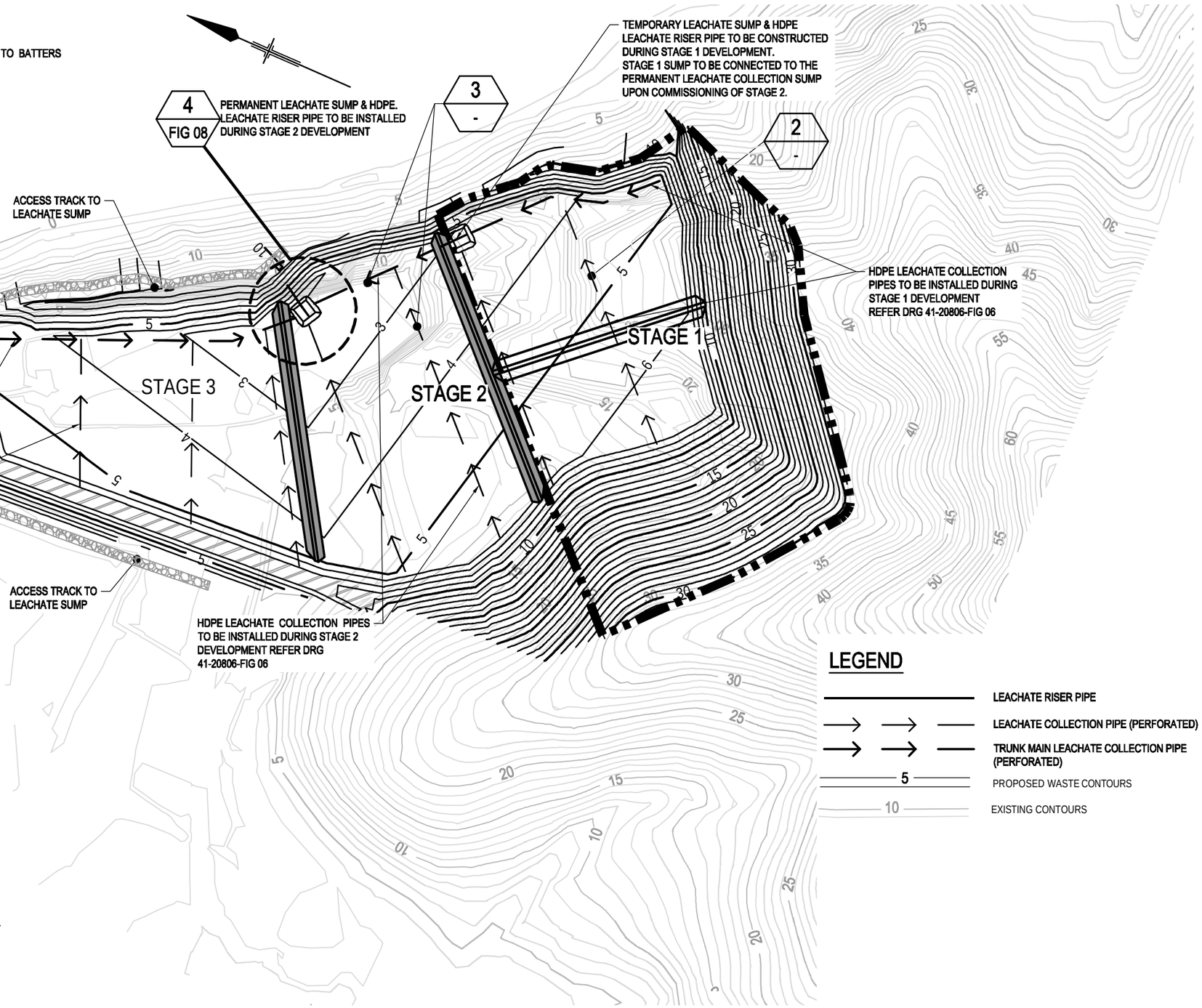
Plot Date: 26 October 2010 - 3:41 PM Plotted by: Nicola Hankin/Brisbane/GHD/AU Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 05-RC.dwg

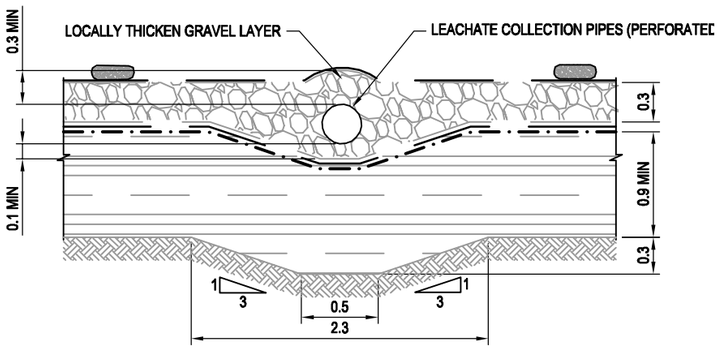


TYPICAL LINER DETAIL

2 / - DETAIL

SCALE 1 : 25





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)

TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

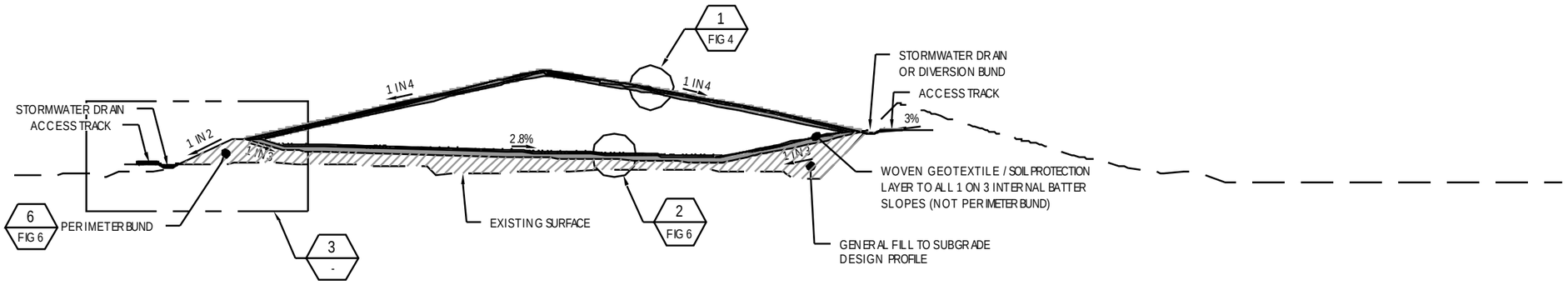
LEACHATE ARRANGEMENT AND DETAILS

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

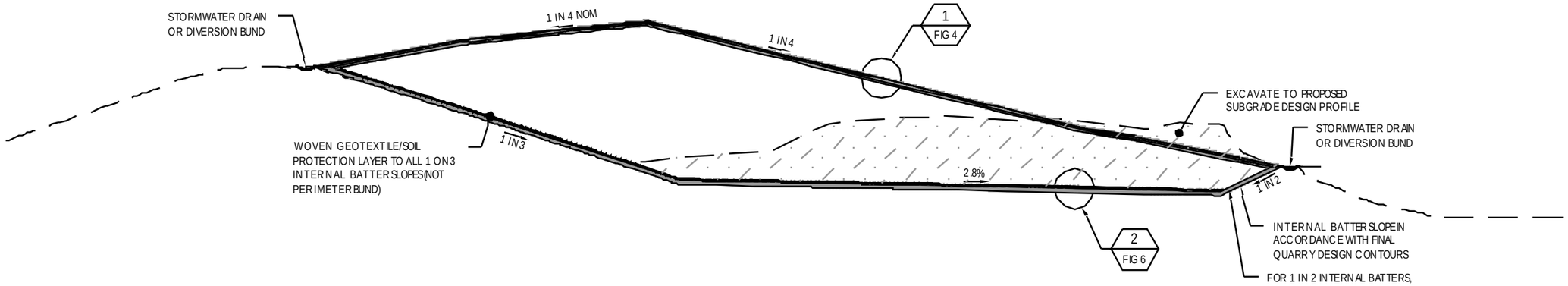
Plot Date: 26 October 2010 - 3:43 PM Plotted by: Nicola Hankin/Brisbane/GHD/AU Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 06-RC.dwg



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)

GHD

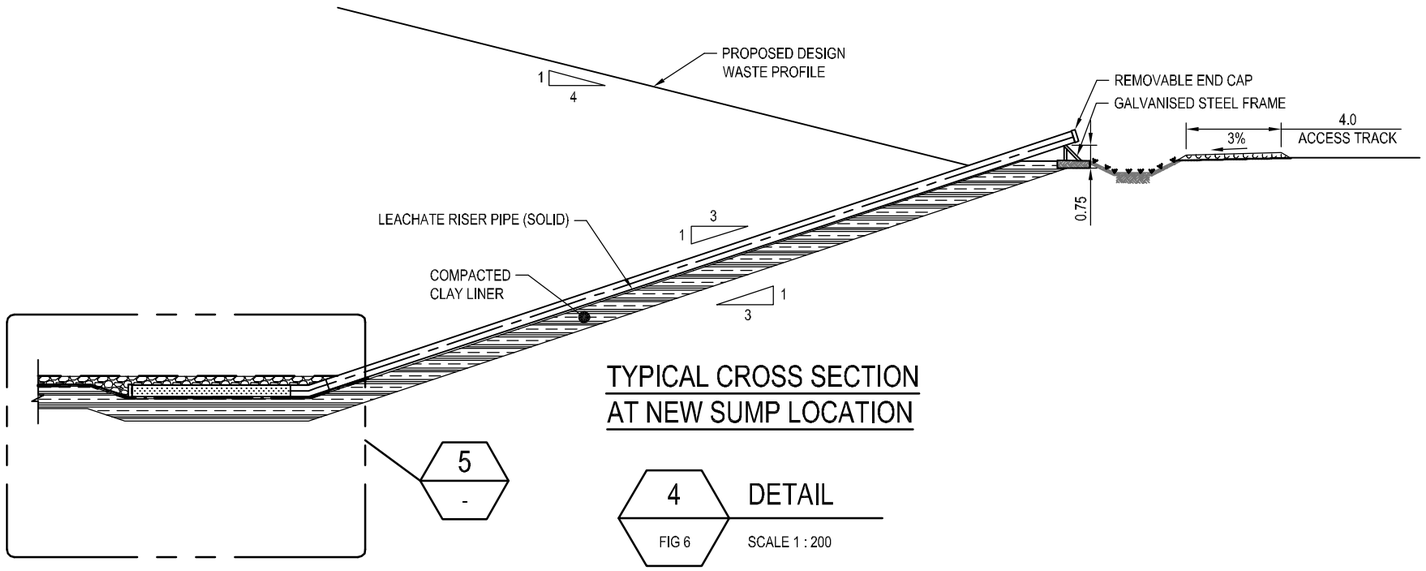
CLIENTS | PEOPLE | PERFORMANCE

TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

TYPICAL CROSS SECTIONS

Job Number 41-20806
Revision B
Date OCT 2009

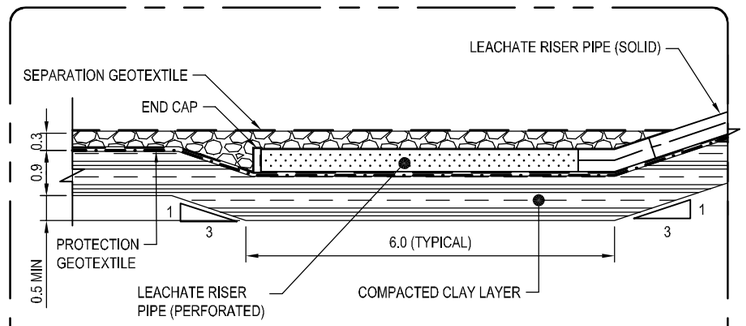
Figure 07



TYPICAL CROSS SECTION AT NEW SUMP LOCATION

4 / FIG 6 — DETAIL

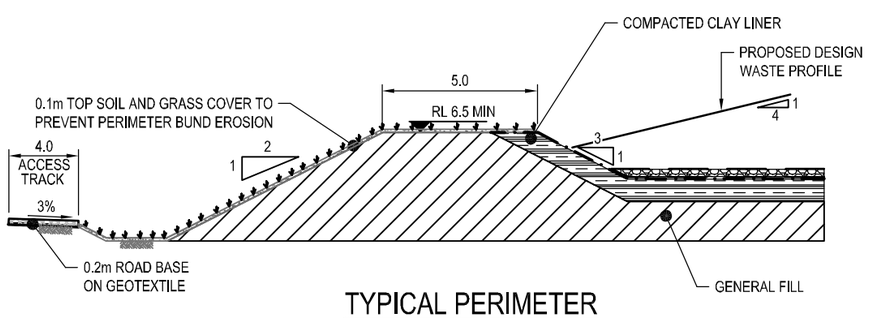
SCALE 1 : 200



SUMP DETAIL

5 / - — DETAIL

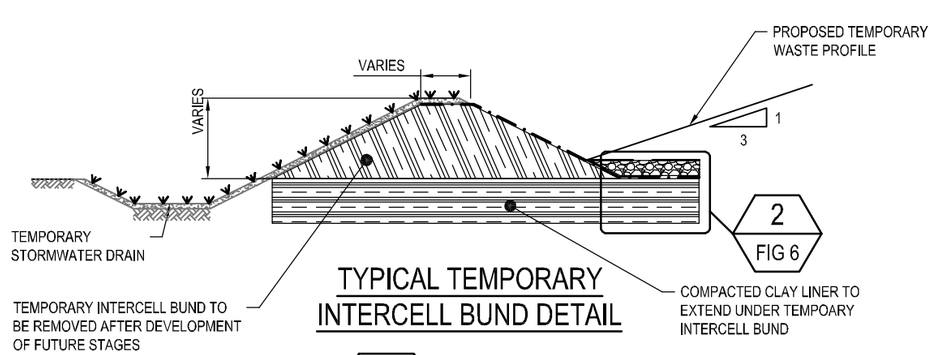
SCALE 1 : 50



TYPICAL PERIMETER BUND DETAIL

6 / FIG 3 — DETAIL

SCALE 1 : 200



TYPICAL TEMPORARY INTERCELL BUND DETAIL

7 / FIG 3 — DETAIL

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)

GHD

CLIENTS | PEOPLE | PERFORMANCE

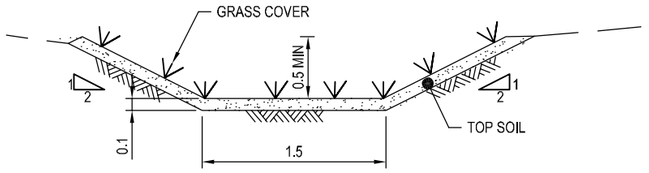
TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

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

EXISTING GULLY

EXISTING STORMWATER DRAIN TO BE RETAINED

ACCESS TRACK

PROPOSED SEDIMENTATION BASIN TO BE INSTALLED DURING STAGE 1 DEVELOPMENT

TEMPORARY CLEAN STORMWATER DRAIN WHILE FILLING UP TO RL 15 IN STAGE 1

TEMPORARY CLEAN STORMWATER DRAIN WHILE LANDFILLING IN STAGE 1

TEMPORARY CLEAN STORMWATER DRAIN WHILE LANDFILLING IN STAGE 2

PUMP CLEAN STORMWATER TO TEMPORARY DRAIN WHEN FILLING IN STAGE 1A ONLY

8 / -

ACCESS TRACK

9 / -

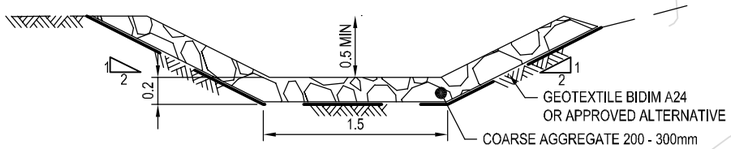
DISCHARGE TO NATURAL WATER COURSE

EXISTING STORMWATER DRAIN TO BE UTILISED AS REQUIRED

EXISTING DAM TO BE UTILISED DURING STAGE 1 DEVELOPMENT (IF POSSIBLE)

EXISTING SEDIMENTATION BASIN TO BE UTILISED AS REQUIRED

EXISTING ACCESS ROAD



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)

GHD
CLIENTS | PEOPLE | PERFORMANCE

TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

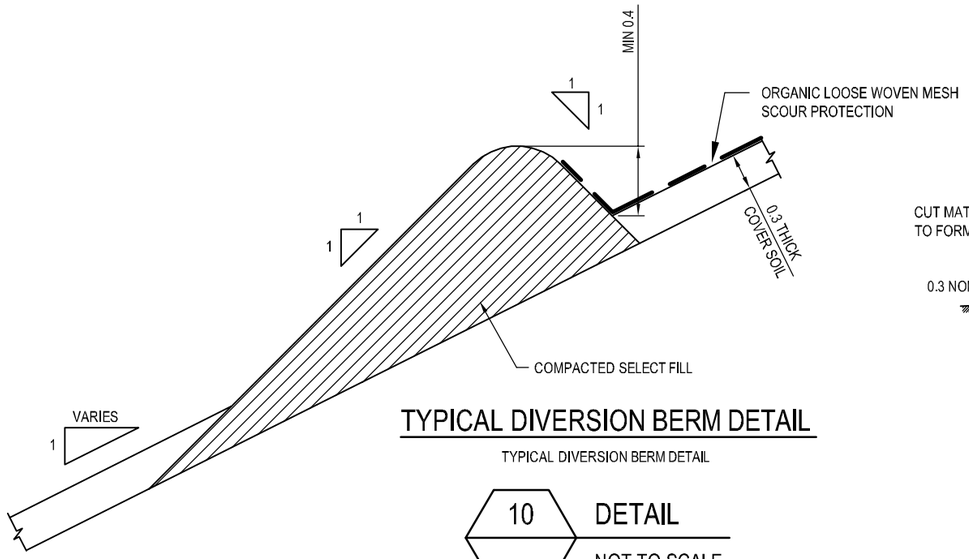
STORMWATER ARRANGEMENT AND DETAILS

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

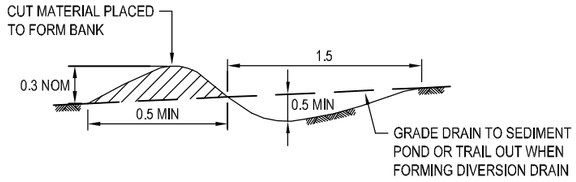
Plot Date: 21 October 2009 - 12:55 PM Plotted by: Nicola Hankin, Brisbane Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 09.dwg



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

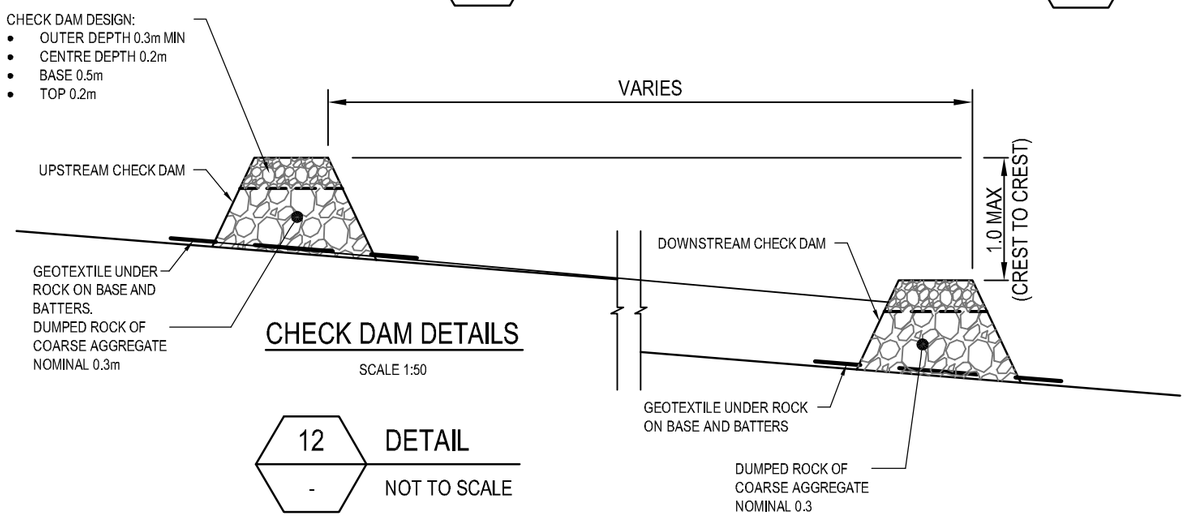
NOTES:

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

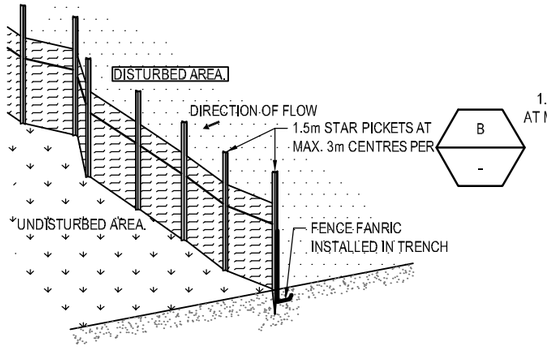
4.SILT FENCE CONSTRUCTION
- 4.1 CONSTRUCT SEDIMENT FENCE AS CLOSE AS POSSIBLE TO PARALLEL TO THE CONTOURS OF THE SITE.
- 4.2 DRIVE 1.5m LONG STAR PICKETS INTO GROUND 3m APART.
- 4.3 DIG A 0.15m DEEP TRENCH ALONG THE UPSIDE LINE OF THE FENCE FOR THE BOTTOM OF THE FABRIC TO BE ENTRENCHED.
- 4.4 BACKFILL 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

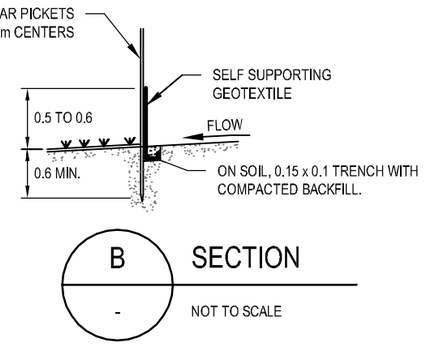
SCALE 1:50

12 DETAIL
- NOT TO SCALE



TYPICAL SILT FENCE

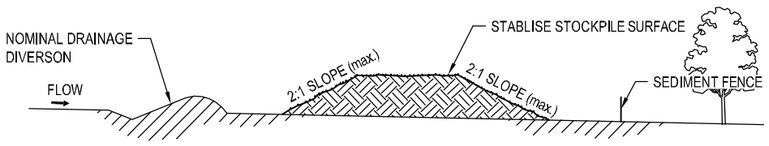
NOT TO SCALE



B SECTION
- NOT TO SCALE

TYPICAL SILT FENCE SECTION

NOT TO SCALE

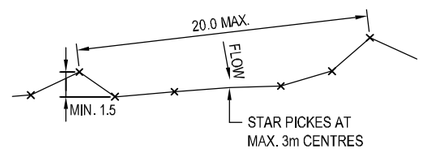


TYPICAL STOCKPILE SECTION DETAIL

NOT TO SCALE

13 DETAIL
- NOT TO SCALE

14 DETAIL
- NOT TO SCALE



SILT FENCE PLAN

NOT TO SCALE

0 0.5 1.0 1.5m
SCALE 1:50 AT ORIGINAL SIZE (A3)

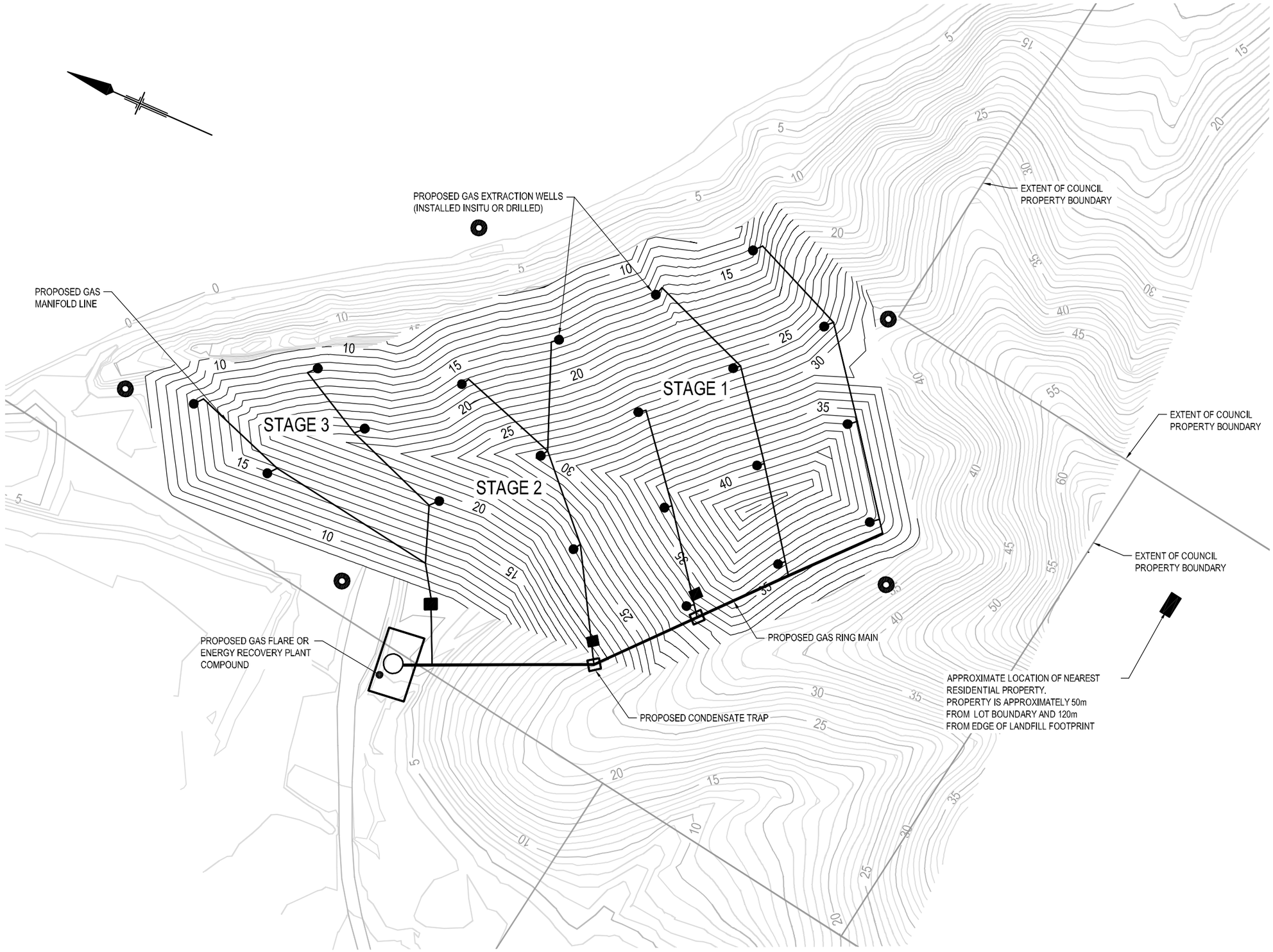
GHD
CLIENTS | PEOPLE | PERFORMANCE

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)

GHD
CLIENTS | PEOPLE | PERFORMANCE

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	(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	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	(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	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	(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	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	(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)**	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**			

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	Cell 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 mm	Annual Total m3	Percent
		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**			

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 mm	Annual Total m3	Percent
		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**			

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				
Disturbed catchment area (ha)	5.75						Whole area will be disturbed as is currently a quarry

Soil analysis

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

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

Concept Design Sedimentation Basin Calculations

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

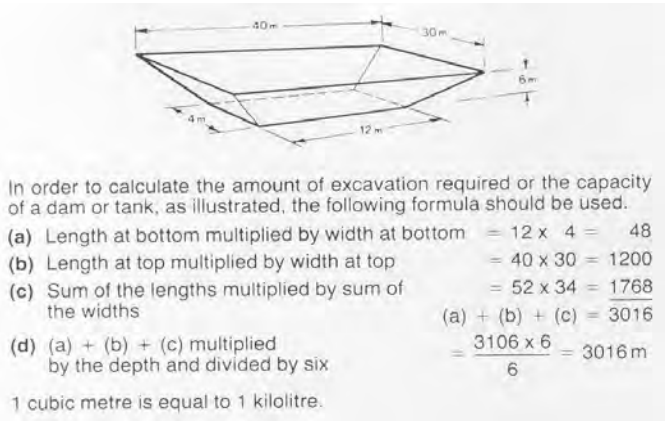
Length	83.00
width	53.00
depth	2.50
internal slopes	3.00

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

CLEAR CAMPHOUR LAUREL & LANTANA & REPLANT WITH KAOLA FEED TREES TO FORM LINK TO SOUTHERN RIDGES AS INDICATED POM.

WET SCLEROPHYLL FOREST TO REMAIN

Bottom of Drain

FINAL QUARRY FLOOR

BM Gip.
RL 36.525

Pine Trees

Open Drain

Entry Gate

BM Nail in Tree
RL 3.695 AHD

Dam

PROPOSED HAUL ROAD

POND

Tree

Drain

Levee

EXISTING QUARRY FLOOR TO BE REHABILITATED

0 40 80
20 60 100m
SCALE 1 : 2000

Ray Sargent & associates
CONSULTING ENGINEERS
A.C.N. 003 108 807
'Rochdale House'
155 Ballina Road
Goonellabah N.S.W.
P.O. Box 147
Lismore N.S.W. 2480
Telephone: (02) 6624 6800
Facsimile: (02) 6624 6888
Email: r.s.a@bigpond.com

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.

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

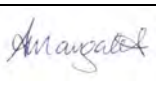
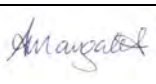
GHD

Level 13, 203 Robina Town Centre Drive,
Robina QLD 4226 Australia
T: 61 7 5557 1000 F: 61 7 5557 1099 E: goldcoastmail@ghd.com

© GHD 2011

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	N. Hankin	P. Navin		DRAFT	DRAFT	Mar 09
1	N. Hankin A.Roberts	A. Roberts	DRAFT	L Rodriguez	DRAFT	Oct 09
2	N. Hankin A.Roberts	A. Roberts		A Marszalek		12/11/09
3	N. Hankin A.Roberts	A. Roberts		A Marszalek		4/10/11

Appendix C

Quirks Quarry Landfill Draft Landfill Environmental Management Plan

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council

Report for Quirks Quarry Landfill

Draft Landfill Environmental Management Plan

November 2011



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

Contents

1. Introduction 1
   - 1.1 General 1
   - 1.2 Scope of the Plan 1
2. Site Overview 5
   - 2.1 Site Location 5
   - 2.2 Site History 5
   - 2.3 Land Use 5
   - 2.4 Land Ownership 5
   - 2.5 Topography 5
   - 2.6 Geology 6
   - 2.7 Soils 6
   - 2.8 Groundwater Hydrology 6
   - 2.9 Surface Hydrology 7
   - 2.10 Climate 7
3. Approvals and Licensing 10
   - 3.1 Environment Protection Licence 10
   - 3.2 Development Consent 10
4. Facility Design and Construction 11
   - 4.1 General 11
   - 4.2 Facility Layout 11
   - 4.3 Staging/Filling of the Landfill 11
   - 4.4 Final Landform and Life of Site 12
   - 4.5 Stormwater Management Works 13
   - 4.6 Green Waste Processing Area Works 14
   - 4.7 Leachate Management 14
   - 4.8 Small Vehicle Drop-off Point 14
5. Facility Management and Operation 16
   - 5.1 General 16
   - 5.2 Planning 16
   - 5.3 Management, Supervision and Staffing 16
   - 5.4 Hours of Operation 18

5.5 Waste Accepted at Facility 18
5.6 Recycling and Resource Recovery 18
5.7 Special Waste Handling Procedures 21
5.8 Covering Layers 21
5.9 Final Cap 22
5.10 Security 24
5.11 Health and Safety Procedures 24
5.12 Wet Weather Operation 25
5.13 Access Road Maintenance 25
5.14 Fire Control 25
5.15 Waste Recording and Reporting 26
5.16 Quality Assurance 27

6. Environmental Management 28

6.1 Water 28
6.2 Air 30
6.3 Litter 31
6.4 Vermin 31
6.5 Noise 31

7. Environmental Monitoring 33

7.1 General 33
7.2 Groundwater 33
7.3 Leachate 34
7.4 Stormwater 35
7.5 Landfill Gas 35
7.6 Monitoring Program Review 35
7.7 Complaints 36
7.8 Record Keeping 36

8. Site Rehabilitation and Post Closure Management 37

8.1 Final Landuse and Site Rehabilitation 37
8.2 Closure Plan 37
8.3 Post Closure Management 37

9. Reporting and Review 39

9.1 Annual Reporting 39
9.2 Incident Reporting 39
9.3 Landfill Environmental Management Plan Review 40

10. References 41

Table Index

Table 1	Environmental Goals and Control Measures	2
Table 2	List of Figures	3
Table 3	Groundwater Levels	6
Table 4	Average Climatic Data	8
Table 5	Life Expectancy for Landfill Footprint	13
Table 6	Groundwater monitoring system	33

Figure Index

Figure 1	Bureau of Meteorology Murwillumbah (Bray Park) Climate Data	9

Appendices

A Figures
B Environmental Protection Licence

1. Introduction

1.1 General

GHD was commissioned by Tweed Shire Council (TSC) to prepare this Draft Landfill Environmental Management Plan (LEMP) for the proposed Quirks Quarry Landfill. This Draft LEMP has been prepared to incorporate the future planned landfill development. Implementation of the draft LEMP will ensure environmental management techniques form an integral part of the operations at Quirks Quarry Landfill,

The following documents have been considered in the preparation of this document:

- NSW Environment Protection Authority's Environmental Guidelines: Solid Waste Landfills (1996);
- Draft Environmental Guidelines: Landfilling, Department of Environment and Conservation NSW, August 2007;
- NSW Environment Protection Authority's Environmental Guidelines: Composting And Related Organics Processing Facilities (2004);
- NSW Environment Protection Authority's LEMP Preparation Manual (1996);
- NSW Department of Environment and Climate Change's Managing urban stormwater: Soils and construction, Volume 2B – Waste Landfills, June 2008;
- Protection of the Environment Operations Act 1997 (POEO Act 1997); and
- Waste Avoidance and Resource Recovery Act 2001.

1.2 Scope of the Plan

1.2.1 Background

To provide a consistent and environmentally responsible approach to managing landfills within NSW, the NSW Department of Environment, Climate Change and Water (DECCW, formerly EPA) issued guidelines in 1996 for solid waste landfills titled Environmental Guidelines: Solid Waste Landfills (the Landfill Guidelines). A performance-based approach to landfill management has been adopted by the DECCW that allows the most appropriate mechanisms to be implemented at each landfill site to achieve specific environmental goals. The goals and the approach to landfill regulation and management are described in the guidelines. The environmental goals identified in the guidelines are:

- Preventing water pollution;
- Preventing air pollution;
- Promoting responsible land management and conservation; and
- Preventing hazards and loss of amenity.

The mechanism for DECCW regulation of landfill operations is based around licensing those facilities that have the greatest potential to cause environmental impact. All licensed waste facilities are required to have a LEMP, which describes the strategies and measures for managing the landfilling operation and achieving the environmental goals as identified in the Landfill Guidelines. Operation of the landfill must then comply with the LEMP.

1.2.2 Contents

This Draft LEMP has been developed to facilitate the safe and efficient operation of the proposed landfill and to ensure that the environment and the surrounding community is safeguarded from pollution and off-site effects. It describes the level of performance expected in managing, operating, monitoring and rehabilitating the site.

TSC shall ensure that all staff and sub-contractors at the site are familiar with the relevant requirements described in this Draft LEMP.

A copy of TSC's Environment Protection License (EPL) (pending approval of the project) for the site and the finalised LEMP shall be kept on site at all times and shall be made available for inspection to the DECCW upon request (a copy of the EPL will be included in Appendix B once granted). Further, TSC will ensure that the landfill and its associated facilities are operated in accordance with all regulatory requirements.

The Draft LEMP addresses the following:

- Approvals and licensing;
- The existing site, including a brief history of the site;
- Design and construction of the landfill;
- Management and operation of the landfill;
- Environmental management measures;
- Environmental monitoring program;
- Site rehabilitation and post closure management; and
- Reporting.

1.2.3 Goals

A summary of the environmental goals identified in the Landfill Guidelines, together with where to find the measures proposed to achieve the goals in this LEMP, is provided in Table 1.

Table 1 Environmental Goals and Control Measures

Environmental Goals	Addressed in section
Water Pollution	
Preventing pollution of water by leachate	4.7, 7.3
Detecting water pollution	7.2, 7.3, 7.4
Remediation of water pollution	7.3, 7.4
Air Pollution	
Preventing landfill gas emissions	5.9, 6.2
Detecting landfill gas emissions	6.2, 7.5
Remediation of landfill gas emissions	6.2, 7.5

Environmental Goals	Addressed in section
Land Management and Conservation	
Assuring quality of design, construction and operation	4
Assuring quality of incoming waste	5.3, 5.5, 5.16,
Recording of wastes received	5.3, 5.5, 5.15
Minimising landfill space used	5.6.12
Maximisation of recycling	5.6
Remediation of landfill post closure	8
Hazards and Loss of Amenity	
Preventing unauthorised entry	5.10
Preventing degradation of local amenity	5.1, 6
Preventing noise pollution	6.5
Adequate fire-fighting capacity	5.14
Adequate staffing and training	5.3

1.2.4 Figures

This Draft LEMP refers to the Figures listed in Table 2, which are included in 0

Table 2 List of Figures

Figure Number	Title
Figure 01	LOCALITY PLAN AND FIGURE 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 INFRASTRUCTURE

Figure 12	Bureau of Meteorology Murwillumbah (Bray Park) Climate Data

1.2.5 Revisions and Updates

TSC will revise and update the Draft LEMP as required to ensure that it reflects the facilities and operations at the proposed Quirks Quarry Landfill facility and any changes in regulatory requirements. This shall include undertaking revisions and updates due to changes in the site's future EPL or due to changes in operations or directives from TSC or the DECCW.

TSC shall review and update the Draft LEMP (as necessary) after every review of the site's future EPL or at least every 3 years (see Section 9.3).

This Draft LEMP has been prepared as part of TSC's application to DECCW for the future planned Quirks Quarry Landfill development.

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 in the suburb of Environ. 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 41-20864-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 Hydrology

It is currently understood that groundwater at the site flows from the south west to the north east. During initial concept design, GHD used groundwater monitoring data from August 2008. Preliminary analysis of additional standing water level data 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 3 shows the historical range of standing water levels recorded for the monitoring wells within the proposed landfill area to date.

During detailed design or at the construction phase, further geological and hydrogeological investigations and assessments are required to further understand the local groundwater conditions.

Table 3 Groundwater Levels

Ground water ID	Top Casing (RL)	Standing Water Level (RL)	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

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). The mean monthly and annual climatic data has been summarised in Table 4 and Figure 12 (located in Appendix A).

Table 4 Average Climatic Data

Statistic Element	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Mean maximum temperature (Degrees C)	29.6	29	28.1	26.2	23.6	21.4	21	22.4	25.1	26.3	27.6	29.2	25.8
Mean minimum temperature (Degrees C)	19.7	19.6	18.1	15.4	12.6	9.8	8.5	8.8	11.4	14.1	16.5	18.4	14.4
Mean rainfall (mm)	198.7	229.5	211.2	161.7	138.3	96.8	67.7	51.3	42.4	87.6	128.8	158.8	1581.3
Mean 3pm wind speed (km/h)	17	15.5	15.5	13.5	11.2	11	12.6	14.6	17.9	18.1	16.9	16.9	15.1

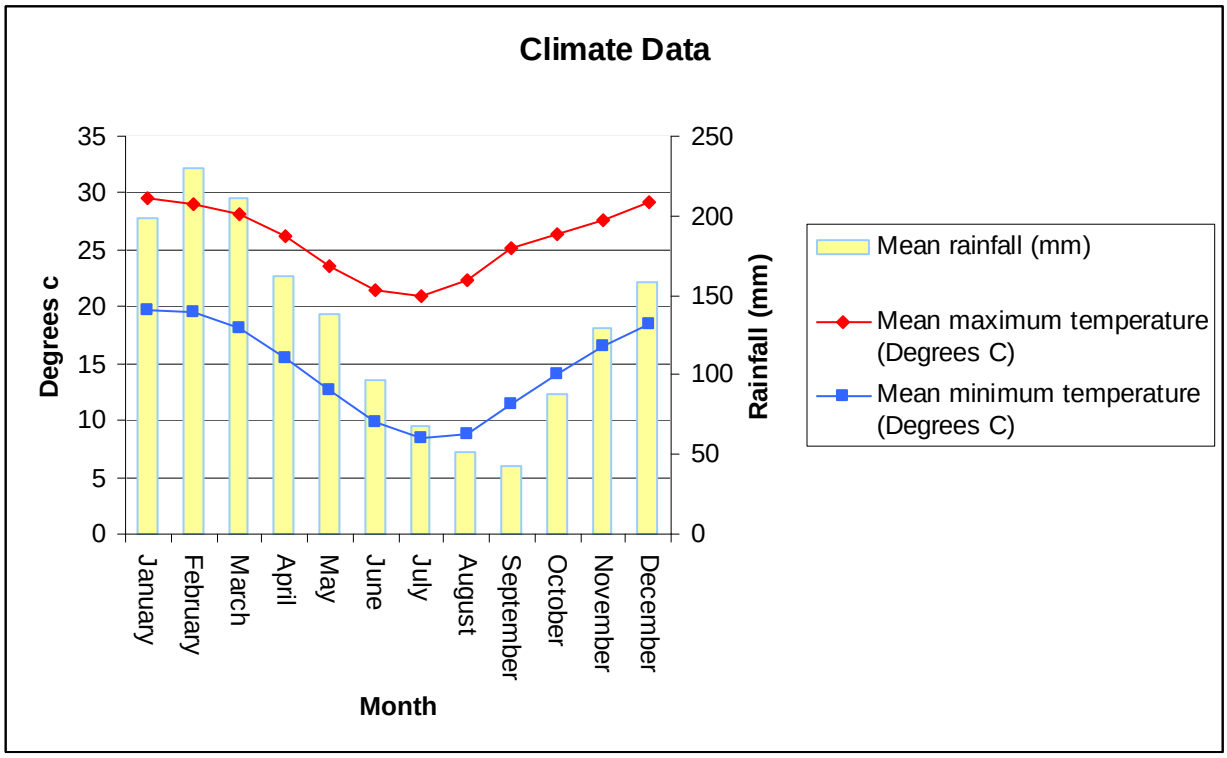


Figure 1 Bureau of Meteorology Murwillumbah (Bray Park) Climate Data

3. Approvals and Licensing

3.1 Environment Protection Licence

This Draft LEMP has been prepared as part of the Environmental Assessment for TSC's Stage 1 Project Application for the Environ Road Landfill and Quarry Proposal. Subsequently this Draft LEMP will form an integral part of TSC's application for an Environmental Protection Licence (EPL) for the landfill operations under the *Protection of the Environment Operations Act 1997* (POEO ACT).

It is proposed that the Quirks Quarry Landfill will be licensed as a Solid Waste Class 1 Landfill, able to accept inert waste, solid waste (including putrescible solid waste), asbestos waste and general clinical waste.

3.2 Development Consent

The quarry activities were previously conducted by TSC under the *Plan of Management, Quirks Quarry V3.0 Eviron Road, Eviron* which was approved on the 16th of June 2000. Landfill development consent is currently being sought.

4. Facility Design and Construction

4.1 General

The Quirks Quarry Landfill will be operated in accordance with the commitments made in this LEMP to achieve the required environmental goals, and will comply with the requirements of DECCW and all other relevant statutory requirements. TSC will implement a range of measures to minimise the potential for environmental impacts from the future landfill.

All front end landfill infrastructure including the gate house, office, recycling facilities, green waste processing and the small vehicle drop of point areas will be retained at the Stotts Creek Landfill Facility and will continue to be managed under the three Stotts Creek Landfill Facility LEMPs (one for each Environmental Protection Licence).

4.2 Facility Layout

The layout of the proposed Quirks Quarry Landfill is shown on Figure 03. Access to the landfill will be via haul road constructed between the existing Stotts Creek facility and the Quirks Quarry Landfill.

The main features of the landfill site include the following:

- Active landfilling area (for council and contractor vehicles only);
- Sediment basin and stormwater drains.

Some of these features are described in more detail in the following sections.

4.3 Staging/Filling of the Landfill

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).

4.4 Final Landform and Life of Site

The final landform of the landfill will be restored to a similar profile to that of the surrounding landscape. The external batters will 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% will be maintained to ensure that rain falling on the site is able to drain away freely, thus minimising infiltration into the waste.

As the landfill reaches the final landform level, areas of suitable size and gradient will be identified and capped as required. Potential capping specification options are discussed in Section 5.9.

Estimated landfill consumption for the landfill is displayed in Table 5 and includes the following assumptions:

- Average increase in annual waste volumes of 3% per annum;
- A waste conversion rate of 1 m^3 to 1 tonne; and
- An estimated annual daily cover of 20% of annual waste volume.

Table 5 Life Expectancy for Landfill Footprint

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
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.

4.5 Stormwater Management Works

4.5.1 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 conceptual 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 edges of the site will be retained. These will 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. These will collect stormwater runoff from current vegetated ground cover areas not associated with the proposed landfill area.

Refer to Figure 41-20806-FIG 09 for locations of the current stormwater infrastructure.

4.5.2 Proposed Stormwater Infrastructure

The proposed stormwater drainage system will comprise:

- Bund construction around the landfill;
- Construction of new stormwater management measures;
- Construction of new erosion and sediment control measures;
- Construction of a new stormwater sediment pond;
- Erosion and sediment control works across the site; and
- Progressive capping and revegetation of the site.

The landfill surface shall be bunded and contoured to prevent the run-on or run-off of surface waters onto / from areas where waste has been deposited. Landfill areas not being actively landfilled will be covered with intermediate cover and the runoff directed to suitable stormwater drainage systems.

Following the closure of an area, intermediate covering and temporary re-vegetation will ensure minimisation of stormwater volumes and improved water quality.

TSC shall arrange for progressive design and construction of suitable stormwater drainage works (as required) in line with the operational stage of the landfill. All drainage works shall be designed and constructed in accordance with the requirements of the NSW EPA, including the requirements specified in the NSW Department of Housing – Managing Urban Stormwater – Soils and Construction Guidebook (1998) and its recent "Waste Landfills" update (2008), otherwise known as the "Blue Book". All stormwater diversion and collection drains shall be sized to convey run-off from the 1 in 10 year ARI rainfall event. Where necessary the drains shall be armoured or lined to prevent erosion.

It is proposed to install silt fencing as required around the site and to finally restore areas of the site as soon as reasonably practicable. Once final capping and revegetation has occurred at the site, stormwater management will become a less significant issue. Re-vegetation of the site's surface by this time will considerably reduce the rate of erosion of the site and will help to trap sediment entrained in stormwater runoff.

4.6 Green Waste Processing Area Works

No green waste processing will occur at the Quirks Quarry Landfill. Green waste will continue to be processed at the Stotts Creek Landfill Facility and will be managed in accordance with the Stotts Creek Landfill Facility, LEMP.

4.7 Leachate Management

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.

4.8 Small Vehicle Drop-off Point

There will be no public access to the Quirks Quarry Landfill, rather the site will be operated with one active area for waste disposal. Small vehicle deliveries by members of the public will be made at the

existing, dedicated small vehicle drop-off point (SVDP) close to the main entrance after being processed through the weighbridge at the Stotts Creek Landfill Facility. This allows for the separation of small vehicles from larger waste disposal trucks, and therefore improves safety and waste segregation. The waste deposited at the SVDP will subsequently be transferred by TSC to the waste disposal area at the Quirks Quarry Landfill via the sealed haul road.

5. Facility Management and Operation

5.1 General

The Quirks Quarry Landfill will be operated by TSC in accordance with the anticipated future Environment Protection Licence and other relevant regulatory directions.

TSC will implement a comprehensive range of measures to minimise the potential for environmental impacts from the future waste management operations conducted at this site. This will include:

- Appropriate site management and staffing to ensure effective and efficient operation of waste management processes;
- A waste screening and inspection program (existing facility at Stotts Creek Landfill);
- Recycling and resource recovery activities (existing facility at Stotts Creek Landfill);
- Landfilling techniques that minimise nuisance e.g. litter, vermin, odour, dust and noise;
- Appropriate leachate minimisation and management measures;
- Appropriate landfill gas management measures;
- Appropriate stormwater management measures which aim to minimise the generation of contaminated water and prevent detrimental impact on adjacent waterways; and
- A comprehensive environmental monitoring and reporting program.

5.2 Planning

TSC will review this LEMP each year or at least after each review of the future site EPL. The purpose of the review is to:

- Evaluate the rate of landfilling and revise the staging / filling plans as required;
- Review site operations and identify areas where site operations / performance can be improved;
- Modify the LEMP to better reflect site operations; and
- Make any changes arising out of legislative changes or changes in TSC's waste management policy.

TSC will update the LEMP incorporating all changes arising from the review process.

5.3 Management, Supervision and Staffing

TSC will provide suitably trained and experienced personnel as necessary to manage, supervise, operate and maintain the Quirks Quarry Landfill in accordance with the site's EPL and other relevant regulatory requirements. This shall include provision of staff to undertake the following activities:

- Planning of the staging of the landfilling operation;
- Overall management, supervision, operation and maintenance of the site and its waste management operations. This shall include personnel experienced in the operation of a solid waste management facility/landfilling operation;
- Design, construction and maintenance of all site roads;

- Supervision of the active tipping face of any waste disposal area;
- Managing cover material at the site, including excavation, separation from incoming waste materials, stockpiling, and transporting on-site using appropriate landfilling / earthworks equipment;
- Spreading, compaction and covering of the deposited waste using appropriate landfilling equipment / earthmoving equipment;
- Management, operation and maintenance of all environmental management measures / controls at the site;
- Management, operation and maintenance of all other facilities and structures at the site including monitoring boreholes, fencing, gatehouse, weighbridge etc.
- Recording of incoming vehicles including waste quantity, type, and source (conducted at existing Stotts Creek Landfill Facility); and
- Securing the site so that unauthorised persons do not enter.

TSC will implement effective control of traffic at the site, and in particular at the active tipping face. TSC will ensure that the equipment engaged in the movement, spreading, compaction and covering of deposited waste in the vicinity of any active tipping face is not operated in such a way as to constitute a risk to persons disposing of waste. TSC will supply and place barricades and / or signs in order to achieve this requirement.

- TSC will keep an operators daily log book for recording activities and incidents that occur during the operation of the site.
- TSC will provide a minimum of two personnel at the site at all operational times.
- TSC will ensure that all staff employed at the site are appropriately trained, qualified and experienced.
- Training will be undertaken to ensure that site staff operate the site in accordance with this LEMP, the EPL and other relevant guidelines and legislation, and will include training to ensure the following:
- All operators of compaction or earthworks equipment are skilled at undertaking all tasks required of them; and
- All those inspecting incoming wastes are skilled at accurate data recording and identifying wastes that are unacceptable.

TSC will provide regular training to all operative and managerial staff on topics including:

- Waste categories recognition;
- Waste management practices, guidelines and regulations;
- Environmental requirements for landfilling, green waste processing and recycling operations;
- OH&S regulations and practices; and
- First aid.

When the landfill site is open, the gatehouse will be manned, and the active tipping area and recycling processing areas will be supervised.

TSC will maintain safe work methods and other Procedures. A copy of these procedures will be kept at the site office and reviewed annually.

5.4 Hours of Operation

The hours of operations of the site are daily between 7:00 am and 4:00 pm Monday to Friday and between 9:00am and 4:00pm Saturday and Sunday. The site is closed (except to kerbside collection vehicles) on Christmas Day and Good Friday.

5.5 Waste Accepted at Facility

5.5.1 Waste types

The Quirks Quarry Landfill will only accept waste in accordance with its EPL. It is proposed that the site will be licensed as a Solid Waste Class 1 Landfill and will be permitted to accept inert waste, solid waste (including putrescible solid waste), asbestos waste and certain clinical waste. Tyres may be accepted at the landfill in accordance with the conditions outlined in Section 5.6.8.

Grease trap waste and waste oil may be stored, but not disposed of, at the premises. No other hazardous or industrial materials may be stored at the site except where they have been illegally dumped at the tipping face and are stored for subsequent removal.

Liquid wastes received will be stored in a bunded concrete tank on site. Liquid waste removal contractors will periodically empty the tank. No liquid wastes will be disposed of on-site.

5.6 Recycling and Resource Recovery

5.6.1 General

State and Federal Governments have adopted significant waste minimisation policies aimed at reducing waste to landfill. TSC supports this waste minimisation initiative and promotes it wherever possible for both the environmental and practical benefits.

TSC will continue the range of resource recovery activities currently conducted at the Stotts Creek site, including collection of source segregated recyclables, separation of clean fill and the collection and processing of green waste.

TSC personnel will take all reasonable efforts to ensure that recyclable and reusable items are diverted from the current and future landfill operations.

5.6.2 General recyclable materials

TSC will endeavour to recycle as much general recyclable materials as practicable. This may be done by advising customers of where recyclables should be placed, explaining to customers the benefits of separating recyclables from general waste, or recovering recyclables from the general waste stream.

This will generally occur at the existing Stotts Creek Landfill Facility prior to the waste entering the Quirks Quarry Landfill. However, should recyclables be commingled with the general waste delivered to the Quirks Quarry Landfill, TSC shall make all reasonable efforts to segregate the recyclable materials and transfer them back to the Stotts Creek Landfill Facility for recycling / processing.

5.6.3 Green waste

Green waste will not be processed at the Quirks Quarry Landfill, rather source separated loads will be diverted to the green waste processing area at the Stotts Creek Landfill Facility. Where green waste is delivered to the Quirks Quarry Landfill (via commingled loads), TSC will make all reasonable efforts to segregate and transfer the green waste back to the Sotts Creek Landfill Facility for processing.

The following quantities of greenwaste are proposed to be stockpiled at the greenwaste facility at the Stotts Creek Landfill:

- 3000m^3 of raw unprocessed greenwaste; and
- 1000m^3 of finished product.

5.6.4 Timber

TSC will separate timber materials into a separate stockpile at least 50 m clear of all combustible items. Treated timber shall not be placed in this stockpile, but shall be disposed of in the landfill. The hierarchy for managing timber will be:

1. Sell it to the public;
2. Mulch unsaleable timber and mix with other green waste. Make the mulch available for sale to the public.

The temporary timber stockpile shall be relocated to the Stotts Creek Landfill Facility for sale or processing as per above.

5.6.5 Motor oil

Materials that may pose a risk to the environment, such as waste oil containers prior to decanting, will be stored in bunded areas at the Stotts Creek Landfill Facility. Site staff will be responsible for decanting of any waste oils into the waste oil collection tank provided. Customers will not be permitted to have access to the oil collection tank for any reason.

5.6.6 Chemicals and chemical containers

Chemical containers will be collected at the site and managed under the DrumMuster scheme. DrumMuster collections will be undertaken as required, although as a minimum, two coordinated events will be scheduled per year. In addition a dedicated hazardous chemical collection will be undertaken by a licenced contractor on an annual basis. Outside of this time the facility will not accept chemicals for onsite storage.

Where possible, TSC will detect chemicals and chemical containers in the general waste stream prior to them being unloaded, or identify them as they are being unloaded. Where materials are detected at this early stage, TSC will explain to the customer that council operates under the DrumMuster collection program for the disposal of these materials.

Where the customer leaves the site prior to these materials being detected, TSC will remove the chemicals from the waste disposal area and store them on a bunded pallet. TSC will check that all containers are adequately sealed against the weather to prevent chemicals from escaping into the environment. TSC will be advised of chemicals stored on the site, and all chemicals stored will be

removed with the annual chemical/hazardous chemical collection program. All chemicals will be handled in accordance with all relevant OH&S requirements..

5.6.7 Scrap metal

TSC will arrange for the separation of scrap metal delivered to the site, including car bodies and parts, white goods, roofing etc. at the existing Stotts Creek Landfill Facility, prior to delivery to the Quirks Quarry Landfill.

5.6.8 Tyres

TSC will use its best efforts to minimise the number of tyres disposed of into the landfill. Where tyres are delivered to the site, TSC will ensure that they are placed in a separate stockpile and are neatly stacked at the Stotts Creek Landfill Facility. The total mass of tyres stored in this stockpile shall not exceed fifty tonnes and will comply with the conditions of the EPL. Commercial quantities of tyres (more than five in a load) will accepted at the site for a fee.

5.6.9 Batteries

Car batteries, truck batteries and solar lead acid batteries will be managed at the Stotts Creek Landfill Facility and will be segregated from the landfill and placed on a pallet within a bunded area for recycling. TSC will ensure that, as soon as one pallet fills, arrangements are made for the collection of the batteries. All arrangements for the removal of batteries, as well as all income from the recycling of the batteries, reside with TSC.

No more than two (2) full pallets of batteries will be permitted to be on the site at any time.

5.6.10 Concrete, Bricks and Tiles

TSC will separate and stockpile all concrete, bricks and tiles disposed of at the Stotts Creek Landfill Facility, which are either saleable or useable for construction. TSC will sell these materials or use them for site road construction as necessary.

The stockpile of concrete, bricks and tiles will be managed in accordance with the Stotts Creek Landfill Facility management procedures and operating licences.

5.6.11 Clean Fill

TSC will ensure that clean fill delivered to the site is stockpiled in a location where it is able to be easily used for cover material or for rehabilitating the site. Where required, TSC will also source clean fill for use as landfill cover or other site development works. Where TSC sources material for landfill lining or bund walls, this material will be tested to ensure it is of an adequate quality to meet the requirements for this use.

TSC will not source or store clean fill on the site in excess of the site needs, and will not use excessive amounts of cover in operating the landfill.

5.6.12 Waste Handling, Deposition, and Compaction

All waste will be deposited in a manner that minimises any nuisance or environmental impacts, and achieves maximum practical in situ density.

Waste will not be deposited into water. Each active waste disposal area will be maintained in a dry condition as far as is possible during the life of the cell.

Every layer of waste deposited in the landfill will be evenly placed and compacted by the landfill equipment to achieve an effective waste density >750 kg/m^3. Large bulky wastes such as furniture and tree trunks, if not deposited in the recycling area or Green Waste Processing Area (GWPA), will be broken up before covering. Such wastes will not be deposited in the final lift of a waste disposal area since settlement of the fill may result in these large items piercing the landfill cap.

The landfilling equipment will generally make 3 to 5 passes over the waste and will generally not operate on slopes exceeding 1:3 (V:H) due to reduced compaction and operational safety considerations. Heavy vehicles may also be directed over completed areas to aid in compaction of the waste.

5.7 Special Waste Handling Procedures

The Quirks Quarry Landfill may be licensed to accept asbestos waste and general clinical waste. TSC will ensure all asbestos waste received has been wetted and sealed in heavy duty plastic. TSC must be contacted prior to disposal to ensure a special burial of the asbestos waste.

Clinical Waste accepted by TSC must comply with the requirements of Part 4, Clause 43 of the *Protection of the Environment Operations (Waste) Regulation 2005* including:

- TSC will provide written approval before the waste is received disposed of;
- The waste will not be disposed of unless it was generated outside the regulated area;
- The waste will not contain any recognisable body parts, sharps waste, cytotoxic waste or radioactive waste;
- The waste will be packaged in accordance with the requirements set out in the NSW Health *Waste Management Guidelines for Health Care Facilities*;
- The waste will not be disposed of in amounts that exceed 40 kg at any time; and
- The waste will be buried, or be immediately contained, in a manner that prevents the waste coming into contact with any person or animal.

5.8 Covering Layers

5.8.1 Daily Cover

To maintain sanitary conditions and minimise the environmental impact of the landfilling operation, at the end of each working day all exposed waste surfaces will be covered by TSC with a layer of compacted soil or other EPA approved material to a minimum depth of 150 mm. The daily cover layer will be graded to minimise ponding of water.

Waste may be covered throughout the working day, as well as at the end of the day if necessary to prevent environmental impacts such as litter or odour.

The material used for the covering of waste will be clean soil and virgin excavated natural material (VENM), including material sourced from materials excavated on-site and suitable incoming waste materials. This may include waste materials such as clean soil, VENM, road base, asphalt and

crushed concrete, as approved by the EPA. Other materials may be used as daily cover subject to EPA approval. TSC will ensure there is, at all times, sufficient cover material on site for daily covering of the deposited waste. Cover material used for daily covering will be stockpiled at a point convenient to the active waste disposal area. The stockpile will be maintained to provide at least two weeks supply of cover material.

TSC will not source or store clean fill on the site in excess of the site's needs, and will not use excessive amounts of cover in operating the landfill. Silt fences and other approved sediment control measures shall be provided by TSC as required.

5.8.2 Intermediate Cover

Where a filled area has not reached the final landform level, but due to the staging of the filling will remain inactive for a period greater than 90 days, TSC shall apply an intermediate covering layer. The intermediate covering layer shall be a 300 mm thick layer of compacted soil or other suitable material approved by the EPA.

5.8.3 Final Cover

The landfill will be progressively rehabilitated as filling is completed. This will involve placing an engineered cover layer over each tipping area as it is completed, and revegetating the final cover. The average slope angle shall not exceed 1:4 (V:H), and level parts of the landfill will be domed or graded to a minimum 5% (1:20).

5.9 Final Cap

The total area to receive a final cap at this site is approximately 6 ha. Details on the final capping options for the landfill are provided in section 4.6 of GHD's Conceptual Landfill Design Report, October 2009, the final capping maximum requirements are as follows.

- 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 selection of the final capping option will be dependent on the operational procedures implemented over the life of the landfill. Waste type, quantity, daily and intermediate cover practices, and rainfall and infiltration data may all impact on the selection of a final cap. Final cap options should be further reviewed during the landfill post closure investigations to determine the most suitable cap for the site.

5.9.1 Final Cover Specification

There are several options for the final cover layer, which are dependent upon the availability and suitability of materials for construction of this layer.

In general, it would be anticipated that the final cover layer would consist of the following:

- A 500 mm thick revegetation layer; overlying;
- A "Sealing Layer"; overlying;

- A 150 mm thick seal-bearing layer.

The Sealing Layer could constitute one of the following:

- A 500 mm thick compacted clay layer (permeability k < 10^{-8} m/s); or
- A geosynthetic clay liner (GCL) (permeability k < 10^{-11} m/s); or
- A geomembrane (permeability k < 10^{-13} m/s) protected by layers of geotextile (top and bottom).

The final sealing layer selected for this site will be in accordance with the relevant EPA requirements contained within the Landfill Guidelines.

The material to be used for the revegetation layer will be suitable for the establishment of grasses (prior to the development of the botanic gardens) on the site, and may incorporate compost, mulched green waste or mulched green waste blends generated at the Stotts Creek Landfill facility.

5.9.2 Seal Bearing Layer

When the site has been filled to the relevant height to allow the final cover layer to be constructed, a 150 mm thick seal bearing layer shall be placed and compacted across the area to be restored. This will comprise material such as soil, VENM or crushed bricks and concrete.

5.9.3 Sealing Layer

Once the most appropriate sealing layer has been selected, it and any associated protective geotextiles will be placed over the seal-bearing layer. Whichever sealing layer is selected, it will be capable of meeting the EPA requirements contained within the Landfill Guidelines. Any laboratory testing required of the sealing layer to confirm that the materials used will meet the required EPA criteria shall be completed by TSC.

5.9.4 Revegetation Layer

Material for the revegetation layer shall be sourced by TSC, and may comprise uncontaminated topsoil delivered to the site, or appropriate subsoils blended with processed green waste from the GWPA.

The revegetation layer shall be able sustain a healthy cover of vegetation over the capped landfill areas, and shall be resistant to erosion. The revegetation material shall be generally classifiable as silt, and shall contain greater than 5% organic matter (% dry matter as per test methods in AS 4454-2003).

5.9.5 Construction quality control

Prior to the construction of the final cover layer, a construction quality control plan will be produced by TSC. This document will detail requirements of TSC and their sub-contractors to conduct appropriate tests in line with the requirement of the Landfill Guidelines, or alternative design as approved by the DECCW. Records shall be kept of all testing completed, any failures observed and any remedial actions taken. These records shall indicate the time, date and location of the tests, failures and remedial actions. Observations regarding weather conditions at the time of conducting any test, or in the case of laboratory samples, collecting the sample. Appropriately qualified personnel shall collect all samples, and all tests conducted by a laboratory registered by NATA for the tests conducted.

5.9.6 Equipment

TSC will maintain and/or engage sufficient and appropriate machinery, plant and equipment to meet the requirements of the LEMP. This will include, but is not limited to, equipment for:

- Spreading, compaction and covering of deposited waste;
- Managing stockpiles of scrap metal;
- Managing stockpiles/windrows of green waste (processed and unprocessed);
- Compacting, trimming, shaping, grading and levelling of cover layers;
- Construction of the final cover layer, including compaction of the sealing layer; and
- Any other operation required for the proper and efficient operation of the landfill.

All plant and equipment will conform to the relevant Australian Standards and be operated in a proper and efficient manner.

All machinery, equipment, and plant will be maintained in a proper and efficient working condition, in accordance with the manufacturer's requirements. In the event of equipment or plant failure, TSC will organise replacement plant or equipment as soon as practical to ensure the requirements of the LEMP are fully complied with at all times.

5.10 Security

Outside opening hours the access gates will be locked by TSC. Coded locks and keys will be provided by TSC to sub-contractors as required, and only TSC provided locks will be used for access gates. Sub-contractors will not “piggy back” or “dummy lock” locks.

Only necessary sub-contractor staff and TSC employees will keep keys to gates and buildings. Approval will be required from TSC for issue of new keys to any party.

Current security measures at the weigh bridge, small vehicle drop-off point and recycling processing areas at the Stotts Creek Landfill Facility will continue to be implemented.

The Quirks Quarry Landfill will not be accessed by the general public. .

5.11 Health and Safety Procedures

TSC will undertake all necessary precautions to ensure the safety of all personnel, users and visitors to the site. The supervising staff at the landfill will undergo a full induction prior to commencing work at the site. An inducted site supervisor will conduct inductions for operational staff or sub-contractors conducting site works.

TSC will be responsible for ensuring that all employees are instructed in potential hazards at the landfill and that all sub-contractor staff observe safe working practices.

TSC will provide, equip and maintain first aid treatment facilities at the landfill and will have a person trained in first aid on site during all operating times.

It is the responsibility of TSC and their sub-contractors to be familiar with the provisions of the *Occupational Health and Safety Act 2000* (OH&S Act) and regulations. The duties and all other obligations that the OH&S Act places on an employer will be properly discharged by TSC and their sub-contractors so that all employees are aware of their responsibilities under the OH&S Act.

TSC will ensure that all necessary protective clothing and safety equipment is available and/or issued to all employees, is maintained in good condition, and is used where necessary.

TSC will ensure that site infrastructure is adequate to meet the OH&S requirements of TSC and sub-contractor personnel, as well as the general public. This includes conducting mulching of green waste away from the general public, and ensuring large depressions are appropriately barricaded.

All contracts and tenders that TSC makes for the site will ensure that contracting companies comply with insurance and health & safety requirements. These companies include waste collection contractors, revegetation & landscaping companies, recycling contractors and environmental consultants.

5.12 Wet Weather Operation

TSC will ensure the landfill is able to accept solid waste under all reasonable weather conditions without compromising the environmental management of the site. This includes placing adequate broken rock, bricks or concrete at the tipping area. If access issues are encountered during wet weather, waste may be deposited near the front of the waste disposal area and pushed to the back of this area by waste handling equipment.

5.13 Access Road Maintenance

TSC will construct all necessary temporary internal access roads within waste disposal areas to provide effective access across the waste disposal areas, to minimise damage to vehicles using the roads. All access roads will be constructed and maintained using suitable bricks, concrete and crushed rock that will be stockpiled on-site for use when required. Access roads will be wide enough to permit safe two-way movement by all vehicles using the site. If insufficient width is available for safe two-way movement, then the roads will be arranged to permit one-way flow of traffic.

Where necessary, site access roads will be constructed to withstand the traffic of waste handling equipment, however the traffic of heavy earth moving machinery on site access roads will be minimised.

5.14 Fire Control

The following measures will be implemented to prevent and control fires:

- Regular compaction and covering of landfilled waste;
- Posted, formal fire management procedures to follow in the event of a fire. These procedures include persons responsible, contact numbers and equipment to be used;
- Maintenance schedule for all fire fighting equipment and facilities. This will include, at a minimum, weekly checks of equipment and facilities for damage, and test operation every three months;
- Fire fighting equipment at site buildings;
- Clear signposting and access of all fire fighting equipment;
- Construction and maintenance of appropriate firebreaks;
- Staff training in fire fighting techniques; and
- Management of the size of green waste stockpiles (processed and un-processed).

In the event of a fire occurring at the site, TSC will take prompt action to extinguish the fire. The local Fire Service will be immediately notified of all fires irrespective of the extent of the fire and whether or not it has been controlled. TSC will cooperate fully with the Fire Service in fighting fires on the site.

TSC will take all reasonable measures to prevent water that has been used to extinguish fires from entering the stormwater system.

All fire events will be recorded in detail including the date, time, location, inferred cause of the fire, time it was extinguished, notification of authorities, and whether any future preventative measures are appropriate or were taken. This information will be recorded in the site's Daily Log Book.

With the exception of burning of the timber stockpile, all fires will be reported to the EPA as well as the Fire Service.

5.15 Waste Recording and Reporting

5.15.1 Waste Reporting

All vehicles entering the site will have a receipt completed and issued by the gatehouse operator. The receipt will include the vehicle registration, waste classification, and amount of money paid. The gatehouse at the site will be staffed by TSC at all times during operating hours to ensure that all vehicles are recorded. Access to the site will be controlled by means of fencing, gates, boom gates and traffic lights to manage the security of the site.

Where waste is to enter the site outside of operating hours, arrangements will be made with the site supervisor to ensure that the site is manned during the deposition of the waste.

The following records will be kept and retained at the landfill operations office:

- A copy of this Landfill Environmental Management Plan; and its various attachments and addendums;
- The site's EPL;
- Site Diary;
- Operator procedures manual; and
- Worksite OH&S Field Folder.

Waste quantities will be electronically recorded and can be reproduced by TSC.

5.15.2 Annual Return

TSC will prepare and submit an Annual Return in accordance with the requirements of the EPL. Annual reporting is discussed further in Section 9.1.

5.15.3 Airspace Surveys

TSC shall engage a suitably qualified surveyor to undertake a topographic survey of the landfill every six months to determine the volume of landfill airspace consumed. Council will revise the staging/filling plans based on the most up to date landfilling rate calculations after each survey. Section 5.2 discusses other LEMP revision requirements.

5.16 Quality Assurance

5.16.1 Design

Suitably qualified and experienced personnel or consultants will undertake all design work in accordance with quality principles.

5.16.2 Construction

Suitably qualified and experienced personnel or construction companies will undertake all construction work in accordance with quality principles.

Key construction work at the site includes the construction of each additional stage, a pipeline connection to sewer and the landfill final cover. Quality assurance of the construction of these and other significant construction works shall be conducted during their construction. Prior to the commencement of any major construction works on site, TSC will prepare a Construction Quality Assurance (CQA) Plan for the relevant works in accordance with the requirements of the DECCW.

5.16.3 Operation

Operation of the landfill and its associated activities will be undertaken in accordance with this LEMP.

All environmental monitoring will be undertaken by suitably qualified and experienced personnel and in accordance with relevant Australian Standards and NSW EPA Guidelines. All sampling will be undertaken in accordance with EPA relevant Australian Standards, NSW EPA Guidelines and other recognised standards. See Section 7 for further details.

6. Environmental Management

6.1 Water

6.1.1 General

TSC will take all practical steps to prevent contaminated waters flowing into the nearby creeks and cane drains and subsequently to the Tweed River.

- Site operations will generate different quality waters, including:
- Runoff from undisturbed areas of the landfill site (clean stormwater runoff);
- Runoff from rehabilitated (revegetated) areas of the landfill site (clean stormwater runoff);
- Runoff from disturbed areas of the landfill site (potentially turbid stormwater runoff);
- Runoff from within the active landfilling area (potentially leachate);
- Leachate from within the landfill.

Management of water at the landfill is aimed at:

- Minimising the generation of contaminated water;
- Preventing deterioration of water quality standards in local surface waterways and groundwater in the vicinity of the site; and
- Ensuring that water is available to meet operational requirements.

Where practical, clean stormwater runoff will be diverted around disturbed areas of the site to minimise the volume of dirty water to manage.

The following sections outline the management of clean stormwater, dirty water, and leachate.

6.1.2 Stormwater

There are three main types of stormwater generated on the site:

- Clean stormwater runoff from undisturbed and rehabilitated / revegetated areas of the site;
- Potentially sediment laden stormwater runoff from disturbed areas of the site; and
- Potentially leachate contaminated stormwater runoff from the active landfilling area.

The fundamental approach to stormwater management is as follows:

- Maintain undisturbed and rehabilitated / revegetated area as filters for sediment from disturbance above;
- Minimise disturbed areas on the site;
- Maintain all stormwater runoff from disturbed areas as diffuse as possible to minimise sediment loads and maximise the opportunities for the vegetation to strip sediment from the runoff. Any concentration of flow will be avoided;
- Erosion control (re-vegetation, silt fencing etc.) shall be established on disturbed areas as soon as practicable and maintained;

- Ensure that water falling in the active tipping area does not leave the site, by placing a series of bund walls along the tipping perimeter. This water will be permitted to drain into the waste.

TSC will design, construct and maintain a series of temporary stormwater drains during landfilling operations to prevent stormwater runoff from entering the active waste disposal area. Details of stormwater management measures are shown on Figure 09 Stormwater Arrangements and Details and Figure 10 Stormwater and Sediment Control Details.

Where the area drained is undisturbed, these drains will drain from the site. Where the area drained is likely to contribute sediment to the stormwater, the drains will either drain to a sediment pond, or will be constructed to spread turbid water over vegetated areas of the site in order to enable the settlement of sediments from the water. If this is not possible, sediment fencing will be installed and maintained at the site perimeter as a temporary measure.

All drainage structures will be designed in accordance with the relevant design criteria including those specified in the EPA publication *Environmental Guidelines: Solid Waste Landfills, January 1996*, NSW Department of Environment and Climate Change's *Managing urban stormwater: Soils and construction, Volume 2B – Waste Landfills, June 2008* and *Australian Rainfall and Runoff*. Where required, approvals licences will be obtained for the drainage structures from TSC, DECCW, and /or the Department of Water and Energy (DWE).

6.1.3 Leachate

Leachate is deemed to include all water that has come into contact with waste. A range of appropriate measures will be implemented to minimise, contain, collect and dispose of leachate generated during landfilling at the site. This will primarily involve implementing all practicable measures to minimise the volume of leachate generated such as:

- Diverting upstream clean stormwater runoff, where possible;
- Minimising exposed areas at the active landfilling area by regular covering of the landfilled waste (at least daily);
- Grading filled areas to direct surface water runoff away from the active waste disposal area; and
- Progressive capping and rehabilitation of landfilled areas.

All leachate collected by the leachate containment and collection systems shall be managed by TSC to prevent adverse impacts on local surface waters and local groundwater. All leachate collected shall be stored, treated and disposed of in accordance with the LEMP (Section 4.7), the EPL and the relevant EPA guidelines.

Leachate collected in the active waste disposal area and leachate sumps will flow, or be stored for the first 2 years in Stage 1. Following assessment of actual leachate generation rates, the leachate will be pumped to a leachate treatment plant prior to being irrigated.

Surface water and groundwater will be monitored to evaluate the effectiveness of these measures. The monitoring network is discussed in more detail in Section 7.

6.1.4 Maintenance

All stormwater drainage, green waste run-off and leachate management works will be maintained in proper functioning order so as to:

- Minimise flooding of the landfill area; and
- Prevent contamination of local groundwater and surface water.

Maintenance will include:

- Regular cleaning of drains/pipes/pits and removal of accumulated sediments and litter;
- Removal of flow concentrations from disturbed areas; and
- Stabilisation of eroded drains.

6.2 Air

6.2.1 Landfill Gas

The requirement for installation of a landfill gas extraction system will be dependent upon the type and quantity of waste landfilled, and the requirements of the landfill license. Based upon various landfill gas assessments carried out by GHD, it is expected that at a minimum, gas extraction wells and a flare will be required. Further information regarding landfill gas extraction infrastructure is provided in section 3.9.3 of the Conceptual Landfill Design Report October 2009.

6.2.2 Odour

The landfill will be operated to minimise the generation and effect of odours arising from the waste management operations on adjoining land users.

All practicable measures will be taken to contain any odours within the boundaries of the site. Odours will be significantly reduced by operating the site in accordance with sanitary landfilling methods and good site management.

Odours will be minimised by:

- Not depositing waste in standing water;
- Depositing wastes in thin layers to optimise compaction;
- Limiting the deposition of potentially malodorous wastes;
- Covering all exposed waste at the end of each working day with daily cover material; and
- Minimising disturbance of previously filled areas.

A record of complaints regarding odours will be kept by TSC in accordance with the complaint management system, and reported to the EPA as required in the Annual Return.

6.2.3 Dust

All practicable measures will be taken by TSC to minimise dust emissions arising from the operations of the landfill and its associated waste management activities. These will include:

- Immediate burial and covering of dusty loads;

- Access roads to be well maintained;
- Speed limits to be enforced;
- Earthworks to be undertaken on days with little or no wind and/or when the soil to be excavated is moist, where practical; and
- Use of a water cart as required.

6.3 Litter

TSC will implement all practicable measures to minimise litter generation and confine litter arising from the operation of the landfill within the boundaries of the site. Where possible, all landfill tipping cells will be designed to face a direction which provides the greatest protection against the prevailing winds.

Other control measures may include the following:

- Undertaking landfilling within a bunded waste disposal area;
- Maintaining a small active waste disposal (tipping) area;
- Regular compaction of landfilled waste throughout the day;
- Covering of all landfilled waste at the end of each day; and
- Use of mobile litter fences around the active tipping area, as required.

All litter shall be cleared continually in order of priority. All loads entering the landfill will be required to be covered. TSC personnel will enforce load covering to prevent litter.

6.4 Vermin

While pesticides and baits may be occasionally used at this site, the preferred overall method of vermin control for the site includes good compaction and covering of deposited waste, including compaction of the covering layers. If used, care will be taken to ensure that pesticides do not enter stormwater, green waste run-off or leachate, or pose an airborne pollution hazard or nuisance.

Vermin control measures that will be implemented by TSC include:

- Daily compaction and covering of landfilled waste;
- More regular compaction and covering of waste throughout the day, if required;
- The use of insecticides and pesticides, as required; and
- The use of scarecrows and bird scarers, as required.

TSC are also responsible for the control of mosquitos and flies at the site. As such, TSC will ensure that any green waste runoff, stormwater ponds or leachate ponds are kept free of mosquito breeding larvae and that water does not pond in any other location that may propagate mosquito breeding.

6.5 Noise

All practicable measures will be taken by TSC to minimise noise emissions arising from the operations of the landfill and its associated waste management activities.

The impact of noise arising from the landfill operations on all surrounding rural residential areas will be minimised by implementing the following measures:

- Maintaining all landfill plant and machinery in proper working order;
- Ensuring all vehicles accessing the site use the designated access roadways; and
- Operating plant and equipment within specified working hours.

TSC will implement such measures as are necessary to satisfy all EPA requirements relating to noise pollution.

7. Environmental Monitoring

7.1 General

TSC will undertake all monitoring of groundwater and surface water, including leachate, in accordance with EPL requirements to ensure operation of the Quirks Quarry Landfill is not causing a detrimental environmental impact. In addition, every 12 months the operation of the landfill will be reviewed by TSC to assess the compliance of the landfill operation with regulatory requirements and this LEMP.

All sampling will be carried out by suitably qualified and experienced personnel, in accordance with EPA accepted procedures, including those described in the EPA publication *Environmental Guidelines: Solid Waste Landfills* and the EPA publication *Methods for Sampling and Analysis of Water Pollutants in NSW*. All analysis of samples will be performed by a laboratory accredited by the National Association of Testing Authorities (NATA) to undertake the analyses specified.

A Quality Assurance and Control (QA/QC) Program will be included as part of the Environmental Monitoring Program in accordance with Section 8 of the Australia Standard AS 44821.1. The QA/QC program will include the collection of:

- Field Split Duplicates;
- Blind Duplicates; and
- Rinsate Blanks.

Additionally, the analytical laboratories will complete their own internal QA procedures (as required by NATA registration) during the analysis of the samples.

Details of the monitoring to be performed for individual aspects are provided in the following sections.

7.2 Groundwater

7.2.1 Groundwater monitoring locations

Table 7 summarises the existing groundwater monitoring locations installed at the Quirks Quarry Landfilll site. Figure 41-20806-FIG 02 shows the locations of these monitoring wells.

Table 6 Groundwater monitoring system

Borehole ID	EPA Monitoring Point	Monitors
GW4	TBA	As per EPL, quarterly and annual monitoring suites
GW7	TBA	As per EPL, quarterly and annual monitoring suites
GW8	TBA	As per EPL, quarterly and annual monitoring suites
GW9	TBA	As per EPL, quarterly and annual monitoring suites
GW10	TBA	As per EPL, quarterly and annual monitoring suites
GW11	TBA	As per EPL, quarterly and annual monitoring suites

Borehole ID	EPA Monitoring Point	Monitors
GW23	TBA	As per EPL, quarterly and annual monitoring suites to be installed
GW24	TBA	As per EPL, quarterly and annual monitoring suites to be installed

Future expansion of the existing landfill may require additional monitoring points to ensure that all areas of the landfill are adequately monitored for potential impacts.

7.2.2 Groundwater monitoring

The following will be undertaken at the boreholes identified in Table 8 on a quarterly basis:

- Field water quality measurements – temperature, electrical conductivity, salinity, pH, dissolved oxygen (DO), and redox potential;
- Measurements of depth to the water table; and
- Sampling and analysis of samples for the parameters required in the site's EPL.

Appropriately trained personnel will conduct all sampling and analysis.

Boreholes that are dry or damaged will not be sampled and consideration will be given to their re-installation by TSC if considered appropriate.

An appropriate quality control program shall be in place to ensure that results of analysis are reliable and accurate.

Results of analysis will be compared to ANZECC/ARMCANZ guidelines for aquatic ecosystems where relevant trigger levels exist. Should monitoring indicate that contamination of the groundwater or sub soil has occurred; the affected monitoring boreholes will be re-sampled as soon as possible after identification of the possible contamination. If the contamination is confirmed by the re-sampling, the EPA will be notified in writing within 14 days. Within 28 days of the written notification, a groundwater assessment program will be prepared, which aims to identify the specific contaminants and extent of pollution of the groundwater. This plan would be submitted to the EPA for approval prior to implementation. Information collected during the groundwater assessment program will be used to prepare a groundwater remediation plan, if required.

7.3 Leachate

7.3.1 Monitoring

Monthly measurement of depth (and volume) of the leachate levels will be undertaken. In addition, the following will be undertaken on a quarterly basis:

- Conducting quarterly field water quality measurements – temperature, electrical conductivity, salinity, pH, dissolved oxygen (DO), and redox potential; and
- Sampling and analysis of samples for the parameters in the EPL plus Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and heavy metals (Cd, Cr, Hg, Pb etc.)

7.4 Stormwater

TSC will monitor the quality of stormwater at this site on a quarterly basis and during selected storm events. Monitoring will encompass undertaking the following at the stormwater pond release point on a quarterly basis:

- Field water quality measurements – temperature, electrical conductivity, salinity, pH, DO, and redox potential; and
- Sampling and analysis of surface water samples for the parameters in the sites EPL plus Total Suspended Solids (TSS).

The location of the surface water sampling location is shown on Figure 02 in Appendix A

In addition to quarterly monitoring, samples should be collected from the surface water locations during or within 24 hours of a significant rainfall event at least twice a year. Samples will be analysed for analytes in the EPL plus TSS.

Should monitoring indicate that contamination of any local surface water ways has occurred, the affected sampling locations will be re-sampled as soon as possible after identification of the possible contamination. If the contamination is confirmed by the re-sampling, the EPA will be notified by TSC in writing within 14 days. Within 28 days of the written notification a surface water assessment program will be prepared, which aims to identify the specific contaminants, causes and extent of pollution of the surface water. This plan would be submitted to the EPA for approval prior to implementation. Information collected during the surface water assessment program will be used to determine necessary remedial drainage measures and to prepare a surface water remediation plan, if required.

7.5 Landfill Gas

Surface gas monitoring for methane will be conducted quarterly on a progressively expanding 25 m grid across the site as the landfill expands, in accordance with Benchmark Technique 17 of the EPA's (1996) Environmental Guidelines: Solid Waste Landfills.

Perimeter landfill gas monitoring bores will be installed around the entire perimeter of the landfill site on a risk assessment basis. These bores will be monitored on a risk assessment basis.

In addition to this, gas accumulation (i.e. methane concentrations) will be monitored monthly in all buildings within 250 m of the deposited waste, in accordance with Benchmark Technique 18 of the EPA's (1996) Environmental Guidelines: Solid Waste Landfills.

Any gas monitoring completed at the site (including surface emissions, sub-surface and in-building) which detects landfill gas above the nominated investigation levels in EPA's (1996) Environmental Guidelines: Solid Waste Landfills, will be advised to EPA by TSC within 24 hours of detection. A written assessment will be provided to the EPA within 14 days of the incident identifying management controls implemented.

7.6 Monitoring Program Review

The groundwater, green waste runoff, leachate, stormwater and landfill gas monitoring program will be reviewed every 12 months to assess trends in the monitoring data, the suitability of the parameters tested for, and recommendations will be made regarding improvements to the program. This review

will be organised by TSC and submitted to the EPA as part of the annual review. It is further recommended that the monitoring location plan is reviewed every 12 months and updated as required.

7.7 Complaints

TSC will handle any complaints through its existing corporate record management system. Complaint records will include:

- Date and time of the complaint;
- Complaint method;
- Any personal details of the complainant if provided;
- Nature of the complaint;
- Subsequent action taken by the licensee; and
- If no action was taken, include the reason why no action was taken.

All complaints received over the course of a reporting year will be reported to the EPA in the annual review report referred to in Section 9.1.

The record of all complaints will be kept for at least 4 years from the date of complaint.

7.8 Record Keeping

The results of all monitoring will be recorded and retained as required in the EPL. The records will include the following:

- Sampling dates(s);
- Sampling time(s);
- Sampling point(s);
- Sampling results; and
- The name of the person who collected the sample.

The monitoring records will be kept for at least four (4) years after the monitoring event and will be produced to any authorised officer on request.

All environmental monitoring will be performed by suitably trained personnel. The requirements of the EPA's Environmental Guidelines must be followed to ensure that all requirements are met.

8. Site Rehabilitation and Post Closure Management

8.1 Final Landuse and Site Rehabilitation

The site is earmarked to form part of the future botanical gardens as detailed in the local planning scheme and the Tweed Shire Botanic Gardens Master Plan.

8.2 Closure Plan

TSC will prepare and submit to the NSW EPA a Closure Plan at least three months prior to the last load of waste being landfilled at the site. The Closure Plan will address the following in detail:

- Final landform selected, land use and landscaping / revegetation;
- Final capping;
- Post closure management and maintenance;
- Post closure environmental management e.g. of groundwater, green waste runoff, leachate, stormwater, landfill gas;
- Post closure environmental monitoring and reporting;
- Certificate of completion; and
- Implementation program.

The following sections generally describe some of these activities

8.3 Post Closure Management

Post closure management of the Quirks Quarry Landfill would encompass ongoing environmental management, environmental monitoring, and maintenance of the landfill.

8.3.1 Environmental Management

Ongoing environmental management of the site would be undertaken by TSC following closure of the site for landfilling. This would consist primarily of:

- Ongoing management and maintenance of stormwater measures;
- Ongoing management and maintenance of the leachate management system;
- Ongoing management and maintenance of the landfill gas management system;
- Ongoing management and maintenance of vegetation;

It is anticipated that following site closure and redevelopment, TSC will continue to monitor the environmental impacts of the site and conduct landscaping and gardening activities.

TSC will ensure that all green waste runoff collection, leachate collection, landfill gas management, stormwater controls and reporting practices are maintained at the same level employed during the operational life of the landfill. These environmental management measures will continue until TSC can demonstrate that the landfill does not pose a threat to the environment.

TSC will ensure that waste materials are not received for landfilling at the site after the landfilling operations cease. Any waste materials that are intended for use in the rehabilitation will be documented and reported in the same method used during the operation of the landfill.

8.3.2 Environmental Monitoring

TSC will maintain the same monitoring program and reporting practices for leachate, groundwater, stormwater and landfill gas as used throughout the operation of the site and described in section 7. Monitoring will continue until TSC is able to demonstrate that the landfilled waste no longer have the direct potential to impact on the environment. TSC will ensure that all neighbouring residents are advised of contact persons to discuss any problems. Any complaints that are received will be recorded in the complaints register.

8.3.3 Maintenance

TSC will undertake regular maintenance of the final landform selected and landscaping as required to maintain its integrity. This will include the following:

- Monitoring of surface water drains and structures, and undertaking repairs where necessary;
- Monitoring of landfill gas emissions, and undertaking repairs where necessary;
- Filling of any cracks that may occur in the final cover layer;
- Filling of depressions created by settling of the landfilled waste (to ensure shedding of surface water runoff);
- Replacement of vegetation affected by landfill gas or erosion if necessary, to maintain the density of the vegetation cover;
- Design and construction of any remedial works if significant areas of vegetation are impacted from landfill gas, leachate or landslips;
- Repairing erosion scours; and
- Ensuring that all monitoring boreholes and locations are maintained and operational as required

9. Reporting and Review

9.1 Annual Reporting

TSC will prepare an Annual Return as required by the EPL. The Annual Return will include a certified "Statement of Compliance" and a signed "Monitoring and Complaints Summary".

The Annual Return will be prepared for the required reporting period, i.e. 12 month period, and will be submitted to the EPA no later than 60 days after the end of the reporting period. TSC will retain a copy of the Annual Return for a period of at least 4 years after the Annual Return is supplied to the EPA.

The Monitoring and Complaints Summary will generally include the following information:

- Tabulated results of all monitoring data collected;
- Graphical presentation of data from at least the last three years in order to show variability/and or trends. Any statistically significant variations or anomalies will be highlighted and explained;
- An analysis and interpretation of all monitoring data;
- An analysis of, and response to, any complaints received;
- Identification of any deficiencies in environmental performance identified by the monitoring data, trends or incidents;
- Remedial action taken or proposed to be taken to address the abovementioned deficiencies; and
- Recommendations on improving the environmental performance of the facility.

9.2 Incident Reporting

Any incident that represents a threat to the environment and which may lead to a breach of licence conditions, will be communicated by TSC to the EPA as soon as practicable after TSC first becomes aware of the incident. Initial contact will be via the EPA pollution line service (131 555) or Client Manager for the site. Written notice must follow within 7 days of the incident. Examples of incidents that require reporting include but are not limited to:

- Identification of non-domestic quantities (>200 g/tonne) of hazardous waste mixed amongst solid waste;
- Fires at the landfill (other than those approved for fire hazard reduction by the EPA);
- Entry of green waste runoff, leachate or waste into the stormwater management system;
- Identification of any failure of an environmental protection system;
- Identification of a significant difference in groundwater or stormwater indicator parameters;
- Identification of a breach of nominated landfill gas investigation levels; and
- Any other incident or observation that could potentially pose an immediate environmental hazard outside normal operating conditions.

The occurrence of any such incident will also be recorded in the site's daily logbook as appropriate.

A written incident report will be provided to the EPA if requested by an authorised officer of the EPA. The report will include, but not be limited to, the following details:

1. The cause, time and duration of the event;
3. The type, volume and concentration of every pollutant discharged as a result of the event;
4. The name, address and business hours telephone number of employees or agents of the licensee, or a specified class of them, who witnessed the event;
5. The name, address and business hours telephone number of every other person (of whom the licensee is aware) who witnessed the event, unless the licensee has been unable to obtain that information after making reasonable effort;
6. Action taken by the licensee in relation to the event, including any follow-up contact with any complainants;
7. Details of any measure taken or proposed to be taken to prevent or mitigate against a recurrence of such an event; and
8. Any other relevant matters.

9.3 Landfill Environmental Management Plan Review

TSC will review the LEMP after each review of the site EPL, or at least every 3 years. The purpose of this review is to identify areas where site performance can be improved, the LEMP modified to better reflect site operations, and any changes arising out of legislative changes or changes in TSC policy can be incorporated.

10. References

Bureau of Meteorology (2008) Climate statistics for the Murwillumbah (Bray Park) Site http://www.bom.gov.au/climate/averages/tables/cw_058158.shtml number 058158. www.bom.gov.au accessed 26 May 2009.

NSW Department of Environment and Climate Change (DECC) and Sydney Metropolitan Catchment Management Authority (CMA); *Managing urban stormwater: Soils and construction, Volume 2B – Waste Landfills, June 2008*

NSW Department of Environment and Conservation (July 2004); *Environmental Guidelines: Composting And Related Organics Processing Facilities*

NSW EPA (January 1996), *Environmental Guidelines: Solid Waste Landfills*

NSW EPA (1996), *LEMP Preparation Manual*

NSW Government, *Protection of the Environment Operations Act 1997*

NSW Government, *Waste Avoidance and Resource Recovery Act 2001*

Brian J. Mackney and Associates. Pty. Ltd. (1995) *Environmental Impact Statement, Quirks Quarry, Eviron Road, Eviron*.

Tweed Shire Council (2004) Stotts Creek Landfill Facility, *Landfill Environmental Management Plan For Solid Waste Landfill Expansion.*

Appendix A

Figures

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

CLIENTS | PEOPLE | PERFORMANCE

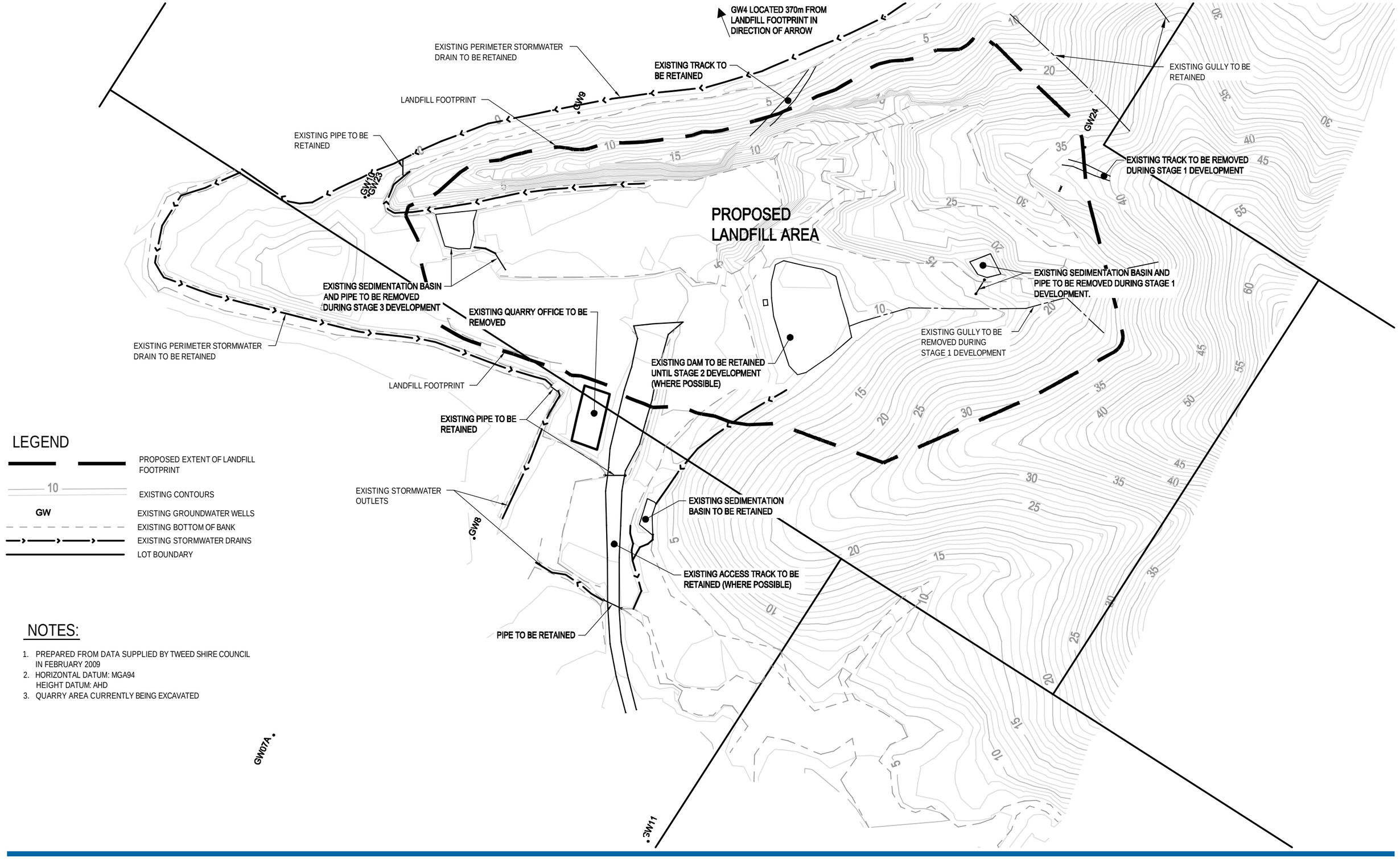
TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

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



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

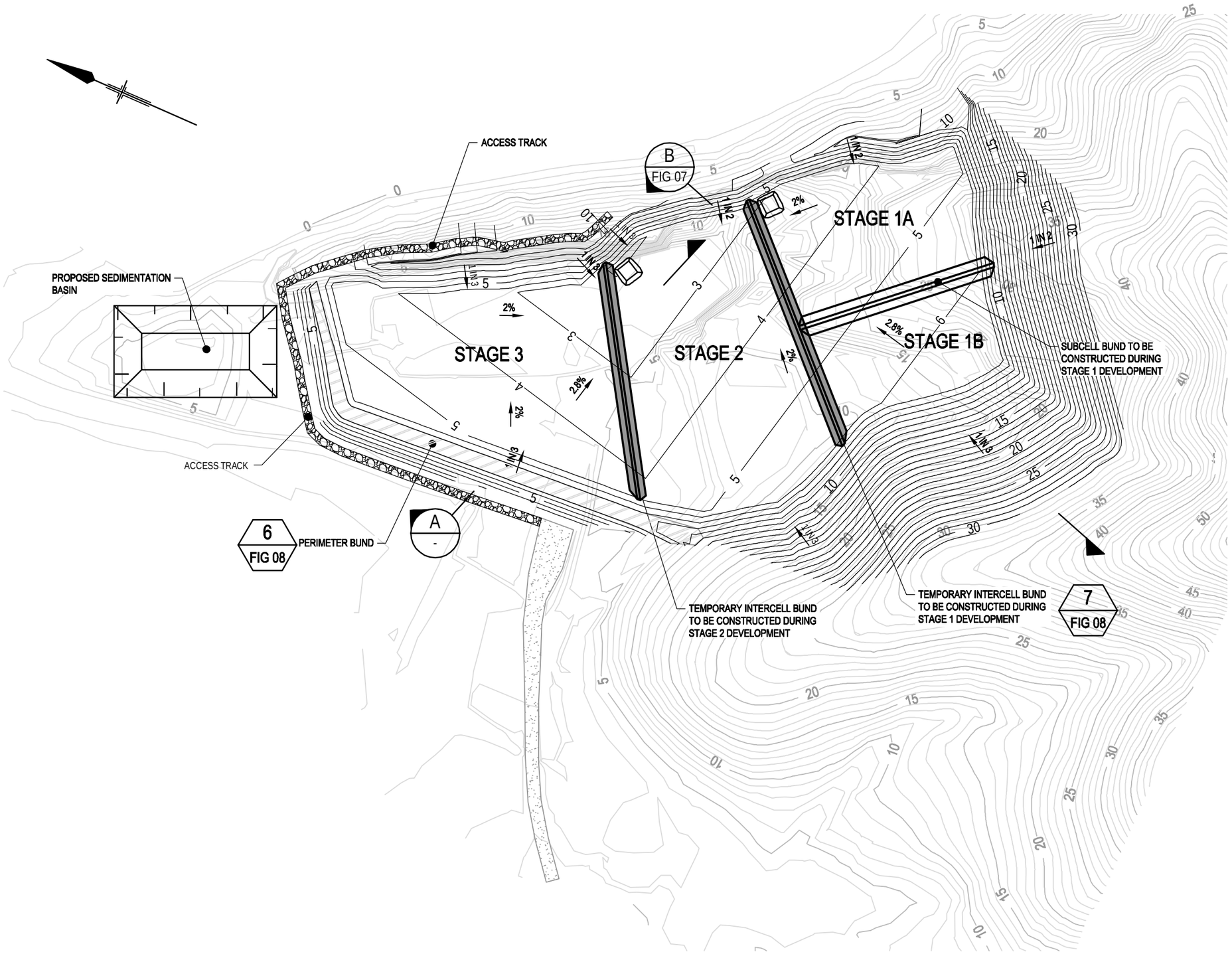
EXISTING SITE PLAN

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)

CLIENTS | PEOPLE | PERFORMANCE

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

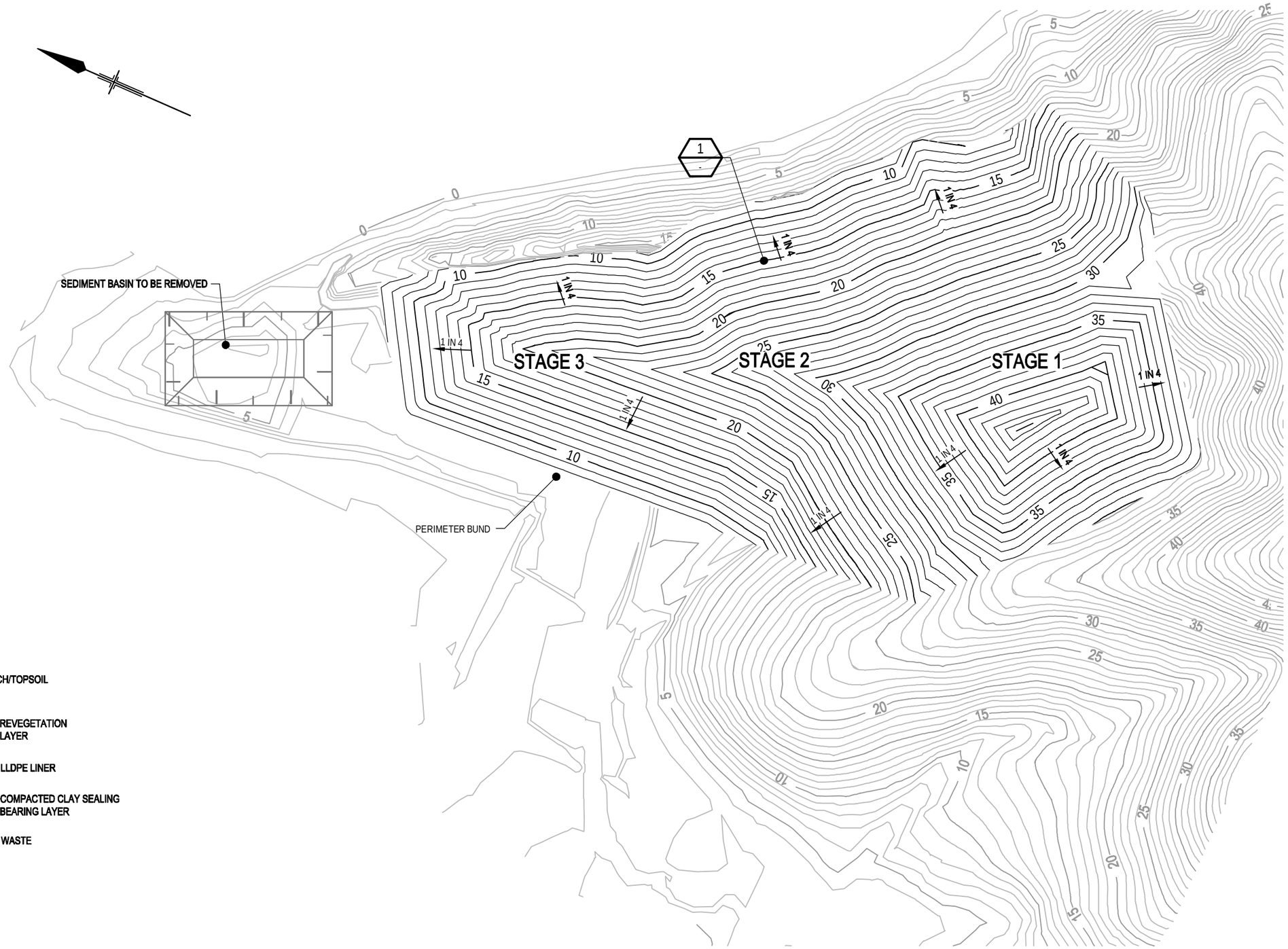
VOLUME CALCULATIONS FOR WASTE / DAILY COVER VOID CAPACITYTO SUBGRADE PROFILE

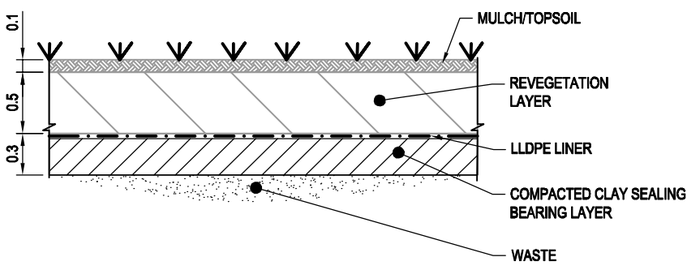
STAGE 1	
PLAN AREA	26,100 m²
VOID CAPACITY	273,000 m³
STAGE 2	
PLAN AREA	17,000 m²
VOID CAPACITY	306,000 m³
STAGE 3	
PLAN AREA	14,400 m²
VOID CAPACITY	171,000 m³
TOTAL	
PLAN AREA	57,500 m²
VOID CAPACITY	750,000 m³

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)

TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

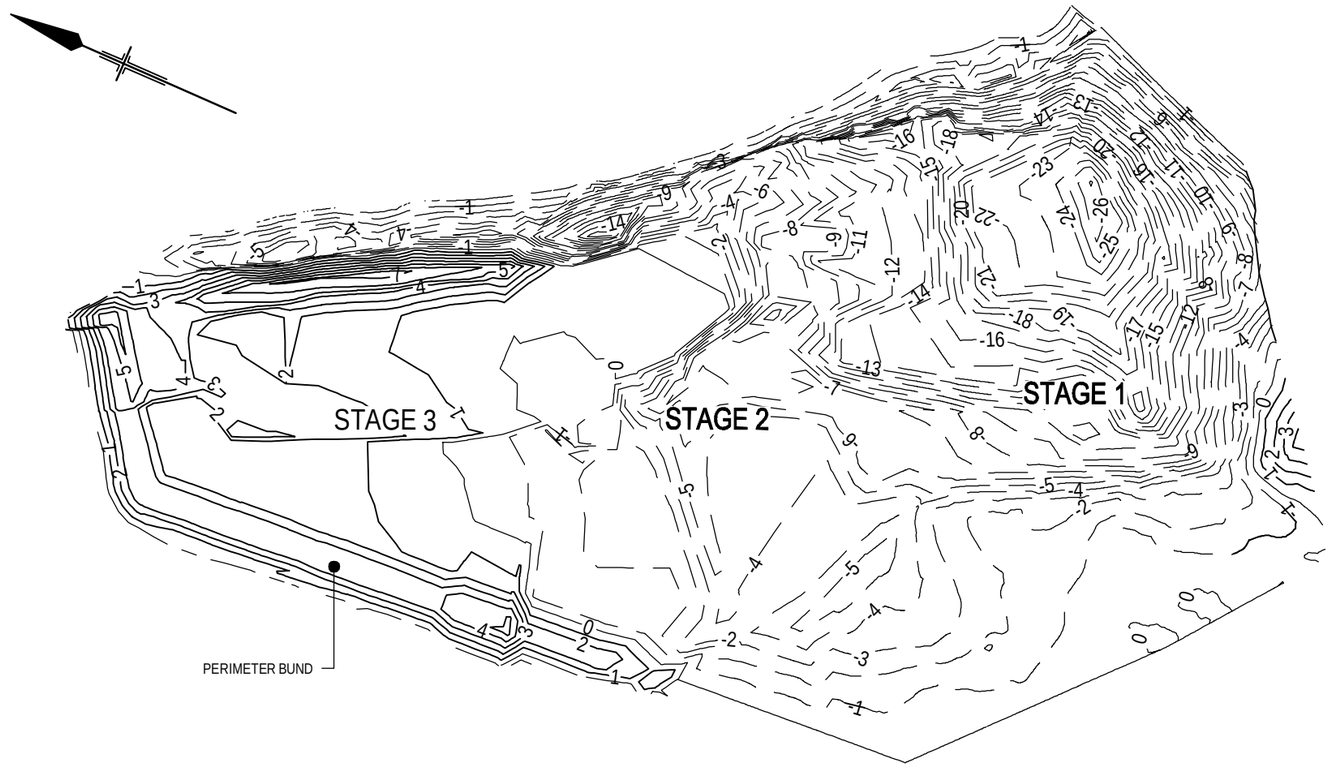
FINAL WASTE FILL CONTOURS AND CAP DETAILS

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

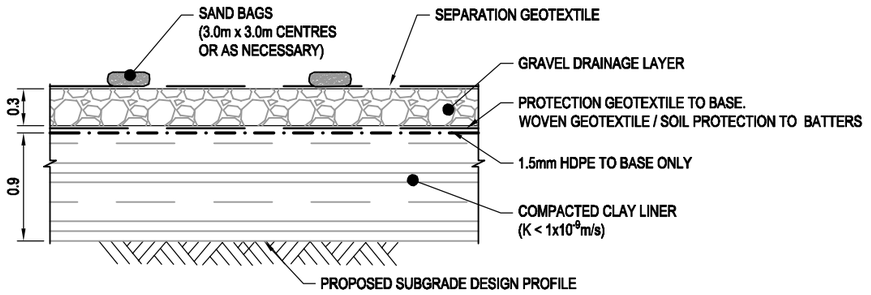
CUT AND FILL PLAN

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

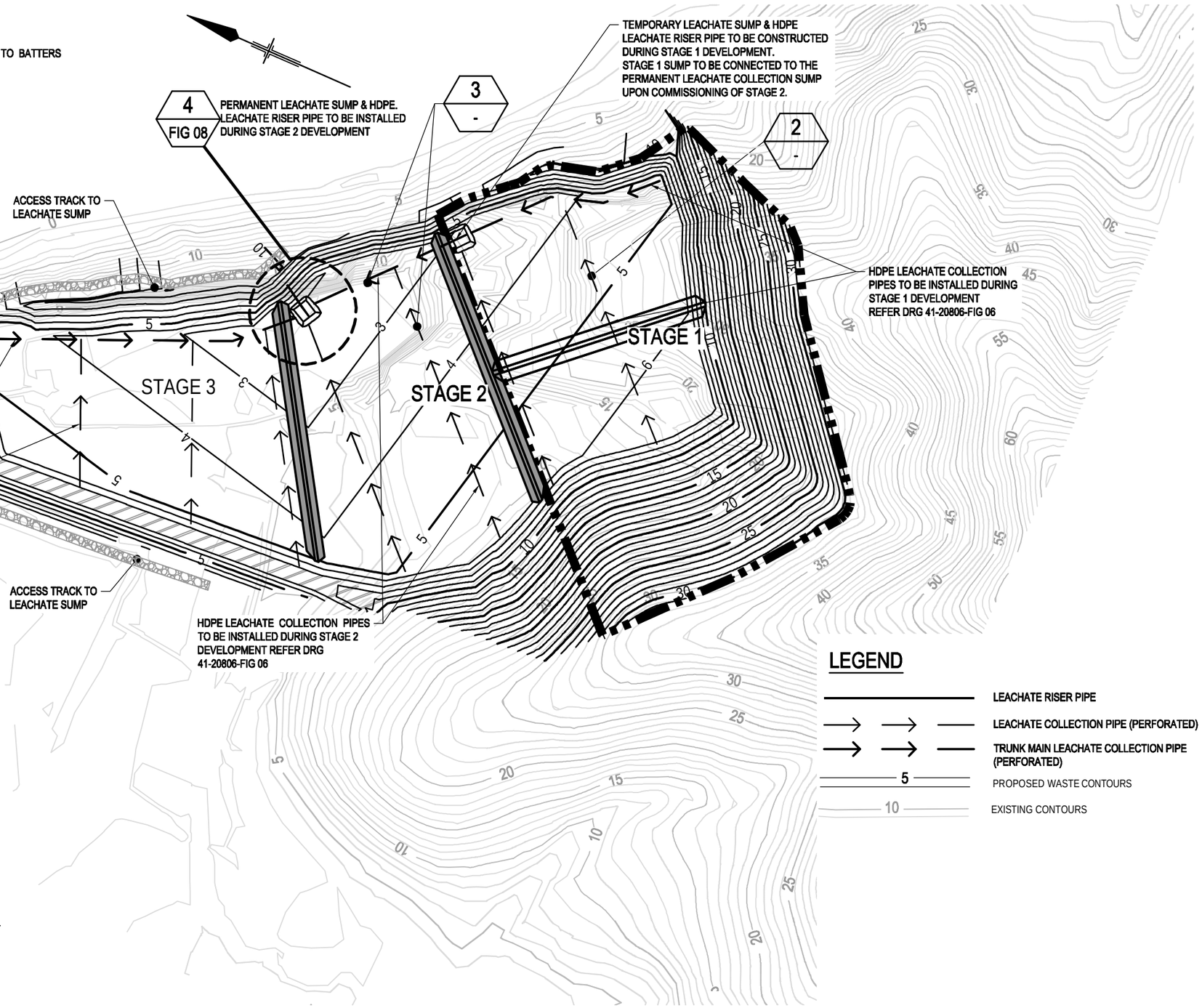
Plot Date: 26 October 2010 - 3:41 PM Plotted by: Nicola Hankin/Brisbane/GHD/AU Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 05-RC.dwg

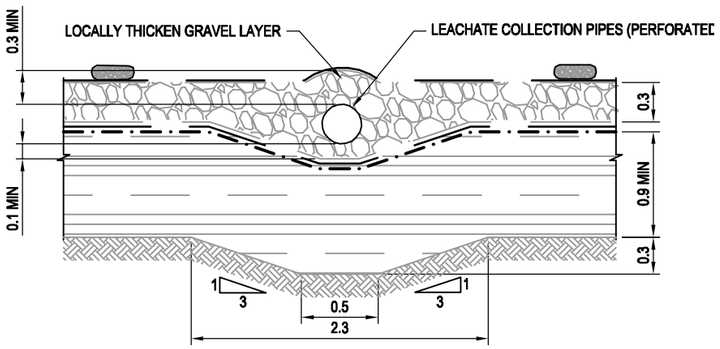


TYPICAL LINER DETAIL

2 / - DETAIL

SCALE 1 : 25





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)

TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

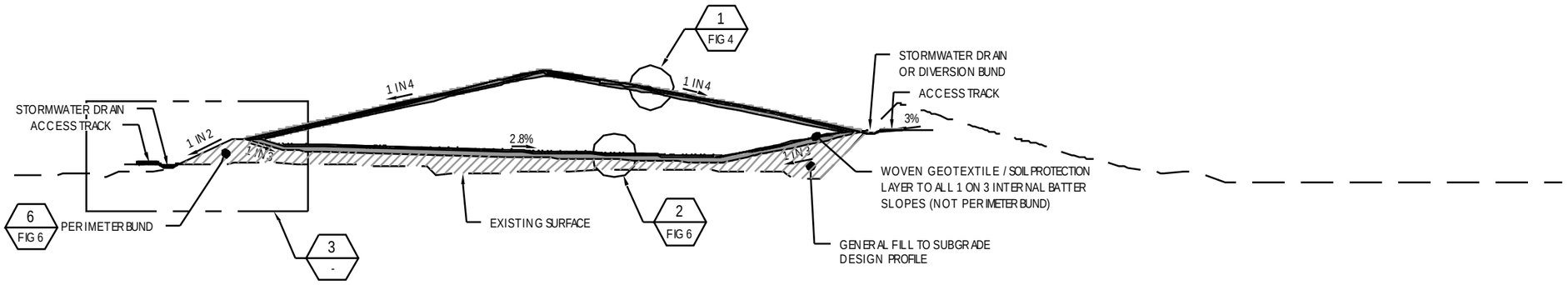
LEACHATE ARRANGEMENT AND DETAILS

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

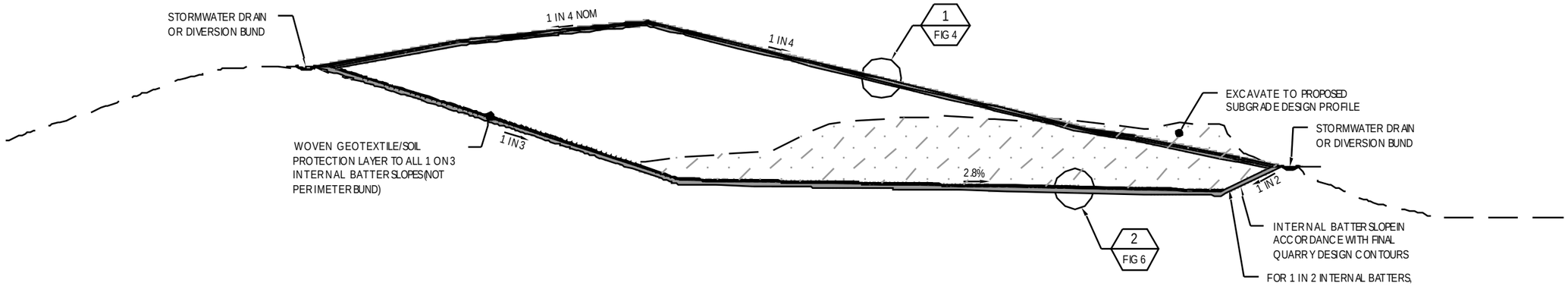
Plot Date: 26 October 2010 - 3:43 PM Plotted by: Nicola Hankin/Brisbane/GHD/AU Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 06-RC.dwg



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)

GHD

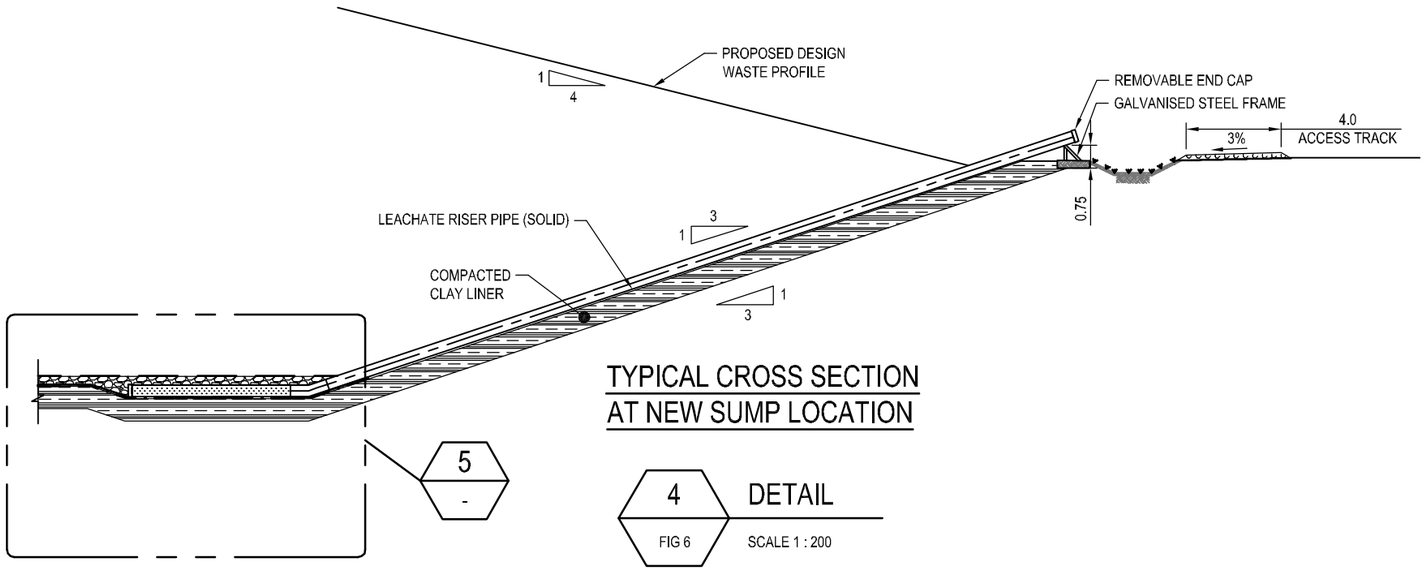
CLIENTS | PEOPLE | PERFORMANCE

TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

TYPICAL CROSS SECTIONS

Job Number 41-20806
Revision B
Date OCT 2009

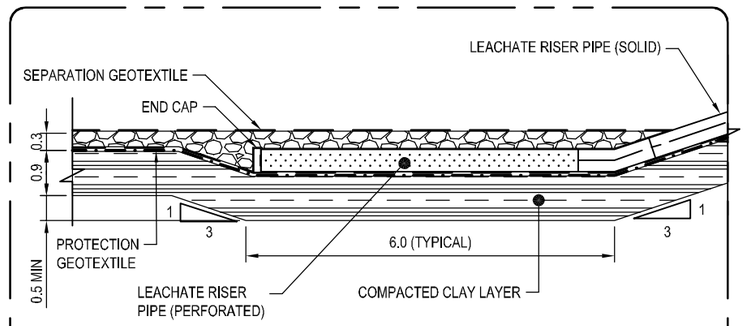
Figure 07



TYPICAL CROSS SECTION AT NEW SUMP LOCATION

4 / FIG 6 — DETAIL

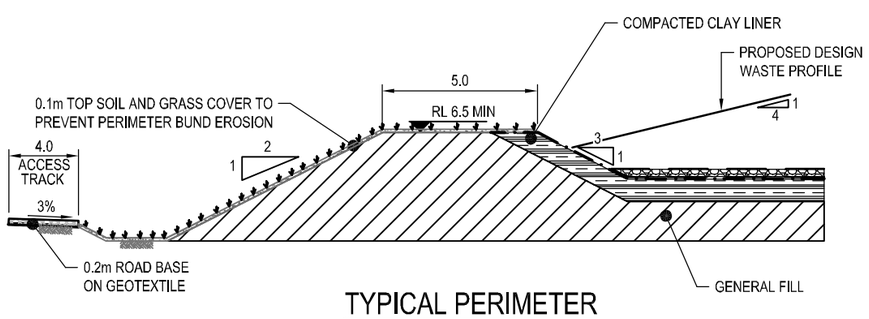
SCALE 1 : 200



SUMP DETAIL

5 / - — DETAIL

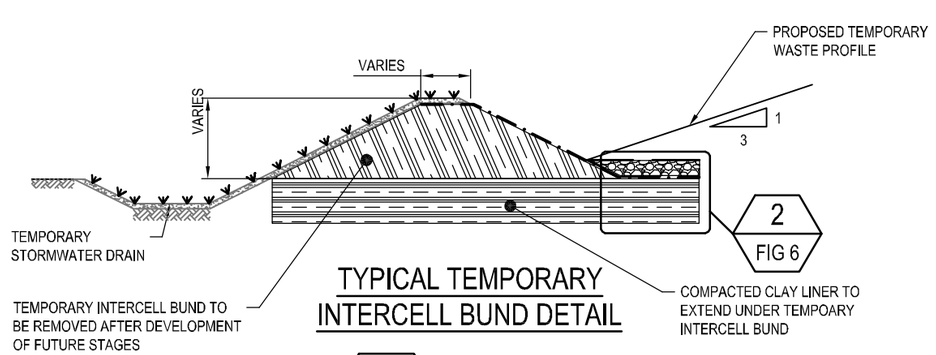
SCALE 1 : 50



TYPICAL PERIMETER BUND DETAIL

6 / FIG 3 — DETAIL

SCALE 1 : 200



TYPICAL TEMPORARY INTERCELL BUND DETAIL

7 / FIG 3 — DETAIL

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)

GHD

CLIENTS | PEOPLE | PERFORMANCE

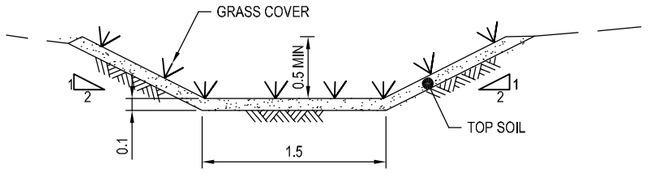
TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

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

EXISTING GULLY

EXISTING STORMWATER DRAIN TO BE RETAINED

ACCESS TRACK

PROPOSED SEDIMENTATION BASIN TO BE INSTALLED DURING STAGE 1 DEVELOPMENT

TEMPORARY CLEAN STORMWATER DRAIN WHILE FILLING UP TO RL 15 IN STAGE 1

TEMPORARY CLEAN STORMWATER DRAIN WHILE LANDFILLING IN STAGE 1

TEMPORARY CLEAN STORMWATER DRAIN WHILE LANDFILLING IN STAGE 2

PUMP CLEAN STORMWATER TO TEMPORARY DRAIN WHEN FILLING IN STAGE 1A ONLY

8 / -

ACCESS TRACK

9 / -

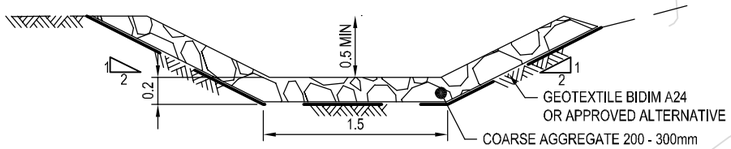
DISCHARGE TO NATURAL WATER COURSE

EXISTING STORMWATER DRAIN TO BE UTILISED AS REQUIRED

EXISTING DAM TO BE UTILISED DURING STAGE 1 DEVELOPMENT (IF POSSIBLE)

EXISTING SEDIMENTATION BASIN TO BE UTILISED AS REQUIRED

EXISTING ACCESS ROAD



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)

GHD
CLIENTS | PEOPLE | PERFORMANCE

TWEED SHIRE COUNCIL
QUIRKS QUARRY CONCEPTUAL DESIGN

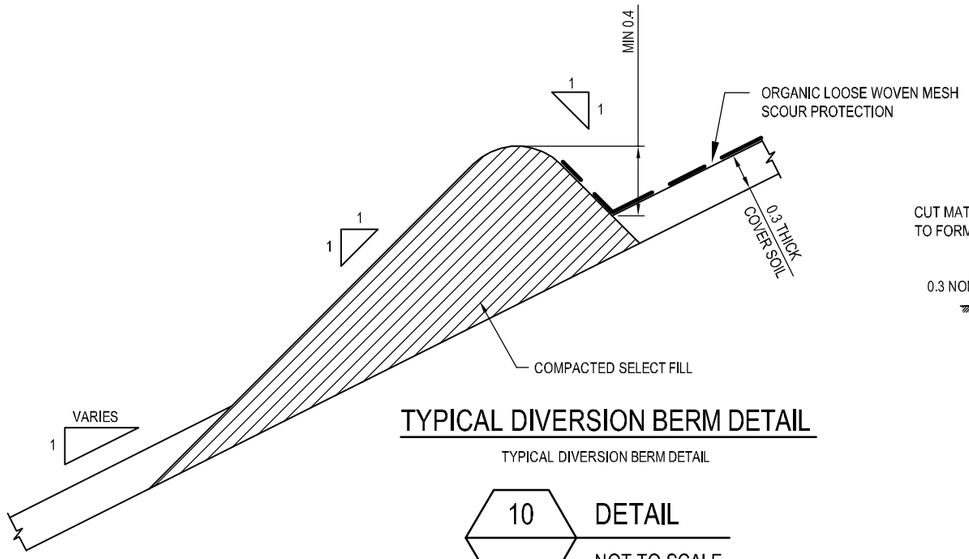
STORMWATER ARRANGEMENT AND DETAILS

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

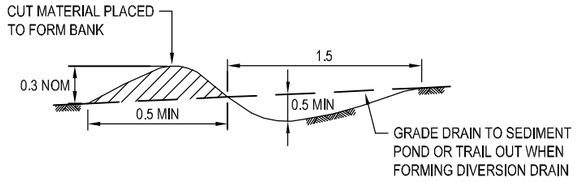
Plot Date: 21 October 2009 - 12:55 PM Plotted by: Nicola Hankin, Brisbane Cad File No: G:\41\20806\CADD\Drawings\41-20806-FIG 09.dwg



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

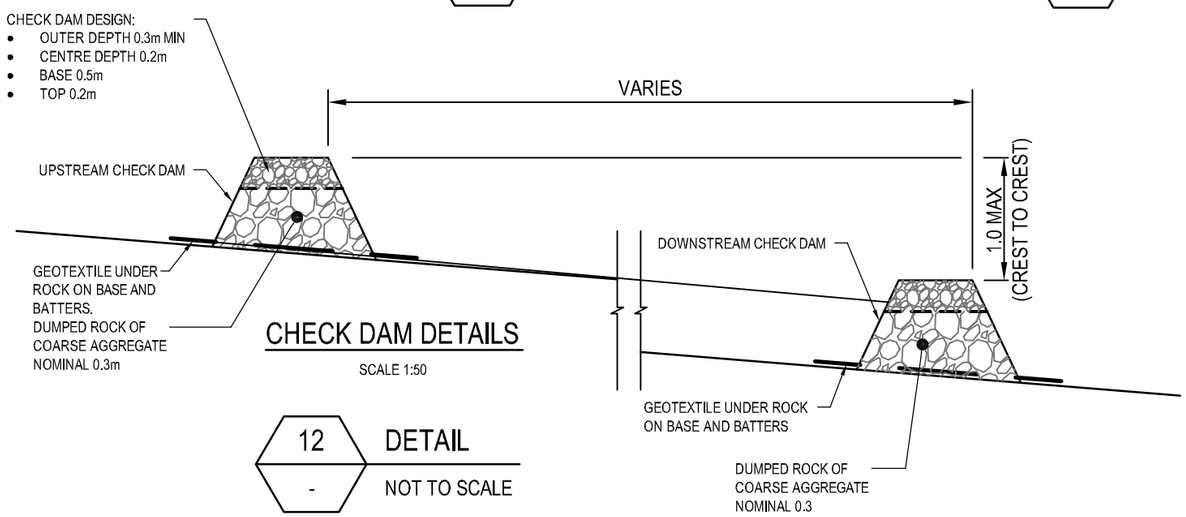
NOTES:

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

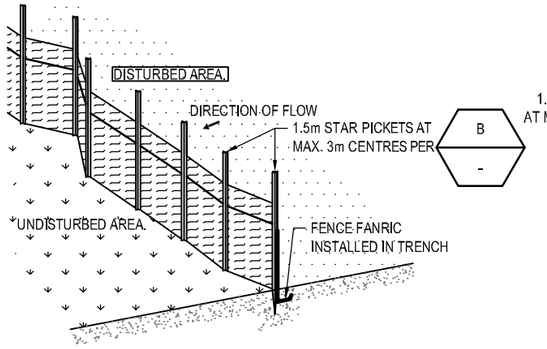
4.SILT FENCE CONSTRUCTION
- 4.1 CONSTRUCT SEDIMENT FENCE AS CLOSE AS POSSIBLE TO PARALLEL TO THE CONTOURS OF THE SITE.
- 4.2 DRIVE 1.5m LONG STAR PICKETS INTO GROUND 3m APART.
- 4.3 DIG A 0.15m DEEP TRENCH ALONG THE UPSIDE LINE OF THE FENCE FOR THE BOTTOM OF THE FABRIC TO BE ENTRENCHED.
- 4.4 BACKFILL 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

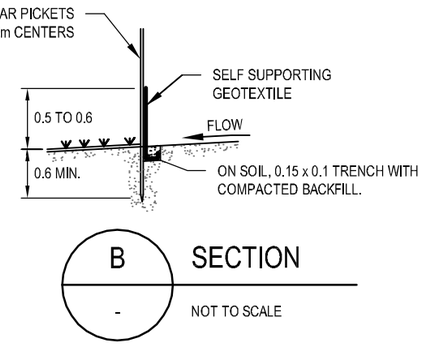
SCALE 1:50

12 DETAIL
- NOT TO SCALE



TYPICAL SILT FENCE

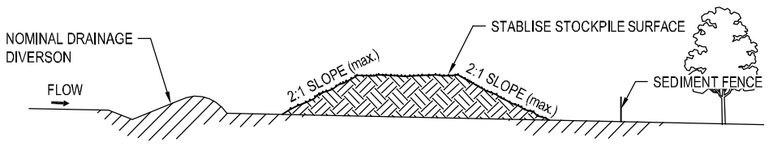
NOT TO SCALE



B SECTION
- NOT TO SCALE

TYPICAL SILT FENCE SECTION

NOT TO SCALE

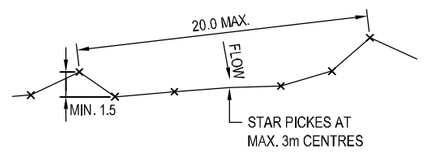


TYPICAL STOCKPILE SECTION DETAIL

NOT TO SCALE

13 DETAIL
- NOT TO SCALE

14 DETAIL
- NOT TO SCALE



SILT FENCE PLAN

NOT TO SCALE

0 0.5 1.0 1.5m
SCALE 1:50 AT ORIGINAL SIZE (A3)

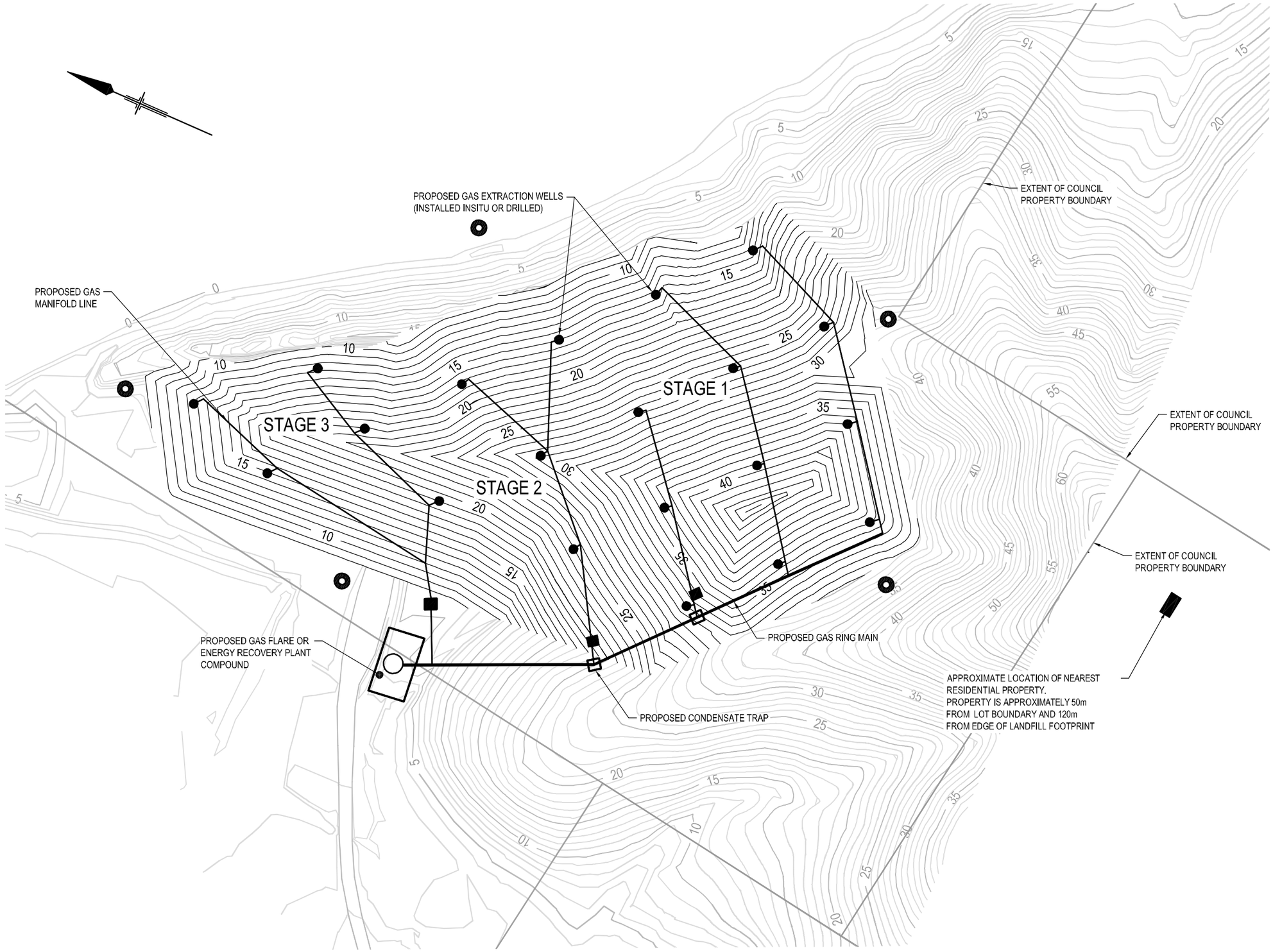
GHD
CLIENTS | PEOPLE | PERFORMANCE

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)

GHD
CLIENTS | PEOPLE | PERFORMANCE

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

Environment Protection Licence

Environment Protection Licence (insert licence number when granted)

GHD

Suite 3, 54-58 Nerang St
Nerang QLD 4211 Australia
T: 61 7 5557 1000 F: 61 7 5557 1099 E: goldcoastmail@ghd.com.au

© GHD 2009

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	L. Gapp N Hankin	A. Roberts		DRAFT	DRAFT	23/10/09
1	L. Gapp N Hankin	A. Roberts		A Marszalek		13/11/09

Appendix D

West Valley Preliminary Quarry Study

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council

Report for West Valley Quarry

Preliminary Study

September 2011



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

Contents

1. Introduction 1

2. Quarrying and Extractive Industry Development 2

2.1 Quarry and Extractive Industry Definitions 2
2.2 Justification of Development 2
2.3 History of the Tweed Shire Relevant to the Proposed Quarry 2
2.4 Products 3
2.5 Industry Structure and Economics 3
2.6 Planning 4
2.7 State and Federal Government and Agencies 4
2.8 Local Government 4

3. Tweed Shire Council Operations 5

3.1 Stott's Creek Operations 5
3.2 Quirks Quarry Operations 5

4. Site Details 8

4.1 Location Details 8
4.2 Site Description 8
4.3 Site Entrance and Access 8
4.4 Land Use 8
4.5 Local Waterways and Drainage 9
4.6 Waterways and Water Bodies 9
4.7 Climate 9

5. Geology of the Site 11

5.1 General Topography 11
5.2 Regional Geology 11
5.3 Local Geology 12
5.4 Drilling Summary 22
5.5 Soil Distribution and Quality- Acid Sulphate Soils potential 23
5.6 Hydrology and Groundwater 24
5.7 Supply Intended Water Source 24
5.8 Recommendations 24
5.9 Resource Estimates 27

6. Quarry Resource and Design 37
6.1 Resource 39
6.2 Pit Design Constraints 39
6.3 Design Methodology 40
6.4 Quarry PIT AREA 1 43
7. Quarry Schedule 46
7.1 Quarry Plan 46
7.2 Material Production Schedule 47
7.3 Proposed Operating Methodology 47
8. Quarry Overview 49
8.1 Overview 49
8.2 Level of Production 49
8.3 Hours of Operation 49
8.4 Activity Sequence of Operations 50
8.5 Extraction Timing 50
9. Quarry Activities 52
9.1 Drilling 52
9.2 Blasting 52
9.3 Extraction 53
9.4 Storage, Handling and Using Explosives 53
10. Quarry Processing Activities 54
10.1 Processing 54
10.2 Screening and Crushing 56
10.3 Stockpiling 56
10.4 Loading and Hauling 56
11. Quarry Infrastructure 57
11.1 Security 57
11.2 Construction 57
11.3 Fuel and Oil Services 58
11.4 Maintenance 58
12. Quarry Haulage 59
12.1 Product Haul Route 59
13. Fire Management Planning 62

13.1 Key Policy and Objectives 62
13.2 Performance Outcomes and Actions 63
13.3 Risk Assessment 64
13.4 Potential Sources of Ignition 64
13.5 Continual Improvement and Mitigation Measures 65
13.6 Fire Fighting Equipment 66
13.7 Fire Training 66
13.8 Monitoring 68

14. Safety Measures and Environmental Measures 69

14.1 Policy 69
14.2 Bunds 69
14.3 Uncontrolled Releases 70
14.4 Spill Management Planning 70
14.5 Minor Spills 71
14.6 Major Spills 71
14.7 Spill Avoidance 72
14.8 Records and Corrective Actions 73
14.9 Site Closure and Rehabilitation 74

15. References 75

Table Index

Table 1 Current Operating Hours for Quirk's Quarry 6
Table 2 Equipment Currently Used and Required at Quirks 6
Table 3 Murwillumbah Metrological Information 10
Table 4 Summary of sampling intervals within TSCBH01 15
Table 5 Summary of assay results from sampling of TSCBH01. 16
Table 6 Possible Drillhole Locations (MGA Zone 56 (GDA 94)) 24
Table 7 West Valley Quarry PIT AREA 1 Bench Configuration 40
Table 8 Assumed Layer Density Definition 41
Table 9 Quarry PIT AREA 1 Quantities by Bench 42
Table 10 West Valley Quarry PIT AREA 1 Estimated Bench Tonnages 43
Table 11 Example 11 Year Production Schedule (Tonnes) 46

Table 12	Example 11 Year Material Schedule (Tonnes)	47
Table 13	Proposed Quarry Services Operating Hours for Eviron Quarry	50
Table 14	Proposed Controls and Actions Table for Fire Management and Plann	67

Figure Index

Figure 1	Drillhole Locations – Site View (with Cross Sections locations)	17
Figure 2	Cross Section North West to South East	18
Figure 3	Cross Section South West to North East (North)	19
Figure 4	Cross Section South West to North East (South)	20
Figure 5	Drillhole Locations showing proposed West Valley Quarry	21
Figure 6	Drillhole Locations showing proposed West Valley Quarry	26
Figure 7	Plan showing drillholes and conceptual West Valley Quarry pit outline with Cross Sections	29
Figure 8	Cross Section 1 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline	30
Figure 9	Cross Section 2 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.	31
Figure 10	Cross Section 3 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.	32
Figure 11	Cross Section 4 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.	33
Figure 12	Cross Section 5 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.	34
Figure 13	Cross Section 1 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.	35
Figure 14	Topography Contours, Land Titles and Quarry Footprint	38
Figure 15	Stage plans for Proposed West Valley Quarry area. Different colour lines represent each bench	45
Figure 16	Example Quarry processing activities	54

Figure 17 Workshop Configuration Example 58
Figure 18 Typical Pavement Structure 61

Appendices

A Geology Mapping Report
B Lithology Logs
C Borehole Core Photographs
D Figures and Diagrams

1. Introduction

Tweed Shire Council's (TSC) existing landfill, the Stotts Creek landfill, is predicted to reach capacity by 2012. As such, Council is seeking to develop new waste infrastructure to provide for the waste management requirements of the Tweed local government area (LGA) in the short term; and gain approval to develop additional waste infrastructure to meet the LGA's projected medium and long term needs.

Council is proposing to establish the Shire's new landfill facilities on existing Council owned land at Eviron Road, Eviron, within the Tweed LGA. Council has developed an overall Concept Plan for the proposed infrastructure, which outlines a staged approach to develop a landfill within the existing void space created by Quirks Quarry, the development of two further quarries to be used as landfills after exhaustion of the quarry resource, and necessary operational infrastructure such as a haul road, and other minor associated facilities as required. This proposed method of landfilling in quarry voids is consistent with the method of landfill creation in the Tweed Shire to date.

Council intends to undertake a staged approach to the development, and has thus sought two approvals from the Department of Planning:

- Project Approval for Stage 1 of the Concept Plan, which involves landfill within Quirks Quarry, development of a new quarry in the West Valley and associated infrastructure including a haul road from Stotts Creek landfill. This is referred to as the Stage 1 (Project Application); and
- Concept Plan Approval for the overall Concept Plan, which includes all components of the Stage 1 Project Application, as well as the further development of a landfill, and a quarry and landfill, which are currently proposed as Stage 2 of the Concept Plan. The 'Concept Plan' thus refers to all components of Stage 1 and Stage 2 encompassing all currently proposed waste and quarrying infrastructure.

TSC has engaged GHD to undertake this Preliminary Quarry Study for the West Valley Quarry, addressing the requirements of the Department of Primary Industries included as part of the Director General's Requirements for the Environmental Assessment of the Project. All assumptions made within this report have been identified herein, and any information that supports these assumptions is based on the conditions and aspects from sites in close proximity to the Quirks Quarry operation.

The proposed operations need to be adequately planned, developed and assessed in order to gain the appropriate approvals in order to commence site works. Items that will be assessed as part of the approval process include site rehabilitation, which also entails the determination of suitable land use options post quarry operations.

Previous studies have recognised that there may be several products that can be extracted for use; however the use of some of these products will only be suitable for specific uses on the Quirks and West Valley Sites.

2. Quarrying and Extractive Industry Development

2.1 Quarry and Extractive Industry Definitions

Extracted materials identified at the Quirks Quarry, which is adjacent to the proposed West Valley Quarry site, includes clays, gravel and rock, and it is predicted that those materials will also be encountered at West Valley Quarry. These materials are classified as extractive material, which is defined as sand, gravel, clay, soil, rock, stone or similar substances, and does not include turf. The proposed quarry operations are therefore classified as extractive industry, defined as the winning or removal of extractive materials (otherwise than from a mine) by methods such as excavating, dredging or quarrying, including the storing, stockpiling or processing of extractive materials, by methods such as recycling, washing, crushing, sawing or separating; but **does not include**:

1. Turf farming.
2. Tunnelling for the purpose of an approved infrastructure development.
3. Cut and fill operations (including the digging of foundations, ancillary to approved development).
4. The creation of a farm dam, if the material extracted in the creation of the dam is used on site and not removed from the site.

2.2 Justification of Development

In previous regional plans for the Eviron area, it was identified that there would be requirements for successive quarry developments for the Tweed Shire area. These plans include quarry operations which have since closed such as Bartlett's Quarry at the current Stott's Creek Landfill Site. Following Bartlett's Quarrying operations, it was proposed that Quirks and Eviron quarries would continue after these operations ceased.

These council-operated quarries were located within close proximity to each other, with the intention that the entire area would be relatively isolated, to allow/ensure:

- The site to be owned by the council acquired when planning was first being developed;
- The intensive activity to be undertaken with minimal impact to the community;
- That all existing neighbours are amenable to quarry activities;
- A continuity of products produced;
- Close proximity to townships, industry and tweed development areas, in order to be economical; and
- It is proposed that once quarry resources have been exhausted in the area, the area will be land-filled and potentially used as a botanic gardens corridor.

Within the initial planning of the Bartlett's, Quirks and Eviron quarry sites, these areas were zoned accordingly, to ensure the proposed plan could be executed stage by stage if required.

2.3 History of the Tweed Shire Relevant to the Proposed Quarry

Extractive industry has historically played a role in Tweed Shire, previously supplying material for highway works, as well as development and construction works linked to the growing population of the area.

There has been a long history of timber felling and cane growing, with particular reference to these activities between the Tweed River and Murwillumbah. It is expected that the Tweed's population and development will continue to grow and require maintenance. It is also expected that new developments and the associated construction works will use the quarry resources, to enable these works to progress.

2.3.1 Site Heritage

The site proposed for Quarry operations has no specific land use prior to this proposed quarry development, as the ridgeline dominated by eucalypts has been unsuitable for grazing cattle or cane growing activities.

The Bartlett's/Stott's Creek operations initially started as a quarry to be decommissioned and used for landfill once all available resource had been extracted and void space created. Currently there is limited void space remaining for landfill use at Stott's Creek. Closure planning is currently being formulated for Stott's Creek to return the landform to a suitable condition for use as part of a botanic gardens corridor.

Quirks Quarry has been operational since TSC acquired the operations. The extraction from Quirks Quarry has been operated continuously since the resource available for extraction has decreased, and another Quarry for the North and West Valley is proposed in order to fill the void that the closure of Quirks will leave. Cessation of works at Quirk's is being planned and post-quarry use for the land is being established so that rehabilitation and closure planning will be successfully integrated.

2.4 Products

The primary products to be produced at the West Valley Quarry are a range of aggregates, road base and fill materials. These products are planned for use and sale in the local area, namely for construction and development purposes. The excavated materials will be screened and crushed on site by pre-existing equipment from Quirk's and Stott's Quarry. Products that have been produced previously include road base material, fill materials and clays, as detailed below:

- 70-30 mm, 40 mm, 20 mm, 10 mm, 7 mm Drainage Aggregates;
- Cracker Dust;
- "C" Grading Type 2.1 and "B" Grading Type 2.3 Road base;
- Overburden / Fill;
- Screened topsoil (Rescreened from imported spoil); and
- Screened Sand (Rescreened from imported spoil).

2.5 Industry Structure and Economics

As the Tweed Shire and surrounding areas continue to grow and develop, there will be continued demand for building aggregates and associated products in this area, as well as further afield.

According to Council as Quirks Quarry resource is close to exhaustion, the market will require the development of Eviron Quarry. It is important that the planning of the closure of Quirks and the opening of Eviron allows seamless product supply.

The local area contains two main competitors; however these are further west of the Eviron Quarry and service the Murwillumbah town and North-Tweed area, whereas the Eviron Quarry would aim to supply

local council and the South-Tweed area, including Kingscliff, Bogangar, Cabarita, to Hastings Point (7 Year Plan Report and Tweed DCP 2008). These areas are all continuing to be developed and therefore are creating demand for fill and quarry products.

2.6 Planning

As part of the planning phase; preliminary studies and plans are being compiled to ensure that all aspects for the approval by local and state regulators can be met. These approvals are essential to enable the development of quarrying operation in the area, by allowing this prior to the absolute closure of the Quirks Quarry will allow seamless flow and availability of products during the interim.

Environmental, operational and community consultation, planning, development and reporting will be conducted to further ensure community awareness and to find any potential issues the greater community may have, or environmental aspects, which may influence the quarry development.

2.7 State and Federal Government and Agencies

As part of the TSC planning, provisions have been made in order to satisfy the greater community's needs for quarry material for development and the landfill uses outlined thereafter.

2.8 Local Government

As TSC is responsible for the construction and development of the local area, including maintaining the local areas' infrastructure, such as roads and reserves, a need for quarry material is maintained by council; and to ensure minimal cost expenditure for materials, the council requires the local development of quarries. Furthermore, by locating the proposed quarries close to previous and current operations on council-owned land minimal residents are affected by the proposed development of the North and West Valley areas.

The proposed Eviron area has correct zoning and is elevated above the floodplain, which reduces the requirement for dewatering, and reduces the risk associated with flood damage to equipment and machinery.

Due to ongoing development needs and population growth it has been identified that the quarry could be used for winning material required for various developments in and around the southern part of the Tweed Shire. Continued growth and landfill use has also been identified, and the quarry resource area can provide a suitable location for landfill and recycling purposes, once the resource is exhausted.

In summary, TSC's local strategy (referred to in 7 Year Plan Report and Tweed DCP 2008) is to create suitable quarry material that sustains the community's growth and development, whilst also identifying locations for potential landfill sites, that allow for the proper allocation, treatment and encapsulation of waste materials.

3. Tweed Shire Council Operations

TSC has developed several quarry operations required for council use and by local industry, as part of the TSC's plan to meet industry and community needs. Stott's Creek Operation, Quirks Quarry and the proposed Eviron Quarries form component parts of TSC's plan.

3.1 Stott's Creek Operations

Stott's Creek Operations include the former working quarry area (Bartlett's Quarry) and the current landfill activities. The area is zoned accordingly [5(a) Special Purpose (Garbage Depot)] and has been identified as such in the Tweed Local Environmental Plan 2000 (TLEP).

The Facility is located in close proximity to the currently operating Quirks Quarry located directly east of Stott's Creek Operations, and adjacent to the Pacific Highway. The area between the two operations consists of privately-owned properties, cane fields and the proposed West Valley Quarry site.

Significant investment of infrastructure has been input into developing the Stott's Creek Site. It has been identified that the use of pre-existing infrastructure could be both practical and cost-effective if the proposed West Valley Quarry is to be developed. This infrastructure includes security measures, a weighbridge, an office block and other staff facilities. During the Operational Phase, the Bartlett's Quarry at Stott's Creek Landfill site produced; aggregates, fill, road base and cracker dust.

The Existing Landfill operation is involved in:

- Methane capture utilisation, technology development and innovations;
- Pollution reduction and waste reduction technologies;
- Recycling technologies; and
- Landfill encapsulation.

Currently the Stott's Creek operations are nearing completion and will move towards other activities and/or start rehabilitation works on areas where works have ceased. It is predicted that landfill operations will cease some time in 2012.

3.2 Quirks Quarry Operations

Quirks Quarry has been operating since the 1950s. In 1996, TSC purchased the quarry and it began operating under the current quarry management plans. The resource at Quirks will become exhausted in 2010.

Initial resource extraction was deferred until council submitted a Quarry Management Plan, including flood study, acid sulphate soils investigation, and an investigation into haulage issues.

3.2.1 Current Operations

The current extraction licence is for a threshold of 100,000 tonnes annually (Lic No. 12777). The current operating hours for Quirks Quarry are identified in Table 1.

Table 1 Current Operating Hours for Quirk's Quarry

Operation	Operating Days	Start Times	Finish Times
Quarrying	Monday to Friday	7:00	17:00
	Saturday	7:00	12:00
Blasting	Monday to Friday	9:00	15:00
	Saturday	9:00	12:00
Hauling	Monday to Friday	7:00	17:00
	Saturday	7:00	12:00

3.2.2 Current Production

Currently a range of materials is produced at the Quirks Quarry site, including:

- 70-30 mm, 40 mm, 20 mm, 10 mm, 7 mm Drainage Aggregates;
- Cracker Dust;
- "C" Grading Type 2.1 and "B" Grading Type 2.3 Road base; and
- Overburden / Fill.

According to Council, the availability of the above materials is highly differential and can very dependent on the area of extraction and the depth that extraction is occurring within.

3.2.3 Current Equipment Fleet

The current quarry fleet utilised at Quirks Quarry is a combined fleet of hired and council-owned machinery and trucks.

Table 2 Equipment Currently Used and Required at Quirks

Council owned Equipment		**Hired Equipment**	
1	Fintec 542 Screening Plant	1.	Cat IT 62 Wheeled Loader
1	Daewoo Mega 300V Wheeled Loader	1.	Volvo L180 Wheeled Loader
		1.	Cat D7 Dozer
Other Equipment Onsite		1.	SEE Symons Cone Crusher
	Blasting equipment and associated vehicles	1.	Sumitomo SH 330-3 Excavator
	Trucks	1.	SEE Kue-Ken Jaw Crusher
1	Water truck (when required)	1.	Fintech 640 Scalper
1	Pneumatic hard rock drill	1.	25m Folding Stacker Conveyor
		1.	Finlay Hydra screen 683 Screening Plant.

3.2.4 Current Programs

The current Quarry Management Plan for Quirks Quarry incorporates multiple facets of the on-site environment and activities undertaken. Each facet and/or activity is identified within a plan to ensure regulatory compliances are maintained during operations. These plans include, but are not limited to the following:

- The Extraction plan for Quirks (method and sequence of extraction);
- Acid Sulphate Soil Plan;
- Vegetation clearing and Topsoil removal Plan;
- Sedimentation and Erosion Control Plan;
- Stormwater Management Plan;
- Dust Control Plan;
- Noise Abatement Strategies;
- Visual Protection and Enhancement (component of other plans);
- Flora and Fauna Protection Strategy;
- Archaeological Protection Strategy;
- Site Rehabilitation;
- Blasting Strategy;
- Haulage/Traffic Control Strategy;
- Fuel Storage;
- Waste Disposal; and
- Ongoing reporting and monitoring plans for environmental aspects.

Many of these plans are part of other plans and are combined to create the Quarry Management Plan, which is ultimately the overriding document pertaining to all aspects of the quarry, including its social, environmental and economic impacts on the local area.

4. Site Details

4.1 Location Details

The proposed North and West Valley Quarry areas are located approximately 1-1.5 kilometres west of the Pacific Highway. The Areas of interest are:

- Lot 1 DP 34555;
- Lot 1 DP 11159352; and
- Lot 602 DP 1001049.

These lots encapsulate the areas of development currently and for future works; these will be closely linked to the operations being undertaken at Stott's Creek, as the entire area is proposed to become a Botanic Gardens Spanning from the Eastern side of the highway to the current Stott's Creek facilities.

4.2 Site Description

The Eviron Quarry site is of varied topography, and water drains to the north-east on the site, as the ridge line lies along the south-west boundaries. The area is located above the floodplain associated with the Tweed River, which is located approximately four kilometres north-west of the Proposed Quarry.

Currently the site is closely located to the existing Quarry (Quirk's) and the Stott's landfill area.

Distances from the quarry to the local towns of the area are approximately:

- 5.5 km Cudgen;
- 5.5 km Bogangar;
- 7.5 km Kingscliff town centre; and
- 10 km Murwillumbah town centre.

4.3 Site Entrance and Access

It is proposed that the entry/exit point for the proposed quarry operations utilise a new haul road to be created between Stott's Landfill and the northern section of the proposed operations. The existing access point for Quirks Quarry onto Eviron Road will be discontinued and access will no longer be permitted from this point.

4.4 Land Use

Currently the land surrounding the proposed quarry areas is predominantly cane fields to the north and west and quarried to the east (Quirks Quarry). North of the proposed West Valley Quarry area is a privately owned small scale privately owned quarry (known as O'Keeffes Quarry).

A number of rural residential properties are located along Eviron Road to the south-east and west of the proposed quarry.

4.5 Local Waterways and Drainage

Currently several cane channels used for water drainage associated with the low lying flood plain area overlooked by the proposed Eviron Quarry site. In addition to this the Tweed River is located approximately 4 km north-west of the proposed quarry site.

Currently drainage on site travels down from the ridge line towards the flood plain and enters cut channels to then be flow to the larger local watercourses.

However some water is captured currently on the Quirks Quarry site in a holding dam and used for operations.

4.6 Waterways and Water Bodies

There are many cane channels cut into the floodplain area to the north of the site, these drain into creeks and then to the Tweed River. These are approximately:

- 4.7 km Condong Creek;
- 1.2 km Mains trust CN;
- 3.5-4 km Tweed River; and
- 3.4 km to Cudgen Lake;

4.7 Climate

Table 3 outlines the average rainfall since 1998 in the Tweed Shire Area. May through to October are predominantly the drier months of the year however some large rainfall have skewed the average of these months.

4.7.1 Murwillumbah

Murwillumbah generally experiences mild winters and summers. Average data for the area is reported in Table 3 as recorded by the official Bureau of Meteorology Weather Station, (http://www.tweed.nsw.gov.au/AboutTheTweed/RainfallChart).

Table 3 Murwillumbah Metrological Information

Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Temp Avg (Daily Max)	29.5	29.0	28.5	26.5	23.6	21.1	20.8	21.1	24.5	25.8	27.6	29.5	25.63
Temp Avg (Daily Min)	19.1	19.2	18.0	15.0	13.3	9.1	8.1	8.2	10.8	13.4	16.1	18.0	13.94
Sum Rain (Mean mthly)	205	222	259	171	158	99	90	60	44	106	132	155	1701
Sum Rain (Median mthly)	174	158	214	104	106	63	63	43	33	93	127	117	1295
Sum Rain (Days Mean)	15	17	18	15	14	10	10	9	9	12	13	14	156

5. Geology of the Site

The proposed West Valley Quarry will extract soils, weathered materials and rocks of the Neranleigh-Fernvale Beds (NF) from the side of a steep hill west of the Pacific Highway.

5.1 General Topography

The topography of the proposed West Valley Quarry area is a combination of low lying floodplain of the Tweed River Valley and a ridge line that borders the south-west parts of Lot 1 DP 34555; Lot 1 DP 1159352 and Lot 602 DP 1001049. The floodplains are used for sugar cane cropping and the ridges occasionally for grazing. Elevations range from 0 RL to 60m RL across the proposed quarry site.

5.2 Regional Geology

In the region of the West Valley Quarry, the Murwillumbah 1:100 000 scale geological map (GSQ, 1978) shows the site as being underlain by the Neranleigh-Fernvale Beds. This unit is Devonian-Carboniferous in age and is mapped to comprise mudstone, shale, greywacke, quartzite/chert, jasper, basic metavolcanics, pillow lava and conglomerate. The depositional environment was deep-water marine. Willmott (2010) indicates that these sediments are folded, metamorphosed and inclined moderately to steeply. Areally, these metasediments are very extensive and have been identified as far north as Yeppoon in central Queensland and as far south as Ballina in New South Wales.

Lithological descriptions are provided within Willmott (2010) as follows;

- Argillite (Mudstone): Dark grey to black, very fine-grained, hardened mudstone; buff to whitish coloured when weathered; represented in lower hills of hinterland but can form prominent ridges.
- Greywacke: Dark grey, hard, massive rocks consisting of fine to coarse angular to sub-angular rock fragments in a recrystallised groundmass; can form beds 100 to 200 m thick.
- Shale: Fine-grained detrital sediments, laminated and easily split into layers; readily weathered.
- Greenstone: Greenish-grey, fine-grained recrystallised basalt resulting from basalt lava flows on the sea bed; weathers to red coloured profiles.

In the district, the lithologies which comprise the Neranleigh-Fernvale have been commercially exploited; for example;

- Slate in the Gold Coast area has been used to decorate walls.
- Greywacke has been used as an important source of crushed rock aggregate for construction. The Ormeau Quarry situated between Brisbane and the Gold Coast has had greywacke quarried for aggregate purposes since 1981. Elsewhere in the Gold Coast, Whitlow (2000) has reported several quarry localities (Darlington ranges, north of Nerang and Andrews area) within greywacke.
- Quartzite has been worked within quarries for road gravels. Whitlow (2000) has reported sand and gravel extraction operations on the Upper Coomera river terraces and in the Pimpama region within the Gold Coast.
- Greenstone (basic metavolcanics) when fresh has been used as aggregate in a quarry within the Albert valley area in the northern part of the Gold Coast.

Low lying areas of the site are underlain by Recent to Tertiary alluvium.

5.3 Local Geology

During August 2011, GHD personnel mapped the geology of the area covered by the West Valley Quarry proposal and noted that the area contained only minor to rare outcrop or sub-outcrop of Neranleigh-Fernvale beds. A detailed geological mapping report is presented in Appendix A.

Locally, the Neranleigh-Fernvale beds consist of a combination of cherts/quartzites, siltstones and greywackes which cannot be traced over significant distances thereby precluding geological interpretation. When observed at the surface, these beds (particularly the siltstone) have moderately well to poorly defined foliation which strikes north to northwest and dips moderately to steeply westward. This foliation appears to form on bedding or lamination planes. The siltstone is the most common lithology observed in outcrop particularly in the western part of the area where a pronounced ridge is present. The other lithologies; cherts/quartzites and greywackes outcrop poorly in the area. These lithologies are mostly observed within road or drainage cuttings and as massive to blocky material often jointed, fractured with some local quartz veining.

Significant additional geological information was obtained from reviewing the Quirks Quarry to the east of the area. The Quirks Quarry contained mostly exposed siltstone with locally isolated exposure of chert/quartzite and greywacke. There are indications of local faulting and alteration (silicification) of particularly siltstone within the Quirks Quarry but lack of outcrop in close proximity to this quarry does not allow the alteration and faulting to be traced along strike.

In the northeastern section of the quarry study area, outcrop is absent as a result of historic land clearing activities and prevalence of Tertiary to Recent alluvium.

In addition to the recent geological mapping undertaken by GHD, five (5) partially cored drillholes were re-logged in January 2011. This re-logging has provided a more detailed description of the lithology and geology at the proposed West Valley Quarry area. Core from the following boreholes was provided for re-logging:

- TSCBH01 (total depth 70.25m)
- TSCBH02A (total depth 20m)
- TSCBH02B (total depth 55.3m)
- TSCBH03A (total depth 20.2m)
- TSCBH03B (total depth 60.3m)

The holes were distributed across the site, with three holes located in the northern one third of the site and two holes located in the southern one third of the site, providing data across all topographic and geomorphological terrains, from the hill crest, slopes and plain adjacent to the creek (Figure 1, Figure 2, Figure 3, Figure 4, and Figure 5)

Overall, 15 holes were attempted included two (2) holes which had to be re-drilled due to hole technical difficulties. Core recoveries within all holes drilled were generally poor with several wide zones of poor recovery observed.

Several other shallow TSCBH prefixed holes were drilled but were very shallow with an average depth of 9.4m and ranging in depth from 1.8m to 20m. Logging of these holes indicated that all holes ended in weathered Neranleigh-Fernvale with between 1 and 3 metres of Tertiary alluvial cover.

Several other diamond drill core holes were also planned to provide a large geographical spread of geological information but could not be completed primarily as statutory approvals could not be attained at that time. Significant core loss experienced within the TSCBH prefixed holes particularly within the top 20m also may have resulted in uncertainty when mapping the boundary between Tertiary or Recent alluvium and Neranleigh-Fernvale beds underneath.

Seventeen holes (hole numbers GW1-GW4, GW6-17, GW19A) were drilled to monitor groundwater levels (GW prefixed holes). Only four (4) of these holes intersected Neranleigh-Fernvale beds; 3 holes (GW1, GW3, GW15 and GW19A) intersected weathered Neranleigh-Fernvale beds and only GW19A intersected fresh Neranleigh-Fernvale beds at 14.6m in depth. The hole depths of these groundwater monitoring holes were generally less than 5m except for GW1, GW3 and GW19A which has depths of 12m, 12.5m and 56m respectively.

5.3.1 Tertiary and Recent Alluvium

Tertiary to Recent alluvium has been recorded in all the holes drilled within the West Valley Quarry area (both TSCBH and GW prefixed holes) and extends to about 20m in depth below the ground level. Intersection of alluvium is displayed best within TSCBH02A. The materials are dominated by silty to sandy clays, generally of moderate to high plasticity. Colour varies throughout, however large fragments of clay recovered in some of the chip samples suggest the base colour is grey, with yellow, orange and red mottling throughout. Alluvium mapped at the surface and within drillholes has not been distinguished as in broad terms the lithology is similar.

A significant sand layer was observed between approximately 14m and 20m (end of hole depth) within TSCBH02A where the grain size varies and a subtle upward fining sequence was also noted. The sand is generally well graded and is comprised of quartz and lithic fragments with trace silt and clay.

Due to significant core loss experienced in drilling core holes prefixed by TSCBH, it is possible that Tertiary or Recent alluvium cover logged in these holes may have been overestimated.

As a result of the drilling method and age of the samples, the in-situ density and moisture condition for these materials cannot be established with certainty from the samples remaining. It is possible that similar materials could occur beneath areas of similar topographic and geomorphological expression.

Surficial cover consisting of Tertiary to Recent alluvium is most prevalent in the central portion of the Tweed Quarry area with geological mapping undertaken in the far west of the area and within the Quirks Quarry to the far southeast indicated often less than 1m of cover.

5.3.2 Neranleigh-Fernvale Beds

The rocks within drillholes TSCBH01, TSCBH02A, TSCBH02B, TSCBH03A and TSCBH03B consist of an interbedded sequence dominated by siltstone and greywacke and rarely black or graphitic shale, with minor brecciation and variably silicified. Pyrite (sulphide) mineralisation is observed in three holes within foliation planes (TSCBH01, TSCBH03A and TSCBH03B) or in apparently local alteration zones (as displayed within TSCBH01).

Strong silicification is observed within TSCBH01 and appears to have resulted from secondary alteration. The intensity of secondary silicification is much less within TSCBH02B, TSCBH03A and TSCBH03B. The alteration observed within TSCBH01 is considered a local effect as holes drilled in relatively close proximity to TSCBH01 are much less altered.

In drill core, the weathered Neranleigh-Fernvale beds exhibit an earthy texture. Fresher material of the Neranleigh-Fernvale beds is generally grey to grey-green in colour and the depth of oxidation is approximately 20m below the ridge in the western section of the West Quarry area to much deeper further east. Weathering varies with depth and is somewhat persistent, with some leaching and discolouration along defects observed until approximately 38m below ground level in TSCBH01.

Rock strength improves below the weathered material, ranging between high and extremely high, with the quartzite being much stronger than the siltstone. Rock strength varies, generally ranging between medium and high strength, with localised areas of very high strength greywacke noted. Low strength material may be present in zones which are more deformed and hence foliated.

The greywacke is generally medium-grained with coarse lithic fragments throughout. The colour of the greywacke varies from pale brown to grey. Typically, the greywacke consists of quartz, feldspar and lithic material.

The siltstones are dark grey to grey in colour when fresh and are thinly laminated to thinly bedded and display a phyllite-like texture when broken. Soft sediment deformation and deformed bedding, is common throughout fine-grained materials interbedded with the greywacke. The siltstone is generally very strongly foliated.

A possible fault zone was noted in TSCBH03B with the greywacke occurring below a brecciated and sheared band, extending from 30.75 to 31.79m. This zone is significantly stronger than the overlying rock and also contains common defects with calcite infill. Occasional defects were noted to contain two phases of infill: calcite and quartz. Pyrite was noted to occur in places within this zone but is much less intense compared with the concentration within the black shales/siltstones of TSCBH01.

Moderately to heavily silicified rocks of the Neranleigh-Fernvale Beds occur only along the unweathered length of TSCBH01. The lithological sequence within TSCBH01 is dominated by siltstone with quartzite/chert and pyritic black shale/siltstone also present in the lower portion of the borehole.

After a further review of drillhole TSCBH01, the hole was selectively sampled from 37 to 70.25m (end of hole depth). This interval contained significant pyrite mineralisation and is commonly strongly silicified. The section of drill core was cut and sampled to analyse for a suite of trace elements in order to determine the prospectivity with respect to metal content. Table 4 shows the section of core within TSCBH01 (drilled outside of the proposed West Valley Quarry area) which was sampled. All drillholes were reviewed and this section of drill core appeared to be the most prospective section of the Neranleigh-Fernvale beds penetrated within the drill program. Assay results have been obtained for the samples listed in Table 4 and are displayed within Table 5. No significant assays were obtained with respect to gold (Au) however some anomalous zinc (Zn) and copper (Cu) was returned within TSCBH01 related to localised pyrite mineralisation and alteration not observed elsewhere within the proposed West Valley Quarry area.

Table 4 Summary of sampling intervals within TSCBH01

Sample Number	From (m)	To (m)	Drilled Length (m)	Approximate Recovered Length (m)	Lithology	Comments
TSCBH0101	37.00	39.00	2.00	1.55	Siltstone	Quartz veining throughout. Carbonaceous band at 38.80m.
TSCBH0102	39.00	40.80	1.80	1.06	Siltstone/Carbonaceous Mudstone	Pyritic
TSCBH0103	40.80	42.00	1.20	1.09	Siltstone	Quartz veining throughout. Carbonaceous bands and cherty in part.
TSCBH0104	42.00	44.40	2.40	1.24	Siltstone/Carbonaceous Shale	Quartz veining throughout. Carbonaceous bands and cherty in part. Pyritic throughout.
TSCBH0105	44.40	46.40	2.00	1.60	Chert/Quartzite	Iron Oxide staining common in veins.
TSCBH0106	46.40	48.40	2.00	1.70	Siliceous Siltstone	Minor iron oxide staining.
TSCBH0107	48.40	50.20	1.80	1.50	Siliceous Siltstone	Abundant quartz and carbonate veins and pyritic throughout.
TSCBH0108	50.20	52.40	2.20	1.45	Siliceous Siltstone	Abundant quartz and carbonate veins and pyritic throughout. Minor carbonaceous bands.
TSCBH0109	52.40	54.45	2.05	1.80	Carbonaceous Shale	Graphitic and pyritic. Iron oxide in quartz and carbonate veins.
TSCBH0110	54.45	56.50	2.05	1.05	Siltstone	Carbonaceous bands at top. Abundant pyrite throughout.
TSCBH0111	56.50	60.70	4.20	0.65	Siliceous Siltstone	Cherty in part. Minor pyrite with graphite bands.
TSCBH0112	60.70	63.30	2.60	1.40	Siltstone	Iron Oxide staining in quartz veins which occur throughout. Pyritic also throughout. Highly altered band at 61.5m.
TSCBH0113	63.30	65.50	2.20	2.20	Cherty Siltstone	Iron oxide staining common. Quartz veining throughout.
TSCBH0114	65.50	67.30	1.80	1.80	Quartzite	Abundant pyrite rich veins and also greenish stain?/mineral? With iron oxide staining. Quartz veining prevalent throughout in country rock.
TSCBH0115	67.30	68.50	1.20	1.20	Quartzite	Abundant pyrite rich veins and also greenish stain?/mineral? With iron oxide staining. Quartz veining prevalent throughout in country rock.
TSCBH0116	68.50	70.25	1.75	1.75	Quartzite	Abundant pyrite rich veins and also greenish stain?/mineral? With iron oxide staining. Quartz veining prevalent throughout in country rock.

Table 5 Summary of assay results from sampling of TSCBH01.

	Au-TL43	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41
SAMPLE	**Au**	**Ag**	**Al**	**As**	**B**	**Ba**	**Be**	**Bi**	**Ca**	**Cd**	**Co**	**Cr**	**Cu**	**Fe**	**Ga**	**Hg**	**K**	**La**
DESCRIPTION	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**%**	**ppm**
TSCBH0101	<0.001	<0.2	0.69	22	<10	60	<0.5	<2	0.02	<0.5	13	20	153	1.23	<10	<1	0.01	10
TSCBH0102	<0.001	0.9	0.77	82	<10	50	<0.5	<2	0.11	<0.5	20	23	136	6.94	<10	<1	0.06	10
TSCBH0103	<0.001	<0.2	0.32	18	<10	10	<0.5	<2	0.13	<0.5	15	12	56	1.68	<10	<1	<0.01	10
TSCBH0104	<0.001	0.3	0.47	34	<10	20	<0.5	<2	0.12	<0.5	19	17	80	3.21	<10	<1	0.02	10
TSCBH0105	<0.001	0.2	0.37	31	<10	20	<0.5	<2	0.08	<0.5	15	22	70	2.89	<10	<1	0.01	10
TSCBH0106	0.001	<0.2	0.07	11	<10	<10	<0.5	<2	0.02	<0.5	3	7	10	1.22	<10	<1	<0.01	<10
TSCBH0107	0.001	<0.2	0.5	4	<10	20	<0.5	<2	0.04	<0.5	4	7	53	2.77	<10	<1	<0.01	<10
TSCBH0108	<0.001	<0.2	1.35	16	<10	40	<0.5	<2	0.28	<0.5	25	25	134	5.95	10	<1	0.02	10
TSCBH0109	<0.001	0.5	1.57	34	<10	50	0.5	<2	0.55	<0.5	45	30	242	8.15	10	<1	0.09	20
TSCBH0110	0.001	0.2	1.14	5	<10	20	<0.5	<2	0.14	<0.5	7	12	90	4.13	10	<1	0.05	10
TSCBH0111	0.001	<0.2	0.32	2	<10	10	<0.5	<2	0.09	<0.5	3	5	38	1.34	<10	<1	0.02	<10
TSCBH0112	<0.001	0.3	0.38	12	<10	20	<0.5	<2	0.22	<0.5	13	15	86	3.2	<10	<1	0.01	10
TSCBH0113	<0.001	<0.2	0.26	13	<10	20	<0.5	<2	0.44	<0.5	18	8	71	2.03	<10	<1	0.01	10
TSCBH0114	<0.001	<0.2	0.86	27	<10	30	<0.5	<2	0.2	<0.5	43	16	167	2.99	10	<1	0.01	10
TSCBH0115	<0.001	0.2	0.77	41	<10	20	<0.5	<2	0.19	<0.5	77	13	194	2.96	<10	<1	0.02	10
TSCBH0116	0.001	<0.2	1.23	8	<10	30	0.6	<2	0.32	<0.5	51	19	184	4.78	10	<1	<0.01	20
	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41	ME-ICP41
SAMPLE	**Mg**	**Mn**	**Mo**	**Na**	**Ni**	**P**	**Pb**	**S**	**Sb**	**Sc**	**Sr**	**Th**	**Ti**	**Tl**	**U**	**V**	**W**	**Zn**
DESCRIPTION	**%**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
TSCBH0101	0.01	70	2	<0.01	46	4930	8	1.02	23	1	89	<20	<0.01	<10	<10	22	<10	23
TSCBH0102	0.11	323	9	0.01	67	2960	19	6.92	36	1	47	<20	<0.01	<10	<10	65	<10	57
TSCBH0103	0.14	623	1	0.01	40	880	7	0.92	10	1	35	<20	<0.01	<10	<10	40	<10	53
TSCBH0104	0.18	685	2	0.01	47	1080	7	2.42	18	1	39	<20	<0.01	<10	<10	60	<10	70
TSCBH0105	0.14	428	3	0.01	44	1140	7	2.35	15	1	36	<20	<0.01	<10	<10	49	<10	181
TSCBH0106	0.02	229	2	0.01	16	170	2	0.74	<2	<1	4	<20	<0.01	<10	<10	6	<10	45
TSCBH0107	0.24	856	1	0.01	18	380	<2	1.6	6	1	21	<20	<0.01	<10	<10	24	<10	28
TSCBH0108	0.76	1705	6	0.01	86	1660	11	3.35	16	3	63	<20	<0.01	<10	<10	91	<10	225
TSCBH0109	0.82	1365	16	0.01	132	2700	32	6.44	26	3	108	<20	0.01	<10	<10	179	<10	580
TSCBH0110	0.69	953	2	0.01	25	690	2	1.84	11	2	20	<20	0.01	<10	<10	39	<10	159
TSCBH0111	0.19	530	1	0.01	18	370	5	0.51	2	1	9	<20	<0.01	<10	<10	16	<10	100
TSCBH0112	0.21	1345	2	0.01	63	970	5	1.78	11	1	32	<20	<0.01	<10	<10	39	<10	176
TSCBH0113	0.14	1075	3	0.01	38	1890	7	0.99	6	1	31	<20	<0.01	<10	<10	89	<10	818
TSCBH0114	0.57	8180	4	0.01	100	730	17	0.5	9	3	19	<20	0.01	<10	<10	72	<10	210
TSCBH0115	0.59	2800	2	0.01	100	760	9	0.85	7	2	19	<20	<0.01	<10	<10	69	<10	133
TSCBH0116	0.75	16500	1	0.01	74	1010	19	1.21	3	3	30	<20	0.01	<10	<10	44	<10	70

Figure 1 Drillhole Locations – Site View (with Cross Sections locations)

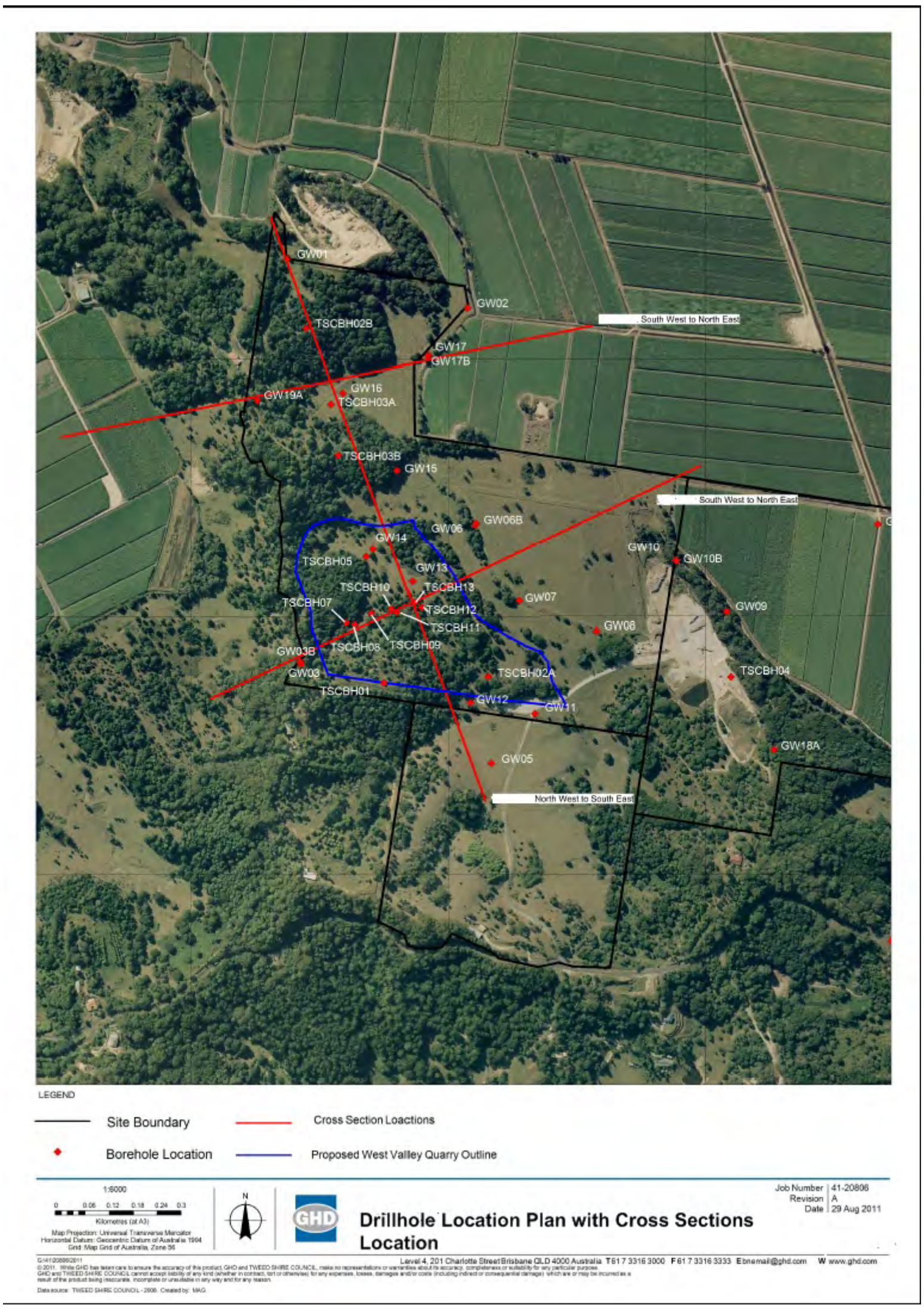


Figure 2 Cross Section North West to South East

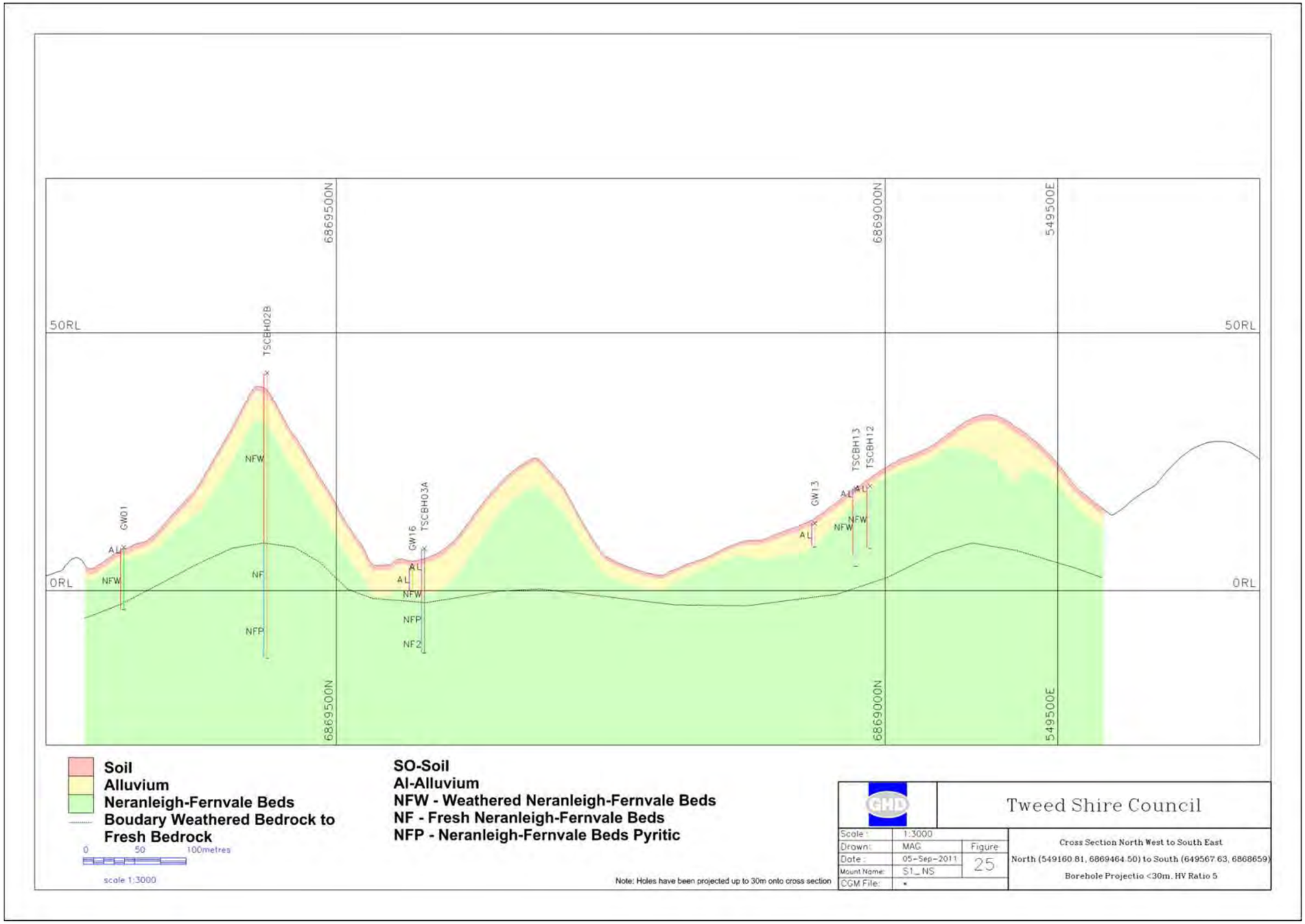


Figure 3 Cross Section South West to North East (North)

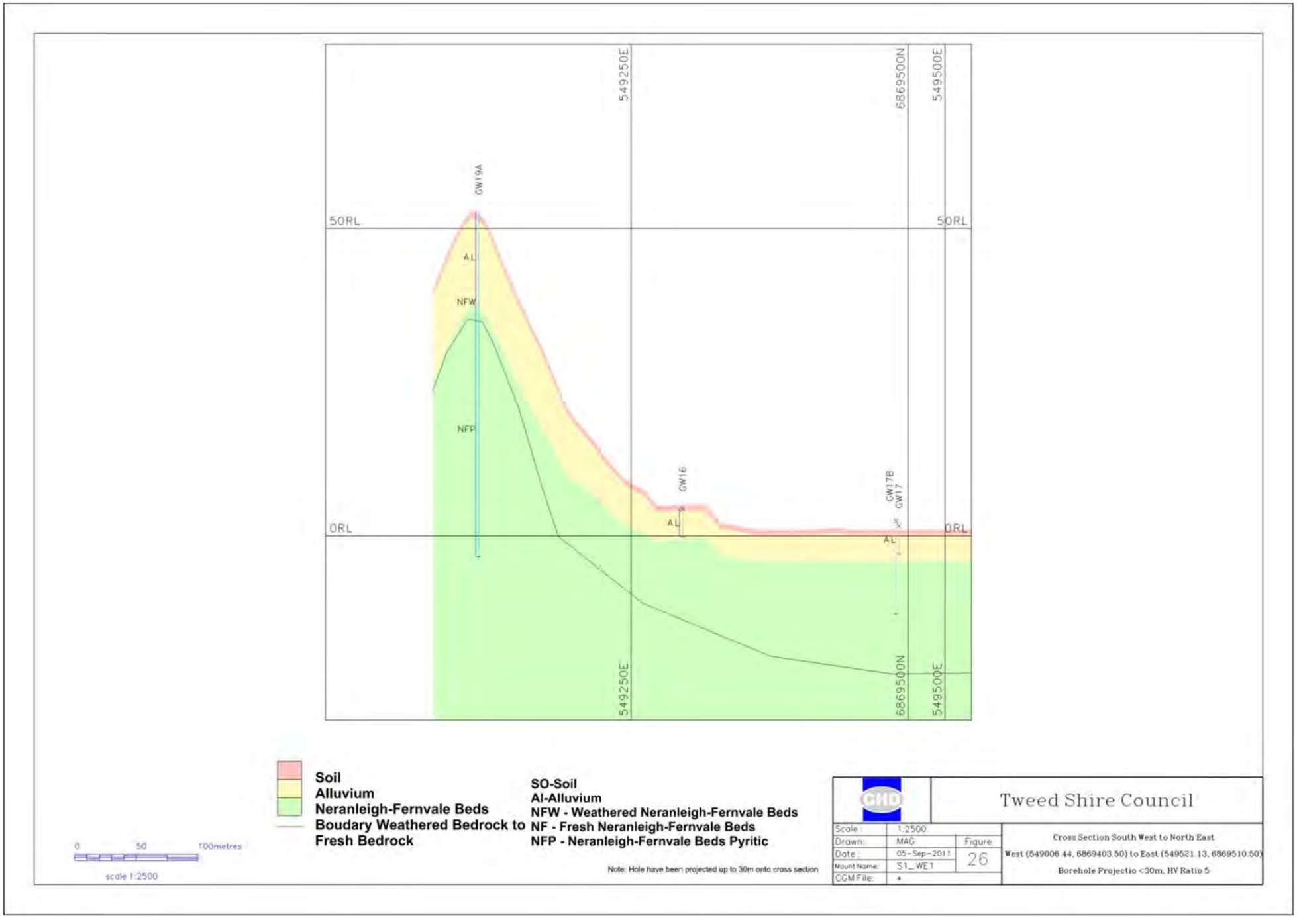


Figure 4 Cross Section South West to North East (South)

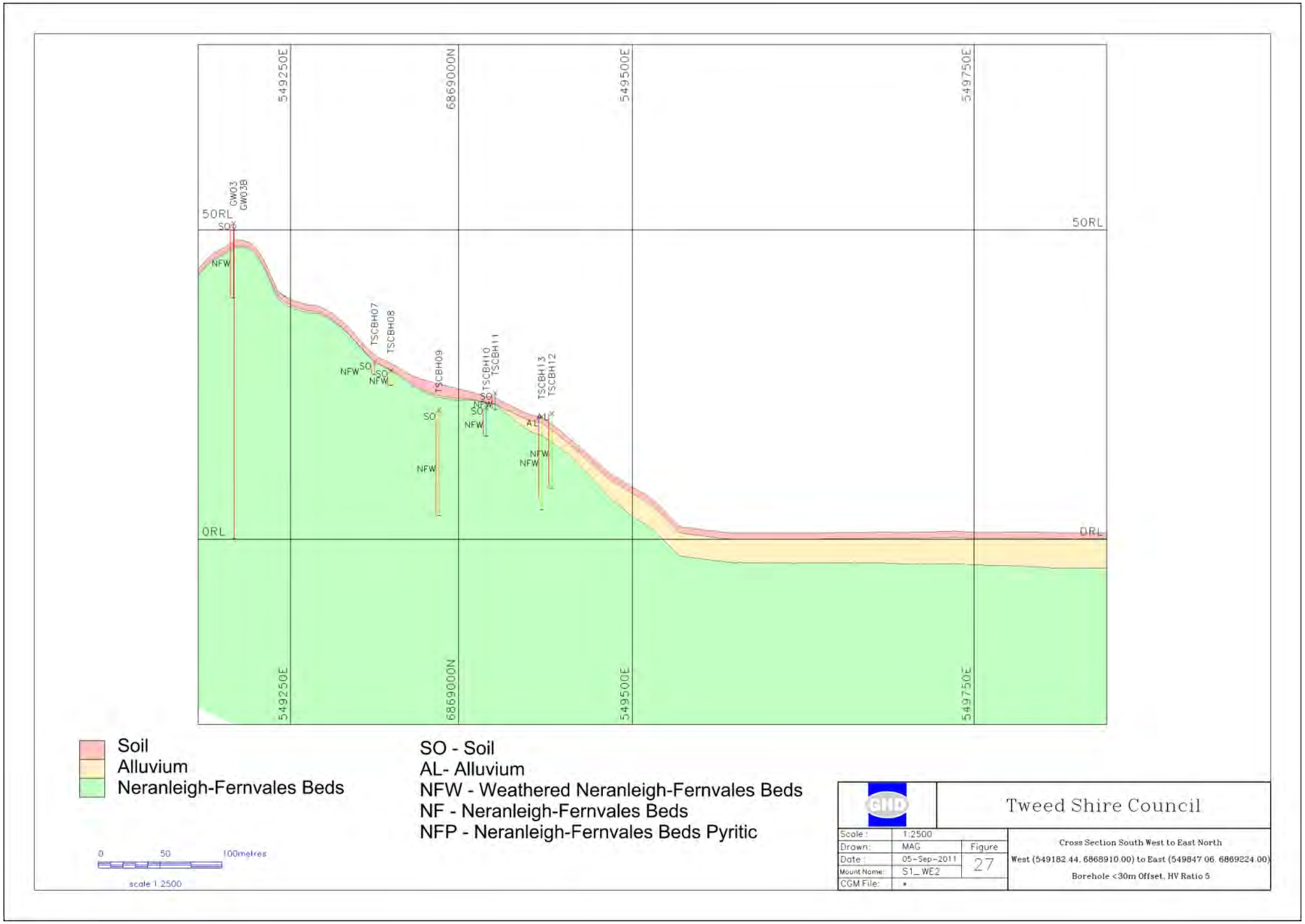
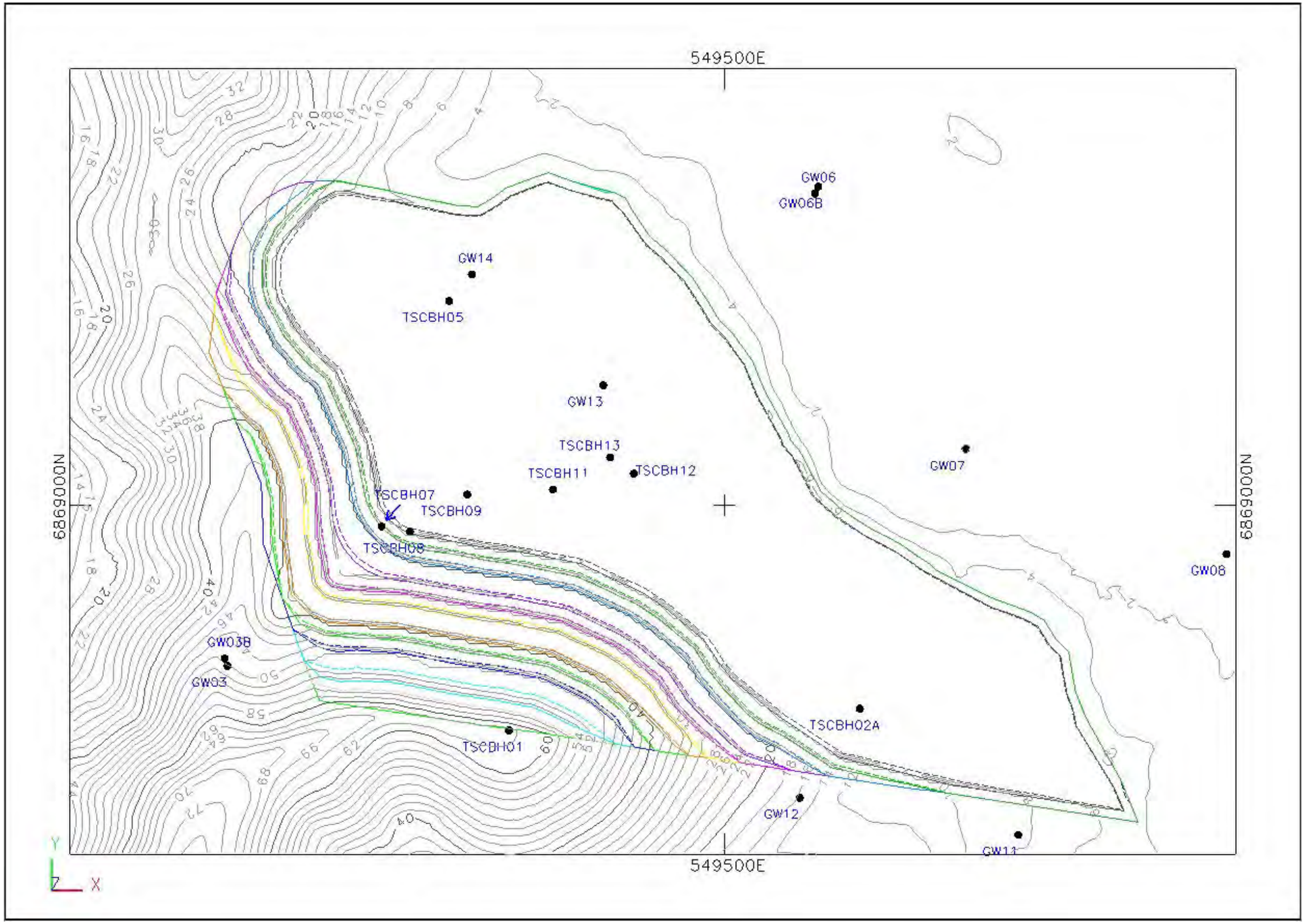


Figure 5 Drillhole Locations showing proposed West Valley Quarry



5.3.3 Stratigraphic Correlation

The entire site was found to be comprised of Neranleigh-Fernvale beds (and their weathered equivalents) and Tertiary to Recent alluvium. Individual units within the Neranleigh-Fernvale were not found to be contiguous between existing drillholes. Logged units were broadly classified based on an assumed quarry product assessment:

- SO – Residual Soils. Typically clayey and sandy to silty with variable organic content. Overburden/Fill quarry product.
- AL – Alluvium. Predominantly Silty to Sandy Clays of moderate to high plasticity. Additionally marine clay including acid sulphate soils. If extracted, Overburden/Fill quarry product.
- NFW – Weathered Neranleigh-Fernvale interbedded siltstone, chert/quartzite and greywacke. Drainage aggregate, cracker dust and road base quarry products. Locally, these beds have been silicified and when this is observed, the rocks are of moderate to high strength.
- NF – Fresh Neranleigh-Fernvale interbedded pyritic to non-pyritic greywacke and siltstone. Drainage aggregate, cracker dust and road base quarry products.

A thick section of silicified material is observed within TSCBH01 and this siliceous zone was sampled and assayed and yielded no significant results with respect to metal prospectivity. The material sampled was mostly fresh rock. Quarrying will be avoided in the vicinity of TSCBH01 where significant pyrite was intersected and is west of the proposed quarry site. The area of West Valley quarry where fresh non-pyritic interbedded greywacke and siltstone is the area being examined for quarrying purposes.

These assumed quarry products have been modelled (see Section 6) and a local stratigraphy compiled.

5.4 Drilling Summary

Findings in the five drillholes logged are summarised below with detailed Lithology Logs and Core photography presented in Appendix B and C respectively.

5.4.1 TSCBH01

The lithological sequence within drillhole TSCBH01 is predominantly siltstone with quartzite/chert and pyritic black shales/siltstones also present in the lower part of the hole. Weathered rocks exhibit chalky or earthy textures and are generally discoloured. Strength ranges between medium and high, with localised zones of soft rock. The variably weathered rock persists to about 38 m below ground level with leaching and discolouration along defects. Below the weathered material, rock strengths range between high and extremely high with the quartzite being stronger than the siltstone. Low strength material may be present in zones of strong foliation. Graphitic/carbonaceous siltstones/black shales occur below 37.78 m with local strong shearing as evidenced by strong foliation. Abundant pyrite is present in the core with the most significant concentrations in areas of carbonaceous/graphitic material. Cubic and framboidal pyrite was noted within the core. Logging of hole TSCBH01 also reveals local strong silica alteration. A significant section of this hole was sampled and assayed and returned no significant metal results.

5.4.2 TSCBH02A

Alluvium was intersected within hole TSCBH02A and extends at least to a depth of 20 m (end of hole) below ground level. Material encountered was predominately silty to sandy clays of moderate to high

plasticity. The colour of the silty to sandy clays was yellow, orange and red mottling throughout to a grey base colour. A significant sand layer at 14 to 20 m (end of hole) was logged. Grain size was variable throughout. The sandy beds exhibit a subtle fining upward trend and are generally well graded. The sandy material consists of quartz and lithic fragments with traces of silt and clay.

5.4.3 TSCBH02B

Hole TSCBH02B contains an interbedded sequence of greywacke and siltstone. The greywacke is typically medium-grained with coarse lithic fragments throughout. They are made up of quartz, feldspar and lithic material and vary from pale brown to grey in colour. The siltstones are dark grey to grey in colour when fresh and are thinly laminated to bedded and display a phyllite-like texture when broken. Soft sediment deformation and deformed bedding was noted throughout the fine grained material interbedded with the greywacke. Weathering was noted to a depth of approximately 33 m from surface. From 45 to 55 m (end of hole depth) pyritic mineralisation was noted but at significantly lower concentrations than those in the black shales/siltstones within hole TSCBH01.

5.4.4 TSCBH03A

Drillhole TSCBH03A intersected about 7 m of alluvium before continuing through the Neranleigh-Fernvale beds. The Neranleigh-Fernvale units are weathered from 7 m to about 11 m. A zone of siltstone and greywacke with pyritic mineralisation extends from about 11 m to 17 m. Non-pyritic siltstone and greywacke make up the remainder of the hole to 20.2 m (end of hole depth).

5.4.5 TSCBH03B

TSCBH03B was drilled to 61.3 m (end of hole depth) and intersected entirely Neranleigh-Fernvale beds. Material was weathered to a depth of around 34 m with fresh material observed from 34 m to the end of hole. A possible fault zone was intersected, with the greywacke occurring below a brecciated and sheared band, extending from 30.75 m to 31.79 m being stronger than the overlying rock and also containing common defects with calcite infill. Occasional defects were noted to contain two phases of infill: calcite and quartz. This fault zone appears to a localised feature.

5.4.6 Other Drilling

A further 28 drill holes consisting of a combination of diamond core holes; TSCBH04 to 13 and groundwater monitoring holes; GW1 to GW19A (except GW5 and GW18) were used to construct the resource model of the site. The samples for these boreholes were not accessible and consequently were not re-logged.

The consistency of the previous logs was assumed for re-classification for quarry product assessment however as the resource model is based on only limited drilling, the vast majority of these holes being shallow and often ended in apparent alluvial cover, the resource model should be treated with some caution.

5.5 Soil Distribution and Quality- Acid Sulphate Soils potential

Soil distribution and quality has been examined and reported. The primary issue relating to the site was the possibility of potential acid sulphate soils being unearthed. This has been examined in depth by the

Eviron Road Quarry and Landfill Environmental Assessment report, (Draft Hydrogeological and Acid Sulphate Soils Desktop Study 2009). For further detail please refer to the report referenced above.

5.6 Hydrology and Groundwater

The hydrogeology of the area has been assessed within the GHD report, (Hydrogeological and Acid Sulphate Soils desktop study 2009), for further details please refer to this document. However further monitoring wells have been installed. For further detail please refer to the report referenced.

5.7 Supply Intended Water Source

Currently at Quirks Quarry, runoff water is directed to holding areas for use on the site and for dust suppression of stockpiles.

Depending on the final workshop location and facilities linked with the site, it may be possible to link to the mains waterline, as is currently the case for Quirks Quarry.

5.8 Recommendations

5.8.1 Exploration Plan

Supplementary drilling is required to obtain additional geological data in order to improve the current geological model. Several drill holes are required throughout the West Valley quarry area and their environs to improve the geological understanding. A significant number of proposed holes will need site preparation, and subject to assessment by an experienced driller and the obtaining of relevant statutory approvals, could be drilled. (refer to Table 6 and Figure 5). The provisional hole depth of these holes is 100m and it is recommended that these holes be drilled with diamond core techniques.

Table 6 Possible Drillhole Locations (MGA Zone 56 (GDA 94))

Easting	Northing
549212.14	6869639.78
549402.14	6869575.05
549258.07	6869433.07
549274.06	6869320.96
549337.41	6869218.01
549285.21	6869144.94
549700.71	6869161.64
549690.27	6868927.79
549493.89	6868879.72
549132.80	6869514.50
549192.48	6869067.45

Easting	Northing
549223.86	6869008.46
549243.46	6868877.68

It is intended that all holes listed above in Table 5 will be drilled at an angle of approximately 60^{o} degrees toward 090^{o}(east).

In conjunction with this drilling program, a program of surface geophysics should be considered to identify the extent of subsurface sulphide such as the pyrite intersected within TSCBH01. This could entail surface electromagnetic surveying using a fixed or moving loop configuration and line spacing of 100 m. The area of the survey would cover the proposed West Valley Quarry area as displayed in Figure 4. Groundmagnetics survey could also be considered if additional structural information is required.

5.8.2 Geotechnical Investigation

A detailed geotechnical investigation is required prior to the recommendation of safe pit wall angles and/or any necessary ground support measures, and this would typically entail the following tasks:

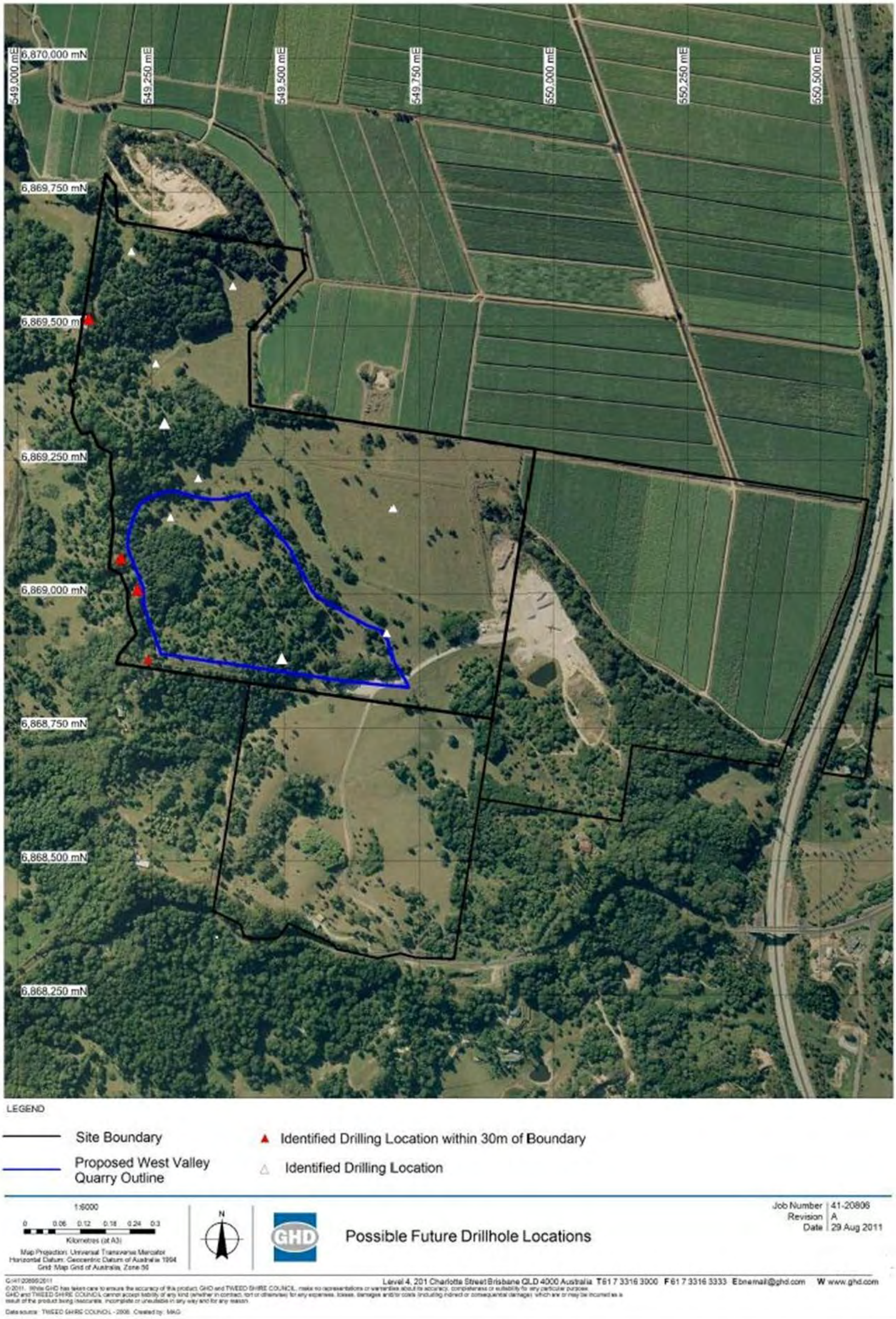
- Desktop study and initial site reconnaissance;
- Open hole (geophysical) test program;
- Core drilling program (as necessary to attain representative samples for testing);
- Laboratory test program; and
- Results reduction and geotechnical analyses.

Specifically, downhole geophysical testing this would comprise acoustic logging for structure orientation, sonic log for material strength, and a general geophysical log (calliper, verticality, gamma and density) for material condition/composition. The results of the geophysical testing within the existing drill holes would also aid in the planning associated with any subsequent core drill holes that may be required (by way of layout and inclination). Laboratory testing for intact rock and joint strength would then be recommended, and would typically comprise the following:

- Shear box testing, to determine the peak and residual shear strength parameters of the joint structures;
- Indirect Tensile Strength (ITS) testing, to determine the tensile strength of the rock mass; and
- Unconfined Compressive Strength (UCS) and Modulus testing.

Following the interpretation of all field and laboratory test results, 2-dimensional limit-equilibrium slope stability modelling would be recommended, to assess the potential for deep-seated failure of the rock mass. This should also be conducted in conjunction with stereographic analyses, to assess for the probability associated with wedge, planar or toppling failure. 3-dimensional discrete-element modelling may also be recommended, to assess any adverse failure mechanisms associated with the proposed stripping sequence. In the case of a supported slope, as part of the above-mentioned analyses the design of any necessary ground support measures, such as rock bolting or buttressing, would also be undertaken.

Figure 6 Drillhole Locations showing proposed West Valley Quarry



5.8.3 Bulk Density Investigation

As the resource model is heavily dependent on bulk and/or in-situ densities, it is strongly recommended that bulk-density measurements be undertaken as part of any future work on the project proposal.

5.8.4 Acid Mine Drainage Investigation

The pyritic mineralisation within the Neranleigh-Fernvale beds identified in core logging particularly in hole TSCBH01 has the potential to cause acid mine drainage if exposed or extracted. The pyritic material was assayed within TSCBH01 and results were displayed within Table 5. No significant metal mineralisation was indicated from the assays. Despite the lack of significant metal mineralisation and the limited spatial extent of the identified pyritic units, the proposed quarry design will still avoid this area of pyritic mineralisation during normal quarrying operations. A detailed Acid Mine Drainage assessment is recommended prior to the development of the detailed Quarry Plan of Management in the event that the material is required to be extracted.

This assessment would entail the following tasks:

- Sample collection;
- Mineralogy;
- Net Acid Generation (NAG) and Net Acid Production Potential (NAPP);
- Whole Rock geochemistry;
- Column leach.

The number of samples to be analysed will be determined based on the tonnages of each rock type. It is expected that in the order of tens of samples representing rock types present at the quarry site would be required for analysis. The actual number of samples will be confirmed once the tonnages of each type are confirmed by the follow-up geotechnical drilling outlined in Section 5.8.1, above.

Mineralogical assessment is critical, in identifying potentially acid–generating and acid-neutralising minerals present, as various sulphides have differing acid-producing potential and different carbonate minerals have different neutralising capacity.

Mineralogical analyses of the various lithological units to determine major mineralogy for assessment. The analysis undertaken is optical and X-ray Diffraction (XRD).

The samples of each rock type will be submitted for net acid generation (NAG) and net acid production potential (NAPP) testing. The oxidised leachate from the NAG test will be analysed for electrical conductivity, dissolved trace metals (ICPMS scan), major and minor ions, radioactivity and phosphorus. Where samples contain more than 2% sulphur, a sequential NAG (SNAG) test will be performed to confirm the relative acid generation and neutralising capacity of the rock.

5.9 Resource Estimates

Resource estimates are based on those available areas identified for quarrying, and are not intended to reflect mineral resources as defined by the Joint Ore Reserves Committee (JORC) Code. A geological model was generated using identified relationships between potential quarry products encountered in the boreholes and the associated regional geology. Relevant lithological units identified in both the ground

water monitoring holes and recent drilling data were used to correlate a number of material units for modelling purposes.

A plan of drill holes within the Resource area is provided in Figure 7. Representative cross-sections through the various modelled units across the conceptual pit are shown in .Figure 8, Figure 9, Figure 10, Figure 11, Figure 12 and Figure 13. Assumed quarry product units used in the modelling process are shown in these cross sections. The red line indicates the lay of the final pit area after extraction has taken place.

The cross-sections take into account the non-contiguous nature of the logged lithologies. The modelled lithological units are assumed to be consistent in stratigraphic order. To produce the resource estimates assumptions have been made to represent the resource floor as being the lowest elevation of three (3) of the more recent holes (TSCBH01, TSCBH02B, TSCBH03B) and four (4) previously drilled groundwater monitoring boreholes (GW01, GW03B, GW18A, GW19A).

All drill holes were used to aid in the modelling process, except for TSCBH01 which contains silicified and pyritic material that are not contiguous with any other units identified in drilling in the West Valley area. Note also that not all holes reached a sufficient depth to model all stratigraphic units encountered in the area.

To enable the modelling of all units, including those that were not encountered within a borehole, these were assumed to have a stratigraphic thickness of 0.0 m. This enabled modelling of all stratigraphic units in the West Valley, and estimates of the type and thickness to be encountered between known points. The Neranleigh-Fernvale Beds were the deepest unit encountered in the cored samples. To enable the modelling process it was assumed that the drillholes ended in their respective stratigraphic unit

Figure 7 Plan showing drillholes and conceptual West Valley Quarry pit outline with Cross Sections

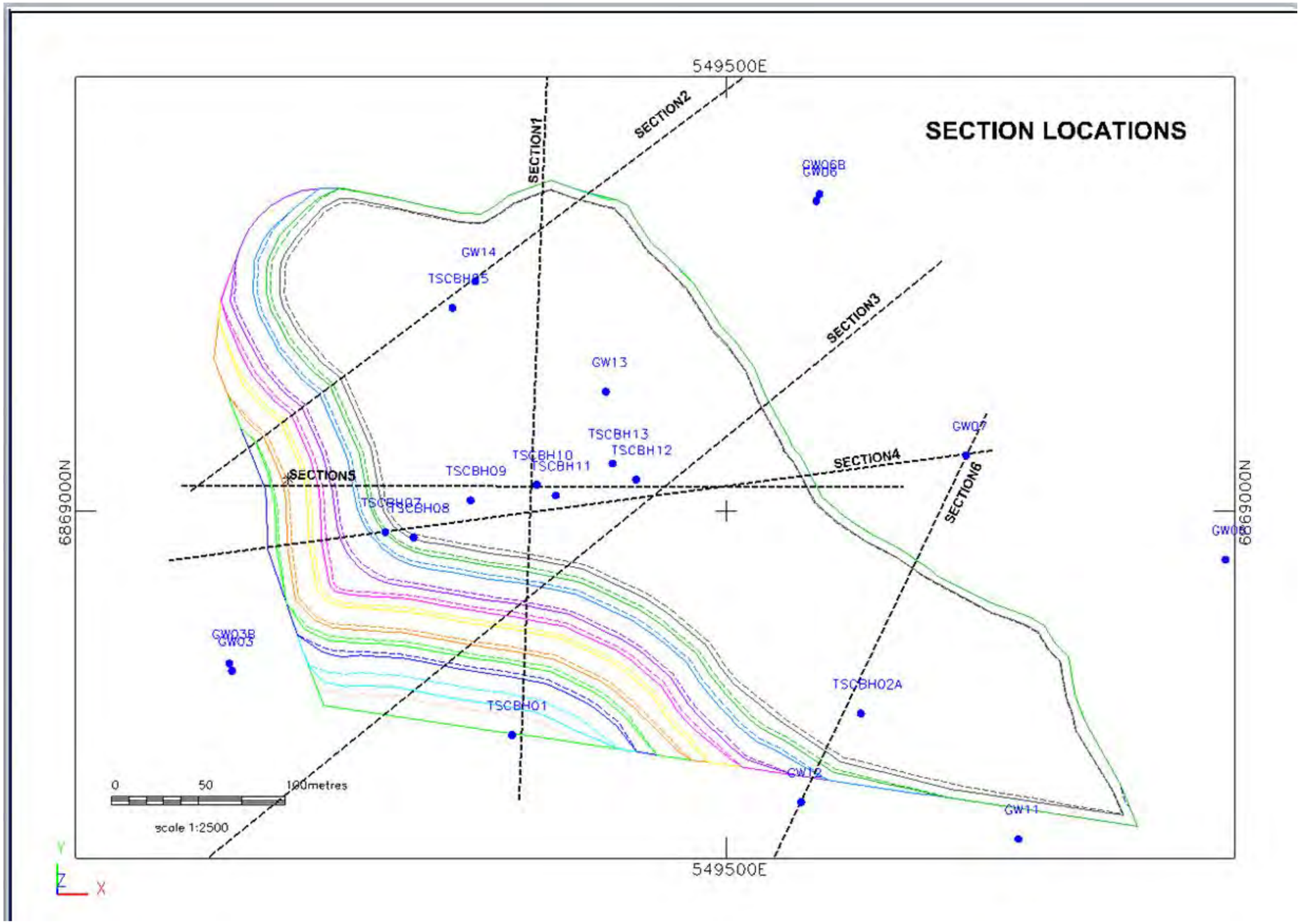


Figure 8 **Cross Section 1 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline**

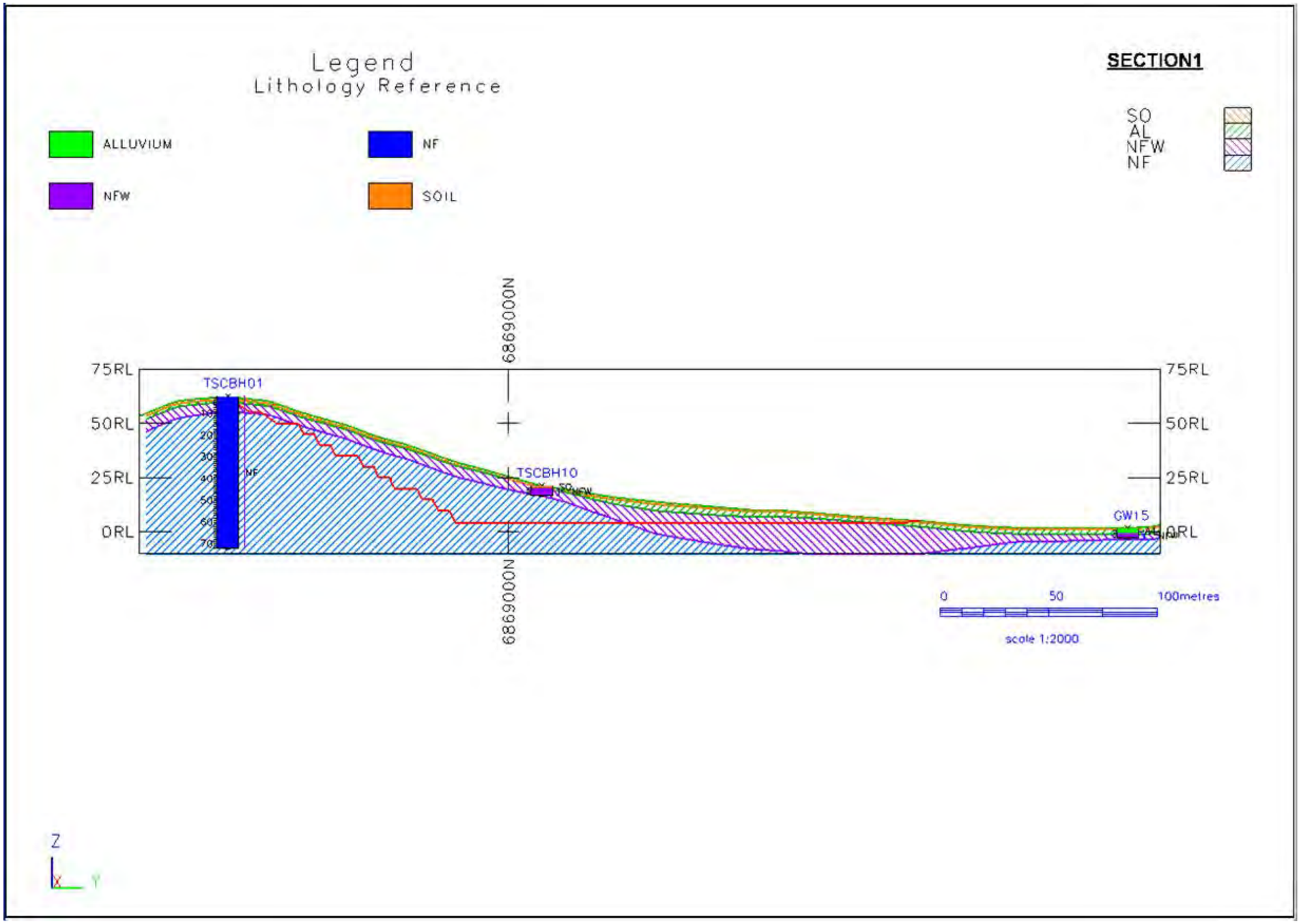


Figure 9 **Cross Section 2 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.**

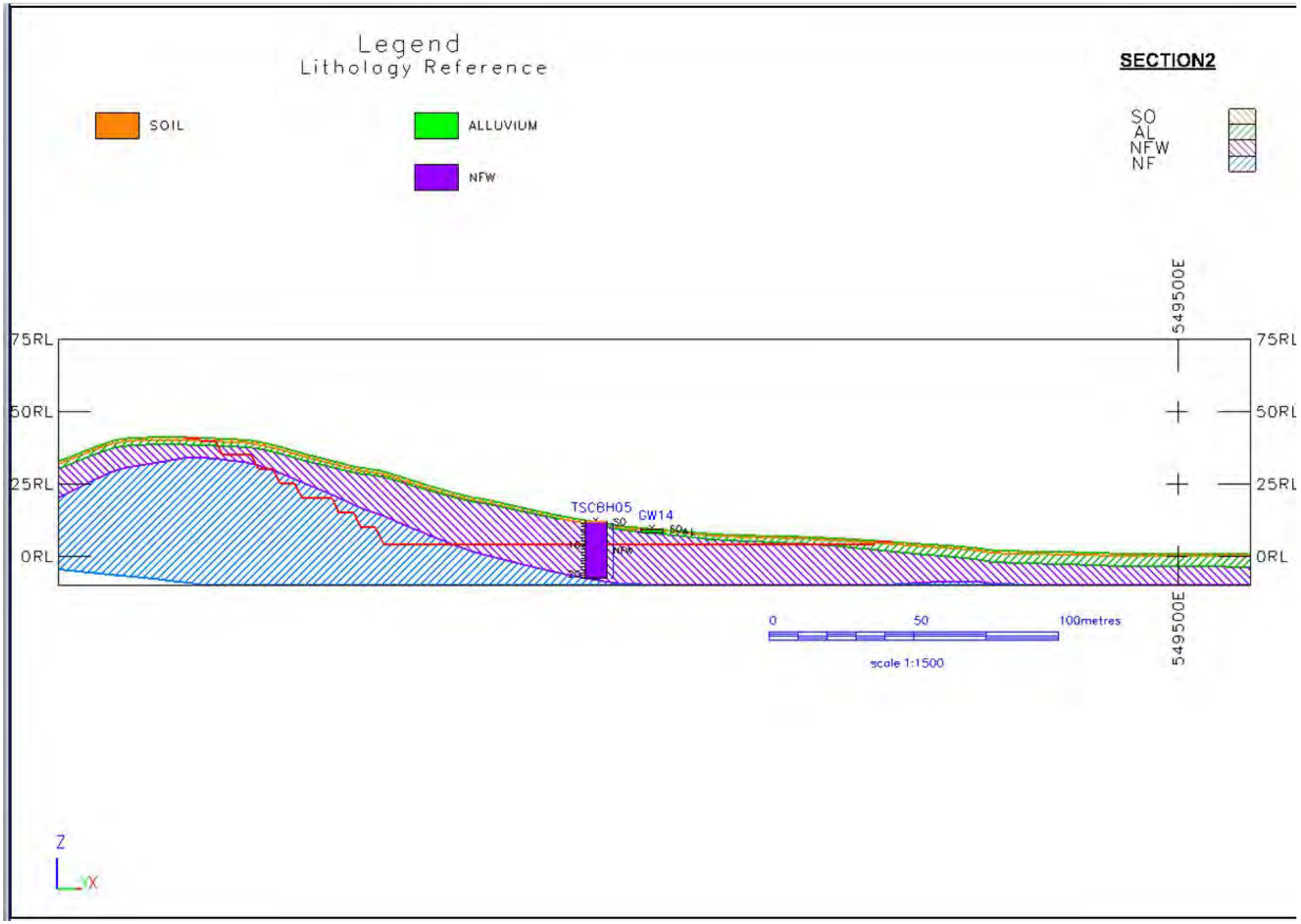


Figure 10 Cross Section 3 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.

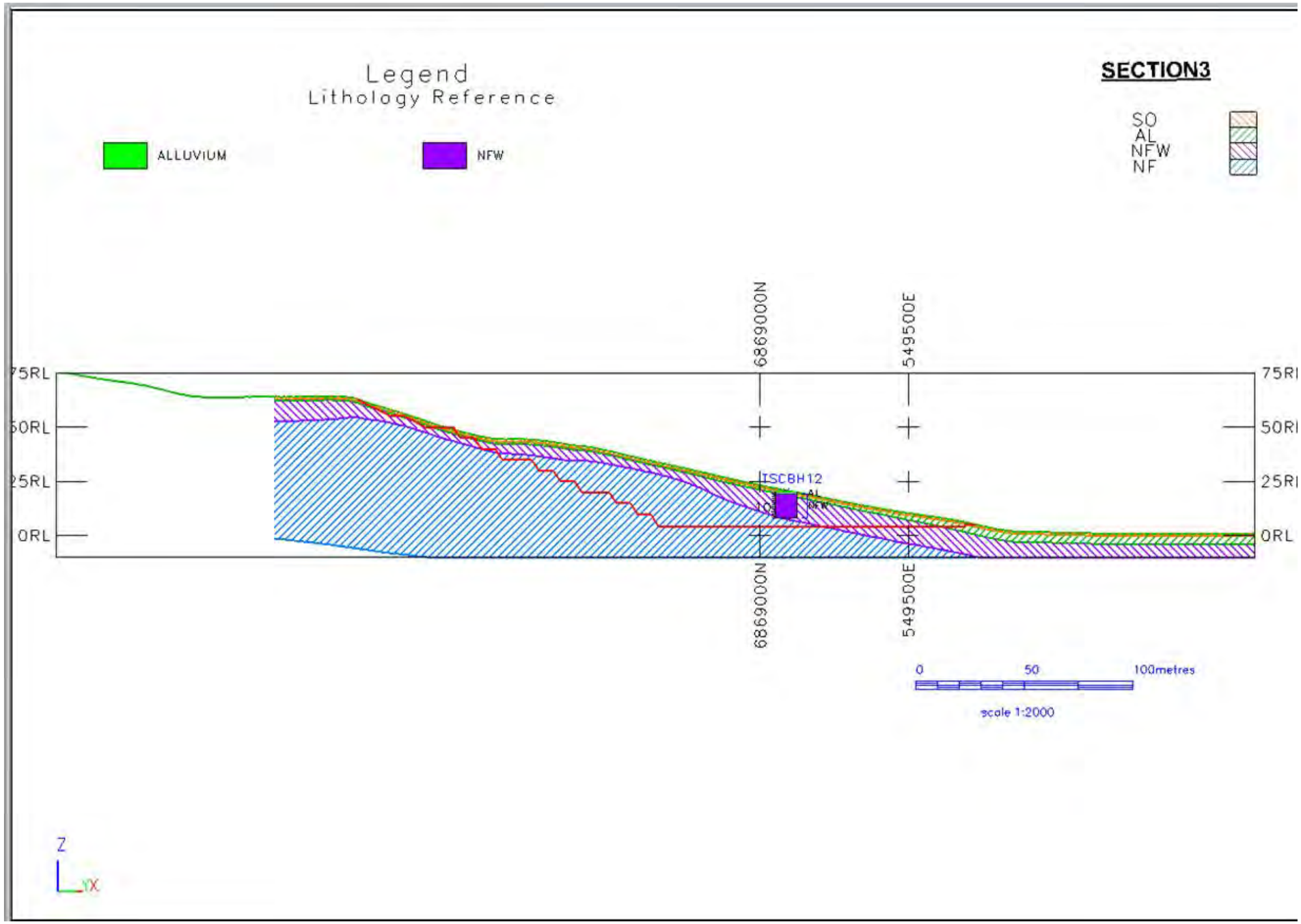


Figure 11 Cross Section 4 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.

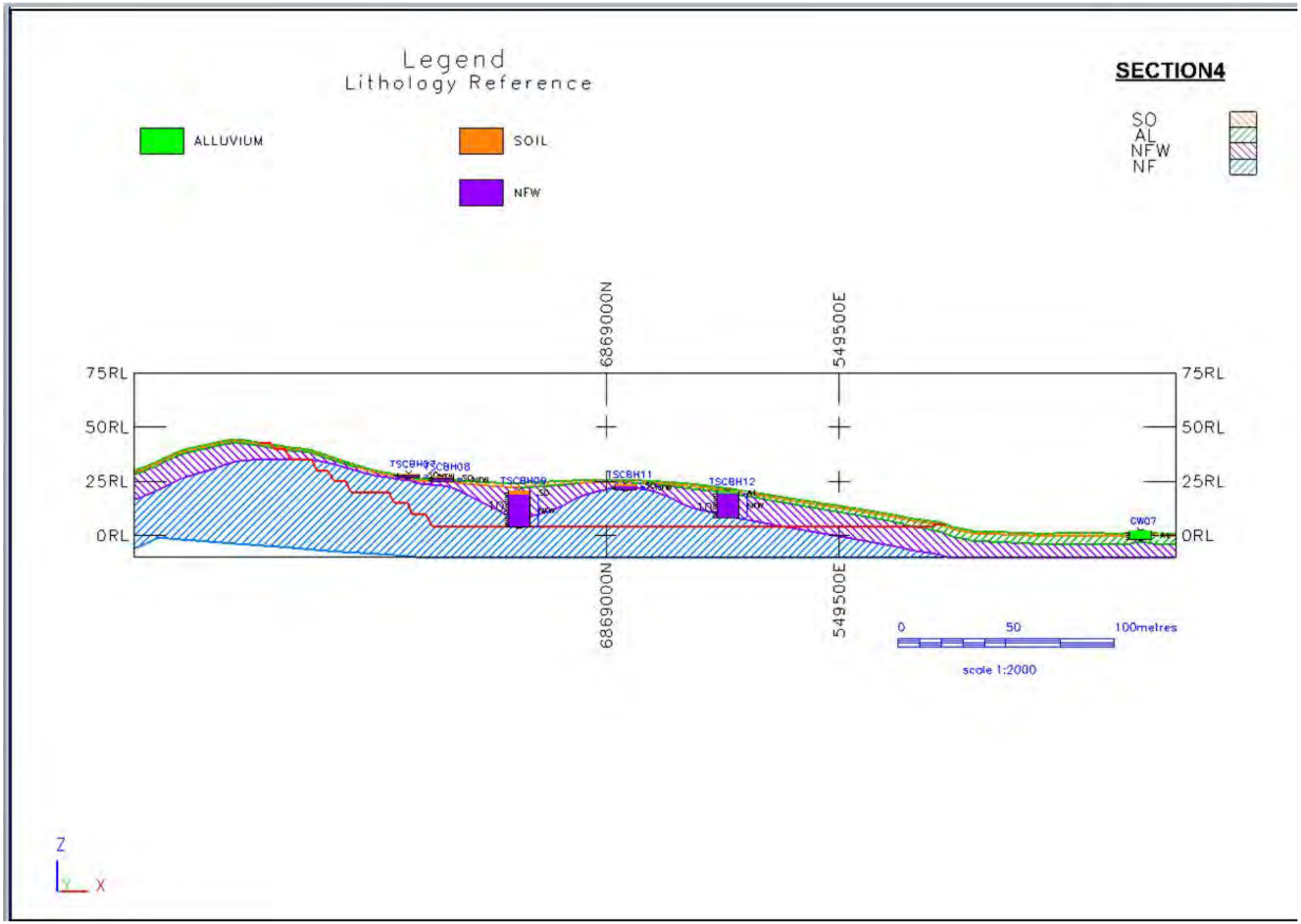


Figure 12 Cross Section 5 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.

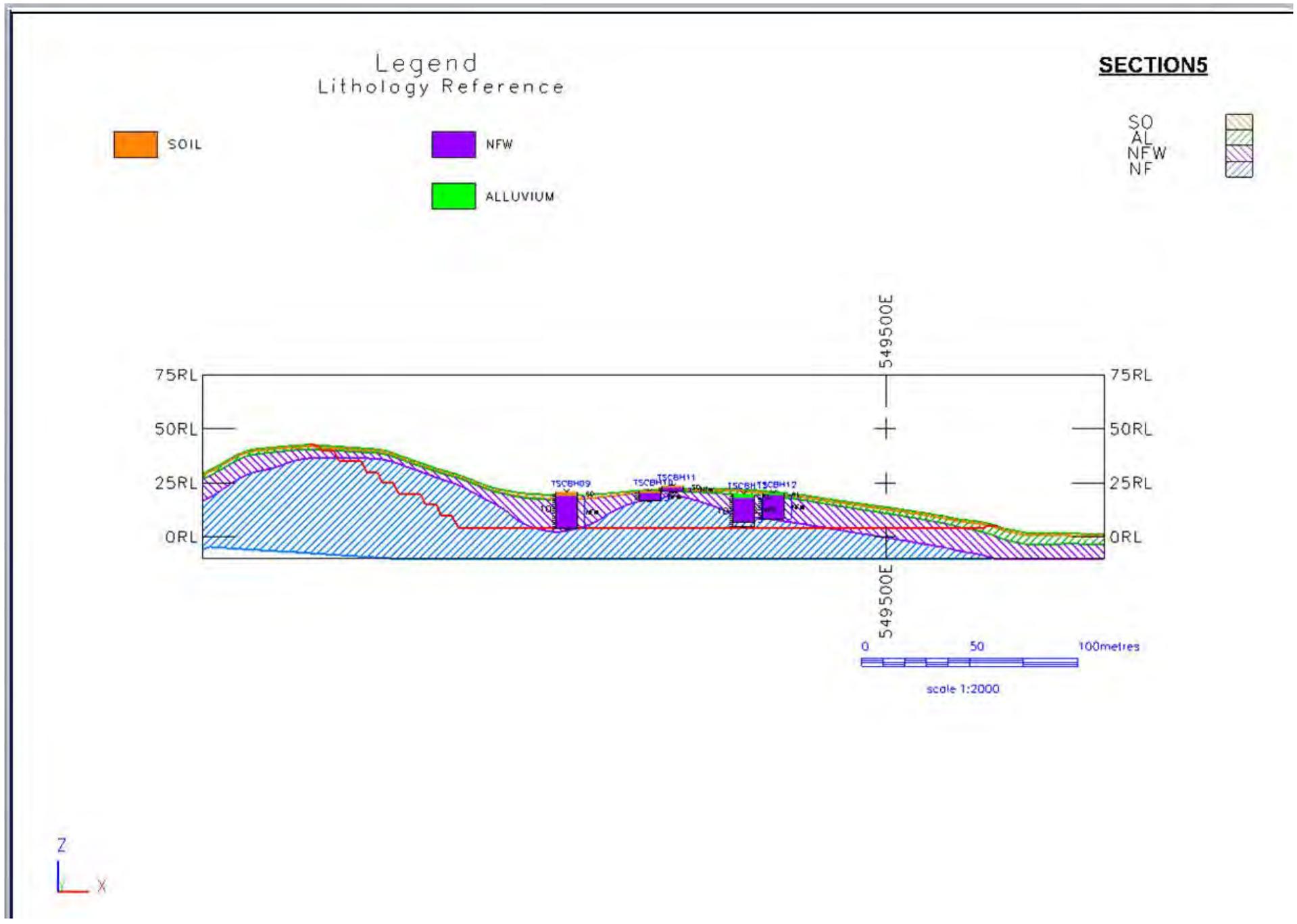
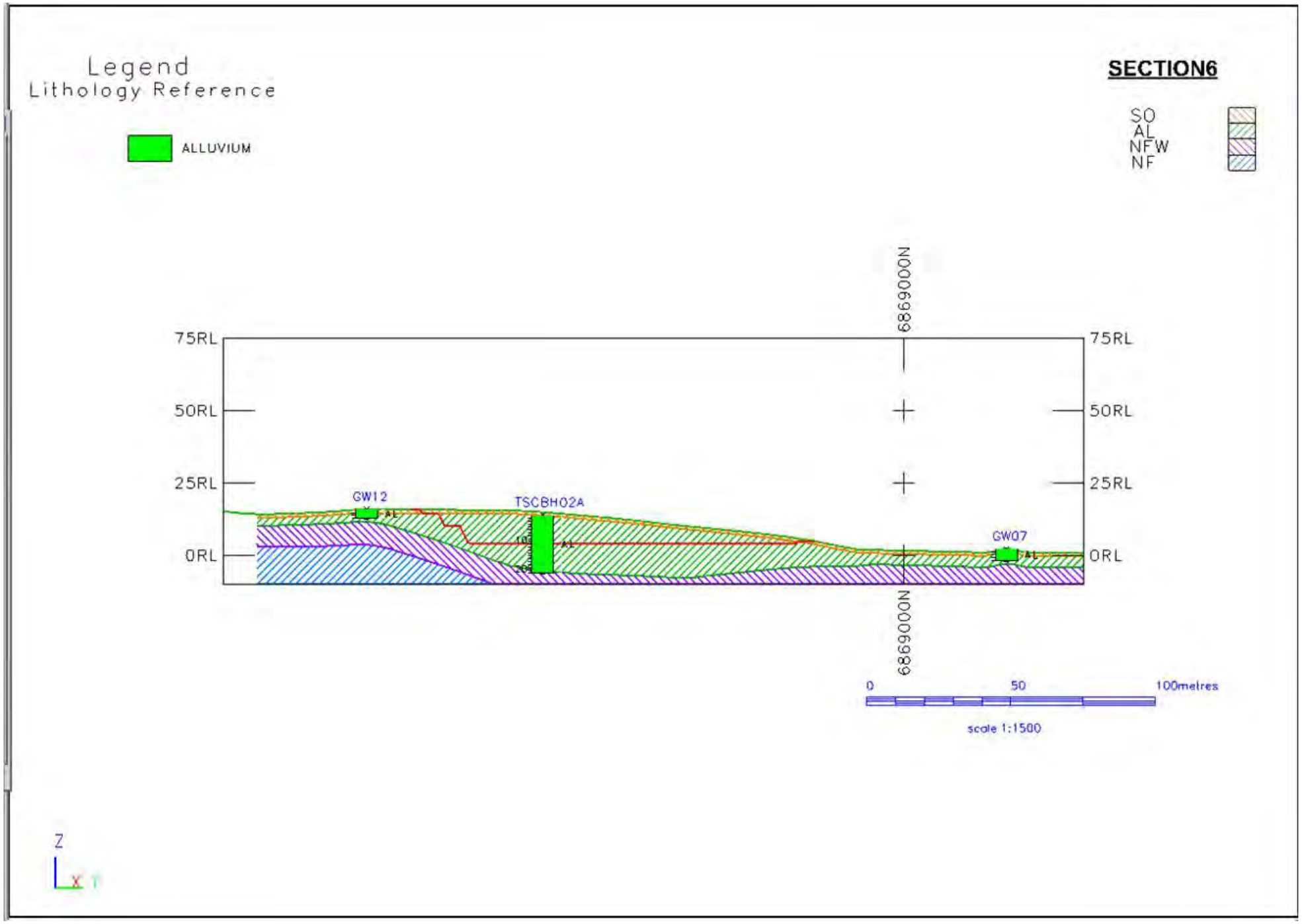


Figure 13 Cross Section 1 as displayed with Figure 7 and also showing conceptual West Valley Quarry pit outline.



It should be noted that a considerable Neranleigh-Fernvale siltstone-greywacke resource has been modelled below the adopted pit floor of RL 4.0m. The assumed quarry product layers have been modelled using logged information supplied in each hole, however in most groundwater monitoring boreholes, the interface between the clay layer and Neranleigh-Fernvale Beds was not intersected. In the shallower holes the siltstone interval has not been identified, as drilling to depth was not possible.

In the modelling process, intersections of lower layers therefore have been derived from surrounding logged thicknesses and interpolated at depths below final drill-hole depths to simulate the full stratigraphic sequence across the resource area. Similarly where layers have not been identified between logged layers, missing layers have been set to exist but their thickness has been set to zero (0) to maintain continuity of the layers over the modelled area. Further to these operations on the drillhole information, the generation of the geological model includes parameters, to interpolate between known and derived layer intercepts in each hole and extrapolate to approximately 50 metres past the last drill-hole intercept for each hole included in the modelling process.

6. Quarry Resource and Design

During the initial development of the Quarry Plan, it was identified that the area required further drilling investigations to be conducted to adequately estimate the existing resource, given that extraction would focus on the West Valley Area only. This data would take the lithological interpretations from existing groundwater monitoring holes and new cored holes to significant depth to be incorporated into a computer generated geological model for the site. The proposed holes were not completed as planned; as such the limited spatial data has been used to infer a resource and provide the base model for conceptual quarry design.

From the digital topographical surface supplied (GHD - 20806Contoursgr10m.dxf, 20806Contours1to10m.dxf & tsc_parcel.dxf, and based on MGA 94 – Zone 56 (GDA 94) TM co-ordinate system & assumed AHD level datum) and the derived geological model, a preliminary quarry pit design and extraction plan was developed. Included in this process was the development of a digital terrain model of existing surface topography from supplied information, comparison and adjustment of drill hole "collar" locations with modelled topography, land title information, and the location of environmental and physical considerations to be included in the design process.

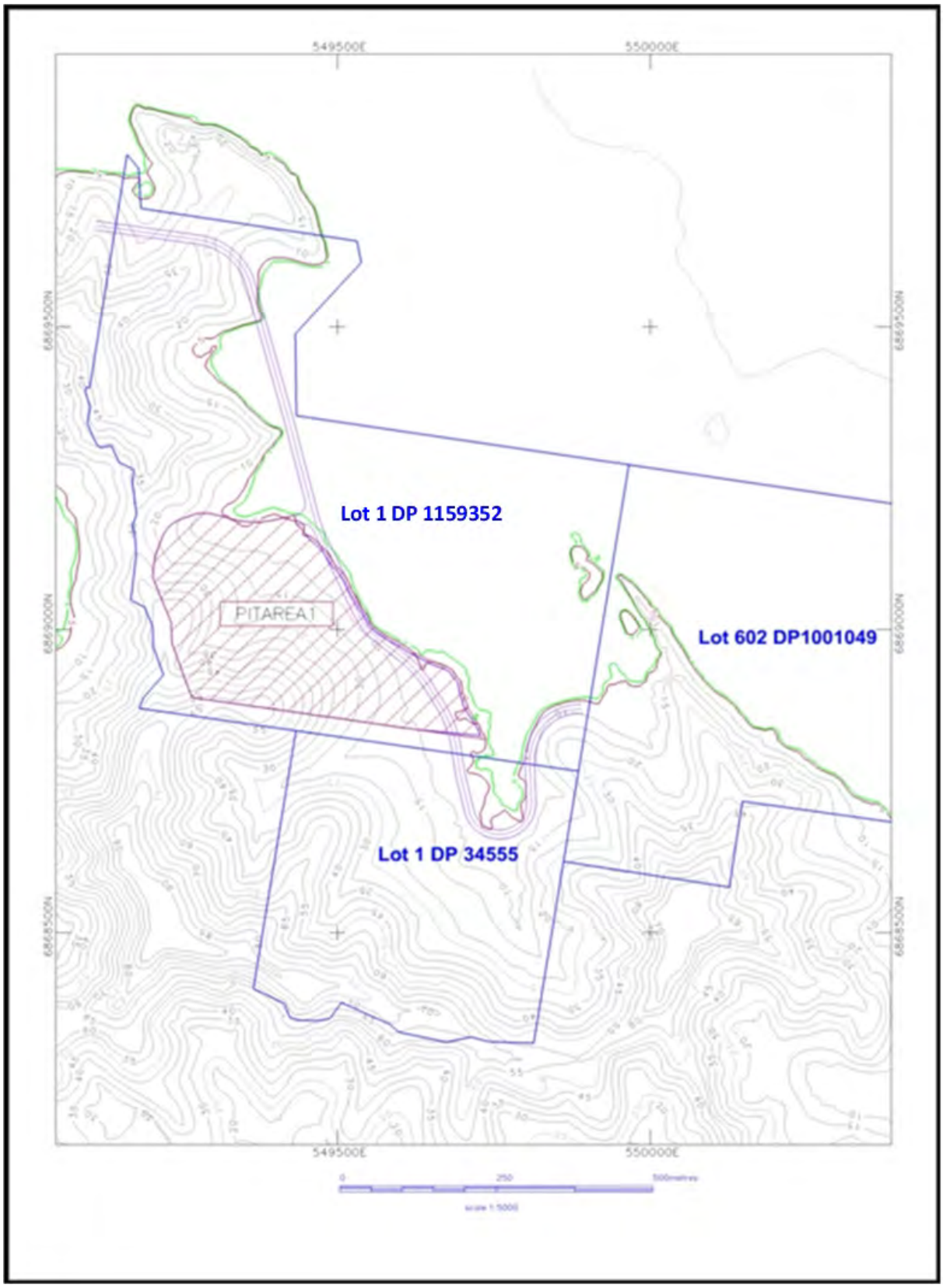
Figure 14 shows final modelled Topography contours, land title information as supplied and preliminary haul road alignment with respect to the proposed quarry footprint (PIT AREA 1). A minimum pit base level of RL 4.0m corresponding to an estimated 100 year flood level event was adopted as the limit of extraction and general alignment of the connecting haul road between existing and proposed TSC extraction areas.

The identified Blackbutt Open Forest Areas (5) and Koala habitat areas (Vegetation Map – Figure 39 Rev 0, Tweed Shire Council Eviron Road Quarry and Landfill Environmental Assessment) has been considered and precluded development in the central ridge area of the initial available land in Lot 1 on DP 1159352.

A 30m Buffer Zone between adjoining land titles and a general alignment of the pit outline to follow below the existing crest line forms the physical constraints for the PIT AREA 1 extent.

Geographic (Latitude/Longitude) GPS Collar information supplied has been converted to MGA 94 – Zone 56 (GDA 94) TM co-ordinate system, and collar levels used as supplied or derived from the digitally-modelled topography.

Figure 14 Topography Contours, Land Titles and Quarry Footprint



6.1 Resource

The resource exploration area targeted was centred in the north (North Valley) and south-west (West Valley) ridge areas of Lot 1 DP 1159352.

The resource area for PIT AREA 1 lies above the floodplain and nominal RL 4.0m (100 Year Flood Event). The higher topography represents the area of resource interest and is associated with the regional geology and north/north-westerly trending ridge line along the western boundary of Lot 1 DP 1159352.

Using Gemcom's MINEX 5 - 3D modelling platform, each drillhole was logged and identified lithological units represented stratigraphically. Interpretation of corresponding units in each drill hole was made based on correlating like lithological units in each hole. A geological model was created and shown to be thickening and thinning equating to trends in the identified lithologies.

The resource estimates are therefore based on the assumption that:

- Results from TSCBH01 have been omitted from the modelling process as the encountered pyritic black shales and siltstones and siliceous Neranleigh-Fernvale units are not contiguous with any other intersections.
- The Neranleigh-Fernvale Bed floor is represented as the lowest elevation of three (3) of the more recent holes (TSCBH01, TSCBH02B, TSCBH03B) and four (4) previously drilled groundwater holes (GW01, GW03B, GW18A, GW19A), all of which remained in the unit at final depth of drilling; and
- The Neranleigh-Fernvale Bed Unit consistently continues below the adopted pit floor (RL 4.0m).

6.2 Pit Design Constraints

The PIT AREA 1 quarry design has taken into account the following constraints:

- Environmental Assessment constraints, (Blackbutt Forest and Koala Habitat);
- Minimum Pit Floor RL 4.0m (100 Year Flood Event RL 4.0 m);
- Minimum Crest RL 5.0 m Contour (1 m freeboard to 100 Year Flood Event RL 4.0 m);
- Minimum 30 m Buffer for wildlife corridor & barrier constraint with respect to adjoining land owners;
- Pit Design constraints (Pit wall angles, safety berms and maximum bench heights);
- The location of internal quarry haul roads;
- The location of external access roads; and
- "Below Ridge Line" pit crest considerations.

The preliminary design of PIT AREA 1 does NOT take into account the following:

- The location of the quarry office/workshop facilities;
- The location of the Run of Quarry Stockpile pad;
- The location of product stockpiles;
- The location of surface drainage and sedimentation control dams;
- Mitigation strategies for dust and noise;
- Mitigation strategies for Visual amenities; and

- Location and design of external access roads.

Note: Redesign of the quarry area will be necessary if Lot 1 on DP34555 is included in final TSC Quarry Development area. The utilisation of a possible larger pit area with the opportunity to work and extract from multiple faces would then allow for extraction to occur at multiple positions on site with drilling and blasting to be done on a site scale rather than face by face in the more restricted PIT AREA 1 design.

6.3 Design Methodology

The PIT AREA 1 Quarry has been designed in horizontal benches. These benches correspond with a 5.0 m bench height from RL 55.0 m to RL 10.0 m with the final bench height being 6.0 metres down to the pit floor at RL 4.0 m. Table 5 details the approximate bench quantities that are recovered from each of these benches. A breakdown of specific material types available from each bench is detailed in the following sections.

Note: The proposed Pit Access Haul Road has been designed at 15 m wide and at a maximum grade of 10% and based on general safety requirements and the availability of medium sized local excavating equipment and trucks. This haul road is constructed prior to the commencement of quarry operations to access the higher levels of the quarry pit design. This internal haul road is removed in retreat with each bench operation. Initially 16,760 m^3 suitable fill and road building material will be required to construct this haul road. A series of 5.0 m width safety berms have been included in the design and extended to 10 m running benches at RL's 50, 35 & 20. Changes to these overall parameters would be possible, however would be subject to further geotechnical studies with respect to final slope stability constraints and mining equipment selection.

The pit crest outline is based on the above design constraints and is projected down from the crest outline intersection with the modelled topography using the bench configuration as shown in Table 7

Table 7 West Valley Quarry PIT AREA 1 Bench Configuration

Bench RL	Elevation	Slope (°)	Berm
RL 55	55	35°	5
RL 50	50	35°	10
RL 45	45	65°	5
RL 40	40	65°	5
RL 35	35	65°	10
RL 30	30	65°	5
RL 25	25	65°	5
RL 20	20	65°	10
RL 15	15	65°	5
RL 10	10	65°	5
RL 04	4	65°	5

6.3.1 Pit, Bench, Layer Resource Definition

From the above Pit design constraints and the established geological model, a preliminary PIT AREA 1 Resource report was generated for each bench showing volumes and estimated tonnages for each layer in each of the designed benches. Tonnage estimates are conservative and based on assumed densities of the modelled lithology layers (refer to Table 8 below). The bulk densities presented below are in accordance to values published on websites; www.simetric.co.uk and Berkman (2001). Additionally, further bulk density information albeit limited was obtained from several reports published detailing quarrying projects in the Tweed Shire and in the Gold Coast region.

Note: Bulk density testing of each of the modelled layers will increase confidence to the final tonnage estimates.

Table 8 Assumed Layer Density Definition

Layer Unit	Density
Soil (SO)	1.10
Alluvial Deposits(AL)	1.50
Weathered Neranleigh-Fernvale interbedded Siltstone and greywacke(NFW)	2.25
Fresh Neranleigh-Fernvale interbedded greywacke and siltstone non pyritic(NF)	2.50

Table 9 shows pit access haul road quantities in cubic metres and individual bench volumes, accumulated bench volumes and estimated tonnages.

Table 9 Quarry PIT AREA 1 Quantities by Bench

PIT AREA 1 Quarry Bench RL	Bench Volumes (Cu m)	Accumulated Volumes (Cu m)
RL 55	7,710	7,710
RL 50	9,720	17,430
RL 45	11,450	28,880
RL 40	21,160	50,040
RL 35	43,240	93,280
RL 30	53,880	147,160
RL 25	80,940	228,100
RL 20	111,380	339,480
RL 15	145,450	484,930
RL 10	199,270	684,200
RL 04	356,070	1,040,270
TOTALS	1,040,270	1,040,270

Pit Access Haul Rd	Nett	Cut	Fill
Volume (Cu M)	-13,020	3,740	16,760

Table 10 shows West Valley Quarry PIT AREA 1 Estimated Bench Tonnages for modelled units.

Table 10 West Valley Quarry PIT AREA 1 Estimated Bench Tonnages

Bench RL	SO	AL	NFW	NF
RL55	3,564	3,165	5,333	-
RL50	3,234	3,330	9,315	1,050
RL45	3,333	3,825	11,858	1,475
RL40	5,852	5,715	19,733	8,125
RL35	7,755	11,760	43,853	22,175
RL30	8,206	12,960	46,575	42,725
RL25	10,780	19,425	64,755	73,525
RL20	12,221	27,345	93,060	101,725
RL15	17,314	45,615	133,448	99,950
RL10	17,677	74,970	189,023	123,025
RL04	30,052	176,295	303,345	191,000
TOTALS	**119,988**	**384,405**	**920,295**	**664,775**

6.4 Quarry PIT AREA 1

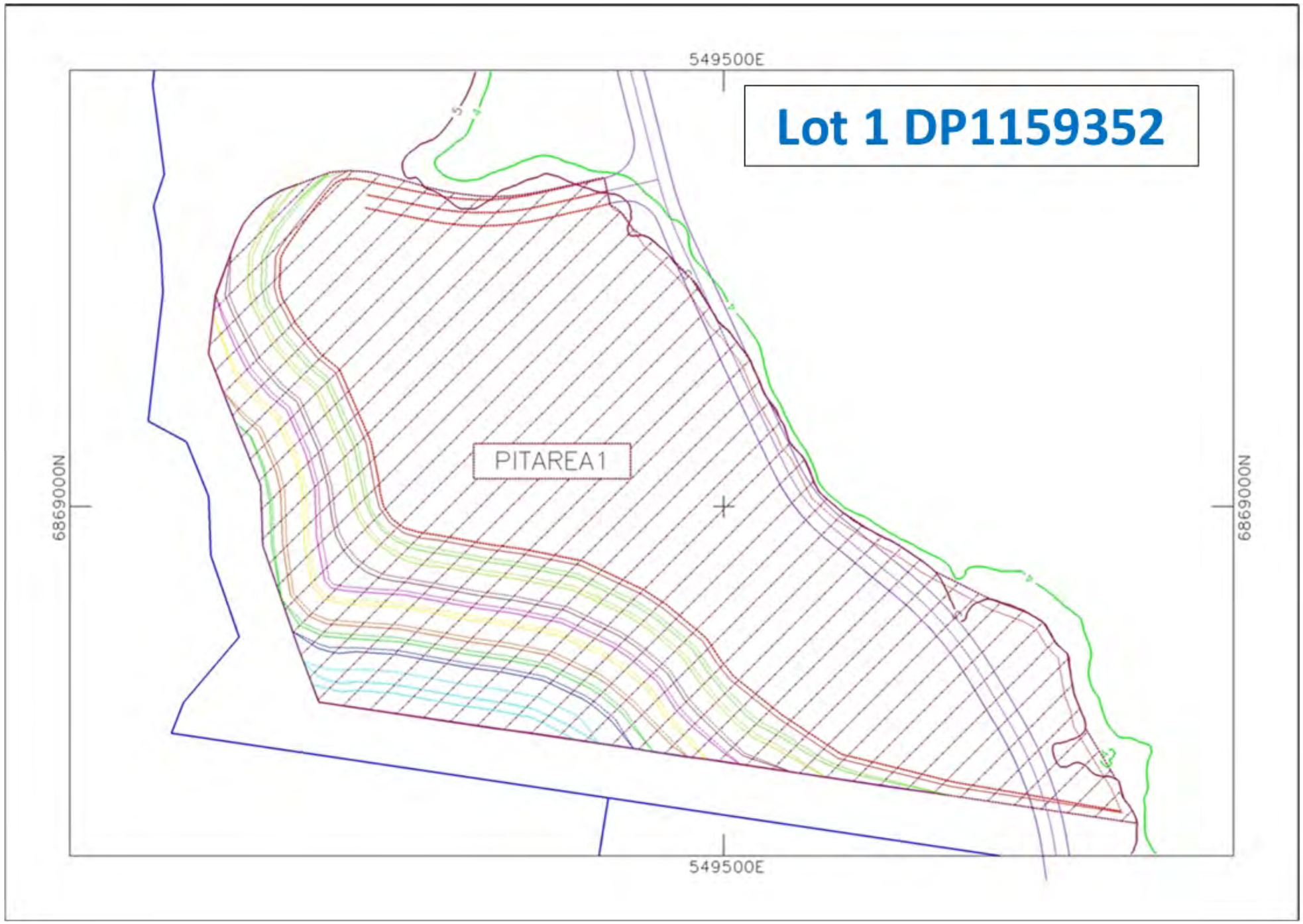
It is essential that run-off water storage facilities are established in and adjacent to the northern eastern intersection of the Pit Access Haul Road and the proposed general alignment of the connecting haul road between existing and proposed TSC extraction areas. Design and Construction of contour drains and general arrangement diversion channels to accommodate run-off and settlement of sediments from the pit area and Pit Access Haul Road is absolutely essential before commencement of any quarrying operations. Design considerations with respect to the proposed connecting haul road between existing and proposed TSC extraction areas should both prohibit water run-off from the PIT AREA 1 quarry and generally divert water to suitable storage and sedimentation dam locations.

Quarry operations are intended to commence in the South western corner of Lot 1 on DP 1 1159352 with the construction of the main pit access haul road (See Figure 15 for Isometric Plan of Quarrying Operations and Appendix D for stage plans for Quarrying Operations). Overburden material, predominantly Soil and weathered Neranleigh-Fernvale materials is removed at the lower slope angle of 35° to establish a competent pit slope and the initial bench at RL 55. Similarly benching operations to RL 50 continues with the same slope angle (35°) leaving a 5.0 m safety berm in the final pit wall and removal of internal Pit Access Haul Road to establish Bench RL 50. Successive benching operations down to the final pit floor Bench RL 04.

In general from Bench RL 55 to Bench RL 35, quarry operations do not intersect the competent materials and appear to be essentially “free dig” benches. Exposure of the modelled weathered Neranleigh-Fernvale units in Bench RL 45 may require a combination of ripping and/or drilling & blasting operations. Bench RL 30 to pit floor uncovers the siltstone layer of varying thickness and of unknown strengths. Various combinations of ripping and/or drill & blasting operations may be required in the lower benches.

Initially there is a high stripping ratio relationship of overburden (soil/weathered NF) to fresh Neranleigh-Fernvale combinations; however this ratio reduces considerably in the lower benches.

Figure 15 Stage plans for Proposed West Valley Quarry area. Different colour lines represent each bench



7. Quarry Schedule

7.1 Quarry Plan

An 11-year life-of-quarry production schedule, based on a 200,000 tonnes total material moved per year, was developed for PIT AREA 1 and is shown in Table 11.

Quarrying material from multiple benches is not possible in the upper benches given the size and working area available at the higher elevations. Multiple Bench working faces however would be possible at lower bench elevations and upper benches provided access to the internal access haul road is maintained.

Key inputs into the schedule were:

- Site preparation works have been ignored in the production schedule;
- Production rate of 200,000 total material tonnes moved per year;
- Schedule reported on an annual basis;
- Single active quarry face; and
- Sequence of operations is from Bench RL 55 down in 5.0m bench heights to Bench RL 04.

Note: Scheduling Details related to construction of the pit access haul road, water catchment and sedimentation control dams and start-up requirements of the quarry have not been considered in the 11 Year Life of Quarry Production Schedule.

Table 11 Example 11 Year Production Schedule (Tonnes)

Bench RL	YEAR1	YEAR2	YEAR3	YEAR4	YEAR5	YEAR6	YEAR7	YEAR8	YEAR9	YEAR10	YEAR11
RL55	12062	0	0	0	0	0	0	0	0	0	0
RL50	16929	0	0	0	0	0	0	0	0	0	0
RL45	20491	0	0	0	0	0	0	0	0	0	0
RL40	39425	0	0	0	0	0	0	0	0	0	0
RL35	85543	0	0	0	0	0	0	0	0	0	0
RL30	25552	84914	0	0	0	0	0	0	0	0	0
RL25	0	115086	53399	0	0	0	0	0	0	0	0
RL20	0	0	146601	87750	0	0	0	0	0	0	0
RL15	0	0	0	112250	184077	0	0	0	0	0	0
RL10	0	0	0	0	15923	200000	188772	0	0	0	0
RL04	0	0	0	0	0	0	11228	200000	200000	200000	89464
TOTALS	200000	200000	200000	200000	200000	200000	200000	200000	200000	200000	89464

For the first year of quarry production, operations are kept within the benches, RL 55 to RL 30. However as detailed in Table 12 the overburden stripping consisting of soil and weathered materials is high.

7.2 Material Production Schedule

A life-of-quarry material production schedule was also created to show the various layer unit tonnages as the PIT AREA 1 Quarry progresses.

The Material Production Schedule reports the following and is shown in Table 10 below:

- SO – Residual Soils. Typically clayey and sandy to silty with variable organic content. Overburden/Fill quarry product.
- AL – Alluvium. Predominately Silty to Sandy Clays of moderate to high plasticity. Additionally marine clay including acid sulphate soils. If extracted, Overburden/Fill quarry product.
- NFW – Weathered Neranleigh-Fernvale interbedded siltstone and greywacke. Drainage aggregate, cracker dust and road base quarry products.
- NF – Fresh Neranleigh-Fernvale interbedded non-pyritic greywacke and siltstone. Drainage aggregate, cracker dust and road base quarry products.

Note: Layers are quoted as in situ tonnes of material.

Table 12 Example 11 Year Material Schedule (Tonnes)

LAYERS	YEAR1	YEAR2	YEAR3	YEAR4	YEAR5	YEAR6	YEAR7	YEAR8	YEAR9	YEAR10	YEAR11
SO	31,944	10,780	12,221	17,314	15,923	1,754	11,228	18,824	-	-	-
AL	40,755	19,425	27,345	45,615	-	74,970	-	176,295	-	-	-
NFW	94,476	106,944	93,060	49,321	84,127	123,276	65,747	4,881	200,000	98,464	-
NF	32,825	62,851	67,374	87,750	99,950	-	123,025	-	-	101,536	89,464
TOTALS	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	89,464

7.2.1 Life-of-Quarry Schedule

As detailed in Table 12, the ratio of soil and weathered material to fresh NF units is consistently high and for most part, weathered NF predominates in each bench from year 3 to year 6.

An economic evaluation may show some merit in this earlier pre-stripping of soil/clay layers from the lower benches (RL 10 and RL 04). This strategy would smooth out the availability of the gravel/siltstone tonnages and the requirement of excessive clay removal. Pending the outcomes of this study, the life of the PIT AREA 1 Quarry, based on the 200,000 tonnes total material extraction per year is approximately 10 to 11 years.

7.3 Proposed Operating Methodology

The quarry has been scheduled to a relatively constant total movement requirement and generally quarry operations would consist of a “top/down” approach to material removal. As can be seen from Table 12, total quarry movements are from the higher benches in Years 1 and 2. Completion of these upper benches and the progressive removal of the internal access haul road, preclude any further material removal and/or access to the higher levels of the quarry.

Changes to the overall design parameters would be possible to maximise the quarry resource. These parameters changes would be subject to additional geological drilling data and further geotechnical studies with respect to final slope stability constraints, operating bench widths and specific mining equipment selection.

8. Quarry Overview

Quarry production is basically divided into a number of elements:

- Site planning and development;
- Extraction involving
  - **Drill and blast** - to provide fragmented rock for crushing; however Density of the rock may lend itself to being easily dug up using an excavator or front end loader;
  - **Load and haul** - to move the rock from the quarry to the crushing plant.
- Processing involving:
  - **Crush and screen** - to process the rock to the required product size and specification product;
  - **Product storage** - to move the rock from the plant to the final product stockpiles;
  - **Dispatch** - to move the final product from the stockpiles to the customer via the weighbridge

8.1 Overview

Planning for the extraction process is collated in three main stages:

Stage 1:

- Development approvals and licensing;
- Preliminary design and further investigations.

Stage 2:

- Detailed design;
- Operations.

By using this staged approach means that all aspects of quarrying activities may be identified and potential issues dealt with before any extraction has taken place or any hazard or accident has impacted the site.

8.2 Level of Production

The level of production for the West Valley Quarry is not to meet a demand in terms of an agreement or contract pertaining to a development in the area such as highway construction; it is to be determined by the total time allocated for these operations determined by TSC and the resource available.

It is assumed that the rate or level of production will total be approximately 200 000 tonnes. However this will be further determined by the amount of material available for extraction and what is outlined in the approvals process as appropriate for the site.

8.3 Hours of Operation

It is recommended that the hours of operation should be the same as those currently at Quirks Quarry, as outlined in Table 13, this will ensure minimal additional disturbance to local area.

Table 13 Proposed Quarry Services Operating Hours for Eviron Quarry

Operation	Operating Days	Start Times	Finish Times
Quarrying	Monday to Friday	7 00	1700
	Saturday	7 00	1200
Blasting	Monday to Friday	9 00	1500
	Saturday	9 00	1200
Hauling	Monday to Friday	7 00	1700
	Saturday	7 00	1200

8.4 Activity Sequence of Operations

The Activity sequence is the common order of in which activities would be undertaken on site. There may be some variations at times with multiple activities being undertaken simultaneously.

The sequence involved in extracting rock from the proposed quarry involves the following steps:

1. Pre strip activities and topsoil stockpiling activities.
2. Blast-hole Drilling and Blasting.
3. Extraction
   - Primary screening;
   - Primary crushing;
   - Secondary Screening and crushing where required.
4. Haulage.
5. Stockpiling.
6. Product Loading and Hauling.

These are the main activities regarding the Quarry operations, however other activities may also be undertaken on site pertaining to quality control of extracted material, dewatering as well as environmental monitoring and control measures, which need to be implemented and undertaken on a regular basis.

8.5 Extraction Timing

Timing and use will revolve around the drill and blast timetable as all quarry pit activities will cease during the loading of the drill sections and detonation activities, however these operations will be on a needs basis.

Extraction of blasted material can only take place after drilling and blasting. After the bench of blasted material is cleared the drill and blast crew will be called in periodically to drill and load the holes and conduct blasting when suitable. However the blast pattern, charge and other variables related to blast outcomes will be used to limit the amount of blasting required to extract large quantities of rock.

As some of the material to be extracted is considered ‘soft rock’ excavator and front end loader operation will have sufficient force and power to break up and extract this material without drill and blast operations.

9. Quarry Activities

9.1 Drilling

Drilling will be required for any blasting operations, drilling will allow for downhole emplacement of explosives so deeper rock can become available for use not just surface rock. Drilling and Blasting activities are closely linked and both should be undertaken on a needs basis. It is recommended that drilling and blasting to be undertaken by a rock on ground contractors who will adjust drilling and blasting patterns, sequences and detonations for the desired outcomes.

9.2 Blasting

Blasting activities seek to fragment the quarrying product and is a necessary quarry activity. The specific type of blasting activities undertaken will be dependent on the drill-hole patterns and initiation sequence to obtain correct sized material required by Council. Using blasting as a method to break and size rock always results in a percentage error created of crushed fines (extraneous material) and possible oversized rock. It is estimated that even in a good blast pattern up to 5% extraneous material and 5% oversized material may result. Over time, this percentage can be reduced, however extraneous material as a percentage of recovery is inevitable in quarry operations.

Blasting causes potential noise impacts; however counteractive measures such as reducing the Maximum Instantaneous Charge (MIC) can be used to reduce the noise caused without sacrificing fragmentation. Amendment to the type and performance of the explosive charge, as well as the type of initiation system and the duration of delays can also assist.

Blasting usually results in both overpressure and ground vibration. The generation of fly rocks is potentially dangerous and can impact on neighbours. Therefore blasting practices should be designed and managed in order to reduce the risk to staff and the greater community.

Although the blast noise is unlikely to cause hearing damage to anyone outside the direct work area, blasting noise is more commonly an annoyance noise or discomfort.

Blasting will not occur at night and will be limited to times when condition are suitable and avoided at times, as outlined below:

- Avoid at times of adverse wind condition, as this may promote the impact of blast over pressure;
- Avoid at times of temperature inversion;
- Avoid overfilling holes with blasting agent;
- Avoid firing holes in the front row which have insufficient burden; and
- Orientation of blast face.

All blasting designs contain considerations to minimise factors such as ground vibration and air blast. It is likely that the drilling and blasting at the quarry will be under taken by qualified contractors to reduce risks associated with these activities. A ‘Rock on Ground’ (ROG) contract with an explosive supplier should cover all factors associated with the supply, store, use and transport all dangerous goods, initiators and blasting materials pertaining to blasting.

9.2.1 Times and frequency of blasting

Times and frequency of blasting are as follows:

- Blasting should generally only be permitted during the hours of 9 am and 3 pm Monday to Saturday;
- Blasting should not take place on Sundays or Public Holidays; and
- Blasting will not generally take place no more than once per day.

9.2.2 Air Blast Overpressure

Considerations for air blast overpressure are as follows:

- The recommended maximum level for air blast overpressure is 115 dB (lin Peak);
- The level of 115 dB may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 120 dB (Lin Peak) at any time;
- The air blast overpressure values referred to apply when the measurements are performed with equipment with a lower cut off frequency of 2 Hz or less. If the instrumentation has a higher cut off frequency then a correction of 5 db should be added to the measured value; and
- Equipment with a lower cut-off frequency exceeding 10 Hz should not be used for the purpose of measuring air blast overpressure.

9.2.3 Slope Stability

It is proposed in the Quarry pit to use geotechnical engineering model slope stability as part of the mine/ quarry design including toe crest stability using back break design to prevent unsafe overhangs. This will be incorporated into all design of blast patterns and earth work plans within the quarry area, but will also be used in the event of overhang or unstable slopes after the initial blast.

In addition to this the slope angle existing on the block should properly be surveyed in order to gain data of the actual slope of the area to enable regrade activities after quarrying activities have ceased.

9.3 Extraction

Extraction will begin when rock is suitable for removal by a front end loader or excavator, usually after drill and blasting operations have been undertaken (especially when excavating hard rock).

Material blasted will be collected from the bench below using either a front end loader or excavator depending on appropriateness.

The excavator will either load a series of mobile crushing/ screening equipment directly or load haul trucks to take material to screens and crushers for processing, this will predominantly be determined onsite by space available in the ‘working pit’.

9.4 Storage, Handling and Using Explosives

As the proposed quarry is relatively small, the operators are usually not drill and blast specialists; therefore it is recommended that all handling and use of explosives is undertaken by qualified contractors. Due to the size of the site, it is suggested that no explosives can safely be stored on site, so it is recommended that the appointed contractor be responsible transport and handling of explosives to be used on site.

10. Quarry Processing Activities

Processing of quarry products and location of this activity is dependent on the access and design of the quarry area to enable these activities to be undertaken. The most cost effective way to process the material is directly from the point of extraction. This methodology can be seen in the existing Quirks Quarry.

Figure 16 Example Quarry processing activities



It is proposed that the North and West Valley quarry areas operate this way when possible, therefore reducing the overall footprint of the development.

10.1 Processing

Processing undertaken on the proposed quarry site will reflect the desire outputs, which will be variable and dependant on market needs present through continued development in the local area, council and local industry needs.

Processing will fundamentally include crushing and screening, from which products will then be segregated and stockpiled ready for use and/or delivery.

All crushing and screening processes will take place when conditions are favourable to minimise dust and reduce water requirements. Processing has a range of environmental aspects which need to be addressed from water use, and dust suppression, machine noise and stockpiling requirements.

The expected products available would be:

- 70-30 mm, 40 mm, 20 mm, 10 mm, 7 mm Drainage Aggregates;
- Cracker Dust;
- “C” Grading Type 2.1 and “B” Grading Type 2.3 Road base;
- Overburden / Fill;
- Screened topsoil (Rescreened from imported spoil); and
- Screened Sand (Rescreened from imported spoil).

However the desired products are dependent on the rock available at the North and West Valley sites. Further testing is to be undertaken on the exact products to be available from this site; however these products are currently available from the Quirks Quarry site and due to their close proximity should reflect that available at West Valley.

All components of extraction and sizing processes will create fines and dust which will have to be closely monitored for both health and environmental reasons. The dust creation will be reduced by frequent watering and sprayers near and around the main dust creation sources such as the crushing and screening areas.

10.1.1 Sampling and Testing

It is understood that TSC will be undertaking further testing and sampling of the materials from the West Valley Quarry site. It is highly recommended that further sampling be undertaken to determine identified rock properties during detail design. By determining the rock properties the type of products to be produced at the site can be confirmed, however to do so this includes a series of tests to determine:

- What would be considered Coarse Aggregate; and further testing to determine what type of coarse aggregate; using:
  - Relative Density and water absorption testing;
  - Ten percent fines value testing;
  - Particle size distribution analysis; and
  - Flakiness index analysis.
- What would be considered Fine Aggregate; and further testing to determine what type of fine aggregate using:
  - Relative Density and water absorption testing; and
  - Particle size distribution analysis.
- What would be considered Filler; and further testing to determine what type of Filler:
  - Relative Density and water absorption testing; and
  - Particle size distribution analysis.

It will also allow for increased validity of tonnage calculations as specific densities of rock intervals could be validated and/or change dependant on test results.

Further sampling and testing will also allow for the most suitable use of the extracted rock, and assist with assessment of the economic viability of the quarry prior to commencement of extraction. Other testing methods or types may be used, depending on Council’s preference and specific property/ product targeted during the testing.

10.2 Screening and Crushing

Screening is required for the sizing and separation of materials, this allows the separation of oversized materials from medium to fine materials, this separation is often enough to allow material to be stockpiled or used, however some material requires crushing to produce certain sizing for sale and use. Most material will have to undergo crushing as the TSC has a variety of sizing which it requires for sale and use. Generally the excavator or front end loader will directly load material into screens and crushers within the pit area an example of which can be seen in Figure .

10.3 Stockpiling

Several stockpiles will be located on the Eviron site as each product will be stockpiled separately even though they may be produced at the same time as several other products. Stockpiles may be required for the raw material if extraction exceeds processing capacity.

Stockpiles will be located away from the main excavation area, close to the work areas containing the screens and crushers. The stockpiled material will be maintained until the product can be loaded for haulage offsite.

Any oversized materials will be stockpiled separately according to size. This material will be graded to determine whether it will be used for other activities or stockpiled as “unusable” material.

Stockpiles may require differing levels of maintenance and stockpiles required may be varying in size dependant on the demand.

10.4 Loading and Hauling

Material will then be processed and loaded into haul trucks to be taken offsite by private customers or to specific TSC working sites and/or stockpiled until it can be removed from the site.

11. Quarry Infrastructure

11.1 Security

The landfill site has a lockable entrance gate, with 2 m high chain wire fences on either side for a distance along the northern boundary. There are no other major security fences along the western, southern and eastern boundaries of the site. The existing Quirks Quarry and North/ West valley areas are contained by fencing except towards the northern boundary where the area is cut water channels separating the Quarry land from the cane field areas; north of the existing and proposed quarries.

11.2 Construction

There are two components on site relating to construction of roads and offices/work areas. There are two options for work areas on site, continued used of pre-existing work area or establishing a site nearer to the West Valley Quarry area. It is likely that the existing facilities will remain in use as there is little area to establish facilities and work areas closer to the West Valley site. There is a need to establish large areas of land for these purposes and stockpiling of processed products, however this should be done in pit where possible to reduce the quarry's overall footprint.

11.2.1 Offices, Amenities, Workshop and Heavy Vehicle Areas

During previous meetings with the current quarry operations manager it was identified that the area in which work is under taken requires a means of storage of equipment and parts. There is also the need to secure equipment during downtimes. It was proposed that the existing Quirks facilities may require improvement but is not absolutely necessary at this point in time.

It is proposed that Royal Wolf demountable containers or similar products spanned by an arch roof would be suitable for servicing and minor repairs of equipment. An additional hardened floor bay is needed to accommodate tracked vehicles. This design also has the advantage of allowing drive-through services if desired, removing the risks of reversing equipment in the area. An installed example of this type of workshop is shown in Figure 17.

Figure 17 Workshop Configuration Example



The illustrated facility consists of a 24 m x 12 m concrete slab with customized shipping containers either side. One container is used for storage of tools and light plant equipment whilst the other is an office/storage combination. A 12 m x 12 m canopy spans the containers, protecting the facility from the environment. This canopy includes an end-wall allowing for control of airflow through the service bay area.

11.3 Fuel and Oil Services

Separate fuel and lube bays for heavy and light vehicles are required. Amenities for both maybe available at the Stott's Creek facility or the Quirks Quarry lay-down/ Site office area, however further development should be made to enable these areas to provide the aforementioned services, if a new site for these activities is not identified for the West Valley Quarry.

11.4 Maintenance

Maintenance of the quarry fleet can if required; take place on site as there will be provisions for this in the workshop and service areas. Maintenance should only take place in these areas in case of fluid spill; such as fuels and lubricants. This will ensure that environmental risks are minimised and/or eliminated in most of the quarry.

12. Quarry Haulage

12.1 Product Haul Route

The product haul route will be indicated by Council and will need strict and detailed monitoring, to minimise the adverse effects of the large trucks on the main roads.

12.1.1 Internal Roads

All internal quarry roads should follow the guidelines as identified below. In the detailed design stage some details may change but the basic principles will remain, these principles include development of the roads drainage, runoff management and channelled appropriately.

12.1.2 Design Standard for Roads

Prior to any road being constructed, a risk review should be conducted on the design or proposed configuration of the road. This shall assess the suitability of the configuration and materials used to ensure that the safety risk to vehicles using the road is of an acceptable level. The design should take the following aspects into consideration:

- Presence of overhead structures and power lines;
- Drainage;
- Layout of and access to parking areas; and
- Access from roads to adjacent dump areas.

12.1.3 Primary Haul Road Regularly Used for Two Way Traffic

All primary haul roads are to be adequately designed in accordance with good practice for heavy equipment roads and the following guidelines:

- ***Road width*** - (as defined) of the road to be at least 3.5 times the width of the largest vehicle regularly using the road;
- ***Road grade*** - generally the grade should be less than 3% (1:30) with a maximum of 10%;
- ***Road profile*** - the pavement shall be shaped so as to readily drain water and to provide a safe surface to travel. The road shall be crowned in the centre with a 2-3% cross-fall to each edge;
- ***Curvature of bends*** - In general, bend radii should be 100 metres or greater for main sections of road if a road speed of 25 km/hr is to be adopted;
- ***Intersections*** - all new intersections should be “T intersections” (angle of approach of at least 70 degrees). Where this is not possible, a risk assessment shall be conducted on the alternative design to ensure that persons can use the intersection with safety;
- ***Safety berms or barriers*** shall be installed at any point where the ‘drop off’ at the side of the road is greater than half a metre (0.5 m), as detailed in the following section. This drop off situation should be avoided wherever possible by allowing a run-off slope at the side of the road battered at an angle no steeper than 1:4.

Design berm height is ideally half wheel height but a minimum berm height of one (1.0 m) metre is recommended for internal haul roads taking into account the need for visibility from light vehicles. However where possible a runoff slope should be implemented preferentially;

- ***Guideposts*** are to be of such size, shape, robustness and visibility (reflectors added) so as to adequately define the road boundaries in all conditions. The spacing of the guideposts shall be a nominal 150 metres on the general mine/quarry site and 100 metres on the haul road. Culverts unprotected by barriers or berms should be marked with pairs of guideposts;
- ***Signage -*** traffic control and direction signage shall be installed where necessary. The signs shall comply with AS 1742 (1...14): Manual of uniform traffic control devices; and
- ***Surface material*** - haul roads should be sheeted with sufficient competent material to provide an adequate degree of traction when wet, and to enable the surface condition to be restored through normal road maintenance.

This will include the main haul route in and out of the quarry site. This does not include the haul routes to the quarry faces, although similar design will be used where there is no pre-existing road.

12.1.4 Construction of Roads

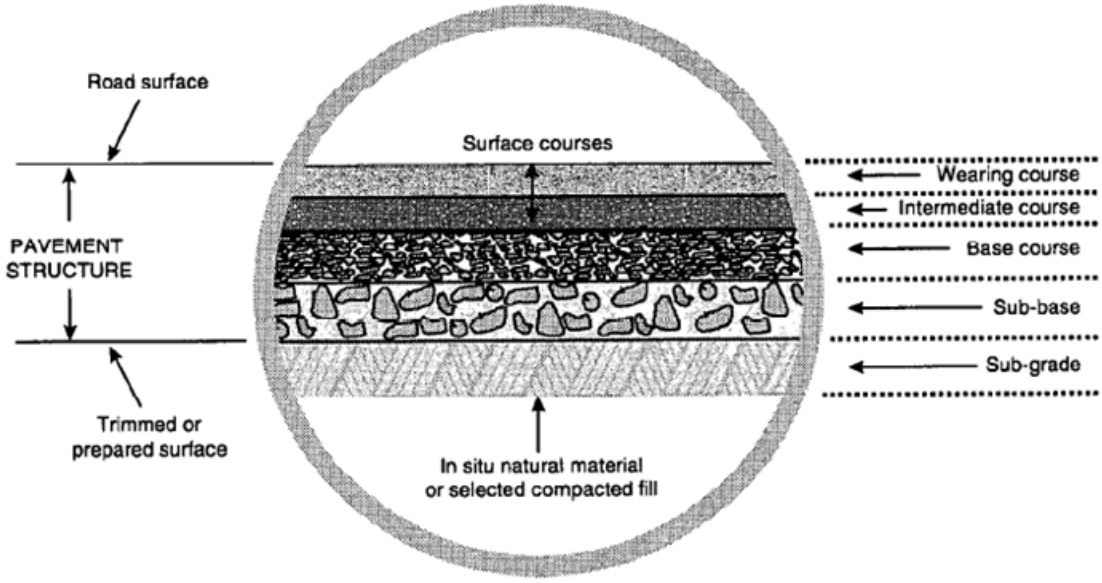
Primary haul roads should be adequately formed and constructed with foundation materials of suitable strength and compaction so as not to be readily prone to failure.

Base and top course materials are to be of adequate strength so as to not prematurely break down and become slippery when wet.

The construction process commonly used is:

- Remove the top and sub soil horizons to a suitable base material;
- Backfill and compact with the most competent overburden material readily available;
- Top course material and pavement (see Figure 18) should be competent material during stripping;
- Operations, suitable material (such as sandstone or gravels with low clay content); and
- Should be stockpiled for road construction purposes if encountered.

Figure 18 Typical Pavement Structure



Other *semi permanent and temporary* roads shall be formed and constructed out of suitable local materials so as to form a safe running surface. Use of unweathered or weathered sandstone will help form 'all weather' roads if required.

12.1.5 12.1.5 Maintenance and Dust Control of Roads- key to reduction in air pollution

All roads should be graded on a regular basis so as to maintain an adequate running surface and drainage.

From time to time the primary haul road (in particular) may require structural maintenance work that could include scarifying and re-compaction and/or resurfacing. Ongoing work is required to ensure that the road boundary is clearly defined at all times including the hours of darkness. This shall include replacement of missing or damaged guideposts and signage, where and if required.

Regular watering is required for dust control and maintenance of surface structure.

13. Fire Management Planning

Fire risks can be assessed and limited to reduce the risks to human life, infrastructure and operations, in a number of ways. A systematic fire response plans can be developed to minimise the risks associated with fire. A response plan can provide guidance within quarry operations to deal with potential fires; using a series of strategies and practical measures.

This section outlines measures to prevent the occurrence of unplanned bushfire the controlling of bushfires and minimise the potential for the spreading of bushfires in, from, or around lands under the care and control of TSC.

As part of risk reduction measures to be undertaken on site TSC shall:

- Provide adequate fire protection works on site, including the availability of trained personnel, water tankers and fire fighting equipment and annual hazard reduction measures with particular attention to boundaries of adjoining landholdings;
- Make available to the Fire Service and emergency services when required, water carts and trucks in cases of bushfire incidents on the quarry site; or adjoining sites; and
- To take all practical steps to prevent the occurrence of bushfires on their land, and to minimise the danger of the spread of bushfires on or from, their land.

13.1 Key Policy and Objectives

To ensure support for required practices and mitigation the following objectives and policies have been created:

- To prevent possible sources of fire or ignition on site where possible;
- Activities on the site are managed to minimise the risk of outbreak of fire;
- Hazard mitigation measures are in place to contain an outbreak of fire should one occur;
- To assist in the protection of the area, equipment and personnel from potential fire hazard or fire damage;
- Sufficient trained personnel, water and fire fighting equipment is available on site to suppress localised fires;
- Each outbreak of fire is investigated to identify root causal factors and to ensure that appropriate mitigation measures are instigated to prevent similar events from occurring in the future; and
- An annual report on fire management activities to assess.

13.1.1 Performance Standard

In the event of fire on site that the correct response and training has been undertaken to minimise environmental, personal and site damages/impacts.

13.2 Performance Outcomes and Actions

Performance outcomes and actions have been created to continually improve bushfire management, to ensure it is undertaken properly. These include the following targets and outcomes:

- An annual inspection and risk assessment is undertaken in time for mitigation measures to be in place prior to the commencement of the fire season;
- Perimeter fire trails are constructed and maintained to ensure access under all reasonable weather conditions;
- Water tanks/pumps and other appropriate fire fighting equipment are available on site and are maintained in good working order;
- All personnel on site receive training in basic fire fighting and are capable of providing a first response capability;
- A fire team comprising employees with additional training in fire fighting is available during operational periods;
- Employees, contractors and service providers are aware of the fire emergency procedures applicable on the site;
- Communication and liaison processes with local fire brigade are in place;
- All fires are extinguished in a quick, expedient and professional manner;
- Fire incidents investigations are completed and appropriate actions implemented; and
- The annual report on fire management activities is acceptable and appropriate

13.2.1 Employee Actions – Major Incident

If a fire on site occurs the personnel at the site must assess the situation and sound an alarm to ensure other employees can instantaneously be evacuated from site. In the case of a major fire outbreak on or around the site the following guideline should be followed:

- If a major fire on site occurs all personnel must evacuate to a safe muster point designated off site;
- All responsible personnel must account for all employees and report to the site foreman;
- The site foreman will contact the fire brigade during the evacuation of the site; and
- The site foreman will inform the fire brigade of any potential combustible chemicals and fuels on site and their location (a lock box at the front gate is also advised to aid in the communication of any important information required when fighting a fire on site.);

The main potential source of ignition and fire will be the equipment and fuel trucks (if on site).

13.2.2 Employee Actions – Minor Incident

Where a minor fire incident occurs on the Quarry site the following should be undertaken:

- All personnel inducted and working on site should be trained in fire safety, reduction and management.

Personnel dealing with the fire will:

  – Assess the size, wind direction and type of fire before extinguishing;

- Extinguish the fire.

- Inform the site foreman/supervisor
  - Source of the fire (if known);
  - How it was extinguished/type;
  - Who was involved

The site foreman will inform the local fire brigade as there may be some smoke due to the incident.

13.2.3 Potential Impacts

In producing this Fire Management Plan (FMP), the principal consideration has been to provide for the protection and safety of human life (including staff and contractors, residents and fire fighters suppressing bushfire events) and quarry property.

Bushfires also have the potential to impact upon flora and fauna of the area.

13.3 Risk Assessment

An annual bushfire risk assessment should be undertaken on the site before the bushfire season begins. The bushfire season typically occurs between October and March. However, factors such as fuel load, rainfall history and climatic conditions may bring forward or extend the bushfire season.

A bushfire risk assessment will consider:

- Fuel loads on the Quarry site;
- Advice from the Upper the Local fire brigade;
- The climatic conditions (particularly rainfall) of the preceding year; and
- Methodologies of bushfire risk assessment and Australian standards should be used and referenced to assess the potential risks.

13.3.1 Preliminary Hazard Assessment

A preliminary assessment of the hazard to building infrastructure and other assets within the lands under the care and control of the TSC should be undertaken as a priority when the initial activities on site begin as potential sources of ignition may become evident or will be reduced in some areas.

13.4 Potential Sources of Ignition

13.4.1 Quarrying Activities

Potential sources of fire or ignition on the Quarry site include:

- Ignition from equipment (metal grinding or welding);
- Ignition from unguarded exhausts of vehicles or equipment parked or travelling over dry pasture

13.4.2 Electricity Transmission Lines

Potential sources of ignition through electricity transmission lines occur due to:

- During hot weather electricity transmission lines may sag and, under windy conditions, may come in contact with each other and arc; and
- Arcing of lines may cause sparks to ignite vegetation in the vicinity of the lines
  - The risk of fire is increased if the lines are close to tall vegetation.

13.4.3 Lightning

Lightning may cause ignition of vegetation, particularly at higher elevations such as along ridgelines.

13.4.4 External Fire

As there are multiple neighbours to the site it is possible that fires started due to other operations or places may carry over to the Site.

13.4.5 Other

Other accidental causes of ignition exist which are usually to related human activity.

- Actions of employees, trespassers or neighbours;
- Vehicles accidents or fires on malfunctioning equipment and motors;
- Deliberately lit fire; and
- Fuel reduction fires.

13.5 Continual Improvement and Mitigation Measures

By continually monitoring and improving site conditions management will reduce the potential for bushfires. Additional fire awareness training and work practices will improve bushfire control and prevention.

13.5.1 Quarrying Activities

Quarrying activities have the potential to create a fire on site, the size will depend on the mitigation measures undertaken to prevent fire and the response systems implemented. Selected mitigation measures are as follows:

- All vehicles will be restricted to identified vehicle routes to reduce the risk of spark emissions;
- If a vehicle is required to traverse across grassed areas, it is to have an upward exhaust;
- Access track will be inspected and maintained when necessary;
- Existing firebreaks will be maintained;
- An area beside the access tracks will be cut or slashed extending the firebreaks;
- A cleared area will be established around above ground facilities and buildings;
- Activities that create sparks or hot particles, such as metal grinding and welding will be limited to workshops and hardstand or areas clear of vegetation;
- Access to dams and water supply will be inspected and maintained when necessary;
- All fire bans will be adhered to by employees, contractors and service providers.

13.5.2 Electricity Transmission

Electricity transmission easements will be inspected regularly to ensure regenerating vegetation does not have the potential to interfere with power lines that sag.

13.5.3 Lightning

No specific management practices are practicable to reduce the risk of lightning strike.

13.5.4 External Fire

The risk of bushfires in adjacent lands will be minimized by the provision of firebreaks along boundary fences.

13.5.5 Other

As the potential sources of ignition are unknown or unqualified, management of these potential outbreak sources are restricted and cannot be anticipated.

13.6 Fire Fighting Equipment

The Quarry site will require a wide range of facilities that will be made available to help control and extinguish bushfires. This equipment will included but is not be limited to:

- Fire hydrants;
- Fast fill hoses and connections;
- Clean water dams with maintained access points;
- Water truck/s;
- Earth moving equipment available;
- Water pumps;
- Portable radios;
- Fire alarms;
- Emergency telephones and fire extinguishers provided at vantage points within the surface facilities; and
- First aid room and supplies

All fire fighting equipment will be maintained or replaced according to Australian Standard 1851 or sooner if necessary.

13.7 Fire Training

Fire training is a key part in identifying and allowing positive action as a response to fire on site. By training personnel and key contractors this will ensure a safer work place and allow for risk minimisation as small fires will be able to be dealt with effectively. It will also allow for early evacuation in if there is a large fire which will reduce potential harm to people on site and may reduce property and infrastructure damages.

- All employees, contractors and service providers will be made aware of the fire emergency procedures applicable on the Quarry site;
- An on-site fire fighting team will be formed;
- This team of employees will receive training in the use and maintenance of fire fighting equipment and safe fire fighting techniques;
- This team will provide a first response to bushfires encountered on the quarry site land co-ordinate with fire fighting efforts of the local fire brigade in the event of larger bushfire onsite;
- The fire fighting team will receive regular training to update their skills;
- All employees on site will receive training in basic fire fighting and will be capable of providing a first response capability for bushfires.

Table 14 lists proposed controls and actions for fire management and planning.

Table 14 Proposed Controls and Actions Table for Fire Management and Plann

Control and Actions	Timing	Trigger/ Responsibility/ Monitoring/ Reporting
Annual inspection	Prior to bushfire/ bushfire season	Environmental bushfire season Environmental Officer in conjunction with Site Senior Supervisor and/or Quarry Manager
Bushfire risk assessment	Annual/ on Appointment	Annual reporting on fire management
Maintenance of fire fighting equipment	Annually and after a fire incident	Environmental officer with assistance of Local Fire Officer
Bushfire protection measures	Three- six monthly basis	Environmental Officer
Fire fighting training	Annually	Quarry personnel / Fire Officer or qualified trainer
Investigation of fire incidents	After a bushfire	Community Safety Officer of the local fire brigade
Control of bushfire		Immediate response- may be under taken by trained quarry personnel, (see actions) Secondary response- Local fire brigade, additional help may be sort from trained Quarry personnel volunteers

13.8 Monitoring

Any personnel involved in a minor fire incident must report it to the site foreman. The site foreman will record all fire incidents.

The site foreman will inform the local fire brigade as there may be some smoke due to the incident and record this contact with the fire brigade.

An incident investigation will be undertaken in both a minor and major event; this will include a variety of personnel from employees, site foreman to local and state authority's dependant on the severity and impacts of the fire. Reporting requirements are as follows:

- A report will be prepared after an incident of bushfire and will include measures to improve the FMP if necessary; and
- Annually in the form of a report on bushfire management activities and bushfire risk assessment.

This FMP will be reviewed after incidents of bushfire as well as annually after the bushfire season. The FMP will be amended after the review process, if required, to increase the effectiveness of this FMP.

The local fire brigade and other fire professionals will be consulted to ensure that any possible corrective measures be implemented on site to prevent a repeat incident if at all possible.

14. Safety Measures and Environmental Measures

Safety and environmental measures often achieve similar outcomes, but focus on different aspects of quarry operations. For example mitigation measures implemented for spills will both have safety and environmental outcomes.

A leak: is a slow discharge over time; a leak may be a drip at a joint which is not tight, worn or under pressure. However is considered under spill management.

A spill: is a large discharge over time; a spill may be from a hydraulic hose which splits or a drum which overturns.

This section largely addresses safety and environmental measures related to spill management, however it is acknowledged that there are numerous other safety and environmental issues that may arise onsite. Other environmental issues are handled within the Environmental Assessment document, and other safety measures should be considered at a preliminary design stage. All such issues and measures will be included in the West Valley Quarry Plan of Management at a later stage in the project development.

14.1 Policy

Policy on site shall reflect the best practice to ensure health and environmental outcomes these include, but are not limited to:

- To reduce potential impacts of potential spills on site; and
- To respond quickly and effectively to spills on site, without endangering or risking health and safety of employees.

14.1.1 Performance Standard

Quarry operations aim to minimise potential harm by planning and performing in such a ways as to reduce risk on site. To do this the following targets have been determined:

- Ensure the minimum risk during operations to the soil and water way;
- Ensure that any unforeseeable spill event can be dealt with swiftly reducing environmental damage to the site;
- Establish secondary precautions to reduce the extent that a spill can cause environmental harm;
- Maintain trained personnel to respond to spills, and assign key personnel to manage response; and
- A chemicals and fuel register be kept on site and a copy kept at the emergency muster point and a copy of Material Safety Data Sheets of chemicals and fuels on site appended to this register.

14.2 Bunds

Bunding high-medium risk areas of operation, to create separation of work areas is a fundamental practice when trying to limit potential environmental aspects created by works undertaken in specific areas.

Bunding can act as a barrier or deterrence to stop interaction or effects/activities of one area affecting other areas; bunding may also create or aid in on site drainage practices.

The bund will ensure capture and enclosure of stray contaminates but an additional spill kit should be located at this point for immediate clean up. This will ensure that the site and its activities remain environmentally compliant and risk and potential cost are lowered.

A bund can be a low wall, tray, speed bump, iron angle, sloping floor, drain or similar and is used to capture spilt liquid for safe and proper disposal.

Often chemicals, fuels and oils require bunding as part of their requirements for use on sites and linked to the approval process, many fuel tanks and chemical containers now have standardized self-bunding and/or internal bunds.

Note: implementation of bunds does not mean there can be no spills or potential leaks and/or spills, but the impacts will be reduced and limited.

14.3 Uncontrolled Releases

Any release of contaminants not in accordance with the conditions of the approval s must be reported by telephone to the relevant agency. Any such release must be reported as soon as practicable, but no later than 24 hours after becoming aware of the release. The relevant state agency may need to respond quickly in some cases, which is why priority needs to be given to the reporting of a spill.

14.4 Spill Management Planning

To reduce the occurrence of spillages and to assist the clean-up process of any spills, both management and staff members should be aware of spill procedures. By formalising these procedures in writing, staff members can refer to them when required thus avoiding undertaking incorrect spill procedures.

Further to aid in the awareness of correction procedures, training should be undertaken by all employees and contractors on site to ensure effective clean-up of spills.

A spill management plan can be as simple as stating the steps taken when a spill occurs (stop, contain, report, clean up and record).

A map is recommended to also be included to show the locations of spill kits or other cleaning equipment and correct evacuation procedures. This document/s could be attached to the spill kits or where other cleaning equipment is stored to ensure easy access.

14.4.1 Responding to Spills

To respond to a spill the following measures should be undertaken:

- Stop the source

If it is safe to do so, the source of the spill should be stopped immediately. This may be a simple action like upturning a fallen container.

- Contain and control the flow;

To stop the spill from expanding, absorbent materials and solid/ liquid barriers should be placed around the spill. Work from the outside to soak up the spill. It is vital that spilt liquid is not allowed to reach stormwater drains, sewer drains, natural waterways or soil.

- Report to relevant authorities;

For large scale spills that involve hazardous materials, the Fire Brigade must be alerted. If a contaminant causes pollution the quarry has a duty to report the incident to the Office of Environment and Heritage (or equivalent) (OEH).

  - Failure to report a pollution incident that has the potential to cause harm to the environment is an offence.

- Clean up;

Using information from Material Safety Data Sheets (MSDS) about the properties of the liquid spilled and the spill equipment available, spills should be cleaned up promptly.

- Record the incident.

By keeping a simple log of all spills, precautionary measures can be put in place to avoid similar accidents from occurring in the future. Recording spills demonstrates that a business is motivated to prevent pollution from spills occurring.

14.5 Minor Spills

A small spill is generally considered to be a spill of 5 litres or less providing the product is not concentrated. For concentrated products of any quantity the spill must be treated as a large spill.

To respond to a minor spill the following steps should be taken:

Assess safety. Make sure that people are kept clear, and that you have the right training and equipment to deal with the spill.

Stop the source. Providing it is safe to do so, stop the spill at its source. This may involve righting an overturned container or sealing holes or cracks in containers.

Contain and clean up the spill. The spill should be mopped up immediately.

Record the spill. Record when, what, how and where the spill occurred, clean up measures undertaken and the names of any witnesses.

Recording of the incident will require the reassessment of the management plans to ensure that changes are made to the Spill management plan to prevent a future spill.

14.6 Major Spills

A large spill is generally considered to be anything over 5 litres or concentrated chemicals of any volume, however will be determined in the site approvals process.

To respond to a major spill the following steps should be taken:

Assess safety. Make sure that people are kept clear, and that you have the right training and equipment to deal with the spill.

Consult the Material Safety Data Sheet (MSDS) or identify the substance. If information on the substance is unknown the MSDS will have instructions on how to deal with specific chemical spills.

Put on protective clothing. If necessary, put on gloves and goggles, a mask and an apron.

Stop the source. Providing it is safe to do so, stop the spill at its source. This may involve righting an overturned container or sealing holes or cracks in containers.

Contain and control the flow. The spill should be prevented from filtrating into the ground or entering the stormwater system. The outer edge of the spill should be dammed with rags, blankets, sand, sands bags, mops and/or absorbent booms.

Clean up the spill. Promptly cover the spill using absorbent materials such as the correct absorbent granules for the product (Note that some strong acids will react with some types of granules and sawdust), sand and rags, being mindful not to splash the spill.

Using a dustpan or spade, the absorbent granules or sand must then be scooped up and placed into a container. This waste material is not to be buried or thrown into the environment. The method of disposing this waste will depend on the amount and the type of chemical that was spilt.

The EPA will advise on the appropriate disposal of hazardous substances. There are several contractors that will dispose of contaminated substances and soils.

Notify the appropriate authority. If the spill does enter a stormwater drain or open ground, the EPA and your local council must be notified. If there is a hazard to health or property, call Fire and Rescue on 000 immediately.

Record the incident. Record what, how and where the spill occurred and the names of any witnesses. Also make note of what changes can be made to the spill management plan and plan of operations if applicable in preventing a future spill.

14.7 Spill Avoidance

Activities on site must be conducted in a way that prevents any potential or actual release of a contaminant to land. The benefit is that the environment is protected from contaminants that can potentially cause harm. This will allow cost savings as there will be no breaches resulting in financial penalties or by wasting of resources through actual releases.

To prevent the release of fuels, lubricants or other contaminants to land the control measures may include, but are not limited to, the following:

- Maintain all refuelling equipment in good working order;
- Use groundsheets or drip trays to capture spillage during maintenance of vehicles and any other equipment and plant;
- Where practicable, locate fuel storages within an impermeable bund;
- Where practicable, undertake refuelling and routine maintenance of vehicles within designated service areas;
- Clean up and dispose of spillages as quickly as practicable and in a manner that prevents the release of waste, contaminants or other materials to land;
- Correct liquid storage, all liquids should be stored in sealed containers that are free of leakage;

- All containers should be stored on sealed ground and in an undercover area;
- These are simple things that can be checked regularly;
- Keep sharp parts and items away from containers containing liquid to avoid damage and leaks.

14.7.1 Spill Kits

Spill kits on site ensure that an available means of cleaning up a spill are readily available and the potential impacts of a spill can be reduced. Spill kits are purpose designed units that contain several items useful for cleaning up spills that could occur. Typical items are:

- Safety gloves and appropriate protective clothing (depending on the type of chemicals held onsite);
- Absorbent pads, granules and/or pillows;
- Booms for larger spills;
- Mops, brooms and dustpans.

Spill kits are used to contain and clean up spills in an efficient manner and the site should have enough spill kits or big enough spill kits to deal with any potential spills.

Access to spill kits needs to ensure the following:

- Spill kits should be kept in designated areas that are easily accessible to all staff;
- Spill kits should be kept nearby to where a spill/s are most likely to occur- for example refuelling areas;
- Staff members should be trained in using the spill kit correctly.

14.8 Records and Corrective Actions

Recording must be undertaken after each incident and management plans should be reviewed annually or after an incident.

Reporting to OEH about an onsite incident must occur if the incident is uncontrolled and considered significant (breaching the conditions of approval and environmental non compliances associated with the activities undertaken on site).

Information about the incident needs to be recorded and written, a notice detailing the following information must be provided to OEH within 14 days of any advice provided if a breach has occurred.

The following information must be included:

- The name of the operator, including their registration certificate number;
- The name and telephone number of a designated contact person;
- Quantity and substance released;
- Person/s involved;
- The location and time of the release;
- The suspected cause of the release;
- A description of the effects of the release;

- The results of any sampling performed in relation to the release;
- Actions taken to mitigate any environmental harm caused by the release; and
- Proposed actions to prevent a recurrence of the release.

All records must be kept for 5 years and should also include and verify the provision of training programs and schedules of routine inspections

By continually improving management plans to reflect the changing nature of the site will ensure that all aspects are investigated and remediated where possible, and these changes need to be also recorded to reflect the continual improvements to management plans to ensure that due diligence can be shown.

14.9 Site Closure and Rehabilitation

The Concept Plan for Eviron Road makes provision for converting the West Valley Quarry into a fully engineered landfill, following cessation of quarrying activities. Following completion of landfill activities including capping, remediation and rehabilitation, the site will form part of the Tweed Shire Botanic Gardens.

15. References

Berkman, D.A (2001); Field Geologists' Manual AUSIMM Monograph 9, AUSIMM, Carlton, Victoria.

Geological Survey of QLD (GSQ) (1978), Murwillumbah 1:100 000 Scale Geological Map, Australia.

Willmott, W. (2010), Rocks and Landscapes of the Gold Coast Hinterland (Expanded Third Edition), Kingswood Press, Underwood, Queensland.

www.simetric.com.co.uk

Appendix A

Geology Mapping Report

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council

Report for West Valley Quarry

Geological Mapping

September 2011



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

This Geological Mapping Report ("Report"):

- *has been prepared by GHD Pty Ltd ("GHD") for Tweed Shire Council;*
- *may only be used and relied on by Tweed Shire Council;*
- *must not be copied to, used by, or relied on by any person other than Tweed Shire Council without the prior written consent of GHD;*
- *may only be used for the purpose of geological mapping (and must not be used for any other purpose).*

GHD and its servants, employees and officers otherwise expressly disclaim responsibility to any person other than Tweed Shire Council arising from or in connection with this Report.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless they are expressly stated to apply in this Report.

GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the Assumptions being incorrect.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation and may be relied on until or after which time, GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with those opinions, conclusions and any recommendations.

Contents

1. Introduction 1

2. Scope of Mapping 3

3. Geological Data 7

3.1 Regional Geology 7

3.2 Quirks Quarry 7

3.3 West Valley Area 15

3.4 Geological Interpretation 21

3.5 Further Drilling 27

4. References 30

Table Index

Table 1 Mapping Waypoint Coordinates 3

Table 2 Possible Drillhole Locations (MGA Zone 56 9GDA94)) 27

Figure Index

Figure 1 Site Location 2

Figure 2 Location and Mapping ID Sample Points 5

Figure 3 Area Traversed 6

Figure 4 Photograph – Waypoint 5 – East Facing – Exposed quarry face displaying siltstone top unit and Chert bottom with thin soil overburden. 8

Figure 5 Photograph – Waypoint 11 – South East Facing – Exposed quarry wall face of predominately chert with siliceous siltstone showing zones of oxidation on the side of the hill 8

Figure 6 Photograph – Waypoint 6 – North Facing Quarry Face – Siltstone with quartz and clayey bands 9

Figure 7 Photograph – Waypoint 9 – On Quarry Floor – Chert interbedded with Siltstone 9

Figure 8 Photograph – Waypoint 13 – South East Facing Quarry Wall – Chert with siliceous siltstone, possible bedding (dip-dip direction) 70-300° 10

Figure 9	Photograph – Waypoint 12 – South East Facing Quarry Wall, Blocky/Jointed siltstone with fault (dip-dip direction 70-315°) gouge of silts/clays	11
Figure 10	Photograph – Waypoint 7 – North East Facing – Extremely weathered rock – clay with remnant rock structure of siltstone (possible mottled zone)	12
Figure 11	Photograph – Waypoint 15 – South East Facing – Extremely weather rock – clay with remnant rock structure, possible siltstone/chert	12
Figure 12	Photograph - Waypoint 8 – South Facing Quarry Wall - Weathering profile showing shallow overburden with extremely weathered rock to moderately/fresh weathered rock zones.	13
Figure 13	Photograph - Waypoint 10 – South West Facing Quarry Wall - Weathering profile showing various weathering zones, shallow overburden with extremely weathered rock to moderately/fresh weathered rock zones	14
Figure 14	Photograph – Waypoint 18 – Minor exposed outcrops of Chert – location of drillhole TSCBH01	16
Figure 15	Photograph – Waypoint 18 – Exposed outcrop of chert – foliation (dip-dip direction 20-020°)	16
Figure 16	Photograph – Waypoint 20 – South West Facing – Chert/Quartzite to siliceous siltstone exposed in drainage cutting.	17
Figure 17	Photograph – Waypoint 27 – South West Facing – Greywacke in road cutting. Note blocky material.	17
Figure 18	Photograph – Waypoint 30 – South West Facing – Greywacke in road cutting with Blocky joints with dip-dip directions of 75-020°, 75-125° and 45-280°	18
Figure 19	Photograph – Waypoint 36 – Chert in a road cutting	18
Figure 20	Photograph – Waypoint 35- North Facing – road cutting of extremely weather rock showing overburden of ~1 m Vegetation growing off cut face	19
Figure 21	Photograph – Waypoint 17 – South Facing – Siltstone to siliceous siltstone in road cutting.	19
Figure 22	Photograph – Waypoint 32 – West Facing – Weathering profile of greywacke displacing ~10 cm soil with transported material and moderately weathered rock.	20
Figure 23	Interpretative Geological Map	22
Figure 24	Cross Section Plan View	23

Figure 25	Cross Section North West to South East	24
Figure 26	South West to North East Section North	25
Figure 27	South West to North East Section South	26
Figure 28	Drill Location Plan	28
Figure 29	Possible Future Drillhole Locations	29

Appendices

A Data Register

1. Introduction

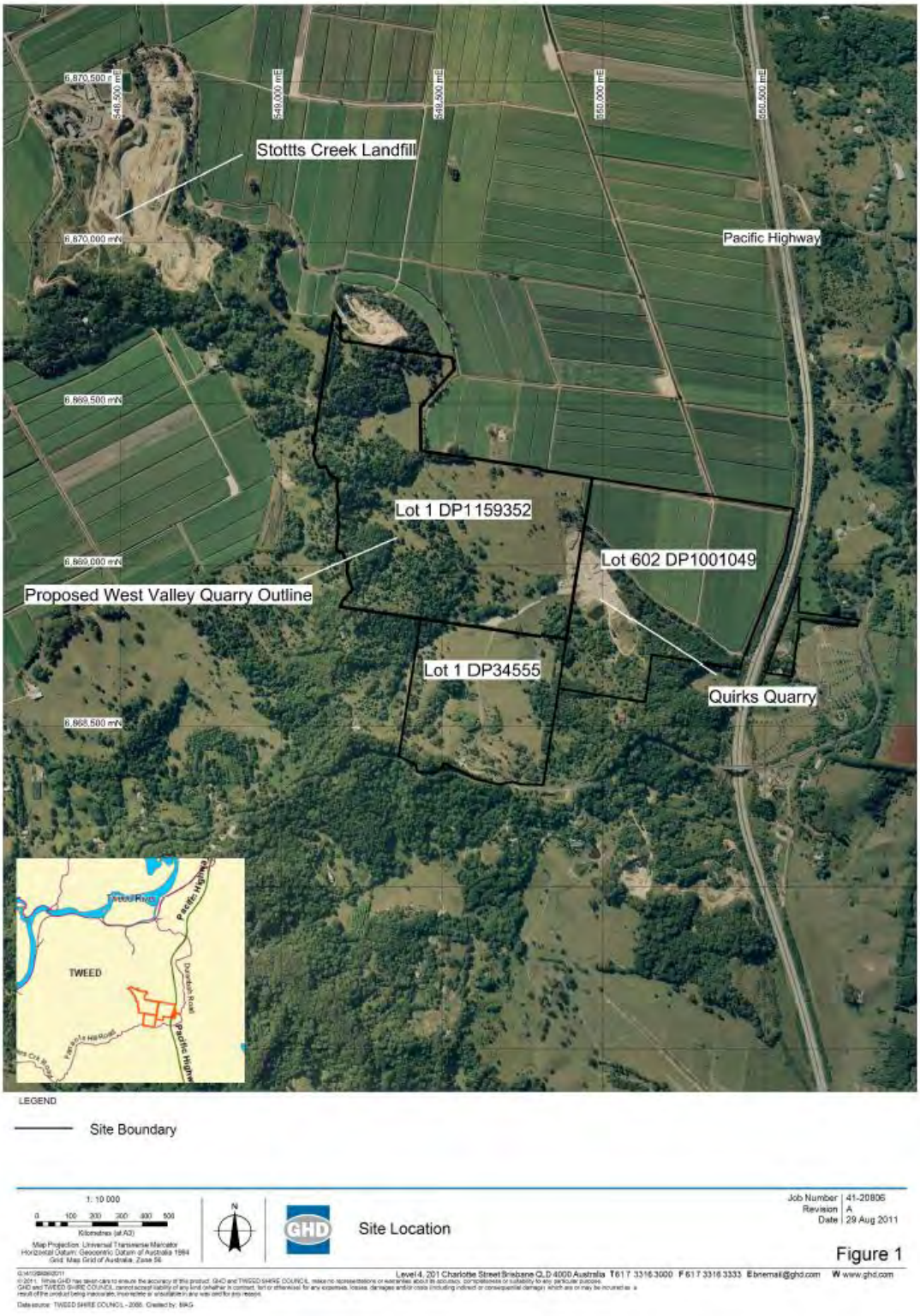
Tweed Shire Council is applying for permission to site a quarry in an area known as West Valley, adjacent to the existing Quirks Quarry and Stotts Creek Landfill sites. The potential quarry is located east of Condong and to the south of the Tweed Valley Highway, approximately 10km east of Murwillumbah (Figure 1).

In 2009, a restricted drilling program was undertaken to obtain geological data for the site. The restricted nature of the drilling program resulted in only a limited number of holes being drilled. This was due to access and permitting difficulties. Additional geological data has been requested by the New South Wales Department of Trade & Infrastructure, Regional Infrastructure & Services in order to progress the project application.

To obtain additional geological data, field mapping of the West Valley area and tenure was undertaken to assess the visible (surface) geology. This would complement the existing geological data. Additionally the mapping assignment aimed to identify possible future drilling locations. Additional sites were identified but will need to be approved by the relevant statutory authorities after suitable notice of surface disturbance has been completed.

The mapping was carried out by two GHD geologists, Dave Winterbotham and Maree Gaughan in August 2011.

Figure 1 Site Location



2. Scope of Mapping

For the purposes of the field mapping, the site was divided into two ‘zones’;

1. Quirks Quarry
2. West Valley Area

Each zone was investigated for presence of geological features (rock type, bedding, foliation, weathering, strength, grain size, alteration and any other properties or geological structures identifiable).

Location data was obtained using a Garmin GPS62. Refer to Figure 2 for GPS sample points information and Appendix A and Table 1for coordinates and field notes of waypoints.

The area covered during mapping was limited by the terrain which at times was too steep or densely vegetated to allow access by either vehicle or foot. Refer to Figure 3 for areas accessible, traversed and mapped.

Table 1 Mapping Waypoint Coordinates

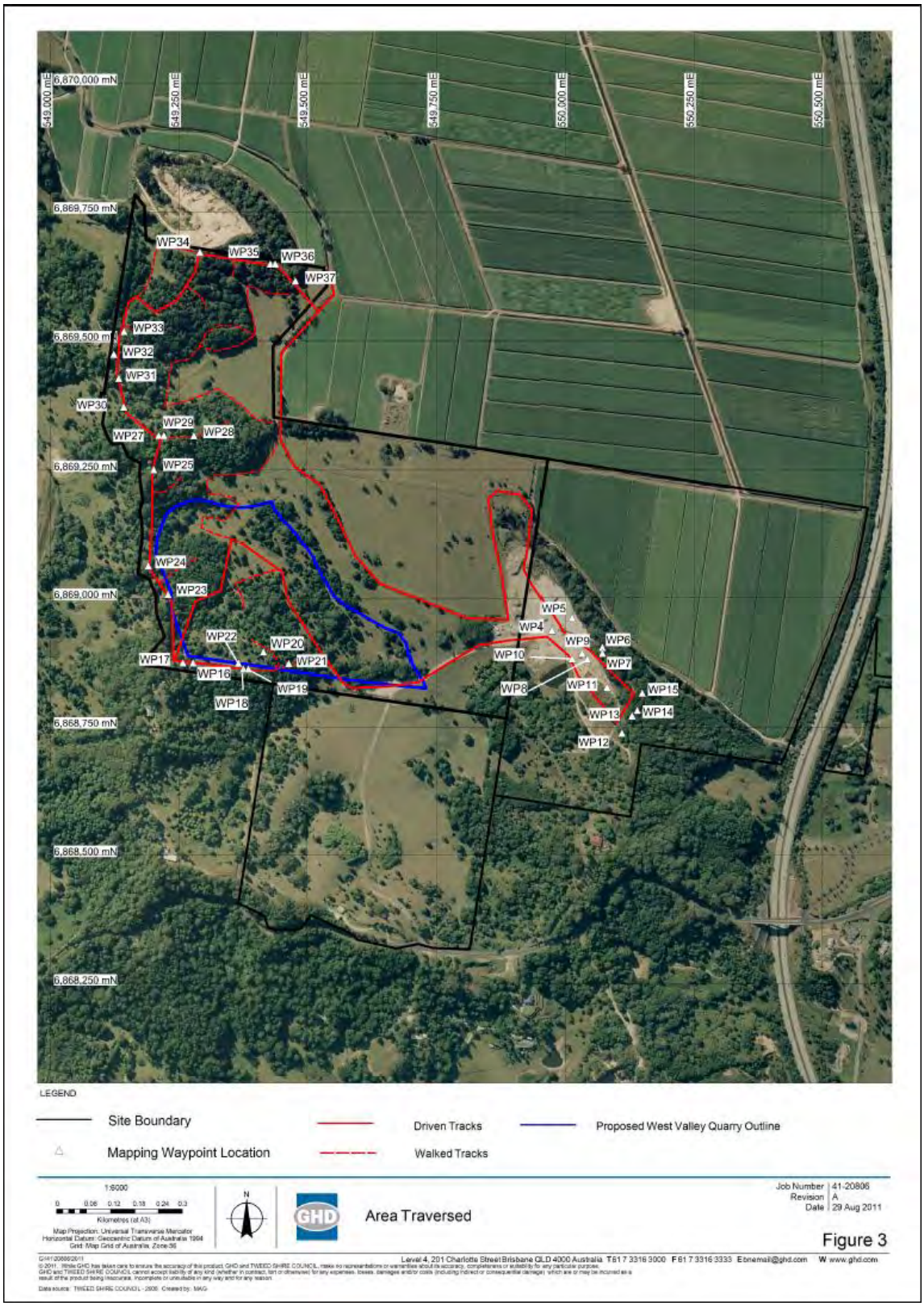
Waypoint ID	Latitude	Longitude	Elevation	MGA Zone 56 (GDA 94)	
				Easting	Northing
4	-28.3047	153.5097	3.3895	549973.7	6868938.3
5	-28.3045	153.5101	6.164616	550013	6868960.3
6	-28.305	153.5107	8.120972	550071.6	6868904.7
7	-28.3051	153.5107	8.250244	550071.5	6868893.6
8	-28.3052	153.5104	7.325806	550042.1	6868882.6
9	-28.3051	153.5103	5.737404	550032.3	6868893.7
10	-28.3052	153.5101	2.672344	550012.7	6868882.7
11	-28.3057	153.5108	10.79648	550081.1	6868827.1
12	-28.3065	153.5111	11.00139	550110.1	6868738.3
13	-28.3062	153.5113	5.691277	550129.9	6868771.5
14	-28.3061	153.5114	5.565376	550139.7	6868782.5
15	-28.3058	153.5115	8.210361	550149.6	6868815.7
16	-28.3053	153.5026	56.27272	549277.3	6868874.7
17	-28.3053	153.5024	57.36137	549257.7	6868874.8
18	-28.3054	153.5036	63.69023	549375.3	6868863.3

Waypoint ID	Latitude	Longitude	Elevation	MGA Zone 56 (GDA 94)	
				Easting	Northing
19	-28.3054	153.5037	61.90484	549385.1	6868863.2
20	-28.3051	153.504	49.614	549414.6	6868896.3
21	-28.3053	153.5045	41.61081	549463.6	6868847
22	-28.3053	153.5035	58.10786	549365.5	6868874.4
23	-28.3041	153.5021	60.23146	549228.8	6868007.9
24	-28.3036	153.5017	42.46847	549189.8	6869063.4
25	-28.3019	153.5018	27.94193	549200.4	6869251.7
27	-28.3013	153.5019	44.15691	549210.5	6869318.2
28	-28.3013	153.5026	25.22784	549279.1	6869317.9
29	-28.3013	153.502	37.94413	549220.3	6869318.1
30	-28.3008	153.5012	47.67372	549142.1	6869373.8
31	-28.3003	153.5011	47.59722	549132.5	686942.3
32	-28.2999	153.501	48.47367	549122.9	6869473.6
33	-28.2995	153.5012	45.49124	549142.7	6869517.9
34	-28.2981	153.5027	25.99124	549290.4	6869672.3
35	-28.2983	153.5041	14.81654	549427.6	6869649.6
36	-28.2983	153.5042	14.27511	549437.4	6869649.6
37	-28.2986	153.5046	8.042927	549476.5	6869616.2

Figure 2 Location and Mapping ID Sample Points



Figure 3 Area Traversed



3. Geological Data

3.1 Regional Geology

In the region of the West Valley Quarry, the Murwillumbah 1:100 000 scale geological map (GSQ, 1978) shows the site as being underlain by the Neranleigh-Fernvale Beds. This unit is Devonian-Carboniferous in age and is comprised of mudstone, siltstone, shale, greywacke, chert, jasper, basic metavolcanics, pillow lava and conglomerate. Willmott (2008) indicated that these beds were metamorphosed near the end of the Carboniferous Period. Therefore the beds of the Neranleigh-Fernvale Beds are meta-sedimentary. All reference to these beds henceforth will assume these beds have been metamorphosed.

Low lying areas of the site are underlain by Tertiary to Recent alluvium.

3.2 Quirks Quarry

Quirks Quarry began operations in the 1950's and was purchased by Tweed Shire Council in 1996. Quarry operations continue at Quirks Quarry today and an in-situ resource of approximately 69,000 cubic metres remains.

A brief exploration of the rock exposed in cut faces of Quirks Quarry was undertaken in order to identify any consistency between the rock and that identified in the West Valley area.

Rock was identified as chert to quartzite, greywacke and siltstones (Figure 4, Figure 5, Figure 6, and Figure 8). These rocks are consistent with units within the Neranleigh-Fernvale Beds.

In general, the sedimentary rocks display jointing (Figure 8), occasional faulting (Figure 9) and have in the case of siltstone undergone deformation resulting in strong foliation. The sediments also display a variable weathering profile from extremely weathered to fresh rock throughout the Quirks Quarry area (Figure 10, Figure 11, Figure 12 & Figure 13).

Figure 4 **Photograph – Waypoint 5 – East Facing – Exposed quarry face displaying siltstone top unit and Chert bottom with thin soil overburden.**



Figure 5 **Photograph – Waypoint 11 – South East Facing – Exposed quarry wall face of predominately chert with siliceous siltstone showing zones of oxidation on the side of the hill**



Figure 6 **Photograph – Waypoint 6 – North Facing Quarry Face – Siltstone with quartz and clayey bands**

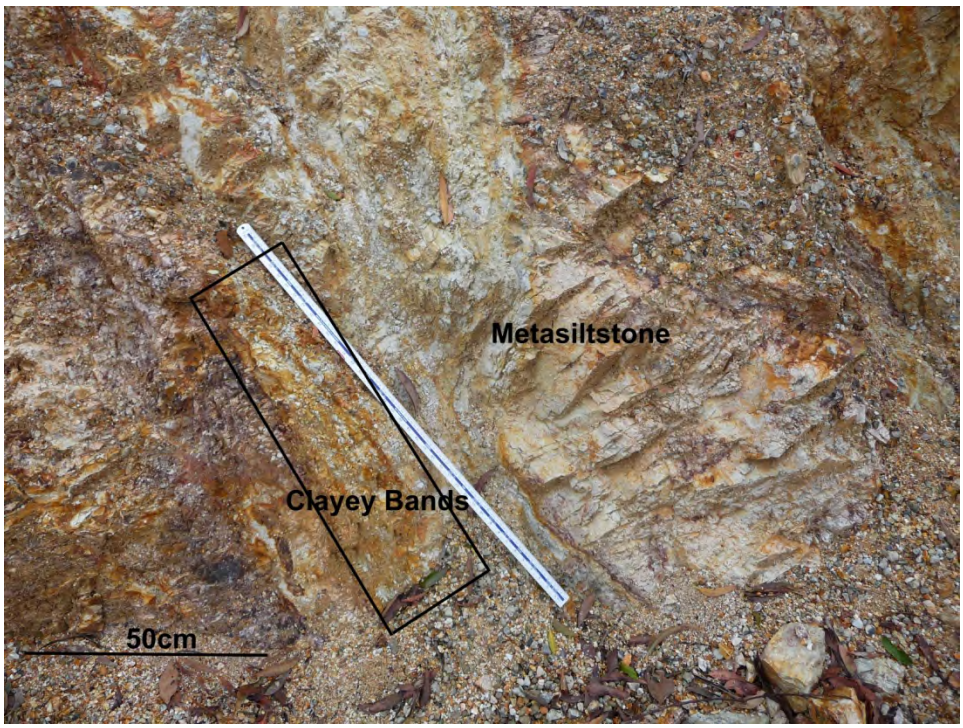


Figure 7 **Photograph – Waypoint 9 – On Quarry Floor – Chert interbedded with Siltstone**

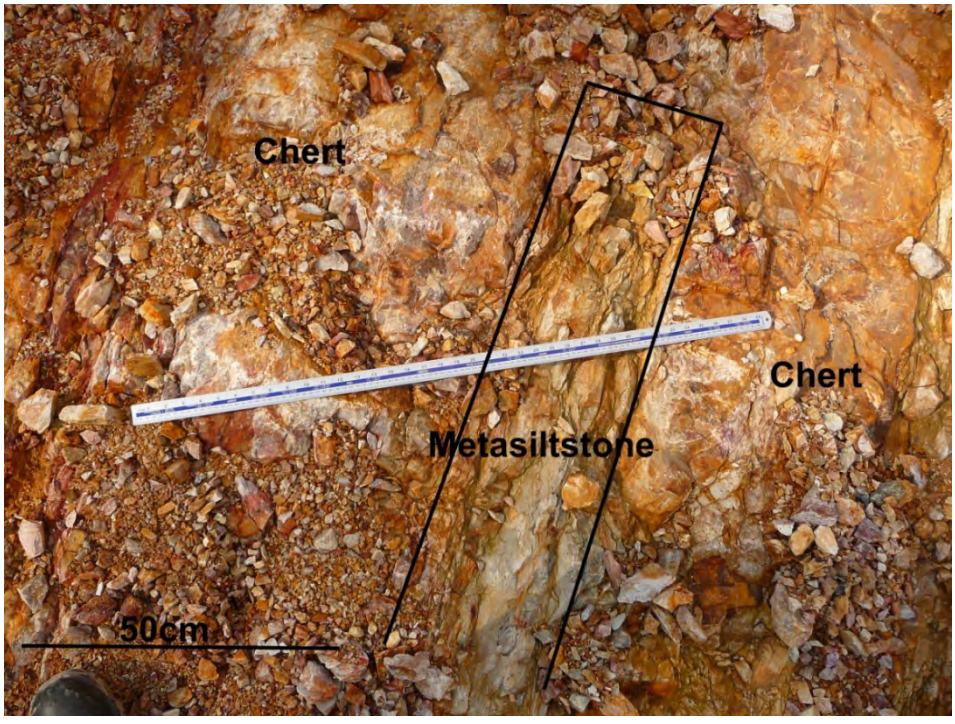


Figure 8 Photograph – Waypoint 13 – South East Facing Quarry Wall – Chert with siliceous siltstone, possible bedding (dip-dip direction) 70-300°



Figure 9 **Photograph – Waypoint 12 – South East Facing Quarry Wall, Blocky/Jointed siltstone with fault (dip-dip direction 70-315°) gouge of silts/clays**



Figure 10 Photograph – Waypoint 7 – North East Facing – Extremely weathered rock – clay with remnant rock structure of siltstone (possible mottled zone)

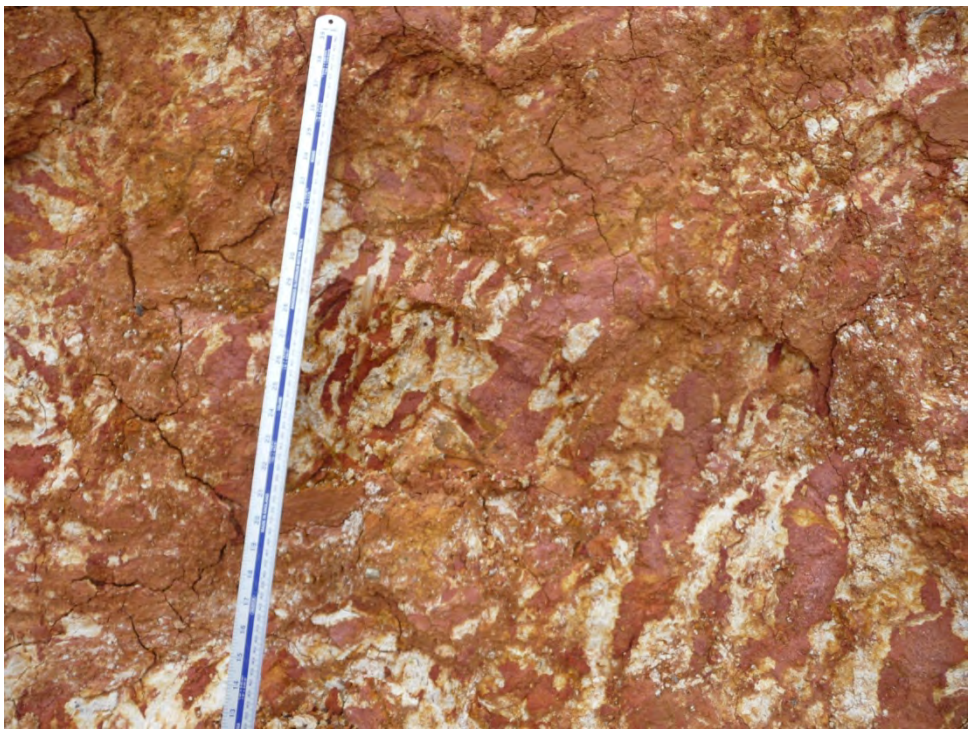


Figure 11 Photograph – Waypoint 15 – South East Facing – Extremely weather rock – clay with remnant rock structure, possible siltstone/chert

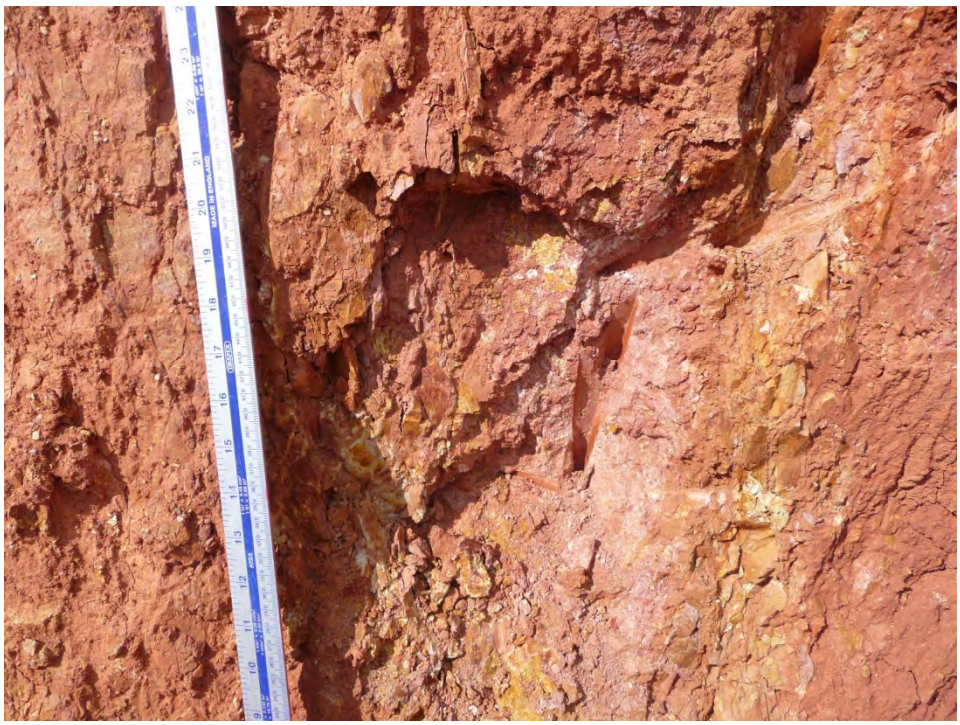


Figure 12 **Photograph - Waypoint 8 – South Facing Quarry Wall - Weathering profile showing shallow overburden with extremely weathered rock to moderately/fresh weathered rock zones.**

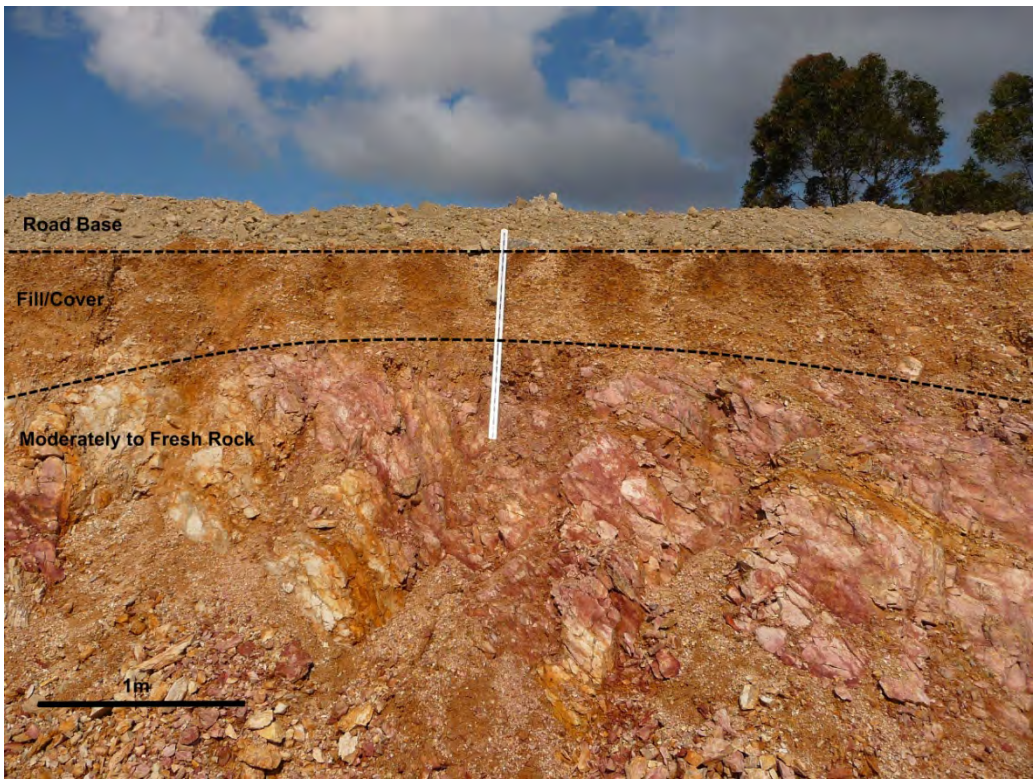
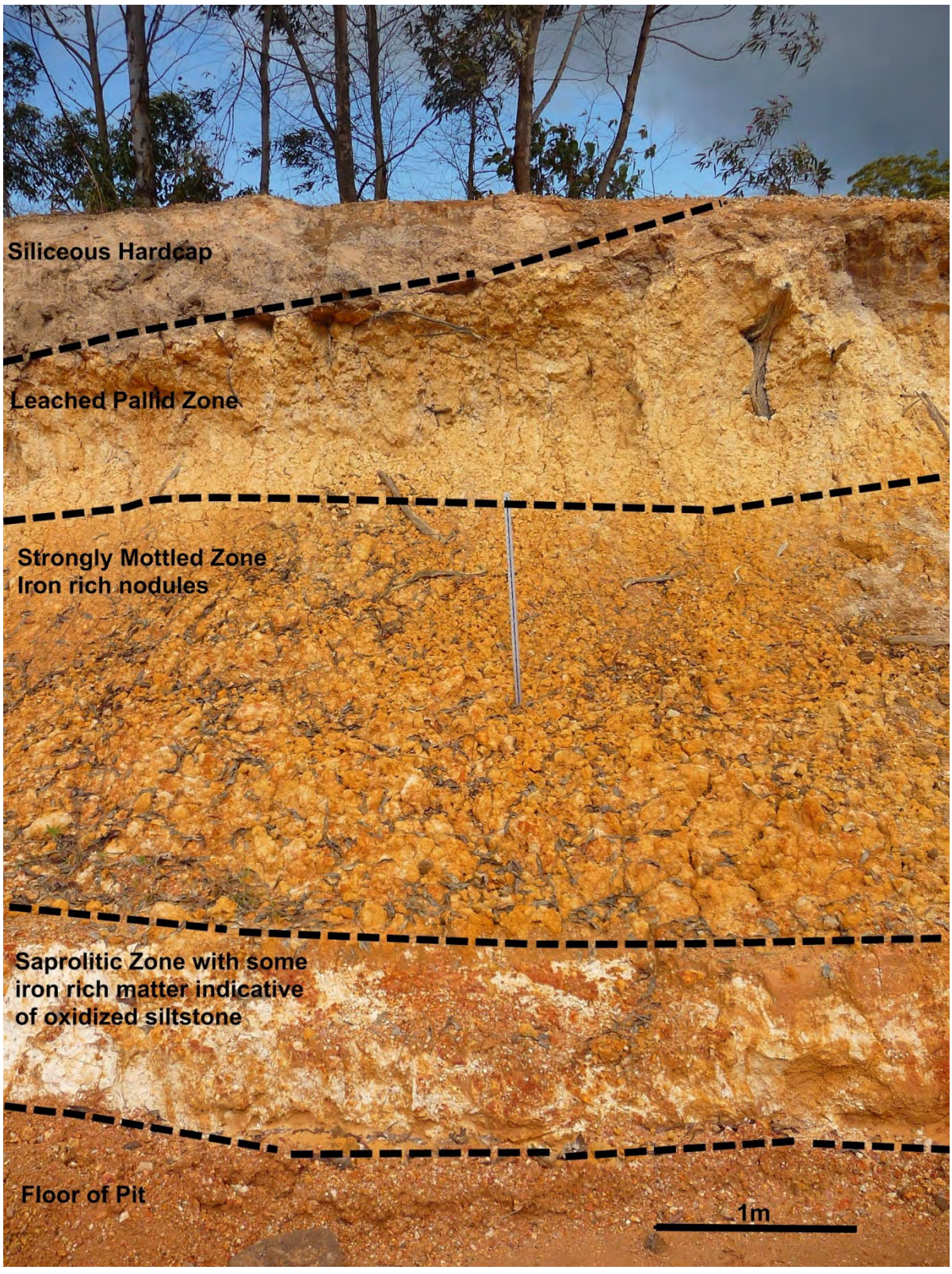


Figure 13 **Photograph - Waypoint 10 – South West Facing Quarry Wall - Weathering profile showing various weathering zones, shallow overburden with extremely weathered rock to moderately/fresh weathered rock zones**



3.3 West Valley Area

The proposed West Valley Quarry is located to the west of Quirks Quarry (Figure 1). Quirks Quarry and the majority of Lot 1//1159352 are located on ridges separated by floodplains. The West Valley area ranges in elevation from 0 to 60 m RL with terrain alternating from gentle undulating slopes to steep hills. The area is partially covered with thin to dense vegetation consisting of trees, shrubs and grasses.

In the accessible areas, the only identifiable outcrops were found in road side and drainage cuttings and on a few occasions as minor exposed outcrop on road or cleared ground (Figure 14).

Rocks in the West Valley are identified as chert to quartzite, greywacke and siltstone.

The chert in the area display variable weathering and often have interbedded highly silicified siltstone (Figure 16, Figure 18, Figure 14& Figure 15). Foliation was identified within the siltstone however due to the lack of outcropping obtaining accurate data proved difficult. Data available indicated that there was some inconsistency in foliation throughout the siltstone.

Greywacke is brown to grey with some iron staining, fine to medium grained with lithic fragments and blocky joints with dip-dip directions of 75-020°, 75-125°, and 45-280°. (Figure 17& Figure 18).

Siltstone is brown to grey, thinly laminated to thinly bedded. Also minor interbedding of chert and quartz veining are apparent within the siltstone.

Overburden identified in road cuttings varies in thickness from 10 cm to 1.5 m (Figure 20, Figure 21 & Figure 22). This overburden was also noted on the top of the ridge line. The nature of the overburden of the plains and hillside was not able to be determined due to vegetation cover.

The floodplains within the area are assumed to contain Tertiary to Recent alluvium (as noted in previous reports) as no additional information was obtained in these areas due to lack of outcrop.

Lithologies observed are consistent with units within the Neranleigh-Fernvale Beds.

Figure 14 Photograph – Waypoint 18 – Minor exposed outcrops of Chert – location of drillhole TSCBH01



Figure 15 Photograph – Waypoint 18 – Exposed outcrop of chert – foliation (dip-dip direction 20-020°)

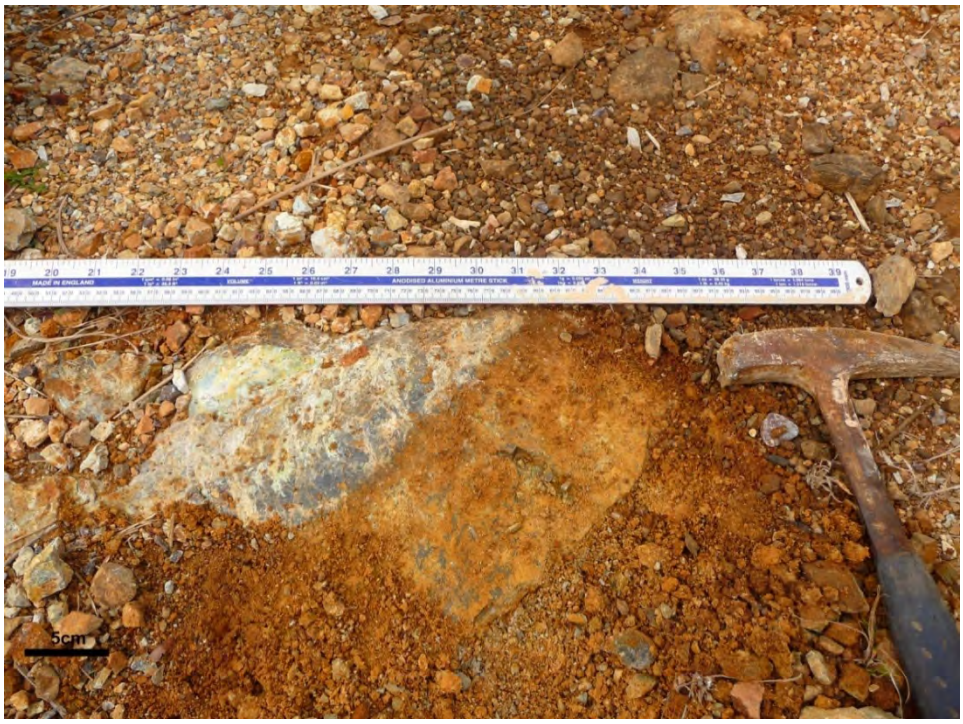


Figure 16 Photograph – Waypoint 20 – South West Facing – Chert/Quartzite to siliceous siltstone exposed in drainage cutting.



Figure 17 Photograph – Waypoint 27 – South West Facing – Greywacke in road cutting. Note blocky material.



Figure 18 Photograph – Waypoint 30 – South West Facing – Greywacke in road cutting with Blocky joints with dip-dip directions of 75-020°, 75-125° and 45-280°



Figure 19 Photograph – Waypoint 36 – Chert in a road cutting

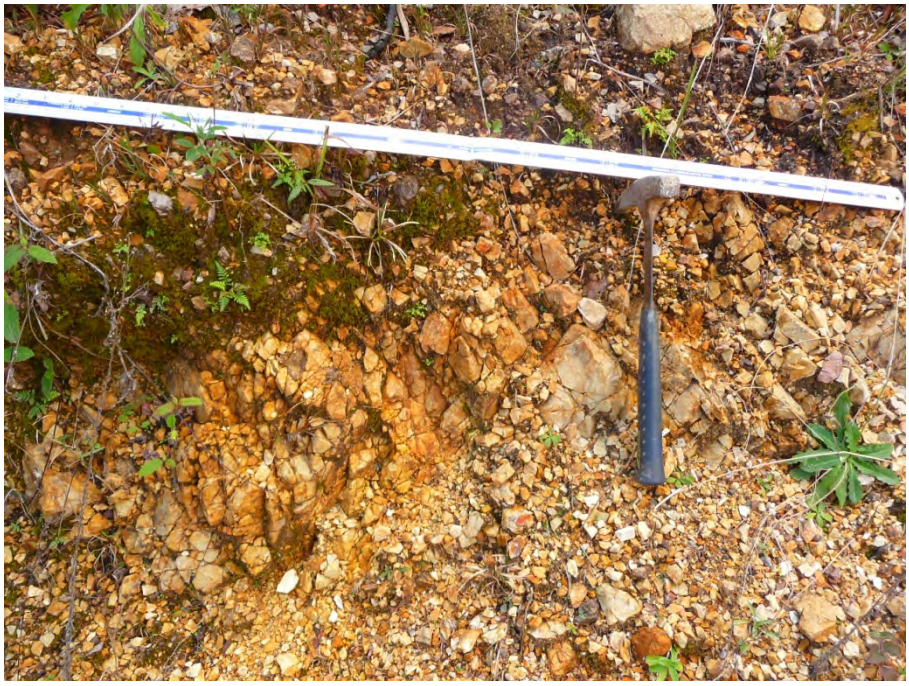


Figure 20 Photograph – Waypoint 35- North Facing – road cutting of extremely weather rock showing overburden of ~1 m Vegetation growing off cut face

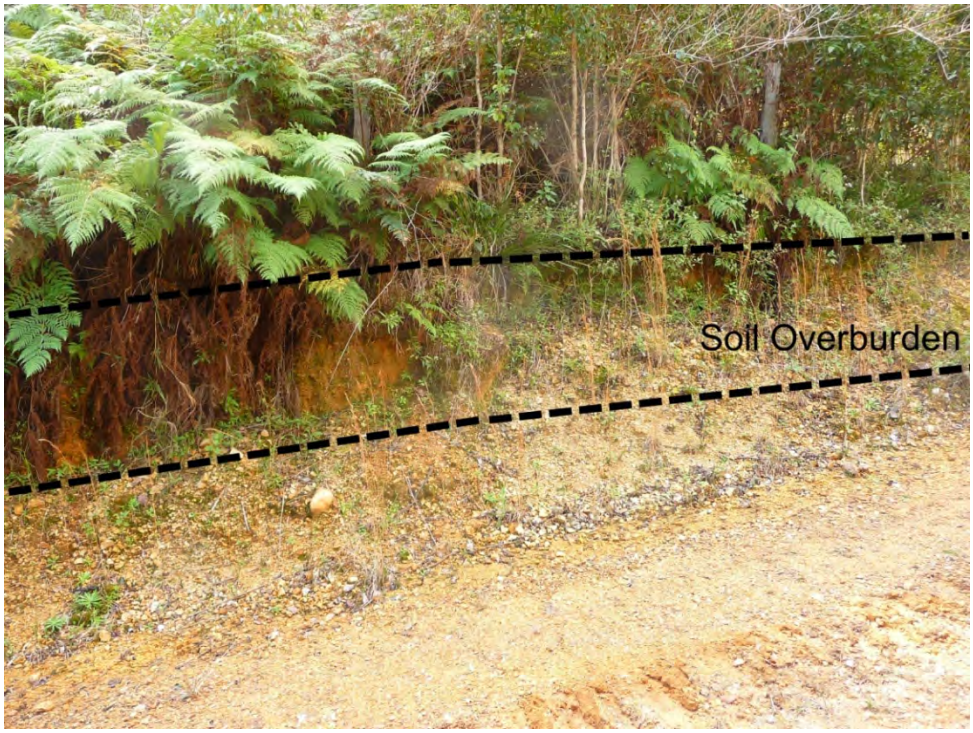


Figure 21 Photograph – Waypoint 17 – South Facing – Siltstone to siliceous siltstone in road cutting.

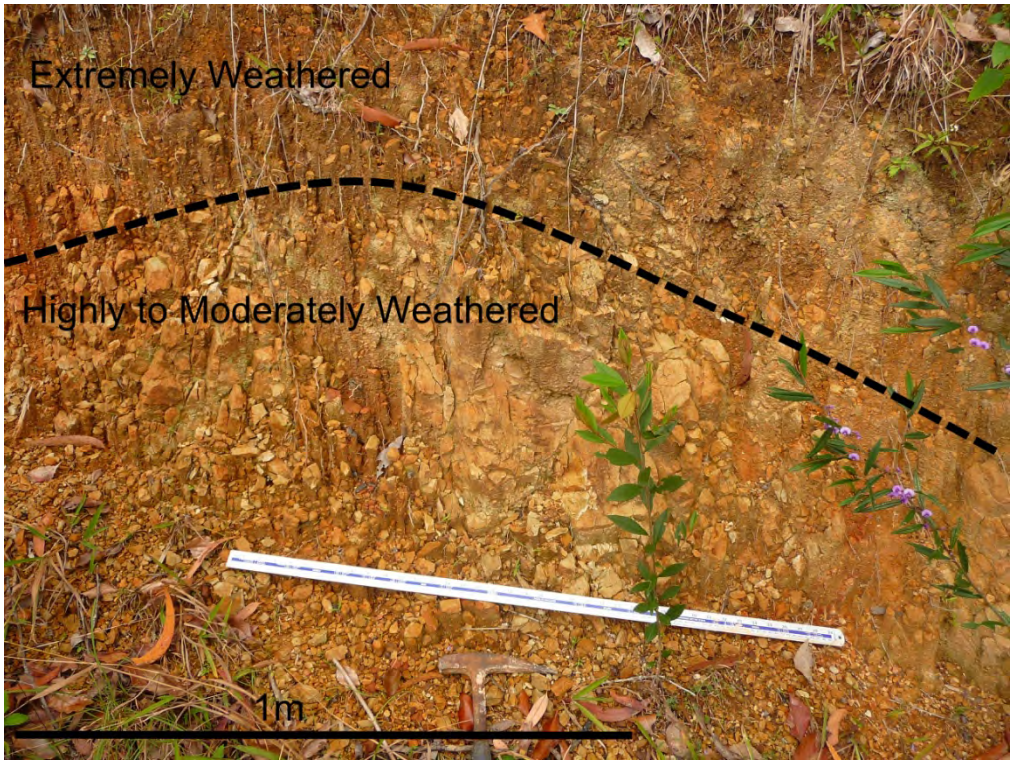
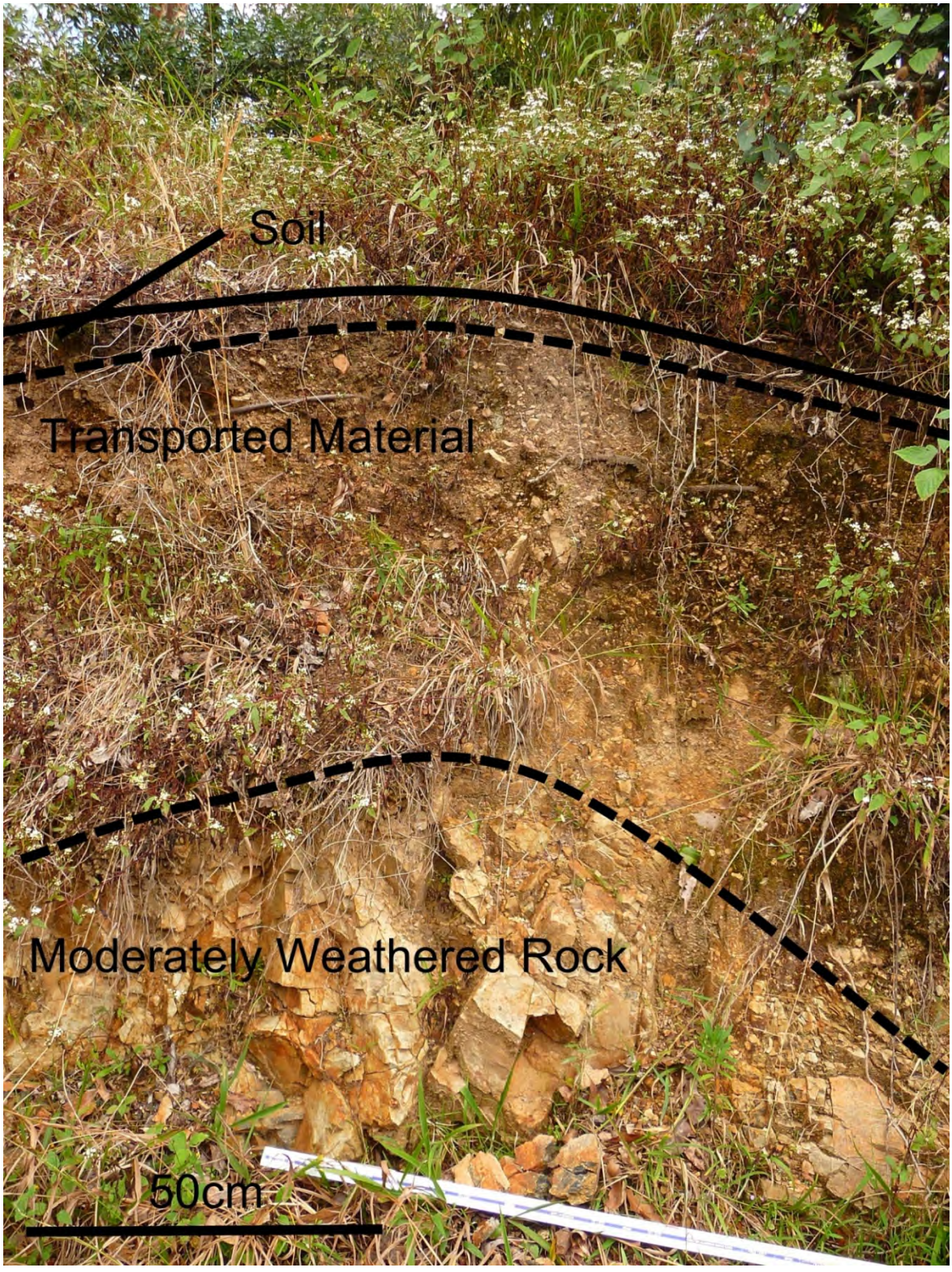


Figure 22 **Photograph – Waypoint 32 – West Facing – Weathering profile of greywacke displacing ~10 cm soil with transported material and moderately weathered rock.**



3.4 Geological Interpretation

A geological map was interpreted from the 2011 field exploration and the previous drilling of the site (Refer to Interpretative Geological Map, Figure 23, Cross Sections, Figure 25, Figure 26 and Figure 27 and Cross Sections Plan View, Figure 23).

The data available does contribute to an improved geological understanding of the area but a paucity of outcrop limits a detailed interpretation. Geological understanding of the area was enhanced however with field mapping of Quirks Quarry although it should be noted that this quarry is situated about 200 m further east. It can be confirmed that the lithologies observed are units of the Neranleigh-Fernvale Beds and that beds/foliation of the beds strike north to northwest and dip moderately to steeply west.

Observations suggest that the area has local faulting and alteration. Faulting and alteration has been mapped but appear inconsistent. Lack of outcropping has made it difficult to identify any consistent trends in bedding and dip direction. Despite this, data observed and presented in previous drilling programs indicates the units are generally dipping moderately to steeply to the west/north west. Limited outcrop of the Neranleigh-Fernvale Beds in the much of the area presented difficulties in interpreting the dipping trend of these areas.

Figure 23 Interpretative Geological Map



Figure 24 Cross Section Plan View

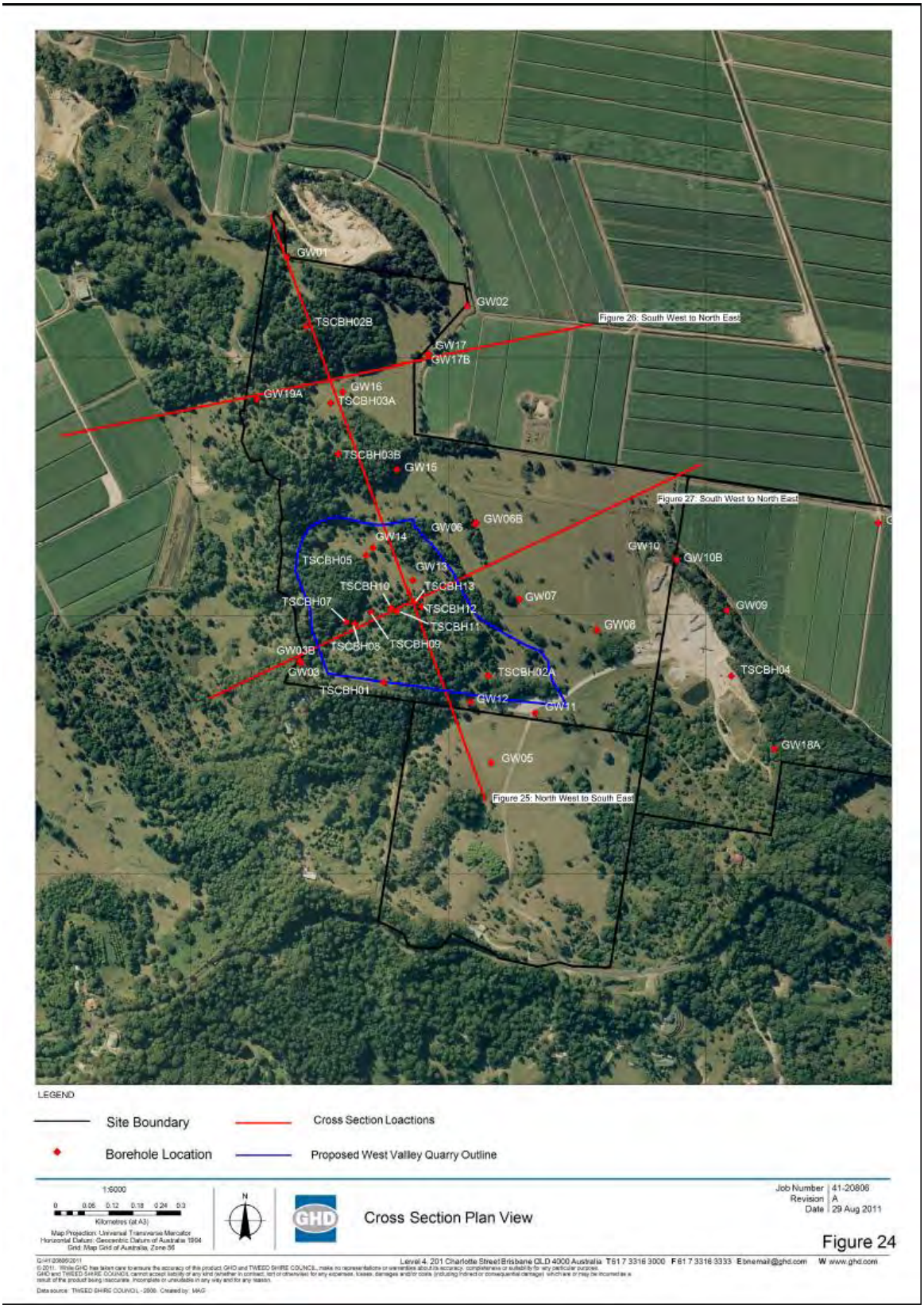


Figure 25 Cross Section North West to South East

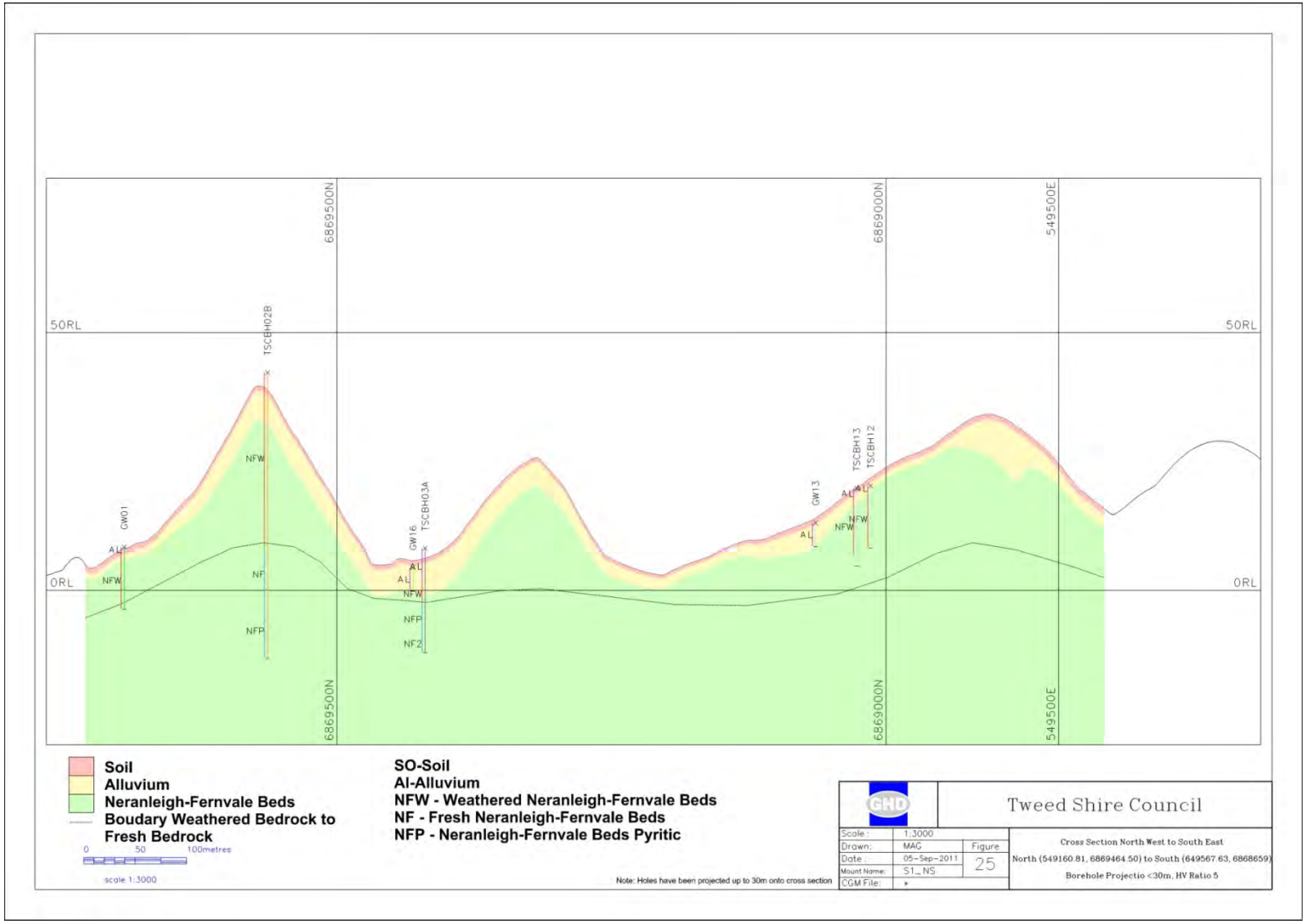


Figure 26 South West to North East Section North

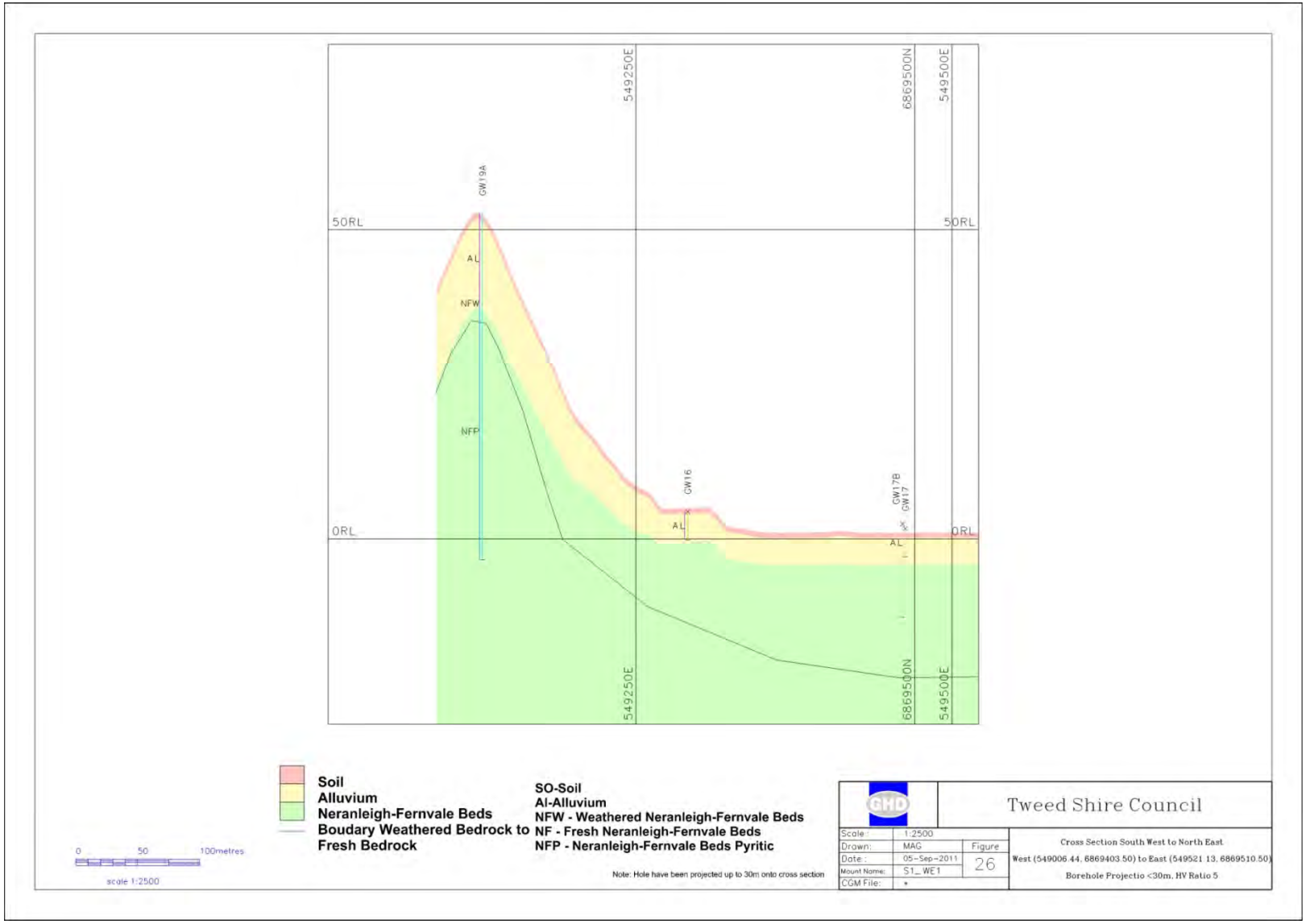
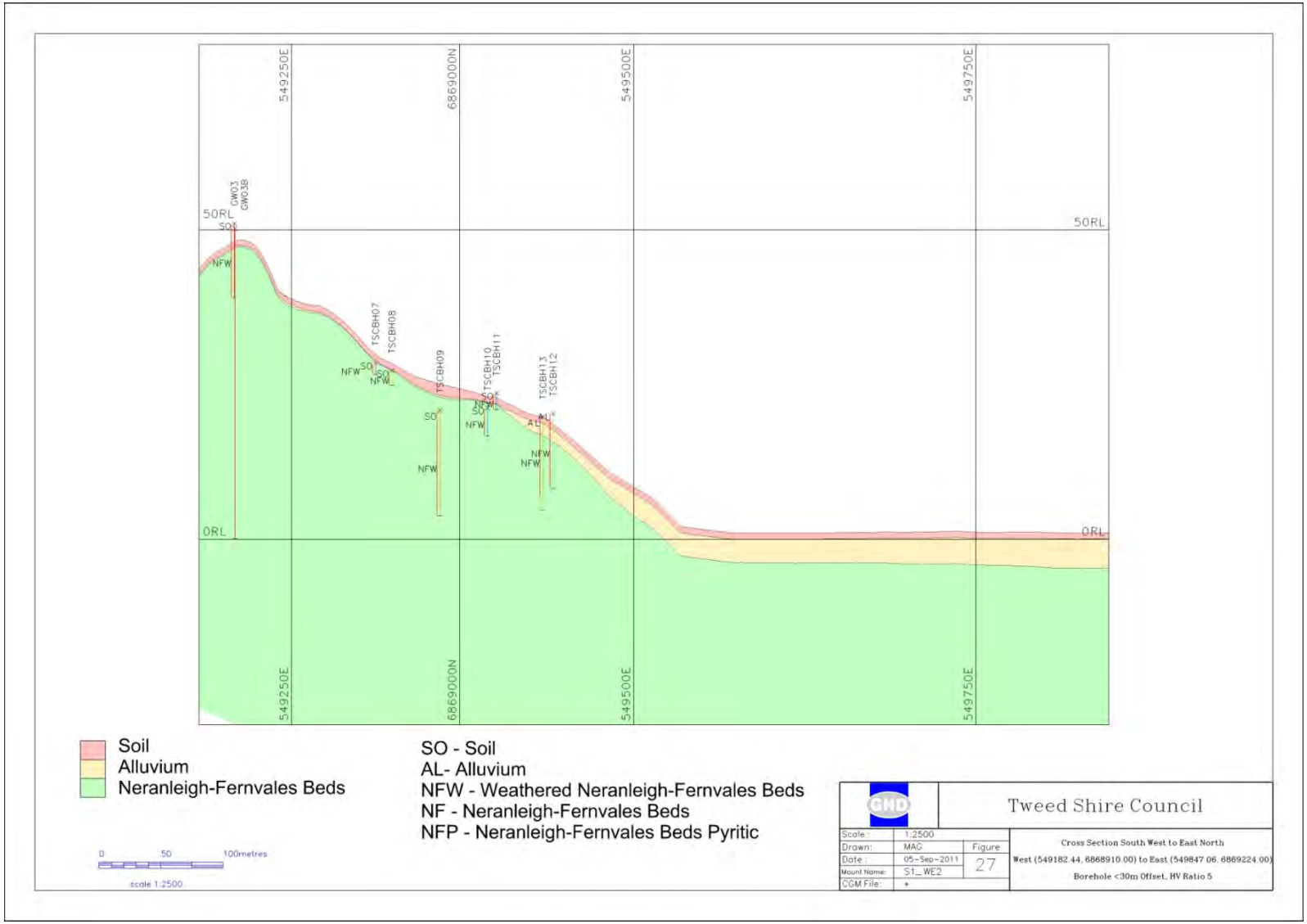


Figure 27 South West to North East Section South



3.5 Further Drilling

Supplementary drilling is required to obtain additional geological data in order to improve the current geological model and the proposed drillholes are presented in Table 2 below. Several drill holes are proposed in a large portion of the area covered with vegetation which would require clearing for drilling. Additionally, other drill sites are situated in the largely cleared areas within the eastern part of the West Valley area probably covered by Tertiary to Recent alluvium.

A significant number of drill sites will need significant site preparation, and subject to assessment by an experienced driller and the obtaining of relevant statutory approvals could be drilled. Refer to Table 2 and Figure 28 and Figure 29 for possible drillhole locations.

The provisional hole depth of these holes are 100 m and it is recommended that these holes be drilled with diamond core techniques. It is intended to drill these holes 60 degrees toward the east.

Table 2 Possible Drillhole Locations (MGA Zone 56 9GDA94))

Easting	Northing
549212.14	6869639.78
549402.14	6869575.05
549258.07	6869433.07
549274.06	6869320.96
549337.41	6869218.01
549285.21	6869144.94
549700.71	6869161.64
549690.27	6868927.79
549493.89	6868879.72
549132.80	6869514.50*
549192.48	6869067.45*
549223.86	6869008.46*
549243.46	6868877.68*

Figure 28 Drill Location Plan

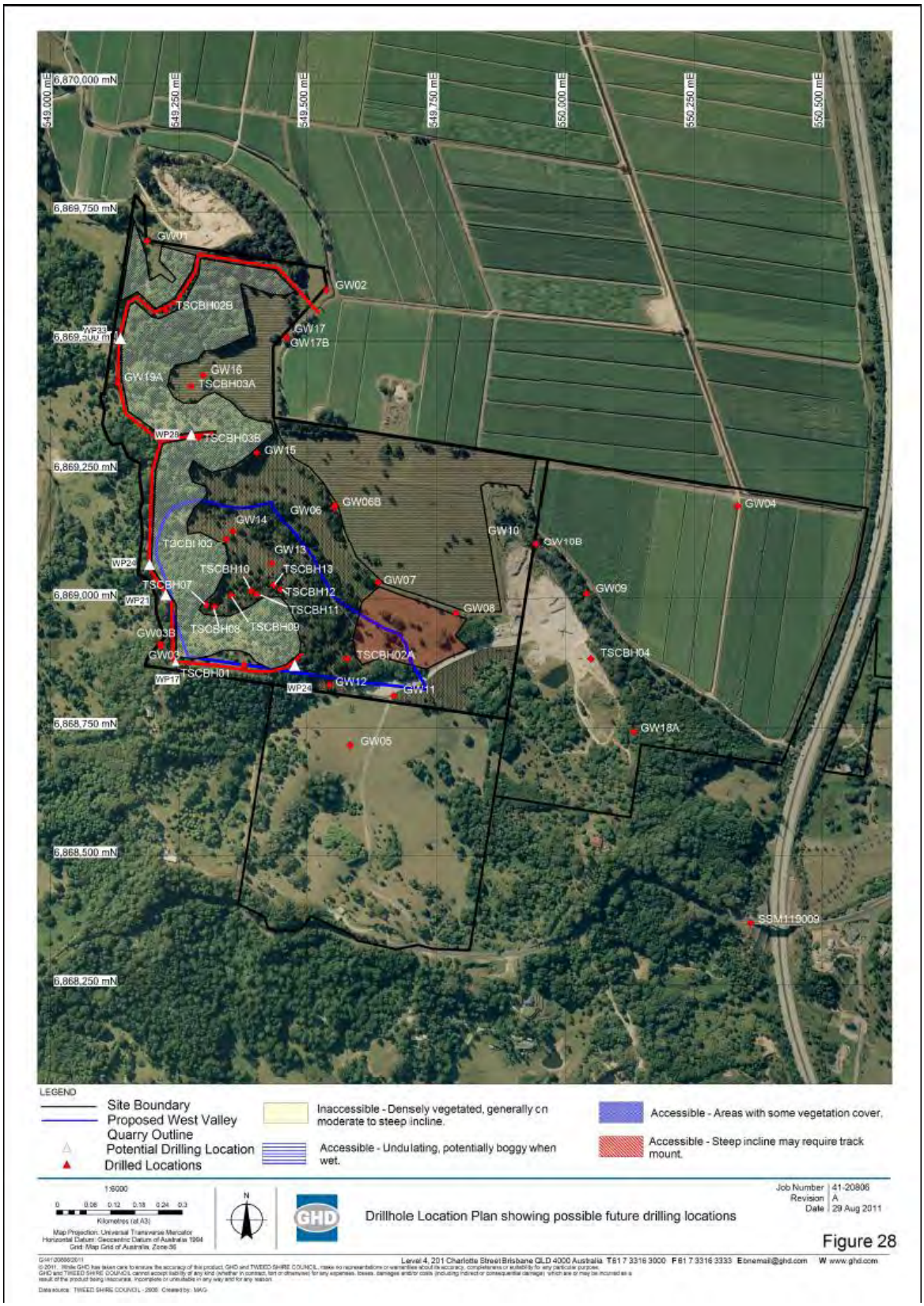
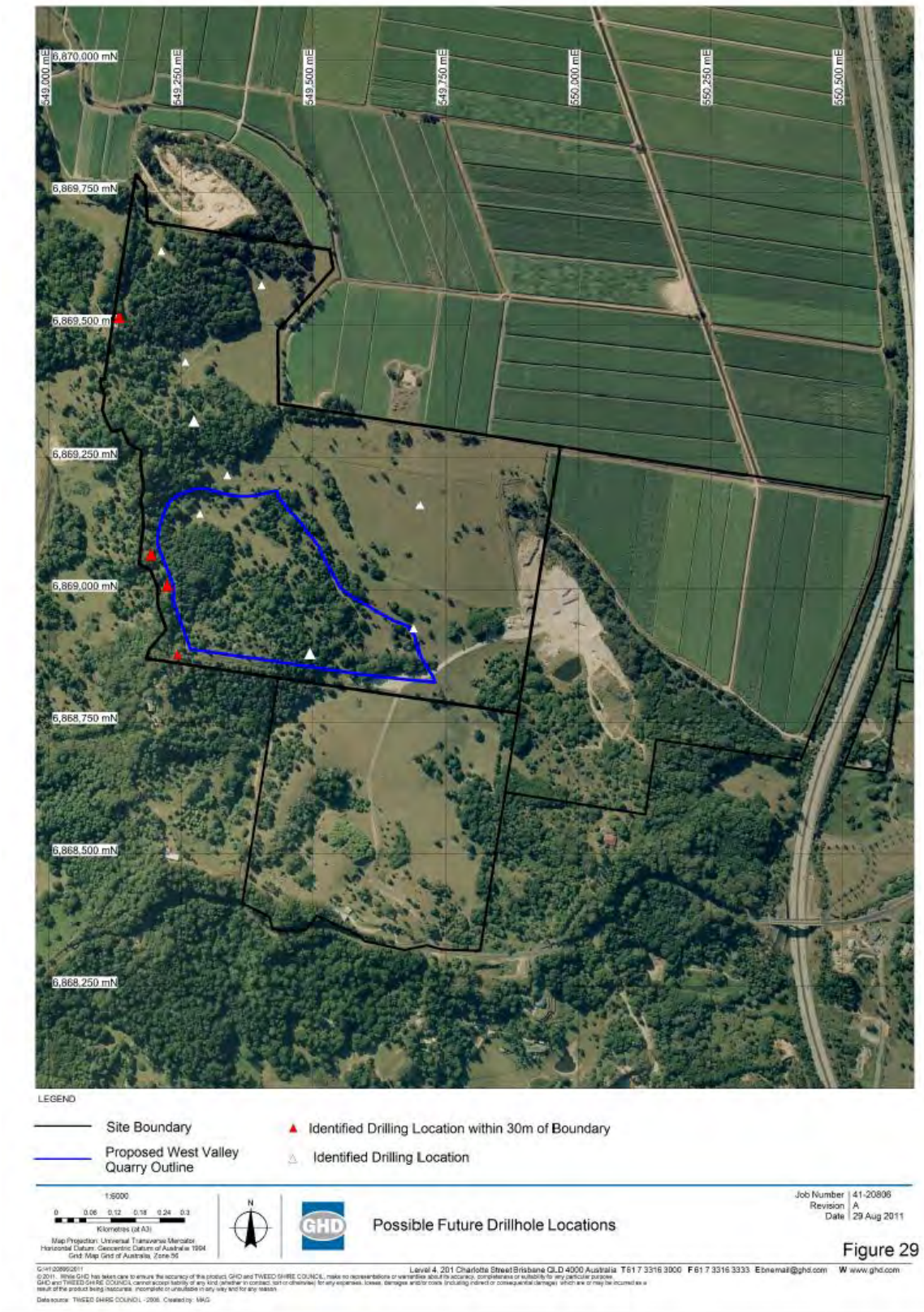


Figure 29 Possible Future Drillhole Locations



4. References

Willmott, W. (2008), Rocks and Landscapes of the Gold Coast Hinterland (Expanded Third Edition), Kingswood Press, Underwood, Queensland.

Geological Survey of QLD (GSQ) (1978), Murwillumbah 1:100 000 Scale Geological Map, Australia.

Appendix A

Data Register

Waypoint number	Photograph number	Location ID	Sampled	Sampled ID	Sample description	Site description	Other description
5	P1080026	WVQ_T1_1	Y	WVQ_T1_1	Sample base of picture siltstone with occasional clayey bands	2 rocks top weathered clayey/siltstone, bottom meta siltsone Si, Fe	View of quarry face facing E from Waypoint 5
5	P1080027	WVQ_T1_1					Closer view of quarry face pointing E from waypoint 5
	P1080028						View of fault in quarry face facing NE from location
	P1080029						Facing north from same point showing change in lithology from E to W in face
6	P1080031	WVQ_T1_2	Y	WVQ_T1_2	Meta-siltstone with occasional clayey bands		Facing N from Waypoint 6
7	P1080032	WVQ_T1_3				clayey rock prob fill	Facing NE from waypoint 7
7	P1080033	WVQ_T1_3					Facing NE from waypoint 7
8	P1080034	WVQ_T1_4				clayey rock as sample T1_2	Facing S from waypoint
9	P1080036	WVQ_T1_5				on ground - interbedded silt/chert with same rock as above, 70-050	Looking down, ruler is approx E-W
10	P1080037	WVQ_T1_6				~3m facing 240 degrees - clayey EW as above overburden ~2m soil	Facing 240 degrees, showing approx 3m overburdern at waypoint 10
11	P1080038	photo location				photolocation	Facing SE from waypoint 11
11	P1080039	photo location					Facing SE from waypoint 11
11	P1080040	photo location					Facing SE from waypoint 11
12	P1080041	WVQ_T1_7	Y	WVQ_T1_7	Greywacke/metasiltstone	possiblr greywacke/metasiltstone fault through middle - gouge clayey/silt 70-315, 3 joints/blocky	Fault gouge facing SE at waypoint 12
12	P1080042	WVQ_T1_7					Fault gouge facing SE at waypoint 12
13	P1080043	WVQ_T1_8	Y	WVQ_T1_8		as above SW facing possible bedding?? 70-300	Bedding structures facing SE at WP 13
14		WVQ_T1_9				poss fuse in wall	POSSIBLE UNEXPLODED SHOT??
15	P1080044	WVQ_T1_10	Y	WVQ_T1_10	Red clay, possible EW meta-siltstone	Red clay possible EW siltstone unit	Clay, facing SE at WP 15
15	P1080045	WVQ_T1_10					Clay, facing SE at WP 15
16		WVQ_T2_1A				BH location, near gate/house	Potential borehole location for further drilling
17	P1080046	WVQ_T2_1	Y	WVQ_T2_1	Meta-siltstone-siliceous	cut on road side-metasiltsone - Si, Fe, little overburden ~1m al or soil	Facing S cutting in roadside WP17
18	P1080047	WVQ_T2_2	Y	WVQ_T2_2	Chert/Meta-siltstone-siliceous	Possible BH of BH01, hill top, metasiltstone, foliation? 20-020	View of BH01 drill site facing W
18	P1080048	WVQ_T2_2					Outcrops in BH01 site looking down
18	P1080049	WVQ_T2_2					Outcrops in BH01 site looking down
19		WVQ_T2_3				as WVQ_T2_2 foliation maybe? 70-070	Foliation in rock dip 70 direction 070
20	P1080050	WVQ_T2_4	Y	WVQ_T2_4	Chert/Meta-siltstone-siliceous	down hill along drainage cut-hard meta silt Siliceous	Hard red outcrop in track side facing SW
20	P1080051	WVQ_T2_4					Hard red outcrop in track side facing SW
18	P1080052	WVQ_T2_2					Cutting outcrop with bedding BH01
21		WVQ_T2_5				Possible BH	Potential borehole location for further drilling - would need tracked rig and clearing for access
22		WVQ_T2_6				outcrop on hill top, maybe foliation west 60-245, east 30-110 with qtz viens	
23		WVQ_T2_7				BH location	Potential borehole location for further drilling
24		WVQ_T2_8				rock as Wp22	Potential borehole location for further drilling
25		WVQ_T2_9	Y	WVQ_T2_9	Greywacke		
27	P1080053	WVQ_T2_11	Y	WVQ_T2_11	Greywacke	Sanstone?Siltstone?	Hard material in cutting facing SW WP27

27	P1080054	WVQ_T2_11					Hard material in cutting facing SW WP27
28		WVQ_T2_12				BH location on road	Potential borehole location for further drilling
29	P1080055	WVQ_T2_13	Y	WVQ_T2_13	Chert/Greywacke with quartz viens	possible insitu - possible but not likely foliation N-S 175 strike, meta siltstone	Subcrop of hard grey material in floor of track WP29
30	P1080056	WVQ_T2_14	Y	WVQ_T2_14	Greywacke	Road cutting-sandstone?siltstone? Blocky, joints 75-020, 75-125, 45-280	Facing SW view of cutting in track at WP30
31	P1080057	WVQ_T2_15				near current hole-blue stone surround possible from BH	Blue metal cuttings showing a lot of hard fresh rock in waterbore, WP31
31	P1080058	WVQ_T2_15					Blue metal cuttings showing a lot of hard fresh rock in waterbore, WP31
32	P1080059	WVQ_T2_16	Y	WVQ_T2_16	Greywacke	same rock as WVQ_T2_14, ~1.5m overburden	Facing W cutting WP32
32	P1080060	WVQ_T2_16					Facing W cutting WP32
32	P1080061	WVQ_T2_16					Facing W cutting WP32
33		WVQ_T2_17				BH location	Potential borehole location for further drilling
34	P1080062	WVQ_T2_18				Red clay on road appears local	Clay in track WP34
35	P1080063	WVQ_T2_19	Y	WVQ_T2_19	Chert siliceous some quartz present	possible contact clay/siltstone clay west. Qtz east	Clay to left, qz or chert to right, facing N at WP35
36	P1080064	WVQ_T2_20	Y	WVQ_T2_20	Chert siliceous some quartz present	Quatzite/chert, joints dominate 85-090, other 75-140, 55-080	Qz or chert outcrop WP36
37	P1080065	WVQ_T2_21				On road-meta siltstone w/ quartz veins	Quartzy, metasiltstone, subcrop in track WP37
37	P1080066	WVQ_T2_21					Quartzy, metasiltstone, subcrop in track WP37

GHD

201 Charlotte Street Brisbane QLD 4000
GPO Box 668 Brisbane QLD 4001
T: (07) 3316 3000 F: (07) 3316 3333 E: bnemail@ghd.com.au

© GHD 2011

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	M Gaughan	F Carrello	F. Carrell	F Carrello	F. Carrell	22/09/11

Appendix B

Lithology Logs

Notes on Logging

TSCBH01 (Cored)

TSCBH02A (Partly Cored)

TSCBH02B (Partly Cored)

TSCBH03A (Partly Cored)

TSCBH03B (Partly Cored)

TSCBH04 – BH13 (Open Hole)

Notes on Logging

The data and information contained herein is based on observations made during the inspection of material recovered from partially cored boreholes that were drilled in 2009. This information is provided as an update to the original logging and is based entirely on the existing 2009 core, some of which has been lost or disturbed since drilling. The core was in good condition with minor deterioration of some unconsolidated/alluvial materials present in TSCBH02A.

Rock Quality Designation (RQD) and the Total Core Recovery (TCR) were calculated based on the run markers provided in the core trays.

All information provided herein is based only on visual and tactile assessment of the core and requires confirmation by standard and certified laboratory methods.

Borehole Number			BH 03A
Box	1	of	3
Depth	7.80	to	12.94

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 03A
Box	2	of	3
Depth	12.94	to	17.70

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



GHD CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 03A
Box	3	of	3
Depth	17.70	to	20.20 E.O.H.

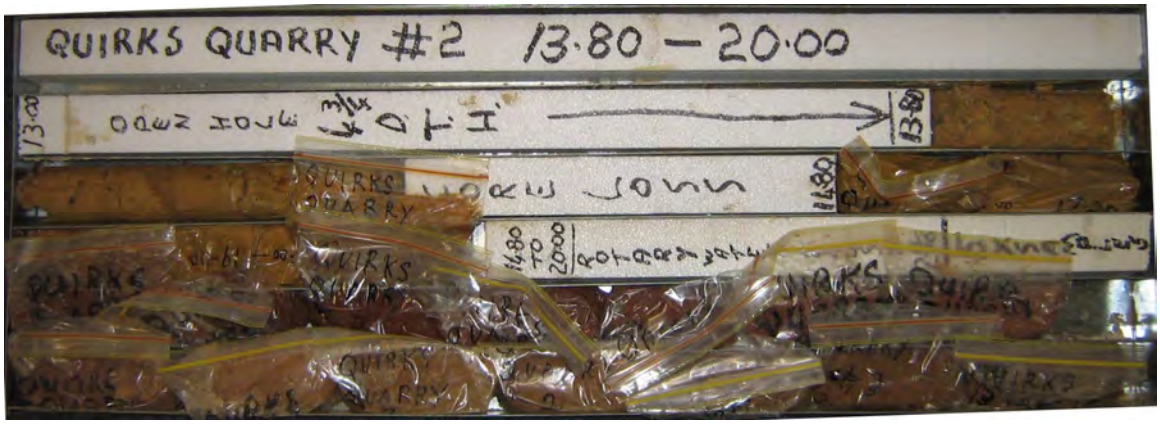
Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



GHD CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 02A
Box	1	of	1
Depth	13.80	to	20.00

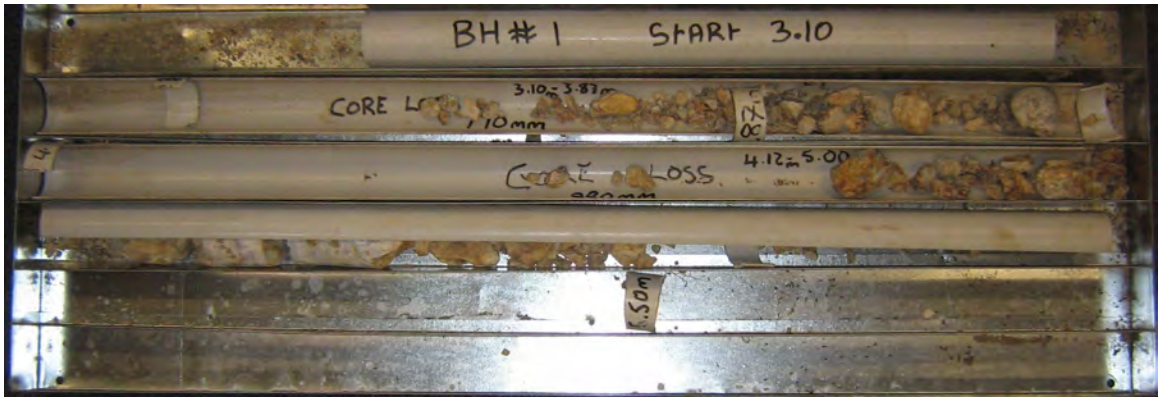
Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



GHD CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 01
Box	1	of	9
Depth	3.10	to	5.50

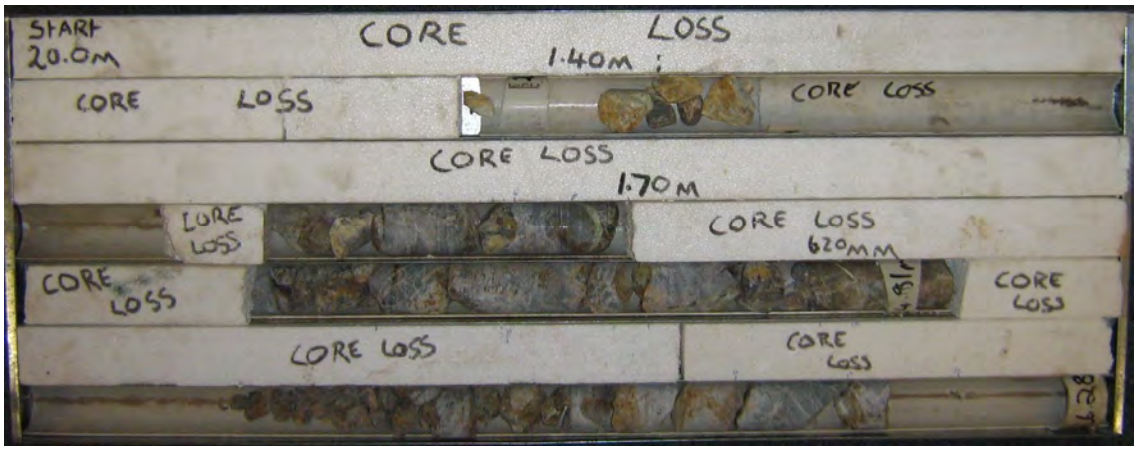
Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



GHD CLIENTS | PEOPLE | PERFORMANCE

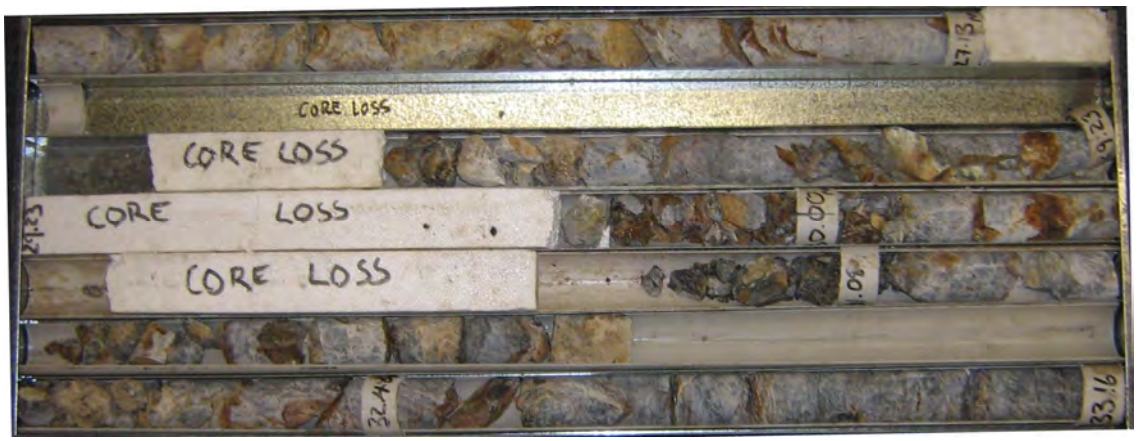
Borehole Number			BH 01
Box	2	of	9
Depth	20.00	to	26.28

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



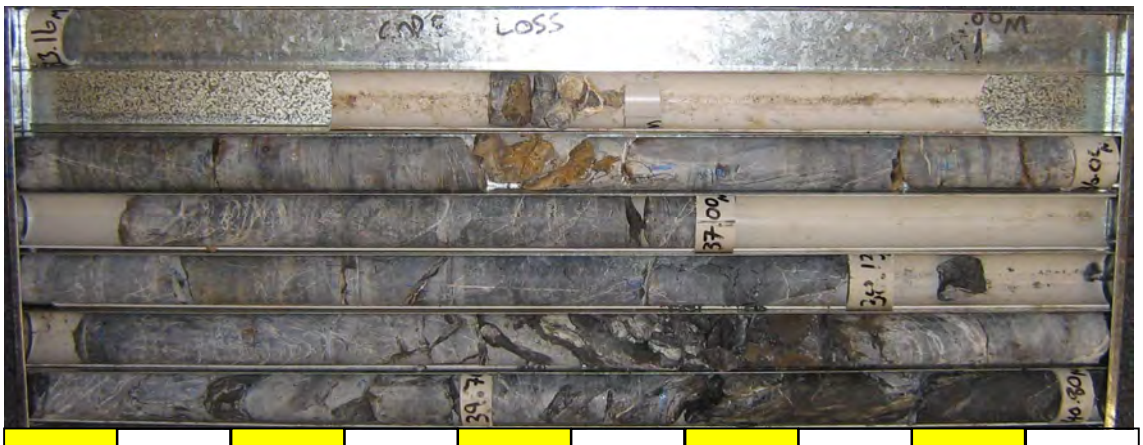
Borehole Number			BH 01
Box	3	of	9
Depth	26.28	to	33.16

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 01
Box	4	of	9
Depth	33.16	to	40.80

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 01
Box	5	of	9
Depth	40.80	to	47.20

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 01
Box	6	of	9
Depth	47.20	to	52.15

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



GHD CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 01
Box	7	of	9
Depth	52.15	to	56.70

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



GHD CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 01
Box	8	of	9
Depth	56.70	to	64.30

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



GHD CLIENTS | PEOPLE | PERFORMANCE

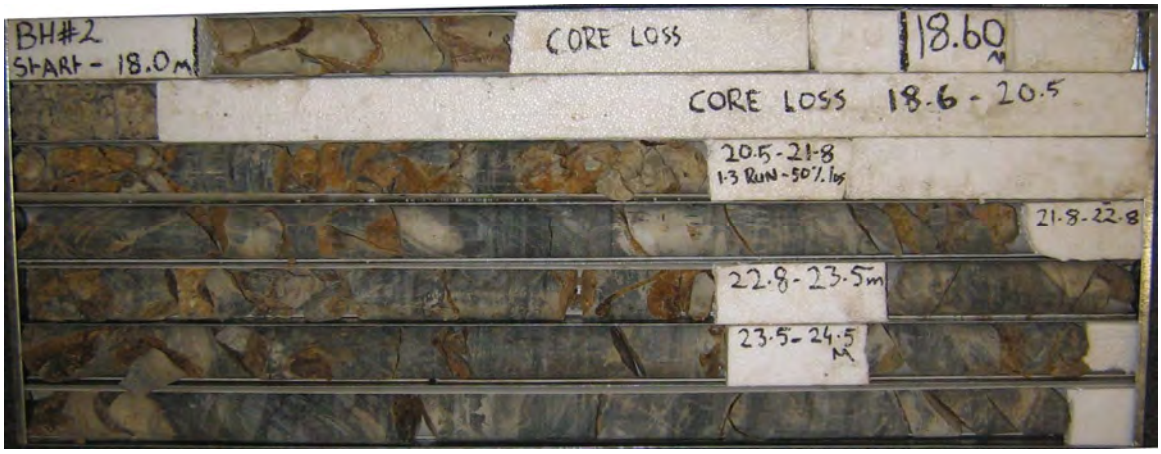
Borehole Number			BH 01
Box	9	of	9
Depth	64.30	to	70.25 E.O.H.

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



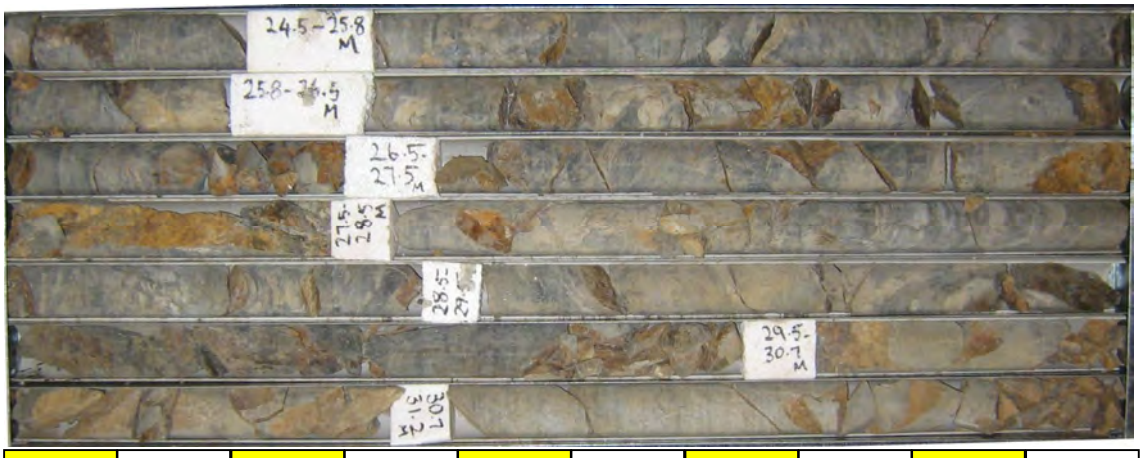
Borehole Number			BH 02B
Box	1	of	6
Depth	18.00	to	24.50

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 02B
Box	2	of	6
Depth	24.50	to	31.20

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 02B
Box	3	of	6
Depth	31.20	to	38.50

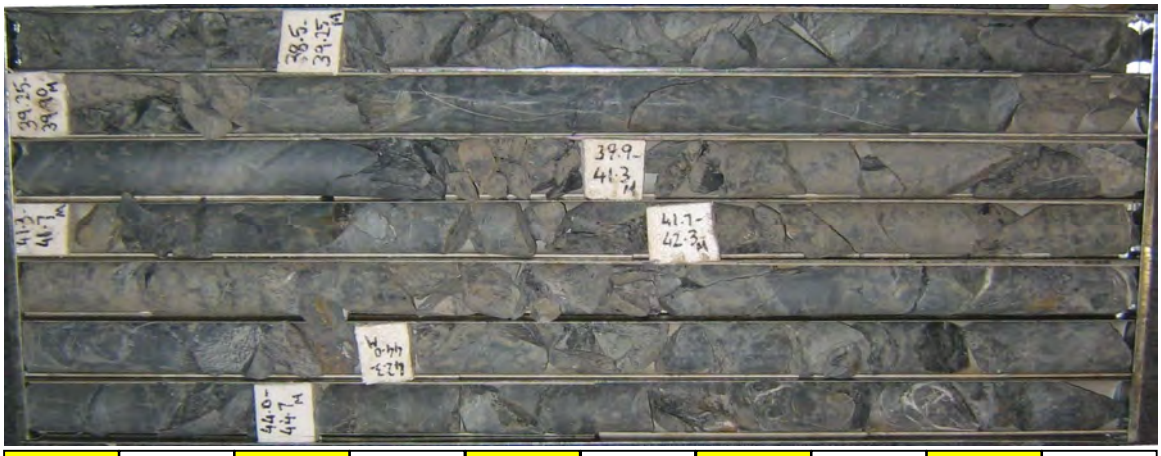
Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



CLIENTS | PEOPLE | PERFORMANCE

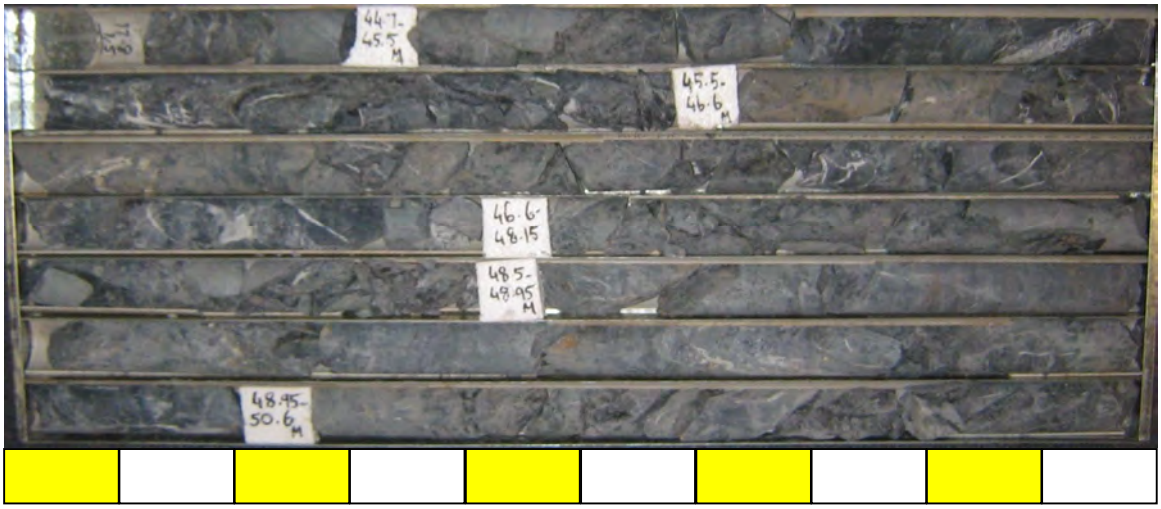
Borehole Number			BH 02B
Box	4	of	6
Depth	38.50	to	44.70

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



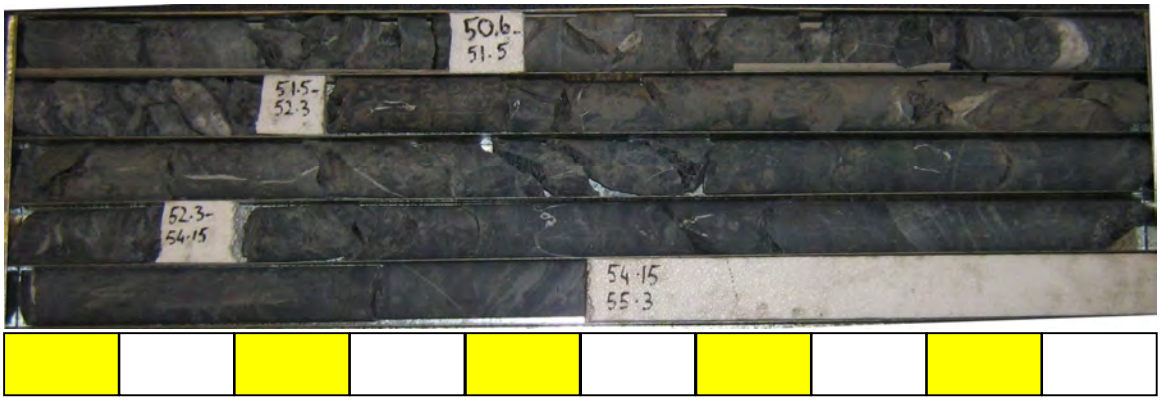
Borehole Number			BH 02B
Box	5	of	6
Depth	44.70	to	50.60

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 02B
Box	6	of	6
Depth	50.60	to	54.15 E.O.H

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 03B
Box	1	of	9
Depth	13.00	to	17.50

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



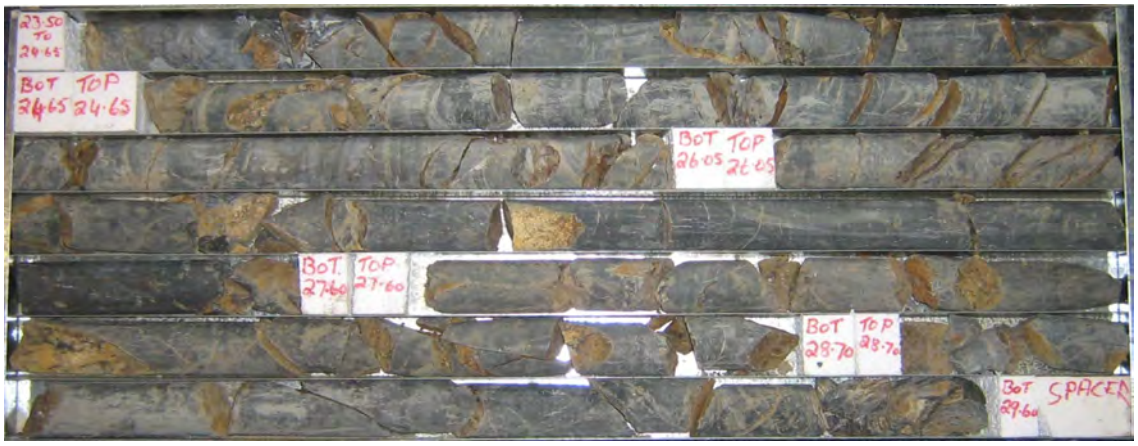
Borehole Number			BH 03B
Box	2	of	9
Depth	17.50	to	23.50

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 03B
Box	3	of	9
Depth	23.50	to	29.60

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 03B
Box	4	of	9
Depth	29.60	to	35.65

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 03B
Box	5	of	9
Depth	35.65	to	40.30

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 03B
Box	6	of	9
Depth	40.30	to	46.30

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 03B
Box	7	of	9
Depth	46.30	to	52.70

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Borehole Number			BH 03B
Box	8	of	9
Depth	52.70	to	57.20

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



CLIENTS | PEOPLE | PERFORMANCE

Borehole Number			BH 03B
Box	9	of	9
Depth	57.20	to	60.30

Project	West Valley Quarry Investigation
Number	41/20806/03
Client	Tweed Shire Council



Appendix C

Borehole Core Photographs

TSC BH01

TSC BH02A

TSC BH02B

TSC BH03A

TSC BH03B

GHD | MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-12**

Sheet 1 of 3

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 448, **N** 6869 018
Ground Surface Elevation: **Total Depth:** 15.0m
Commenced: 01-May-09 **Completed:** 01-May-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Dry				RESIDUAL SOIL Dark reddish brown, organic, silty, clayey, soft.	EW		100						0
1					Moist	1.0			CLAY Browny to yellow, silty, sandy, low to medium plasticity, cohesive, inorganic, soft to firm, alluvial.	HW		100						1
2										HW								2
3				Rotary Chip								100						3
4						4.0			CLAY Browny to yellow (mottled grey), silty, low to medium plasticity, occasionally sandy, cohesive, inorganic, soft to firm, alluvial to completely weathered siltstone.	HW		100						4
5																		5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-12**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 448, **N** 6869 018
Ground Surface Elevation: **Total Depth:** 15.0m
Commenced: 01-May-09 **Completed:** 01-May-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip	Wet				CLAY Browny to yellow (mottled grey), silty, low to medium plasticity, occasionally sandy, cohesive, inorganic, soft to firm, alluvial to completely weathered siltstone.	HW		100					6
										HW								
7				Rotary Chip	Moist							100						7
8				Rotary Chip	Wet	8.0			CLAY Browny to yellow (mottled grey), silty, low to medium plasticity, occasionally sandy, cohesive, inorganic, soft to firm/firm, alluvial to completely weathered siltstone.	HW								8
9												100						9
10																		10

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-12**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 448, **N** 6869 018
Ground Surface Elevation: **Total Depth:** 15.0m
Commenced: 01-May-09 **Completed:** 01-May-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip	Moist				CLAY Browny to yellow (mottled grey), silty, low to medium plasticity, occasionally sandy, cohesive, inorganic, soft to firm/firm, alluvial to completely weathered siltstone.	HW		100					11
12				Rotary Chip	Wet	12.0			CLAY Browny to yellow (mottled grey), silty, medium plasticity, occasional to common sandy, inorganic, cohesive, firm, alluvial to completely weathered siltstone.	HW		100					12
13				Rotary Chip	Moist							100						13
14										HW		100						14
15						15.0			Termination Depth = 15m									15

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-11**

Sheet 1 of 1

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 401, **N** 6869 009
Ground Surface Elevation: **Total Depth:** 2.6m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Dry				Dark red to brown, gravelly to silty clay, moist, loose, soft.	EW		100						0
1				Rotary Chip	Dry	1.0			Brown to orange, gravel to clayey, silty, low plasticity, non-cohesive.	EW		100						1
2				Rotary Chip	Moist	2.0			Brown orange, clayey, soft to firm, non-cohesive.	HW		100						2
						2.6			Termination Depth = 2.6m									
3																		3
4																		4
5																		5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-10**

Sheet 1 of 1

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 391, **N** 6869 015
Ground Surface Elevation: **Total Depth:** 4.5m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Dry				RESIDUAL SOIL Dark reddish brown.	EW		100						0
1				Rotary Chip	Dry	1.0			CLAY Brown orange, silty, gravelly, dry, firm to soft, low to medium plasticity, alluvial.	HW		100						1
2				Rotary Chip	Dry	2.0			2.00m: Increasing gravel.	HW		100						2
3				Rotary Chip	Dry					HW		100						3
4				Rotary Chip	Moist	4.0			CONGLOMERATE to SANDSTONE Dark brown, silty, clayey, moist, moderately hard.	HW		100						4
						4.5			Termination Depth = 4.5m									
5																		5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-09**

Sheet 1 of 4

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 352, **N** 6869 006
Ground Surface Elevation: **Total Depth:** 17.0m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted **Inclination:** Vertical
Drilling Fluid:
Core Diameter (mm):

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Moist				RESIDUAL SOIL Dark brown, high in clay (medium plasticity), organic.	EW								0
1																		1
2						2.0			CLAY Red brown, orange to brown mottled, silty, medium plasticity, cohesive, sandy in part (fine to coarse), alluvial.									2
3				Rotary Chip	Moist													3
4						4.0			CLAY Orange to brown, medium to high plasticity, silty, cohesive, sandy in part (fine), alluvial.	HW								4
5																		5

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-09**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 352, **N** 6869 006
Ground Surface Elevation: **Total Depth:** 17.0m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted **Inclination:** Vertical
Drilling Fluid:
Core Diameter (mm):

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip	Wet				CLAY Orange to brown, medium to high plasticity, silty, cohesive, sandy in part (fine), alluvial.	HW								6
7				Rotary Chip	Moist													7
8						8.0			CLAY Orange to brown, medium plasticity, increasing sand content (fine to medium), cohesive, alluvial.									8
9				Rotary Chip	Wet													9
10																		10

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-09**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 352, **N** 6869 006
Ground Surface Elevation: **Total Depth:** 17.0m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted **Inclination:** Vertical
Drilling Fluid:
Core Diameter (mm):

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip	Moist				CLAY Orange to brown, medium plasticity, increasing sand content (fine to medium), cohesive, alluvial.	HW								11
12				Rotary Chip	Wet	12.0			CLAY Orange brown, cohesive, medium plasticity, sandy (fine to medium), alluvial.									12
13				Rotary Chip														13
14				Rotary Chip	Moist													14
15						15.0												15

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-09**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 352, **N** 6869 006
Ground Surface Elevation: **Total Depth:** 17.0m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted **Inclination:** Vertical
Drilling Fluid:
Core Diameter (mm):

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
16				Rotary Chip		16.0			SILT to CLAY Orange brown, completely weathered, medium plasticity, cohesive, inorganic, alluvial.	EW								16
									SILT to CLAY Orange brown, completely weathered, low plasticity, inorganic, cohesive, granular to gravelly in part.									
17						17.0			Termination Depth = 17m									17
18																		18
19																		19
20																		20

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-08**

Sheet 1 of 1

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 320, **N** 6868 985
Ground Surface Elevation: **Total Depth:** 2.3m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade

Logged:	L. McAnally	08-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Moist				RESIDUAL SOIL Organic.	EW		100						0
1				Rotary Chip	Moist	1.0			GRAVEL Dark brown to red, moist, clayey, medium cohesion, sandy.	HW		100						1
2				Rotary Chip	Dry	2.0 2.3			CONGLOMERATE Brown reddish, clayey, moderately hard, silty in part, dry.	HW		100						2
									Termination Depth = 2.3m									
3																		3
4																		4
5																		5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-07**

Sheet 1 of 1

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 303, **N** 7868 988
Ground Surface Elevation: **Total Depth:** 1.8m
Commenced: 30-Apr-09 **Completed:** 30-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	DRY	1.0			Dark brownish red, highly clayey, moist, organic.	EW		100						0
1				Rotary Chip	DRY	1.8			Brown orange, mottled, highly clayey sandy and silt, moist, moderately hard to low plasticity where clay.			100						1
									Termination Depth = 1.8m									
2																		2
3																		3
4																		4
5																		5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-06**

Sheet 1 of 3

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E , N
Ground Surface Elevation: **Total Depth:** 13.5m
Commenced: 24-Apr-09 **Completed:** 24-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	12-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	DRY				RESIDUAL SOIL Dark red brown, gravelly, organic, silty and sandy, alluvial, low cohesion, low plasticity (where clayey).	EW								0
1												100						1
2										EW								2
												100						
3						3.0			CLAY Brown to red, mottled orange brown, silty, sandy to granular in part (fine to coarse), alluvial, cohesive, low to medium plasticity.	HW								3
												100						
4										HW								4
												100						
5																		5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-06**

Sheet 2 of 3

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E , N
Ground Surface Elevation: **Total Depth:** 13.5m
Commenced: 24-Apr-09 **Completed:** 24-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	12-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip		6.0			CLAY Brown to red, mottled orange brown, silty, sandy to granular in part (fine to coarse), alluvial, cohesive, low to medium plasticity.	HW		100						6
									CLAY Orange brown, silty, occasional sand (fine to medium), medium cohesion, medium plasticity, alluvial.	HW								
7												100						7
8										HW								8
												100						
9						9.0			CONGLOMERATE Orange brown, mottled grey, silty, sand (fine to medium), occasional pebbles, granular, low cohesion, clayey (low to medium plasticity), alluvial. End of samples at 13.50 meters. Refusal on blades.	HW		100						9
10																		10

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-06**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E , N
Ground Surface Elevation: **Total Depth:** 13.5m
Commenced: 24-Apr-09 **Completed:** 24-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	12-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip					CONGLOMERATE Orange brown, mottled grey, silty, sand (fine to medium), occasional pebbles, granular, low cohesion, clayey (low to medium plasticity), alluvial. End of samples at 13.50 meters. Refusal on blades.	HW		100						11
12										HW								12
13						13.5						100						13
14									Termination Depth = 13.5m									14
15																		15

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-05**

Sheet 1 of 4

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 342, **N** 6869 117
Ground Surface Elevation: **Total Depth:** 20.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0					Moist				RESIDUAL SOIL Dark red brown, gravelly, alluvial, high in clay.			100						0
1						1.0			CLAY Red brown, sandy in part (fine), alluvial, high in silt, medium plasticity.			100						1
2										HW								2
3												50						3
4						4.0			CLAY Brown to red, silty, low to medium plasticity, cohesive (medium), sandy in part (fine to medium), alluvial.	HW		100						4
5																		5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-05**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 342, **N** 6869 117
Ground Surface Elevation: **Total Depth:** 20.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6					Wet				CLAY Brown to red, silty, low to medium plasticity, cohesive (medium), sandy in part (fine to medium), alluvial.	HW		100						6
										HW								
7												100						7
8						8.0			CLAY Brown to red, mottled yellow brown, gravel in part, sandy (fine to medium), high silt, non-cohesive, medium plasticity.	HW								8
9												100						9
10																		10

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-05**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 342, **N** 6869 117
Ground Surface Elevation: **Total Depth:** 20.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11					Moist				CLAY Brown to red, mottled yellow brown, gravel in part, sandy (fine to medium), high silt, non-cohesive, medium plasticity.	HW		100					11
12						12.0			CLAY Yellow brown, high in silt, sandy tending from fine to medium to granular in part, non-cohesive, low to medium plasticity.	HW							12
13												100						13
14										HW								14
15												100						15

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-05**

Sheet 4 of 4

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 342, **N** 6869 117
Ground Surface Elevation: **Total Depth:** 20.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
16						16.0			CLAY Yellow brown, high in silt, sandy tending from fine to medium to granular in part, non-cohesive, low to medium plasticity.	HW		100						16
									CONGLOMERATE-SANSTONE Mottled brown orange, fine to loose sand, granular in part, high silt content, alluvial, inorganic, non-cohesive, occasional clay.	HW								
17												100						17
18										HW								18
19												100						19
20						20.0			Termination Depth = 20m									20

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-04**

Sheet 1 of 6

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 550 049, **N** 6868 883
Ground Surface Elevation: **Total Depth:** 30.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Moist				RESIDUAL SOIL Red brown to brown, silty, highly clayey, gravel in part, organic, low plasticity where clayey, low cohesion.	EW								0
1												100						1
2										EW			100					2
3						3.0												3
				Rotary Chip	Wet				CLAY Light orange brown to brown, silty, low medium plasticity, low cohesion, inorganic, alluvial.	HW		100					
4										HW								4
												50						
5																		5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-04**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 550 049, **N** 6868 883
Ground Surface Elevation: **Total Depth:** 30.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6					Moist	5.8			CLAY Light orange brown to brown, silty, low medium plasticity, low cohesion, inorganic, alluvial.	HW		50						6
									5.80m: Slightly silty.	HW								
7						7.0			CLAY Light orange to brown, silty, inorganic, low to medium plasticity, low to medium cohesion, alluvial, sandy (fine to medium).			50						7
8										HW								8
9												100						9
						9.8			9.80m: Gravel in part.									
10																		10

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-04**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 550 049, **N** 6868 883
Ground Surface Elevation: **Total Depth:** 30.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip	Wet				9.80m: Gravel in part.	HW		100						11
12						12.0			CLAY Orange brown to brown, inorganic, highly silty, low plasticity, low cohesion, alluvial, sandy in part (fine to medium).	HW								12
13												100						13
14				Rotary Chip						HW		100						14
15																		15

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-04**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 550 049, **N** 6868 883
Ground Surface Elevation: **Total Depth:** 30.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
16				Rotary Chip	Moist	15.8			CLAY Orange brown to brown, inorganic, highly silty, low plasticity, low cohesion, alluvial, sandy in part (fine to medium). 15.80m: Gravel in part.	HW		100						16
17					Moist	16.0			CLAY Red to brown, mottled yellow brown, inorganic, highly silty, gravelly, occasional sand (fine to medium), medium plasticity, alluvial, moist to wet.	HW		100						17
18					Wet					HW								18
19					Moist							100						19
20						20.0												20

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-04**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 550 049, **N** 6868 883
Ground Surface Elevation: **Total Depth:** 30.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
21					Wet				CLAY Yellow brown, silty, sandy (fine to medium).	HW		100						21
22										HW								22
23					Moist							100						23
24						24.0			CLAY Yellow brown, mottled grey to yellow, completely weathered silt to silt in part, occasional sandy (fine to medium), medium plasticity, alluvial.	HW		100						24
25																		25

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-04**

Sheet 6 of 6

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 550 049, **N** 6868 883
Ground Surface Elevation: **Total Depth:** 30.0m
Commenced: 23-Apr-09 **Completed:** 23-Apr-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	10-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
26					Wet				CLAY Yellow brown, mottled grey to yellow, completely weathered silt to silt in part, occasional sandy (fine to medium), medium plasticity, alluvial.	HW		100						26
										HW								
27												100						27
28						28.0												28
					Moist				CLAY Light brown to yellow, silty to completely weathered silt, highly sandy (fine to medium), low plasticity, alluvial.	HW							
29												100						29
30						30.0			Termination Depth = 30m									30

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Sheet 1 of 13

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Wet	1.0			CLAY Dark brown, silty, low to medium plasticity, low cohesion, alluvial, organic.	EW		100						0
1				Rotary Chip	Moist	3.0			CLAY Light yellow brown, silty, occasional sand (fine), medium plasticity, low cohesion, alluvial, inorganic.	EW HW		100 100						1
2																		2
3				Rotary Chip	Dry				CLAY Light yellow brown, very silty, granular to gravelly in part, occasional sand, low plasticity, low cohesion, inorganic.	HW		100						3
4										HW		100						4
5																		5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip	Moist				CLAY Light yellow brown, very silty, granular to gravelly in part, occasional sand, low plasticity, low cohesion, inorganic.	HW		100					6
										HW		100					
7						7.0			CLAY Light yellow brown.	HW		100					7
8				Rotary Chip	Dry					HW		100					8
9				Rotary Chip		9.0			SILTSTONE Yellow brown to yellow grey, high in clay (low to medium plasticity), occasional sand (fine to medium).	HW		100					9
10																		10

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Sheet 3 of 13

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip					SILTSTONE Yellow brown to yellow grey, high in clay (low to medium plasticity), occasional sand (fine to medium).	HW		100						11
										HW		100						
12						12.0			12.00m: Yellow grey.	HW		100						12
13					Dry	13.0			SANDSTONE Grey to brown, medium to coarse grained, indurated, slightly metamorphosed, fractured, moderate to hard, quartz veins.	HW		100	11				13.00, Abundant joints, 30° angle 13.70, Joints very broken up approximately 5cm, 30°, PLN, iron stained	13
14				Rotary Coring		14.5			CORE LOSS.	HW		100	5					14
15																		15

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Sheet 4 of 13

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Total Depth: 60.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
16				Rotary Coring		16.4			Intermixed to Interbedded SANDSTONE and SILTSTONE Grey to dark grey, indurated, 60% sand, 40% silt, fractured, quartz veining throughout iron staining, slightly metamorphosed.	HW		100	5				15.30, Joints very broken up approximately 5cm, 40°, PLN, iron stained	16
						16.7			SANDSTONE Grey, medium to coarse grained, iron staining, fractured, indurated.	HW								
17						17.1			Dark grey to brown, indurated, sandy in part, slightly metamorphosed.			100	51				16.68, JT, 30°, QZ infill (2mm), PLN	17
						17.5			Grey to brown, mottled, indurated, medium to coarse grained, well sorted, massive, quartz veining, iron staining.								17.10, QZ veining, healed, PLN	
18						18.0			Mottled grey brown, silty, indurated, fine to coarse grained, slightly metamorphosed, massive structure.	HW		106					17.75, JT, 30°, PL, MD, IN	18
						18.4			Mottled grey brown, indurated, fine to coarse grained, slightly metamorphosed, massive, poorly sorted.									
						18.7			CORE LOSS.									
						18.9			Mottled grey brown, silty (fine to medium), altered, indurated, carbonaceous.	HW		125	0				18.65-19.00, BK	
19						19.2			Dark brown grey, sandy (fine), carbonaceous, thin to thick bedding/bed frequently disturbed, indurated.	HW		100	0				19.00-19.50, BK	19
									Mottled brown grey, silty, indurated, fine to coarse grained, massive, poorly sorted, quartz veining.	MW		100	10				19.80, JT, 15°, PL-ST, @80	
20																		20

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
21				Rotary Coring					Mottled brown grey, silty, indurated, fine to coarse grained, massive, poorly sorted, quartz veining.	MW		100	10				20.20, JT, 30°, PL, FM, IS	21
										MW							20.40, JT, 40°, PL, FM, IS, muddy	
																	20.70-21.20, BK	
												100	0					
																	21.20, JT, 15°, FM, 05°, subvertical	
						21.5												
22									Interbedded SILTSTONE and SANDSTONE Medium bedding, fine to coarse grained, carbonaceous, slightly metamorphosed, indurated.	MW							21.50, JT, 5°, 35°, PL, IS, FM, healed, muddy 21.60, JT, 10°, PL, 30°, PL, IS, FM, muddy 21.70, JT, 15°, PL, 45°, PL, IS, FM, muddy 21.80, JT, 23°, PL, 60°, PL, IS, FM, muddy 21.90, JT, 30°, PL, 45°, PL, IS, FM, muddy 22.00, JT, 12°, PL, 30°, PL, IS, FM, muddy 22.10, JT, 50-60°, PL, 30°, PL, IS, FM, muddy	22
												100	26					
						22.6												
23									SANDSTONE Medium to coarse grained, silty in part, massive, veined, jointed, broken in part, carbonaceous, indurated, alluvial.	MW							22.60, JT, 66°, PL, IS, FM, muddy	23
																	22.80, JT, 84°, PL, IS, FM, muddy 22.90, JT, 98°, PL, IS, FM, muddy 23.00, JT, 05°, PL, IS, FM, muddy 23.10, JT, 30°, PL, FM@38, muddy 23.20, JT, 30°, PL, FM@44, muddy	
												100	42					
																	23.40-23.70, BK	
										MW		100	0					
						23.7												
24									SILTSTONE Medium grey to grey, sandy (medium), carbonaceous, broken in part, irregular bedding, calcite in breaks, indurated.	MW								24
												100						
						24.7												
25									SILTSTONE Grey brown, sandy (fine to medium), jointed, veined, broken in part, carbonaceous, poorly sorted, indurated.	MW		86						25

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Total Depth: 60.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
									SILTSTONE Grey brown, sandy (fine to medium), jointed, veined, broken in part, carbonaceous, poorly sorted, indurated.	MW		86					25.80, 30°, MD-PL, QZ VN (12mm thick)	
26						26.0			Grey orange, sandy (medium), alluvial, carbonaceous, metamorphosed, iron staining, thinly to thickly bedded (disturbed), broken in part, jointed.	MW		100	0				26.20, JT, 45°, PL, IS-MD, FM	26
27						27.6			Dark grey to dark grey orange, highly carbonaceous, metamorphosed, iron staining, thinly to thickly bedded (disturbed), alluvial, sandy (fine), indurated, broken in part/jointed.	MW		100	0					27
28										MW		100	0				28.40, JT, 45°, PL, IS, FM	28
29						29.1			Dark grey, iron staining, sandy, highly carbonaceous, broken in part, metamorphosed, indurated.	MW		100	0				29.10, JT, 40°, UND, IS, FM 29.20, JT, 40°, PL, IS, FM 29.30, JT, 45°, PL, IS, FM 29.40, JT, 35°, PL, UND, IS, FT, FM, 30° closed 29.50-29.70, BK	29
										MW		100	0				29.70-30.75, BK	
30																		30

Rotary Coring

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Sheet 7 of 13

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
									Dark grey, iron staining, sandy, highly carbonaceous, broken in part, metamorphosed, indurated.	MW		100	0					
						30.8												
31									SILTSTONE Sandy (medium to coarse), carbonaceous, metamorphosed, quartz veining, iron staining, thinly to thickly interbedded (disturbed), broken in part, indurated.	MW		100	0				30.75-31.30, BK	31
										MW								
32				Rotary Coring								100	18				31.75, QZ veining, varied directions on 30°	32
										MW							32.70-33.50, BK	
33												100	60					33
										MW							33.50, QZ veining, multidirectional at 70°	
												100	33					
34						34.0			Grey to blue, metamorphosed, occasionally sandy (fine), carbonaceous, irregular bedding, iron staining, indurated.								34.20, BK, JT, CL/QZ infill 34.40, JT, 55°, PL, QZ, FM 34.50, JT, 61°, PL, QZ, FM 34.60, JT, 71°, PL, QZ, FM 34.70, JT, 79°, PL, QZ, FM	34
										SW		100	43					
35																		35

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
36				Rotary Coring		36.0			Grey to blue, metamorphosed, occasionally sandy (fine), carbonaceous, irregular bedding, iron staining, indurated.	SW		100	43				35.00, JT, 52°, PL, QZ, FM 35.15, JT, 15°, PL, QZ, FM 35.20, JT, 22°, PL, QZ, FM 35.40, JT, 34°, PL, offset 10mm/closed	36
										SW							35.65-35.80, BK	
									SILTSTONE Grey blue to dark grey, iron staining, irregular bedding, metamorphic, quartz veining common, broken in part, occasional pyrite on breaks/joints, indurated.			100	10				36.00-36.60, BK	
37										SW							37.00, QZ veins (2-5mm thick), multidirectional	37
38																	38.00-38.20, BK	38
										SW							38.20-38.40, BK	
																	38.80-39.00, BK	
39						39.0			Coaly.	SW								39
						39.5											39.40-39.60, BK	
									SILTSTONE Grey blue to dark grey, carbonaceous, irregular bedding (disturbed), metamorphic, coaly laminae, occasional pyrite on breaks/joints, indurated.									
40																		40

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Sheet 9 of 13

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Total Depth: 60.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
41				Rotary Coring					SILTSTONE Grey blue to dark grey, carbonaceous, irregular bedding (disturbed), metamorphic, coaly laminae, occasional pyrite on breaks/joints, indurated.	SW SW SW							41.20, QZ VN infill with calcite, closed 300mm thick 41.50, JT, 45°, PL, OP, FM, QZ infill 41.70, JT, 70°, PL, VN, PR @ 47 and 48, QZ infill, closed	41
42						42.0			SILTSTONE Dark blue grey, metamorphic, occasional sand (fine to medium), carbonaceous, muddy, pyritic.								42.00, JT, 15°, PL, FM, QZ 42.40, JT, 30°, PL, VN, CL, 200mm thick 42.70-48.20, BK	42
43						43.0			MUDSTONE Dark grey to dark brown, silty, carbonaceous.	SW								43
44						43.5			SILTSTONE Dark blue grey, metamorphic, sand (fine), carbonaceous, irregularly bedded (disturbed), indurated, veining (quartz), joints/calcite and calcite pyritic.									44
45																	44.90, JT, 14°, PL, OP, FM, CB-QZ	45

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
46				Rotary Coring		46.3			SILTSTONE Dark blue grey, metamorphic, sand (fine), carbonaceous, irregularly bedded (disturbed), indurated, veining (quartz), joints/calcite and calcite pyritic.	SW SW							45.50, QZ veins 10mm thick 45.70, JT, PL, CM, QZ, subvertical	46
47						48.0			SILTSTONE Blue grey, metamorphosed, rare sand (fine), carbonaceous, coaly to muddy in part, fractured, broken in part, indurated, quartz veining.	SW							47.70, JT, 40°, PL, FM, QZ 47.80, JT, 45°, PL, FM, QZ	47
48																		48
49									SILTSTONE Blue grey, metamorphosed, rare sand (fine to medium), carbonaceous, occasionally coaly, indurated, occasionally muddy, irregularly bedded.	SW SW							49.00-49.30, BK	49
50						50.0												50

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
51				Rotary Coring					SILTSTONE Grey to dark grey, metamorphic, carbonaceous, tending to sandy (fine to medium), carbonaceous laminae, rare coal laminae, indurated.	SW							50.50-51.30, BK	51
										SW								
																	51.30, JT, 50°, CC, FM, QZ 51.40, JT, 50°, CB, FM, QZ	
52										SW								52
53										SW							53.00, JT, 30°, PL, FM, QZ 53.10, JT, 50°, QZ vein 2mm 53.20, JT, 30°, QZ vein 2mm	53
						53.5			SANDSTONE Grey to blue grey, fine to coarse grained, metamorphosed, quartz veining, some chlorite, occasional iron staining, carbonaceous laminae, indurated.	SW								
54																	54.00, Carbonaceous laminae/offset 54.30, JT, PL, OP, FM, QZ	54
55																	54.70, JT, 45°, PL, CL, QZ	55

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Sheet 12 of 13

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Total Depth: 60.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
56				Rotary Coring		56.0			SANDSTONE Grey to blue grey, fine to coarse grained, metamorphosed, quartz veining, some chlorite, occasional iron staining, carbonaceous laminae, indurated.	SW							55.40, JT, 35°, PL, FM, QZ 55.60-55.70, BK	56
57									SANDSTONE Grey to blue, fine to coarse grained, metamorphic, quartz veining, occasional chlorite, occasional carbonaceous laminae, iron staining, breaks and joints with quartz.	SW							56.00, JT, 40°, PL, CL, QZ, healed 56.20, JT, 30°, QZ VN, subvertical 56.40, JT, 35°, FM, QZ 56.80, JT, PL, CL, FM, QZ 57.20, JT, 40°, FM, QZ infill, calcite 57.40, JT, 40°, PL, QZ, healed, closed 57.60, JT, 45°, PL, QZ vein 5mm 57.80, VN, ST, CL, QZ	57
58						58.0			SANDSTONE Grey to grey blue, medium to coarse grained, metamorphosed, silty in part, occasionally carbonaceous, quartz veins - 100mm spacing.	SW		100	46				58.20, JT, 45°, PL, FM, QZ, chlorite	58
59						59.5			SANDSTONE Grey to grey blue, fine to coarse grained, muddy, silty, metamorphosed, occasionally carbonaceous, occasional joints and quartz/calcite.	SW		100	100				58.80, JT, 30°, PL, FM, QZ, chlorite 59.20-59.30, BK	59
60										SW		100	77					60
										SW		100	0				59.90-60.30, BK	

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 288, **N** 6869 315
Ground Surface Elevation:
Date Tested:
Total Depth: 60.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	13-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
										SW		100	0				60.00, JT, 60°, PL, IS, FM, QZ	
						60.3			Termination Depth = 60.3m									
61																		61
62																		62
63																		63
64																		64
65																		65

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03A**

Sheet 1 of 5

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 274, **N** 6869 414
Ground Surface Elevation:
Date Tested:
Total Depth: 20.2m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade / Fair

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip					RESIDUAL SOIL Mottled dark brown, clayey, loose to very loose sand, dry, soft, organic.	EW		100						0
1						1.0			CLAY Reddish brown, silty, sandy, dry, soft to firm, organic in part.	EW		100						1
2						2.0			CLAY Reddish brown, silty, gravelly, dry, firm to stiff, inorganic.	HW		100						2
3						3.0			CLAY Reddish brown, silty, firm to stiff.	HW		100						3
4						4.0			CLAY Yellow brown, silty, dry, firm.	HW		100						4
5						5.0												5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03A**

Sheet 2 of 5

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 274, **N** 6869 414
Ground Surface Elevation:
Date Tested:
Total Depth: 20.2m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade / Fair

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip		6.0			CLAY Yellow brown, silty, dry, firm.	HW		100						6
7				Rotary Chip		7.0			CLAY Grey brown, very silty, gravelly, dry, firm.	HW		100						7
				Rotary Chip		7.8			SILTSTONE Grey brown, clayey, gravelly, dry, low to medium strength. BEGIN CORE at 7.18 meters.	HW		100						
8				Rotary Coring					SILTSTONE Dark grey-orange, medium to coarse sand, indurated, carbonaceous, occasional irregular beds (disturbed), iron oxide staining.	HW HW HW							7.80, Highly fractured, friable in part 7.80-8.73, Broken, fractured, indurated, stepped 8.30-8.58, Subvert joint, ST, UN	8
				Rotary Coring		8.5			8.50m: Common Drilling Induced (DI) breaks.								8.70, JT, PLN, indurated, weathered 8.70-8.90, Some DI breaks 8.76, JT, PLN, indurated, weathered	
9				Rotary Coring		9.7			9.70m: Frequent DI breaks.	HW							9.17, JT, W at 45°, PL, indurated 9.20, JT, W at 45°, PL, indurated 9.55, JT, W at 20°, PL, indurated 9.60, JT, W at 30°, PL, indurated 9.60-9.70, Frequent DI breaks 9.70, JTx5 spacing, 300mm at 50°	9
10				Rotary Coring		10.0												10

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03A**

Sheet 3 of 5

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 274, **N** 6869 414
Ground Surface Elevation:
Total Depth: 20.2m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade / Fair

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Coring		10.3			10.00m: Increasing carbonaceous traces.	MW							9.74-9.76, JT, W at 65°, PL, indurated 9.84-9.86, JT, W at 60°, PL, indurated 9.90-10.11, W, PL, indurated 10.14-10.63, JTx10, PL, W, 300mm spacing at 45° 10.2-10.50, Frequent DI breaks	11
						10.7			10.25m: Frequent DI breaks.									
						11.0			10.70m: Frequent micro faulting; sandy tending towards massive.								10.88-11.20, JTx5 at 50°, muddy infill CP, medium faulting	
						11.2			Carbonaceous wisps/ coal traces.									
						11.4			CARBONACEOUS MUDSTONE Dark grey black, coaly/altered/jointed/broken.	Wk							11.15-11.44, Broken	
12									SILTSTONE Dark grey to grey, coaly/indurated, carbonaceous wisps/traces/altered, occasionally sandy.	Wk								12
						12.7			12.72m: Broken frequently.								12.50-12.78, DI breaks	
						12.9			No recovery.			0						
13									SILTSTONE Dark grey, sandy, carbonaceous, abundant breaks/joints, fine bedding, quartz veining, very fine, fractured, indurated.	Fr							13.00-13.25, DI kbreaks	13
																	13.55-13.64, JT, 30°, PL, carbonaceous to muddy infill 13.69-13.75, JT, 30°, PL, muddy halo	
14						14.0			14.00m: Frequent DI breaks.								14.00-14.20, Frequent DI break	14
																	14.30-14.40, DI break	
																	14.45-14.55, DI break	
																	14.75-15.00, DI break	
15																		15

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03A**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 274, **N** 6869 414
Ground Surface Elevation:
Total Depth: 20.2m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade / Fair

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						15.0			No recovery.	Fr		0						
						15.3			SILTSTONE Dark gey, sandy in part, carbonaceous, rare quartz veining, fractured/indurated.	Fr							15.65-15.75, 2xJ, 20°, (infill) muddy/ PL, 300mm spacing
16												109						16
																	16.50-16.80, Frequent DI break	
						16.8			No recovery.			0						
17				Rotary Coring					SILTSTONE Dark grey to grey, carbonaceous, muddy/sandy in part, fractured in part, occasionally sandy, common veining of calcite and quartz, irregularly bedded in part, rare pyrite in broken rock.	Fr							16.90-17.00, JTx2, 20°, QZ infill/ PL, 200mm spacing	17
																	17.85-18.02, JT, 45°, QT-CC infill, PL	
18						18.0			18.00m: Carbonaceous wisps, occasional rootlets.	Fr		257						18
						18.7			SILTSTONE Dark grey to grey, carbonaceous/muddy, altered/indurated/irregularly bedded in part, occasional veining of calcite and quartz (second/ primary), occasional pyrite in broken rock.	Fr							18.90-19.20, Frequent DI breaks	
19												100						19
						19.6			No recovery.			0						
						19.7				Fr		200					19.70-19.90, Frequent DI breaks	
						19.9												
20												0						20

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-03A**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 274, **N** 6869 414
Ground Surface Elevation:
Date Tested:
Total Depth: 20.2m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Core Barrel: NMLC
Bit Condition: Blade / Fair

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						20.2			SILTSTONE Dark grey to grey, carbonaceous, sandy, fractured, irregularly bedded, calcite quartz veining. No recovery. Termination Depth = 20.2m			0						
21																		21
22																		22
23																		23
24																		24
25																		25

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Sheet 1 of 12

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Date Tested:
Total Depth: 55.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
				Rotary Chip		0.5			RESIDUAL SOIL Yellow to brown, clayey, silty, gravel in part, organic, dry , soft.	EW		100						
						1.0			GRAVELLY CLAY Yellow brown, silty, low cohesion, dry.	EW		100						
1						2.0			CLAY Yellow to brown, silty, sandy in part, common gravel.	HW		100						1
2						3.0			2.00m: Common sand, fine to medium, occasional gravel.	HW		100						2
3						4.0			CLAY Yellow to brown, silty, highly sandy, low to medium plasticity, low cohesion.	HW		100						3
4				Rotary Chip	Moist				4.00m: Common sand, fine to medium.	HW								4
				Rotary Chip	Wet							100						
5						5.0												5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Date Tested:
Total Depth: 55.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip	Dry	5.5			5.00m: Decreased plasticity (low plasticity).	HW		100						6
									SILT Mottled yellow to brown, highly clayey, gravel, grey, medium to low cohesion, completely weathered to clay.	EW		100						
						6.5				EW		100						
7									CLAY Yellow to brown, silty, sandy, low to medium cohesion.	HW		100						7
						7.0			7.00m: Increasingly silty, low to medium plasticity.	HW		100						
8				Rotary Chip	Dry	8.0			CLAY Yellow to brown, silty, sandy, low to medium cohesion, medium plasticity, high in part.	HW		100						8
9				Rotary Chip	Dry					HW		100						9
10						10.0												10

GHD | MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Sheet 3 of 12

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Total Depth: 55.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip	Dry				CLAY Yellow to brown, silty, low sandy, low to medium plasticity, low to medium cohesion.	HW		100						11
										HW		100						
12				Rotary Chip	Dry	12.0			CLAY Yellow to brown, mottled grey, highly silty, low to medium plasticity, low cohesion.	HW		100						12
13				Rotary Chip	Dry					HW		100						13
14				Rotary Chip	Dry	14.0			14.00m: Increasing SILT, grey to yellow grey.	HW		100						14
						14.5			SILTSTONE Yellow brown to yellow grey mottled, highly sandy, silty, highly clayey, low cohesion.	HW		100						
15						15.0												15

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Total Depth: 55.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
				Rotary Chip	Dry				15.00m: Low plasticity.	HW		100						
16						16.0												16
				Rotary Chip	Dry				SILTSTONE Yellow to grey, clayey, silty, low plasticity, low cohesion.	HW		100						
17						17.0												17
				Rotary Chip	Dry				SILTSTONE Yellow grey, clayey, silty, low to medium plasticity, low cohesion, dry. End of chips at 18.00 meters. Begin core.	MW		100						
18						18.0											18.00-18.27, BK	18
				Rotary Coring					SANDSTONE Brown grey, silty, medium to coarse grained, indurated.	MW		45	0				
						18.3			No recovery.			0	0					
						18.6											18.60-18.7, BK	
						18.7			SANDSTONE Brown grey, medium to coarse grained, indurated.	MW								
19									No recovery.									19
						19.9											19.90-20.10, BK	
20										MW		10	0					20

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Sheet 5 of 12

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Total Depth: 55.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
				Rotary Coring		20.5			SANDSTONE Brown grey, medium to coarse grained, silty, iron staining, indurated.	MW		10	0				20.20-20.50, BK	
						21.0			No recovery.			0	0					
21									SILTSTONE Dark grey to orange, sandy (fine to medium), slightly metamorphosed, carbonaceous, occasional to common joints (rare quartz on joints).	MW		100					21.07, JT, 30°, PL, muddy 21.20, JT, 40°, PL, muddy 21.46, JT, 50°, PL, muddy 21.52, JT, 50°, PL, muddy 21.55, JT, 50°, PL, muddy 21.65, BK, QZ veins/heal	21
22										MW		100	31				22.37, JT, 50°, PL, muddy, firm	22
23						23.0			SANDSTONE Orange grey, medium to coarse grained, silty, iron staining, indurated, carbonaceous in part.			100	84				22.85, JT, 45°, PL, muddy, firm	23
24						24.5				MW		100	72				23.50-23.80, BK 24.04, JT, 45°, PL, muddy, firm 24.30, JT, 45°, PL, neutral	24
25						25.0			SILTSTONE Grey to blue, mottled orange grey, sandy, indurated.	MW		100	0				24.50, JT, 50°, PL, muddy, firm 24.55, JT, 55°, PL, muddy, firm 24.65, JT, 45°, PL, firm 24.94, JT, 55°, PL, firm	25

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Date Tested:
Total Depth: 55.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
26				Rotary Coring					SILTSTONE Grey to blue, mottled orange grey, sandy (fine to medium), iron staining, muddy in fill, carbonaceous in part, broken in part, slightly metamorphosed/altered, tending to sand in part.	MW		100	0				25.70, JT, 40°, PL, infill, muddy, firm	26
										MW		100	34				26.40-26.60, BK	
										MW							26.65, JT, 60°, PL, weat coat, firm 26.76, JT, 55°, PL, MD IN, firm	
27						27.0						100	0					27
									SILTSTONE Grey to blue, mottled orange grey, sandy (medium), carbonaceous, slightly metamorphosed, broken in part, indurated.								27.30-27.50, BK	
										MW								
28												100	10				28.20-28.50, BK	28
						28.5				MW								
									SANDSTONE Grey orange, silty, medium to coarse grained, carbonaceous in part, muddy in part, indurated.								28.80-29.20, BK	
29												100	45					29
																	29.40-29.50, BK	
										MW		100	0					
30						30.0												30

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Total Depth: 55.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
31				Rotary Coring		31.0			SANDSTONE Orange grey, silty, medium to coarse grained, carbonaceous in part, indurated.	MW		100	0				30.15, JT, 70°, PL from 44-49 35° PL, indurated, firm 30.30-30.70, BK	31
										MW		100	42					
									SANDSTONE Grey to orange, silty, medium to coarse grained, indurated.	MW		41	19				31.50-31.80, BK	
32						31.8			CORE LOSS.			0	0					32
						32.6			SANDSTONE Grey to orange, silty, medium to coarse grained, slightly metamorphosed, indurated.	MW		100	0				32.55-33.00, BK	
										MW		100	0					
33						33.0												33
						33.1			CORE LOSS.			0	0					
									SANDSTONE Orange grey, silty, occasionally carbonaceous, slightly metamorphosed, tending towards siltstone, iron staining, indurated.	MW		75	0				33.10-33.40, BK	
										MW		100	0					
34										MW		100	0					34
										MW		100	0					
										SW							34.80-35.20, BK	
35						35.0												35

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Sheet 8 of 12

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Total Depth: 55.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
36				Rotary Coring		36.0			SILTSTONE Grey to blue grey, mottled grey brown, sandy (fine to medium), carbonaceous, slightly metamorphosed, iron staining, quartz veining.	SW		117	46				35.35, QZ VN 20mm, subvertical -20°, closed/healed, offset veins either rock	36
									SANDSTONE tending to SILTSTONE Grey to brown grey, fine to medium grained, carbonaceous, iron staining, indurated.	SW							36.00-37.00, QZ VN 2-5mm	
37						37.0			SILTSTONE Grey to grey blue, sandy (fine to medium), carbonaceous, indurated, slightly metamorphosed, microfaulted, irregular bedding (distrubed in part), iron staining.	SW							37.00-38.00, QZ VN 2-5mm	37
38										SW							38.25-38.90, BK	38
39						39.0			SILTSTONE Grey to grey blue, sandy (fine to medium), carbonaceous in part, indurated, metamorphosed, altered, quartz veining and calcite, irregular bedding (distrubed in part), pyrite on breaks/joints.	SW		15	47				38.94, JT, 40°, PL, CC IN, firm 39.50, JT, 55°, PL, carbonaceous, firm 39.75, JT, 40°, ST, carbonaceous, firm	39
40										SW		100	67					40

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Total Depth: 55.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
41				Rotary Coring	Dry	41.0			SILTSTONE Grey to grey blue, sandy (fine to medium), carbonaceous in part, indurated, metamorphosed, altered, quartz veining and calcite, irregular bedding (distrubed in part), pyrite on breaks/joints.	SW		100	67				40.10-40.30, BK 40.19, JT, 40°, ST, carbonaceous, firm 40.50-40.70, BK	41
42									SILTSTONE Grey to blue grey, sandy (medium), carbonaceous in part, indurated, metamorphosed, quartz veining and calcite, pyrite breaks and joint surface, 37' d - fractured, irregular bedding.	SW SW		100	0				41.40, PL, CC, firm 41.45, PL, CC, firm 42.00-43.00, QZ VN, MF, multidirectional	42
43				Rotary Coring		43.0			SILTSTONE Grey to blue grey, sandy (medium), carbonaceous, indurated, metamorphosed, quartz veining and calcite, pyrite on breaks and joint surface, irregular bedding (thin to thick), occasional iron staining.	SW		100	0				43.00-44.00m: QZ VN, MF, multidirectional	43
44										SW		100	0					44
45						45.0				SW								45

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Sheet 10 of 12

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: **E** 549 225, **N** 6869 560
Ground Surface Elevation:
Date Tested:
Total Depth: 55.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
46				Rotary Coring					SILTSTONE Grey to dark grey, sandy (medium), carbonaceous, metamorphosed, quartz veining and calcite, breaks and joint, irregular bedding, occasional iron staining.	SW							45.20, QZ VN, 30mm thick, QZ vein heavily multidirectional (MF)	46
										SW								
										SW								
47																	47.00-48.00, BK	47
												6	0					
48				Rotary Coring		48.0			SILTSTONE Dark grey to blue grey, sandy (medium to fine), carbonaceous, metamorphosed, quartz veining, occasional calcite, irregular bedding.	SW							48.50-49.00, QZ VN 2mm apart	48
49										SW								49
50						50.0												50

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Date Tested:
Total Depth: 55.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
51				Rotary Coring					SILTSTONE Dark grey to blue grey, sandy in part (fine), carbonaceous, metamorphosed, quartz veining, occasional calcite, irregular bedding, occasionally disturbed bed, microfaulting.	SW								51
										SW								
										SW								
52						52.0			SILTSTONE Grey to grey blue, slightly sandy (fine to medium), carbonaceous, metamorphosed, microfaulting.	SW							52.00-53.00, QZ VNS throughout 2mm-5mm thick, multidirectional	52
53						53.0			SILTSTONE Dark grey to grey blue, sandy (fine), carbonaceous, metamorphosed, quartz veining/quartz or joint/break, thickly massive bedding.									53
54						54.2			CORE LOSS.	SW		100	0					54
55																		55

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02B**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 225, **N** 6869 560
Ground Surface Elevation:
Date Tested:
Total Depth: 55.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	17-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						55.3			CORE LOSS.	SW		100	0					
									Termination Depth = 55.3m									
56																		56
57																		57
58																		58
59																		59
60																		60

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02A**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 577, **N** 6868 883
Ground Surface Elevation:
Total Depth: 20.0m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley Truck

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Moist				CLAY Red brown, alluvial, very silty, occasional sand (fine to medium), low to medium plasticity, low cohesion, moist, inorganic.									0
1																		1
2																		2
3																		3
4						4.0			CLAY Red brown, alluvial, very silty, occasional sand (fine to medium) sand, low to medium plasticity, low cohesion, inorganic.									4
5																		5

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02A**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 577, **N** 6868 883
Ground Surface Elevation:
Total Depth: 20.0m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley Truck

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip					CLAY Red brown, alluvial, very silty, occasional sand (fine to medium) sand, low to medium plasticity, low cohesion, inorganic.									6
7																		7
8						8.0			CLAY Orange brown, very silty and completely weathered, inorganic, alluvial, rare sand (fine), medium plasticity, low cohesion. END OF CHIP SAMPLES at 13.00 meters.									8
9																		9
10																		10

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02A**

Sheet 3 of 4

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 577, **N** 6868 883
Ground Surface Elevation:
Total Depth: 20.0m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley Truck

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip					CLAY Orange brown, very silty and completely weathered, inorganic, alluvial, rare sand (fine), medium plasticity, low cohesion. END OF CHIP SAMPLES at 13.00 meters.									11
12																		12
13					Moist	13.0			CLAY Yellow red, silty, low plasticity, low cohesion.									13
14				Core OH		13.8			CLAY Yellow brown, silty, low to medium palsticity.	HW							13.80-14.80, BK, no structure	14
15						14.5 14.8			CORE LOSS. CLAY Yellow brown, very silty, alluvial.	HW		65	0					15

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-02A**

Sheet 4 of 4

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 577, **N** 6868 883
Ground Surface Elevation:
Total Depth: 20.0m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley Truck

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	09-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
16				Rotary Chip					CLAY Yellow brown, very silty, alluvial.	HW								16
										HW								
17																		17
18						18.0			CLAY Yellow brown, inorganic, alluvial, very soft to soft, occasional gravel, sand (fine to medium), silty, low to medium plasticity, low cohesion.									18
19																		19
20						20.0			Termination Depth = 20m									20

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 1 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0									No recovery.									0
						1.0												
1									No recovery.			0	0					1
						2.0												
2									No recovery.									2
						3.0												
3				Rotary Coring					CLAY Red brown, silty, gravelly.	EW							3.00-3.10, BK	3
									No recovery.									
						3.9												
4									CLAY-CONGLOMERATE Mottled red brown, silty, occasional sandy, low plasticity, low cohesion.	EW		100	0				3.87-4.12, BK	4
						4.1												
									No recovery.			0						
5						5.0												5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
				Rotary Coring		5.5			CLAY-CONGLOMERATE Mottled red brown.	EW		100	0				5.00-5.50, BK	
				Rotary Chip					CHIP SAMPLES CLAY-CONGLOMERATE Mottled grey orange, silty, low to medium plasticity, low cohesion.	HW		100					
6																		6
												100						
7																		7
												100						
8						8.0			CLAY Low to medium plasticity. Matrix - pebble sized - granular clasts, mottled orange grey, alluvial, inorganic, moist, cohesive, silty (occasional), sandy (fine to coarse).	HW								8
												100						
9																		9
												100						
10																		10

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 3 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip		11.0			CLAY Low to medium plasticity. Matrix - pebble sized - granular clasts, mottled orange grey, alluvial, inorganic, moist, cohesive, silty (occasional), sandy (fine to coarse).	HW		100						11
12									CONGLOMERATE-CLAY MATRIX tending to CLAY (Cl) Pebbly - granular clasts, mottled orange grey, alluvial, inorganic, moist, silty and sandy (medium to coarse), cohesive-low plasticity.			100						12
13												100						13
14						14.0			CONGLOMERATE-CLAY MATRIX tending to CLAY Mottled orange grey, pebbly - granular clasts, cohesive, low plasticity, silty and sandy (medium).	HW		100						14
15												100						15

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 4 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Date Tested:
Total Depth: 70.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
16				Rotary Chip		16.0			CONGLOMERATE-CLAY MATRIX tending to CLAY Mottled orange grey, pebbly - granular clasts, cohesive, low plasticity, silty and sandy (medium).	HW		100						16
						16.5			SILT Dark grey, orange, clayey, low plasticity, completely weathered, sandy in part.			100						
17									CONGLOMERATE-CLAY MATRIX Mottled orange grey, carbonaceous in part, cohesive, low plasticity, silty, pebbly clasts (occasional), sandy (medium), moist, alluvial.									17
18																		18
19						19.0			CONGLOMERATE-CLAY MATRIX tending to CLAY Mottled orange grey, silty, low plasticity, cohesive, alluvial, moist.									19
20						20.0												20

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						20.4			CORE LOSS.									
									1.40M			71	0					
21						21.4												21
						21.5			CLAY Orange grey/carbonaceous, silty/gravelly.	HW							21.40-21.50, BK	
									CORE LOSS.									
22						22.0			1.70M			17	0					22
23						23.0												23
									CORE LOSS.									
						23.2			SILTSTONE Dark grey blue, laminated, chloritic.	HW							23.20-23.55, BK, microfaulted	
						23.6			CORE LOSS.									
24						24.2			SILTSTONE Mottled grey brown, fine to medium sand, slightly metamorphosed, quartz veining, carbonaceous, indurated.	MW		51	10				24.17-24.81, BK	24
						24.8			CORE LOSS.			86	0					
25																		25

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Date Tested:
Total Depth: 70.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
									CORE LOSS.									
						25.9												
26									SILTSTONE Mottled grey brown, fine to medium sand, slightly metamorphosed, quartz veining, broken in part, carbonaceous, indurated.	MW		86	0				25.85-27.15, BK	26
27						27.2												27
				Rotary Coring					CORE LOSS.									
28												25	0					28
						28.7												
29									SILTSTONE Mottled grey brown, sandy (medium), slightly metamorphosed, carbonaceous, quartz veining, jointed, indurated.	MW							28.70-29.23, BK	29
						29.2												
									CORE LOSS.									
						29.7												
										MW							29.70-30.20, BK	
30																		30

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 7 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						30.2			SILTSTONE Mottled grey brown, sandy (medium), slightly metamorphosed, carbonaceous, quartz veining, indurated.	MW							
									CORE LOSS.									
31						31.0			SILTSTONE, as above.	MW							31.00-32.00, BK	31
						31.4			CORE LOSS.									
						31.8			SILTSTONE, as above.									
32				Rotary Coring														32
33						33.0												33
						33.2			SANDSTONE Mottled brown grey, medium to coarse, very silty, indurated, slightly metamorphosed, occasional carbonaceous.	MW							
									No recovery.									
34																		34
35																		35

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 8 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Date Tested:
Total Depth: 70.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
35				Rotary Coring		35.2			No recovery.	MW							35.00-35.18, JT, SPC, QZ	
									SANDSTONE tending to SILTSTONE.			100	26				35.80-36.10, JT, 15°, SPC QZ, BK	
36						36.2				Wk								36
									CORE LOSS.			59	0				36.50-36.80, BK	
						36.5			SILTSTONE Grey to dark grey, sandy (fine to medium), carbonaceous, metamorphosed, indurated, broken.									
37						37.0			CORE LOSS.			55	60					37
						37.5			SILTSTONE, as above.									
38						38.1			CORE LOSS.								38.00-39.00, QZ VN 38.10-38.50, BK	38
						38.5			SILTSTONE Dark grey, slightly coaly in part.			79	11					
39										SW							39.00-40.00, QZ VN	39
						39.7			CORE LOSS.			100	55					
40																		40

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						40.2			CORE LOSS.	SW		100	55				40.00-40.20, BK	
41						41.0			SILTSTONE Coaly, highly carbonaceous, low in sand.									41
									SILTSTONE Grey to dark grey blue, metamorphose, carbonaceous, coaly, quartz veining, medium sand (occasional), irregular bedding (disturbed).								41.00-42.00, QZ VN (2mm), multidirectional, pyritic common	
42						42.1			CORE LOSS.									42
				Rotary Coring		42.4			SILTSTONE Dark grey to blue grey, sandy (medium), metamorphosed, carbonaceous, coaly in part, irregular bedding disturbed, quartz veining, quartz on joints.									
43																	43.00-44.00, QZ VN (2mm), multidirectional joints, pyrite common	43
44						44.9			CORE LOSS.									44
45																		45

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 10 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):

Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						45.3			CORE LOSS.	SW								
									SILTSTONE Dark grey to blue grey, medium grained sand, metamorphosed, carbonaceous, coaly in part, irregular bedding disturbed, quartz veining, quartz on joints.									
46						46.4			CORE LOSS.									46
						46.8			SILTSTONE Dark grey, coal, carbonaceous, metamorphosed, irregular bedding (disturbed), jointed, microfaulted, occasional sandy, pyritic in breaks/joints (occasional).			100	51					
47				Rotary Coring														47
48												100	0					48
												100	0					
49										SW		100	88					49
												100	0					
50																		50

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 11 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Date Tested:
Total Depth: 70.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
51				Rotary Coring					SILTSTONE Dark grey, coal, carbonaceous, metamorphosed, irregular bedding (disturbed), jointed, microfaulted, occasional sandy, pyritic in breaks/joints (occasional).	SW		100	0					51
												100	0					
												60						
						51.5												
52									SILTSTONE Dark grey, coal, carbonaceous, metamorphosed, irregular bedding (disturbed), jointed, microfaulted, occasionally sandy, muddy in part, pyritic in breaks/joints (occasional).								51.70-52.10, BK	52
												100	0					
53												100	0					53
												100	0					
54												100	14					54
												100	23					
55						55.0												55

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 12 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						55.3			SILTSTONE Dark grey, coal, carbonaceous, broken, quartz on break and joints, occasional sand (fine to medium), metamorphosed, irregular bedding (disturbed), microfaulting.	SW		100	0				
						55.4			CORE LOSS.			50	0				
						55.7						50	0				
						55.8			CORE LOSS.								
56						56.2												56
									CORE LOSS.			127 53	0 0				
						56.5												
57										SW		85	13				57.00-57.30, BK	57
						57.3			CORE LOSS.								57.30-58.00, BK 57.30-57.60, QZ VN (2mm), multidirectional	
				Rotary Coring					SILTSTONE Dark grey, metamorphosed, jointed and broken, coaly carbonaceous, rare sand (fine to medium), pyritic on joints and breaks, irregular bedding (disturbed), muddy in parts, quartz veins.			37	0				57.60-58.00, BK	
58												11	0				58.00-58.60, QZ VN (2mm), multidirectional	58
																	58.60-59.00, BK	
59												17	0				59.00-59.50, QZ VN (2mm), multidirectional	59
												100	0					
60						60.0												60

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 13 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Date Tested:
Total Depth: 70.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						60.2			CORE LOSS.	SW		25	0					
												66	0					
												100	0					
						60.9												
61									CORE LOSS.			0	0					61
						61.3											61.20-62.50, BK	
									SILTSTONE Grey to dark grey, metamorphosed, coaly, carbonaceous, rare sand (fine to medium), pyritic on joints and breaks, irregular bedding (disturbed), quartz veins.			83	0					
62												100	0					62
												40	0					
63				Rotary Coring								67	0					63
												100	28					
64												100	24					64
												100	28				64.62, JT, Closed 45°, joints side, QZ VN	
65						65.0												65

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 14 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Total Depth: 70.3m
Date Tested:
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
66				Rotary Coring					SILTSTONE Grey to blue grey, metamorphosed, carbonaceous, coaly in part, rare sand (medium), joints/ microfaulting.	SW		100	28				65.50-65.60, JT/ VN sets, 5-10mm spacing	66
												100	78					
67												100	70				67.35-67.44, JT, 45°, CH, PL, OP, FM	67
												100	62					
68						68.0			SILTSTONE Grey to grey blue, highly metamorphosed, carbonaceous, coaly in part, rare sand (medium to coarse), jointed, microfaulted, quartz veins/ on joints.								68.00, JT, 45°, PL, OP, FM, CB INF, QZ VN	68
69												100	83					69
												100	59					
70																		70

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-01**

Sheet 15 of 15

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 376, **N** 6868 871
Ground Surface Elevation:
Date Tested:
Total Depth: 70.3m
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade/ NMLC

Logged:	L. McAnally	
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
						70.3			Termination Depth = 70.25m	SW		100	59					
71																		71
72																		72
73																		73
74																		74
75																		75

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-13**

Sheet 1 of 3

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 434, **N** 6869 027
Ground Surface Elevation: **Total Depth:** 13.0m
Commenced: 01-May-09 **Completed:** 01-May-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
0				Rotary Chip	Wet				Orangey brown to brown, inorganic, silty, sandy, fine to medium, low to non-cohesive, low plasticity.	EW		100						0
1										HW		100						1
2						2.0			CLAY Orangey to brown, silty, sandy, soft to firm, low to medium plasticity, low to non-cohesive.	HW		100						2
3					Moist													3
4				Rotary Chip		4.0			CLAY Orangey to brown, sandy (highly silty), low plasticity, soft to firm.	HW		100						4
5																		5

COREHOLE 412080603_TSCBH-01-TSCBH13.GPJ GHDPER.GDT 10/5/09

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-13**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 434, **N** 6869 027
Ground Surface Elevation: **Total Depth:** 13.0m
Commenced: 01-May-09 **Completed:** 01-May-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
6				Rotary Chip	Dry	6.0			CLAY Orangey to brown, sandy (highly silty), low plasticity, soft to firm.	HW		100						6
7				Rotary Chip	Dry	8.0			CLAY Orangey to brown, silty, low plasticity, soft to firm.	HW		100						7
8				Rotary Chip	Moist				CLAY Orangey to brown, silty, sandy in part, low plasticity, soft to firm.	HW		100						8
9				Rotary Chip	Moist													9
10						10.0												10

GHD MANAGEMENT ENGINEERING ENVIRONMENT

BOREHOLE LOG

*** ROCK CORE FORMAT ***

Borehole No.: **TSCBH-13**

Client: TWEED SHIRE COUNCIL
Project: WEST VALLEY QUARRY
Job No.: 41-20806-03

Coordinates: E 549 434, **N** 6869 027
Ground Surface Elevation: **Total Depth:** 13.0m
Commenced: 01-May-09 **Completed:** 01-May-09
Contractor: Bordertech **Driller:** G. Corley

Rig Type & Mounting: Truck mounted
Drilling Fluid:
Core Diameter (mm):
Inclination: Vertical
Bit Condition: Blade

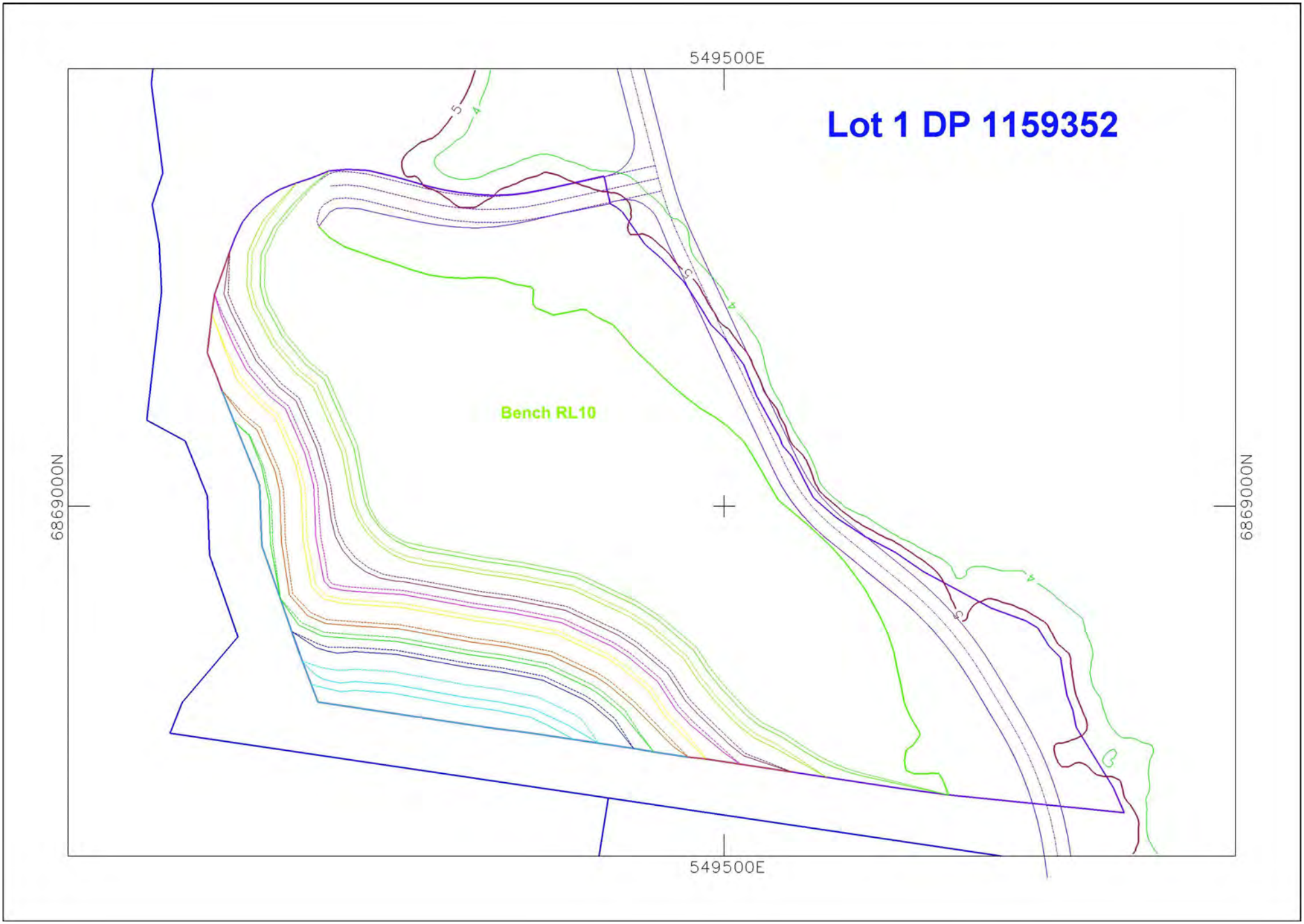
Logged:	L. McAnally	15-Jun-09
Processed:	ED	05-Oct-09
Checked:		

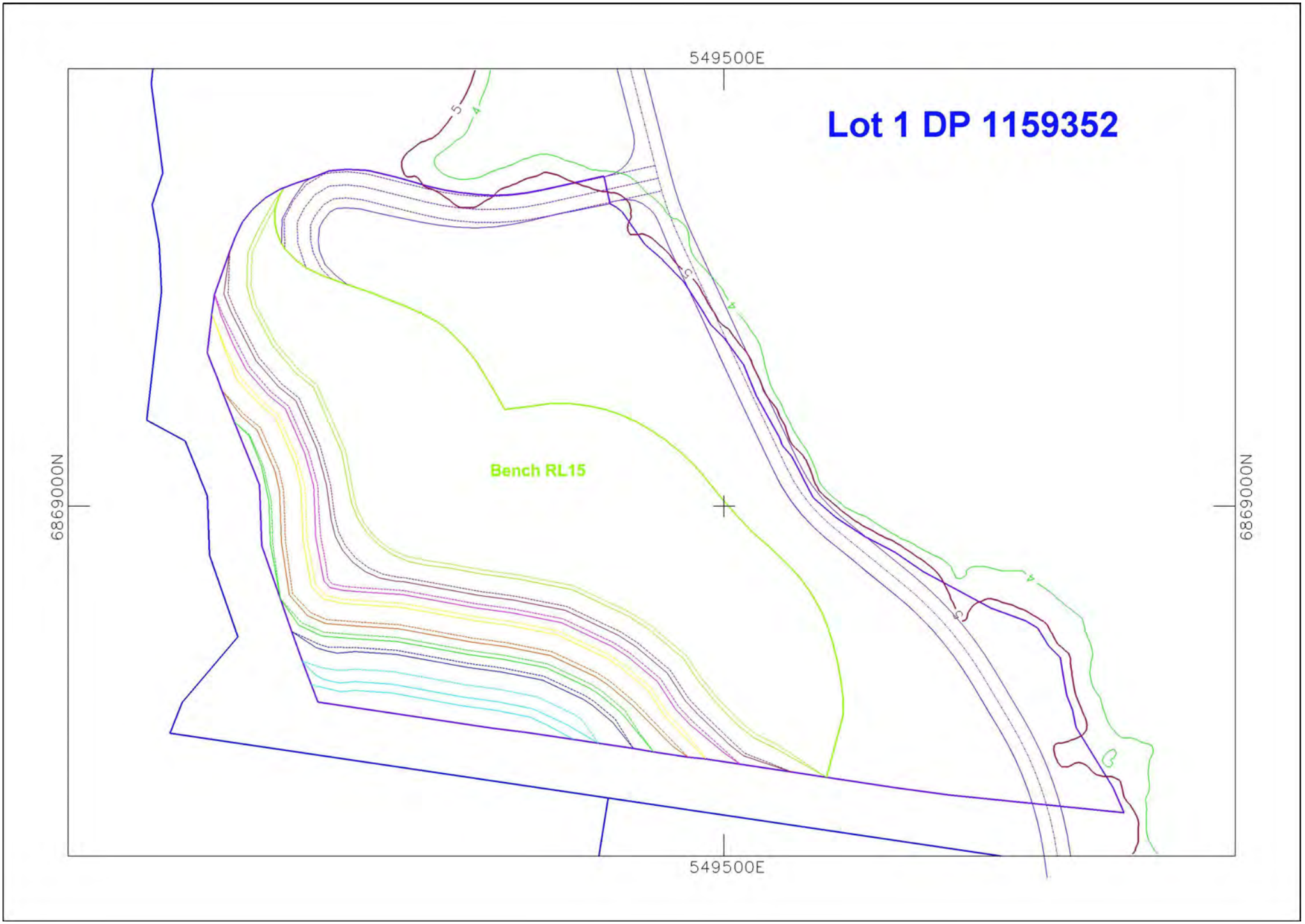
Depth Scale (m)	Daily Progress/ Observations: Date	Casing Depth (m)	Fluid Depth (m)	Drilling Method	Water	Depth (m)	Geological Unit	Graphic Log	Strata Description (Rocktype; grain size; texture & structure; colour; strength; fracture condition; minor constituents)	Weathering/ Cementation	Estimated Rock Strength (EL VL L M H VH EH)	Rock Core Quality: TCR (%)	RQD (%)	F (fractures/m)	Defect Log	Drill Rate (min/m)	Defect Description & Comments	Depth Scale (m)
11				Rotary Chip	Wet				CLAY Orangey brown, silty, low plasticity, low cohesion.	HW		100						11
12				Rotary Chip		12.0			CLAY Orangey brown, silty, firm, low plasticity, very wet.	HW		100						12
13						13.0			Termination Depth = 13m									13
14																		14
15																		15

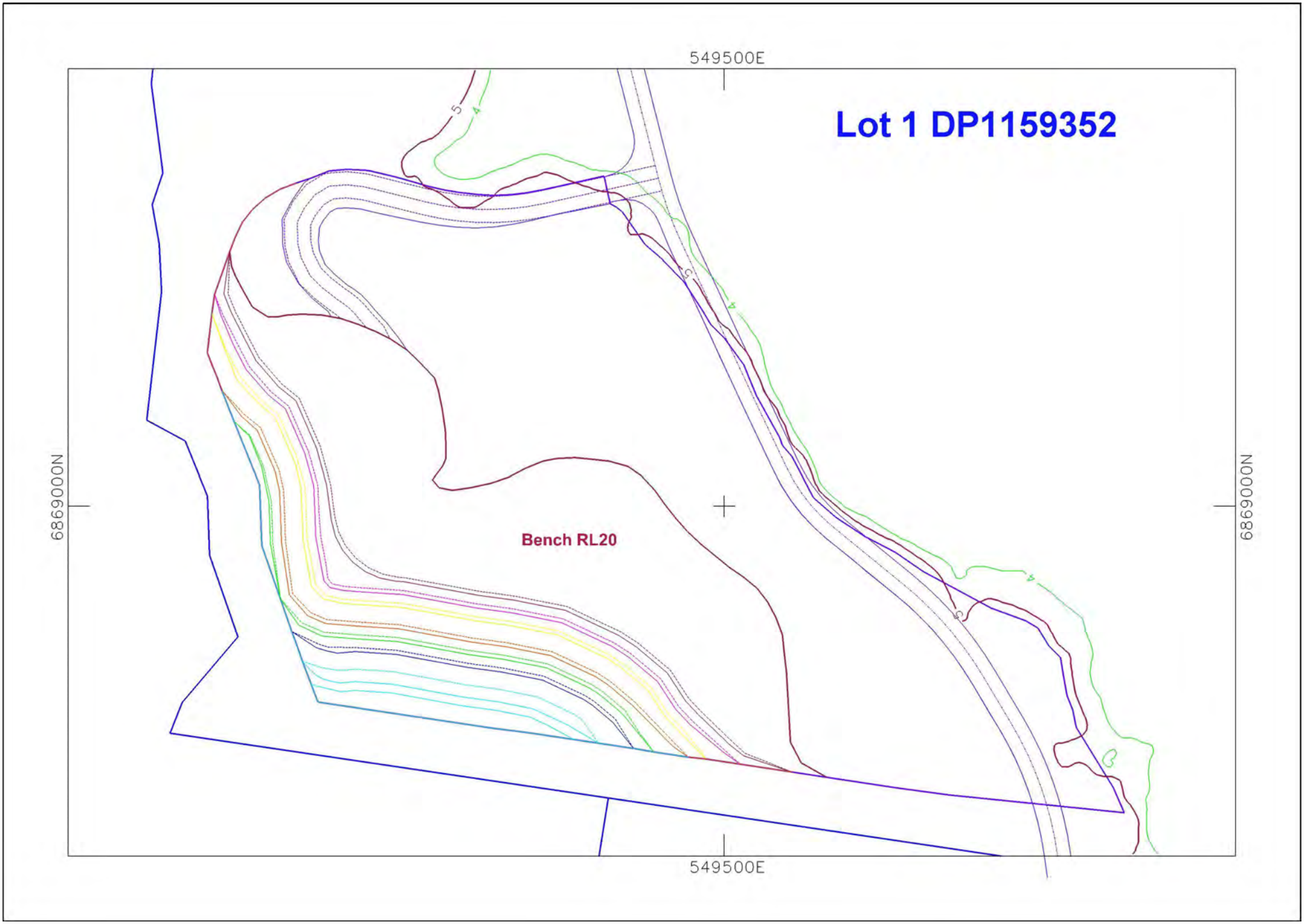
Appendix D

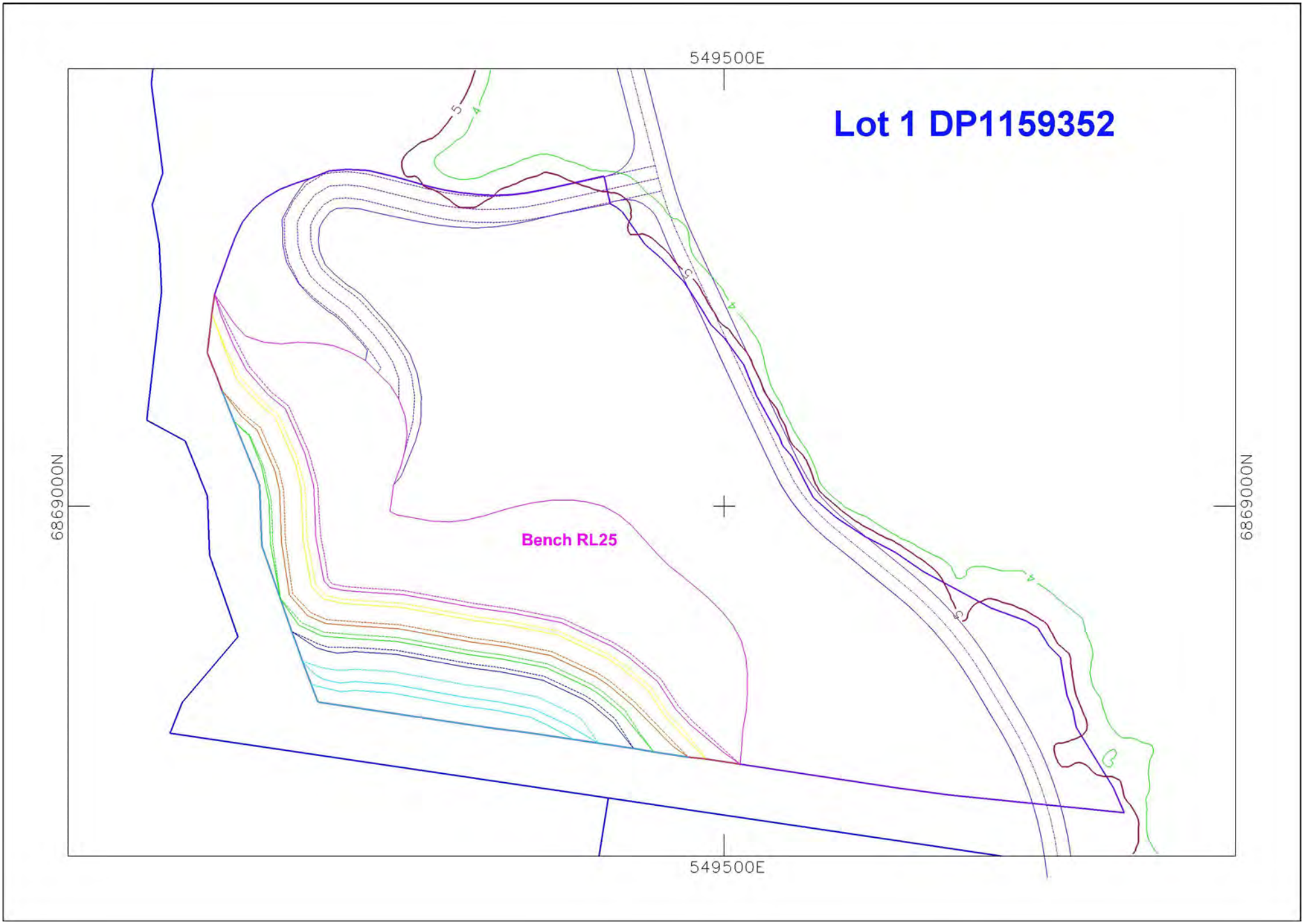
Figures and Diagrams

West Valley Quarry Schedule Plans

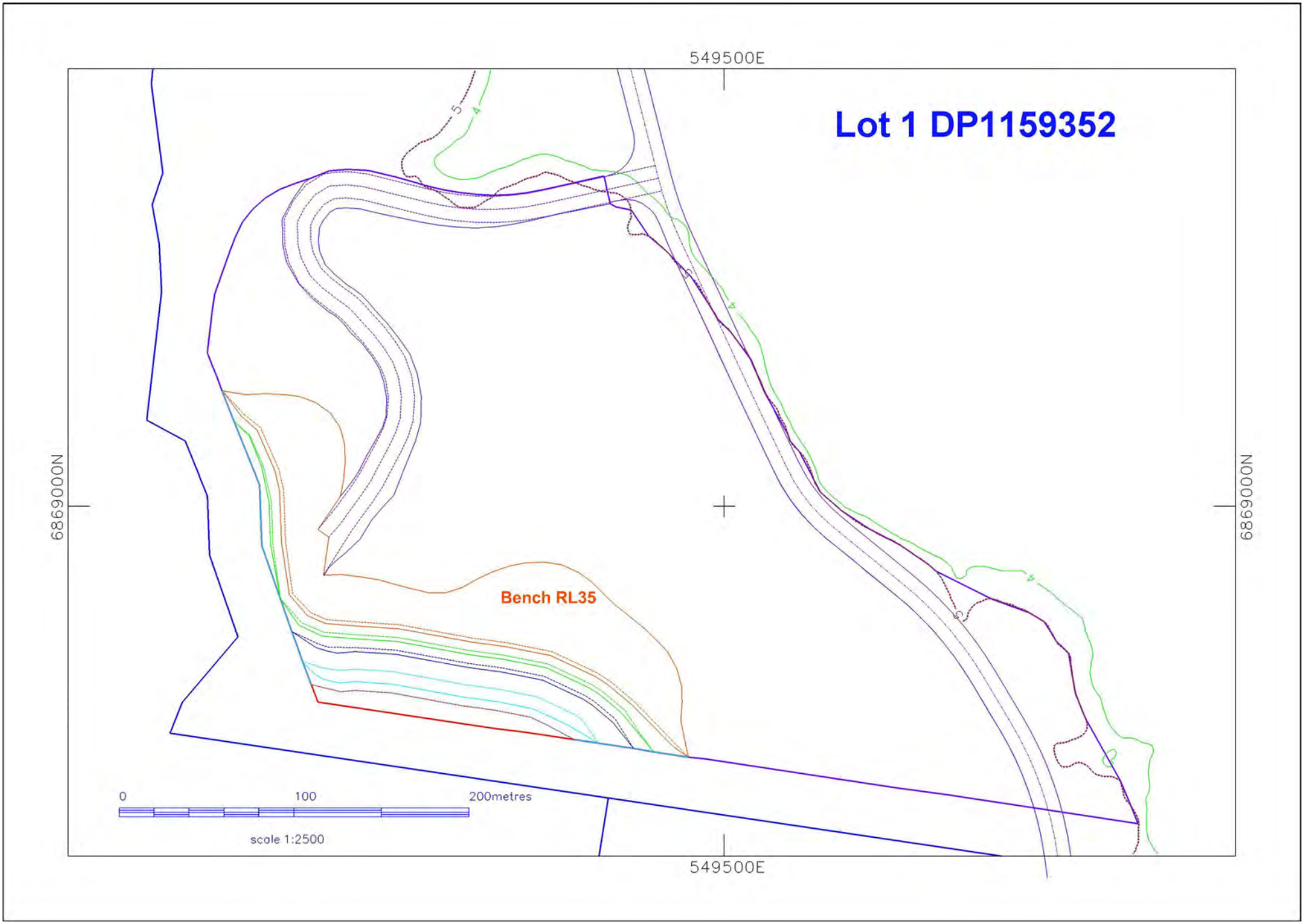

549500E
Lot 1 DP 1159352
Bench RL10
6869000N
6869000N
549500E

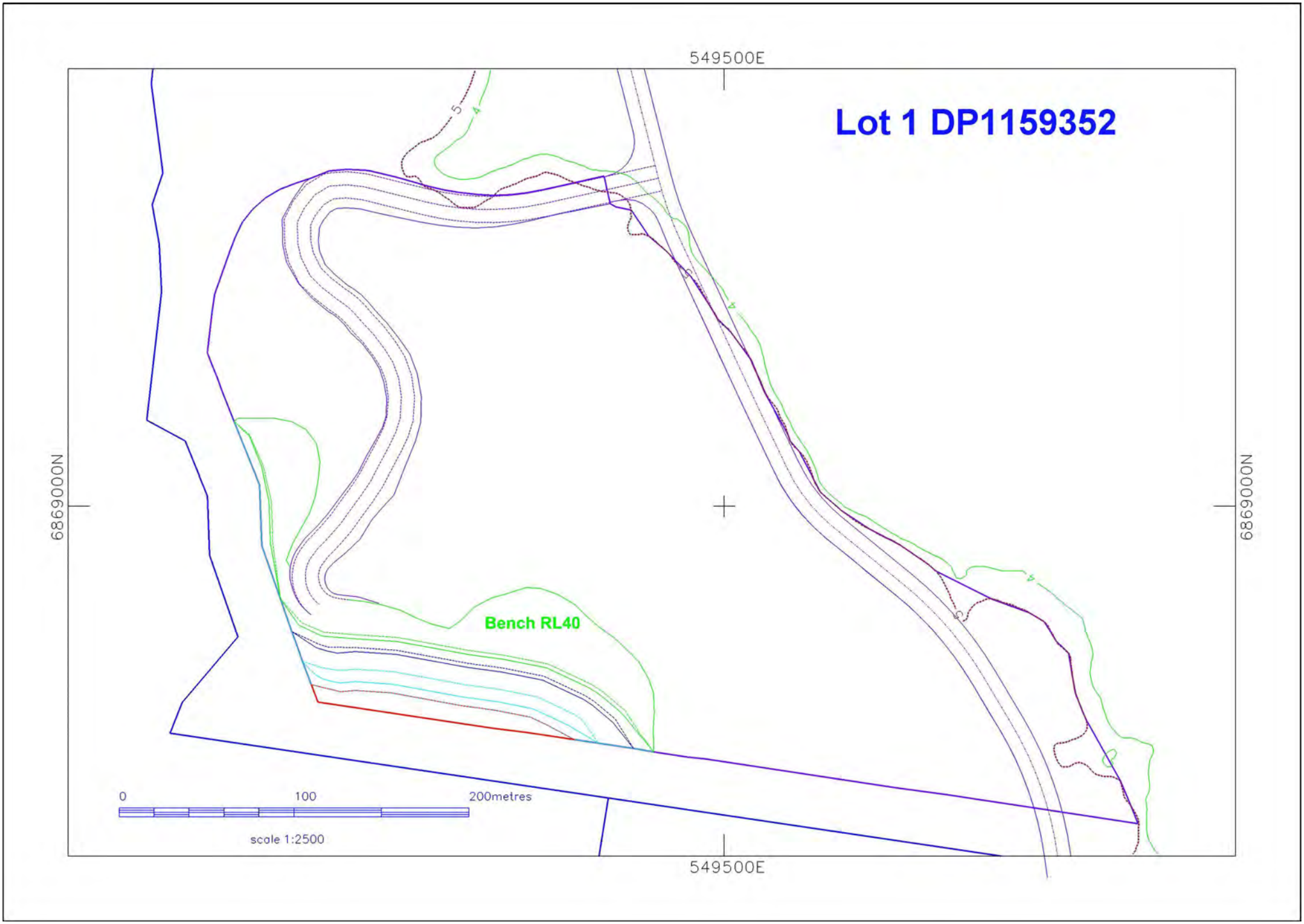

549500E
Lot 1 DP 1159352
Bench RL15
6869000N
6869000N
549500E

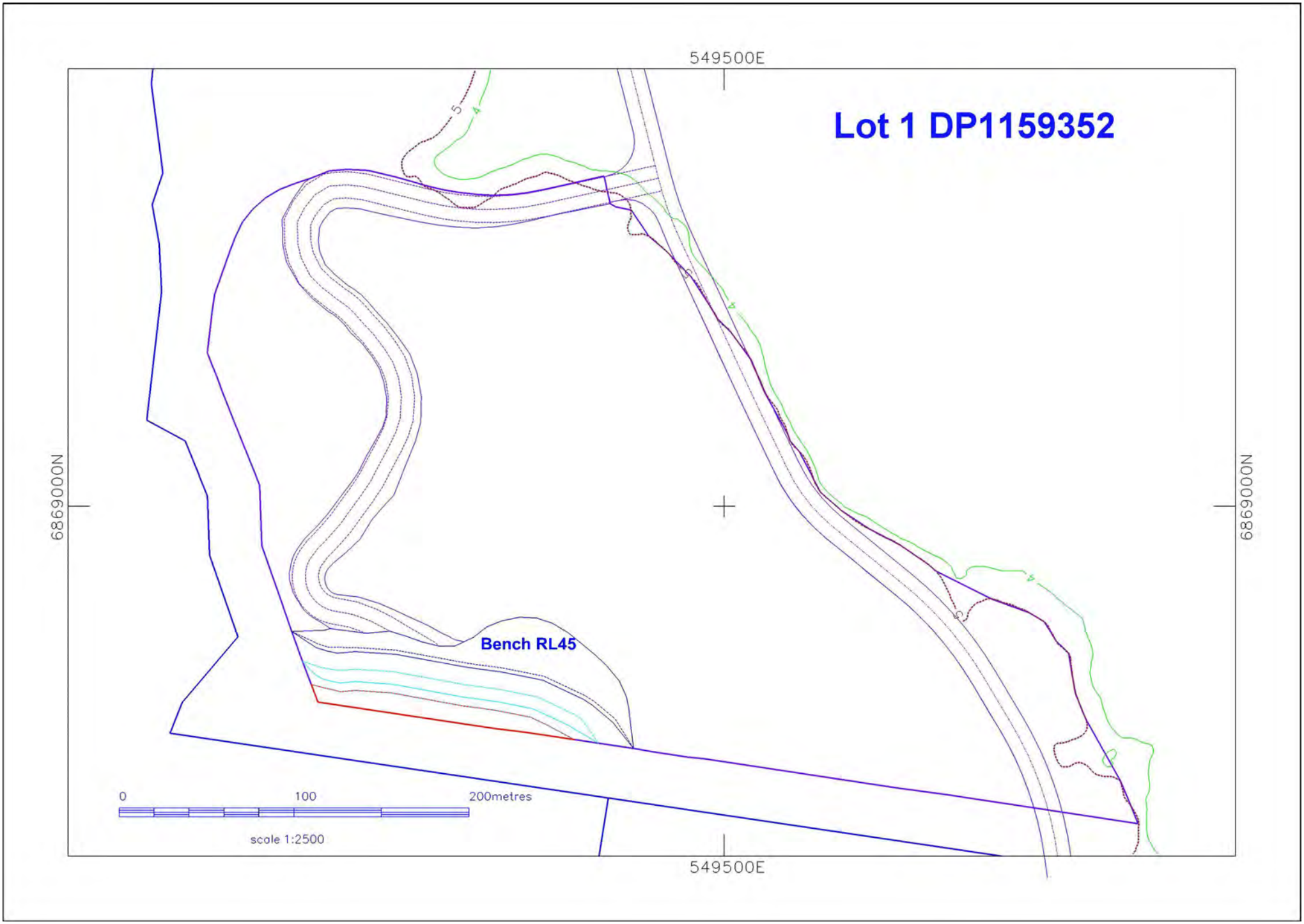

549500E
Lot 1 DP1159352
6869000N
Bench RL20
549500E

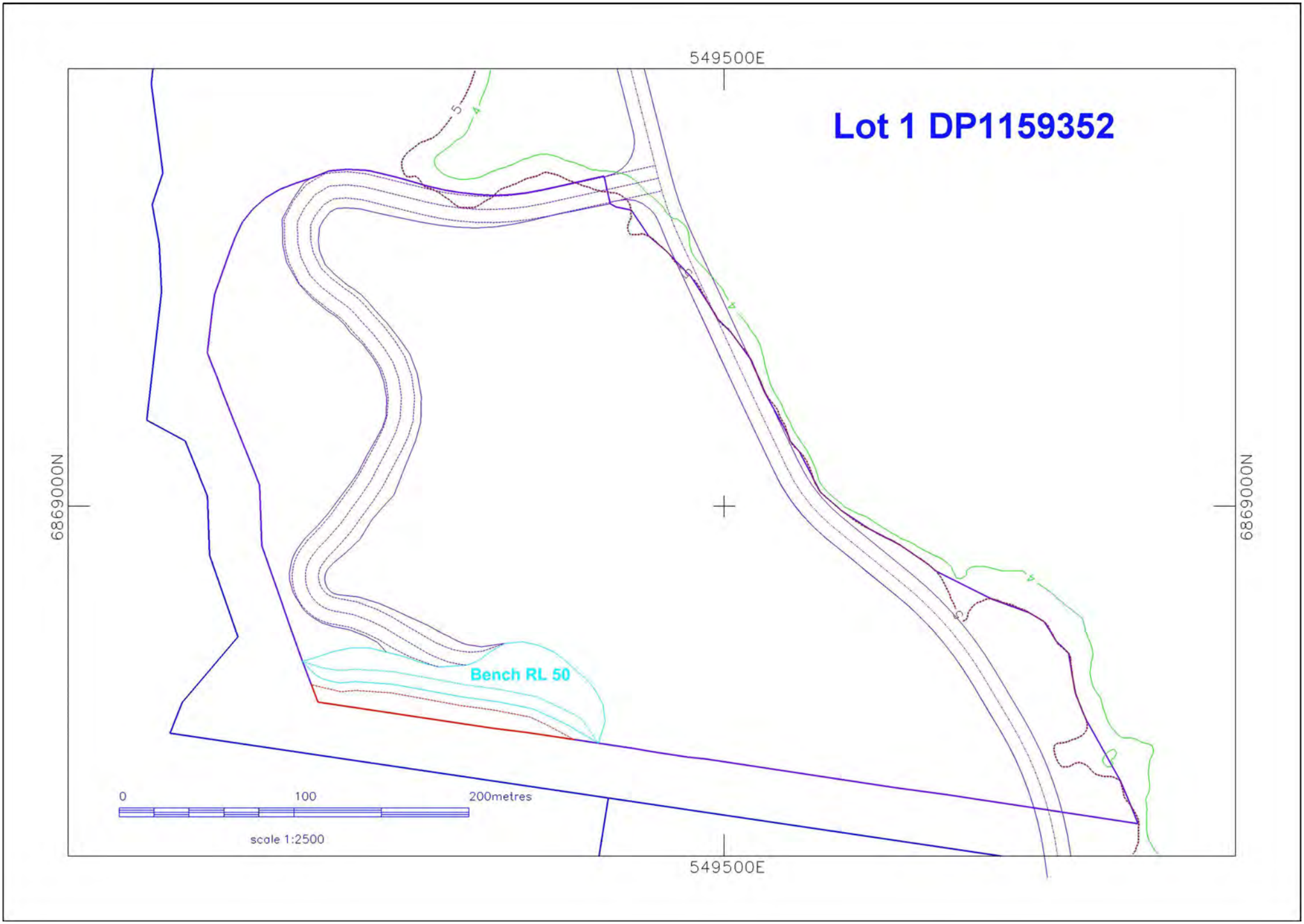

549500E
Lot 1 DP1159352
6869000N
Bench RL25
549500E

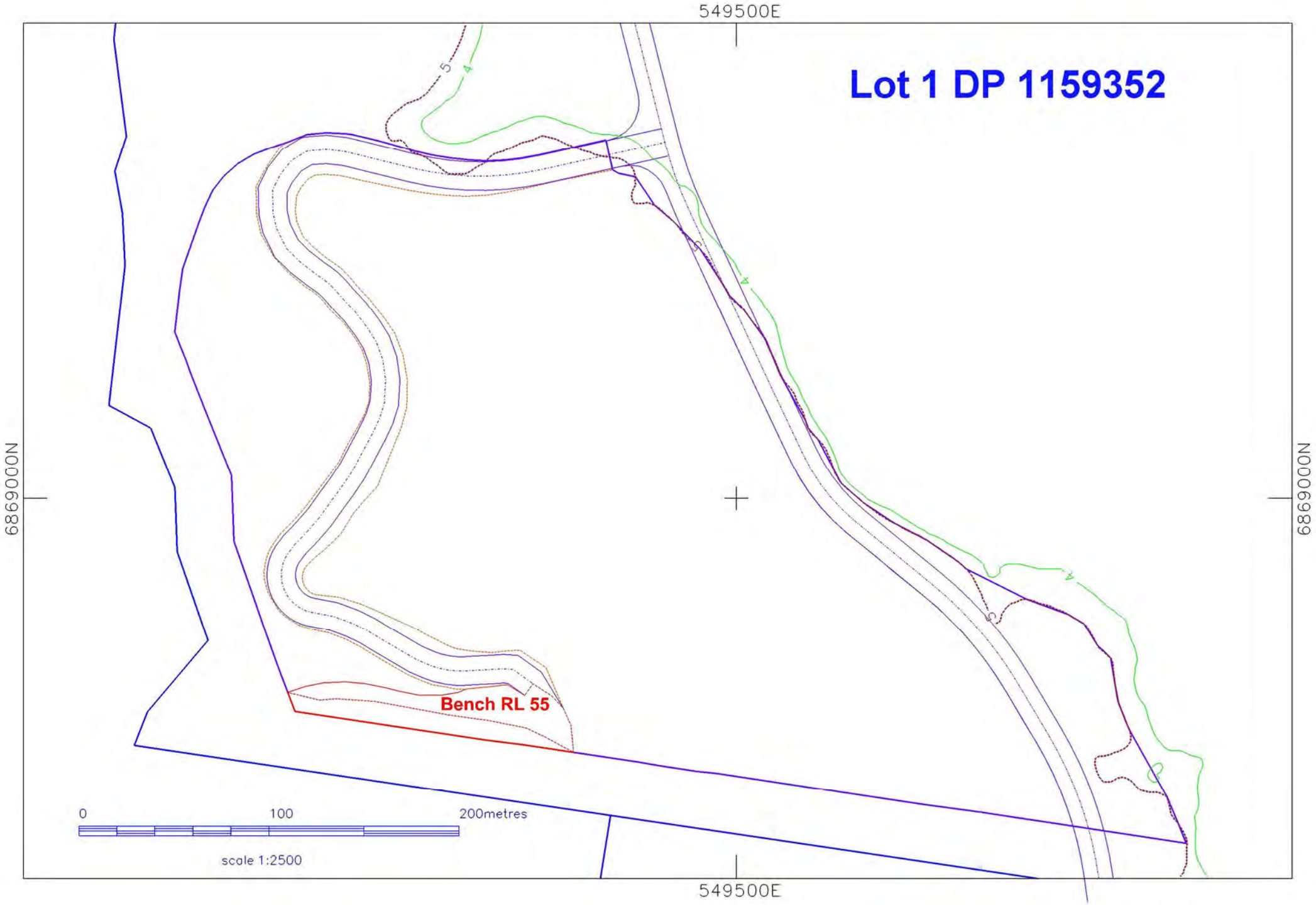

549500E
Lot 1 DP1159352
6869000N
6869000N
Bench RL30
0
100
200metres
scale 1:2500
549500E

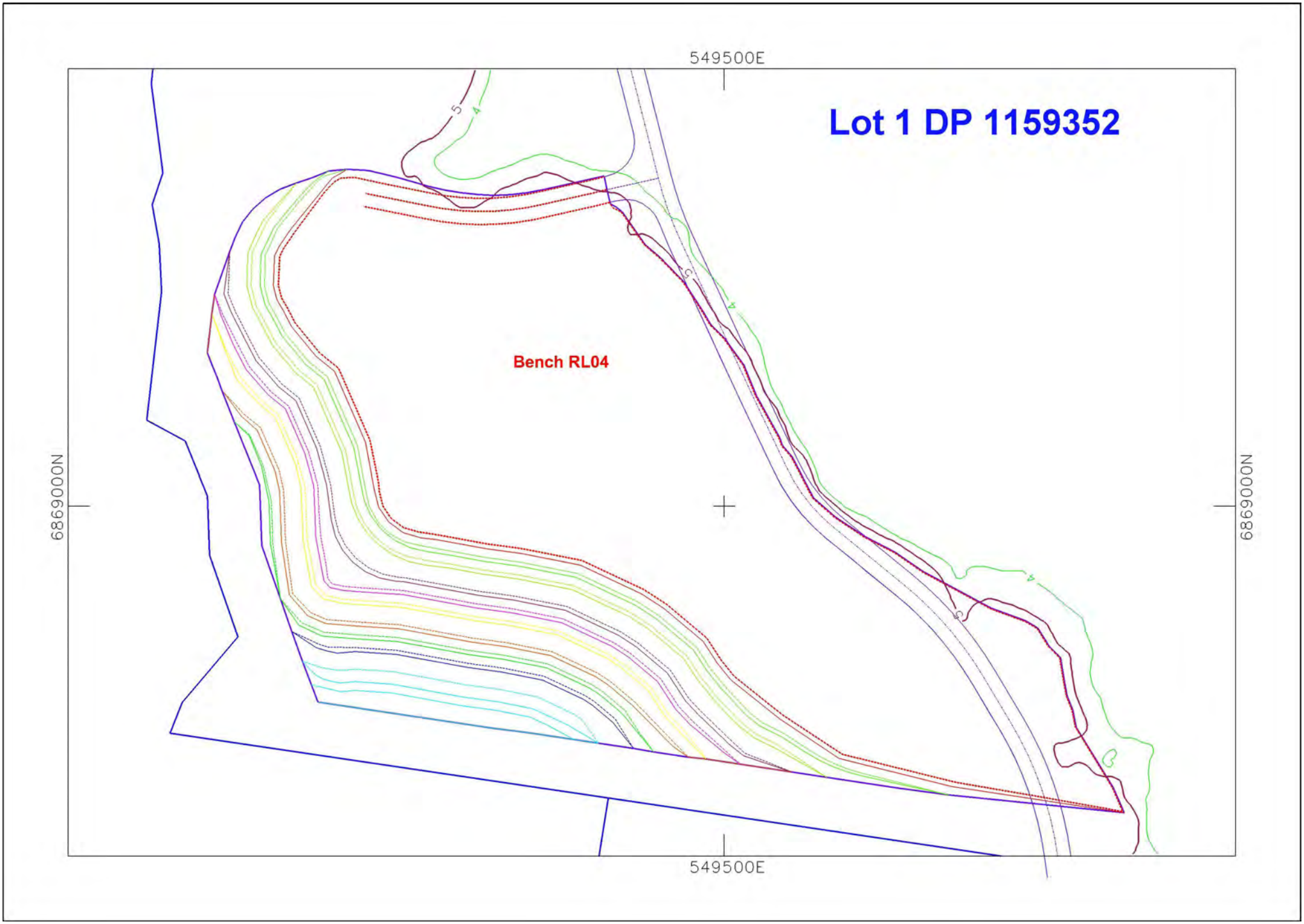

549500E
Lot 1 DP1159352
6869000N
6869000N
Bench RL35
0
100
200metres
scale 1:2500
549500E


549500E
Lot 1 DP1159352
6869000N
6869000N
Bench RL40
0
100
200metres
scale 1:2500
549500E


549500E
Lot 1 DP1159352
6869000N
6869000N
Bench RL45
0
100
200metres
scale 1:2500
549500E


549500E
Lot 1 DP1159352
6869000N
6869000N
Bench RL 50
0
100
200metres
scale 1:2500
549500E


549500E
Lot 1 DP 1159352
6869000N
6869000N
Bench RL 55
0
100
200metres
scale 1:2500
549500E


549500E
Lot 1 DP 1159352
Bench RL04
6869000N
6869000N
549500E

GHD

201 Charlotte Street Brisbane QLD 4000
GPO Box 668 Brisbane QLD 4001
T: (07) 3316 3000 F: (07) 3316 3333 E: bnemail@ghd.com.au

© GHD 2011

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	L McAnally	D Holgate D Stolberg	Signed	A Marszalek	Signed	13/11/09
1	C Coles et al	I Reid A Marszalek	Signed	J Haines	Signed	18/1/11
2	M Gaughan	F Carrello	F. Carrello	F Carrello	F. Carrello	22/9/11

Appendix E

Tweed Shire Domestic Solid Waste Management Strategy

APC Environmental Management





DOMESTIC SOLID WASTE MANAGEMENT STRATEGY

FOR

TWEED SHIRE COUNCIL

June 2007

APRINCE CONSULTING PTY LTD TRADING AS APC
ACN 077 504 226
PO Box 54 Terrey Hills NSW 2084 ~ Phone: 612 9907 0994 Fax: 612 9907 0330
PO Box 1163 Kenmore Qld 4069 ~ Phone: 617 3878 5515 Fax: 617 3878 5510
PO Box 6782 East Perth WA 6892 ~ Phone 618 9472 8811 Fax: 618 9472 1212
Web: www.aprince.com.au E-mail: admin@aprince.com.au

This report was researched and prepared by

APC – APrince Consulting Pty Ltd
ACN 077 504 226
Email: admin@aprince.com.au
Web: www.aprince.com.au

Sydney	Brisbane	Perth
PO Box 54	PO Box 1163	PO Box 6782
Terrey Hills NSW 2084	Kenmore Qld 4069	East Perth WA 6892
Phone: (02) 9907 0994	Phone: (07) 3878 5515	Phone: (08) 9472 8811
Fax: (02) 9907 0330	Fax: (07) 3878 5510	Fax: (08) 9472 1212

for

Tweed Shire Council
PO Box 816
Murwillumbah NSW 2484
Phone: (02) 6670 2440
Fax: (02) 6670 2590
Web: www.tweed.nsw.gov.au

Document status

Rev. no.	Document	Authors	Editor	Date
1	Draft	Anne Prince, Rick Ralph	Pat Skinner	January 2007
3	Final	Anne Prince,	Pat Skinner	June 2007

© June 2007 APrince Consulting

DISCLAIMER

Any representation, statement, opinion or advice, expressed or implied in this publication is made in good faith, but on the basis that APrince Consulting is not liable (whether by reason of negligence, lack of care or otherwise) to any person for any damage or loss whatsoever, which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any representation, statement of advice referred to here.

TABLE OF CONTENTS

ACRONYMS 7
EXECUTIVE SUMMARY 8
1. INTRODUCTION 16
2. TWEED SHIRE COUNCIL 18
3. WASTE MANAGEMENT STRATEGY 20
4. LITERATURE REVIEW 22
5. POLICY FRAMEWORK 26
5.1 COMMONWEALTH 26
5.2 STATE GOVERNMENT 26
5.3 LOCAL GOVERNMENT 28
6. CURRENT WASTE MANAGEMENT SYSTEM 30
6.1 DOMESTIC SERVICES 30
6.2 WASTE DISPOSAL 34
6.3 WASTE COLLECTION SERVICES 41
6.4 INDEPENDENT WASTE PROGRAMS 43
6.5 WASTE MANAGEMENT COSTS 43
7. WASTE CHARACTERISATION STUDY 46
7.1 REGIONAL MUNICIPAL WASTE CHARACTERISATION STUDY 46
7.2 SOLO WASTE AUDIT 53
7.3 MRF AUDIT 54
8. MARKET RESEARCH 56
8.1 METHOD 56
8.2 SURVEY RESULTS 57
8.3 KEY FINDINGS 65
9. STAKEHOLDER CONSULTATION 67
9.1 REGIONAL COUNCILS 67
9.2 REGIONAL WASTE ORGANISATIONS 71
9.3 STATE GOVERNMENT AGENCIES 71
9.4 LANDFILL OPERATORS 72
9.5 RECYCLING PROCESSORS 73
10. ASSESSMENT OF DISPOSAL PRACTICES 74
10.1 BI-ANNUAL HOUSEHOLD CLEAN-UP SERVICE 74
10.2 LANDFILL ACTIVITY 76
10.3. KEY FINDINGS 84
11. STRATEGIC OPTIONS BY MATERIAL 86
11.1 AGRICULTURAL CHEMICAL CONTAINERS 88
11.2 ASBESTOS 88
11.3 BATTERIES 89
11.4 BUILDING MATERIALS 89
11.5 GAS BOTTLES 90
11.6 HOUSEHOLD FURNITURE, BRIC-A-BRAC 90
11.7 HOUSEHOLD HAZARDOUS 91
11.8 RECYCLABLES 92

12 PROPOSED WASTE MANAGEMENT SYSTEMS 93

12.1 CURRENT PERFORMANCE 93
12.2 RECYCLING 94
12.3 GREEN ORGANICS COLLECTION 100
12.4 FOOD WASTE COLLECTION 103
12.5 DOMESTIC WASTE 107
12.6 BI-ANNUAL HOUSEHOLD CLEAN-UP SERVICE 110
12.7 RECYCLING PROCESSING – MRF 111
12.8 ORGANICS PROCESSING 114
12.9 PUBLIC-PLACE WASTE MANAGEMENT 116
12.10 COMMERCIAL, CONSTRUCTION AND DEMOLITION WASTE 121
12.11 EDUCATION AND COMMUNICATION 124

13 WASTE DISPOSAL OPTIONS & ALTERNATE WASTE TECHNOLOGY... 128

13.1 NEW LANDFILL AT ENVIRON 128
13.2 ALTERNATIVE OPPORTUNITIES – EXPORT TO EXISTING LANDFILLS 131
13.3 ALTERNATIVE OPPORTUNITIES – EXPORT TO NEW LANDFILL 131
13.4 ALTERNATIVE WASTE TECHNOLOGIES OPTIONS AND OPPORTUNITIES 131
13.5 MECHANICAL SEPARATION TECHNOLOGIES 132
13.6 MECHANICAL BIOLOGICAL TREATMENT TECHNOLOGIES 133
13.7 LANDFILL TECHNOLOGIES 134
13.8. AWT IN AUSTRALIA 135

14. Community Consultation 141

14.1 METHOD 141
14.2 COMMUNITY FEEDBACK 145
14.3 FEEDBACK SUMMARY 149
14.4 STAKEHOLDER FEEDBACK 151
14.5 ISSUES FOR CONSIDERATION 154
14.6 CONCLUSION 155

15. STRATEGIC FRAMEWORK 156

15.1 STRATEGIC FRAMEWORK 156
15.2 SYSTEM PERFORMANCE INDICATORS 156
15.3 RECOMMENDATIONS 157
15.4 ACTION PLAN AND TIMELINE 160

16. CONCLUSION 162

APPENDIX 1 –SOCIO-DEMOGRAPHICS TWEED SHIRE 164

APPENDIX 2 - TWEED RESIDENT SURVEY – URBAN 169

APPENDIX 3 - TWEED COUNCIL RESIDENT SURVEY – RURAL 174

APPENDIX 4 - TWEED COUNCIL VISITOR SURVEY 177

APPENDIX 5 - COMMUNITY CONSULTATION HANDOUT 183

APPENDIX 6 - DRAFT REPORT EXECUTIVE SUMMARY 187

APPENDIX 7 - TWEEDLINK ARTICLES 196

APPENDIX 8 - LETTER TO PROGRESS ASSOCIATIONS 199

APPENDIX 9 - E-MAIL FEEDBACK 201

APPENDIX 10 - FEEDBACK LETTERS 210

APPENDIX 11 - STAKEHOLDER SUBMISSION 219

CHARTS AND TABLES

Table 1 - Tweed LGA and NSW Key Demographic and Social Indicators 16
Table 2 - Community's Willingness to Pay for Garden Waste Collection Program 23
Table 3 - NSW Waste Targets 27
Table 4 - NSW Wastes of Concern – Priority Materials 27
Table 5 - Domestic Waste Management Fees and Charges 34
Table 6 - Commercial Waste Management Fees and Charges 34
Table 7 - Landfill Licence Details 35
Table 8 - Contractor's Obligations 37
Table 9 - Landfill Licence Details 40
Table 10 - The Domestic Waste Management Charge Components 06/07 44
Table 11 - Comparison with DECC Performance Standards 51
Table 12 - Survey Distribution and Sample Size – Proposed and Actual 56
Table 13 - Question 5. On average, how full is your rubbish side each time you put it out? 58
Table 14 - Question 6. On average, how full is your recycling side each time you put it out? 58
Table 15 - Questions 5 and 6. Average levels of rubbish/recycling 58
Table 16 - Question 7. Does your rubbish or recycling side fill up first? 59
Table 17 - Question 8. Do you put your rubbish/recycling in plastic bags before putting them in the bin? 59
Table 18 - Question 9. Which materials do you separate for recycling? 59
Table 19 - Question 10. What do you do with any excess recyclables? 59
Table 20 - Question 10 'Other' included 59
Table 21 - Question 11. Do you think Council should introduce a separate bin for recycling collected every fortnight? 60
Table 22 - Question 11. Do you think council should introduce a separate bin just for recycling collected every fortnight? – by household size 60
Table 23 - Question 11a. Why? 60
Table 24 - Question 12. Do you have a wheelie bin for garden waste collected fortnightly? 60
Table 25 - Question 12a. If no, did you know Council provides this service for an additional cost of $35 per year (some rural areas excluded)? 61
Table 26 - Question 13. Do you think Council should introduce a fortnightly garden waste wheelie bin as a standard service for every property? 61
Table 27 - Question 14. What do you do with leaves, prunings and grass clippings? 61
Table 28 - Question 15. Do you use Council's bulky household clean-up service? If so, how often? 61
Table 29 - Question 16. Do you visit the waste depots or transfer station? If yes, which one? 61
Table 30 - Question 17. Frequency of visits to waste depots/transfer stations 62
Table 31 - Question 18. Size of load delivered to waste depots/transfer stations? 62
Table 32 - Question 19. What type of materials do you take to the waste depot? 62
Table 33 - Question 20. If Council were to close Murwillumbah landfill, would you travel to Stotts Creek Landfill, which is open 7 days per week? 63
Table 34 - Question 21. Do you think the current opening hours at Stotts Creek landfill are adequate? 63
Table 35 - Question 22. What do you do with any food waste? 63
Table 36 - Question 23. Are you aware that Council provides FREE mulch at the Murwillumbah depot? 63
Table 37 - Question 23a. Are you aware that Council provides mulch at Stotts Creek landfill for $15/trailer loaded? 63
Table 38 - Question 24. Do you have any suggestions on how waste management could be improved in Tweed? 64
Table 39 - Questions 25 and 26. Dwelling type and household size 65
Table 40 - Question 27. Respondent's age by gender 65
Table 41 - Gold Coast City Council Landfills 70
Table 42 - Household Clean-up Service 74
Table 43 - Murwillumbah Landfill 81
Table 44 - Stotts Creek Landfill 81
Table 45 - Stotts Creek Landfill Transactions 85
Table 46 - Murwillumbah Landfill Transactions 85
Table 47 - Building Waste Fees 89

Table 48 - Tweed Shire Waste Stream 93
Table 49 - Current Recycling Stream Composition – Tweed and NSW Average 95
Table 50 - Comparison with DECC Performance Standards 96
Table 51 - Collection System Configurations Assessed 96
Table 52 - Cost Elements Summary 99
Table 53 - Cost Elements – Service 100
Table 54 - Cost Elements Summary 102
Table 55 - Cost Elements – Service 102
Table 56 - Food Waste Bin Costs Summary 107
Table 57 - Byron Bay Council – Bin Use by Size 108
Table 58 - Recommended Bin Colours 109
Table 59 - Cost Elements Summary 109
Table 60 - Cost Elements - Service 110
Table 61 - Household Clean-up Service 110
Table 62 - Kangaroo Island Landfill Fees and Charges 123
Table 63 - MBT Process Summary 134
Table 64 - Recommendations and Community Views 149
Table 65 - NSW DECC Model Contract Management Timeline 161

Chart 1 - Average Weight of Waste Streams by Bin Configuration 47
Chart 2 - Composition of the Residential Garbage Stream 47
Chart 3 - Potentially Recoverable Proportion of the Garbage Stream 48
Chart 4 - Waste Generation by Material Type 48
Chart 5 - Recycling Stream Composition 49
Chart 6 - Recyclable Recovery Rates 49
Chart 7 - Recycling Contamination by Household 50
Chart 8 - Composition of Contamination in the Recycling Stream 50
Chart 9 - Tweed Audit Data v DECC Targets – Net Yield Per Week 51
Chart 10 - Tweed Audit Data v DECC Targets – Diversion and Contamination Rates 52
Chart 11 - Composition of the Recycling Stream – Solo Waste Audit 53
Chart 12 - MRF Diversion Rate 54
Chart 13 - Weight of Recycling Found in Previous Audits 55
Chart 14 - Consolidated Composition of the Clean-up Garbage Stream by Volume 75
Chart 15 - Number of Households Presenting Materials 75
Chart 16 - Average Litres per Household of Different Materials 76
Chart 17 - Number of vehicles per hour, Stotts Creek 77
Chart 18 - Number of Vehicles by Patron, Stotts Creek 77
Chart 19 - Number of Vehicles per Hour, Murwillumbah 78
Chart 20 - Vehicles per Hour Both Landfills 79
Chart 21 - Number of Vehicles by Type 79
Chart 22 - Number of Vehicles by Waste Source 80
Chart 23 - Number of Vehicles by Waste Type 80
Chart 24 - Vehicles Entering Stotts Creek Landfill – APC Survey Results v Solo Figures v Council 82
Chart 25 - Vehicles Entering Stotts Creek Landfill – APC Survey Results v Solo v Council 82
Chart 26 - Large Vehicles Entering Stotts Creek Landfill – APC Survey Results v Solo v Council 83
Chart 27 - Vehicles Entering Murwillumbah Landfill – APC Survey Results v Council Figures 83
Chart 28 - Tweed Shire Kerbside Diversion Rate 94
Chart 29 - Percentage of Broken Glass v Load Density – Commingled Loads Only 97
Chart 30 - Dee Why/Collaroy Public Place Bins - KPIs 121
Chart 31 - Projected Tweed Shire Kerbside Diversion Rate 157

ACRONYMS

AGT	= Australian Glass Technologies
APC	= APrince Consulting
AS	= Australian Standard
CCA	= Copper Chrome Arsenic
C&D	= Construction and demolition
C&I	= Commercial and industrial
DA	= Development Application
DECC	= Department of Environment and Climate Change
EMP	= Environmental Management Plan
EPL	= Environmental Protection Licence
FTE	= Full-Time Equivalent
GCCC	= Gold Coast City Council
JRG	= Jurisdictional Recycling Group
LEMP	= Landfill Environmental Management Plan
MRF	= Materials Recovery Facility
MSW	= Municipal Solid Waste
NPWS	= National Parks and Wildlife Service
SEQROC	= South East Queensland Regional Organisation of Councils
WMS	= Waste Management Strategy
WRAP	= Waste Reduction and Purchasing Policy

EXECUTIVE SUMMARY

Tweed Shire Council (TSC) appointed APrince Consulting (APC) to prepare a Waste Management Strategy for the council area. APC has previous experience in developing waste plans for similar coastal areas which are experiencing substantial population growth, balancing equitable service delivery for rural and urban areas and meeting the expectations of the 'sea and tree changers' as well as those of long-term residents.

The Tweed area is a popular holiday destination for visitors from NSW, other Australian states and overseas. It has over 30 kilometres of coastline which attracts visitors all year round but particularly in the summer school-holiday period, a time which places strain on resources and services. The region is also one of the State's fastest growing areas with increasing numbers of 'sea and tree changers' and retirees choosing to live permanently in the area. The airport at Coolangatta also allows professional people to base themselves in the area and still have easy access to the capital cities.

Tweed Shire Council and the Department of Environment and Climate Change's National Parks and Wildlife Branch control and manage the land assets of the area.

The recommendations in this Waste Strategy are based on sound quantitative and qualitative research. A review of previous studies, reports and correspondence on waste management relating to the past and current systems were made available to the consultants for review and provided invaluable background information. In addition, the consultants undertook:

- Extensive stakeholder consultation
- Market research to determine the current attitudes, views, opinions and behaviour of local residents and visitors
- Detailed analysis of historical and current data to determine usage patterns at waste disposal facilities
- Exploration of a range of options for the collection, treatment and disposal of the various waste streams generated.
- Detailed community consultation program

There are a number of factors that influence waste generation and therefore hinder our efforts towards waste avoidance; these include:

- Economic activity and consumption – as people achieve higher social economic status or as positive economic conditions occur, there is a higher level of consumption of goods and services, leading to more waste.
- Population – an increase in waste generated has been shown to have proportional links to population increases.

Tweed Shire is currently experiencing and is expected to continue to experience both of these conditions.

Council currently contracts out the collection of household waste, recycling and optional green waste services and public litter bins, and provides a bi-annual bulky household waste collection. The contractor also undertakes the day-to-day management of the Stotts Creek Landfill and all activities on that site, including the operation of the current putrescible and inert landfill cell and composting operations. The contractor sub-contracts the operations of the tip shop and Materials Recovery Facility (MRF) where recyablables are separated and processed for on selling and / or export.

The current Waste Management Services Contract commenced in 2004 and expires on 30th November 2009, and Council is seeking guidance and direction on the provisions which should be contained in the new contract. The NSW DECC has developed a Model Waste and Recycling Collection Contract, which specifies that a period of 24 months should be allowed from the commencement of the preparation of the tender documents to the service implementation.

Council introduced a divided 240-litre garbage and recycling service for which the divider was originally positioned for a 70:30 division with 70% of the space for garbage and 30% for recycling. A community survey in 2003 clearly indicated that there was insufficient room for recyclables with the current configuration and, as a result, Council required the new contractor to reposition the divider to a 50:50 position.

Council provides domestic waste services to 31,566 premises. In 2005–06 Council collected 23,394 tonnes of domestic waste, 6,560 tonnes of recyclables and 2,109 tonnes of garden waste representing a diversion rate of 27%.

The current waste management program has been audited as part of a North East Waste Forum waste characterisation project, and it was found that, on average, 15% of the recycling stream contained material unsuitable for recycling which is termed contamination. This is consistent with an annual audit conducted in September 2006 by the contractor, which found 17.9% contamination.

Based on data provided by the contractor for the performance of the Materials Recovery Facility (MRF), where all kerbside-collected recyclables are sorted using a mix of mechanical and manual methods, only 60% of what the householder places in the recycling section of the bin is recovered. The remaining 40% is lost as glass fines and contamination, therefore just 2.5 kg per household are recovered.

The NSW State Waste Strategy has set a target of 66% diversion for municipal waste by 2014. The regional audit found that currently the garbage bin comprises 48% organic material and a further 23% consists of undiverted recyclables. Up to 70% of the Tweed Shire garbage stream can be classified as potentially recoverable resources, leaving a residual waste of 30%, or 3.5 kg per household per week. Clearly, Council has to address the organics stream and improve its current performance and be aligned to the state target.

Results from neighbouring Councils Clarence and Lismore indicate that it is possible to reduce the quantity of garden organics in the garbage stream by up to 80%, and food organics by up to 50%.

As part of this project a community survey was undertaken, in which 215 residents were randomly selected and interviewed. The key results reveal that 36% of people indicated the rubbish side of their domestic waste bin was full to overflowing each collection, while 37% indicated the recycling side was full to overflowing and 28% indicated that both sides of the bin were overflowing. When asked what people did with any excess recyclables, the majority placed it in the rubbish bin, kept it until the next collection, used the neighbour's bin or took it to work.

When asked if Council should introduce a dedicated kerbside recycling container the majority of the residents, 59%, supported this outcome. When the analysis was undertaken based on household size, households with 1–2 people were fairly equally represented, with 47% supportive and 49% opposed to its introduction. However, in families with three or more people, the results were very clear, with 82% in support and only 18% in disagreement. Clearly Council has a mandate to introduce a separate recycling bin.

Council provides a voluntary user-pays garden organics service in a 240-litre bin on a fortnightly collection schedule. Currently 25% of households have signed up for the service. During the survey, 47% of respondents indicated they did not know about the service. When asked if this should become a standard service, overall 42% supported this. However, when the results were analysed by type of dwelling and location, 50% of single households in townships supported the introduction, while those living on acreage mulched their garden waste, and medium-density dwellings tended to contract garden services.

Council offers free mulch at Murwillumbah depot, however, 62% of survey respondents said they did not know about this option while 58% did not know mulch was offered for sale at Stotts Creek. Several comments were made about the poor quality of the mulch, particularly at the Murwillumbah depot.

In total, 116 suggestions for improvements to the waste management programs were offered by the survey participants, with the key common emerging themes relating to the need for greater recycling and waste capacity, the need for a three-bin system, the quality of the mulch and the need for continued education of the community.

A detailed community consultation program followed the delivery of the draft waste strategy and included:

- promotion of the Draft Waste Plan in the Tweed Link which is delivered to all residents,
- preparation of a community consult document summarising the eleven key recommendations and the Executive Summary of the draft Waste Plan was available upon request from Council offices or web site,
- an opportunity to meet or talk with the consultants was provided the week of 5th March,
- presentations Progress Associations,
- briefing with the current contractor
- Tweed Link advertisements sought feedback on draft strategy

Council's website recorded 81 hits on the Community Consultation Summary document and 291 hits on the Draft Waste Strategy Executive Summary. Consultants

and Council staff attended and presented at three Progress Association meetings. In total, five letters and nineteen emails were received. A response was forwarded to each submission received addressing or clarifying any particular area of concern.

The community consultation program yielded a disappointing result in terms of the number of community responses however, the quality of the feedback was very high and mostly well considered reflecting an informed and caring community. There was in principle support for all recommendations except for the co-tendering with Gold Coast City Council for collection and processing services.

Based on the community consultation feedback Council staff and the consultants made a number of changes to the recommendations of the draft Domestic Waste Management Strategy including: removing 10 recommendations associated with co-tendering with Gold Coast City Council, seeking DECC approval for processing food waste during trials, the provision of a chemical storage cabinet and training of staff to receive and process chemicals. A further 11 recommendations were modified.

Council should therefore offer a standard 240-litre commingled recycling service fortnightly, a user-pays garbage service based on the size of the bin, with 80-litre, 140-litre and 240-litre options and a compulsory garden waste service for all single residential premises in townships, and an optional service for multi-unit dwellings.

The consultants recommended that Tweed Shire Council should enter into discussions with Gold Coast City Council, as both domestic contracts expires in a similar time frame. The option of a regional collection contract should be fully explored, as it is considered that Tweed Council would benefit from the economies of scale achieved by joining with a larger council, particularly when the boundary between the two councils is indistinguishable at Tweeds Heads and Coolangatta. However, this approach was not supported by the local community and has been removed from the final Waste Management Strategy document.

Currently, Council will retain ownership of the MRF at Stotts Creek at the expiration of the contract in 2009, however, the plant is old and antiquated, and will require a significant and costly upgrade. Based on Ballina Council's investigations, Tweed Council may need to spend $1 million to upgrade the current facility to process the 6,500 tonnes collected per year, with a processing cost of up to $200 per tonne.

Visy Recycling purchased the Cleanaway MRF at Carrara, which currently processes all Gold Coast, Beaudesert, Ballina and Lismore Councils' dry recyclables. This plant is currently the only one in Australia that has a glass refining operation attached, so that all glass placed in the bin by the householder is either recovered for reuse in glass manufacture or is processed and used in a variety of other applications. It is recommended that Tweed Council discuss processing options directly with Visy, who are quoting a processing cost of $15 per tonne up to 6,000 tonnes and $10 per tonne between 6,000–10,000 tonnes per year plus transport. A local MRF could not compete with the Visy costs and this option will remove the need to undertake the $1 million dollar upgrade of the current facility.

The Stotts Creek Landfill current putrescible cell is nearing capacity and is expected to full by 2010. Council has acquired a nearby site for future landfill and quarrying activities and is proceeding with site investigation and designs. The site development

and operating costs are unknown at the time of writing this report, however, we have determined that Council has a number of other options available in addition to developing the proposed new site.

Council could export waste from the area at a cost of $50 per tonne which removes the necessity of Council developing its own landfill for the foreseeable future. Veolia Environmental Services (formerly Collex), in partnership with JJ Richards, has constructed the Ti-Tree Bio-energy Landfill Facility at Willowbank, located west of Ipswich, where the bio-reactor rapidly breaks down waste by re-circulating leachate, and gas produced is used in renewable power generation and Thiess Services operates a secure fully engineered landfill at Swanbank near Ipswich. Both companies offer long-term contracts and can provide disposal for $25–$30 per tonne and transport for $25 per tonne.

The current MRF at Stotts Creek Landfill could be converted to a transfer station for loading directly into 100-m^3 walking-floor transfer trailers for transport to either of these sites.

Council also owns and operates a transfer station at Tyalgum and a landfill at Murwillumbah. The NSW Department of Environment and Climate Change (formerly the NSW EPA) is concerned about ground water contamination at both Murwillumbah and Stotts Creek landfill sites. In recent communication the DECC is suggesting Council establish post-closure plans for the Murwillumbah site. The DECC is particularly concerned about the green waste processing operations are exacerbating leachate issues. It is suggested that Council close the Murwillumbah operation and centralise all activities at Stotts Creek, which is centrally located in the council area.

Council recovers its operating costs for waste management through the Domestic Waste Management Charge applied to the council rates which for the 2006–07 financial year is set at $189. Council, through careful planning and good financial management, has a reserve fund of over six million dollars to allow for expected future changes in both the domestic service and also the need to establish a new local landfill before the end of this decade. Therefore, there are adequate funds to explore and implement the recommendations contained within this report and to expand the range of services offered at negligible additional cost.

We believe that the approach recommended in this report following the community consultation program provides Tweed Shire Council with the most socially responsible, economically viable and environmentally sustainable outcome to achieve both community expectations and that of the state government.

Outlined below are the 35 recommendations in the order as they appear within this report which does not necessarily reflect their priority.

1. ***That Council continue to monitor the activities of the South East Queensland Waste and Recycling Network Group and the NEWF. It would appear that Tweed Shire has more in common with the Queensland group and its activity better reflects the immediate and long-term needs of Council.***

2. ***That Council request the waste contractor to have trained staff available at all times to receive and process DrumMUSTER containers.***

3. ***That the contractor uses the service of the free DrumMUSTER training program.***

4. ***That Council continue to support the efforts of DrumMUSTER through community education and promotion of either continuous receipt of containers or one-off collection programs.***

5. ***Council continue to promote that asbestos should be removed, handled and stored in accordance with the Work Cover Regulation.***

6. ***That all batteries received at all waste depots be correctly stored.***

7. ***That Council include the correct disposal of gas cylinders and bottles in future community educational material and promote the drop-off of these materials at each waste disposal facility.***

8. ***That Council continue to support the operation of reuse facilities at all waste disposal facilities.***

9. ***Council ensures the community is informed about household hazardous collection programs.***

10. ***That Council continue to promote the current practice of source-separation and free delivery of recyclables at all waste facilities.***

11. ***That Council should introduce a new fully commingled recycling service in a 240-litre bin collected fortnightly to all of its residents.***

12. ***That Council should introduce a garden service in a 240-litre bin collected fortnightly to all single residential dwellings in townships.***

13. ***That Council offers an optional garden waste service to all medium-density and multiple-occupancy residential buildings.***

14. ***That Tweed Council offer residents a 140-litre bin as the standard service with the option of a differential service rate for an 80-litre or 240-litre in the interests of social equity. The price differential for these service options will be assessed once the tender for domestic waste management services is completed.***

15. ***That new lids in accordance with the Australian Standard 4123 Mobile Waste Container be provided to all existing and new domestic waste, recycling and garden organics bins as part of the collection contract.***

16. ***Council should continue to monitor developments by other local governments which have introduced or are proposing to introduce organic waste collection programs, in particular, Coffs Coast and Hastings Councils,***

to learn from their experiences. Council should also assess new and emerging technologies and processes which have applicability for the area.

17. ***That Council introduce dedicated collections for specific materials, that is, metals / whitegoods and continue with the bi-annual household cleanup service.***

18. ***Should Council maintain its own MRF, then the future collection contract should specify a maximum compaction for the collection of recycling at 180 kg/m^3 and in accordance with best practice.***

19. ***That Council enter into discussions with third parties in relation to the acceptance of Tweed Shire Council recyclables.***

20. ***That a two-bin system – garbage and 'containers only' or alternate litter bin system be trialled in key strategic areas.***

21. ***That a performance review of the system be undertaken three months after the system is introduced.***

22. ***Recycling stations should be provided in strategic visitor locations to reduce the incidence of visitors using private or commercial bins.***

23. ***That the existing blue litter bins should be replaced with green bins with red lids for rubbish and yellow lids for recycling.***

24. ***That Council develop a Waste Not DCP and place a notation or condition on all Development Approvals requiring the source separation and containerisation of all waste on building sites to minimise waste generation and prevent unintended pollution.***

25. ***That source-separation of loads prior to delivery is desirable due to the differential pricing policy to be applied to mixed loads at Stotts Creek and Murwillumbah landfills.***

26. ***That Council undertakes a community education and industry information campaign to promote source-separation of all loads delivered to the Stotts Creek landfill.***

27. ***That Council directly approaches the significant users of its landfills on a personal basis to inform and educate them regarding the role of source-separation and of Council's intention to introduce a substantial change to the future fee structure and charges for disposal of waste.***

28. ***That Council resolves to introduce differential landfill fees for sorted and unsorted loads and offer a significant price variation to create the necessary motivation for source-separation within the community.***

29. ***That council introduces a significant differential pricing policy to encourage source – separation by waste generators of building materials.***

30. That the current education and communication program delivered by the contractor be reviewed to assess and evaluate the effectiveness and value for money prior to developing the new contract specification.

31. Given the high proportion of visitors to the area, that the use of graphic images supported by the English words must be incorporated into all communication modes

32. That Council must commit sufficient and ongoing budgetary resources to continue the education of both residents and visitors.

33. That the waste depots should be renamed as Resource Recovery Centres.

34. That Council ensure that the new waste education centre is a demonstration site for green building and sustainable living and be called The Sustainable Living Centre.

35. That concurrently with developing plans for the local landfill, Council reviews other long-term disposal options for the Shire's waste as identified in the Strategy having regard to transport and disposal costs, method and number of vehicle movements to accurately assess traffic impact.

1. INTRODUCTION

The Tweed Shire is located on the far north coast of NSW and covers an area of 1,303 km^2.

Prior to European settlement, the area was home to the Bundjalung people. Captain James Cook, in 1770, identified and named two of Tweed Shire's most prominent features, Mount Warning (Aboriginal Wollumbin) and Point Danger. The area was first settled by timber-getters around 1844 with the river port of Tumbulgum was the population centre.

Tweed Shire Council today adjoins the shires of Byron, Lismore and Kyogle to the south and west and the Queensland State border to the north. The shire has 30 kilometres of natural coastline, together with wetlands, estuarine forests and farmlands.

The region is considered an area of high conservation significance which provides residents and visitors with a unique opportunity to observe a wide range of fauna and flora.

The Shire supports a population of about 73,800.[1] The table below details the key demographic and social indicators for the Shire compared to NSW. A full list of demographic information from the 2001 ABS census is provided in Appendix 1.

Table 1 - ***Tweed LGA and NSW Key Demographic and Social Indicators***

Indicator	Tweed LGA	NSW
Population	73,821	6,311,168
Households	30,286	2,343,677
Median age	43	35
Median weekly individual income	$281	$387
Percentage of households in separate houses	63.1%	70.3%
Percentage unoccupied dwellings	8.2%	8.9%
People per household	2.18	2.39
Percentage of households owned or purchasing	66.9%	64.4%
Percentage of households rented from housing authority	2.6%	4.9%
Unemployment Rate	12.6%	7.2%
Average vehicles per household	1.6	1.8
Median weekly household income	$514	$829

The median age of Tweed residents is much higher than the NSW average (43 years vs 35 years), possibly due to the large number of retired people in Tweed.

Income levels in Tweed are markedly lower than the NSW average both for individuals and households.

[1] ABS Census data 2001.

The proportion of households owned or purchasing is several percentage points higher in Tweed than the NSW average with the majority of people living in the northern end of the shire and along the coastal strip.

The majority of residents live in separate housing, which accommodate on average 2.7 people per households.

Retail, health and community services, and construction are major industries in the Tweed. Together these industries employed approximately 38% of the total workforce in 2001. Rising rural land prices and a push for rural-residential living is placing the primary industries sector under increased pressure. Agricultural industries of sugar cane and small cropping remain buoyant, while new ventures into alternative cropping; wineries and farm tourism have emerged. Tourism remains a key industry in the shire and employed approximately 10% of the work force in 2001.

The Tweed Shire is ageing; approximately 27% of residents are aged 55 and over. If current trends continue by 2011, 34% of residents will be in this age sector. The Tweed Shire has proportionally more families in the lower- to middle-income range compared to the state average. In 2001, 46% of households earned less than $500 per week; 18% of these households received an income less then $299 per week.

The Tweed continues to experience high youth unemployment. A limited number of new jobs and a trend in casual and part-time employment have forced the migration of young adults out of the area for work and education. The closure of the railway and a lack of public transport in rural areas have meant most residents must rely heavily on private transport.

The Tweed Valley, like most of coastal Australia, is experiencing significant growth and development as people seek to retire early and invest in a coastal and rural community. Population growth continues to increase, with a five-year estimated average of 2.5%, and conservative projections predict that the population may increase by an additional 40,000 people by 2016. The future coastal, rural-residential, and tourism accommodation development will require careful management to ensure the unique qualities which attract people to the Tweed area are preserved.

The proximity of the Gold Coast – Coolangatta airport provides a ready access for intrastate, interstate and international visitors. The area offers a holiday destination with a relaxing coastal lifestyle with over 30 kilometres of coastline. The peak periods for visitors are the summer months and school holidays.

2. TWEED SHIRE COUNCIL

Murwillumbah was declared a Local Government Municipality in 1902 and the Municipality of Murwillumbah and the Shire of Tweed was amalgamated in 1947 to create the Tweed Shire. Today the population is scattered through 17 villages, two townships and the major urban areas of Tweed Heads and South Tweed many bearing their names from the language of the original Aborigines.

The state government appointed three Administrators in May 2005 to govern the council area until elections are held in September 2008. The administrators are Frank Willan, Gary Payne and Max Boyd.

The council has approximately 34,000 ratable properties and operates on a $160 million budget, of which 38% is derived from rate revenue, with the remaining income from user charges (13%), grants and contributions (39%) and 10% interest and other income.

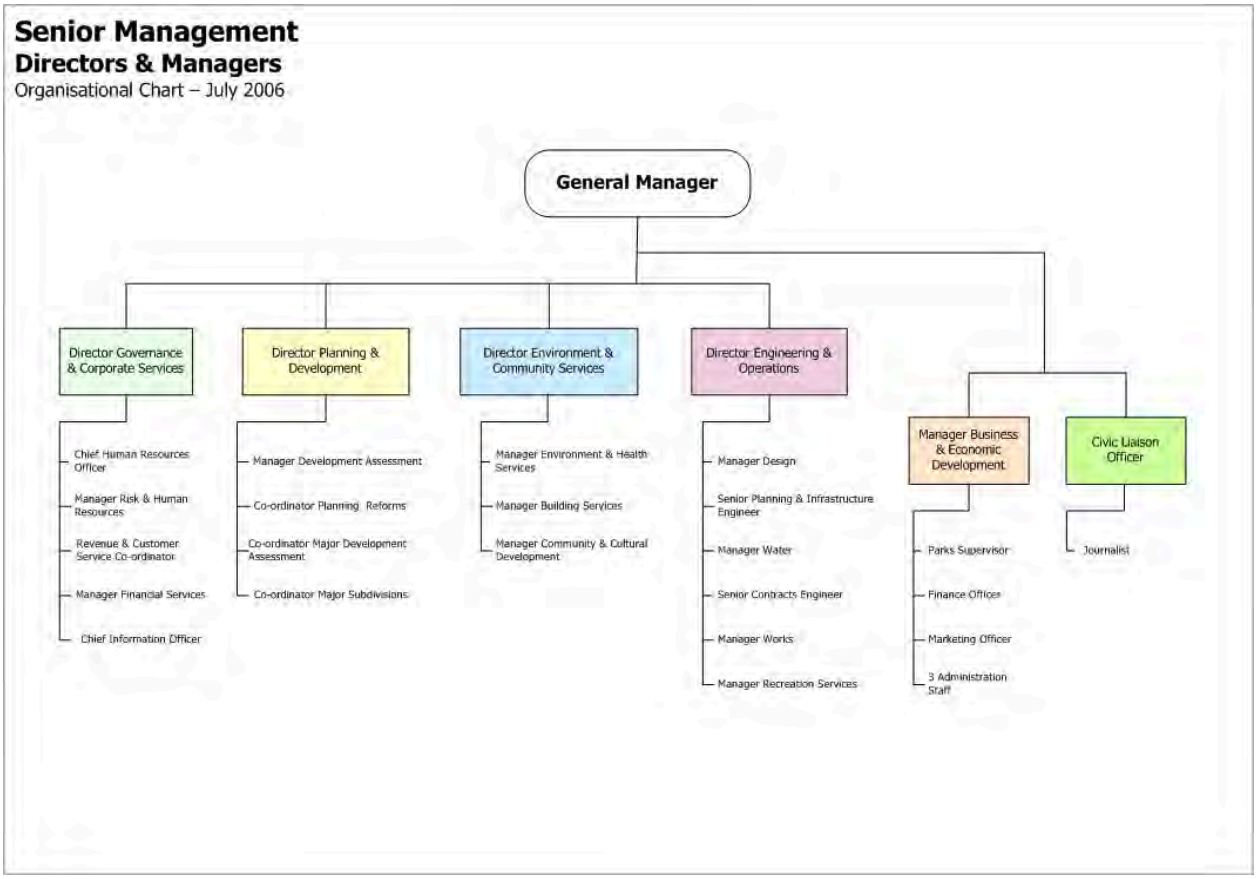
Tweed Council has developed a Strategic Plan titled Tweed Futures which states:

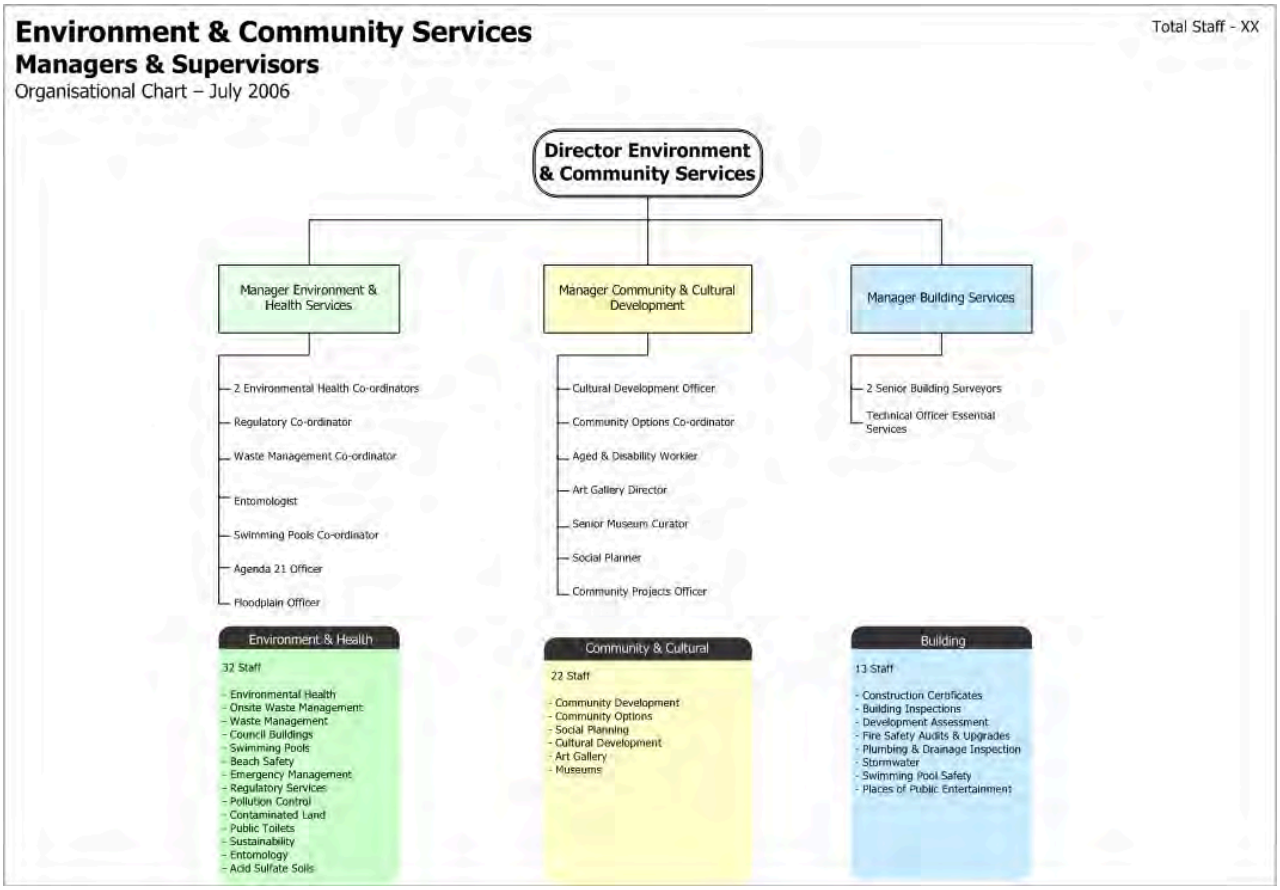
The Vision: *The Tweed is to become the premier area in which to live, work and visit.*

The Mission : *In partnership with the community, balance people's aspirations for development and enhancement of the unique environment by providing affordable quality services in a competitive manner.*

Waste Management is overseen by Council's Waste Management Co-ordinator, Ian Percy, and assisted by its Waste Management Officer, Adam Faulkner. Both positions report to the Manager, Environment and Health Services, and the Director, Environment and Community Services, Don Buckley. Together this team ensures all waste management services meet the expectations of the community, while overseeing the contract in place for the delivering of services and operation of the landfills and transfer station. Copies of the council's organisational chart and that of the Environment and Community Services division, are provided on this and the following pages.

Tweed Shire Council is currently an observer of the North East Waste Forum, however, due to its geographic location, the council relates more to activities occurring in the south-east corner of Queensland.


Senior Management
Directors & Managers
Organisational Chart – July 2006
General Manager
Director Governance & Corporate Services
Director Planning & Development
Director Environment & Community Services
Director Engineering & Operations
Manager Business & Economic Development
Civic Liaison Officer
Chief Human Resources Officer
Manager Risk & Human Resources
Revenue & Customer Service Co-ordinator
Manager Financial Services
Chief Information Officer
Manager Development Assessment
Co-ordinator Planning Reforms
Co-ordinator Major Development Assessment
Co-ordinator Major Subdivisions
Manager Environment & Health Services
Manager Building Services
Manager Community & Cultural Development
Manager Design
Senior Planning & Infrastructure Engineer
Manager Water
Senior Contracts Engineer
Manager Works
Manager Recreation Services
Parks Supervisor
Finance Officer
Marketing Officer
3 Administration Staff
Journalist


Environment & Community Services
Managers & Supervisors
Organisational Chart – July 2006
Total Staff - XX
Director Environment & Community Services
Manager Environment & Health Services
Manager Community & Cultural Development
Manager Building Services
2 Environmental Health Co-ordinators
Regulatory Co-ordinator
Waste Management Co-ordinator
Entomologist
Swimming Pools Co-ordinator
Agenda 21 Officer
Floodplain Officer
Cultural Development Officer
Community Options Co-ordinator
Aged & Disability Worker
Art Gallery Director
Senior Museum Curator
Social Planner
Community Projects Officer
2 Senior Building Surveyors
Technical Officer Essential Services
Environment & Health
32 Staff
- Environmental Health
- Onsite Waste Management
- Waste Management
- Council Buildings
- Swimming Pools
- Beach Safety
- Emergency Management
- Regulatory Services
- Pollution Control
- Contaminated Land
- Public Toilets
- Sustainability
- Entomology
- Acid Sulfate Soils
Community & Cultural
22 Staff
- Community Development
- Community Options
- Social Planning
- Cultural Development
- Art Gallery
- Museums
Building
13 Staff
- Construction Certificates
- Building Inspections
- Development Assessment
- Fire Safety Audits & Upgrades
- Plumbing & Drainage Inspection
- Stormwater
- Swimming Pool Safety
- Places of Public Entertainment

3. WASTE MANAGEMENT STRATEGY

Council committed to developing a Waste Management Strategy and issued a consultancy brief. In response, APC, which has a proven track record in developing innovative and practical waste plans and strategies for regional, rural and remote communities, was appointed, and stated that the key objectives of the project were:

- To develop a WMS for Tweed Shire Council that is supported by all key stakeholders and enables Council and the community to implement sustainable waste management practices for current and future generations
- To engage major waste generators and the broader community in the development of the WMP, so that the outcomes are supported in the implementation phase
- To develop the WMS in accordance with the waste management hierarchy and the principles enshrined in the guidelines and best-practice principles of the NSW Department of Environment and Conservation's Model Waste and Recycling Collection Contracts.
- To increase the local community's and visitors' level of knowledge, awareness and understanding of local waste management issues and their role in providing solutions.

Outlined below is the way in which APC has structured this project in response to the project brief, to provide an affordable and realistic range of options which are practical and capable of being implemented by Council and its community.

Stage One – Research

- Detailed literature review of the extensive available documentation provided by the client
- Undertake market research to determine the views and issues, as seen through the eyes of visitors and residents
- Undertake extensive stakeholder consultation with regard to current and future waste management options.

Stage Two – Draft Waste Management Plan

In the second stage APrince Consulting has developed the draft Waste Management Plan, based on environmental, social and economic benefits for review and feedback by the Council and the community.

Stage Three – Community and Stakeholder Consultation

Community and stakeholder consultation will be undertaken to canvass the opinions and attitudes of residents and key stakeholders regarding the range of options developed in response to the research.

Stage Four – Final Waste Management Plan

A report on the feedback from the consultation phase of the project will be developed and provided to Council for consideration. Based on the feedback from the stakeholders, community and Council, the draft Waste Plan document will be refined and finalised.

This report:

- Provides an overview of previous studies relating to waste management practices
- Contains the results of a regional waste audit
- Contains the results of market research surveys conducted with residents and visitors
- Provides outcomes of stakeholder meetings in relation to views and opinions about current and future waste management practices.
- Contains an exploration of a range of options for the treatment of all waste types and provides a cost–benefit analysis of both the capital and operating costs for those options.
- Identifies strategies including education and infrastructure requirements to improve waste avoidance, minimisation and resource management, consistent with the goals of sustainability.
- Contains the community consultation program and outcomes
- Provides an action plan for implementation.

Following the completion of the Strategy, Council intends to implement the strategy and develop tender documents and new contract service provisions based on the strategy outcomes, in line with the NSW DECC Model Waste and Recycling Collection Contracts framework.

4. LITERATURE REVIEW

To assist the consultants, Council as well as the North East Waste Forum provided copies of internal and external reports, correspondence, and plans for review and evaluation relevant to the development of this plan. A summary of the key reports is provided below as a background to the evolution of waste management program.

4.1. Waste Collection and Disposal Strategy, 2003

In December 2003 Council adopted the Waste Collection and Disposal Strategy and resolved to encourage all sectors of the community to participate in waste avoidance as a strategy towards more sustainable waste management in the Shire. Specifically, the Strategy targeted three areas of waste generation:

- Domestic Streams – to increase the amount of recyclables recovered from the domestic sector
- Commercial and Industrial – to reduce green waste disposed of to landfill, increase recycling and reduce inert waste streams from its landfill
- Construction and Demolition – to increase the amount of recyclable material from this sector.

4.2 Waste Collection & Disposal Community Survey 2003

A community survey was undertaken by Council in December 2003 in the *Tweed Link* newsletter, to which 1,262 residents responded, equating to a response rate of 4.2%. The purpose of the survey was to determine the community's views in relation to current collection programs to provide input into the draft Waste Collection & Disposal Strategy, and for these matters to be considered as part of the development of a new waste collection contract. The key survey results are detailed below:

1. 46% of respondents considered the existing collection bin to be adequate.
2. 49% considered the existing recycling section too small.
3. Of these 49%, almost 50% preferred a 50/50 garbage/recycling split instead of the 70/30 split.
4. 45% of respondents preferred a separate 240-litre recycling bin serviced fortnightly.
5. Only 32% of respondents were prepared to pay an extra $35 per year for this extra bin.
6. 34% of respondents were prepared to accept a 140-litre garbage bin collected weekly.
7. 44% of respondents indicated they would use a fortnightly garden waste collection service.
8. Only 33% indicated that they would be prepared to pay $35 extra for the garden waste service.
9. 89% of respondents indicated their satisfaction with the biannual clean-up service, with over 65% indicating a preference for the collection to be held in May and November.

45% indicated a preference for a separate 240-litre recycling bin serviced fortnightly; only 32% of the respondents indicated that they would be prepared to pay an extra $35 per year for this service.

A similar situation occurs for garden waste whereby 44% of respondents supported a fortnightly green waste collection service, however, only 33% were prepared to pay an additional $35 per year for this service. Most support for a garden waste program came from Banora Point, Tweed Heads South, Terranora and the Tweed Coast residents, as detailed in the table below:

Table 2 - Community's Willingness to Pay for Garden Waste Collection Program

Area	Responses	Support introduction of garden waste service	Willingness to pay
Murwillumbah & Surrounds	197	30%	24%
Tweed Heads/Tweed Heads West	200	36%	24%
Kingscliff/Chinderah	135	40%	33%
Banora Point/Tweed Heads South/Terranora	575	50%	38%
Bogangar/Hastings Point/Pottsville	130	53%	42%

As a result of the survey findings, the previous 240-litre split 70/30 garbage bin, which provided just 72 litres for recycling and 168 litres for garbage, was modified to a split 50/50 garbage/recycling at the commencement of the new contract in December 2004, and an optional green waste service was offered.

4.3 The Local Government Action Plan 2003

This document was prepared to provide a framework that sets out how councils can contribute to the achievement of the outcomes and targets contained in the WARR Strategy. The Plan includes commitments, actions and sub-targets across a range of key waste management issues, wherein local government's best position is to initiate and sustain changes in practices.

4.4 North East Waste Forum – Regional Waste and Resource Management Plan 2006–2009

The North East Waste Forum aims to achieve the development and implementation of locally based solutions to waste management. The forum was established as one of four pilot regional waste management groups in 1996, with support from the EPA (now part of the DECC). The current financial member councils are Ballina, Byron, Clarence Valley, Lismore and Richmond Valley. The forum also has strong ties to the neighbouring councils of Kyogle and Tweed which, although not members, have been active participants in many of the forum's projects.

The councils have been working co-operatively since 1996 on priority issues for the region. Each council has its own strategy for dealing with its waste management, aimed at optimising resource use and recovery, improving waste management and educating the communities about waste and environment. This plan focuses on domestic waste but also deals resource recovery in the commercial and industrial and construction and demolition sector.

Funding of the forum's activities is shared between the DECC and member councils on a per capita basis. Funds have been verbally confirmed as being committed to from

the DECC for the period up to July 2009. The forum operates on an annual budget of $290,000, $150,000 funded by member Councils and $140,000 from the DECC.

4.5 NSW Environmental Education Plan 2006–2009

The NSW Council on Environmental Education has recently released this document which builds on the previous document 'Learning for Sustainability Plan', which sets out the strategic framework to developing environmental education in NSW, guided by a Vision to 'Achieve effective and integrated environmental education which builds the capacity of people in NSW to be informed and active participants in moving society towards sustainability'. The plan aims to address the needs of those delivering environmental education as well as those who seek access to it. A series of strategies, actions and outcomes have been set to help achieve these aims with a wide range of stakeholders identified to make the plan work.

4.6 North East Waste Forum Regional Education Plan 2006–2008

The North East Waste Forum Regional Education Plan 2006–2008 is consistent and meets the obligations that are identified within the NSW Government Environmental Protection Education Plan for Sustainability and also meets the commitments of the NSW WARR Strategy 2003 (revised in 2006).

This document was developed to assist the member councils in the provision of best-practice waste education programs for the regional community on the north coast of NSW, supports the Regional Waste Plan and provides a detailed planning approach for education actions identified in the regional plan. It is designed to assist local and regional educators to design, develop, deliver and evaluate education programs and projects about waste management.

Education, training, communication are now recognised as fundamental tools in achieving waste reduction measures throughout NSW and beyond.

Aim – The aim of the education program is to promote the adoption of sustainable waste practices by the north coast community through the provision of innovative education programs for our regional and local communities.

The objectives are:

- Increase awareness for the community about ways of producing waste through waste avoidance and resource recovery.
- To increase the skills of the community to make informed decisions and undertake sustainable waste practices.
- Encourage the adoption of these sustainable waste practices for engaging the community.
- Support the NEWF member councils in their education programs through providing consistent messages, shared projects, resources and materials.
- To build the capacity of NEWF member council personnel to undertake best-practice waste education planning and evaluation.

The target groups are:

- The member council communities

- education providers – TAFEs, primary school and high school teachers, early childhood centres
- businesses
- community groups
- visitors.

Strategic outcomes:

1. Increase community and education and support waste avoidance and resource recovery.
2. Provide environmental education programs that meet the specific needs of community sectors.
3. Enhance cross-sector co-ordination of programs.
4. Enhance the training, professional development and other support for those developing and delivering environmental education.
5. Provide consistent co-ordinated information and education for stakeholders.
6. Improve integration environmental education with other tools and strategies used to promote ESD.
7. Increase research and evaluation of effective environmental education.

5. POLICY FRAMEWORK

The government sector in general provides the overall regulatory and legislative framework in which the waste management industry operates, and provides strategic direction to the broader community and all stakeholders with regard to waste policy issues.

5.1 Commonwealth

Commonwealth bodies that influence waste policy include the Department of Environment and Heritage and the Department of Industry, Tourism and Resources. The Commonwealth influences waste management in four main ways:

1. International Treaties – governs the export of waste
2. National Environment Protection Council (NEPC) – aims to develop a harmonious approach to waste management across jurisdictions.
3. Levies and Excise – the Commonwealth can tax products, that is, levy applies to oils and lubricants
4. National Agreements – National Packaging Covenant.

In October 2005 the Federal Treasurer referred the matter of waste generation and resource efficiency in Australia to the Productivity Commission for inquiry and report within twelve months. The Commission was to examine and report on current and potential resource efficiency in Australia. Two consultation documents have been released for public comment. An Issues Paper was released in December 2005 and a draft Report in May 2006. Two rounds of public hearings have also been held. The final report has been delivered to the government for consideration. Under the *Productivity Commission Act 1998*, the Government is required to table the report in each House of the Parliament within 25 sitting days of receipt. The document has not as yet been considered by Parliament, nor has it been released publicly.

5.2 State Government

Most waste policy and management are developed and take place at the state government level. The Waste Avoidance and Resource Recovery Act 2001 (WARR Act) was enacted after a review of the previous Waste Minimisation and Management Act 1995. The review recommended that waste be regarded as a recoverable resource through the uptake of new waste processing technologies, and created a central State Government-based agency, Resource NSW, to replace the NSW Regional Waste Boards. Resource NSW had as its charter to develop a framework and to support the implementation of programs to avoid waste and recover resources.

Resource NSW released the Waste Avoidance and Resource Recovery Strategy in February 2003, which set targets for avoidance and resource recovery and was endorsed by the NSW Government. The targets are shown in the table below:

Table 3 - NSW Waste Targets

Stream	Baseline Resource Recovery 2003	Target by 2014
Municipal	26%	66%
C & I	28%	63%
C&D	65%	76%

In 2003 the NSW Government restructured the environment agencies and created a new state environment body called the Department of Environment and Conservation (DEC which incorporated the former Environment Protection Authority, NSW National Parks and Wildlife, Resource NSW and the Royal Botanic Gardens Trust.

Resource NSW became the Sustainability Programs Division, the aim of which is to accelerate the shift towards environmentally sustainable practices through:

- The Waste Avoidance and Resource Recovery Strategy and Environmental Trust
- Community education and information
- Partnerships focused on business and urban sustainability issues
- Programs with local government and other agencies.

The DEC established an Extended Producer Responsibility (EPR) Expert Reference Group to advise the Minister on EPR and Product Stewardship. The first EPR Priority Statement, published in March 2004, listed 16 wastes of concern, with the following nine materials having priority status. A supplementary EPR Priority Statement, published in March 2006, identified 17 wastes of concern with the seven priority materials. These are listed in the table below.

Table 4 - NSW Wastes of Concern – Priority Materials

2004 Priority Wastes	2005–06 Priority wastes
Computers	Computers
Televisions	Televisions
Ni-cad batteries	Mobile phones
Used tyres	Used tyres
Plastic bags	Plastic bags
Packaging wastes	Paint
Agricultural and veterinary chemicals	Office paper
Agricultural and veterinary chemical containers	

In November 2005, the NSW Government announced the City & Country Environment Restoration Program which would be funded from annual increases in the Waste and Environment Levy of $6 per year over the next five years, generating an anticipated $426 million. The levy is only applicable in the metropolitan and Extended Regulated Areas of Newcastle, Central Coast and Wollongong. The levy increase will be used to fund the following initiatives:

- $105 million: Riverbank to buy back water licences
- $30 million: Marine parks
- $13 million: Buy back perpetual crown leases

- $80 million: Urban sustainability grants
- $76 million: Strategic Environmental Trust grants
- $37 million: Native Vegetation Assistance Package
- $80 million: Local Government rebates
- $18 million: Illegal dumping.

In addition to the WARR Act, the following legislation and policies can influence waste management in NSW:

- *The Protection of the Environment Operations Act, 1997* Waste Regulations set out regulatory requirements for specific wastes, waste facilities and activities, transporters and the collection of the waste levy by the NSW EPA (now part of the DECC)
- *The Environmental Planning and Assessment Act 1979* directs the overall planning and building system in NSW**.**
- State Environment Planning Policy SEPP 48 (1995)
- *The Local Government Act 1993* guides councils in developing policies affecting waste management activities.

In March 2007 following the NSW state election the DEC was replaced with the Department of Environment and Climate Change (DECC) which brings together conservation and natural resources science and programs, including native vegetation, biodiversity and environmental water recovery, with the objective of integrating the government's approach to natural resource management. The DECC also includes the Greenhouse Office, formerly a specialist policy unit within the NSW Cabinet Office. Total responsibilities include:

- climate change and greenhouse issues, including the new climate change fund;
- programs to reduce waste, toxicity, litter and illegal dumping;
- air and water quality, noise control, and regulation of chemicals and radiation;
- national parks and reserves, including management of marine parks;
- biodiversity, threatened species and native vegetation management;
- protection of soils and land and catchment management;
- environmental water management and coastal lakes and estuaries;
- botanic gardens - Sydney's Royal Botanic Gardens and Domain, Mount Annan and Mount Tomah Botanic Gardens;
- Aboriginal cultural heritage and historic sites;and
- sustainability programs, including environmental education, energy efficiency and water conservation programs and renewable energy policy.

5.3 Local Government

As the closest interface between government, communities and business, local government has several important roles to fulfil, including providing waste and recycling services to the community, being a major buyer and consumer of goods and services, a local planner and regulator, a leader of local communities and key agent for social change.

Local Government is involved in service planning and delivery to the communities it serves, principally domestic waste, recycling and organics services. For historic

reasons connected with public health and sanitation, local government is responsible for the collection, transport and disposal of municipal solid waste generated by the community at a household level. In conjunction with this service, local councils also often collect recyclable materials and garden organics. In most cases local government provides infrastructure for waste disposal in regional and rural Australia**.**

While the number of councils operating their own services is still substantial, many councils now engage a contractor to provide some or all of these services. Councils using contractors typically enter into seven- to ten-year contracts. Many councils are entering into regional groupings to gain economies of scale in relation to contracting services for collection, processing (using alternative waste technologies) and for disposal.

Tweed Shire Council is responsible for establishing the policy framework and guidelines from which decisions about developments are made. As the local planning and consent authority, Council can influence and regulate a range of issues and contribute to the targets of the waste strategy. Council can use the DCP to better control and regulate waste reduction, minimisation and resource recoveries through building and development process by adopting a Waste Not DCP. Council can then influence the management of waste generated from the commercial and industrial, as well as the construction and demolition sectors.

6. CURRENT WASTE MANAGEMENT SYSTEM

Council has contracted out the collection services for waste, recycling, green organics, public-place litter bins and the management of the major landfill and associated activities, as part of a Waste Management Services Contract with Solo Waste Australia trading as Solo Resource Recovery which commenced on 1 December 2004 for a period of five years concluding in 2009.

6.1 Domestic Services

The contractor is responsible for providing a depot from which all staff commence and complete their duties, and vehicles that are not in use for this contract should be parked at the depot.

Collection vehicles must be of a reasonable standard and be freshly painted and sign written prior to the commencement of the contract.



Figure 1 – Domestic Collection Vehicle

At the commencement of the contract all domestic bins were divided 70:30 for waste and recyclables, however, based on the response to the feedback from the 2003 community survey, wherein the community indicated a clear preference for more space for recyclables, Council decided to move to a 50:50 division.

The Contractor was instructed by Council to retro-fit the current divided bin from a 70:30 division to a revised 50:50 division within six months of the contract commencement date.

Recyclable materials are deemed to be:

- Aluminium cans
- Glass bottles and jars,
- Liquidpaperboard cartons.
- Newsprint, magazines, cardboard
- Plastics – PET, HDPE, milk containers,
- Steel cans.



Figure 2 – Divided Domestic Bin

The exclusion or inclusion of additional materials is subject to negotiation with reference to availability, viability and market value. All collected recyclables must be transported to the MRF at Stotts Creek depot or other location agreed to between Council and the contractor for processing from time to time.

The contract provides for the collection of domestic waste in a 240-litre 50:50 divided bin for the co-collection of waste and recyclables. The current cost per service is $1.69 per week. Council offers residents an optional garden organics service at a cost

of $1.49 per week. Council did pay the contractor for a minimum of 30% of rateable properties, however currently only 5,600 or 25% of properties have elected to use this service after extensive promotion. Council has recently re-negotiated with the Contractor to revert to a fee for service basis for future payments.

A bi-annual clean-up service is offered in May and November at a cost of $1.31 per property, street litter bins are serviced at $1.78 and mobile garbage bins in parks and reserves at $4.50 per service.

The contract stipulates certain operating parameters including:

- Kerbside collection services occur between the hours 7.00 a.m. – 8.00 p.m. Monday to Friday, including public holidays. For high traffic and potential incident areas which generate OH&S concerns, Council can approve an earlier collection on a case-by-case basis. After receiving written notification from council, the contractor is required to deliver a replacement or repaired bin on the next collection day
- Where a bin is damaged beyond reasonable use, delivery shall be within 48 hours
- The contractor is liable for labour and materials used in the repairs or replacement where the bin has been damaged by the contractor
- Council is liable for the cost of repairs and replacement where damages occurred during the normal course of collection
- Any new services will have a bin delivered by the contractor on the next scheduled collection day
- All mobile garbage bins provided by the contractor throughout the term of the contract become the property of Council
- Should any spillage occur the contractor is responsible to ensure the area is left in a tidy condition
- All collected waste is deposited at the Stotts Creek waste depot
- All vehicles must be washed down on a daily basis.

On-property services are provided to the aged or infirm where other options have been exhausted for bin collection.



Figure 3 – Bins at MUDs

6.1.1 Multi-Unit Dwellings (MUDs)

For multiple-unit dwellings and high-rises, non-divided bins and bulk bins are provided and charged according to a schedule of rates.

6.1.1.1. Waste: The contractor must be able to offer a range of bin sizes and configurations for multi-unit residential premises and council caravan parks. Where bulk bins are provided in a compound, a wheel-out wheel-back service is provided.

6.1.1.2 Recycling: the contractors are to provide dedicated mobile garbage bins or separate bulk bins for the separation and collection of recyclable materials and the available recycling volume should be equal to that of the waste volume. A wheel-out,

wheel-back service is also provided for bins and/or bulk bins. These receptacles should be clearly marked to indicate the type of material to be deposited in each container and education material developed to educate and encourage residents to recycle.

6.1.2 Recycling Contamination Protocols



Figure 4 – Contaminated Recyclables

In relation to recycling contamination, the contract states that where an operator identifies that material is contaminated in the recycling section of the bin, s/he should alight from the vehicle and place a tag/sticker on the bin. Where gross contamination is evident the contractor should not empty the container until the residents have removed the contaminated or offending material, and the following protocol should take place:

1. Appropriate educational material is to be left at the household.
2. The contractor should tag and not service the bin and if the contamination occurs for a third time within 12 months of the first occasion,
3. the contractor is not to service the bin and notify council and a written warning is to be sent by the council to the owner.
4. If contamination continues to occur, the contractor is to seek approval to remove the bin for a period of three months and replace with undivided bins for an additional fee.

Following the expiration of the three-month period, a request from the owner or occupier to the council for the divided bin to be returned can be made.

6.1.3 Community Education

Council's objective is to minimise contamination in the recycling stream and maximise resource recovery, the contractor shall therefore ensure this objective is maintained through the implementation of a community education strategy. The contractor should be involved in the ongoing promotion and education of residents on broad issues of waste minimisation and specifics of the recycling scheme. Such promotion and education must first be approved by Council. The contractor should provide to Council before the 1 December and 1 June each year a six-month work program for six months in advance specifying the activities to be undertaken and a promotional budget for the following 12-month period as at 1 November of each year and a reconciliation statement of the previous 12 months' promotional activities by 1 February of the following year.

The contract requires the contractor to employ a full-time Recycling Education Officer and to commit $20,000 per year to promotional expenditure – school and community waste education.

6.1.4 Recycling System Performance

The contractor shall conduct a sample audit of the recyclables collection service annually to determine the yield per premises, material types and levels of contamination of the samples audited.

6.1.5 Materials Recovery Facility

All practical measures should be used to extract recyclable materials for recovery. Material that is unsuitable for recycling shall be deposited at the landfill at no cost to the contractor. The contractor shall have exclusive scavenging rights to the kerbside materials and have full ownership of the recyclables collected and retain all proceeds from the sale.

Benchmark pricing shall be applied to the recyclable material prices, whereby a 10% differential in market price will be applied (5% increase or decrease). Should the market place for the recyclable materials be lower than the benchmark, Council shall accommodate the contractor for the difference between the current market price payable multiplied by the tonnage of the commodity collected in any month. Should the market price exceed the recycled benchmark price by 5%, the council will receive the proceeds of the difference between the benchmark price and the sale price, multiplied by the tonnage collected for each month. These calculations shall be determined by the contractor from time to time and submitted to Council. If the market price for a commodity has reduced significantly below the benchmark for a period of 12 months or more and is unlikely to increase, the council may declare the respective recycled commodity as being a non-recyclable material. In this event, Council will take the necessary step to educate the general public to place this material in the waste stream and shall accommodate the contractor for the income lost from declaring this material un-recyclable.

The contractor shall submit quarterly records of the weight and composition of the material collected and processed and disposed of to landfill.
Ownership of the MRF and associated equipment and site works shall pass to the council on completion of the contract and it shall be in reasonable condition and working order. The paper and cardboard baler is not owned by the contractor and will not be part of the transfer assets.

6.1.6 Other Services

The contractor is responsible for the removal and disposal of dead animals upon notification from Council. Any animals removed from private property will be at the owner's expense and through direct relationship between the contractor and property-owner.

The contractor can also provide septic tank, chemical closet and night soil collection services, with the contents to be transported to the Chinderah sewerage treatment plant for discharge.

6.2 Waste Disposal

Council owns and operates one landfill at Murwillumbah for inert waste and a transfer station at Tyalgum. In addition, Council owns and contracts out the operation of the major landfill at Stotts Creek, approximately 13 km from Murwillumbah town.

Council sets its waste fees for the landfills and transfer station annually and the current schedule of fees effective from 1 July 2006 at all sites is provided below.

Table 5 - Domestic Waste Management Fees and Charges

Domestic Vehicle Type	Stotts Creek	Murwillumbah	Tyalgum TS
Sorted domestic waste			
Car, station wagon	$7	$7	$5
Small trailer, van, ute	$11		
Large trailer	$21		
Unsorted domestic waste		**N/A**	**$7**
Car, station wagon	$11		
Small trailer, van, ute	$17		
Large trailer	$26		

Table 6 - Commercial Waste Management Fees and Charges

Commercial Vehicle Type	Weight-based	Volume-based	
Minimum load	$20	$17	$27
Green waste	$30/t	$17	
General waste	$65/t		
Small truck <1 m^3		$28	
Small truck 1–3 m^3 , small skip		$54	
truck –4 m^3 , large skip		$103	
truck >5m^3		$156	
truck 1–3 m^3			
Waste generated outside Council	$74		N/A
Builders waste sorted (with permit)	$15/t		
Builders waste unsorted (with permit)	$32 t		
Builders waste unsorted (without permit)	$65 t		
Product	**Fee**		
Domestic green waste	$7		
Recycling, metals	Free		
DrumMUSTER containers	Free	N/A	
Asbestos	$78		
Dip site material	$136– $196	N/A	
Animals	$5– $14		
Clean cover material (prior arrangement)	FREE		
Tyres	Car $6, 4WD $8, truck $15		

6.2.1 Stotts Creek Landfill

The current site is approximately 13 km east of Murwillumbah, accessible from either Bartletts Road or Leddays Creek Road, which run off the Tweed Valley Way. The site is adjacent to cane fields and Council's Dog Pound. Its current opening hours are Monday to Friday from 7.00 a.m. to 4.00 p.m., Saturday–Sunday 10.00 a.m. to 4.00 p.m. Solo has control and management of the garbage depot as part of the Contract for the Provision of Waste Management Services, which expires on 30 November 2009.



Figure 5 – Disposal Charges

This landfill is operating in an old quarry site and has been used as a landfill for approximately 25 years. The site has been managed under contract by Solo and formerly the Richards family group of companies.. The site holds three separate licences issued by the NSW DECC detailed in the table below.

Table 7 - Landfill Licence Details

EPL No.	Site Description and area	Activity	Activity Threshold Tonnes per year	Review Date
12181	Lot 1 part DP 5902201 2.76 ha	Solid waste	55,000	9 December 2007
11974	Lot 1 part DP 590220 22.2 ha	Inert landfill	15,000	31 March 2007
6108	Lot 5 DP 221825 Lot 1 part DP 590220	Previous landfill	N/A	27 February 2011

The site accepts all waste types including putrescible and inert material, recyclables, garden waste, designated hazardous materials including batteries, oils, gas bottles and has a DrumMUSTER compound. Based on the available projections, the current putrescible landfill cell is due to fill by 2010 and the inert cell is due to fill by 2016.

The contractor is required to provide a Garbage Depot Manager and Supervisor which may include a plant operator to the transfer station, inert waste area and solid waste area as well as weighbridge operations at all times when open to the public. All operations must comply with the DECC-approved Landfill Environment Management Plan (LEMP). The operations of the MRF and Tip Shop are currently sub contracted by Solo.

Landfill Site General:

The contract states the contractor shall:

- Provide a site manager to oversee the depot operations
- Provide a weigh bridge operator from 7.00 a.m. – 4.00 p.m. Monday – Friday, 10 a.m. – 4 p.m. weekends, except Christmas Day and Good Friday.
- Account for all gate fees to the satisfaction of the council. Record quantities, types and sources of waste received.
- Check incoming loads where possible
- Direct traffic

- Maintain the road network within the landfill operation
- Maintain registers of complaints, incidents, emergency, staff training, equipment maintenance staff
- Control dust
- Maintain site security
- Pay electrical fees
- Maintain litter on the site and surrounding areas to a minimum.

Council is provided with a report detailing vehicle movements and fees collected and pays Council a royalty payment based on patronage in accordance with details contained in the Contract for the Provision of Waste Management Services. This information is then collated and supplied to the DECC as part of the annual reporting requirements.

Transfer station: the contractor shall provide appropriate facilities including storage and transport bins for depositing and collecting of recyclable materials and ensure that the public access for the tipping area is kept clear and free of obstructions. In addition, the contractor is required to:

- ensure wind-blown debris is minimised
- remove and replace bulk bins as and when necessary
- provide areas for the placement of recyclable waste which are adequately signed
- provide a minimum of one 36 m^3 transfer bin.



Figure 6 – Transfer Station

Landfill operation: the contractor shall be responsible for the management of the day-to-day impacts and operation of both the solid waste and inert landfills in accordance with the LEMP, including:

- the development of standard operating procedures
- checking of incoming loads
- management of the landfill space, including compaction and covering
- supply of covered material sourced on-site
- surface water management system
- pumping of water from sediment traps
- operation of the leachate collection and irrigation system
- construction of the tip face
- fire control
- management of pests, vermin and noxious weeds control, odour and noise control.

Council will be responsible for:

- the development of landfill infrastructure
- long-term environmental performance
- construction and maintenance of liners and drainage layers

- maintenance, construction and monitoring of sampling of ground water bores
- the supply, installation and maintenance of leachate systems and pumps,
- the installation, operation and maintenance of gas collection systems
- the development of landform,
- erosion control, fire control,
- maintenance of haul and sealed roads
- construction of the final layers.

The contractor was required, at the commencement of the contract, to undertake the following works at Stotts Creek Waste Deport at no cost to Council and the ownership of the fixtures will revert to Council at the expiration period of the contract.

Table 8 - Contractor's Obligations

Description and purpose	Estimated Contractor Cost	Completion Date	Status
Design and upgrade the existing transfer station to receive all recyclables	$470,000	1 December 2004	Complete
Design / construct a recycling education centre	$130,000		Outstanding *
Inert waste recycling program to divert recyclable inert material from landfill	$800,000		Ongoing
Upgrade the collection fleet and landfill equipment to improve operations	$1,200,000		Complete
Construction of a revolve centre compound	$50,000	1 December 2005	Complete

* due to site selection issues

A Landfill Environment Management Plan has been prepared for the site and inspections to audit compliance with the licence conditions have been carried out by the DECC.

Inert landfill:

The following materials are accepted and a brief description of their management is provided below.



Figure 7 – DrumMUSTER cage

6.2.1.1 Agriculture chemical containers – Council participates in the DrumMUSTER Program, whereby plastic containers must be triple-rinsed and free-from-liquid residual. These are stored in a wire compound that has been erected to contain accumulated containers. Collection occurs on twice per year over one or two days on each occasion, by authorised contractors. The most recent collection was scheduled for Friday 15 December 2006. DrumMUSTER advises that 1,111 containers were returned from 35 farmers, indicating a return or recovery rate of approximately 18.4%.[2] Currently, drums can only be delivered on these scheduled days due to limited number of staff

[2] DrumMUSTER Program Report, December 2006.

trained to inspect and record them. In situations where drums can be delivered to a depot at any time, this has proven to be extremely convenient for farmers and thus the recovery rates have been substantially increased and much greater than on Tweed's current program of only two collection days per year.



Figure 8 – Batteries

6.2.1.2 Asbestos – all asbestos is required to be double-wrapped in heavy-duty plastic, taped in accordance with health requirements and is buried onsite.

6.2.1.3 Batteries – lead acid batteries are stored in metal bins and are the contractor's responsibility for removal for recycling.



6.2.1.4 Recyclables – paper, cardboard, glass, plastics, aluminium and metal cans are collected in large, open-topped bulk bins and transferred to the onsite MRF for sorting and selling for remanufacture.

6.2.1.5 Chemicals and paints – currently Council's site is not licensed to receive and store chemicals and paints. However, Council participates in the Annual Household Hazardous Collection Program which NEWF co-ordinates, which historically collects large volumes of paint. Empty paint tins or tins with dried paint are accepted as metal recycling.



6.2.1.6 Construction and Demolition Waste – this material, including clean fill, rubble, brick and concrete, is received, recyclable metals are removed where possible and the residual buried in the inert landfill.

6.2.1.7 Gas bottles – are stored on-site until a sufficient quantity is generated for removal and are the contractor's responsibility for disposal.

6.2.1.8 Metals – all scrap metal, ferrous and non-ferrous, including motor vehicles, white goods, scrap metal and wire, are all stored separately at the landfill site. The material is stockpiled, and is the contractor's responsibility to remove for recycling. All proceeds remain with the contractor.



Figure 11 – Oil Storage Unit

6.2.1.9 Oils – are currently stored in a designated bunded lockable storage area and are the contractors responsibility for removal for recycling.

6.2.1.10 Tyres – the disposal of whole tyres has been banned by State legislation and tyres delivered to Council waste depots must be shredded prior to landfilling or collected for recycling. This is the contractor's responsibility

6.2.1.11 Vegetation and timber – garden waste, timber and pallets are delivered to the designated vegetation area, where they are stockpiled prior to being tub-ground and stockpiled as mulch for sale at \$15 per m^3,



Figure 12 – Green Waste

6.2.1.12 Wood – oversized materials are tub ground and added to the mulch stockpile.

6.2.2 Murwillumbah Landfill

The landfill is located on a 22.2 hectare site approximately 3 km south of Murwillumbah, with access from Wardrop Valley Road. It is adjacent to the Council Nursery, wetlands and opposite cane fields. The site is recorded as having been used as a waste depot since the late 1960s and is part of an operating quarry.

The site is managed by Council and includes an inert landfill, green waste processing area and scrap metal drop-off area.





Figure 13 and 14 – Murwillumbah Landfill

There is no weighbridge on site and all waste received is charged by volume. The current opening hours are Friday to Monday 10.00 a.m. to 4.00 p.m. Typically two staff operate the site with one stationed at the gate house to direct traffic and collect fees and the other at the tip face, who also acts as a plant operator on site.

A tip shop, currently subcontracted, is accommodated in two used shipping containers. No permanent shed or structure is provided for this activity. The tip shop operator also sorts the scrap metal to maximise a return.

The site holds a single Environment Protection Licence issued by the NSW DECC. detailed below:

Table 9 - Landfill Licence Details

EPL No.	Site Description and Area	Activity	Activity Threshold Tonnes per Year	Review Date
6106	Lot 1 DP 232745 and Lot 10 part DP 25812 2.76 ha	Inert Waste	3,500	27 February 2011

A Landfill Environment Management Plan for it has been prepared and inspections to audit compliance with the licence conditions have been carried out by the NSW DECC. The DECC are concerned that quarterly monitoring of groundwater has shown readings exceed trigger levels for pH and copper at two sites on thirteen separate occasions over the past three years. Council has engaged a consultant to undertake a detailed groundwater study and considers that the excessive levels maybe due to acid sulfate soils rather than directly from on-site leachate generation.

The landfill receives the following commodities:

6.2.2.1 Recyclables – modified bulk bins obtained from the contractor are provided for glass, plastics, aluminium and metal cans



Figure 15 – Recyclables Bin

6.2.2.2 Construction and Demolition Waste – This material, including clean fill, rubble, brick and concrete, is received and buried in the inert landfill or used as cover material to raise on-site profiles.

6.2.2.3 Metals – all scrap metal, ferrous and non-ferrous, including motor vehicles, white goods, scrap metal and wire, is stored separately at the landfill site. The material is stockpiled, and must be removed bimonthly by the licensee of the tip shop who contracts Smorgon Steel to remove the material for recycling. Payment summaries are provided to Council who receives 30% of all monies collected by the tip shop licensee for ferrous and non-ferrous metals. Since commencement of the licence agreement in September 2006, 227.38 tonnes of light-gauge steel & 7.52 tonnes of aluminium have been collected and recycled.

6.2.2.4 Vegetation and Timber – garden waste, timber and pallets are delivered to the designated vegetation area where it is stockpiled prior to mulching and placed in windrows for free collection by residents.



Figure 16 – Tyalgum Transfer Station

6.2.2.5 Wood – selected oversized materials are tub ground and added to the mulch pile. Most wood delivered in mixed loads is landfilled.

6.2.3 Transfer Station – Tyalgum

The existing landfill at Tyalgum was a

gully fill and has now been redeveloped as a transfer station to serve the local rural area where residents do not receive a kerbside collection service. Council has constructed a new shed, entrance and provided bulk bins for the collection of household waste, garden waste and recyclables which are transferred to Stotts Creek for disposal. The Council-employed operator removes some reusable items as a waste minimisation initiative. The transfer station is open 10 a.m. – 4 p.m. Saturday and Sundays only. The site presents well and appears to be well managed.

6.3 Waste Collection Services

It is generally accepted that the local council takes responsibility for domestic waste collections to residential premises and public litter bins. Council also provides a service to commercial premises of a standard bin, however, where waste generated exceeds this volume, the generator contracts with a private collector for a more frequent or larger bulk-bin service.

6.3.1 Domestic Premises

Council has contracted Solo Resource Recovery for its weekly collection of residential waste, including recyclables and a fortnightly kerbside organics service. A 240-litre divided waste/recycling bin is provided to 21,016 single residential premises. This represents 90% of all single properties in the council area.

The area also accommodates a further 10,550 multi-unit dwellings which are accommodated on 2,102 properties. These premises are serviced by a combination of bin configurations depending on size, scale and access, including divided bins, single 240-litre bins shared between units or bulk bins. The overall weekly presentation rate is reported as 95%.[3]

The total number of premises receiving a waste service is 31,566 premises however, Council estimates that only 5,000 of the 10,550 MUDs properties receive a recycling service.

The contents of the domestic bins are collected and transported to the Stotts Creek facility, where waste is discharged at the landfill, and recyclables at the adjoining MRF.

In 2005–06 Council disposed of to landfill 23,394 tonnes of domestic waste, and 6,560 tonnes of recyclables were collected. Of this, 1,892 tonnes were processed at the local MRF and 4,668 tonnes sent to Brisbane for sorting at the Visy MRF.[4] The weekly generation rates are estimated at 14.2 kg of waste and 4.00 kg of recyclables per household.

Council offers a fortnightly kerbside organics service to all non-rural properties. Approximately 5,600 of a total 22,340 properties currently participate in the service representing 25% of the total. Users of the service in 2005–2006 generated 2,109 tonnes or 14.7 kg of organics per household fortnightly.

[3] NEPM report to the NSW DECC by Council, as at 30 June 2006.
[4] NEPM report by Tweed Council.

6.3.2 Compost Bins and Worm Farms

Council offers compost bins and worms at below cost to the community. In the last 6 months from 1 July – 13 December 2006 with 34 worm farms and 32 compost bins have been sold.

6.3.3 Litter bins

Public litter bins are collected on the same schedule as residential bins. In the low season (May to October) public litter bins are serviced weekly, while in the high season (November to April) bins are serviced twice weekly and during the peak season - December/January School Holidays the majority of coastal bins are serviced daily.. In total, 364 public bins are located throughout the area in parks, reserve, streets and at popular tourist destinations.



Figure 17 – 240 litre litter bin

6.3.4 Commercial Premises

Typically commercial premises contract waste removal with a private operator, however, Council does service 270 non-residential premises with a divided bin service. Most other premises and generators have a regular service provided with a bulk bin, which is serviced based on generation needs. Regular uses of Council's Stotts Creek waste facility delivering loads of waste generated from this sector include:



Figure 18 – Commercial Cardboard

- Cleanaway
- Collex
- JJ Richard
- Richmond Waste
- Sita Environmental Solution
- Wanless.

Some contractors also provide a recycling service for cardboard as shown above.

Council has a number of skip companies that offer services to the domestic and commercial sector. The following companies are registered to deliver waste:

- Gold Coast Skips
- Ross Brims Bulk Transport
- Tweed Skips
- Gold Coast Bin Hire
- Smartskips Pty Ltd.
- Rick Skips.

6.3.5 Construction and Demolition

Construction companies either self-haul waste to the depot or contract a skip hire business to remove the waste on their behalf. Council has the following contractors listed on its records:

- Brims Earthmoving
- Twin Towns Sand and Gravel
- Munbilla Demolition
- Col Moore and sons
- Byrnesy's Excavations
- Barry Bros. Specialised Services.

6.4 Independent Waste Programs

6.4.1 Medical Waste

The local hospital, medical centres, dentists and veterinary practices should all have contracts in place for the collection of sharps and medical waste by a licensed transporter. Local pharmacies offer a free community service for the return of sharps containers, expired medications and pharmaceutical products. Council has provided fixed wall units for the collection of Sharps in 21 amenity locations, in addition to Council Depots, throughout the shire. These units are serviced by Pink Health Care.



Figure 19 – Sharps Container

6.4.2 Hazardous Waste

Currently there is no DECC -licensed site to receive or store hazardous chemicals in the area. Council has participated in the Household Hazardous Collection Program co-ordinated by the NSW DECC, whereby householders are notified and can deliver unwanted chemicals including herbicides, pesticides, batteries and oils for free. The service was last offered in 24 June 2006 at the Stotts Creek Landfill, where a total of 68 people presented 2,201 kg of material for assessment and correct disposal. The last scheduled collection was on 10th March 2007.

6.4.3 Bio-solids

Bio-solids from the Banora Point Waste Water Treatment Plant are graded as Class B and Council has a contract with Arkwood. The company collects the dried bio-solids twice a week and delivers them to farms located locally or to Toowoomba for land application. Council is not licensed to accept bio-solids at its landfills.

6.5 Waste Management Costs

As part of the development of this strategy, the consultants were provided with access to a number of budget documents. Mr Ian Percy, Waste Management Co-ordinator, is responsible for the preparation of the annual budget and reporting against its

performance. Currently approximately 4% of the $160 million annual general budget of Council is dedicated to waste management.

6.5.1 Cost Recovery

The Domestic Waste Management Charge is levied on all premises outside the general revenue rate system, allowing for full cost-recovery accounting. This charge is also outside the bounds of rate-capping. Waste management is managed as a business unit with the income derived from the Domestic Waste Management Charge offset against anticipated expenditure. Where this exceeds income the balance would be derived from borrowings however, when income exceeds expenditure these funds are placed in reserves.

Table 10 - The Domestic Waste Management Charge Components 06/07

Component	Cost	Total income
Domestic waste service charge	$95.00	$3,001,586
Waste minimisation & recycling	$31.20	$987,516
Domestic waste management fee	$62.80	$2,136,600
Sub-total	**$189.00**	**$6,125,702**
Optional Garden waste service	$35.00 *	$175,000
Total	**$224.00**	**$6,300,702**

* service subsidized from reserve funds

Council documents reveal a healthy reserve of $6,255,501 being held as at the 2004-2005 financial year.

6.6 Key Waste Management Issues

The following are the key issues for waste management in the Tweed:

- The area has one of the highest population growth rates in the state at 4% per year and is an ideal destination for the 'sea and tree' changers seeking retirement and tele-commuting
- Relatively small population spread over a large geographic area for servicing
- High visitation by tourists
- The Murwillumbah landfill has been identified as having groundwater contamination issues with high levels of copper and pH recorded. The DECC has mentioned, in recent correspondence, possible closure plans for this site
- There is no weighbridge at Murwillumbah landfill, with all charges volume-based.
- The Stotts Creek landfill's current operating putrescible cell is nearing capacity and is expected to fill by 2010.
- The DECC suspects that the old capped cells at Stotts Creek site are leaking and that leachate is now migrating across the site. However, it is unclear to what extent local acid sulphate soils are exacerbating current site conditions.
- The DECC advises that if green waste processing operations are not properly managed at that Stotts Creek and Murwillumbah landfills it may negatively influence leachate generation on-site,.
- Council provides a divided bin collected weekly for the co-collection of recycling and rubbish on a 50:50 division.

- Only 25% of households voluntarily use the garden organics service at $35 per year
- Council's current contract for kerbside collection services and Stotts Creek Landfill management expires in November 2009
- Council needs to consider the future domestic service and landfill management options.

7. WASTE CHARACTERISATION STUDY

Waste auditing, or characterising the waste stream, is imperative for accurately understanding the current composition and to be able to accurately plan, predict and undertake a cost–benefit analysis on various system options for improving resource recovery and increasing diversion from landfill, based on actual results.

Tweed Council was one of the participating councils in a Regional Municipal Waste Characterisation Study co-ordinated by the North East Waste Forum on both domestic waste and recycling collections in February and March 2005. The objectives of the study were to:

- determine the composition of each of the six participating councils
- determine the composition of the region as a whole and
- determine current performance of recycling and organics collection programs.

In addition the Council Waste Management Services Contract requires Solo to conduct quarterly waste audits.

This section contains the findings of the regional waste audit and the September 2006 Solo recycling audit.

7.1 Regional Municipal Waste Characterisation Study

This study was co-ordinated by the North East Waste Forum and conducted by Full Circle Environmental Solutions. The actual audit for the Tweed Shire was carried out from 3–8 April, 2005. A total of 126 bins were sampled, from which 1.5 tonnes of mixed waste and 0.7 tonnes of recyclable materials were analysed. The auditing was conducted at the Solo Resource Recovery Centre at Chinderah.

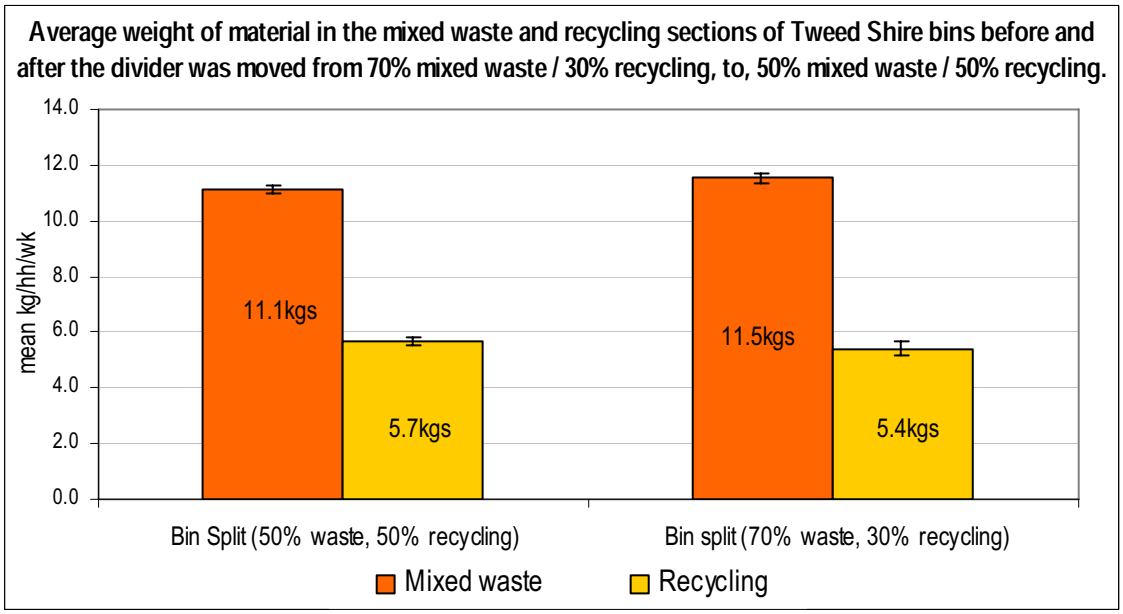
The audit found that the average resident places out 17.2 kilograms of waste for collection weekly, of which 11.7 kilograms consist of garbage and 5.4 kilograms consist of recyclables, representing a diversion rate of almost 27%.

The charts used in this section are taken directly from the report written by Full Circle Environmental Solutions.

7.1.1 Average Weight of Waste Streams by Bin Configuration

At the time of the survey, Tweed Shire Council was in the process of changing the divider from a 70:30 division – 70% waste to 30% recycling – to a 50:50 division. Of the 125 bins analysed in Tweed Shire, 54% of bins were split 50:50 and 46% of bins were split 70:30. The chart below shows the difference in weight between the two systems, with slightly more recyclables and less waste in the 50:50 division.

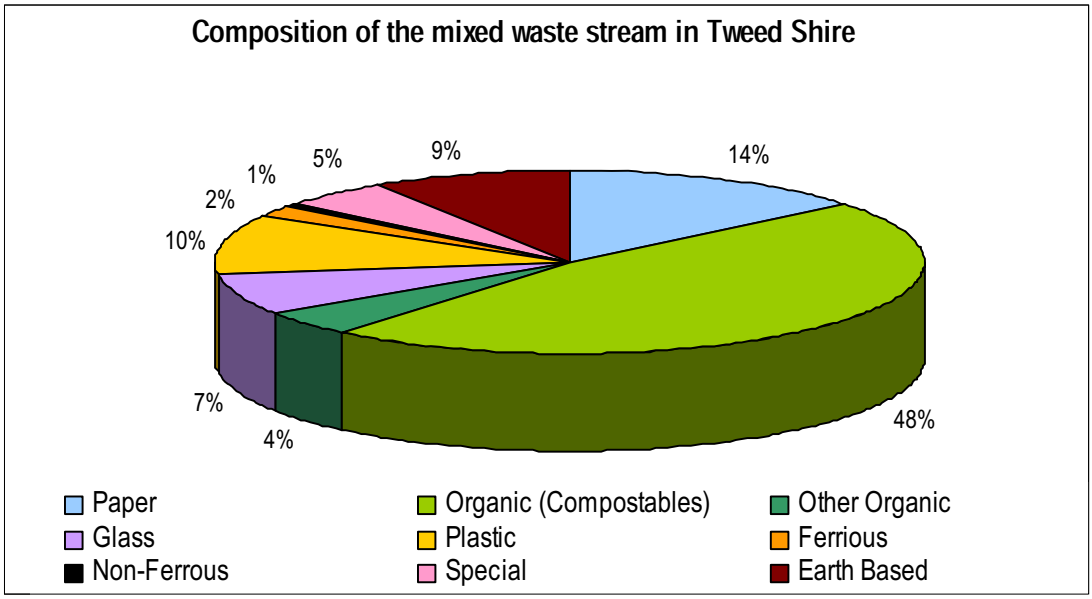
Chart 1 - Average Weight of Waste Streams by Bin Configuration[5]



7.1.2 Composition of the Residential Garbage Stream[6]

Organics material, at 48%, represents the largest component of the bin contents, followed by recyclable paper and cardboard, at 14%, and glass containers at 7%.

Chart 2 - Composition of the Residential Garbage Stream

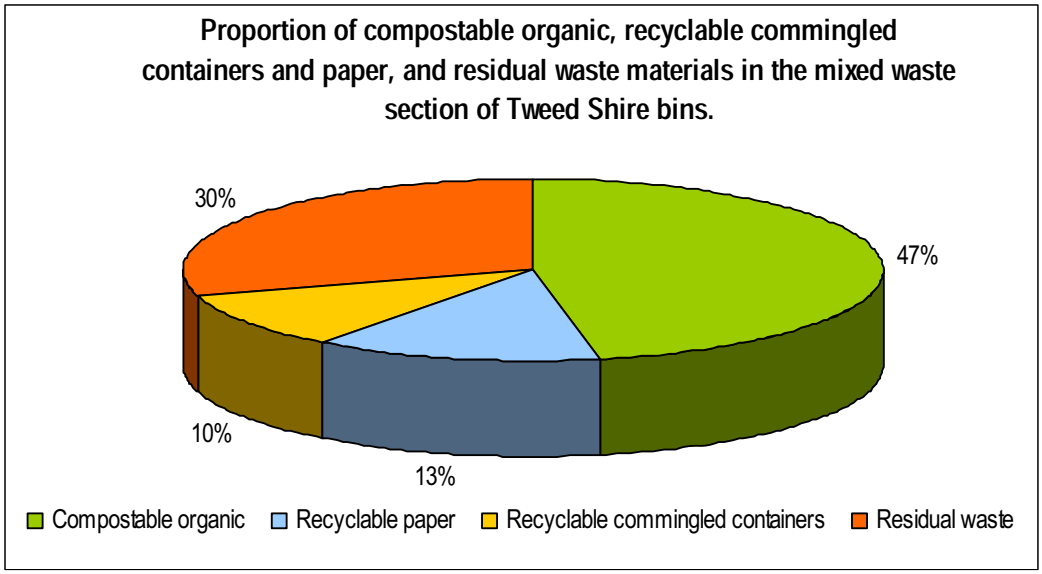


7.1.3 Potentially Recoverable Proportion of the Garbage Stream

Up to 70% of the Tweed Shire garbage stream can be classified as potentially recoverable resources or a mean weight of just over 8 kg/hh/wk, while residual waste comprises 30%, or 3.5 kg/hh/wk.

[5] Chart from Full Circle Environmental Solutions' 2005 Waste Characterisation Study of Tweed Shire Council.
[6] Chart from Full Circle Environmental Solutions' 2005 Waste Characterisation Study of Tweed Shire Council.

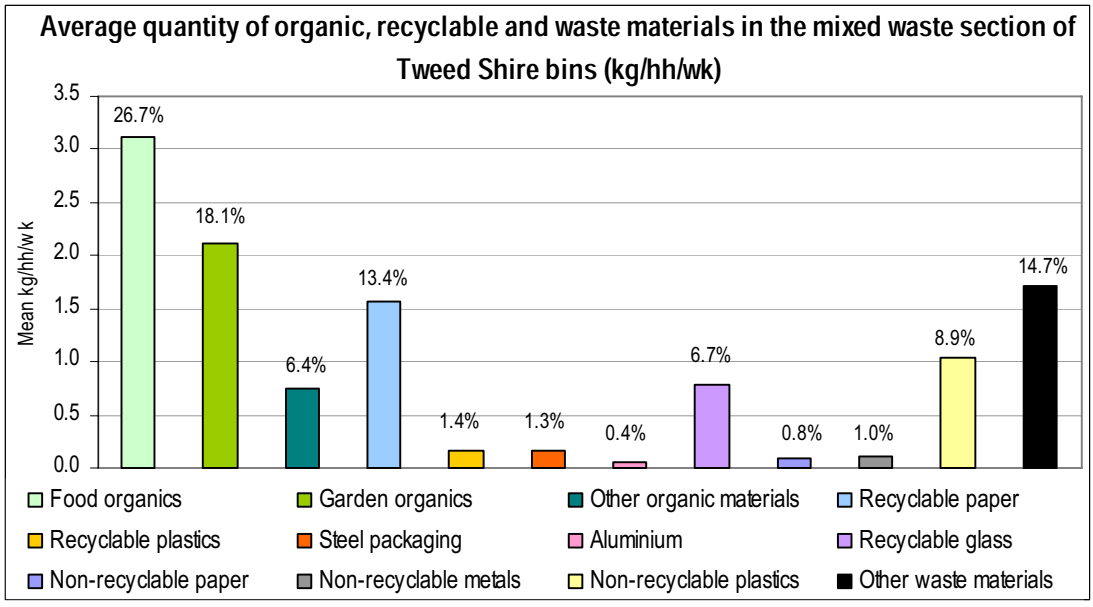
Chart 3 - Potentially Recoverable Proportion of the Garbage Stream[7]



7.1.4 Waste Generation – Kilograms per Household per Week

The average bin weighs 11.7 kg, with food waste comprising the greatest quantity at 26.7%, followed by garden organics at 18.1%. Together the organic fraction comprises 44.8%. Recyclable items comprise 23.2%, with paper 13.4%, glass 6.%, plastics 1.4% steel 1.3% and aluminium 0.4%.

Chart 4 - Waste Generation by Material Type[8]

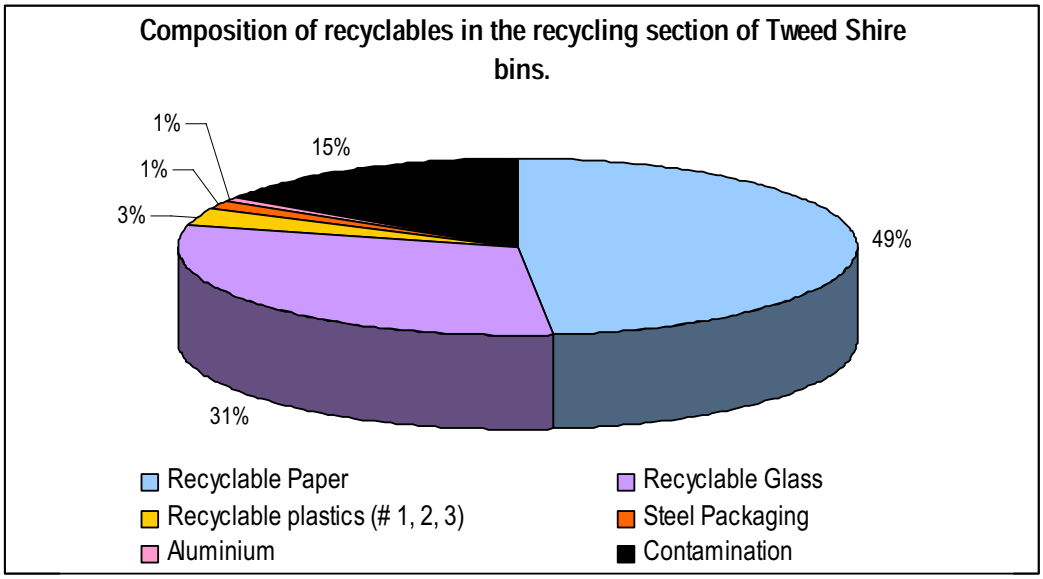


7.1.5 Recycling Stream Composition

Recyclable paper makes up 49% or 2.6 kg/hh/wk, followed by glass at 31% or 1.7 kg/hh/wk. Contamination was 15% or 0.8 kg/hh/wk.

[7] Chart from Full Circle Environmental Solutions' 2005 Waste Characterisation Study of Tweed Shire Council.
[8] Chart from Full Circle Environmental Solutions' 2005 Waste Characterisation Study of Tweed Shire Council.

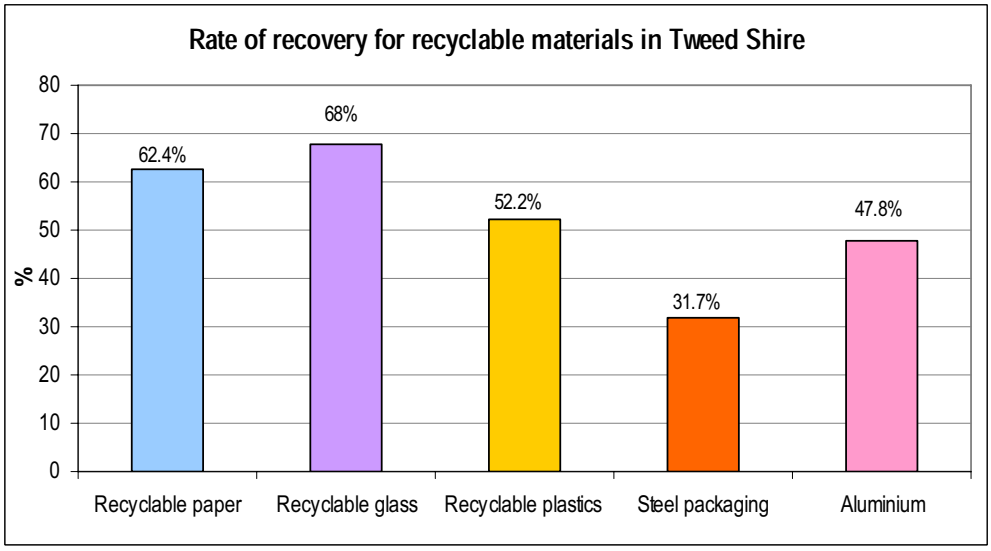
Chart 5 - Recycling Stream Composition[9]



7.1.6 Recyclables' Recovery Rates

This represents the amount of material recovered as a percentage of overall consumption and is calculated by dividing the weight of recyclables in the recycling bin by the combined weight of recyclables in the recycling bin and the weight of recyclables in the garbage bin. Paper and glass were the two material categories with the highest rates of recovery. The overall mean recovery rate for recyclables in Tweed Shire was 63%.

Chart 6 - Recyclable Recovery Rates[10]

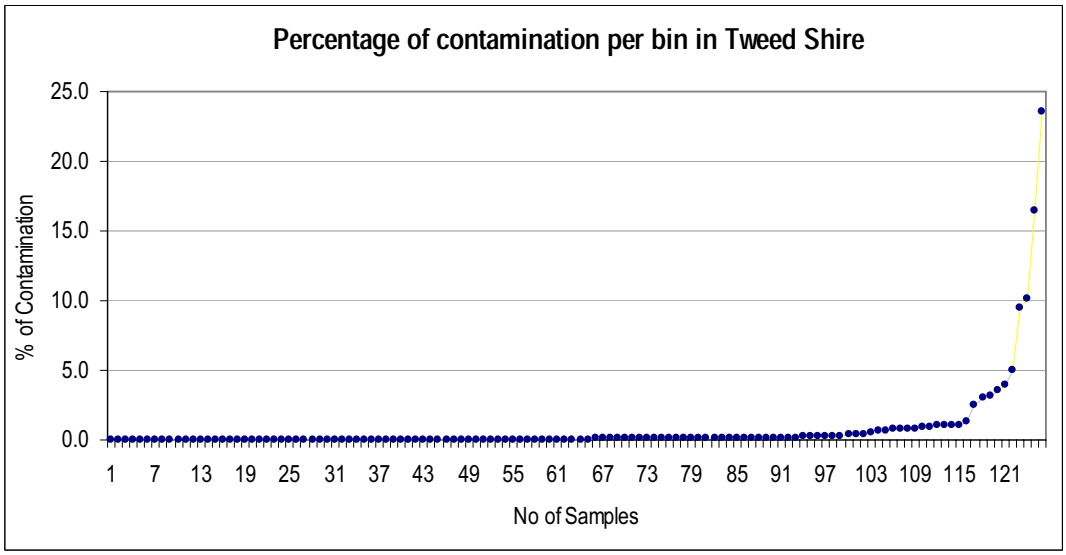


[9] Chart from Full Circle Environmental Solutions' 2005 Waste Characterisation Study of Tweed Shire Council.
[10] Chart from Full Circle Environmental Solutions' 2005 Waste Characterisation Study of Tweed Shire Council.

7.1.7 Recycling Contamination

The proportion of contamination in the sample ranged from 0% to 24%, with an average of 15%. While most residents are diligent, a small minority heavily contaminate the recycling section. Of the 126 samples, six samples were statistical outliers and, if removed from the analysis, contamination is reduced from 15% to 6%.

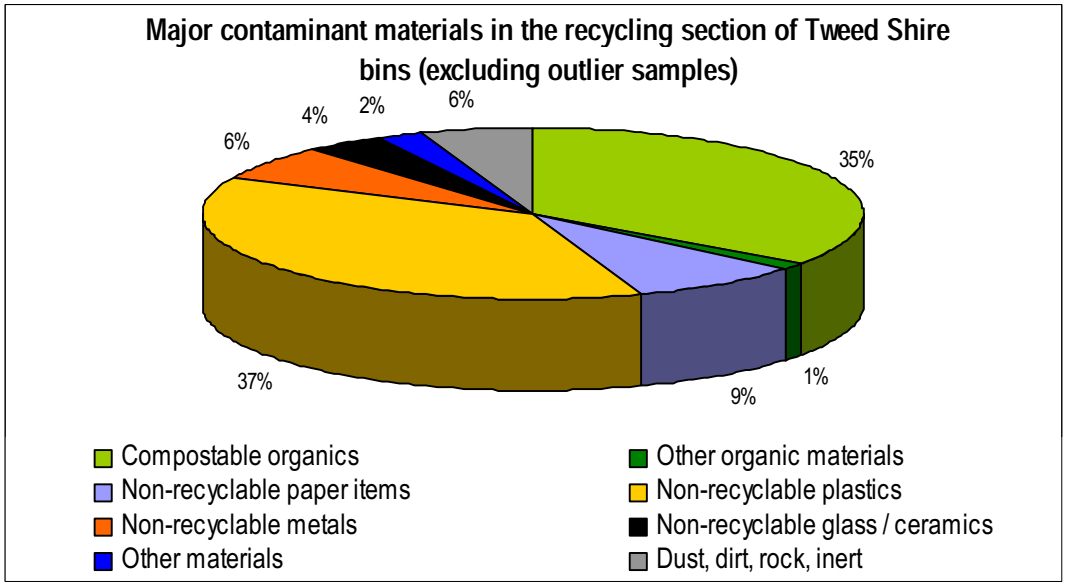
Chart 7 - Recycling Contamination by Household[11]



7.1.8 Composition of Contamination

A breakdown of the material comprising the contamination is provided below. Non-recyclable plastics at 37%, followed by compostable organics at 35%, were the most prevalent materials.

Chart 8 - Composition of Contamination in the Recycling Stream[12]



[11] Chart from Full Circle Environmental Solutions' 2005 Waste Characterisation Study of Tweed Shire Council.
[12] Chart from Full Circle Environmental Solutions' 2005 Waste Characterisation Study of Tweed Shire Council.

Table 11 - Comparison with DECC Performance Standards

Performance Measure	Unit	Description	Baseline	Target	Tweed Audit
			NSW		
Household net yield	kg/hh/wk	Total kerbside recyclables collected per household, excluding gross contamination	>4	>5.5	5.4
Per capita net yield	kg/pp/wk	Quantity of kerbside recyclables collected per person, excluding gross contamination	>1.5	>2.1	2
Net diversion rate	Percentage	Total proportion of domestic waste diverted to the recycling stream	19%	>29%	27%
Contamination rate	Percentage	Contaminants placed in recycling bins by householders	N/A	<3.5%	15%

Chart 9 - Tweed Audit Data v DECC Targets – Net Yield Per Week

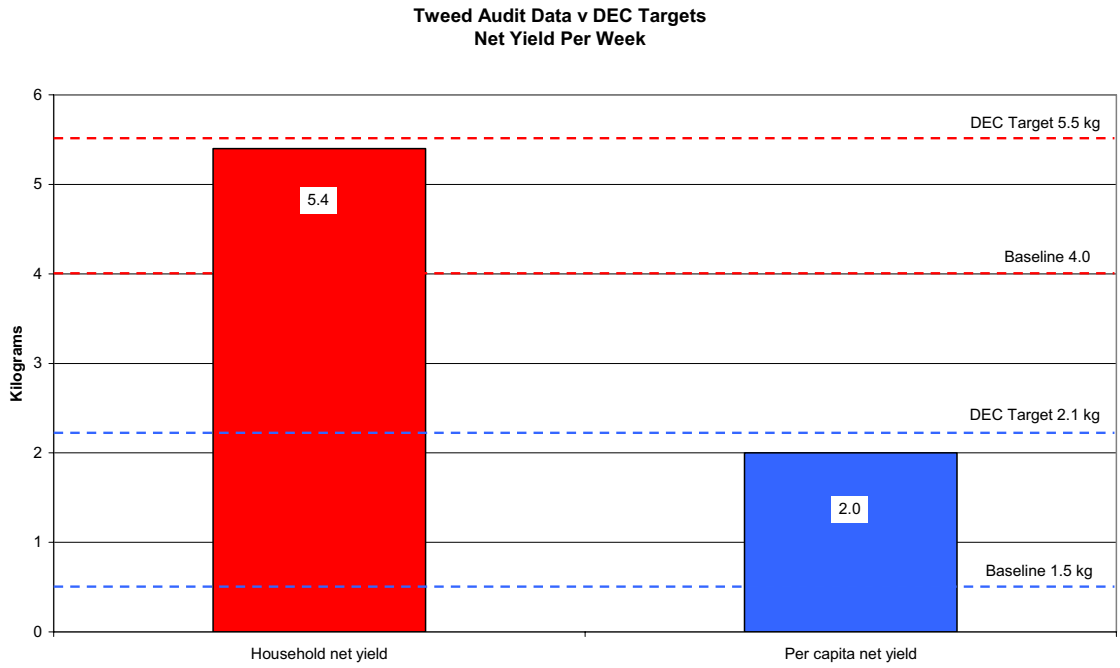
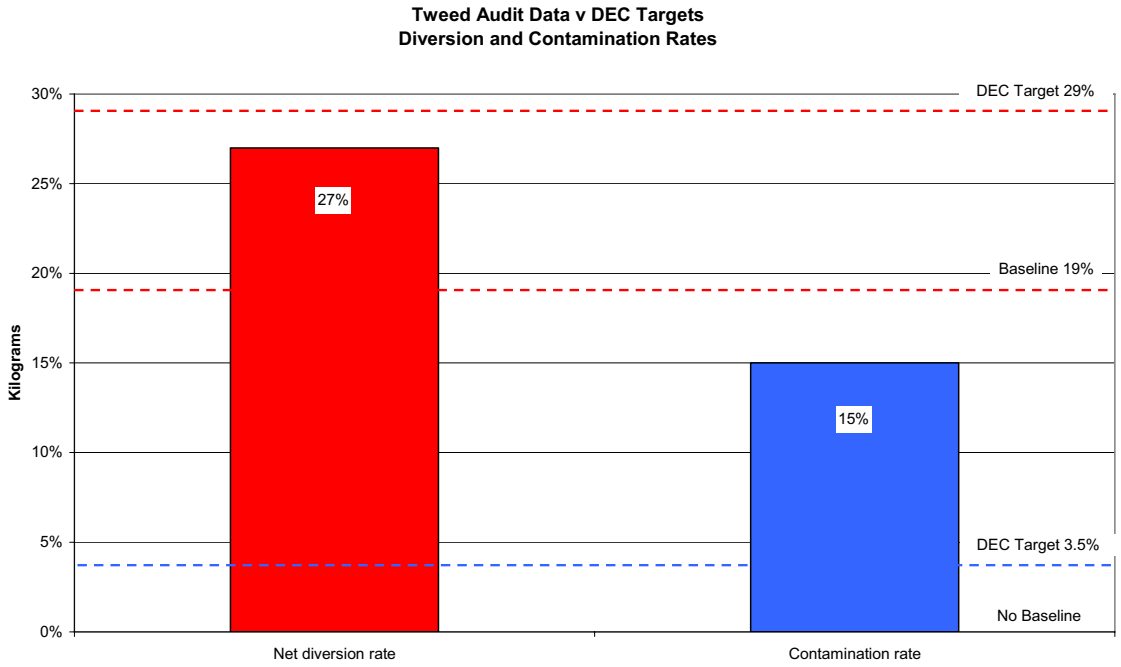


Chart 10 - Tweed Audit Data v DECC Targets – Diversion and Contamination Rates



7.1.9 Summary

Total waste stream (garbage and recycling)

- On average, each household in generates 17.1 kg of material weekly
- Net diversion of recyclables in the domestic kerbside waste stream was 27%.
- 76% of the waste stream is potentially recoverable materials.
  - Garden organic comprised 12.5% (or 2.1 kg/hh/wk);
  - Food organics comprised 19% (or 3.3 kg/hh/wk);
  - Recyclable paper materials comprised 24% (or 4.2 kg/hh/wk);
  - Commingled containers comprised 18%
  - Residual waste comprised 25% (or 4.2 kg/hh/wk).

Garbage stream

- The average weight was 11.7 kg, comprising:
  - Garden organics comprised 18%, or 2.1 kg/hh/wk
  - Food organics comprised 27%, or 3.1 kg/hh/wk
  - Recyclable paper comprised 13%, or 1.6 kg/hh/wk
  - Commingled containers comprised 10%, or 1.2 kg/hh/wk
- Residual waste 32%, or 3.7 kg/hh/wk.

Recycling stream

- The average weight was 5.4 kg/hh/wk
  - Recyclable paper comprised 48%, or 2.6 kg/hh/wk
  - Recyclable glass comprised 31%, or 1.7 kg/hh/wk
  - Recyclable plastics comprised 3.4%, or 0.2 kg/hh/wk
  - Steel packaging comprised 1.3%, or 0.1 kg/hh/wk
  - Aluminium comprised 0.8%, or 50 grams/hh/wk
- The overall recovery rate for recyclables was 63%

- The highest recovery rates were for recyclable glass (68%) and recyclable paper (62.4%), and the lowest was for steel packaging (31.7%)
- The average yield for all recyclables was 4.6 kg/hh/wk
- Average contamination was 15%, or 0.8 kg/hh/wk. Six samples, or 4.7% of the sample set, were identified as outliers, and, if excluded from the analysis, contamination decreased to 6%
- Non-recyclable plastics and compostable organics represented 37% and 35% respectively of the total contamination.

7.1.10 Comment

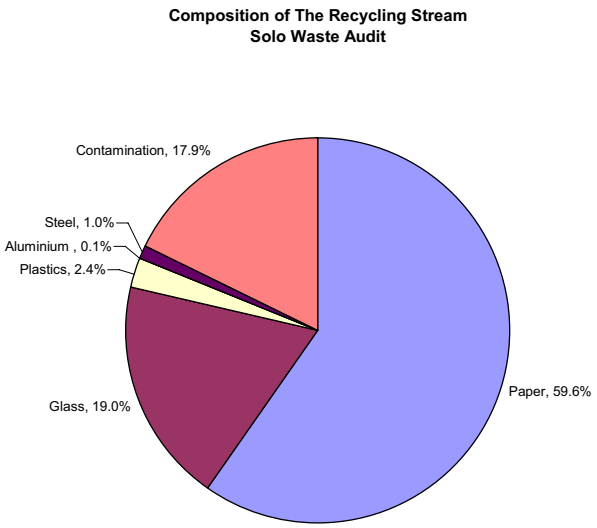
At the time of sampling, Tweed Shire Council was offering residents the option of a separate 240-litre organics bin with a fortnightly collection schedule. Results from both Clarence and Lismore indicate that it is possible to reduce the quantity of garden organics in the garbage stream by up to 80%, and food organics, by up to 50%.

The high proportion of non-recyclable plastics in the contamination stream is common and not surprising, considering that many residents have difficultly in identifying recyclable from non-recyclable plastics. Compostable organics contamination, on the other hand, is usually the result of deliberate actions.

7.2 Solo Waste Audit

The audit was conducted on 22 September 2006 at the Solo Resource Recovery Centre at Chinderah. Of the 31,000 services, 200 bins were audited, representing 0.65% of the service area. The audit was of the recycling stream only. In total, 826 kg of recyclables were audited representing a generation rate of 4.13 kg per household per week. The composition of the recycling stream comprised paper and cardboard at 59%, followed by glass at 19%. Contamination represented 17.9%.

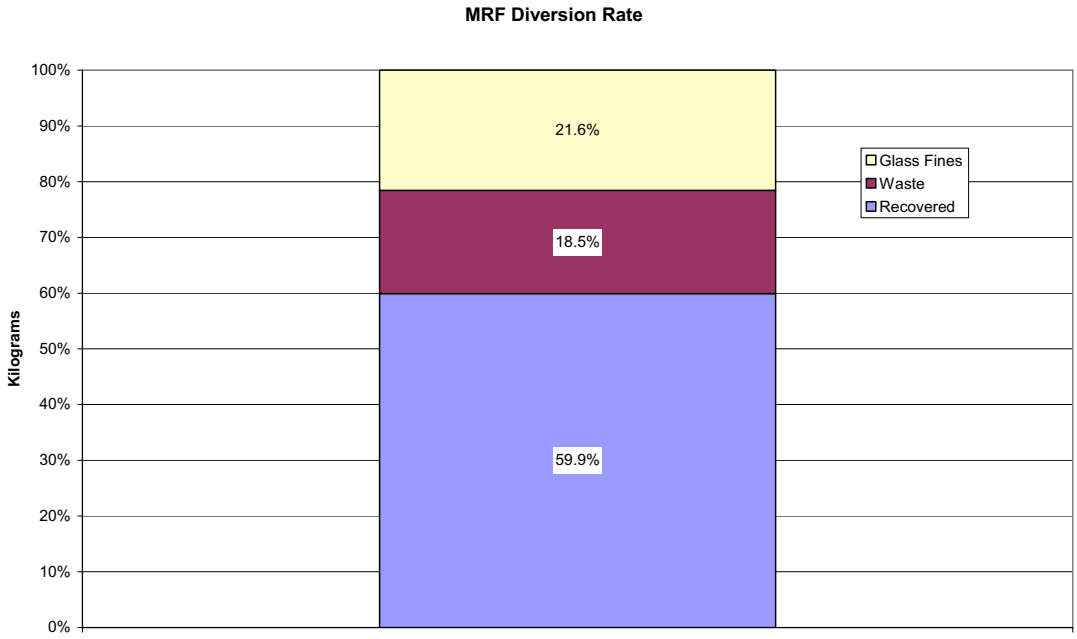
Chart 11 - Composition of the Recycling Stream – Solo Waste Audit



7.3 MRF Audit

Solo provide quarterly reports to Council to verify the quantity processed and recovered. These reports reveal that on average 2.5 kg per household are recovered, with the remaining material, 1.63 kg, lost as glass fines, contamination or waste. This represents an actual recovery rate of 60%, as shown in the chart below.

Chart 12 - MRF Diversion Rate



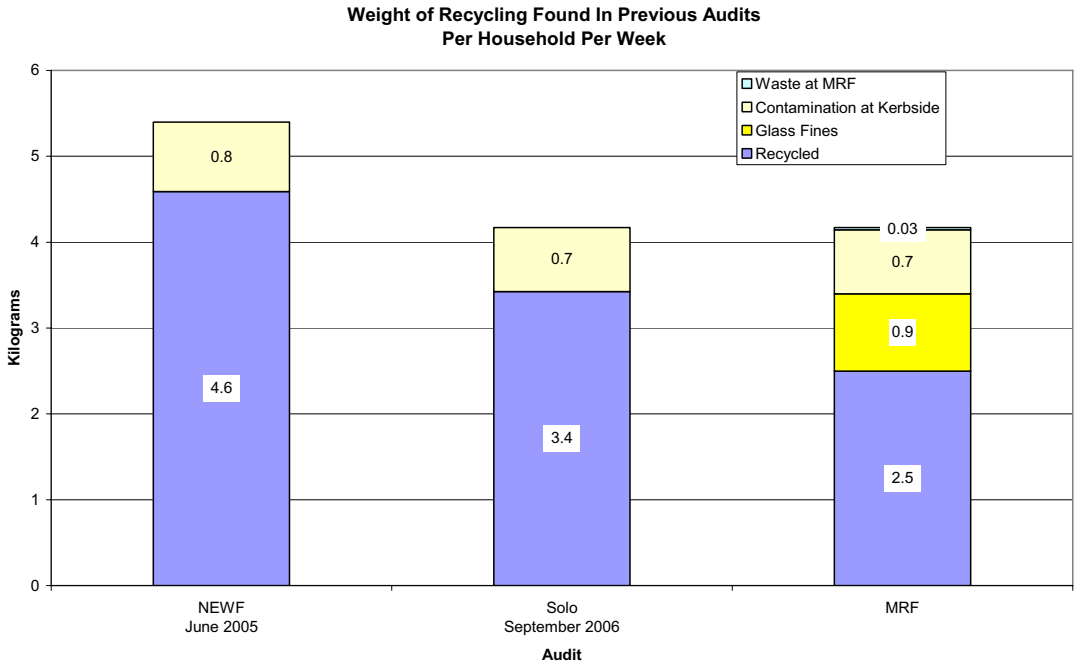
7.3 Comparison of Recycling Audits

The chart below shows the three audits of the recycling steam which have been conducted for Tweed Shire. The key finding is that of all the material placed at the kerbside, between 15–18%, is contamination representing between 0.7–0.8kg per household per week.

This amount then increases by a further 0.9 kg, as a significant quantity of the glass breaks during collection to a point where it is non-recoverable and is classified as glass fines.

Effectively, only 64% of what is placed out at the kerbside is recovered, due to loss of product at the processing and sorting stage at the MRF.

Chart 13 - Weight of Recycling Found in Previous Audits



8. MARKET RESEARCH

The success of almost any program depends on the quality and level of involvement by the target audience in the project's development. The best way to determine the attitudes and opinions of the target audience is to carry out a survey. Any survey should conform to the following guidelines:

- The survey sample must be representative
- The survey questions should be clear and easy to understand
- The survey questions should not be ambiguous, emotive or leading.

Using information gathered during the briefing and scoping visit and discussions with Council staff, a series of questions were formulated into surveys to canvass the community and visitors' attitudes, behaviour and opinions in respect of a range of waste management issues.

8.1 Method

During the development of the surveys, it became apparent that three separate surveys would be required for the local community. These were based on the following:

1. Urban – access to a current garbage/recycling and optional garden organics
2. Rural – access to no service
3. Tourist or visitor to area.

A statistically representative sample for the surveys was deemed to be 200 responses, based on the following breakdown of localities and proportional to the population.

Table 12 - Survey Distribution and Sample Size – Proposed and Actual

Postcode of residence	Target	Actual	Percentage
	Number	Number	
2483		2	1%
2484	40	40	19%
2485	60	39	18%
2486	80	91	42%
2487	20	28	13%
2488		6	3%
2489		8	4%
2490		1	0%
Total	**200**	**215**	**100%**

The surveys sought to explore the following issues:

- Knowledge of current waste management programs
- Methods of disposal of surplus waste
- Frequency of visitation to waste depots
- Willingness to pay and change behaviour
- Future waste management.

The survey was approved by council prior to commencement. Copies of the surveys can be found in Appendices 2–4. An article was published on the front page of the *Tweed Link* community newsletter, Issue 491 on 21 November, making residents aware of the project and seeking their support and participation. A copy is provided in Appendix 5.

The surveys were administered principally by face-to-face interviews from the 23rd to 26th November, 2006, by randomly approaching pedestrians in the following locations:

- Rainforest Tourist Information Centre
- Banora Point Shopping Centre
- Tweed City Shopping Centre
- Murwillumbah Swimming Pool.

In addition, a small number of surveys were administered using randomly selected phone numbers sourced from the current White Pages to gain the number of responses required by postcode.

8.2 Survey Results

This section provides the key findings of the 215 completed urban surveys and a full copy is provided in Appendix 6. However, only 14 visitor surveys and 4 rural surveys were completed. Statistically these are insufficient to undertake any meaningful analysis.

Q1. Do you live in an area with a kerbside garbage collection service? Yes / No

Two hundred and fifteen survey respondents were identified as living in the Tweed Shire with a kerbside collection service. A smaller number of residents identified that they lived in the area with no service and these residents completed a rural survey, which due to the limited number, were not analysed.

Many of the tables below are divided into the categories ‘Single house in township’ and ‘Other’.

Question 2. How often do you put your rubbish bin out for collection?

All residents living in town placed their bin out for collection weekly, while 91% of ‘other’ also had a weekly pick-up. Eight per cent of households had some other arrangements including: twice per week, use of bulk bin which was collected twice or three times per week

Question 3. Does your rubbish bin have a divider?

Of the six households that had bins with no dividers, one said that it did previously had a divider and the remaining five did not reply to the question regarding whether it had had a divider.

Question 4. Can you tell me what goes in which side of the rubbish bin?

The majority of residents (92%) correctly identified the separation of rubbish and recyclables, while 2% had difficulty and 6% did not respond, indicating they couldn't recall.

Table 13 - Question 5. On average, how full is your rubbish side each time you put it out?

Percentage	Single house in town	Other*	Total
< 25%	2%	4%	3%
25–50%	6%	7%	6%
50–75%	25%	28%	26%
7 –100%	27%	31%	28%
> 100%	40%	30%	36%
Total	100%	100%	100%

Table 14 - Question 6. On average, how full is your recycling side each time you put it out?

	Single house in town	Other*	Total
< 25%	1%	3%	1%
25–50%	7%	4%	6%
50–75%	21%	25%	22%
75–100%	29%	26%	28%
> 100%	41%	29%	37%
No response	1%	13%	6%
Total	100%	100%	100%

Table 15 - Questions 5 and 6. Average levels of rubbish/recycling

Response	Percentage
Rubbish up to 50%, recycling up to 50%	4%
Rubbish up to 50%, recycling 50%–100%	4%
Rubbish up to 50%, recycling >100%	1%
Rubbish 50%–100%, recycling up to 50%	4%
Rubbish 50%–100%, recycling 50%–100%	36%
Rubbish 50%–100%, recycling >100%	13%
Rubbish >100%, recycling up to 50%	1%
Rubbish >100%, recycling 50%–100%	10%
Rubbish >100%, recycling >100%	28%
No response	1%
Total	100%

(table population: Single houses in town only)

Table 16 - Question 7. Does your rubbish or recycling side fill up first?

	Single house in town	Other*	Total
Rubbish	36%	33%	35%
Recycling	32%	30%	31%
About the same	30%	25%	28%
No response	2%	12%	6%
Total	100%	100%	100%

Table 17 - Question 8. Do you put your rubbish/recycling in plastic bags before putting them in the bin?

Response	Number	Percentage
Rubbish yes, recycling yes	4	3%
Rubbish yes, recycling no	121	90%
Rubbish no, recycling yes	0	0%
Rubbish no, recycling no	6	4%
No response	4	3%
Total	135	100%

Single houses in town only

Table 18 - Question 9. Which materials do you separate for recycling?

	Single house in town (n 135)	Other dwelling types (n 80)	Total (n215)
Material	Percentage		
Glass bottles	89%	79%	85%
Aluminium cans	67%	51%	61%
Metal food cans	59%	49%	55%
Plastic drink containers	84%	73%	80%
Detergent/shampoo	13%	6%	11%
Paper/cardboard	96%	84%	91%
Milk cartons	69%	45%	60%
Other	1%	1%	1%

Table 19 - Question 10. What do you do with any excess recyclables?

	Single house in town	Other*	Total
Stotts Creek waste depot	1%	3%	1%
Murwillumbah depot	1%	0%	0%
Rubbish bin	5%	9%	7%
Other	20%	10%	16%
No response	73%	78%	76%
Total	100%	100%	100%

Table 20 - Question 10 'Other' included

Disposal method	Number	Disposal method	Number
Keep till next collection	23	Clubhouse bin	1
Neighbours bin	6	Tugan landfill	1
Takes to work	2	Paper in compost bin	1

(NB: Some people gave multiple answers)

Table 21 - Question 11. Do you think Council should introduce a separate bin for recycling collected every fortnight?

	Single house in town	Other*	Total
Yes	61%	54%	59%
No	36%	38%	37%
No response	3%	8%	4%
Total	100%	100%	100%

Table 22 - Question 11. Do you think council should introduce a separate bin just for recycling collected every fortnight? – by household size

	Household size		
	1 or 2	3 or more	Total
Yes	47%	82%	61%
No	49%	18%	36%
No response	4%	0%	3%
Total	100%	100%	100%

Single house in township only

Table 23 - Question 11a. Why?

'Yes' Responses			
Reason	Number	Reason	Number
1 bin not big enough, more space	32	Armidale Council has a crate with lid	1
Encourages more people to recycle	12	Absolutely, now	1
Brisbane/Byron/Orange/Dubbo/ Moree/Qld/Kiama has this system	5	Prefer no divider – easier large items and cardboard	1
Easier	4	Easy to pick up extra bin – truck in street anyway	1
Keep completely separate	3	Good idea	1
Recycle better with bigger bin	2	Large family	1
recycling into rubbish bin	1	cardboard would fit	1
		People can fill garbage without divider	1
Adequate for us	4	300-m driveway – only 1 bin	1
Not enough room for more bins	4		

Table 24 - Question 12. Do you have a wheelie bin for garden waste collected fortnightly?

	Single house in town	Other*	Total
Yes	36%	15%	28%
No	62%	75%	67%
No response	2%	10%	5%
Total	100%	100%	100%

Table 25 - Question 12a. If no, did you know Council provides this service for an additional cost of $35 per year (some rural areas excluded)?

	Single house in town	Other*	Total
Yes	45%	33%	40%
No	45%	48%	47%
No response	10%	19%	13%
Total	100%	100%	100%

Table 26 - Question 13. Do you think Council should introduce a fortnightly garden waste wheelie bin as a standard service for every property?

	Single house in town	Other*	Total
Yes	50%	29%	42%
No	41%	46%	43%
No response	9%	25%	15%
Total	100%	100%	100%

* Other = Single house on rural land, Villa, townhouse, Home unit, Caravan park

Table 27 - Question 14. What do you do with leaves, prunings and grass clippings?

	Single house in township (n135)	Other dwelling types (n80)	Percentage
Garden waste wheelie bin	38%	21%	32%
Take to waste depot	6%	5%	6%
Stotts Creek	3%	4%	3%
Murwillumbah	1%	1%	1%
Tyalgum	0%	0%	0%
Compost/mulch	35%	24%	31%
Burn	2%	1%	2%
Other	25%	45%	33%

Table 28 - Question 15. Do you use Council's bulky household clean-up service? If so, how often?

	Single house in town	Other*	Total
Once per year	35%	20%	29%
Twice per year	39%	28%	34%
Don't use it	24%	49%	33%
No response	2%	3%	4%
Total	100%	100%	100%

Table 29 - Question 16. Do you visit the waste depots or transfer station? If yes, which one?

	Single house in town	Other*	Total
Stotts Creek waste depot	33%	19%	28%
Murwillumbah waste depot	13%	4%	10%
Tyalgum transfer station	0%	3%	1%
Tugun	11%	8%	10%
Burleigh	0%	1%	0%
None, no response	43%	65%	51%

Table 30 - Question 17. Frequency of visits to waste depots/transfer stations

	Stotts Creek	Murwillumbah	Tyalgum
Weekly	0	1	0
Fortnightly	2	0	0
Monthly	11	3	1
Six times per year	7	1	0
4 times per year	6	4	0
3 times per year	3	2	0
Twice per year	10	7	1
Once per year	20	3	0
Not specified	1	0	0
Total	60	21	2

Table 31 - Question 18. Size of load delivered to waste depots/transfer stations?

	Stotts Creek	Murwillumbah	Tyalgum
Car, station wagon	14	5	2
Ute	18	8	0
Small trailer	20	8	0
Large trailer	1	0	0
Truck	4	0	0
Not specified	3	0	0
Total	60	21	2

Table 32 - Question 19. What type of materials do you take to the waste depot?

	Stotts Creek	Murwillumbah	Tyalgum
General household waste	22	8	1
Metals/whitegoods	6	4	0
Garden waste	29	10	2
Wood and timber	5	5	0
Building material	12	8	0
Furniture/mattresses	10	3	0
Paper/cardboard	6	1	0
Glass bottles	1	0	0
Plastic bottles	0	0	0
Aluminium cans	0	0	0
Car batteries	1	2	0
Motor oil	2	0	0
Tyres	0	3	0
Reuse shop	1	0	0
Other	4	1	0

Table 33 - Question 20. If Council were to close Murwillumbah landfill, would you travel to Stotts Creek Landfill, which is open 7 days per week?

	Single house in town	Other*	Total
Yes	50%	67%	52%
No	33%	33%	33%
No response	17%	0%	15%
Total	100%	100%	100%

Table population: those who currently use Murwillumbah

Table 34 - Question 21. Do you think the current opening hours at Stotts Creek landfill are adequate?

	Number	Per cent
Yes	60	57%
No	23	22%
No response	22	21%
Total	105	100%

Table population: those who currently use any waste depot/transfer station

Table 35 - Question 22. What do you do with any food waste?

	Single house in town	Other*	Total
Garbage bin	59%	75%	65%
Compost bins	27%	9%	20%
Worm farm	2%	0%	1%
Chooks	5%	4%	5%
Other	5%	8%	6%
No response	2%	4%	3%
Total	100%	100%	100%

Table 36 - Question 23. Are you aware that Council provides FREE mulch at the Murwillumbah depot?

	Percentage
Yes	33%
No	62%
No response	5%
Total	100%

Table 37 - Question 23a. Are you aware that Council provides mulch at Stotts Creek landfill for $15/trailer loaded?

	Percentage
Yes	35%
No	58%
No response	7%
Total	100%

Table 38 - Question 24. Do you have any suggestions on how waste management could be improved in Tweed?

	Suggestion	Number of responses
	Happy with service	17
Collection system – garbage	Optional bin size for garbage	1
	Overflowing bins get collected – didn't get collected at Byron.	1
	More garbage space needed	3
	Divided bin useless	1
	Weekly collection good. Extra one at Xmas	1
Collection system – Recycling	2 bins for recycling or more space fortnightly collection	37
	separate recycling bin free of charge.	4
Collection system – Garden waste	Garden waste – weekly service.	3
	Garden waste collection for townspeople	1
	Garden waste bin – cheap to start but will go up.	1
	Green bins should be provided to all residents without extra charge	1
	Organics service – in town yes, out of town optional.	1
	Organics optional	1
	Palm fronds a problem	1
Collection – general	3 bins	9
	More bins	3
Clean-up	Clean-up service too limiting, no paint and batteries.	
	Green waste should be included	3
	Too restrictive, should include building	1
		1
Mulch	Mulch at Stotts – too many weeds, poor quality	
	Mulch is crap and full of weeds, too big, chunky, plastic no presort,	1
	Mulch – not available sold to nursery 16 months ago	5
	Self-load at Murwillumbah – loaded would be better	1
		1
Tip fees	Dump rubbish for free. No extra charge.	
	Green waste – free tipping	1
	Happy to go to tip but $11 trailer load – palm trees too expensive	1
		1
Education	Educating all residents. Make sure everyone knows what to recycle	3
	More information about services	1
	Promote mulch options	1
Household hazardous	More emphasis chemical – paints, household hazardous chemical	1
	containers – contents and container	
Litter	Poor attitude – bottles everywhere	1
	Birds drag out rubbish.	1
Other related issues	Everyone do the right thing.	1
	Do away with junk mail	1
	Garbage bins need updating	1
	Bin cleaning service	1
	Trucks should be working properly. They drop things along the way.	1
	Drivers spill bin contents and don't pick up	1
	Dubbo would take car to drop-off centres – none here – need some	1
	Need program for small batteries	1
	Too much water wasted on cleaning bottles – shouldn't need it	1
	Green waste bins go into storm water drain when collected.	1
	Likes Lismore's service.	1
	Not interested as live in unit complex with own separate bins.	1
	Over 80 – neighbours take out bin, Collectors should come to door.	1
	Not impressed with garbage collectors' attitudes	1

Questions 25 and 26. Dwelling type and household size

Most respondents (63%) live in separate houses with three or more occupants while villa, townhouses and home units accounted for 27% of responses and tend to accommodate 1–2 people.

Table 39 - Questions 25 and 26. Dwelling type and household size

Type of Dwelling	Household Size		
	1 or 2	3 or more	Total
Single house in township	58%	72%	63%
Single house on rural land	4%	17%	8%
Villa, townhouse	18%	6%	14%
Home unit	18%	5%	13%
Caravan park	3%	0%	2%
No response	-1%	0%	0%
Total	100%	100%	100%

Table 40 - Question 27. Respondent's age by gender

Age	Male	Female	Total
16–24	2%	6%	5%
25–34	11%	10%	11%
35–44	6%	13%	10%
45–54	18%	17%	17%
55+	59%	53%	55%
No response	4%	1%	2%
Total	100%	100%	100%

8.3 Key Findings

Recycling container – the majority of the residents (59%) support Council introducing a dedicated kerbside recycling container. When the analysis was undertaken based on household size, families with 1–2 people were fairly equally represented, with 47% supportive and 49% opposed to its introduction. However, in families with three or more people the results were very clear, with 82% in support and only 18% in disagreement. The key reasons given to support the introduction of a dedicated bin were:

- one divided bin not big enough
- need more space
- encourages more people to recycle
- a number of other quoted councils use a two-bin system
- it would be easier.

Current divided bin – in relation to the current divided bin, 36% of people indicated the rubbish side was full to overflowing each collection, while 37% indicated the recycling side was full to overflowing and 28% indicated that both sides of the bin were overflowing. When asked what people did with any excess recyclables, the majority placed it in the rubbish bin, kept it till the next collection, used the neighbour's bin or took it to work.

When asked to indicate what material was placed in front or rear of the bin 8% failed to recall or indicated the wrong material. When asked if recycling was placed in plastic bags prior to being placed in the recycling bin, 3% indicated that was their common practice. The most commonly recycled materials were paper/cardboard and glass containers.

Garden organics bin – of those interviewed, 28% had a garden organics bin, however, 47% of people did not know the service was available. When asked if this should become a standard service, overall 42% supported this. However, when the results were analysed by type of dwelling and location, 50% of single households in townships supported the introduction, while those living on acreage mulched their garden waste, and medium-density dwellings tended to contract garden services.

Bulky household clean-up – the majority of urban residents (63%) supported a bi annual bulky household clean-up service with the majority of residents using it twice per years. Comments were made that it was too restrictive and people wanted to place out vegetation, building materials, batteries and paint tins for collection

Food waste – on average, 65% of households placed food in garbage bins with 20% composting and just 1% using a worm farm.

Waste depots – forty-nine per cent of urban respondents said they visited a council waste facility, with the majority visiting Stotts Creek 28%, once per year or monthly and 10% equally visiting Murwillumbah and Tugun in the Gold Coast City Council area.

The majority visited Murwillumbah twice per year. The most common items delivered were garden waste, household waste and building materials. The majority (57%) was satisfied with the opening hours of Stotts Creek Waste Depot, however, a comments that the depot should be opened earlier on weekends were made.

Mulch – 62% of respondents said they did not know that Council offered free mulch at Murwillumbah depot and 58% did not know mulch was offered for sale at Stotts Creek. Comments were made about the quality of the mulch at both sites, but in particular at the Murwillumbah depot.

In total, 116 suggestions for improvements were made, many offering multiple comments. Many common themes emerged, including the need for greater recycling and waste capacity, the need for a three-bin system, the quality of the mulch and the need for continued education of the community. Residents are concerned about the cost of the new services and the impact on local rates.

9. STAKEHOLDER CONSULTATION

A series of meetings were held with key stakeholders to discuss their views on waste management both in respect of Tweed Shire and within the North East Region. It has been found that informal consultation with a small number of key stakeholders has been found to be less intimidating and more likely to elicit information than conducting a survey or group meeting. Each meeting covered the following issues:

- Project outline
- Types and quantities of waste generated
- Exchange of regional and industry information
- Identification of opportunities for collaboration.

A summary of the key outcomes of these meetings is provided below by stakeholder group.

9.1 Regional Councils

9.1.1 Byron Shire Council – Russell Chaplin, Manager of Waste Services

Council operates its own landfill and over the past three years has actively focused on raising profiles, capping and rehabilitating the current landfill cell to meet with the EPA requirements prior to developing its new cell and expanding the current facility. Council has deliberately allowed green waste amnesty fee periods at landfill to bring in additional quantities of material, which was used to mulch and create a material suitable for topsoil layer for rehabilitation. Separated C&D had a 25% reduced gate fee of that for mixed C&D, and was recycled to create material for drainage layer. . These positive pricing signals were used to encourage supply of raw materials that were processed and used, with significant financial benefits and reduced demand on natural resources. Council expects to have its existing operations fully capped and compliant with state EPA guidelines by March 2007.

Council currently transports all of its domestic waste to Thiess in Swanbank, near Ipswich in Queensland. It is anticipated that Byron's new double lined bentonite GCL over 900mm clay cell will be ready by Easter 2007, when all domestic waste currently sent to Thiess at a total cost of $72.00 tonne will be redirected back into its own facility at a lesser cost. The expanded site has been modelled on satisfying Council's own requirements for a period of 5–7 years. However, Council is confident that with its continued focus on diverting waste and aggressive recycling options , the facility may last up to 12 years or more, based on current trends. Byron is participating in NEWF discussions regarding regional disposal options.

Solo Resource Recovery secured a ten-year contract with Council in 2004 for the provision of all domestic collection services and Council replaced its previously divided garbage/recycling bin system with a new two-bin waste and recycling service. To maintain a focus on reducing its waste generation, Council provided residents with the option of a differential charge for 80-, 140- or 240-litre garbage bins, and with a 240-litre fully commingled fortnightly recycling service. Currently 7% of residents have elected for a 80-litre bin, 82% a 140-litre bin and 11% for the 240-litre service. All residents are offered a fortnightly recycling service, excluding the remote rural residents.

Council generates approximately 75 tonnes of commingled recyclables per week, which are delivered to the Tweed Shire MRF located at the Stotts Creek landfillfor processing.

Byron Shire Council is an active participant in the North East Waste Forum (NEWF) process and expressed a view that it would like to see Tweed Shire Council rejoin and participate more actively.

9.1.2 Clarence Valley Council – Ken Wilson, Council's Sustainable Services Co-ordinator

The Clarence Valley Council was formed in 2004, following the amalgamation of four local government areas: Copmanhurst, Grafton, Maclean and Pristine Waters. Its major landfill, located at Grafton, has an estimated more than 100 years' disposal capacity. In addition to this facility, Council has inherited five other smaller sites following the merger, which are located at Copmanhurst, Glenreagh, Tyringham, Hermani and Baryulgil.

Council provides a two-bin system, for garbage and recycling as well as an organics service to selected residents (non-rural). All three bins have a 240-litre capacity. Council operates a combination of day labour and contractor services to provide the collection services. Current recycling processing contracts for recyclables are in place until 2012 and its organics processing contract is an 'evergreen' arrangement with the local contractor.

It was determined that, given the Council's geographic location, well south of Tweed Shire, apart from contributing to regional activities through the NEWF process Clarence Valley and Tweed Shire Council have limited opportunities for working together.

9.1.3 Lismore Council – Phil Klepzig, Councils Manager of Waste, Quarrying and Asphalt

Council operates its own day labour collection service and offers a three-bin collection system to its residents. Residents are provided with a 240-litre fortnightly commingled recycling service, 240-litre organics, including food waste, weekly service and a 140-litre fortnightly residual refuse bin service.

The system was introduced to maximize diversion from landfill and the Tryton worm farming operation at the landfill was seen as an end use for the organic waste component when that was introduced in 2000.

The fortnightly service of the residual bin does present issues to the community where disposable nappies are concerned however Council has no plans to change from the base level service of fortnightly residual collection. Council does offer a weekly waste service for residents for an extra charge and also a larger fortnightly waste bin if required.

Council now undertakes the shredding and mulching activities associated with the collected kerbside organics and delivered green waste as part of its waste operations.

A contract is in place for Tryton to have first option on the compost produced for their Worm Farm activities.

Currently the public uses the same landfill face as commercial vehicles delivering to the landfill. Council has commenced works to remove this potential liability by issusing tender documents for the construction of a waste receival and sorting facility for all domestic and a percentage of commercial deliveries.

Lismore was previously delivering its kerbside recyclables to Ballina Council's MRF, but, with its closure, is now hauling this to Visy at Carrara on the Gold Coast. Council is currently investigating the building, owning and operation of its own MRF, as it considers it can build a small MRF operation linked to its proposed new transfer station and recover additional recyclables in it.

Council has withdrawn its support from NEWF, as it was dissatisfied with the level of financial commitment required and of the performance and deliverables achieved by it. Council has now employed its own education officer to deliver its community needs.

9.1.4 Ballina Council – Mathew Fanning, Group Services Manager

Council's landfill is located immediately adjacent to the city's airport and has had a history of significant operational issues relating to birds and operating aircraft. Council has recently completed an internal evaluation of its landfill operations and has applied to the EPA to reopen the landfill for putrescible waste, as a means to delivering its long-term pre-closure plans.

For the past 12 months Council has been transporting and disposing of its waste at the Thiess Services facility in Swanbank, Queensland, at an average cost of $ 61.00 per tonne, including transport. This disposal method was required following the closure of its existing landfill and during the construction of the new landfill.

Council has closed its MRF as it needed a major capital upgrade and could not source adequate product quantity to remain a viable operation. . This decsion impacted on Lismore and Kyogle Councils, resulting in those Councils' reassessment of their future MRF processing options. Ballina has contracted the recyclables processing to Visy at Carrara on the Gold Coast, to where the recyclables are now transported.

Council decided the best long-term financial option for it was to reopen its current landfill with changed operational practices, and to develop a long-term pre-closure plan. The existing MRF building has been converted to a baling operation for waste, with the purchase of a waste baler. From March 2007 the landfill will be operational and baling will significantly reduce the current operational issues relating to birds, and maximise landfill space utilisation

Council is an active participant in NEWF and would like Tweed to rejoin as an active member, not project-based only.

9.1.5 Kyogle Shire Council – Scott Turner, Director of Planning, Environment and Community Services.

Council shares a common boundary with Tweed Shire to the western perimeter, however, Kyogle Shire covers a large geographic area. It only services 2,600 properties per week and does not offer a kerbside recycling service to its residents but promotes a drop-off system at the landfill. Council was affected by Ballina's decision to close its MRF and is now transporting its recyclables to Kevin Teeling in Casino.

Council's own landfill has an estimated 10- to 12-year capacity. However, due to buffer concerns with encroaching new developments, Council has DECided to transport its waste to Casino, approximately 35 km away, as the Casino landfill has more than 40 years' capacity, rather than continue with its own operations. Council has also directed all commercial waste from its current landfill facility, which it is now converting into a small transfer station. Council participates on an irregular basis in NEWF.

9.1.6 Gold Coast City Council – Rod Dawson, Acting Waste Services Manager

The city owns and operates four landfill operations. These are shown in the table below.

Table 41 - Gold Coast City Council Landfills

Landfill	Life Expectancy (Years)
Stapleton	15
Suntown	8 – 10
Molindinar	0.5
Tugan	> 20

Gold Coast does not charge its residents for disposal of waste delivered to any of the five landfills or several small transfer stations it operates, provided residency can be established by the user. A significant number of Tweed Shire's residents live immediately adjacent to the Gold Coast council boundary and Tweed's residents commonly use the Tugun landfill as it is closer and more convenient than the Stotts Creek waste facility.

Where Gold Coast residency cannot be established by users, the following fees and charges apply:

- Cars, small vehicles – $8.00 each
- Trailers, vans, utes – $13 each
- Commercial loads – $60 per tonne

Gold Coast City Council's domestic and commercial waste and recycling collection contracts are due to expire at the same time as Tweed Shire Council's, in 2009. It is currently completing an organics trial and the results will determine whether a service is introduced in the next contract across the city.

Council indicated a willingness to co-tender all waste collection services and processing contracts and to discuss developing an alliance with regard to future disposal options

9.2 Regional Waste Organisations

9.2.1 North East Waste Forum (NEWF) – Bernadette Thomas, Co-ordinator

NEWF is a jointly funded initiative of the region's Councils and the DECC. It replaces the previous NOROC group and was established to facilitate joint waste and education issues within the region on behalf of Councils and to focus on obtaining consistency of activity in this area.

It has three part-time Education Officers delivering Waste Wise, Council Waste Reduction and Purchasing Policy (WRAP) and general community education programs for its members. The annual budget is estimated at $390,000, funded $140,000 by Member Councils based on a self-imposed per capita levy and $150,000 from the DECC. Funding by the DECC is secured for a further two years.

There appears to be differing views within the region on the value of the organisation with several Councils endorsing the work, whereas others have withdrawn support.

9.2.2 South East Queensland Council of Mayors

The former South East Queensland Regional Organisation of Councils (SEQROC) Waste Working Groups have been replaced by a Waste and Recycling Network Group initiated by the Council of Mayors representing the region's nineteen member Councils. The new group is chaired by Harry Copeland of Brisbane City Council. The group is attempting to reinvigorate itself, however, at this stage is more of a network group rather than a structured organisation. The Chair welcomed any input from Tweed Shire to it.

A priority for the group is to encourage greater use of recycled construction and demolition materials by seeking to achieve consistency in product processes, outputs and in educating member councils of the value in reusing these materials, compared to virgin products.

9.3 State Government Agencies

9.3.1 New South Wales (DECC) – Geff Cramb, Regional Officer, Grafton

The DECC has expressed concern to Council regarding the level of contamination being observed in groundwater monitoring at the Stotts Creek waste facility and the fact that the background bore used as the base datum point also appears to be now contaminated. The DECC expressed the view that it would like to see more attention applied by Council to reviewing its data being collected and that there was a need to trend this information.

Recent tests now indicate that levels of contaminants appear to be migrating across the site from the old cells to the new cells, however, information to date is

inconclusive as to its point of entry or source. While it appears to be leachate-related, it could also be due to the acid sulphates from the adjacent cane fields.

The DECC also expressed the opinion that the Murwillumbah site also had serious groundwater issues, and that closing the landfill and converting it to a transfer station was a valid option, allowing long-term remediation of the site to commence if Council took this position.

9.3.2 Queensland Environmental Protection Agency

This regulator has no direct control or interface with activities conducted by local authorities outside its jurisdiction, unless transporting regulated and trackable wastes across state borders.

From a Queensland perspective, the EPA has no issues in respect of any future actions that Tweed Shire may take with regard to possibly transporting wastes into South East Queensland's large landfill facilities. It expressed the view that it would like to see waste minimisation at source encouraged and that any waste transported for disposal should be disposed of at a fully engineered facility that operates on sound environmental principles including the provision of mitigating CO_2 production from its methane generation.

The EPA would like to see Tweed Shire actively engaged in South East Queensland issues as they are developed, with regard to state waste policy, given the significant development and population growth which is and will continue to occur along the coastal corridor, which impacts on Tweed .

9.4 Landfill Operators

9.4.1 Thiess Services – Chris White Manager Commercial and Business Strategy– QLD / NT.

Thiess operates a secure fully engineered landfill at Swanbank near Ipswich in South East Queensland that is designed and engineered on environmentally sustainable principles for receiving, disposing and treating solid waste. The facility receives waste from within South East Queensland as well as northern NSW. Its current site has in excess of 40 years' capacity, based on current disposal volumes. The site's landfill gas generation is now being used by Swanbank Power Station to displace coal for its power generation.

The company expressed a desire to work with Tweed Shire should the opportunity arise and that it was willing to enter into a long-term disposal contract for transport and disposal of waste. Thiess has provided an estimate of $25–$30 per tonne for disposal plus transport, estimated to be approximately $25 per tonne.

9.4.2 Veolia Environmental Services – Colin Hines Manager, Resource Recovery Services

The company operates, in partnership with JJ Richards, the Ti-Tree Bio-energy Landfill Facility at Willowbank, located west of Ipswich.

The landfill has been designed and built as a operating bio-reactor with waste deposited rapidly broken down by re-circulating leachate, and gas produced used in renewable power generation. Veolia has provided to APC an indicative quotation to transport in 110 m^3 trailers. The transport cost and gate fee would both be approximately $25.00 per tonne, and the company would be willing to commit to a long-term contract.

9.5 Recycling Processors

9.5.1 Visy Recycling – John Hadden, Queensland General Manager

The company operates six MRFs in Queensland and is the largest operator nationally in its field. Visy is a vertically integrated organisation and uses the recyclables recovered from both the domestic and commercial sectors. The company is internationally recognised as a key player in recycling markets globally.

Early in 2006, Brambles decided to dispose of its global Cleanaway assets and sold its operating entity in Australia to US-based Kohlberg Kravis Roberts & Co. Visy Recycling purchased all of the Cleanaway MRFs and related processing contracts and has expressed a desire to maintain its significant profile in processing kerbside collected recyclables in the region.

Visy has offered its Carrara facility on the Gold Coast for processing of Tweed's recyclables when the existing Solo contract expires. It currently processes all recyclables collected from the Gold Coast City Council and Beaudesert Shire and is also contracted with Ballina and Lismore Councils. Visy indicated it would actively pursue growth and sustainability of supply to its paper mill in Brisbane and to this end will tender for Tweed's recyclables in any future contract opportunities. Indicative gate prices are provided based on throughput ie processing cost of $15 / tonne up to 6,000 tonnes, $10 / tonne between 6,000 – 10,00 tonnes per year plus transport.

9.5.2 AMCOR – Ian Lewis, State Recycling Manager.

Amcor has recently established a kerbside recyclables presence in Queensland and is currently constructing a MRF at its Petrie Paper Mill in Brisbane. The CP Manufacturing design is modular in form. The facility is currently under construction and will be commissioned by July 2007. The decision by AMCOR to establish a MRF presence will provide a long-term alternate option for councils in the region for potential reprocessing of commingled product, built on sustainable markets for paper and cardboard.

Recommendation:

1. ***That Council continue to monitor the activities of the South East Queensland Waste and Recycling Network Group and the NEWF. It would appear that Tweed Shire has more in common with the Queensland group and its activity better reflects the immediate and long-term needs of Council.***

10. ASSESSMENT OF DISPOSAL PRACTICES

10.1 Bi-annual Household Clean-up Service

Currently Council provides the clean-up service twice per year, in May and November. Council requests residents to present materials in three piles:

1. Recyclable materials – whitegoods
2. Reuseable material – furniture in reasonable condition
3. Waste.

The following restrictions apply:

- The maximum length of any item is 1.8 m
- Weight limit means able to be lifted by two people
- The maximum amount is 1 m^3 per household
- Only items detailed below are accepted.

The service accepts and rejects the following materials:

Table 42 - Household Clean-up Service

Accept ✓	Reject ✘
Furniture	Builders' rubble and household renovations
Floor Coverings	Green waste
Whitegoods	Fencing material
Mattresses	Car parts and tyres
	Paint
	Oil
	Gas bottles
	Asbestos

The collection occurs over four weeks. APC undertook a visual assessment of selected clean-ups on Sunday 26 November 2006. In total, 261 premises were visited, of which 115 had material on the footpath for collection. This represents a presentation rate of 45%.

The survey was conducted in Zone 3 in the following streets:

- Boyd St
- Enid St
- Gray St
- Lakes Dr East
- Riviera Ave
- Panorama Dr
- Lalina Dr
- Bilambil St
- Norman St
- The Quarterdeck

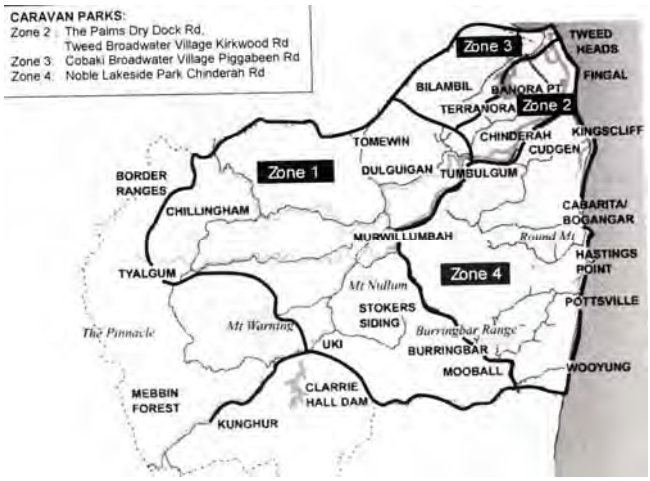
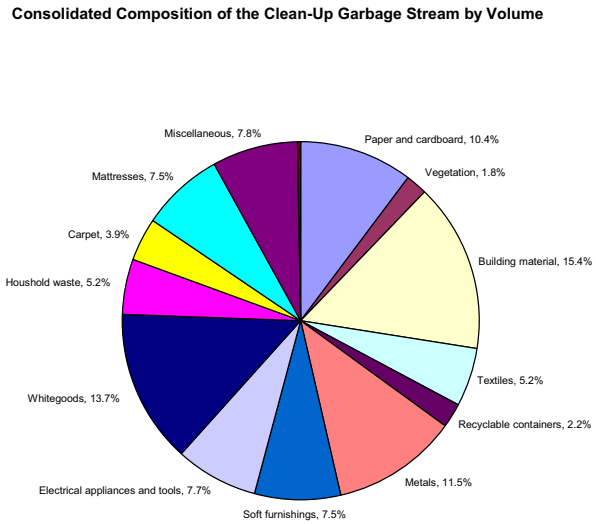


Figure 20 - Map showing collection Zones

10.1.1 Composition of Clean-up by Volume

The following chart shows the composition of the clean-ups by material type. Building materials represented 15.4%, followed by white goods (13.7%) and metals (11.5%). Cardboard represented the largest single group of materials.

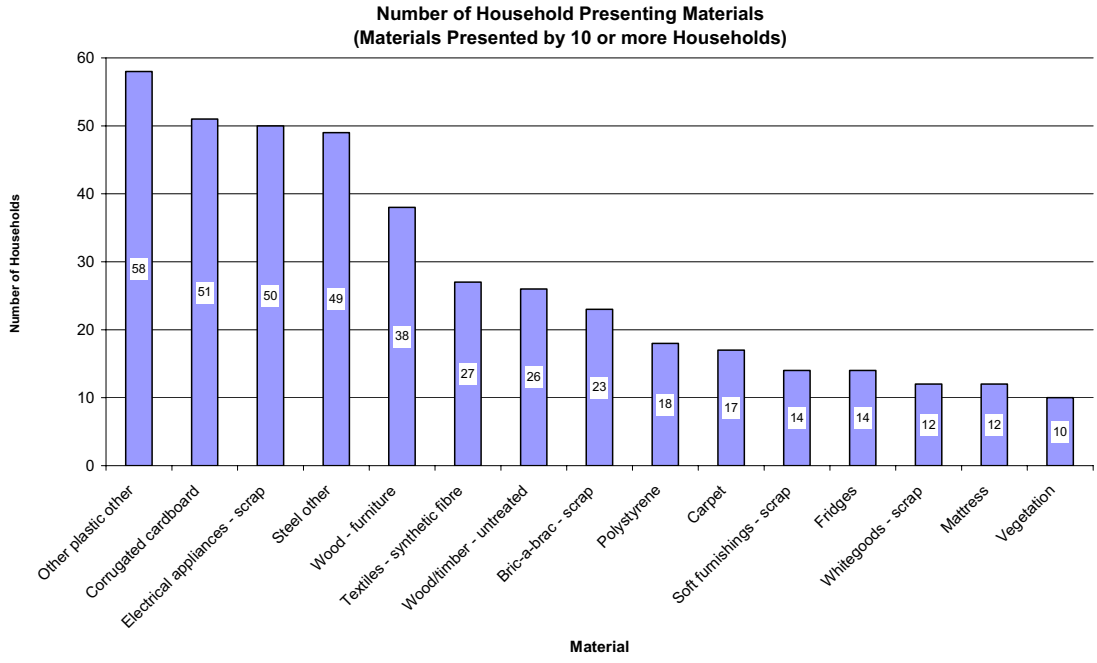
Chart 14 - Consolidated Composition of the Clean-up Garbage Stream by Volume



10.1.2 Household Clean-up – Number of Participating Households by Material

The chart below shows the number of participating households and the type of material they presented. Fifty per cent of premises placed out plastic items, 44% cardboard and paper, 43% whitegoods and 42% metals.

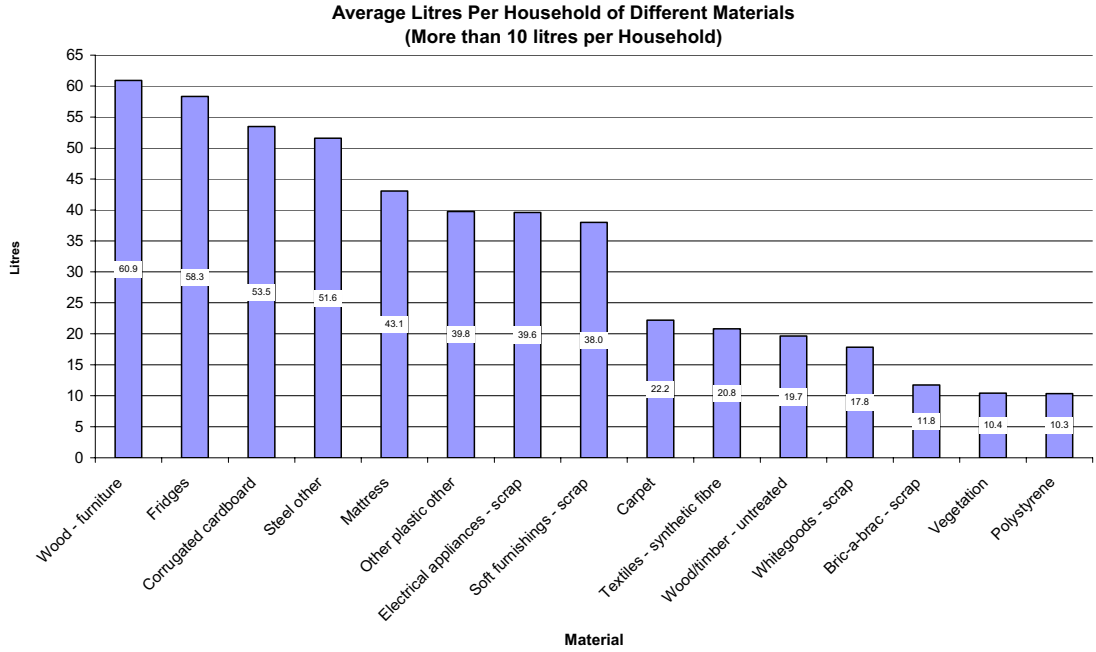
Number of Households Presenting Materials



10.1.3 Volume of Material by Household

The single largest amount of material placed out for collection was furniture, followed by fridges and cardboard. The high presence of cardboard may relate to the high transient nature of the population and the fact that cardboard does not easily fit into the divided rubbish and recycling bin, but can be stored flat until the next bulky collection.

Chart 15 - Average Litres per Household of Different Materials



10.2 Landfill Activity

Council, in its brief for the project, identified that more than 50% of waste currently being disposed of to landfill is from commercial and industrial sources. While we were provided with an array of data in relation to both landfill operations, upon evaluation it became evident that some data appeared to be inconsistent, specifically in relation to small vehicles as well as commercial movements.

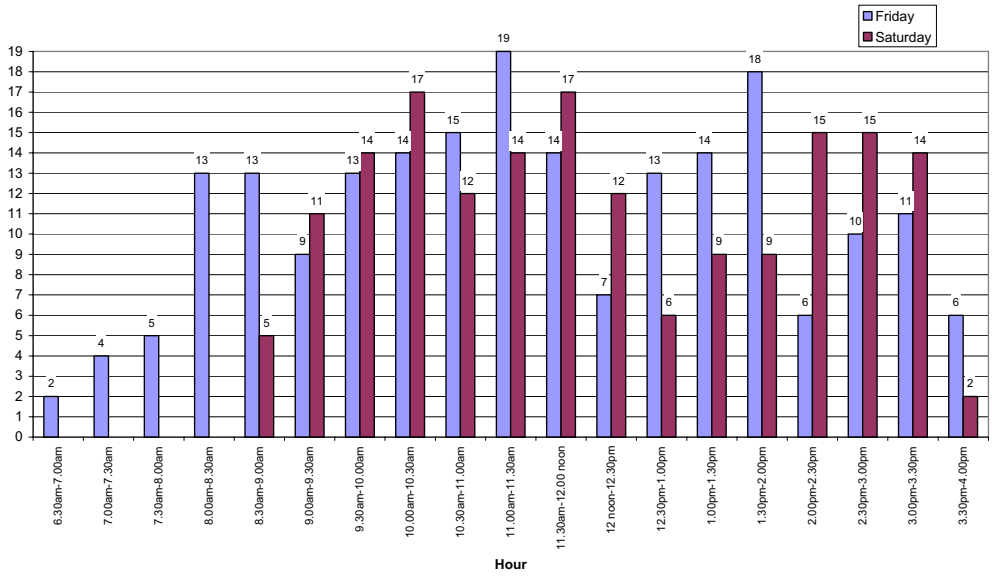
10.2.1 APC Observations at Stotts Creek and Murwillumbah landfills

The consultants felt it was imperative we ascertain the true number and type of transactions occurring and the type of loads delivered to all waste facilities over a given period. It was proposed to conduct a visual assessment over four consecutive days at the three waste facilities - Stotts Creek and Murwillumbah landfills and Tyalgum Transfer Station. Council did not support this approach initially so APC staff recorded the number and type of loads entering both landfill facilities only by time, day and registration plate over two consecutive days Friday 24th and Saturday 25th November, 2006 by sitting outside the landfills and recording passing traffic. The following charts detail the observations made by APC over this period.

10.2.2 Stotts Creek Landfill

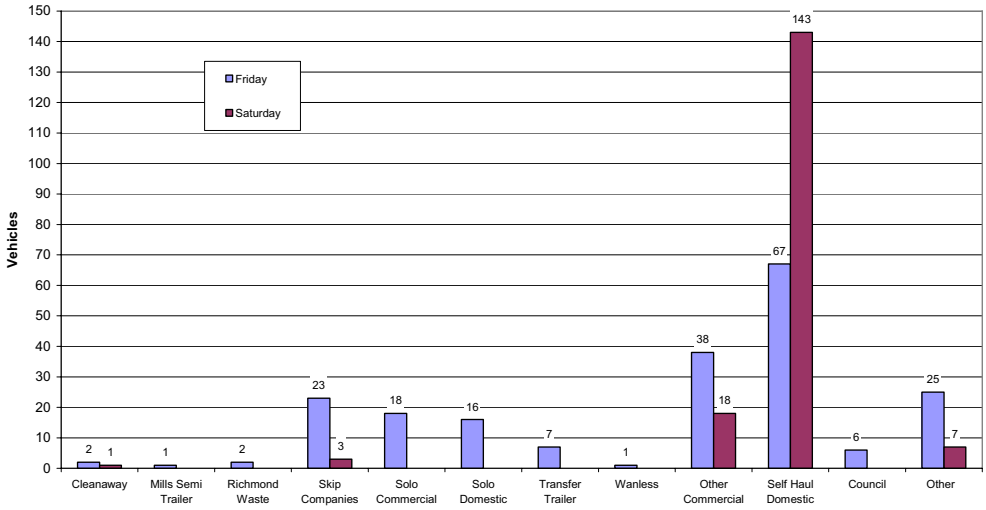
10.2.2.1 Number of vehicles per hour: The chart below details the number of vehicles entering the landfill over the course of the two sample days. The landfill is open from 7 am on weekdays and 10 am on weekends. Unofficially, Council is accepting loads from the public from 9am in stead of the advertised 10 am. On the Saturday 30 loads entered the landfill prior to the official opening time of 10 am which represents 17% of the total number 172 patrons.

Chart 16 - Number of vehicles per hour, Stotts Creek



10.2.2.2 Number of Vehicles by Patron: The chart below details the number of vehicles entering the landfill over the course of the two sample days by patron. On both days self-hauled domestic waste was the highest user category. Commercial users and skip operators were significant users on Friday but less so on the weekend.

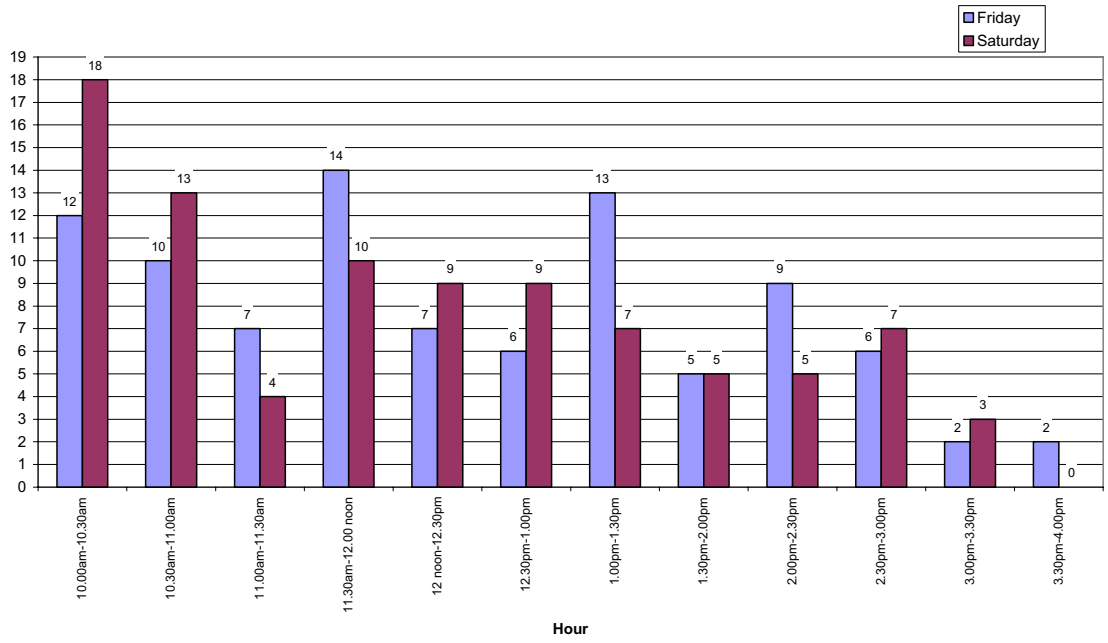
Chart 17 - Number of Vehicles by Patron, Stotts Creek



10.2.3. Murwillumbah Landfill

10.2.3.1 Number of Vehicles per Hour: The chart below details the number of vehicles entering the landfill over the course of the two sample days. The landfill is open from 10 am on weekdays and weekends. The highest number of users arrived between 10 – 10.30 a.m. on the Saturday morning. Whilst there is no distinct pattern of use over the two sample days the number of patrons was relatively consistent, with 93 patrons on the Friday and 90 on the Saturday.

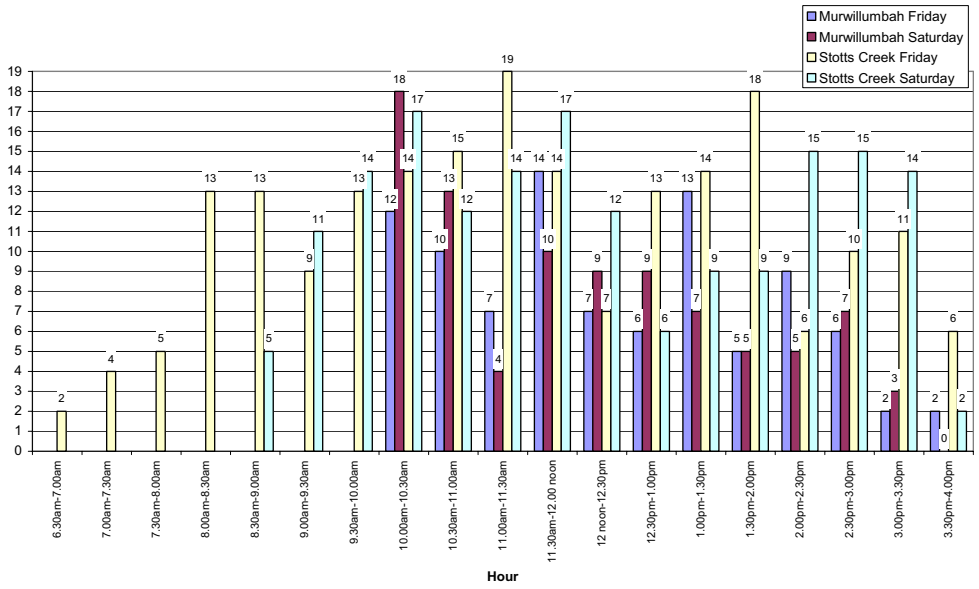
Chart 18 - Number of Vehicles per Hour, Murwillumbah



10.2.4 Stotts Creek and Murwillumbah Landfill Activity Compared

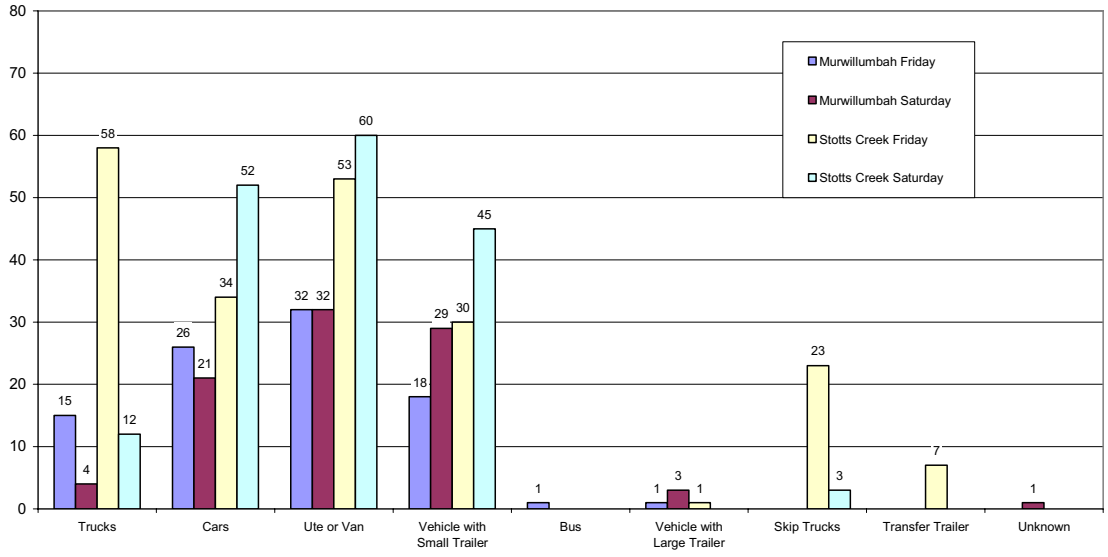
10.2.4.1 Number of vehicles per hour: The chart below shows the Use patterns at both landfills over both sample days. The minimum number of vehicles at both sites per half hour was six vehicles with the maximum per half hour peaking at 18 at Murwillumbah and 19 at Stotts Creek. In total, 206 patrons visited the Stotts Creek Landfill on the Friday and 172 on the Saturday, compared to 93 patrons visited Murwillumbah Landfill on the Friday and 90 on the Saturday. In total, 67% of the patrons visited Stotts Creek, compared to just 33% at Murwillumbah.

Chart 19 - Vehicles per Hour Both Landfills



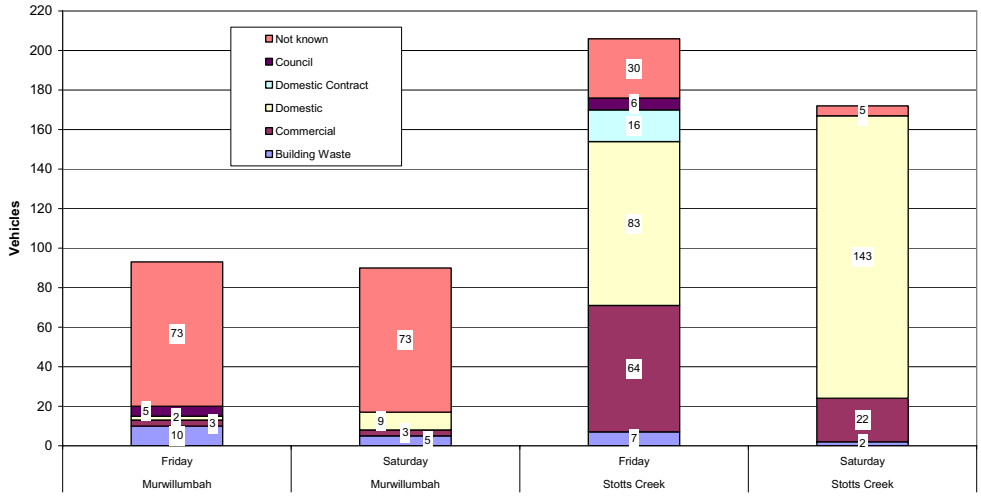
10.2.4.2 Number of vehicles by type: The chart below shows the Use patterns by type of vehicle at both landfills over both sample days. The most common type of vehicle delivering loads was utes or vans, followed by trucks and cars at Stotts Creek, while at Murwillumbah it was utes or vans, followed by cars with small trailers and then cars (without trailers).

Chart 20 - Number of Vehicles by Type



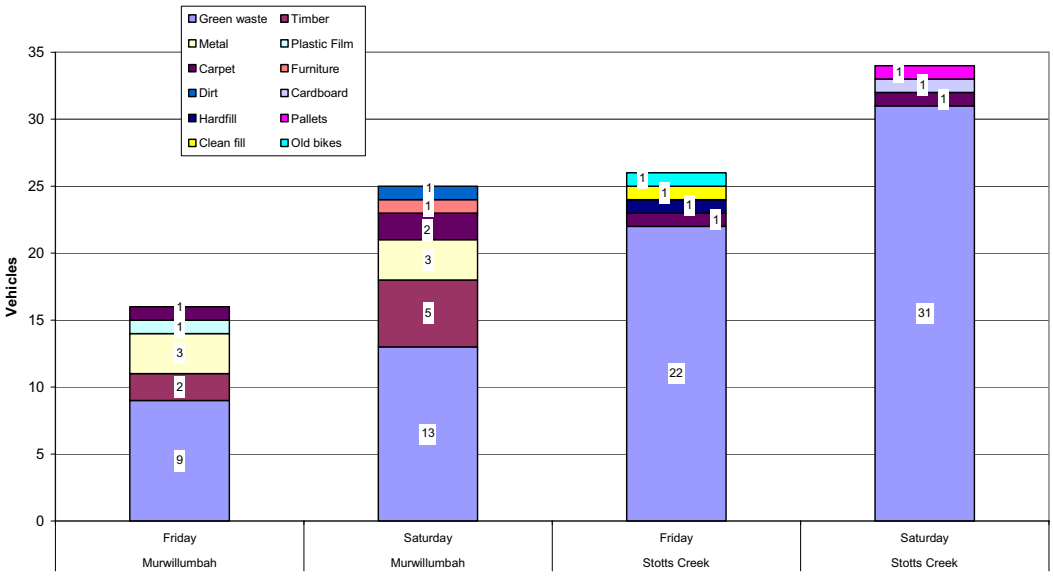
10.2.4.3 Number of Vehicles by Waste Source: The chart below shows the source of waste at both landfills over both sample days. The most common type of waste delivered at Stotts Creek was domestic waste. At Murwillumbah it was not possible to determine the source of waste in most cases.

Chart 21 - Number of Vehicles by Waste Source



10.2.4.4 Number of Vehicles by Waste Type: The chart below shows the type of waste delivered at both landfills over both sample days. The most common type of waste delivered at both sites was green waste.

Chart 22 - Number of Vehicles by Waste Type



10.2.5 Council Observations

Tweed Council undertook a comprehensive survey of vehicles entering the Murwillumbah Landfill between Friday December 8 and Monday December 11, 2006 and at Stotts Creek Landfill between Monday December 4 and Sunday December 10. The data provided is shown in the tables below.

Table 43 - Murwillumbah Landfill

Waste Type	Fri 8/12	Sat 9/12	Sun 10/12	Mon 11/12
Domestic waste mixed - car /trailer / utility	12	20	29	18
Domestic green - car / trailer / utility	9	9	29	9
Recyclables	4	5	2	1
Tip shop	30	50	45	39
Commercial waste	1			
Builders	2			
Mixed waste	1			
Mixed green & general	1			
Large truck more than 5 tonne – Green	2 mixed			

Table 44 - Stotts Creek Landfill

Waste Type	Mon 4/12	Tues 5/12	Wed 6/12	Thur 7/12	Fri 8/12	Sat 9/12	Sun 10/12
Domestic green waste							
Car / station wagon	7	8	6	2	6	2	4
Utility / small trailer	23	11	23	13	21	23	19
Large trailer 1 x 2 x 1.8m	1	7	7	6	7	4	5
Recyclables Sorted Waste							
Car / station wagon	9	7	5	6	5	5	6
Utility / small trailer	9	7	2	6	3	6	3
Large trailer 1 x 2 x 1.8m	2	2	2	4	6	1	2
Mixed Waste							
Car / station wagon	16	25	13	13	23	18	36
Utility / small trailer	21	15	23	18	28	33	52
Large trailer 1 x 2 x 1.8m	10	13	11	6	7	8	11
Commercial Waste							
Mixed waste / tonne	14	3	5	6		1	
Green waste / tonne	10		14	4	4	1	
Builders' tubble / tonne	6	1	10	4	4	5	
Builders waste within TSC / tonne	12	19	15	19	6		3
Builders waste outside TSC / tonne					15	3	
Contaminated waste asbestos / tonne	1	1	1		1		
Tyres		2					
Car Bodies		**1**					
Clean fill / tonne	**4**	**13**	**10**	**10**	**30**	**1**	
Byron waste / tonne	**1**		**1**				
Tip shop	**39**	**37**	**30**	**32**	**34**	**29**	**34**

10.2.5.1 APC Observations Compared with Data Supplied by Council and Contractor

In this section we compare the three sets of data from APC, Council and Solo. The APC and solo data relate to the same period of time Friday November 24 and Saturday November 25, 2006 whereas Council data relates to a slightly different period i.e. early December, 2006.

10.2.5.2 Stotts Creek

A summary of the key findings is shown graphically in the following charts which show the number of several different types of vehicles recorded entering the Stotts Creek Landfill on Friday November 24 and Saturday November 25, 2006 by APC and Solo. Council data relates to a different time frame 8 – 9th December 2006.

Chart 24 - Vehicles Entering Stotts Creek Landfill – APC Survey Results v Solo Figures v Council

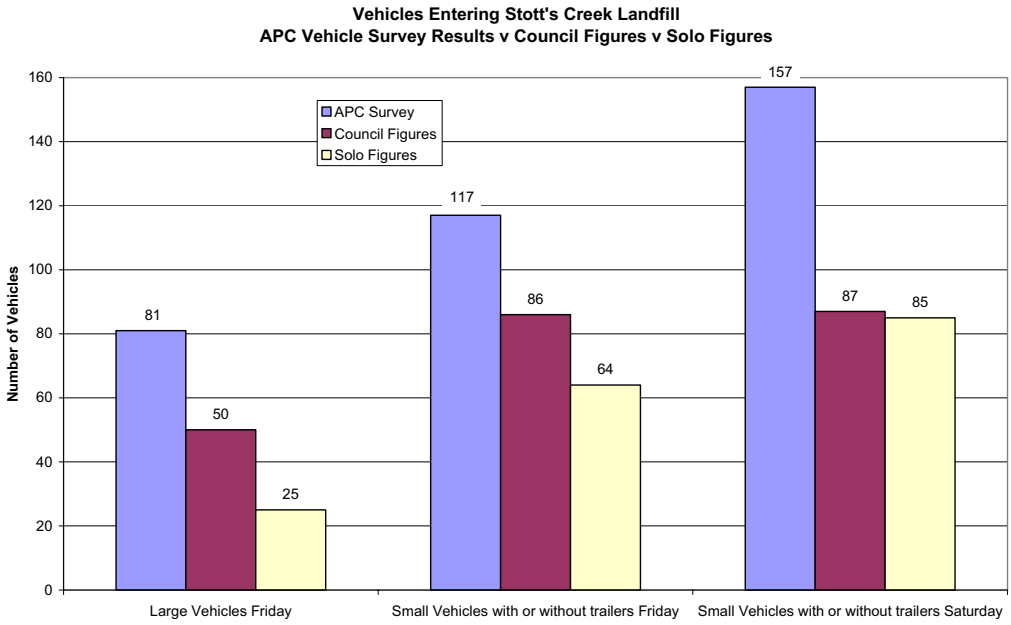


Chart 25 - Vehicles Entering Stotts Creek Landfill – APC Survey Results v Solo v Council

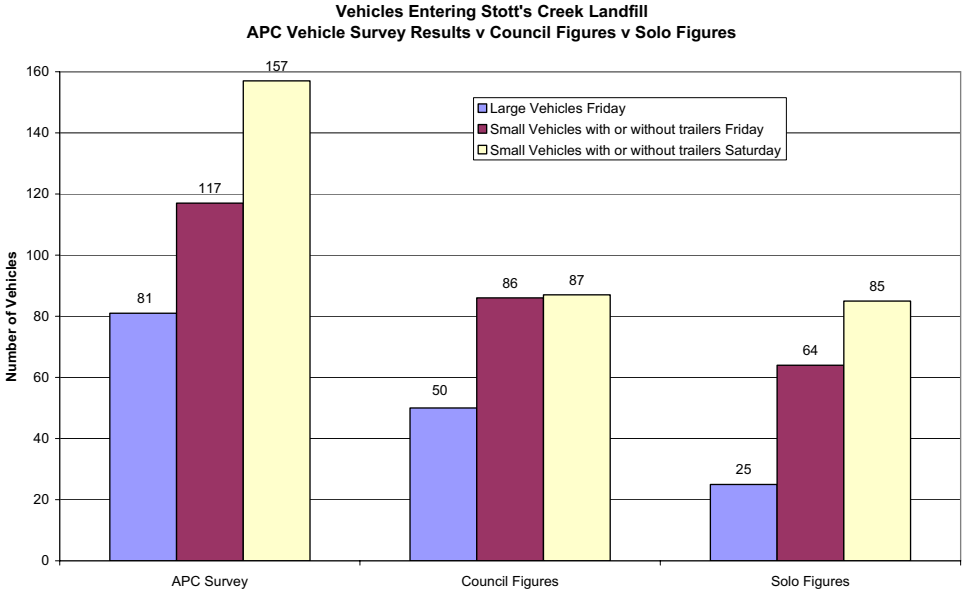
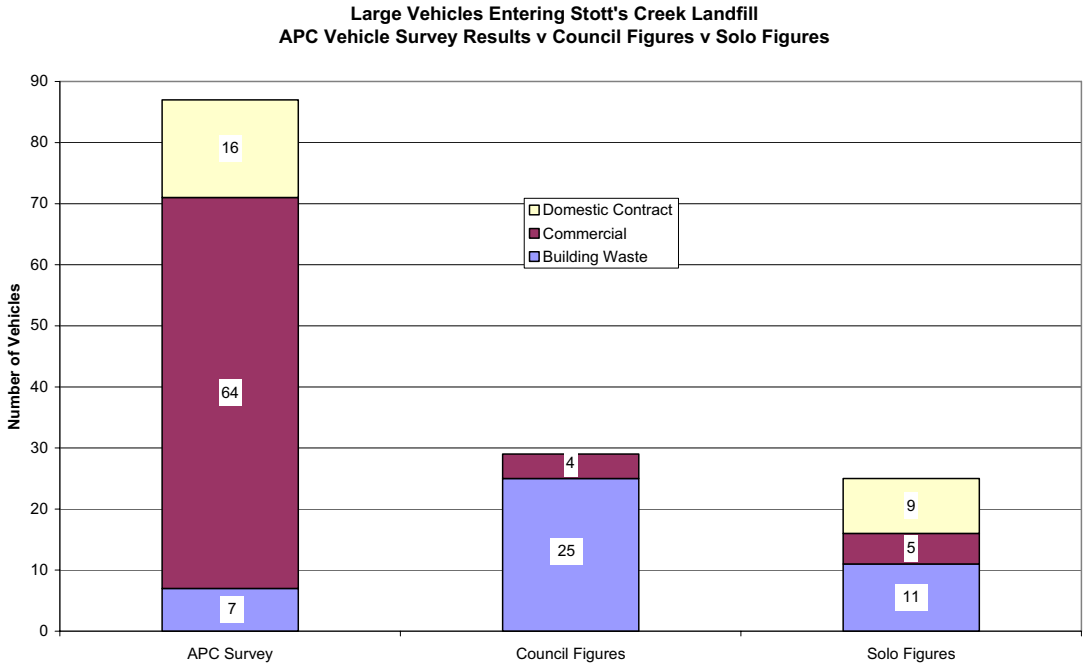


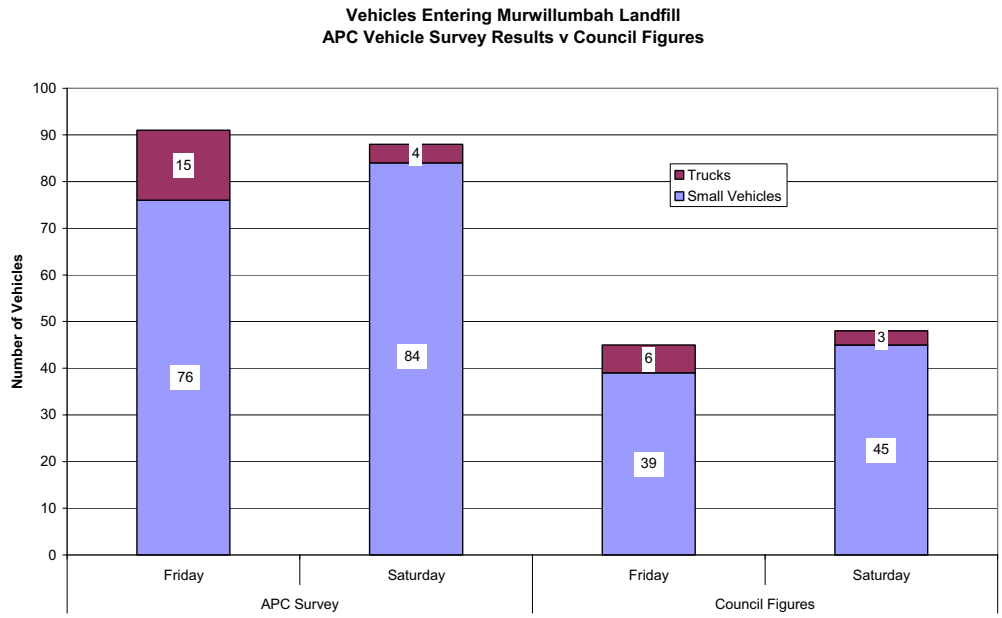
Chart 26 - Large Vehicles Entering Stotts Creek Landfill – APC Survey Results v Solo v Council



10.2.5.3 Murwillumbah Landfill

The charts below shows the number of small vehicles and trucks recorded entering the Murwillumbah Landfill by APC on Friday November 24 and Saturday November 25, 2006 and by Council on Friday December 8 and Saturday 9th, 2006. A summary of the key findings is provided below and shown graphically in the following charts:

Chart 27 - Vehicles Entering Murwillumbah Landfill – APC Survey Results v Council Figures



APC's figures show significantly greater numbers of small vehicles in particular entering the landfill on both days, compared to those recorded by Council. It is possible that these vehicles were dropping off recyclables or visiting the tip shop, activities for which vehicles are not recorded by Council.

10.3. Key Findings

Stotts Creek
APC's and Council's Stotts Creek surveys show some inconsistencies. The total number of vehicles recorded by APC was 206 on Friday and 172 on Saturday. Council recorded 200 on Friday and 140 on Saturday. APC recorded 87 small vehicles on Friday and 112 on Saturday. Council recorded 86 and 87. When small vehicles with trailers were included, the total number of small vehicles with or without trailers recorded by APC was 117 on Friday and 157 on Saturday. Council recorded 106 and 100. APC recorded 22 vehicles on Friday and 31 on Saturday delivering green waste. Council recorded 34 and 29. APC recorded 46 large commercial vehicles on Friday and four on Saturday while Council recorded 30 on Friday and ten on Saturday.

At Stotts Creek the proportions of all vehicles entering the landfill to visit the tip shop were relatively low ranging from 16.9% on Wednesday to a high of 21.6% on Tuesday. The proportion of small vehicles visiting the tip shop was slightly higher ranging from 33.2% on Thursday to 44.1% on Sunday. These figures are similar to those found by APC during audits of other regional landfill and a transfer stations. For example, at Shoalhaven Council where similar facilities and population base are similiar for comparison purposes of 745 vehicles entering Nowra Landfill over five days, 22% (215 vehicles) were recorded as only going to the tip shop while at Ulladulla Transfer Station of the 167 vehicles arriving over one day 37% (98 vehicles) were recorded as going only to the tip shop.

Murwillumbah Landfill Findings

Some of the Murwillumbah survey results are also similar. APC recorded 76 small vehicles with our without trailers entering on Friday and 82 on Saturday. Council recorded 55 and 84. APC recorded nine vehicles delivering green waste on Friday and 13 on Saturday. Council recorded nine on both days.

There were however some unusual results for the Murwillumbah survey. The survey data shows that of the total number of vehicles entering the Murwillumbah Landfill each day (53 on Friday, 75 on Saturday, 76 on Sunday and 58 on Monday), most were attending the tip shop. If the few commercial, building, mixed waste and large trucks which entered on Friday are ignored, the proportion of vehicles going to the tip shop is quite large; Friday 74%, Saturday 73%, Sunday 62% and Monday 69%.

This appears to be an unusual result when compared with the prior data supplied for the activities of the 24th - 25th November. That data showed that of the 76 small vehicles entering on the Friday and 82 on the Saturday, vehicles entering the site and not issued with a ticket therefore assumed to be visiting the tip shop numbered 37 on both days. Therefore the proportion of vehicles visiting the tip shop was 49% and 45% respectively for both days. This is significantly lower then the survey data referred to above.

10.2.5.5 Landfill Revenues

Council provided information relative to the APC survey period for both landfills in relation to the number and value of transactions. These are summarised below:

Table 45 - Stotts Creek Landfill Transactions

Transaction value ($)	24/11		25/11	
	Number	Total $	Number	Total $
$7	21	$140	23	$161
$10	9	$90	9	$90
$11	54	$594	79	$869
$17	8	$153	14	$238
$20	5	$100	1	20
$21	1	$21	0	0
$26	1	$26	2	52
Total	**101**	**$1124**	**130**	**$1430**

Source: Email Adam Faulkner 29/11/06

Table 46 - Murwillumbah Landfill Transactions

	24 November		25 November	
Transaction value ($)	**Number**	**Total**	**Number**	**Total**
$7 minimum charge	39	$273	45	$315
Volume charges	6	$308	3	$302
Total	**45**	**$581**	**48**	**$617**

Source: Adam Faulkner 29/11/06

11. STRATEGIC OPTIONS BY MATERIAL

The aim of this section of the report is to provide clear guidelines on preferred options and to discuss the rationale and budgetary implications. There are a number of possible options in relation to collection, processing and disposal. The overall Strategy objective is to increase resource recovery and in so doing, to improve the current diversion rate of waste from landfill.

Each of the options has been considered in relation to the economic cost of service provision, in addition to the environmental and social benefits achieved by its implementation. In addition, the consultants, in making the recommendations contained in this section, have done so mindful of the following principles:

1. Ecological Sustainable Development (ESD – local government and government agencies are required by legislation to have regard to the principles of ESD in exercising their functions. Sustainability or ESD is generally acknowledged by the definition used by the OECD which is: using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.

The effects of decisions that we make today have far-reaching impacts on future environments and society. Decisions are based only on short-term economic advantages, then we can perpetuate the thinking that has so far delivered a degraded environment. The sustainability provides its framework for evaluating options based on environmental, economic and social benefits and costs. Waste management Decisions should not be short-term commercial outcomes, or local expediency, but rather about responsible management of materials and resources to retain and conserve their value for secondary uses, which results in the conservation of natural resources for current and future generations.

2. Compliance with the Waste Management Hierarchy – the waste management hierarchy is a nationally and internationally accepted philosophy for prioritising and guiding efforts to manage waste. It is the foundation upon which NSW State Waste Strategy has been developed. The waste management hierarchy establishes approaches to waste management according to their importance and preference in descending order.

3. Compliance with State Waste Strategy – the strategy contains goals, targets and milestones to guide the community to fulfilling the strategy objective. For municipal waste the targets are from a baseline of 26% diversion in 2003 to a target of 66% diversion by 2014.

4. Risk-free options – councils are typically risk-averse and do not operate on a commercial basis motivated by profit, but rather providing value-for-money services to the communities they serve.

5. Waste is not a core business – increasingly councils are contracting out service provision to the private sector, which can undertake services more cost-effectively and efficiently with economies of scale not available to local councils. Waste management is their core and often sole business interest and focus.

6. Growing and ageing population – the area is growing at an annual rate of 4%, projected to continue for the foreseeable future as the population seeks lifestyle changes. As the population retires, its service needs, mobility and level of disposal income all reduce.

7. Social equity – whether people choose to live in an urban, semi-rural or rural area, there are community expectations that basic services will be delivered.

8. Timeframe – for planning, amortisation of plant and equipment, it is important to take a medium-term view. Waste management, like society generally, is evolving at an exceedingly faster pace and it is not possible to 'crystal ball' what new and emerging technologies may be commercialised and in production beyond this timeframe.

9. Best practice – significant research has been undertaken to determine the methods to achieve the optimum outcomes in relation to productivity, efficiency and resource recovery. It is important to ensure that these findings are considered.

10. Demonstrate leadership – local government needs to lead the community by setting good examples and providing services which will enable the community to achieve the council objectives.

The following options are based on the results of background research, waste audits, market research and consultation with the key stakeholder groups. Available technologies and options have been researched and budgetary constraints taken into account, along with an evaluation of the social, environmental and economic imperatives.

To enable ease of implementation, the options have been listed by material type and based on the waste management hierarchy, with the focus on avoidance, reuse and recycling prior to disposal.

The NSW *Waste Avoidance and Resource Recovery Act 2001* refers to the following waste hierarchy:

1. 'avoidance of unnecessary resource consumption,
2. resource recovery (including re-use, reprocessing, recycling and energy recovery),
3. disposal'.

A short discussion relating to future collection systems handling of key waste materials and recommended actions is provided in this section. A summary table has been provided at the end of this section.

11.1 Agricultural Chemical Containers

Council participates in the DrumMUSTER Program whereby plastic containers and drums must be triple-rinsed and free from liquid residual prior to being stored in a wire cage at the Stotts Creek Waste Depot. Since the program began in 2000 12,864 containers have been returned, which is an estimated return rate of 36% based on estimated drum sales. With the increasing sub-division development occurring within the shire, the number of farmers is slowly decreasing, however, the number of users of this program is increasing.

We understand that previous collections have been over a two-day period, whereas the most recent collection in December 2006 was for four hours on one day only. Council promoted this event prominently in the *Tweed Link* newsletter.

DrumMUSTER undertakes a community education program with the farming and agricultural community through the retail outlets from which product is purchased, to encourage the correct disposal of these containers. Colin Hoey, the DrumMUSTER Regional Consultant, advises that the greatest return rates from drums and containers are in areas where drums are accepted at any time. This requires trained staff to inspect and record drum deliveries. This staff training takes approximately three hours and is provided free of charge by DrumMUSTER. Council could assist to improve return rates by increasing the opportunities for when returns are being accepted, by requiring Solo to have more staff trained in the receipt of these materials

Recommendations:

2. ***That Council request the waste contractor to have trained staff available at all times to receive and process DrumMUSTER containers.***

3. ***That the contractor uses the service of the free DrumMUSTER training program.***

4. ***That Council continue to support the efforts of DrumMUSTER through community education and promotion of either continuous receipt of containers or one-off collection programs***

11.2 Asbestos

Asbestos dust contains tiny, almost indestructible fibres which can cause damage when breathed into the lungs. The most dangerous fibres are those which are almost invisible to the naked eye but which can penetrate the lungs the furthest. Health risks associated with breathing in the fibres include: asbestosis, lung cancer, mesothelioma and other forms of cancer. Unfortunately, asbestos-related diseases do not often present symptoms until between 20 and 40 years after the first exposure.

A large number of products made from asbestos cement are still found in buildings, including flat fibro, corrugated or compressed asbestos cement roof sheeting and asbestos cement pipes used for water, drainage or flues. While these products are maintained in good order they present no significant health risks, however, safety precautions must be taken when renovating or demolishing a building that contains

asbestos cement material or when disturbing any product containing asbestos in a way that is likely to generate dust.

The Australian Work Cover Authority has issued Health and Safety Notes in relation to working with asbestos. Asbestos, once removed in accordance with the safe working methods described, should be double-wrapped in heavy-duty plastic, taped in accordance with state regulations and buried at the landfill.

Recommendation:

5. Council continue to promote that asbestos should be removed, handled and stored in accordance with the Work Cover Regulation.

11.3 Batteries

The contents of batteries are poisonous and can leach into the environment if not correctly stored and disposed of. Lead acid batteries should be stored in a covered bunded area which is provided adjacent to the transfer station area at the Stotts Creek waste depot.

Recommendation:

6. That all batteries received at all waste depots be correctly stored

11.4 Building Materials

Building materials, generated through construction and demolition activities, include a range of items such as masonry, bricks, tiles and concrete, are inert and do not contain substances which could create long-term environmental hazards to the groundwater. Frequently these materials are mixed with other waste streams and not separated. Currently these materials have a differential fee to encourage separation. Clean fill is received free and used as cover material.

Table 47 - Building Waste Fees

Category	Cost
Builders water sorted (with permit)	$15/ t
Builders waste unsorted (with permit)	$32 / t
Builders waste unsorted (without permit)	$65 / t

11.5 Gas Bottles

Gas bottles and cylinders present a considerable OH&S risk to the waste and recycling industry, due to the potential for explosion if the pressure vessel is ruptured. There is currently no dedicated program to collect, safely DECommission and dispose of old, outdated or damaged bottles and cylinders.

Elgas has established a successful gas bottle exchange program 'Swap 'n Go' initiative which operates at many service stations.

End-of-life, apparently empty, gas bottles particularly BBQ gas bottles, will always have enough residual propane, LPG or butane to be dangerous in a scrap yard or landfill. These bottles need to be completely purged with an inert gas and the cylinder punctured to be no longer considered dangerous.

These bottles, while metal, cannot be added to the metal stockpile, due to the risk of explosion upon baling and processing and should not be included in either the waste or recycling bins for collection, due to the risk of explosion.

Council has a role to educate the community and raise awareness about correct disposal procedures and promote the recovery program at the Stotts Creek Landfill and necessary to maximise the safe recovery of these potential 'bombs'.

Recommendation:

7. ***That Council include the correct disposal of gas cylinders and bottles in future community educational material and promote the drop-off of these materials at each waste disposal facility.***

11.6 Household Furniture, Bric-a-Brac

Households update and replace household items including furniture, books, clothing and bric-a-brac frequently prior to the items being past their useful life, with many items still fully functional. Currently, some items are sold to second-hand shops or handed down to family and friends or donated to charities.

Scavenging at tips has been a culture at landfills and a favourite pastime for many decades, however, with increased insurance premiums and associated risks, scavenging has become more organised, with the development of 'reuse enterprises', 'revolve', 'tip shops' or 'drop and swap' centres where materials are rescued both prior to dumping and retrieved during and after dumping. Communities, with increasing information and education, are changing the culture, and making old things new again has brought an added new dimension to the possibilities associated with these operations. The concept requires little technology or equipment, but to be truly successful and, in the long term, profitable, requires the operation to be run as a small business. Their presence at disposal facilities is now becoming mainstream.

Tweed Council, in the current contract for the management of the Stotts Creek Waste Depot required the contractor to establish a reuse or tip shop in a new building designed and built for this purpose. The contractor has subcontracted the operation of the tip shop, known as Flanagahan's Tip Shop, which appears to be well patronised.

The subcontractor gains materials from either scavenging through material deposited at the transfer station or by material being directly delivered.

At Murwillumbah depot a similar operation exists, however, this is operating out of shipping containers and appears to be a more makeshift arrangement, with no permanent secure on-site storage shed provided by Council.

These initiatives put into practice the saying 'one man's trash is another's treasure'.

Recommendation:

8. That Council continue to support the operation of reuse facilities at all waste disposal facilities.

11.7 Household Hazardous

Households collect a range of hazardous substances. Many properties, domestic garages and sheds contain chemical cocktails of out-of-date, unwanted and often unknown pots and bottles of chemicals, herbicides, pesticides and other substances which are all potentially detrimental to the environment if not properly controlled and disposed of correctly**.** Some chemicals, in the presence of others, can create explosions and other volatile reactions.

Council continues to participate in the Household Hazardous Collection Program co-ordinated by the NEWF, whereby householders are notified and can deliver unwanted chemicals including herbicides, pesticides, batteries and oils for free. Trained and skilled contractors receive, assess and pack for transport and destruction the range of products surrendered over a period of time. The service was last offered on 24 June 2006 at the Stotts Creek Landfill where a total of 68 people presented 2,201 kg of material for assessment and correct disposal. The next scheduled collection is on 3 March 2007.

The DECC landfill licence does not allow for the receipt and storage of hazardous chemicals in the area. However, clean-outs of garages, sheds and deceased estates do not always coincide with the bi-annual collection program.

Purpose-built fully enclosed and ventilated storage sheds are available for containing chemicals prior to their assessment by experts. A modular four-compartment relocatable hazardous goods storage unit is available from Dangerous Goods Storage Systems Pty Ltd in Young NSW for $6,500 (not including GST or transport). The diagram and picture shows the proposed unit.

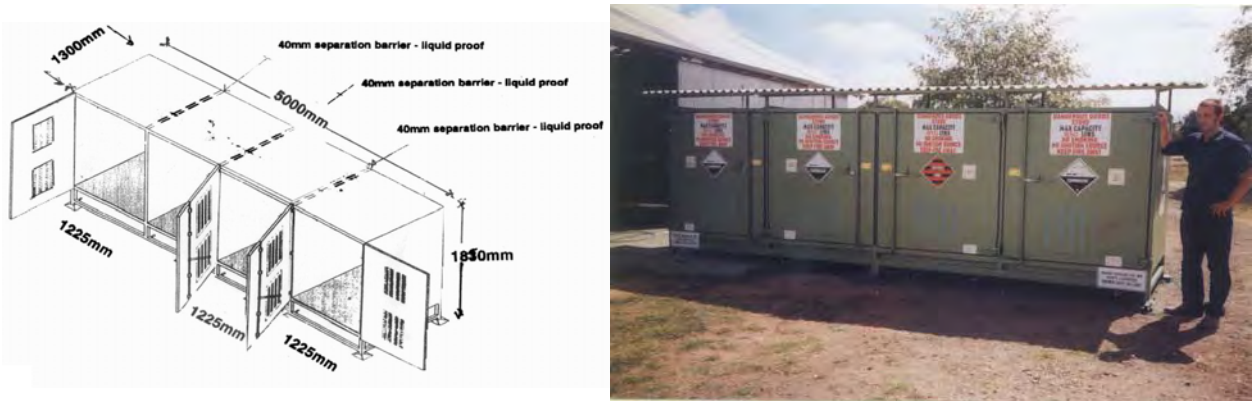


Figure 21 - Proposed hazardous goods storage unit

The installation of a chemical storage shed would require approval from the DECC, modification to the licence conditions and possible modification to the LEMP to reflect this addition. In addition the contract staff would need to be trained on the identification and correct storage of chemicals. Coffs Harbour and a number of other regional waste facilities have provided such facilities as a service to the community and to provide an outlet for these types of materials rather than their being placed in domestic waste bins with unknown consequences.

Recommendations:

9. Council ensures the community is informed about household hazardous collection programs.

11.8 Recyclables

Council currently receives recyclables free of charge at all waste facilities. Bulk bins are provided at all waste depots for the excess recyclables. This material is then transferred to the local MRF for processing, baling and on-selling to local or export markets. Scrap metal is also accepted free and recycled at all waste depots.

Recommendation:

10. That Council continue to promote the current practice of source-separation and free delivery of recyclables at all waste facilities.

12 PROPOSED WASTE MANAGEMENT SYSTEMS

The aim of this section of the report is to provide clear guidelines on the rationale of the preferred options and to discuss budgetary implications of future service options. Based on the waste audit results and interviews with key stakeholders, it has been identified that there are a number of possible future service options that Council should consider in the quest to increase the diversion rate of waste to landfill, in addition to improving resource recovery from the waste streams it manages.

Each of these options will need to be considered in terms of the economic cost of service provision, in addition to the environmental benefit achieved by its implementation. Simply swapping one collection system for another without looking at opportunities to manage all elements would be a gross underestimation of the opportunity available. While addressing all issues may see an increase in immediate expenditure, they should be viewed as opportunity costs with long-term payback, not as the additional costs of implementing a new system. Any changes need to underpin, reinforce and support waste avoidance and minimisation in a community.

The aim of the Waste Management Plan is to adopt current best-practice principles in relation to the current and future management of solid waste in Tweed Shire.

12.1 Current Performance

The New South Wales Department of Environment and Conservation's *2006 updated* report on the 2003 *Waste Avoidance and Resource Recovery Strategy* states that the waste diversion targets set in 2003 remain in place and unchanged. Principally the key target for local government is to divert 66% of municipal waste from landfill by 2014.

The 2005 Waste Characterisation Report co-ordinated by the North East Waste Forum indicates that on average each week Tweed Shire residents place 17.1 kg of mixed waste and recyclables at the kerbside for collection. This material comprises:

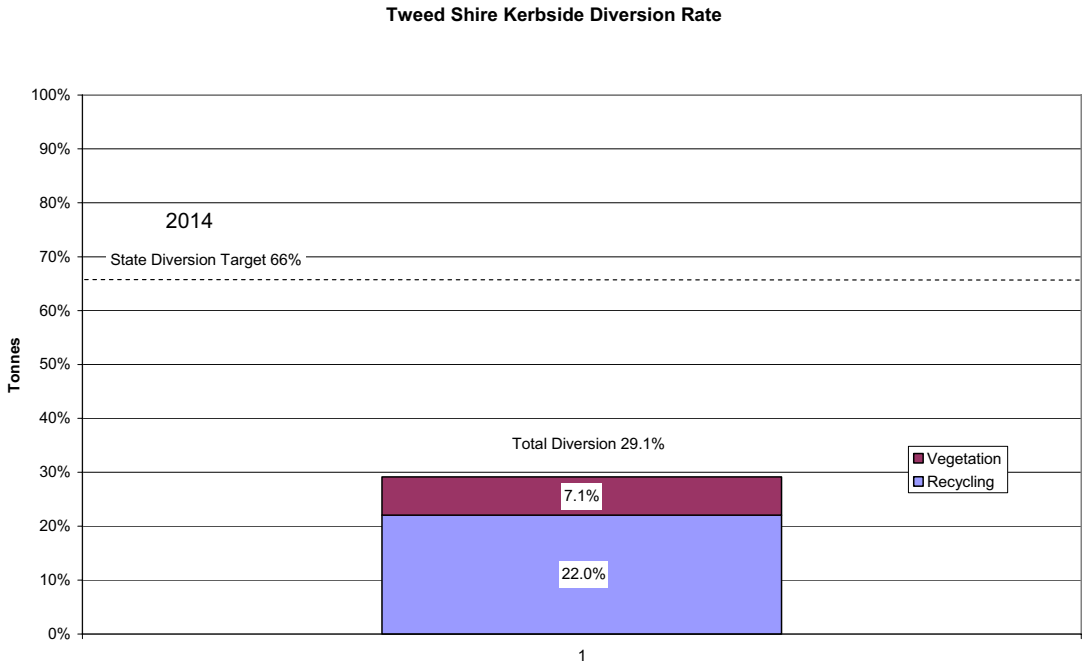
Table 48 - Tweed Shire Waste Stream

Waste type	Percentage of Total Waste Stream	Weight (kg)
Recyclables	42%	7.3
Garden and organics	34%	5.9
Residual	24%	4.2

To achieve the DECC targets by 2014, Council will have to achieve a diversion of approximately 11.2 kg per week from its current waste generation. Based on this study, Council was achieving a diversion rate of 27% through the kerbside recycling program.

However, based on actual Council data for all services for the 2005–06 financial year, Council achieved a domestic diversion rate of 29.1%, which is shown in the chart below.

Chart 28 - Tweed Shire Kerbside Diversion Rate



Clearly Council's current waste management system will require a substantial re-design if the State waste target of 66% by 2014 is to be met.

12.2 Recycling

Recycling programs have been supported by some local government councils for over 20 years. Initially collection vehicles carrying out kerbside recycling collections were divided into various compartments and households were provided with bags, crates or used cardboard boxes, however, due to concerns with OH&S related to manual handling, the 240-litre mobile garbage bins have become the standard receptacle. Typically all materials are commonly mixed together and termed 'commingled'.

12.2.1 Current System Performance

Council introduced a divided bin for garbage and recycling collection. The 70% side was for waste and the 30% side for recycling. Based on the findings of a community survey of over 1,200 residents, Council responded to the feedback that the recycling side was insufficient and in the most recent contract that commenced in 2004, had the contractor to modify all bins to a 50:50 division.

Council reports that the actual weekly generation and domestic waste in 2005 was 17.39 kilograms, of which 3.89 kg were recyclables. The 2005 regional waste audit concluded that the average household generated 17.1 kg of waste of which 5.4 kg were recyclables. Contamination of the recyclables currently being collected has been identified as ranging from 15% as reported in the Regional Waste Characterisation Study 2005 to 18% reported by Solo (Council's contractor) in its own September 2006 audit of the system.

Typically the most voluminous wastes are packaging, in particular soft drink, plastic milk and juice bottles and cardboard products. The narrow compartment of the

divided bin makes cardboard recycling a challenge for many residents and results in many air voids being created the narrow space when larger items are placed in it. Due to the items' shape, the voids are not filled, thus leaving further limited available storage capacity. It is considered that while theoretically 120-litres of bin space are available in the split bin, due to container shapes and air voids the reality is that usually less than 80-litres of space are in fact available for product recovery.

Information provided to Council by its MRF contractor reports that the current recovery of materials from its recycling system can be estimated as per the following table.

Table 49 - Current Recycling Stream Composition – Tweed and NSW Average

Material Stream	Commingled System	
	Industry Average %	Tweed %
Paper and Cardboard	57	49.5
Glass	25	5.2
PET	2	1.04
HDPE	2	1.04
Mixed Plastics	1	.99
Steel	1.4	1.58
Aluminium	0.6	0.4
Waste	11	40.25*
Total	**100**	**100**

* Includes 21% of Glass fines identified as currently going to landfill

On the basis of this information it can be concluded that of the current 3.89 kg of recyclables recovered weekly, only 2.32 kg are, in fact, being recovered for reuse. It is confirmed from assessment of Council's own reports that, on average, 1.57 kilograms of materials collected per household are, in fact, returned to landfill, either through being contaminated or in the form of glass fines..

12.2.2 Reference Documents

In reviewing the options available to Council to improve its existing waste management service, APC has reviewed a number of relevant research reports and guidance documents.

12.2.2.1 Good Practice Performance Measures for Kerbside Recycling Systems – NSW Department of Environment and Conservation

This report has established a set of good-practice measures against which to assess kerbside recycling systems. The following table from this report provides a summary of these measures, along with suggested targets for each measure.

Table 50 - Comparison with DECC Performance Standards

Performance Measure	Unit	Description	NSW DECC		Tweed	
			Baseline	Target	Actual *	Post MRF *
Household net yield	kg/hh/wk	Total kerbside recyclables collected per household, excluding gross contamination	>4	>5.5	4.0	2.4
Per capita net yield	kg/pp/wk	Quantity of kerbside recyclables collected per person, excluding gross contamination	>1.5	>2.1	1.7	1.0
Net diversion rate	%	Total proportion of domestic waste diverted to the recycling stream	19%	>29%	22%	13%
Contamination rate	%	Contaminants placed in recycling bins by householders	N/A	<3.5%	18%	

Source: Solo reported annual tonnages

While the Tweed Recycling system performs relatively well in terms of yield and diversion, when contamination and post processing is considered the system is underperforming.

12.2.2.2 Getting More from Our Recycling Systems. Assessment of Domestic Waste and Recycling System – NSW Department of Environment and Conservation

This report contains an assessment of domestic waste and recycling systems to determine the relative performance of different kerbside collection configurations. The latest available recycling and waste generation information was collated from a number of councils. In this study, six domestic waste management collection scenarios were considered. The following table sets out these scenarios:

Table 51 - Collection System Configurations Assessed

Scenario	Domestic Garbage		Kerbside Recyclables		
	Receptacle	Frequency	Receptacle	Frequency	Materials Collected
Baseline	120-L bin	Weekly		Fortnightly	Commingled containers and paper/cardboard
Scenario A	240-L bin	Weekly	–	–	–
Scenario B	120-L bin	Weekly	120-L bin	Fortnightly	Paper/cardboard
			120-L bin	Fortnightly	Commingled containers
Scenario C	120-L bin	Weekly	240-L bin	Fortnightly	Commingled Containers no paper
Scenario D	240-L bin split	Weekly	240-L bin split	Fortnightly	Commingled containers and paper/cardboard
Scenario E	120-L bin	Weekly	Crate	Weekly	Commingled containers
			Crate	Weekly	Paper/cardboard

Recyclables diversion was ranked highest in the following systems:

1. 2 x 120-litre bin collected in alternate weeks for commingled containers and paper and cardboard with a 120-litre garbage bin
2. 1 x 240-litre bin fully commingled recycling service collected fortnightly 120-litre garbage bin ?service collected fortnightly
3. 1 x 240-litre bin divided garbage and recycling system (current system)

12.2.2.3 Glass Compaction Study, APC 2005

The NSW Jurisdictional Recycling Group sought to determine whether a relationship existed between the load density of kerbside material and the proportion of glass broken in loads. The aim of the project was to establish an optimum load density to protect the integrity of recyclable commodities from breakage during kerbside collection, while providing a cost-effective service to the community.

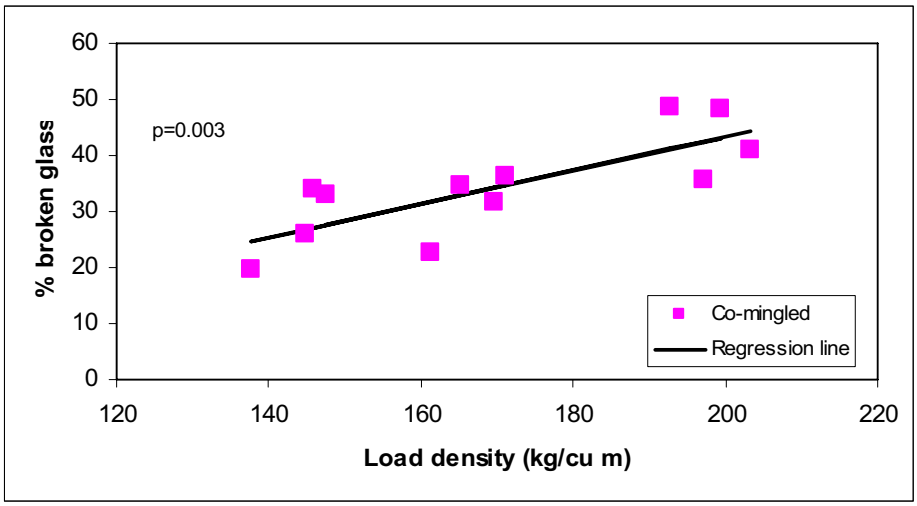
It should be noted that this study was conducted in Sydney where typically glass containers represent 25% of the product mix. A controlled trial with scientific parameters was developed, and took place using four of the latest model collection vehicles, including side- and rear-loaders. As a result of this study,[13] it is now possible to predict with confidence the proportion of broken glass that can occur in recycling loads from fully commingled kerbside collections using side-loading vehicles with known load densities.

The following formula can be used to predict the proportion of broken glass at any compaction setting:

Percentage broken glass = 19.4 + 2.9% for every 10 kg/m^3 over 120 kg/m^3

This is graphically represented in the following chart:

Chart 29 - Percentage of Broken Glass v Load Density – Commingled Loads Only



12.2.3 Market Research Results

The following is a summary of the key findings from the survey conducted of 213 residents in relation to current and future waste management needs.

12.2.3.1 Current divided bin – in relation to the current divided bin, 37% indicated the recycling side was full to overflowing while 28% indicated that both sides of the bin were overflowing. When asked what people did with any excess recyclables the majority placed it in the rubbish bin, kept it until the next collection, used the neighbour's bin or took it to work.

[13] APrince Consulting, Glass Compaction Study, 2005.

When asked to indicate what material was placed in front or rear of the bin 8% failed to recall or indicated the wrong material. When asked if recycling was placed in plastic bags prior to being placed in the recycling bin 3% indicated that was their common practice. The most commonly recycled materials were paper/cardboard and glass containers.

12.2.3.2 Excess recyclables – 22% of respondents indicated that they had surplus recyclables that would not fit in the bin. When asked what they did, most, 43%, kept them until the next collection while 27% admitted to putting them in the rubbish side, 8% used a neighbour's bin or took them to the waste depots, while 6% took them to work.

12.2.3.3 Recycling container – the majority of the residents (59%) support Council introducing a dedicated kerbside recycling container. When the analysis was undertaken based on household size, households with 1–2 people were fairly equally represented with 47% supportive and 49% opposed to its introduction. However, in families with three or more people, the results were very clear with 82% in support and only 18% in disagreement. The key reasons given to support the introduction of a dedicated bin were:

- one divided bin is not big enough
- need more space
- encourages more people to recycle
- a number of other quoted councils use a two-bin system
- it would be easier.

12.2.4 Potential Recycling Performance

Yield rates of recycling bins from participating residents have a fundamental impact on both recovery volumes as well as operational logistics. Industry standards suggest a figure of 70% is the benchmark to aim for of product to be recovered of the total available tonnages. It is anticipated that 75% of all available properties will use the service which takes into account unoccupied or holiday lettings. The 2001 ABS Census data quoted 8.2% of properties unoccupied in Tweed Shire.

Using these principles and the waste audit data composition, Council could expect to recover around 5.11 kg from an available 7.3 kg of material per week or 10.22 kg on a fortnightly basis. A single bin should also dramatically reduce contamination levels from the current 15–18% to a more reasonable level of lesss then 5%.

This would increase the current 4 kg collected per week or 6,063 tonnes recovered, by an additional 2 kg per fortnight, equating to 3,282 tonnes or a total of 9,345 tonnes per year.

While the main intention of introducing a new system is to maximise waste diversion, recycling significantly assists with greenhouse gas abatement as every tonne of paper landfilled generates 2.1 tonnes of CO_2 equivalent gas during the decomposition process.[14] Council's opportunity to divert these items from the residual waste stream

[14] BRBA December 2006.

will be considerably enhanced through a redesign of the collection system for both the garbage and recycling, thus directly assisting with reducing greenhouse gas emissions from its waste.

12.2.5 Costs

12.2.5.1 Retrofitting Bins

12.2.5.1.1 Remove Divider – to remove the divider may cost between $8–$10 per bin. When Council calls its new tender, it should seek a price of divider removal and a price for a new 240-litre bin. The age of many of the existing bins is anticipated to be at least 10 years. Maintenance costs from wear and tear significantly increase after seven years, as warranties on performance have expired and effects from weekly mechanical collection impacts, and ultra-violet sun rays impact on the HDPE plastic.

12.2.5.1.2 New Lid – it is strongly recommended that the new collection contract requires new lids be retrofitted to the existing bin. Lids cost approximately $11 each and retrofitting approximately $5. Until all councils adopt the standard lid colours, Australian communication programs cannot be effectively implemented. More information about colour-coding of lids is provided in Section 13.5, Domestic Waste service.

12.2.5.2 New Bins – the cost of introducing the new recycling service requires either the provision of a new 240-litre bin for recycling or removal of the divider as described above.

12.2.5.3 Bin Cost Summary – Council may choose to either pay this cost directly as a one-off cost from its reserve funds or to include the provision for it in any future new contract. The provision of a new recycling bin on a five-year contract would cost about 35 cents per tenement per week (excluding interest). This cost to residents can be reduced if the contract term is carried over a longer period, allowing for the recovery of capital to be extended.

Table 52 - Cost Elements Summary

Expense Element	Estimated Cost per Unit (ex GST)	Distribution Cost (E recording)	Estimated Numbers for Replacement	Cost of Changeover
Remove divider	$10	N/A	34,000 *	$340,000
Provide new lid	$11	$5		$
Purchase new				
140-litre waste, red lid	$37.50	$5.25		$ 1,453,520
240-litre garbage bin yellow lid	$40.23			$1,546,320

* Base 31,500 garbage services + 8% population growth in 2 years for commencement in 2009.

12.2.5.4 Collection fees – servicing a total of 31,500 bins on a fortnightly basis over a five-year contract period based on current market rates, the indicative rate for 240-litre fortnightly service in a rural and urban area like Tweed is in the vicinity of $1.25 per household.

Table 53 - Cost Elements – Service

Expense Element	Estimated Cost per household /Service	Estimated Numbers for Replacement	Cost per Year/ household
Recycling	$1.25 *	34,000	$32.50
Garbage with bin	$1.95 *		$50.70

* fortnightly collection

12.2.6 Regional Co-operation

A unique regional opportunity has been identified through stakeholders' engagement: that Tweed Council could consider co-tendering its new service in 2009 with Gold Coast City Council (GCCC). The GCCC waste collection and recycling contracts expire at the same time as Tweed Shire's. By co-tendering but applying separate council contracts, Tweed Shire would stand to gain a substantial advantage over its own ability to secure a decent contract price for the new service. This opportunity also enables it to align the new recycling collection system with the fully commingled system currently in place in the GCCC and confirmed as remaining so in any new contract term. It also provides opportunities for jointly letting recycling processing contracts, and in managing broad community education of the systems.

Recommendations:

11. That Council should introduce a new fully commingled recycling service in a 240-litre bin collected fortnightly to all of its residents at the end of current contract in 2009

12.3 Green Organics Collection

The NSW Government, in the 1990s, threatened to ban garden waste landfill in the metropolitan area of Sydney and the Extended Regulated Area of Wollongong, Newcastle and the Central Coast of NSW in an effort to reduce the environmental impacts that organics material creates when it breaks down and forms leachate and generates greenhouse gases in landfill.

This proposal created a momentum for councils to seriously address the organics fraction of the waste stream which previously had been dealt with by councils with tokenistic annual or bi-annual clean-ups. Some councils moved to more frequent kerbside bulk collections, that is, monthly, while other councils moved to introduce a containerised service in a 240-litre bins on monthly fortnightly or weekly collection cycles.

If Tweed Council is to achieve the state targets applied to it, then increasing organic recovery from the waste stream will need to be a priority.

12.3.1 Current System Performance

Council currently offers its non-rural residents an optional fortnightly kerbside organics service. During the last financial year, of the total 22,340 properties, only

5,600 services or 25% contracted to use the service. Council charges participating residents an annual service fee of $35 per year for the service. However, Council is required to pay the contractor based on a minimum take-up rate of 30% of households. The figure is also further subsidised by Council, as the current contractor charges $38 per year or $1.46 per fortnight.

Last financial year Council recovered 2,109 tonnes of organics or an equivalent 14.4 kg per bin per service. These organics were stockpiled, shredded and processed by the contractor at the Stotts Creek landfill and the product outputs used on site in rehabilitation, sold to the community or manufactured into high-grade soil products.

The 2005 Regional Waste Characterisation Study found that the average household bin contained 18% of garden organics and 6% other organics material excluding food which represented 27% of the total.

12.3.2 Market Research Results

The following is a summary of the key findings from the survey conducted of 213 residents in relation to current and future waste management needs.

12.3.2.1 Garden Organics Bin – of those surveyed, 28% already had a garden organics bin. Interestingly, 47% of people claimed not to know that the service was available**.**

When asked if the service should become a standard service, only 42% of all respondents supported the concept. However, when the results were analysed by type of dwelling and location, 50% of single households in townships supported the introduction while 41% opposed it.

Those living on acreage mulched their garden waste while those in units, high-rise developments and villas contracted commercial garden care services, which removed the garden waste from the premises.

12.3.3 Potential Service Performance

If 23,340 premises are potentially available, of which 5,600 currently use the service, a further 17,740 premises would be eligible for a compulsory service, while an optional service could be extended to medium-density and multiple-occupancy residential buildings.

If Council chose to introduce a standard fortnightly garden organics service to all of its non rural residents and assuming a participation rate of 75% the average number of services to be provided could increase by over 10,000 to 16,755 properties. Assuming the current average of 14.4 kg remains the same, annual diversion estimates could be expected to increase from the current 2,109 tonnes to 6,273 tonnes.

Council would need to consider operational costs as well as market development strategies for this additional material. Currently the collected garden wastes are the contractors responsibility to process and market the product, with no return or responsibility by Council.

12.3.3.1 Costs of New Bins – the cost of introducing an extended garden collection program requires the provision of a new 240-litre bin. Council may choose to either pay this cost directly as a one-off cost from current reserve funds, or to include the provision in any future new contract. The provision of a new recycling bin in a five-year contract would cost about 35 cents per tenement per week (excluding interest).

Table 54 - Cost Elements Summary

Expense Element	Estimated Cost per Unit (ex GST)	Distribution Cost (E recording)	Estimated Numbers	Cost of Changeover
Purchase new				
240 – litre garbage bin lime lid	$40.23	$5.25	17,740	$806,815

* Base 31,500 garbage services + 8% population growth in 2 years for commencement in 2009.

12.3.3.2 Collection Fees – servicing a total of 23,340 bins on a fortnightly basis over a five-year contract period, based on current market rates, the indicative rate for a 240-litre fortnightly service in a rural and urban area like Tweed is expected to be in the vicinity of $1.25 per household. If the bin were to be provided by the contractor and not purchased by Council, the service cost could be around $1.95 at the commencement of the contract.

Table 55 - Cost Elements – Service

Expense Element	Estimated Cost per hh /Service	Estimated Numbers	Cost per Year/hh
Garden waste – no bin	**$1.25 ***	17,740 **	$32.50
Garden waste with bin	**$1.95 ***		$50.70

*fortnightly collection
** Maximum 23,340 possible – 5600 existing services.

12.3.4 Regional Co-operation

Gold Coast City Council currently does not offer a garden waste service, however, is considering this option for its next contract. The GCCC waste collection and recycling contracts expire at the same time as Tweed Shire's. By co-tendering but applying separate council contracts, Tweed Shire would stand to gain a substantial advantage over its own ability to secure a decent contract price for the new service. This opportunity also enables it to potentially align the processing or the collected materials.

Recommendations:

12. That Council should introduce a garden service in a 240-litre bin collected fortnightly to all single residential dwellings in townships at the end of current contract in 2009.

13. That Council offers an optional garden waste service to all medium-density and multiple occupancy residential buildings 2009

12.4 Food Waste Collection

The 2005 regional waste audit determined that almost 27% of the current waste bin contents was food waste, which equates to 5,000 tonnes per year. Organic waste (food and green waste) makes up 47% of the domestic waste stream and contributes to leachate generation which can contaminate groundwater and generates methane, a greenhouse gas, when buried in landfill**.**

The market research conducted in conjunction with this project found that 65% of residents placed food waste in the garbage bins while 20% composted, 1% worm-farmed, 5% fed to poultry and 6% undertook other activities including feeding food scraps to animals.

Council currently promotes composting and worm-farming and has a number of brochures available to instruct residents on options and correct methods. In addition, Council provides information on where to purchase worms. Council sells compost bins and worm farms at less then cost price ranging from $20–$35 for compost bins and $45 for worm farms. The program could be run in conjunction with various campuses of the school, the many progress associations, service groups and hardware outlets.

Given that the majority of homes place food scraps in the waste bins, even with the options available for Council to meet the NSW State Waste Strategy target of 66% diversion from landfill for municipal waste will require the inclusion of source-separated food waste in future collection programs.

Where garden waste services are already containerised using a wheelie bin, the opportunity is available for Council to incorporate food waste if a composting facility is licensed to accept this component. Typically, odour and vermin issues are the key concern for regulators. The collection of food organics in combination with green organics from kerbside is the next logical step towards increased diversion of organics from landfill. A range of new and innovative collection programs have been and are being trialled across the nation, including:

12.4.1 Case Studies

12.4.1.1 Willoughby City Council (NSW) – undertook a Non-Fatty Food Waste Collection Trial in 1998, with funding from the NSW EPA. The trial of approximately 400 households encouraged householders to separate non-fatty food into the existing 240-litre kerbside garden waste bin, which was collected weekly. The study demonstrated the critical role that a kitchen waste container plays in promoting correct source-separation of food waste at the point of generation. A range of qualitative and quantitative research methods were employed, including waste characterisation studies and household surveys, to endeavour to match behaviour and attitudes with results. The results indicated that the domestic garbage bins only decreased in weight by 0.33 kg per bin and, on inspection, 17% of the bins contained food residues. However, the feedback surveys indicated 74% of residents took part in the project. The study found no significant odour or contamination detected in the loads.

12.4.1.2 Lismore City Council (NSW) – introduced a weekly collection of a 140-litre bin for organic materials including food scraps, garden waste, paper and cardboard. This service is offered in conjunction with a fortnightly collection of the residual waste stream and recyclable material on alternate weeks. The collected material is currently processed at a vermiculture facility located at the waste disposal facility. The plant is the largest enclosed vermicast facility in the Southern Hemisphere and is currently processing approximately 7,000 tonnes per year, with a capacity of up to 30,000 tonnes for all organics.

12.4.1.3 Hastings Council (NSW) –.introduced in 2001 a three-bin kerbside collection program for its 23,000 domestic premises. An 80-litre or 120-litre weekly garbage bin, a 240-litre recycling and 240-litre organics bin are collected in alternate weeks. Councils encouraged premises to separate food and vegetable waste into their organics bin by providing a 2.5 litre kitchen tidy.



Figure 22 – Kitchen Tidy Bin

All kerbside-collected organics are delivered to the Organics Resource Recovery Facility (ORRF) operated by Rethmann Australia, where bio-solids are added in a tunnel composting system and the resultant high-quality compost demand exceeds supply.

Council, in 2003, conducted a trial seeking to increase the amount of food and garden waste source-separated from residential premises by conducting a trial of 1,261 premises over a five-month period in four trial areas:

- Trial Area 1 – was a control with a normal fortnightly green waste service.
- Trial Area 2 – 240-litre Cleanaway Bio Bin insert bin, fortnightly collection.
- Trial Area 3 – weekly collection of the organics bin.
- Trial Area 4 – fortnightly collection with compostable paper bags or cornstarch bags

Pre-and post-trial surveys, focus groups and waste audits were conducted to monitor and measure the trial's performance. The weekly collection area increased recovery by 33%, while the compostable bag area had higher average bin weights. Contamination, at 2.2%, was highest in the compostable bag area, principally due to two households in one week significantly contaminating the bin. From the surveys the compostable bag area had the highest increase in participation and the largest amount of diversion of fruit and vegetable scraps. Eighty-three per cent supported the use of a paper bag compared to 63% for cornstarch bags.

A combination of weekly collection and the use of a compostable bag would be the optimum system to capture organics from domestic premises. The current cost of this service to the community is $0.71cents per pickup by 26,000 households and $59 / tonne for processing. The contractor was required to provide $100,000 for the purchase and distribution of bio bins and bags.

12.4.1.4 Coffs Coast Regional Waste Services (NSW) – will shortly be introducing an organics bin for food and garden waste, collected weekly, and a residuals bin collected fortnightly. The residuals bin will be collected in the alternate weeks to the fortnightly recycling bin collection. All collected organics will be processed through a $15 million Resource Recovery Park featuring autoclave technology, which is currently being commissioned. Council has decided to provide a kitchen tidy and request householders to wrap scraps in newspaper prior to placing it in the bin.

12.4.1.5 City of Burnside (SA) –.the City services 18,000 households and concluded a six-month food collection trial on 11th April 2006 with 1,775 properties or 10% of the population.[15] Food waste was placed in the garden organics bin collected fortnightly over summer months.

Each household received a bio-basket with a roll of 100 compostable bags specifically screen-printed with instructions and a letter introducing the program, calendar and sticker for the garden organics bin. This initial delivery was followed up two weeks later by a letter.

The trial was conducted for six months and the number of bags provided was based on an estimated bag change every two or three days. In reality, approximately 2% of the households used bags daily and requested additional supplies.

The 6.6-litre basket is a one-off purchase of $4.00 and the roll of 100 cornstarch bags was imported from Norway at a cost of $10 per household per year. The bins with a bag liner were assembled and distributed by the contractor East Waste.

Regular random monthly waste audits of the garbage and garden organics bin to determine composition, contamination and yield were undertaken. A telephone survey was conducted of 317 households, revealing overwhelming support for the project.

The garden organics bins with the compostable bags were collected and transported to Jeffries for open windrowing. Jeffries' EPA licence allowed the company to participate in trials. In many cases the compostable bags had already started to deteriorate within one week and were not evident after turning the windrow at Jeffries.

Burnside is currently diverting 56% of all waste from landfill and the trial increased diversion by a further 8.6% or 2.57 kg per fortnight to 65%. Support for this project both financially and in kind came from ZWSA, East Waste and Jeffries.

Council decided not to proceed with full implementation following the trial due to the cost of the bio-bags.

[15] Burnside Council, Burnside Bio-organics Trial: Diverting Food Waste from Landfill.

12.4.2 Processing Options

If a collection of food waste were undertaken, then the organics fraction would need to be processed into a beneficial product for community use. A range of processing options are available, including vermiculture and composting methods, while some councils are engaging Alternate Waste Technologies (AWT) processes to recover the organic fraction from the residual waste stream. Typically, AWT processes require greater quantities of material than are available within the Tweed Shire for processing, given the high capital costs and minimum throughput required for cost-effective operation.

Tweed Shire Council would need to consider entering into a regional approach with a neighbouring council such as Gold Coast for a suitable facility to be built. AWT options are discussed in section 13 in relation to residuals processing.

12.4.3.1. Vermiculture

Vermiculture is the breaking-down of organic material through the action of bacteria and earthworms. As with composting, conditions within the waste have to be controlled to ensure optimum oxygen and moisture levels. Commercial systems employ raised beds housed in a purpose-built enclosure.

As with composting, training and support are required to ensure biomass materials are blended correctly and bed conditions are controlled to prevent anaerobic conditions from forming. Should suboptimal conditions persist, there is a danger that the worm population will be destroyed, in which case fresh worms would be needed to re-establish the process. During this re-establishment period, a contingency operation would be required to manage the accumulated biomass waste.

Various techniques are available, such as sophisticated, fully automated continuous flow principles using automated in-vessel systems wherein material is spread on top of the beds typically to a depth of approximately 40 cm; the system produces vermicast which is harvested from beneath. Alternatively, a windrow system uses worm stock and bedding that is supplied based on the waste, type, volume and space available.

A critical component of vermiculture is the carbon–nitrogen ratio, which normally needs to be at 25:1. Carbon can be obtained from paper and cardboard, sawdust and manure while nitrogen is predominantly generated from food. Material needs to be blended prior to application, either manually or in hammer-mill type equipment. Typically, worms should be able to process the food stock within 24 hours.

Vermiculture relies on a skilled operator, given the worms require an exact moisture content in their food and are sensitive to heat, cold and light. Worms prefer a non-fatty food diet.

Lismore Council has contracted Tryton, which uses vermiculture, to process the organics fraction, however, claims the system is very costly and is underperforming. Given this local and current experience, it does not appear to be an appropriate solution for the Tweed Shire.

12.4.4 Costs

12.4.4.1 Kitchen Bin

While no collection bin is required due to the inclusion of food waste with the garden waste stream the provision of a kitchen bin is strongly recommended, to encourage maximum participation and diversion from landfill of food scraps. A number of council have used plastic bench-top tidy bins, buckets and Bio bins with cornstarch compostable bags or paper bags.

The selection of the type of container will have a significant impact of use and success of the system, as has been shown in the trials and programs described above and also a cost impact on service delivery.

From the Hastings surveys the compostable bag area had the highest increase in participation and the largest amount of diversion of fruit and vegetable scraps, with 83% supporting the use of a paper bag compared to 63% for cornstarch bags. However, the paper bags were more expensive then the cornstarch bags.

Burnside in SA, Christchurch in New Zealand and Hastings and Kogarah Councils in NSW have provided each household with a 6.6-litre bio-basket with a roll of 100 compostable bags specifically screen-printed with instructions. The basket was a one-off purchase of $4.00 and the roll of 100 cornstarch bags cost of $10 per household per year. Unfortunately the bags are imported from Norway, however, they are cheaper than locally produced bags at this time. The bins with a bag liner were assembled and distributed by the contractor.

Willow Ware manufactures a small kitchen bench-top bin which in the quantities required, would cost $3.44 excluding GST.

Table 56 - Food Waste Bin Costs Summary

Expense Element	Estimated Cost per Unit (ex GST)	Distribution Cost (E recording)	Estimated Numbers for Replacement	Cost of Changeover
Bio-bin	$4.40	Contractor	23,340	$102,696
Bags (4/week/per year)	$11.00			$256,740
Ongoing bags per year				$256,740
6-litre kitchen tidy	$3.78			$88,225

Recommendations:

14. Council should continue to monitor developments by other local governments which have introduced or are proposing to introduce organic waste collection programs, in particular, Coffs Coast and Hastings Councils, to learn from their experiences. Council should also assess new and emerging technologies and processes which have applicability for the area.

12.5 Domestic Waste

On the basis we estimate that Council should be able to achieve an increase in the recovery rate of recyclables from the current baseline of 4.1 kg to at least 5.11 kg a week with the introduction of a new fully commingled service. The remaining

residual garbage to be disposed of is then estimated to be 12 kg if the audit data base is used.

As a component of the garbage stream, based on the 2005 regional audit, 18% is garden waste and other organic material, excluding food waste. If the majority of this was diverted through the garden waste service a further reduction of 2 kg per week could be achieved, with the general waste bin containing approximately 10 kg per week.

The anticipated collection per year could be as low as 16,414 tonnes per year, excluding population growth, instead of the current 21,089 tonnes, however, it must be remembered that frequently when councils have changed over services, the available space has then been filled by users of the systems with other materials that previously may not have fitted.

Council could justify providing a 140-litre bin as standard and offer a 80-litre and 240-litre at a differential rate to cater for smaller and larger families similar to that offered by Byron Bay Council to its residents.

12.5.1 Byron Bay Case Study

Byron Bay Council offered a differential charge for the waste service based on bin size when it commissioned its new collection contract, with the following results of user types:

Table 57 - Byron Bay Council – Bin Use by Size

Bin size	Households
80-litre,	7 %
140-litre	82%
240-litre	11%

12.5.2 Garbage Bin Colours

Australian Standard 4123 Mobile Waste Container stipulates bin design, dimensions, performance requirements, testing, health and safety, environmental considerations and bin colours. Councils should adhere to these bin colours for national consistency and ease of understanding for an increasingly transient population. All bins are recommended to have a dark green or black body colour with the coloured lids, as specified in the table below.



Figure 23 –Bins with coloured lids

Table 58 - Recommended Bin Colours

Bin Types	Bin Lid Colour
Garbage	Red
Recycling – fully commingled or containers only	Yellow
Recycling paper only	Blue
Garden organics	Bright green or lime

12.5.3 Costs

12.5.3.1 New bins – the cost of introducing the new recycling service requires either the provision of a new standard 140-litre bin for waste with the option of 80-litre of 240-litre for smaller and larger families. Council may choose to either pay this cost directly as a one-off cost from its reserve funds or to include the provision for it in any future new contract. The provision of a new bin on a five-year contract would cost about 35 cents per tenement per week (excluding interest). This cost to residents can be reduced if the contract term is carried over a longer period, allowing for the recovery of capital to be extended.

Table 59 - Cost Elements Summary

Expense Element	Estimated Cost per Unit (ex GST)	Distribution Cost (E recording)	Estimated Numbers for Replacement	Cost of Changeover
140-litre waste, red lid	$37.50	$5.25	34,000*	$ 1,453,520

* Base 31,500 garbage services + 8% population growth in 2 years for commencement in 2009

12.5.3.2 Collection fees – servicing a total of 31,500 bins on a weekly basis over a five-year contract period based on current market rates, the indicative rate is likely to be around $1.00 per service. Recently Pine Rivers and Caloundra tenders were contracted for $0.89 cents per collection. Collection rates are totally dependent on service numbers, contract terms and requirements and the industry's competitive position at any given time. The numbers set out in the table below should be viewed as indicative only.

Table 60 - Cost Elements - Service

Expense Element	Estimated Cost per hh/Service	Estimated Numbers for Replacement	Cost per Year/hh
Garbage – no bin	**$1.00**	34,000 *	$52.00
Garbage with bin	**$1.35**		$70.20

Recommendations:

15. That Tweed Council offer residents a 140-litre bin as the standard service with the option of a differential service rate for an 80-litre or 240-litre in the interests of social equity. The price differential for these service options will be assessed once the tender for domestic waste management services is completed.

16. That new lids in accordance with the Australian Standard 4123 Mobile Waste Container be provided to all existing and new domestic waste, recycling and garden organics bins as part of the collection contract.

12.6 *Bi-annual Household Clean-up Service*

This collection system is common to assist the community in disposing of large bulky items that do not fit in the normal garbage bin, and to assist those people who do not have ready access to a trailer or vehicle to personally take items to a waste depot. Currently the clean-up service is offered twice per year, in May and November, and the service accepts and rejects the following materials:

Table 61 - Household Clean-up Service

Accept ✓	Reject ✘
Furniture	Builders rubble and household renovations
Floor Coverings	Green waste
Whitegoods	Fencing material
Mattresses	Car parts and tyres
	Paint
	Oil
	Gas bottles
	Asbestos

Council asks for the materials to be presented in three separate for piles for:

1. Recyclable materials – whitegoods
2. Reusable material – furniture in reasonable condition
3. Waste

however only one collection vehicle now undertakes the collection with all inert material diverted at the landfill. The maximum length of any item is 1.8 m and the weight limit means that an item is able to be lifted by two people. The maximum amount is 1 m^3 per household.

The majority of urban residents (63%) supported the bi-annual bulky household clean-up service, with the majority of residents indicating that they use the service twice per year. However, comments made included that it was too restrictive and people wanted to place out vegetation, building materials, batteries and paint tins for collection.

Many councils include bulky garden waste services which require the resident to bundle or tie branches and prunings, or place items out in cardboard boxes. Plastic bags are not permitted, as they contaminate the composting process.

Recommendation:

17. That Council introduce dedicated collections for specific materials, that is, metals / white goods and general waste once per year.

12.7 Recycling Processing – MRF

When the recyclables are collected in a commingled form they are mixed together in the collection vehicle and have no economic value until they are sorted into their respective material types. Sorting of collected recyclables occurs at a Materials Recovery Facility (MRF).

MRFs can be a simple design of a single-line conveyor belt, whereby material is fed onto a moving conveyor with people stationed at various intervals along the line picking off particular items and placing them into bulk bins. The contents of these bins are then emptied into balers for economies of transport. However, glass needs to be maintained as whole as possible for sorting at a beneficiation plant, where the glass is processed to a furnace-ready stage. Any waste or rubbish in the recycling bin is termed contamination and must be disposed of to landfill.

Anecdotally, Council advises that three to four truck loads of waste material are disposed of at the landfill from the MRF daily, with glass fines comprising up to 40% of this material.

Council's existing MRF, located at the Stotts Creek waste depot facility, will, at the expiry of the current contract in 2009, be more than 15 years old and will revert to Council. It has been identified that it is not viable to modernise or rebuild, as technical advances in MRF design and automation have overtaken this aged plant's ability for it to be modernised. Thus a total new facility will have to be considered post the 2009 term, for local processing to continue.

The costs of constructing and operating a MRF are totally determined by the product throughput. All MRF designs have a core of basic equipment required, the size of which is dependent upon volume. Regardless of the quantity to be processed, a base capital cost for infrastructure is required and the greater the throughput the more cost-effective processing operations become and the sustainability of the business is assured, thus risk is mitigated long term for Council.

Where high volumes of recyclables are sorted, the sophistication of a MRF's design increases, with the aid of trommels, eddy currents, air blowers, magnetic heads and multiple conveyors, optical sorting equipment and balers. The objective of the operator is to reduce processing costs by increasing operational efficiency. MRFs, like

landfills to operate, require a charge to be applied to all users, recognised as a gate fee per tonne to process the material. Typical gate fees range between $35–$85 per tonne in Queensland and New South Wales.

It is apparent that, based on anticipated recovery levels, Tweed Shire Council is likely to generate approximately 520 tonnes of recyclables per month, or about 6,299 tonnes per year.

Recycling industry benchmarks[16] put the standard operating size and expected annual product throughput for the design, building, operating and maintaining of a stand–alone, financially successful commingled recyclables Materials Recycling Facility (MRF) at approximately 8,000 tonnes per year.

Critical to the financial viability of the operation are the processing fees applicable to it, as well as the product mix and yield recovery of each plant. Generally 150 tonnes per week throughput is satisfactory for a small stand alone MRF operated on a single shift basis.[17] However, the larger the plant, the greater the technology that can be applied cost effectively to capture products including glass fines, which are currently lost from the current system.

The financial model of an operation, however, is heavily dependent on the expected EBIT required by an operator for its investment over the length of the contract term. It is unlikely that Tweed Shire's quantity in its own right could justify the investment of building a new MRF.

While MRFs have been built and do operate below this threshold they are predominantly labour-intensive, using manual handling methods to sort the products. A new MRF builder, Brittos Engineering, has been identified and has entered the market in NSW, building small-scale rural MRFs for around $300,000–$500,000. Some of this equipment is designed to be used by disability industries employing 5–7 staff, while other plant is designed to be used by able-bodied people, employing just 3–4 people. The company has designed, installed and commissioned MRFs at Gunnedah, Inverell, Glen Innes and Tamworth and is currently building a plant for Armidale. It is also in discussions with a number of central west councils and recycling companies.

Whatever the MRF system used, quality is paramount and all sorted product must meet specific industries' quality standards. Industry specifications for all kerbside-collected and sorted materials are downloadable from the website of the Australian Council of Recyclers: www.acor.org.au.

12.7.1 Glass Breakage

Glass containers are the second highest recovered material by residents in their recycling programs, after paper and cardboard. Glass is then taken to MRFs for sorting and is sold for use in the re-manufacture into glass containers.

[16] CQLGA EOI Regional MRF, November 2006.
[17] Confirmation – Australian Bale Press Company and Recycling Design Technologies, November 2006.

The glass manufacturers that buy the recovered glass specify that glass must be separated by colour – clear, green and brown – be a minimum of 50 mm in diameter and comply with extremely stringent specifications in relation to the presence of ceramic, stones etc. Glass is currently manually sorted, however, technology is now available and has been incorporated into a number of larger and newer MRFs to recover glass down to 6 mm in diameter.

It has been identified that Council's current MRF recovers less than 24% of all glass from the current commingled system with the remaining amount being classed as glass fines[18] which equates to 1,350 tonnes per year and is currently being landfilled locally.

The quantity of glass fines could be as a result of a number of factors or combination of factors including:

- **Lightweighting of glass** – glass bottles have been light-weighted over the years and require care during the collection and sorting process to minimise breakage.

- **Over-compaction during the collection cycle** – while it is highly desirable to compact garbage to gain as large a payload as possible, to apply the same load densities to recyclable items which contain glass is detrimental to the quality of glass and other recyclable materials. When glass breaks, the fragments can become embedded in the paper products at high densities.

From a previously described Glass Compaction Study, it has been determined that a relationship does exist between compaction and breakage, with the minimum breakage being 20% at 120 kg/m^3 increasing at the rate of 2.9% for every additional 10 kg/m^3 compaction.

There must be a balance between operational efficiency and glass breakage. It is generally agreed that compaction setting should not exceed 160–180 kg/m^3, this generating between 30–36% breakage.

12.7.2 Case Study – Ballina Shire

Ballina Council, which generates approximately 4,500 tonnes per year, was faced with a similar situation and recently sought quotations to upgrade its MRF facility, which were between $950,000–$1,050,000, excluding the existing cardboard baler and using Council's existing shed and hardstand. The processing costs were then around $200 per tonne. If Byron joined the project with an additional 4,000 tonnes (that is, the 8,000-tonne threshold) the gate fee would drop to $83 per tonne. It was only when the quantity of material to be processed increased to 15,000 tonnes that the gate fee reduced to $25 per tonne.

Ballina Council decided that the most effective options for it was to bulk-transport recyclables to Visy's Carrara MRF where the gate fee is $15 per tonne, plus transport from Ballina in 140-m^3 walking-floor trailers at $30 per tonne, based on 18-tonne loads. The total cost for transport and processing was therefore $45 per tonne.

[18] Solo Resource Recovery MRF data, Jan. – Sept. 2006.

12.7.3 Regional Co-operation

Based on the fact that Tweeds tonnages at best would provide the marginal tonnages required for building a stand-alone modern facility, Council could consider aligning future processing with that of the Gold Coast City Council.

Gold Coast City Council, in its last collection tender, specified that there was to be 100% glass recovery. To win the contract, Cleanaway teamed up with Australian Glass Technologies (AGT), which has pioneered technology and applications for glass fines.

AGT currently processes between 10,000–12,000 tonnes per year of glass fines into new products at a plant located adjacent to the Gold Coast City Council's Materials Recovery Facility. As a result, the compaction setting on the collection vehicles was irrelevant, as all glass was being recovered. The MRF was owned by Cleanaway and has since been purchased by Visy. It is located at Carrara.

The refined glass is suitable for use in a various applications including abrasives, concrete, brick-making and water filtration, and is sold both nationally and internationally.

Currently AGT is not able to receive material from other suppliers due to the only infeed to the existing operation being through the MRF. It has, however, visited the Tweed Shire MRF recently, and is familiar with the quantity and type of glass fines generated.

Fortuitously both the Gold Coast and Tweed Council Kerbside Collection Contracts expire at the same time and through aligning Tweed with a larger council, Tweed will benefit, as greater economies of scale should translate to a reduction in processing costs, and a greater level of recovery would be achieved.

Should Council co-tender the collection and processing of recyclables with Gold Coast City Council, access to this glass fines processing facility may be available.

Recommendations:

18. Should Council maintain its own MRF, then the future collection contract should specify a maximum compaction for the collection of recycling at 180 kg/m^3 and in accordance with best practice.

19. That Council enter into discussions with third parties in relation to the acceptance of Tweed Shire Council recyclables.

12.8 Organics Processing

Council has introduced a voluntary 240-litre garden organics service with a fortnightly collection frequency for a cost of $35 per year. Currently approximately 25% of residents in townships and non-rural areas have taken up the service. Council is currently collecting 2,109 tonnes of garden organics, and a further 2,000 tonnes are self-hauled.

Kerbside-collected garden waste is delivered to Stotts Creek waste depot, where it is stockpiled, shredded and composted on a bunded pad. Recently, Solo Resource Recovery commenced a soil-conditioning trial using septic tank pump-out waste and similar residuals injected into the green organics. However, the DECC, in a recent communication dated 8 September 2006, stated that such an activity had not been approved, although correspondence had been received in relation to conducting a soil-conditioning trial. The DECC's key concerns are in relation to leachate generated from the area potentially contributing to existing groundwater contamination problems at the site. This compost is sold to the public at $15 per trailer load or made into a number of premium blends and sold to the public or commercial users.

During the recent market research, 58% of respondents indicated that they were not aware that mulch was available for sale from the facility. Only one negative comment was made in relation to the quality.

Garden waste delivered at Murwillumbah waste depot is shredded and placed in windrows. Over the past twelve months approximately 700 tonnes of vegetation have been delivered for chipping. The chipped material is not screened and is provided free to residents. During the market research, many residents noted the poor quality, and the presence of weeds and plastics in the finished product. During the recent survey, 62% of respondents indicated that they were not aware that Council provided free mulch. Most of the Murwillumbah material is used for on-site rehabilitation of the landfill's batters and other landscaping works as a part of the rehabilitation program.

For good compost the correct carbon–nitrogen balance is required for structure, and to provide aeration to the windrow. Windrows should be turned at least weekly for a minimum of 12 weeks to ensure all materials are exposed to at least 55^{o}C for three consecutive days. A moisture content of between 40–60% should be maintained and the temperature monitored using digital probe thermometers. The goal of any process should be to comply with AS4454 for compost and soil conditioners; assessment is undertaken by independent laboratory analysis. Once pasteurised, the material should then be screened.

Composting is usually carried out in either open windrows or within an enclosed vessel.

12.8.1 Open Windrows

This is a simple 'low-tech' option, requiring the least capital cost, but requiring attention to ensure the compost pile is properly turned at regular intervals. Purpose-designed windrow turners are available, however, a front-end loader would suffice in relatively small operations.

12.8.2 In-vessel Systems

Enclosed composting units, while having a higher capital cost compared to open windrow systems, have a smaller footprint, increased consistency of product quality, more controlled environmental impacts and shorter composting times. Many enclosed processes are modular, therefore controlling capital cost outlays and providing flexibility for future expansion.

Numerous proprietary designs for commercial composting systems are available. An important factor in system selection is to consider the level of technical support available. Correct operation will require training to ensure adequate bed porosity and moisture levels are maintained, and that the materials to be processed are blended in the correct proportions. The system has the benefit of total leachate control.

Examples of enclosed composting units include Hot Rot composting systems and Vertical Composting Units (VCU). Indicative pricing for these units ranges from $30–$70 per tonne (including amortised capital and operating costs). The compost product would be suitably stabilised.

12.8.3 Case Study – Hastings Council

Hastings Council has contracted Remondis, which designed, built and operate the Organics Resource Recovery Facility (ORRF). The facility receives 8,000 tonnes of food and garden waste collected from the weekly garden organics service which has a very low contamination rate of just 1%. In addition, 3,000 tonnes of self-hauled garden waste and 6,000 tonnes of bio-solids were received.

All material is placed on a concrete floor, inspected to remove any obvious contamination that would impact on the process, for example, rope. The materials are shredded and then mixed in a ratio of 2:1 garden waste to bio-solids to ensure the correct carbon–nitrogen mix is achieved. The mixed material is then loaded into a tunnel composting system with forced aeration, computer-controlled with probes to provide accurate information of the conditions of the composting product, that is, moisture and temperature are monitored. No leachate is produced outside the system and any is recovered and re-circulated though the system to increase the moisture content.

After 30 days the material is placed in a covered maturation areas for three weeks prior to screening into various sizes and being wind-sifted to remove any light impurities. The product has been classified as AA grade and the demand for the resultant high-quality compost exceeds supply. The gate fee for such a process would be required to be around $80 per tonne and construction would be the range of $6 million dollars. Any contractor would require a 15- to 20-year contract.

12.9 Public-place Waste Management

Tweed Council currently provides 240-litre litter bins in strategic locations throughout the Shire, catering for waste generated by people when outdoors. Bins are provided in parks, ovals and reserves, key tourist destinations and along footpaths in townships. While the majority of these bins are used by visitors, they are also used by residents. Currently the bins are typically 240-litre in capacity and light blue in colour.

12.9.1 Background to Public-place Recycling

With the success of kerbside recycling, the community also expects to be able to recycle at work and in public places. Various state governments have funded investigations into away-from-home recycling programs. A simple but versatile

system of colour-coded bins and labels was developed to differentiate between garbage and recyclable materials by the NSW government in the early 1990s.

The NSW Government Recycling Advisory Unit tested different systems in different public places in 1991 and found that:

1. There was widespread public support for recycling in public places
2. People who recycle in public places would separate their waste
3. Colour-coded bins had a high recognition and a low contamination rate
4. Black bins with commingled recyclables had a very high contamination rate and low recognition rate
5. People at leisure were more likely to recycle than people in a hurry
6. Awareness of recycling as a concept was high and the attitude to it extremely positive. The level of public knowledge about recycling processes was very low.
7. Some people used the recycling bins in public places as a drop-in centre, bringing recyclables from their home, office, restaurants or shops.

The study developed a set of guidelines for establishing recycling in public places, including:

1. Clear labelling on the bin front, bin lid and overhead signs are essential to minimise contamination
2. Litter bins incorporated in the recycling centre and placed at the each end of a row of recycling bins result in lower contamination
3. Multiple stand-alone bins in the general vicinity of recycling bins dramatically lower the quantities of recyclables retrieved at the recycling centre
4. Re-positioning and reducing the number of litter bins does not result in significant increases in littering
5. Public awareness campaigns are essential to avoid the dumping of garbage in recycling bins and scavenging
6. In the absence of clear signs overhead, people will look in the bins, and, if there is contamination, further contamination is highly likely.

12.9.2 Public-place Waste Management Guidelines, Resource NSW

The guidelines set out the critical elements for establishing a successful public place system. In summary these are:

- The bins are conveniently located
- They are clearly marked with labels on the front, side and tops of the bins
- There are overhead signs so that people can see where the bins are, even if there is a crowd
- There are arrows pointing from the signs down to the bins
- The overhead signs should be visible and readable from a distance and be double-sided where appropriate
- The signs and labels should communicate by colours, symbols and words
- In certain areas signage should be multi-lingual
- The bins are colour-coded with one colour for each material
- The lids on the recycling bins are closed and locked
- There are holes in the lids to admit the correct recyclables

- The litter bin lids are open
- There is no recycling bin without a litter bin on either side
- The bins are side-by-side, not back-to-back.

Contamination rates will decrease if:

- Bins are emptied regularly – not allowed to fill up or overflow
- Litter bins have no lids or have their lids open.

The diagram below shows an ideal recycling station with all its features.



Figure 24 – Ideal Public Place Bin Configuration

A summary of the Guidelines is provided below.

Step 1 – Waste Audit – determine what is the composition of the typical litter bin. Typically, experience has shown that where paper and cardboard are included in recycling programs, high levels of contamination result, mainly from food, therefore, a containers-only collection program is recommended.

Step 2 – Developing Your System – the waste audit will reveal the maximum diversion rates achievable based on introducing a containers-only recycling bin adjacent to the existing litter bins in lieu of the current stand-alone garbage or litter bin, to mirror the domestic program.

The blue litter bins should be replaced with green bins with red lids (consistent with the Australian standard) and recycling bins should have green bodies with yellow lids.

Step 3 – Signage and Labels

It is important that public place bins are set up to follow these standards:

- Clear signage and stickers should be provided on a backing board
- There should be arrows pointing from the signs down to the bins
- Signage should be visible and readable from a distance and be double-sided where appropriate
- Stickers should be provided on the front body and bin lid
- The signs and labels should communicate by colours, symbols and words.

Samples of bin stickers developed in NSW are provided below:

Market research could be conducted to determine a suitable slogan. In a similar project recently conducted by the consultants, 'Recycle, It's Vital' was the most popular.



Step 4 – Bins
It is important that public place bins are set up to follow these standards:

- The bins are conveniently located
- They are colour-coded in accordance with the Australian Standard AS4123 Mobile Waste Container for commingled container collection, that is, yellow lid for recycling and red lid for garbage.
- The lids on the recycling bins are closed and locked, and holes are provided in the lids to admit the correct recyclables
- There is no recycling bin without a litter bin
- Where multiple bins are provided, the recycling bin should be in the middle of the litter bins to reduce contamination
- The bins are placed side-by-side, not back-to-back.

While aesthetics are important, it is also important to consider how the bins are emptied and serviced, and they must be time-efficient for servicing.

Step 5 – Promoting the Recycling System

- Implementing a recycling system is a promotional tool which shows that Tweed cares about the environment. Council could include information about the system in tourism brochures and community newsletters.

Step 6 – Servicing
All bins should be emptied frequently enough to avoid overflowing. The frequency of the collection will be dependent upon seasonality.

Step 7 – Monitoring
The new waste management system is not 'set-and-forget'. Waste audits and visual inspections of bin contents should be undertaken to monitor performance. It is suggested that a trial be conducted for a period of three months to determine success and a waste audit be carried out to accurately measure contamination levels. Regular inspections of various sites should be ongoing.

12.9.3 Current Applications of Public-place Recycling

A whole range of different bin types and stands are suitable for use in public places. Most public places require simply a bin frame to contain the bins. However, recycling stations require that a bin stand be provided so that clear overhead signs can be affixed. Below are some examples of different public-place recycling stations, each designed for their own specific conditions.



Figure 26 - Centennial Park, Sydney



Figure 27 - Royal Botanic Gardens, Sydney

Centennial Park and the Royal Botanic Gardens were two of the first NSW State government agencies to implement public place recycling in the early 1990s, with bins in timber enclosures.

Rottnest Island WA – recently commissioned new recycling stands manufactured from recycled plastics. This picture was taken prior to the overhead sign being installed. The stands are flat-packed for easy of transport and assembly and are reasonably priced and come in 2-, 4-, 6- or 8-width stations.



Figure 28 - Rottnest Island WA

12.9.3.1 Case Study – Warringah Council

Warringah is a coastal Council with beaches and other heavily used public places, especially during the weekends. Two grassed picnic areas near the beach at Dee Why and Collaroy were chosen for a trial. The main criteria used for bin site selection was that they should be placed where people are ready to dispose of waste. This included the entrances and exits to the areas, near picnic tables, near toilets and next to natural walkways.



Figure 29 - Message incorporated into picnic furniture



Figure 30 - Public-place bins at Dee Why Beach

Bin Design – The design of the bin stations complied with the Guidelines for Public Place Recycling. The enclosures were of a galvanised steel frame with powder-coated panels, with one panel hinged to open and allow access to the bin inside for emptying and having a lock to prevent

unauthorised access. Bin stations included two garbage bins with a recycling bin between. Signage was provided on the bin and overhead.

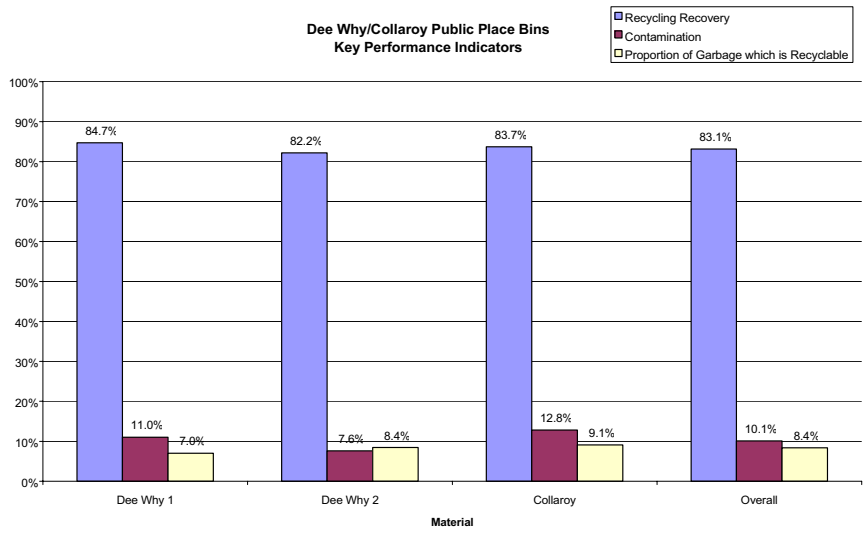
Bin Installation – where bin stations were installed, all litter bins were removed.

Education – small signs were placed on the picnic tables in the areas, reminding patrons to separate their recycling from other garbage.

Servicing – Collex Waste Management, Council's residential garbage contractor, serviced the recycling bins.

Key Performance Indicators – diversion rates, recovery, contamination and the proportion of garbage which was recyclable were four key performance indicators used to assess the performance of a waste management system.

Chart 30 - Dee Why/Collaroy Public Place Bins - KPIs



A recovery rate of 83.1% is an excellent result.

Recommendations:

20. That a two-bin system – garbage and 'containers only' or alternate litter bin system be trialled in key strategic areas.

21. That a performance review of the system be undertaken three months after the system is introduced.

22. Recycling stations should be provided in strategic visitor locations to reduce the incidence of visitors using private or commercial bins.

23. That the existing blue litter bins should be replaced with green bins with red lids for rubbish and yellow lids for recycling.

12.10 Commercial, Construction and Demolition Waste

Collection of commercial and industrial (C&I) as well as construction and demolition (C&D) wastes within the region is performed by private sector operators under direct contracts with the waste generators.

The selection of receptacle size and type, frequency of services and provision of recycling services and costs are negotiated on individual needs.

Critical to the commercial viability of each service offered is consideration of the amount, type of waste to be collected, distance to the disposal location for the collected wastes and disposal fees applicable at waste depot.

Tweed Shire is serviced by a number of large private sector operators that service and unlike the Gold Coast, which operates its own commercial waste collection service (under contract) in direct competition with the private sector, Council has no direct responsibility in this area apart from servicing its rate-based customers with its divided bin weekly option, which only 270 premises use.

From analysis of Council's internal data, a traffic management study and inspection at both Stotts Creek and Murwillumbah facilities, it is evident that the quantities of waste being generated from both of these sectors is rising rapidly, spurred by the growth in the area.

Without controls being put in place and a focus on more effectively managing these waste streams, Council's landfill asset is at great risk of being compromised, in, to the extent that valuable airspace will be lost through the lack of regard by the private sector towards more effectively managing its environmental impacts in the region.

The most effective mechanism to control or influence the private waste collection service providers is to adopt a clearly defined strategy that is multi-faceted and targeted at both the point of generation as well as disposal.

The introduction of a strong education program to more effectively handle and reduce waste being produced, disposed, combined with differential pricing policies for sorted and unsorted loads delivered to its landfill acts as a strong financial incentive and is a key driver for change.

By implementing a tiered pricing strategy targeted towards loads with no recyclable materials contained, separated dry wastes only and encouraging a strong diversion focus across these streams, Council will drive a change in the collection sector and enact a change in community culture.

If Council were to introduce substantial differential disposal fees for various types of waste streams then it is feasible to expect that the commercial service providers would start to introduce separate 'wet' and 'dry' runs to mitigate these economic impacts on their operations and customers. They would be forced on pure economic grounds, if not environmental responsibility, to enact change at the point of generation with their customers, not, as is currently the case, enforce the impacts at the point of disposal and thereby transfer the problem to Council.

Until such time as Council acts to differentiate itself and to drive change, there is no incentive for action by the community or service-providers to alter their habits, as the

incentive to do nothing is more attractive that doing something new. Council must send a price signal to the market and, y, in addition to preserving the community's long-term asset, a substantial change its pricing signals and charges for waste disposal is recommended.

This course of action is fully justified and would assist Council in its ongoing negotiations with the DECC regarding groundwater. It would also be seen as a proactive action by Council in attempting to redefine and mitigate its environmental impacts at landfills.

12.10.1 Case Study: Kangaroo Island SA

Kangaroo Island was faced with a landfill crisis and implemented a price differential to encourage all sectors of the community to separate loads. Below is a copy of its current fees and charges.

Table 62 - Kangaroo Island Landfill Fees and Charges

Domestic Vehicle Type	Sorted	Unsorted
Car	$5	$25
Single axle, van, car type ute	$10	$50
Double axle trailer, tray-top ute	$15	$75
Double axle trailer with cage	$20	$100
Commercial Vehicle Type		
Any load minimum	$10/t	$50/$m^3$ or 150/t

That council should use its planning and regulatory powers when assessing and conditioning Development and Building Applications to ensure that:

- suitable space should be provided in garbage storage areas for both waste and recycling receptacles
- That during construction, all waste generated from the development should be source-separated
- That once the building is occupied, adequate waste and recycling receptacles are provided.

Recommendations:

24. That Council develop a Waste Not DCP and place a notation or condition on all Development Approvals requiring the source separation and containerisation of all waste on building sites to minimise waste generation and prevent unintended pollution.

25. That source-separation of loads prior to delivery is desirable due to the differential pricing policy to be applied to mixed loads at Stotts Creek and Murwillumbah landfills.

26. That Council undertakes a community education and industry information campaign to promote source-separation of all loads delivered to the Stotts Creek landfill.

27. That Council directly approaches the significant users of its landfills on a personal basis to inform and educate them regarding the role of source-

separation and of Council's intention to introduce a substantial change to the future fee structures and charges for disposal of waste.

28. That Council resolves to introduce differential landfill fees for sorted and unsorted loads and offer a significant price variation to create the necessary motivation for source-separation within the community.

29. That council introduces a significant differential pricing policy to encourage source – separation by waste generators of building materials.

12.11 Education and Communication

A continuing challenge for any council, let alone one with a highly transient tourist population, is to how to communicate to its community and visitors about the waste management system to ensure that the correct items are placed in the correct receptacle. There is an added challenge when visitors are staying in self-contained accommodation, in that they are indistinguishable from residents.

Councils rely almost exclusively on printed resources to communicate to their residents and visitors about recycling and waste services, using a range of resources including:

- Bin stickers
- Brochures
- Letters
- Calendars
- Fridge magnets.



Figure 31 – Education Materials

The type of collection system selected, the resources developed and the method of delivery of these will all have a substantial impact on the results achieved in terms of diversion from landfill and the contamination levels achieved.

Councils need to appreciate that different people, due to their age, background and education, receive, process and respond to information in different ways. Visitors, particularly from non-English-speaking countries or with low language skills, rely heavily on the use of visual images and graphics to convey messages.

Many of our methods of depicting information are ambiguous and open to interpretation, leading to the potential for undesirable actions and outcomes. It is therefore imperative to use clear, unambiguous images and words to convey the correct message. What is apparent to people involved in the resource recovery and waste management fields in terms of images, graphics and words, is not always clearly understood by many sections of our diverse community.

Contamination in recycling programs is a community-wide problem caused by apathy, lack of information, knowledge, skills or interest. Contamination has a financial implication as items placed in the recycling section which are not recyclables fill up space in the collection vehicle, cost the processor without any return and further cost

to discard to landfill. It appears that the average contamination rate of Tweed is between 15–18% which is extremely high, and reveals that the community is not using the system correctly. In addition, all the resources that could have been recycled but are in the garbage stream are lost and buried in landfill forever. The regional audit showed 23% of recyclables were present in the garbage stream.

Many councils, in their quest to identify and manage contamination at its source, have used a variety of communication methods including:

- Leaflets, brochures, calendar fridge magnets
- Bin stickers
- School education programs
- Media advertisements – newsprint and radio
- Video surveillance cameras in the collection vehicle hoppers
- Bin auditors who routinely inspect bins prior to collections.

Typically, rural councils are resource-poor and do not have a dedicated person within council to undertake these specialised activities. Tweed Shire has outsourced the provision and budget for education to the contractor with mixed results. We understand there has been a high turnover of staff, long gaps with no staff available and staff appointed with little or no experience in the field and seeking guidance and direction from Council rather than their employer.

The role of the Waste Education Officer was to develop and execute public awareness and comprehensive community communication programs within a budget of $20,000 per annum.

Council needs to review all options to ensure that a quality service is available in a timely manner in regards to education. The options available include:

1. The contract should clearly specify what services are required from the contractor
2. Council consider employing a suitability qualified person part- or full-time
3. Council outsource the education component separately.

Residents and visitors alike need to know what is expected from them, why they need to modify their behaviour and implications of the changes, both on a broad community and on a local household and individual level. The community education and communication programs need to encourage the community to participate in waste avoidance, reuse and recycling initiatives as part of the waste minimisation and management programs.

A specific education program is needed for the community – urban, rural and visitors. Real-estate agents, holiday-home owners and the tourist sector generally will need to be informed about and engaged in the new program to ensure that visitors are correctly informed about the waste management system in the Tweed. Should Council and Gold Coast City Council decide on the same system, communication will be easier, as the boundary between the two council areas is seamless to the visitor.

Council has the following schools and libraries in the area:

Schools:

- community run and numerous private facilities for pre-school age children.
- 35 primary schools
- 9 high schools
- three TAFE centres located at Tweed Heads, Murwillumbah and Kingscliff.
- university campuses located at Tweed Heads

Libraries: Tweed Heads, Kingscliff, Murwillumbah.

Council should clearly specify what services are required, including:

1. Development of a slogan and logo for the new waste program
2. Communicate the changes and options available in the new service
3. Explain to the community the reason and rationale behind the new program
4. Explain the reason for a potential increase new waste management charges
5. Develop and deliver innovative community education and communication programs on waste minimisation and management programs.

Council is extremely fortunate to have available the weekly community *Tweed Link* newsletter and some of the key messages the education program needs to deliver prior to the new kerbside service being introduced include:

- Council provides an optional garden waste service, as a significant number of residents were unaware of this in the community survey
- Free mulch is available at the Murwillumbah waste depot
- Mulch and soil conditioners are available for sale at Stotts Creek facility
- Council should continue to promote the sale of compost bins and worm farms
- Household Hazardous collection days
- The range of materials that can be recycled in the domestic bin and at the waste depots
- The new landfill pricing structure, aimed at encouraging greater source-separation.

The current contract requires the provision of $130,000 to be committed to a waste education centre to be constructed on a site approved by Council. We understand that a decision on a suitable site has been protracted but is likely to be resolved in the near future. This will offer an excellent resource and could be a demonstration site for other environmental initiatives, including water and energy savings and no-dig gardens.

Recommendations:

30. That the current education and communication program delivered by the contractor be reviewed to assess and evaluate the effectiveness and value for money prior to developing the new contract specification.

31. Given the high proportion of visitors to the area, that the use of graphic images supported by the English words must be incorporated into all communication modes.

32. That Council must commit sufficient and ongoing budgetary resources to continue the education of both residents and visitors.

33. That the waste depots should be renamed as Resource Recovery Centres.

34. That Council ensure that the new waste education centre is a demonstration site for green building and sustainable living and be called The Sustainable Living Centre.

13 WASTE DISPOSAL OPTIONS & ALTERNATE WASTE TECHNOLOGY

Tweed Council currently operates two landfills – the first being an inert landfill at Murwillumbah on a site close to town that has been used for approximately 50 years. This site is an operating quarry, however, the DECC, which ,in recent correspondence, has mentioned the need for post-closure plans. This site could be closed or made into a transfer station.

The larger landfill site is located some 13 km east of Murwillumbah at Stotts Creek, which has both a putrescible and an insert landfill cell and is operating in an old quarry site. Currently a private quarrying operation is operating adjacent to the current site. Based on the available projections, the current putrescible landfill cell is due to fill by 2010 and the inert cell is due to fill between 2016–2026.

The current licence for the putrescible waste allows for 55,000 tonnes per year, while the inert cell is licensed for just 15,000 tonnes per year, plus a further 3,500 tonnes at the Murwillumbah site. Therefore, the combined landfill licences for Tweed Shire allow for 73,500 tonnes per year. Records for Stotts facility for the 2005–06 financial year reveal that just over 39,000 tonnes of putrescible materials and 25,000 tonnes of inert material were delivered, making a total of 64,000 tonnes. In addition, about 6,000 tonnes of garden waste were delivered for processing at Stotts Creek facility

Council has acquired land nearby but not immediately adjacent to the exiting Stotts Creek site, and has undertaken preliminary assessment to determine the suitability of the site as a future landfill to service the area.

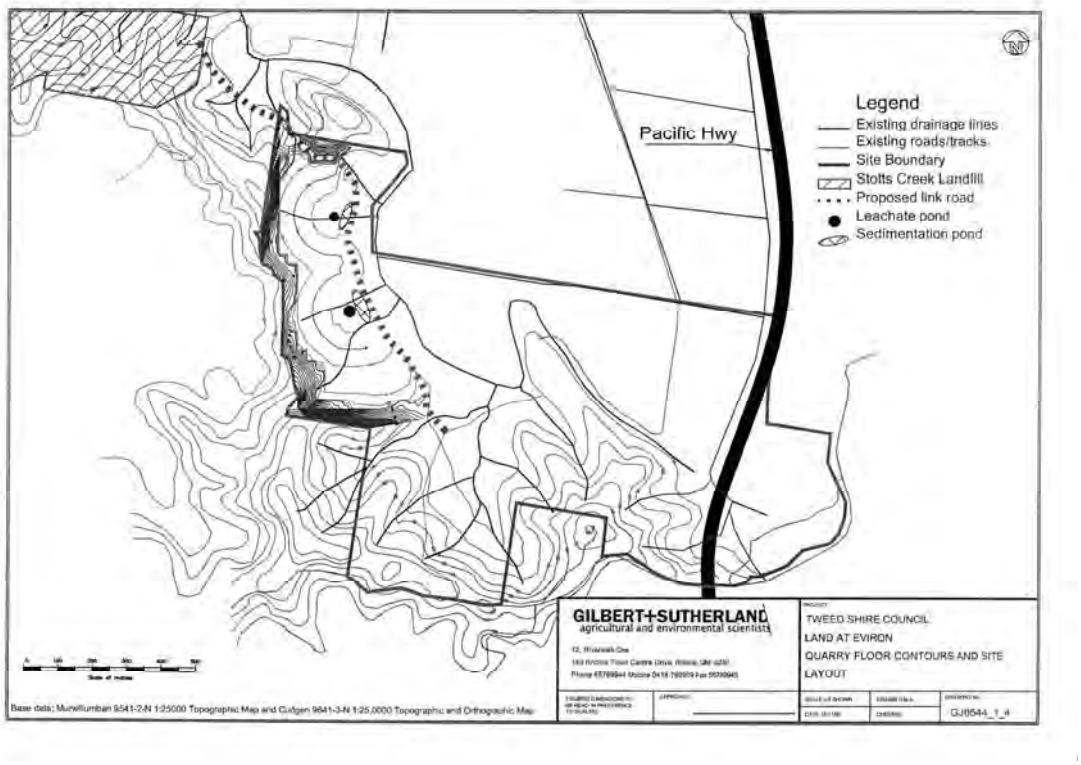
Given the unknown infrastructure costs an alternative approach, which may be more cost-efficient in the short term, subject to fuel price increases, is to export the waste from the Shire into South East Queensland, given the excellent road network and cheap landfill disposal rates available, due to an abundance of landfill capacity.

It would be prudent of Council to undertake a cost–benefit analysis to compare the cost of transporting waste to Queensland with landfilling locally, once detailed financially modeling of the final design has been determined.

This section discusses both of these options.

13.1 New Landfill at Environ

Council owns a site comprising 157 hectares where the cemetery, Botanic Gardens and farming land are located, and where Council is proposing to construct a new landfill site and quarry operation, at Eviron. Refer to the site map below:



Council has recently commissioned Gilbert+Sutherland, Agricultural and Environmental Scientists, to undertake a site investigation to determine the following:

- investigate and determine the commercial quantities of hard rock gravel available at the site
- determine whether the sources of landfill liner or covered material were present
- propose locations on the site for suitable future landfill development
- propose leachate capture areas for the site
- prepare a detailed service water management program
- identify the preferred location for internal roads networks
- identify the preferred location of the link road, between the new site and the existing landfill
- consider land-use constraints imposed by the Tweed Botanical Gardens Master Plan
- consider provisions contained in the Quirks Quarry Management Plan.
- Acid Sulphate Soil Investigation
- the establishment of a groundwater bore network
- preparation of a site management plan.

The company prepared 27 bore holes and eight groundwater wells and undertook rock core samples at three locations.

The report recommends that the landfill activities occur in the north and west valleys. The proposed Link Road, with a moderate incline, would provide access for quarrying and landfilling activities from the current to the future site and would also form a

Q100 Flood Immunity Bund to prevent floodwaters entering and impacting on either quarrying or landfill activities.

The north valley has an estimated 1,800,000 m^3 of material suitable for quarrying, while the west valley has 2,800,000 m^3. The materials found would be suitable for aggregates, concrete, road base and road sub-base.

The DECC requires any new landfill cell to be lined with a synthetic or natural clay liner to minimise the risk of adverse environmental impacts, that is, contamination of groundwater and surface water, and control landfill gas. A high plasticity clay was found on the site which may be suitable to use as the landfill cap or liner, as the testing showed a permeability of $10^{-6m/s}$ while the Environmental Guidelines for Solid Waste Landfills[19] requires $10^{-9m/s}$.

The current design allows for quarrying and landfilling activities to occur concurrently on the site. It is proposed that landfilling activities will follow the quarrying in the north and the west valleys and, as recommended by this report, that the quarrying activities occur in the north valley first.

Two central leachate collection ponds are proposed with leachate collection lines located at 50-metre spacings. A sedimentation pond will be located adjacent to the Link Road to collect runoff from the roadways, active quarry areas and landfill areas. Refer to the diagram below for more detail.

The sedimentation ponds for the northern area would require a surface area of 1,850 m^3 to a depth of 2.7 metres, while the southern amphitheatre would have a surface area of 2,980 m^3 and 2.6 metres in depth. It is suggested that these ponds, once quarrying and landfill operations cease, could be rehabilitated and form water features as part of the Tweed Botanical Gardens.

If the new cell is not constructed for several years, it is likely that the current design documentation may need to be reviewed and updated.

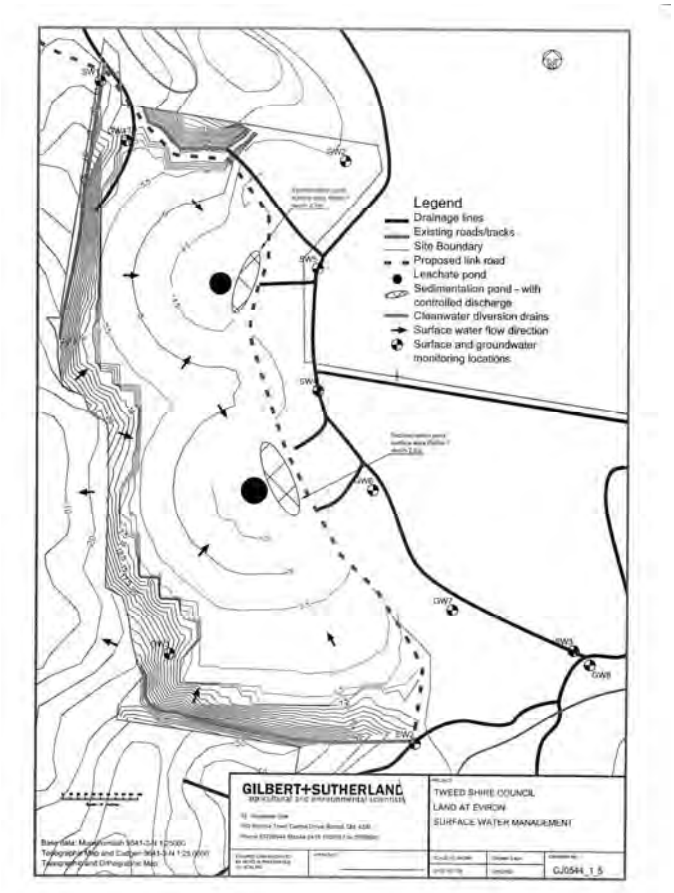


Figure 33 - Surface Water Management

[19] NSW EPA (1996) Environmental Guidelines; Solid Waste Landfills.nsw.epa.

13.2 Alternative Opportunities – Export to Existing Landfills

In preparing this report, the consultants met with representatives of both Thiess Services and Veolia Environmental Services (formerly Collex). Both companies own and operate large fully engineered landfills in the South East corner of Queensland and both can provide transport and disposal solutions.

Thiess operates a fully engineered landfill at Swanbank near Ipswich in South East Queensland with a 40-year capacity, and can offer a long-term contract for transport and disposal at around $55 per tonne, based on gate fee of $25–$30 per tonne, plus transport at $25 per tonne.

Veolia Environmental Services operates, in partnership with JJ Richards, the Ti-Tree Bio-energy Landfill Facility at Willowbank, located west of Ipswich. Veolia indicated that transport in 110-m^3 walking-floor transfer trailers would cost around $35 per tonne plus a gate fee of $25, and the company is willing to commit to a long-term contract.

Recommendation

35 That concurrently with developing plans for the local landfill, Council reviews other long-term disposal options for the Shire's waste as identified in the Strategy having regard to transport and disposal costs, method and number of vehicle movements to accurately assess traffic impact.

13.3 Alternative Opportunities – Export to New Landfill

In addition to exploring disposal options and the associated costs with both Thiess and Veolia Environmental for Tweed's residual waste streams, Council should approach Gold Coast City Council and explore the options in relation to the joint development of the Reedy Creek site or long-term use of the facility.

13.4 Alternative Waste Technologies Options and Opportunities

13.4.1 Background

In 1999 the Alternative Waste Management Technologies and Practices Inquiry was commissioned to inform decisions about future waste management infrastructure and practices in New South Wales. Its primary aim was to demystify waste management issues and inform Government, business and citizens about how improved practices and technologies might contribute to sustainable waste management.[20] Since the report's publication in 2000, it has assisted in facilitating debate about alternate ways of managing solid waste in Australia in the future.

The inquiry received more then 80 submissions from all sectors of the industry and found that an abundant array of technologies exist to increase recycling and to gain value from various parts of the waste stream, however no one technology offers a complete solution, rather, each system forms part of an integrated management system.[21]

[20] Report of the Alternative Waste Management Practices Inquiry, April 2000.
[21] Report of the Alternative Waste Management Practices Inquiry, April 2000.

Alternative Waste Technologies are categorised as follows;

1. Mechanical Separation Technologies – typically, materials sorting and waste separation processing.
2. Biological Treatment Technologies – typically open windrow composting, vermiculture, enclosed composting, anaerobic decomposition and fermentation.
3. Thermal Technologies – typically incineration, pyrolysis/gasification and plasma destruction
4. Landfill Technologies – typically conventional wet or dry landfills, bioreactors.

All four technologies are operating in Australia, however, Thermal Technologies are only applied to material specific streams such as those in disposing of hazardous wastes or organic only wastes, that is, using green waste or sugar-cane wastes to create steam generation for on-site power generation processes. There have been several attempts to commercialise thermal technologies for the processing of mixed residual waste in Australia, Brightstar's SWERF in NSW and the TEST incineration plant in Tasmania being the most notable.

Both projects were terminated due to high cost, technical or community-related issues. Thermal processing of bagasse (a by-product from the sugar-making process), and also the processing of single-type organic wastes such as timber or green organics in co-firing boiler applications is occurring in limited applications, that is, Visy's Tumut Paper Mill, however, these are still emerging technologies in Australia and not considered applicable for general mixed waste stream materials at this stage.

13.5 Mechanical Separation Technologies

13.5.1 Materials Recycling Facilities (MRFs)

Typically these technologies focus on various means of mechanical sorting of materials and are commonly referred to as Materials Recycling or Recovery Facilities. The facilities typically separate commingled dry recyclables by the use of mechanical sorting techniques. MRFs may be constructed using high or low technology, depending upon throughput, investments and sophistication of the plant and equipment.

MRFs typically employ a system of conveyors which carry the recyclables over sorting screens and trommels, inclined tables and air classifiers that divide the components by heavy and light fractions. The recyclables then pass over magnetic and eddy current separators and may also incorporate advanced optical recognition equipment which separate out different types of plastics or glass by polymer or colour. There will also typically be a significant component of manual sorting. Balers are used to compress the recyclate for transport to secondary reuse markets, either locally or overseas.

There will always be some materials referred to as contamination, which are disposed of to landfill as waste from the process.

13.5.2 Wet or Dirty Materials Recovery Facilities

Wet or Dirty Materials Recovery Facilities (W/DMRF) are fully enclosed facilities that combine a number of screening and sorting techniques to divide residual municipal and commercial wastes into the recoverable and non-recoverable components. These facilities may act as a pre-sort for an organics or other downstream treatment process.

A W/DMRF employs conveyor systems, bag splitters, screens or trommels that divide the waste into different size fractions with magnets, and eddy current separators recovering the metals. Handpicking or other sorting techniques such as air classifiers divide the waste stream although the trend is towards mechanisation of the entire process to eliminate human contact with waste, that is, the BaxVis plant in Melbourne.

The process does not recover recyclates of the same quality as produced from a dry MRF due to the contamination from putrescible and other organic wastes, and markets offer heavily discounted values on the purchase price of the commodity from these facilities.

Dirty MRFs will typically recover around 10–15% of material as recyclables and the remainder would either require further processing or disposal to landfill.

13.6 Mechanical Biological Treatment Technologies

The Mechanical Biological Treatment (MBT) concept for waste processing evolved in Germany as a response to a strong desire to reduce the quantity of biodegradable waste sent to landfill, and to increase the potential recovery of resources.

MBT inherently incorporates two core stages: mechanical treatment and biological treatment. The different elements of the process can be configured in various ways to meet a wide range of specific objectives:

- to maximise resource recovery
- to produce a compost
- to produce a soil conditioner
- to produce a bio-stabilised material for landfilling
- to produce a bio-gas for heat and/or power generation
- to produce a good quality solid fuel.

MBT processes mixed household waste and other organic waste streams by mechanically removing some parts of the waste and by biologically treating others, so that the residual fraction is smaller, more stable and more suitable for a number of uses.[22] It typically involves one of the two types of waste processing of the organic streams, being either aerobic decomposition or anaerobic decomposition. The choice

[22] Juniper Consultancy Services Ltd 2005.

of the biological element is intrinsically linked to the desired output of the MBT process itself.[23] The process can involve some or all of the following elements:

Table 63 - MBT Process Summary

Process	Possible Process Elements						
Mechanical	Trommel	Screen (static or vibrating)	Magnets	Eddy current	Hand-picking	Air classification	Infrared/optical sorters
Biological	Open windrow composting	In-hall composting	Tunnel composting	In-vessel composting	Anaerobic digestion	Percolation	Bio-drying

13.6.1 Aerobic Decomposition

Aerobic decomposition involves the decomposition of organics by microbial activity under aerobic (in the presence of oxygen) conditions to produce stable organic materials while maintaining core plant nutrients in its outputs. Typically this type of process is used in composting and other similar organic production. The quality of the output is totally dependent on the quality of the feedstock. The process produces a moderately high-quality soil conditioner or mulch which has a variety of market uses.[24] Pre-treatment or sorting of the feedstock is an important component of the process. Typically used in composting in open windrows, aerated static piles, that is, Cleanaway's Gore process, and drum systems, that is, Bedminster and Dano and Conporec processes.

13.6.2 Anaerobic Decomposition

Anaerobic DEComposition (in the absence of oxygen) involves microbial activity being used in a reactor. This process is well established in the water industry to stabilise bio-solids as a part of the processing phase. Methane rich gas is produced suitable for use in energy generation. Input preparation or source-separation is required to ensure that waste is free of non-organic contamination.[25]

Anaerobic processes are usually very sensitive to exposure from contaminants and wastes such as those generated by residual battery and other toxic materials. These wastes significantly hamper real anaerobic processes due to the impact these toxins have on microbial colonies.

Contamination by inorganic materials or the levels of these in input feedstocks directly affect the quality of the processed outputs. A digestate sludge is produced which is suitable for enriching compost materials. Typically the outputs are used for soil enhancement and other fertiliser applications, thus it is critical that any anaerobic processes have reliable pre-sort and treatment processes in place.[26]

13.7 Landfill Technologies

Three are three options for landfilling of wastes:

[23] Juniper Consultancy Services Ltd 2005.
[24] Maunsell AECOM SEQROC Report 2002.
[25] Report of the Alternative Waste Management Practices Inquiry, April 2000.
[26] Maunsell AECOM SEQROC Report, 2002.

1. conventional wet landfill
2. conventional dry facility
3. bio-reactor

13.7.1 Wet Landfill

This is a mature technology that is used to facilitate waste decomposition in a controlled way. As the process of bio-degradation takes place, methane and carbon dioxide are released, and at most facilities across Australia this is captured by way of landfill gas extraction and the gas used for energy generation. Where gas production is not of either the correct calorific value and/or volume for power generation, it is flared on-site to mitigate harmful greenhouse gas resulting from the release of raw gas itself.

13.7.2 Dry landfill

These are found typically in low precipitation climates, where rainfall is low and thus the wastes disposed are not heavily impacted upon by moisture, or they are facilities that are engineered to accept low putrescible or inert (usually less than 5% moisture by volume) wastes, typically construction and demolition wastes and selected commercial and industrial wastes and totally inert materials.

13.7.3 Bio-reactor

This has been developed by Veolia in France; these landfills are engineered to accelerate the rate of decomposition and thus increase gas generation. These landfills accept all waste streams and particularly attract sludges, municipal and other high organic specific streams. They accelerate decomposition by circulating microbial-rich leachate and in some cases particularly liquid sewerage wastes. The process aims to improve gas and power generation and reduces the time to stabilise the resource. This technology is now established as a viable alternative to traditional landfill management and usually substantially lower gate fees are charged than for MBT processes, for example, Ti-Tree Bio-Energy Landfill Facility at Willowbank, located west of Ipswich.

13.8. AWT in Australia

Pivotal to all AWT processes and opportunities are several core underlying principles. These are that all AWT options require:

- significant investment decisions
- available feedstock ,
- local markets and application of outputs

Current technology options fall into two categories:

1. commercially proven and operating businesses.
2. technologies still under development

13.8.1 Commercialised Technologies

13.8.1.1. Global Renewables Ltd.

Global Renewables has commercialised the UR-3R process at Eastern Creek in Sydney's west. The UR-3R process integrates four technologies, being;

- An advanced dirty MRF
- ISKA percolation from Italy
- Composting halls
- On-site power generation.



Figure 34 - UR-3R Facility

The facility is designed to process MSW collected from kerbside refuse bins, recover some recyclables and reprocess the organics into compost. The bio-gas generated during the anaerobic bio-digestation phase is captured and used to fuel on-site power generators. All surplus energy is exported and sold into the grid as green power.

The facility charges a gate fee for all refuse delivered to it, currently set at $130.00 per tonne of refuse. Its design was to process up to 175,000 tonnes of refuse per year and it is currently operating at its limit.

13.8.1.2 Tryton Vermiculture

Located at Lismore City Council's Wyrallah Road Landfill, the Tryton Group operates one of the largest worm farms in the world processing organic waste streams into a range of value-added fertilisers and bio-organic soil enhancers.

The Tryon facility was built in 2001 and is designed to process mixed organic streams including food wastes, which are fed into a process using more than 100 tonnes of worms (representing approximately 21 million). The plant has the capability of processing 4,000 tonnes of kerbside collected organics and 3,000 tonnes of self-hauled shredded green wastes per year.

The company markets a range of organic products under the Virotec brand. Organic liquid and solid fertilisers as well as soil enhancers are sold to commercial growers of macadamia nuts, soy beans and bananas, as well as for general application in the agricultural sector.

The most significant hurdle the operators have had to overcome in developing the technology has been in gaining strong commercial sales for the outputs. Gate fees are estimated at $45.00 per tonne for the kerbside organics and $40.00 for the shredded green waste. Residual wastes are disposed of at $85.00 per tonne. Tryton has been unable to secure further contracts with regard to the vermiculture process, outside the 20-year agreement with Lismore.

13.8.1.3 SITA/CEC Group (ex Bedminster Operations)

In August 2006, Sita Environmental Solutions and the CEC Group based in Cairns formed a joint venture and purchased the assets of the Bedminster facility from Cairns City Council. The joint venture has invested more than $15 million in rebuilding the plant and has now redesigned and rebuilt the front end and vessel units. As a result of its success in recommissioning the plant, the joint venture has now purchased all of the Australian Bedminster technology and its troubled operations and will be remarketing the concept under the new MBT process.

On current design criteria, the process requires a minimum of 60,000 tonnes of both domestic and commercial and industrial wastes with a gate fee of at least $85 per tonne to be successful. The outputs of the plant are both recyclables from the front end as well as compost and soil conditioners from the organics. It requires some residues being returned to landfill.



Figure 35 - Bedminster Facility

Other processes using the same technology are located at Port Stephens in NSW and Canning Vale in Perth. The Perth was closed by the regulator in December 2006 due to odour issues.

13.8.1.4 Remondis Residuals Processing

Hastings Council has contracted Remondis to design, build and operate the Organics Resource Recovery Facility (ORRF) for a 20-year contract. The facility includes two key components:



Figure 36 - ORRF

1. In-vessel Composting Facility – processes 17,000 tonnes of food, garden waste from domestic premises and 3,000 tonnes of self-hauled garden waste and 6,000 tonnes of bio-solids received.

2. Residuals Processing Plant – processing 20,000 tones of mixed household waste from the kerbside collection program. The material is tipped onto the floor where it is screened, and any contaminants likely to impede the process are removed. The material is shredded and screened, metals are removed by magnetic head and eddy current and account for approximately 5% of inputs and organics between 10–20%. The material is then placed on an aerated floor for drying and stabilisation. The processed materials are then suitable as either cover material at landfill disposal to a Class 1 landfill. No greenhouse gas is generated and only minor leachate. The gate price for this process is between $40–50 per tonne.

13.8.1.5 Ti-Tree Gully Bio-reactor Landfill

Developed by two of Australia's major waste management companies, Veolia Environmental Services (formerly Collex) and JJ Richards, in 2004, the Ti Tree BioEnergy facility located west of Ipswich is the latest in new developments in landfill disposal.

The fully engineered and environmentally contained facility is located in a disused mine. The facility uses a process of recirculating leachate to feed the microbial colonies it inoculates the leachate with. By pumping this into a network of pipes positioned in the waste, it rapidly starts the decomposition process, stabilises the waste and increases methane generation. The gas is captured and currently flared, and once the facility reaches commercial gas production, it will be used for energy production and sale to the grid.

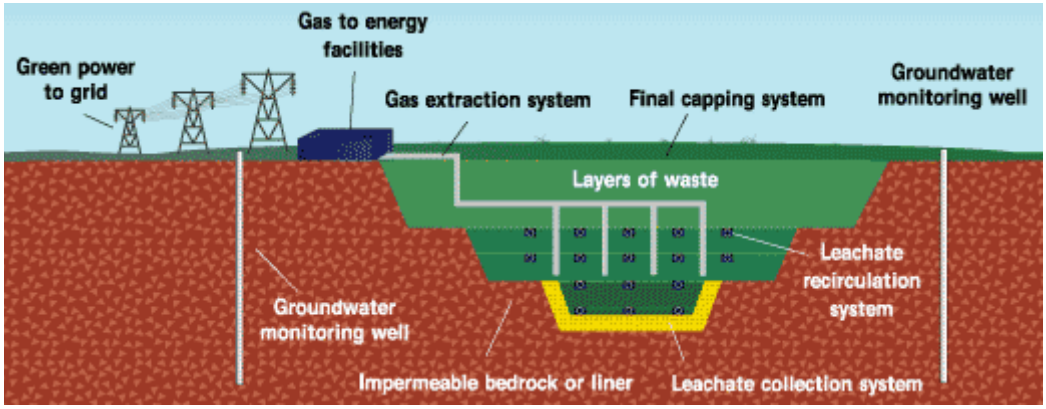


Figure 37 - How the Bioreactor Works

The current capacity is designed to accept 400,000 tonnes per year of waste, from the South Eastern Corner of Queensland, with an operating life in excess of 35 years. Gate fees applicable to using this facility have been advised as being $25 per tonne.[27]

13.8.2 Commercially Unproven Technologies

13.8.2.1 AnaeCo Limited (ex Organic Resource Technologies)

The company has patented the DICOM MBT process, being a hybrid biological system that integrates both an aerobic and anaerobic in-vessel solid waste process. It has evolved from previous MBT processes, but has been developed by Australian expertise using Australian waste to achieve its technical capability.

This is a significant breakthrough, as all current MBT processes operating in Australia have originated from either Europe or Canada and there are differences in Australia's waste composition from those countries, so current operating facilities have undergone fundamental change, to become operational.

Australia's first DICOM plant is expected to be processing 50,000 tonnes of domestic waste by the end of 2007, in Perth. The facility has been designed to be located at an

[27] C Hines, Veolia, confirmation e-mail advice, November 2006.

existing transfer station located in the centre of the metropolitan area. Estimated gate fees have been set at $60–$70, inclusive of residual material disposal costs.[28]

13.8.2.2 Biomass Solutions

The Coffs Coast region, comprising Coffs Harbour, Bellingen, and Nambucca Heads Councils, has entered into a 20-year $125 million contract with Biomass Solutions (Coffs Harbour) Pty Ltd to develop an AWT MBT process operation at the Coffs Harbour England Road Landfill and Transfer Station site. The objective is to achieve a waste diversion target of 85% reduction to landfill over the project term. The site includes:

- Enclosed LMC composting and agitation bays for the compost from the kerbside organics fraction including vegetation and food waste
- Mixed residual waste processing system using autoclave technology, that produces a refuse derived fuel for use by local sugar mills
- Traditional MRF for processing commingled recyclables.

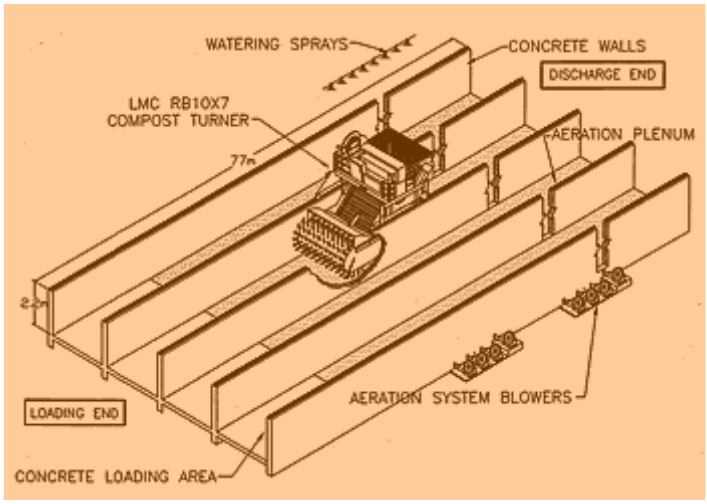


Figure 38 - LMC System

LCM composting reactors are long concrete channels or bays with an aerated floor with a blower per zone that is controlled based on temperature readings from sensors for each zone in the bays. Rails on top of the walls are for the compost turner to run along to mix, aerate and move the compost mix towards the discharge end with each pass.

Typically, the compost turning machine makes one pass per day through each bay. This creates loading space at the feed end of the channels for additional feedstock. Finished compost is discharged out the end of the bays with each pass.

The facility will start processing 56,000 tonnes per year in year one, increasing to 90,000 tonnes in year 20. Domestic waste management charges will be increased in 2007 from the 2004 base year when the contract was awarded by 15%, from $242 to $284 per household, inclusive of new bins, collection and disposal, plus two bulk collections annually. Indicative gate fees for disposal by 2007–08 for general refuse will be $90.00 per tonne and $66.00 per tonne for organics.

13.8.2.3 WSN – Ecolibrium Technology

WSN Environmental Solutions (formerly Waste Services New South Wales) was awarded a 15-year contract to convert the Jacks Gully Waste and Recycling Centre into the Macarthur Resource Recovery Park, a fully integrated waste processing facility, capable of handling all waste streams collected by Camden, Campbelltown,

[28] M Gravett AnaeCo, DECCember 2006.

Wollondilly and Wingecarribee Councils. In December 2005, WSN was awarded the contract based on using the Ecolibrium Mixed Waste Processing Facility and the Ecolibrium Organics Facility. The Facility includes:

- Mixed Waste Facility (using the Arrow Technology from Israel) designed to process up to 90,000 tonnes of household waste per year
- fully enclosed tunnel composting system – 30,000 tonnes per year
- Materials Recycling Facility – 30,000 tonnes
- resident drop-off centre for small quantities of putrescible and green waste, recyclables and domestic hazardous materials
- landfill for non-putrescible waste.[29]

Gate fees are estimated to be > $120.00 per tonne.

[29] WSN, DECCember 2006.

14. COMMUNITY CONSULTATION

Community consultation is imperative as part of the development of any strategic document which will involve the community and require a modification or possible change of behaviour. Any community consultation program should aim to meet the following objectives:

- Maximise community awareness of the process
- Educate the community about the issues
- Advise the community on the outcomes of the consultation process.

Successful public consultation provides the participants with the necessary facts and information to make informed decisions. When selling the benefits of any new approach it is important to frame the possible options and relative costs of any new service against the broader social, economic and environmental benefits that can be realised. It is important to move beyond the narrow focus of fees and charges to successfully capture the hearts and minds of the community.

A community consultation program was developed in partnership with council staff. Council is to consider the findings of this report of the feedback received which is deemed to reflect the opinions of the community in regard to the draft Waste Strategy.

Based on this report Council staff and their consultants will then discuss and determine any changes or amendments to the draft Domestic Waste Management Strategy so that it can be approved by Council.

This section contains the findings of the community consultation program and stakeholder feedback.

14.1 Method

It was agreed between the consultants and Council officers that the community should be consulted as widely as possible using a combination of methods to determine community opinion. A multi-pronged consultation program was developed which offered a variety of forums and venues to engage with and to capture the widest range of responses from the community as possible. These elements included:

1. Promotion of the Draft Waste Strategy in the Tweed Link publication which is delivered to all residents each week.
2. Preparation of a community consultation document summarising the eleven key recommendations was made available upon request
3. The Executive Summary of the draft Waste Strategy was made available upon request from Council offices Council's website contained items 2 – 3 above
4. The Tweed Link advertisement and editorial seeking feedback on strategy
5. An opportunity to meet or talk with the consultants was provided the week of 5th March
6. An personal invitation was extended to every Progress Association to meet with the consultants and council staff or for them to attend a meeting

7. A meeting was held with representatives of one progress Association while presentations were made to three Associations
8. A briefing was offered and provided to the current waste management contractor, Solo Resource Recovery, as a key stakeholders

Below is a summary of the Community Consultation Methods.

14.1.1 Summary Document

The three page summary document or overview was developed by the consultants, approved by Council and both printed and posted on Council's web site. The document included key findings including market research and waste audit results and listed eleven key recommendations. A copy is provided at *Appendix 5.*

14.1.2 Executive Summary from Waste Strategy

Due to the complexity of the strategy, length of report and the "commercial in-confidence" information obtained Council and the consultants determined that the Executive Summary would be available upon request from Council Offices and posted on the web site. This eight page summary sought to explore the issues in greater detail then the summary document. A copy of this document is provided in *Appendix 6.*

14.1.3 Notification to the community

The Tweed Link was used as the method to reach the community given it is delivered to every household every week. Advertisements were place in edition 504 and 505 seeking feedback on the strategy recommendations. A copy of both advertisements is provided in *Appendix* 7.

14.1.4 Progress Association Meetings

Council forwarded correspondence by letter, fax or email to all Progress Associations offering them the opportunity for Council staff and the consultants to attend and present at a meeting or to meet with the Executive or their members at a mutually convenient time. A copy of the letter is provided in *Appendix 8.*

Three Associations took up this opportunity:

- Monday 5th March - Kingscliff Ratepayers and Progress Association Inc.
- Tuesday 6th March Uki District and Resident Association - 9 Attendees
- Monday 19th March Murwillumbah Ratepayers and Residents Association Representatives

A summary of those meeting and the issues raised are provided below.

The meetings on the 5 and 6th March, 2007 were facilitated by Anne Prince who summarised the background, methodology and key recommendations of the draft Waste Management Strategy. The forums were interactive and attended by Council Officer's Ian Percy or Adam Faulkner to hear the issues, concerns and opinions of the community at all meetings.

14.1.4.1 Kingscliff Ratepayers and Progress Association Inc.

Monday 5th March, 2007, 8.15 pm Kingscliff Public School Library. Presentation by Anne Prince and Adam Faulkner-18 people attended this meeting. Extract of meeting minutes below:

Waste Management Strategy: Presentation by Anne Prince – Director APC and Adam Faulkner, TSC. Anne distributed the market research summary and spoke to the document. Discussion included the following questions:

- *Will there be a loss of jobs?*
- *Will there be any relocation of staff?*
- *Can some of the waste be used a gully fill?*
- *What volume could be sent to Queensland?*
- *Is it possible to have extra bins for holiday periods especially in the tourist areas?*
- *The sugar mill is using co-generation. Can the waste be used as well?*
- *What rewards could be possible for those who "recycle right" or for minimum waste?*
- *Is it possible to have a 4 bin system as is used in other parts of the world*
- *e.g.plastic, cans, paper, rubbish at all the public areas.*
- *It is not necessary to "hide" the bins – celebrate them.*
- *Schools need the 4 bin system and tangible returns for successful sorting.*
- *Is the Ipswich Road site up to the task?*
- *We need to keep the re-cycle shop.*
- *Re: the twice yearly council pick-up: Will it continue? Has consideration been given to allowing people to request a skip instead? How will computer waste be dealt with?*

Standing orders resumed: Further statement: The current council kerbside pick-ups had support as, although unsightly, it allowed a lot of local recycling to occur prior to the pick-up and that activity was seen a positive.

*The meeting felt that the presentation was very informative and appreciated the opportunity to have Anne and Adam as guest speaker*s.

14.1.4.2 Uki District and Resident Association

Tuesday 6th March, 2007 -7.30 Pm at Uki Community Hall. A Presentation by Anne Prince and Ian Percy was made to the 9 committee representatives. Key Issues discussed:

- opportunities for schools to recycle
- the type of plastics which are able to be recycled
- whether containers needed to be washed prior to placed in bins
- the separation of hard waste for bulky waste collections
- Could a transfer station be built at Murwillumbah landfill if it is closed

14.1.4.3 Murwillumbah Ratepayers and Residents Association Representatives

19th March, 2007. Meeting attended by Adam Faulkner who addressed the recommendations and answered questions for approximately one hour. Residents raised many issues including:

- 240L fortnightly recycling is same yield as current arrangement of 120L weekly. Mr Faulkner responded by saying that the advantages in the system were the decreases observed in contamination, due to the shape and size of 240L allows for increased volumes of product to be diverted from waste etc.
- Council should be composting food scraps i.e. Tryton worm farm, Regenisis, household worm farms. The response was that Council have identified this requires further investigation in the strategy, and that the Tryton worm farm is experiencing problems and that Council has had talks with Regenisis. In the interim of any decision being made, Council offer cost price worm farms/compost bins to residents interested in taking up the option.
- David Stratton from Regenisis was invited to address group by the Secretary, and spoke of their commercial food scrap collection program in Byron Bay, he appreciated Council's efforts in trying to amend the Stotts licence to allow composting to occur on site and noted that the NSW DEC were stalling progress not Council
- Mr Ken Forster of Solo Resource Recovery was present at the meeting and advised that tendering with Gold Coast will encourage multi-nationals companies to tender and service performance will decrease, they are unlikely to travel out to Tyalgum to collect missed service, and that TSC may be bullied by big brother (GCCC), Tweed should keep waste in its own backyard as it may be $26 per tonne at Ipswich today but increases can occur overnight. Council discussed these points generally with the group and advised that the contract expiry timing merely provides an opportunity to engage in talks with GCCC.
- Pollution and pressure on road network from hauling to QLD. Council discussed better environmental outcomes were achievable from world-class landfills across the Qld border.

14.1.5 Stakeholder Engagement

A meeting was arranged by Council with the current waste management contractor – Solo Resource Recovery to meet with council and the consultants prior to the commencement of the community consultation program. The purpose of this meeting was to discuss directly and gauge feedback on the reasoning and rationale behind the Consultants recommendations and to enter into meaningful discussions. This meeting was held on Friday the 2nd March at Council offices with Adam Faulkner and Ian Percy present along with the principle consultants Anne Prince and Rick Ralph.

14.1.6 Community Interaction

14.1.6.1 Phone Calls - Five phone calls were received by Council and two phone calls were received by the consultant who advised the callers that all comments should be in writing. Callers included:

- Mr Warren James – 07 55 999 659 – indicated that he had spoken to Geneieve Slattery on a number of occasions in 2006 and also had written a letter to the paper regarding Solo trucks mixing recyclables with waste. He was pleased that council had listened to his outcry and were now taking professional action.
- David Stratton – Regensis 0427 665 393 –left a message and the consultants have been unsuccessful in making contact

14.1.6.2 Caldera Environment Centre - The consultant delivered a community consultation brochure to the Centre

14.1.6.3 Resident Interaction - As the consultant stayed in the area she met with several local residents who sought info on whether long life milk containers were recyclable, recycling of batteries, bin allocation on MO's and recycling opportunities at schools.

14.2 Community Feedback

Written responses were requested from the community to allow Council and the consultants to consider their views in refining the draft Waste Strategy. Potential respondents were requested to submit comments by Friday 30th March, 2007 by post, fax or email. A summary of all responses is provided on the following pages.

14.2.1 Community Submission Summary

In total nineteen email responses and four letters, two from community members and two from Progress Associations were received. The full text of the email responses is provided in *Appendix 9* and a copy of the letters is provided in A*ppendix 10.* A summary of the community feedback is provided below:

14.2.1.1 Uki Village and District Residents Association - 30th March, 2007

- Commend Council on the key recommendations
- The proposed community education program is essential
- Need incentives to encourage residents to reduce waste
- Demand for organic material and compost locally
- Council should exploit to have organic waste processed locally prior to entering into agreements with Gold Coast

14.2.1.2 Peter Harding at Pottsville - 30th March, 2007 via Diane Rowles

- Shire wide education program should be undertaken prior to new multi bin system

14.2.1.3 Sandra Grayson - 29th March, 2007

- Need education and enforcement to reduce contamination
- Seeks to have uncovered crate style containers
- Offer free or cheap worm farms
- Education of school age children is imperative
- School visits to recycling depots should be organised

14.2.1.4 Julia Newsome - Banora Point 21st March, 2007

- Supports fortnightly recycling collection
- Weekly collection of rubbish OK

- Needs optional additional garden organics bins
- Would rather no change to current bins or collection

14.2.1.5 Thali Bower/Williams - 19th March, 2007

- If goal is to reduce waste by 66% how will 280 litres of rubbish and 240 litres of recycling achieve the goal.
- More space available the more people find something to put in it
- Need to supply 66% of recycling capacity and 34% rubbish capacity
- Rubbish / recycling bin picked up fortnightly at a lower cost than a weekly rubbish / recycling bin – differentiate by colour
- Need to reward correct activity and provide incentives
- Garden organics bin should be "optional"
- Town residents should be encouraged to compost
- Consider having a bi-annual chipper service to process cuttings and prunings on site and leave with residents
- Bi-annual bulky waste collection should be once per year

14.2.1.6 Kelly Tyrrell - Tweed Heads - 7th March

- Weekly recycling

14.2.1.7 Michael Dodd - 7th March, 2007

- Don't wait for to current contract to expire 2009, void contract or re-negotiate
- Need a 240 litre waste and separate recycling bin

14.2.1.8 Megan Hancock - Southern Cross University - 8th March, 2007

- Strategy is excellent – long overdue, completely support

14.2.1.9 Ian and Les Brookes - Banora Point - 8th March, 2007

- Support recommendations – 1, 2, 3, 9, and 11 i.e. separate recycling bins, 140 litre rubbish bin, garden waste bin, differential landfill charges and exploring other landfill options.

14.2.1.10 Wendy Fulford - 9th March, 2007

- Green waste should be collected every week
- Problems accessing document on Tweedlink website

14.2.1.11 Barbara Deece - Banora Point - 9th March, 2007

- Divided bin is hopeless
- Recommendations for waste collection and disposal vast improvement
- Three bin system worked well in suburb in Sydney

14.2.1.12 Rob and Julie Watkins - 13th March, 2007

- Gosford Council offer urban residents with a garden organics bin, 3 bulk collections per year, must be booked in advance, must not be placed out until day prior to the collection or issued a $200 on-the-spot fine.
- Love their green waste bins and a wait with relish for their recycling bins
- More education required.

14.2.1.13 Bronwyn Trathen – Murwillumbah – 14th March, 2007

- Clean Ups **-i**nstead of two per year, rate payers should be given 2 vouchers to take their own rubbish to the tip

14.2.1.14 Jaatro Skam – Mount Burrell - 15th March, 2007

- This couple come from the Netherlands set up a Used Battery Recovery Program that spread to all supermarkets - a battery bin was provided near the retail point and old batteries taken back, stored, emptied into a special drum for collection. Tweed should lead the way in used batteries.

14.2.1.15 Margaret Poole – Tweed Heads South - 14th March, 2007

- Wants two bins – rubbish and recycling
- Most people mix up material in both sides

14.2.1.16 Jan Bidstrup - 15th March, 2007

- Wants dedicated rubbish and recycling bins, used this system in Townsville and worked well
- Current system useless as recycling compartment not large enough

14.2.1.17 Lorraine Atkinson - Banora Point - Wednesday 14th March, 2007

- Education is vital. Seen Ads on Gold Coast TV re how to separate and recycle correctly.
- Need to sticker bins where lids aren't closed correctly
- Need education about take the plastic lids off and squash plastic bottles
- Passionate about "responsible recycling"
- Happy with the current arrangements with the bin size and green bins fortnightly

14.2.1.18 Gordon Davidson – Friday 16th March, 2007

- He would like division : rubbish 70% and recycling 30%
- They put rubbish in the recycling because they don't have enough room and wants a twice per week pick up

14.2.1.19 Neville Chivers – Kingscliff

- Would like to know what extra costs to rate payers these recommendations would occur.
- He is happy to stay with the status Quo
- Does not want a garden waste bin - considers it an imposition to pay for services, not required as one size does not fit all
- Extra services should only be offered to those who register and pay for it

14.2.1.20 Richard Hann – Murwillumbah

- Satisfied with the one divided bin and has no need for a garden waste bin.
- Objects to having three bins and the additional cost
- Considers the community consultation process flawed based on the 215 resident surveys
- Principal of user pays and choice have been abandon
- Residents should be able to elect what division they seek in their bins and garbage trucks adapted to suit

- Garden waste bins are not large enough for trees and shrubs, only the small leaf litter, all of which can be composted as can food waste
- New garden waste service unnecessary
- Criticism of the quality of the council's mulch
- Residents will use the new garden waste bins as a defacto garbage bin
- Greatest public cooperation will be achieved if residents are offered the flexibility in service delivery
- Council should keep resources and expertise in the Tweed and the Gold Coast option is undesirable
- Trucking waste to Ipswich should be an option of last resort.
- The NSW Government needs to pursue measures to reduce the waste entering households
- Murwillumbah landfill should be made into a transfer station
- There should be additional collection points around the Shire particularly for bulky waste and the current bulky household waste collection is good but should be expanded to include bulk garden waste

14.2.1.21 Banora Point and District Residents Association

- They oppose the amalgamation with Gold Coast for the purpose of waste disposal as they will only be a minor partner and could in future become a dumping ground for the regions waste due to our smaller population and undeveloped land - Tweed should remain independent
- They oppose the increase in the number of bins and believe that the current divided bin is sufficient
- The green waste bin is a good initiative, those that want it, have it.
- Potential problems is storage of extra bins
- They oppose the extra charges for different size bins for recycling or general waste
- The present system is satisfactory
- Bi-annual clean ups – dissatisfaction with the length time between when householders place the material on the kerb and when it is collected, becomes unsightly and dangerous, suggest an on-request system at a small cost as was the previous council system.

14.2.1.22 Murwillumbah Ratepayers and Residents Association

- Supports separate bins for recycling and rubbish
- Does not support the co-tendering with Gold Coast Council for a waste management contract as a larger council will call the shots, we need to keep control of our own waste and two councils in different states will have two different sets of state laws, service levels may deteriorate with a multi national waste operator, the shire is rapidly growing, 10,000 households in the next 10 years and Gold Coast have a totally different philosophy and approach to waste management than Tweed
- Rule out transport organic waste to Ipswich and recycle to Carrara given the potential greenhouse gas emissions.
- Local composting has been brushed aside as too difficult and too expensive.
- Regenisis Organic Farm are in discussion with Solo Resource Recovery regarding a commercial collection of food waste for composting at Stotts Creek and they are

confident that the EPA requirements can be met. To set up at Stotts Creek Regenisis would need 8 acres of land and capital investment
- Targets will only be met if organic waste is reduced from landfill as it represents 50%.
- Weeds can be turned into compost with weed seed kill during process
- Seek to encourage households to continue to compost their own waste, by providing affordable compost bins and worm farms and should provide a Bokoshi Bin as an option
- Suggest offering vouchers to householders to defray the cost of more expensive options

14.3 Feedback Summary

The table below summaries the community views relating to these key recommendations

Table 64 - Recommendations and Community Views

No.	Recommendation	Support	Oppose
	Rubbish, Recycling and Garden Waste Service		
1	**Recycling bin -** introduce a separate 240-litre bin collected fortnightly	Support x 8	• Want crate style containers to discourage contamination • Weekly recycling
2	**Rubbish bin -** "user pays" service, 140 litre bin is the standard service, 240 litre larger	• Support x 6	• Keep existing
3	**Garden waste bin -** 240-litre bin, fortnight collection, for single residential dwellings	• Need optional additional bins available	• Collection weekly • Does not require service • No need • Only those who need it pay for it • Encourage home composting
4	**Garden waste bin -** optional for medium-density and multiple-occupancy residential buildings	• Support x 4	
5	**Bulky household waste collection** – continue current	• Support • Include bulky garden waste	• 1 per year • Provide 2 vouchers for free tipping • Reintroduce on call at cost service
	Contracts		
6	**Collection Contract -** consider co-tendering with Gold Coast City Council		• GGCC has different philosophy, bigger, 2 sets state laws, service level will decrease, GGCC poor track record
7	**Sorting recyclables** - consider co-tendering with Gold Coast City Council		• Impact on GGH from truck movements
8	**Process organics** -investigate options locally and with Gold Coast City Council.		• Process locally x 2
	Landfill Charges		
9	**Introduce substantial differential landfill fees -**	• Support	

	sorted and unsorted loads		
	Education and Promotion		
10	Community wide education and information campaign	• Education prior to system introduction • Education and enforcement • Children a priority with depot visits • More education required • Vital	
	Landfill Options		
11	Council close the Murwillumbah operation. Centralize all activities at Stotts Creek. Council investigate South East Queensland's options	Support	• Murwillumbah landfill should be converted to Transfer Station. • Need to keep landfill and resources in Tweed and maintain independence • Waste to Qld should be option of last

14.3.1 Other community comments and suggestions

14.3.1.1 Status quo

- Stay with current bins and collection days x 2
- Quite happy with current arrangements for bin size and with green bin
- Wants to maintain status quo

14.3.1.2 Organics management

- Offer free or very cheap worm farms
- Provide vouchers to offset cost of Bokashi Bin
- Bi-annual chipper service for pruning and branches and leave wood chips for gardens
- Gosford Council offer three bulky garden organics services pa, must book in advance, only place on footpath day prior or $200 on spot fine
- Don't require green bin and would consider imposition to pay for services not required as one size does not fit all
- Why should residents who compost be compelled to use or pay for an unnecessary service
- Critical of council mulch quality
- Expect high levels of contamination in the garden waste service if rubbish bins too small

14.3.1.3 Smaller rubbish bins

- Have 66% recycle space and 34% rubbish space or won't meet target
- Bigger the bin human nature is we fill it
- Need or provide incentives – weekly collection more expensive then fortnightly collection
- Providing 280 litre rubbish and 240 litre recycling per fortnight won't meet targets

14.3.2.4 Bigger rubbish bins

- Go back to 70% rubbish and 30% recycling, not enough space for rubbish, put in recycling side

14.3.2.5 Contract

- Don't wait till 2009 – void the contract and renegotiate

14.3.2.6 Support

- Excellent strategy, long overdue , completely support
- Supports 3 bins system , vast improvement, worked well in Sydney

14.3.2.7 Batteries

- Council should establish a system for battery recovery at point of sale checkouts - lead the way

14.3.2.8 Education

- Gold Coast Council have TV ads on "how to" recycle
- Need to sticker bins if rubbish bin lids not closed prior to collection
- Need to educate to remove lids and squash plastic containers

14.3.2.9 Other

- Flawed community consult program
- Principle of "user pays" abandoned
- Public cooperation will be greatest if flexibility is offered

14.4 Stakeholder Feedback

Solo Resource Recovery submitted a detailed letter in response to our meeting and the consultation documents and Executive Summary. Where the community responded principally to the 11 key recommendations provided in the consult document Solo have responded to the more detailed Executive Summary and the entire recommendations. A summary of their views are expressed below and a full copy of their letter is provided at *Appendix 11* .

14.4.1 Letter received from Solo Resource Recovery 21st March, 2007

- Concerned regarding the survey findings and the accuracy and representation of these findings to that of the wider community. Example provided that whilst - the community advised many had full to overflowing bins, this is not the experience of the contractor
- While there is high support for a dedicated 240 litre bin a different result may have been achieved if the cost of the supplying service of the bin was provided.
- Solo support the three bin system proposed on the following basis:
  - the recycling service be extended to all tenements including seek C & I on a at-least fortnightly basis
  - the green organic service is extended to all residential tenements with the option service to the C & I tenements on a fortnightly basis.
  - that the garbage service be extended to all tenements including C & I on a weekly basis
  - that whilst council may propose separate MGB's for each waste stream, they should allow alternative options that meet the above criteria that may involve

the use of more fewer bins that provide other advantages of council in relation to reduced costs or other benefits.

Specific concerns and comments

1. Tender preparation period of 24 months

- Solo have interpreted that the tenders would close 24 months prior to commencement (*it is intended that work on the contract should commence with a six month period from awarding the contract to contract commencement.)*

2. Regional collection contract with Gold Coast

- The Tweed Council Contractor is large enough in its own right to achieve the critical mass and economies of scale required.
- That a contract with Gold Coast, but separate contract could result in a loss of control, reduction in service levels.
- The critical number to achieve an economy of scale is 20,000 tenements or greater. Tweed is currently 33,400 and rapid population growth is expected to continue
- The major cost components of a contract are collection and bin supply with one vehicle servicing 4,000 urban tenements. There is no reduction in the cost per service based on number of tenements. The only potential savings are in administration costs which accounts for 10% of the total collection contract value
- Large contracts attract industrial disputes and result in poorer service levels.
- Combining of contracts will potentially reduce the number of tenderers submitting tenders due to the capital intensive nature and larger contractors are out of the financial reach of smaller contractors, large multi national companies, majority of which are foreign owned will be the most likely tenderers.

3. MRF processing

- The draft strategy indicates several errors of fact regarding the Visy Carrara MRF. It is not the only MRF in Australia that has a glass refining operation attached, as Earth Care in Somersby processes material from Lake Macquarie, Cessnock, Maitland and Gosford and commenced operations five years prior to Visy Carrara.
- Not all glass fines are recovered from the Carrara MRF and thousands of tonnes are actually stockpiled at the Gold Coast Molendinar Landfill
- Glass fines processing technology is still in the developmental stages and there is no simplistic solutions
- Council should treat with caution the low indicative processing fees quoted by Visy at $10 - $15 per tonne as these are supported by record high paper prices which are currently double the average and can't be sustained in the longer term
- Visy are a dominate player in the recycling industry and have a track record of dishonouring written agreements when and as industry conditions change. For example Visy gave one months notice that glass fines would reduce from $30 – 0 for glass fines income.
- Concern over recommendation 16 relying on Visy and the MRF at Carerra
- Re compaction settings – should council maintain its own MRF that the collection contractor should specify maximum compaction setting of 180 kg/m^3, Solo, based on their experience as a MRF operator and collection contractor believe the maximum compaction should be 200 kg/m^3. Lower than this will increase

collection costs particularly in rural areas. There is negligible impact on the glass from increasing compaction from 180 to 200.

4. Landfill Options

- Council would lose its independence if it was to proceed into developing a regional landfill with Gold Coast City Council at Reidy Creek.
- Gold Coast Council prematurely closed a landfill at Molendinar due to poor town planning and the landfill site has not reached capacity and as a result a cost increase has been placed on all ratepayers as putrescible waste had to be transported to Staplyton.
- In relation to converting the MRF at Stotts Creek to transfer station, it is recommended that it be incorporated into the collection contract to maximise efficiency as a collection processing and disposal facility and allow tenderers to submit holistic and innovative proposals for all facets from collection to disposal
- If council enters into a disposal contract prior to the collection tender process it could restrict the options available to council and evaluating collection tenders.

5. Recycling Service

- The proposed recycling service should be extended to all C & I tenements who produce domestic recycled at offices and workshops and will simplify the recycling message to the entire population whether at home or work using the same system.
- One bin shared between two units is adequate.

6. Public Place Recycling

- Experience in other areas has shown in popular holiday coastal destinations, contamination of recyclables was very high.
- A comprehensive education program may mitigate this; however contamination rates are likely to be very high.

7. **Garden Waste Service**

- Proposed service to single dwellings and an optional service to medium density and MUD's Solo recommend recycling of garden organics to all residential tenements with the optional service to commercial and industrial. Experience shows one between three to be adequate for organics for MUD's.
- According to other councils where it has been delivered to all residential areas is experienced extremely effective in terms of reductions in waste to landfill.
- It provides economy to scale in relation to truck logistics, collection productivities and ensures the cost to council is on a per service basis is kept to a minimum.

9. Optional Garbage Bin Size

- Proposed service to offer a 140 litre as a standard with a 240 litre or 80 litre option experience shows that 140 litre bin with a 240 litre garden organics and 240 litres recycling bin are adequate.
- It is recommended that in lieu of a 240 litre bin for larger households that a second 140 litre be provided at a second garbage rate.
- Introducing additional bins sizes as to bin stock, administration change over and potential loss of collection vehicles, economies to scale and productivity.

In summary

- Little will be gained from joining forces with Gold Coast given Tweeds, low waste management costs and charges, the quality of service delivered to the ratepayers, the technological advancement introduced and the political instability of Gold Coast Council. Any tenderer would focus, because of the population balance on Gold Coast at the expensive to Tweed.
- Council should also ensure that it can seek alternate collection systems and proposals from tenderers.
- Council should not lock itself into waste, recycling or organics processing contracts prior to the collection contract, but rather combine processing options with the collection tender and seek innovative and cost effective proposals.

14.5 Issues For Consideration

14.5.1 Community Issues

The following concerns and opinions expressed by the community members are in the opinion of the consultants worthy of further consideration in the preparation of the final document include:

- Collection Contract - not in favour of co-tendering with Gold Coast City Council for collection or disposal options due to concerns relating to different council philosophies, experience, size , population base, state laws and service levels may decrease
- Close Murwillumbah – one submission suggested converting to transfer station
- Bulky garden waste service to be one of the bulky waste collections
- Bulky waste collection on footpath too long can only place on footpath the weekend prior to collection week or consider $200 on spot fine
- Need for incentives
- Need to tackle organics to achieve targets and process and keep compost locally

14.5.2 Stakeholder Issues

The following issues expressed by the stakeholder are in the opinion of the consultants worthy of consideration and inclusion in the final Waste Strategy.

- Reconsideration of co-tendering with Gold Coast Council
- Any extra bins should be of the 140 litre size not a 240 litre bin option to reduce bin stock, cost and administration
- Seek alternate system options from tenderers and not be overly prescriptive but specify outcomes desired at least cost
- Consider the timing of entering into processing and disposal contracts before collection contract awarded
- Provide waste and recycling and services to all tenements including the commercial and industrial sector.
- Provide garden waste service to all tenements with an option for the commercial and industrial sector.

14.5.3 Community perceptions to be managed

- The strategy did not propose to transport organic waste to Qld but to continue to process and make recovered product available to the local community
- Queensland's landfill option will create added greenhouse gas with transport – this will be offset by the methane gas capture at the landfill site
- Some residents consider it an imposition to pay for services not required – the new services should be provided within the existing budgetary framework. Garden waste bins may cost $35 per year which translates to 67cents per week.

14.6 Conclusion

The draft domestic waste management strategy was prepared based on detailed quantitative and qualitative research, analysis and assessment as to how waste arising from the community should be managed including collection, treatment and disposal. The draft waste strategy contained 47 recommendations.

While the program yielded a disappointing result in terms of the number of community responses the quality of the feedback was very high and mostly well considered reflecting an informed and caring community.

Based on the community consultation feedback Council staff and the consultants made a number of changes to the recommendations of the draft Domestic Waste Management Strategy including: removing 10 recommendations associated with co-tendering with Gold Coast City Council, seeking DECC approval for processing food waste during trials, the provision of a chemical storage cabinet and training of staff to receive and process chemicals. A further 11 recommendations were modified. The final number of recommendations is now 35.

15. STRATEGIC FRAMEWORK

Regional areas face their own unique waste avoidance and resource recovery challenges, governed by population distribution, geographic area and distances required to aggregate materials to reach markets.

By taking a regional approach rather than a council-specific approach and looking at regional co-operation for greater resource recovery, better use of regional infrastructure and sharing service delivery will enable a more cost-effective service to be provided to the community which Council serves.

Extensive research has been undertaken to determine the most appropriate integrated waste management system for Tweed Shire, based on the waste stream characteristics, quantities and budgetary constraints. This section contains the strategic framework for implementing and delivery of the proposed waste management strategy including key performance indicators, implementation program and budget for resourcing the strategy.

15.1 Strategic Framework

Vision: ***Working towards Zero Waste***

Mission: ***Manage waste in a sustainable way for the benefit of current and future generations***

Goal: ***Maximise resource recovery and minimise waste generation, treatment and disposal through the use of economic instruments and community education in accordance with best- practice principles and demonstrating compliance with:***

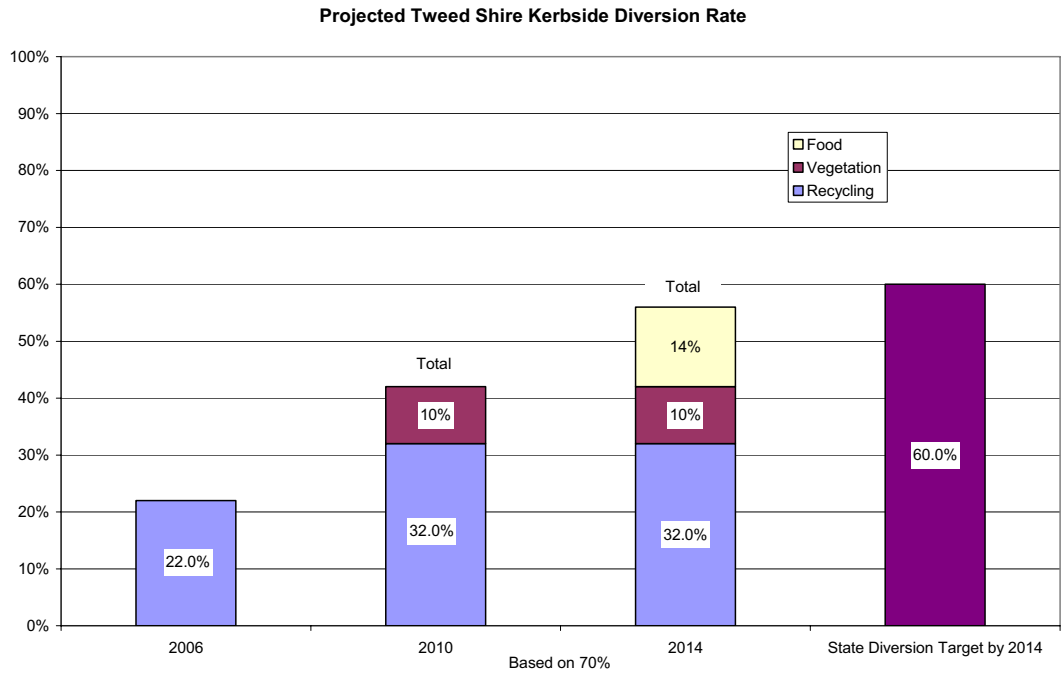
- ***Ecological sustainability***
- ***The waste management hierarchy***
- ***The need for continuous improvement,***
- ***The need for leadership and innovation***
- ***Transparency of pricing policies***
- ***Social equity***
- ***Compliance with statutory obligations***
- ***Benchmarking progress.***

15.2 System Performance Indicators

The achievement of the waste targets will require continuous improvement, and progress is not likely to be linear.

Targets: From a baseline of 27% diversion from landfill in 2006 we seek, through the continued efforts of the community and Council, to reach 42% by December 2010 and aim for 56% by 2014. Targets should be set and reviewed every two years based on agreed key performance indicators.

Chart 31 - Projected Tweed Shire Kerbside Diversion Rate



Regular audits should be conducted and compared in the same climatic season, using the same method to enable trends to be assessed and direct comparisons made between audits. The audits should be conducted for all waste streams.

15.3 Recommendations

Outlined below are the 35 recommendations in the order as they appear within this report which does not necessarily reflect their priority.

1. ***That Council continue to monitor the activities of the South East Queensland Waste and Recycling Network Group and the NEWF. It would appear that Tweed Shire has more in common with the Queensland group and its activity better reflects the immediate and long-term needs of Council.***

2. ***That Council request the waste contractor to have trained staff available at all times to receive and process DrumMUSTER containers.***

3. ***That the contractor uses the service of the free DrumMUSTER training program.***

4. ***That Council continue to support the efforts of DrumMUSTER through community education and promotion of either continuous receipt of containers or one-off collection programs.***

5. ***Council continue to promote that asbestos should be removed, handled and stored in accordance with the Work Cover Regulation.***

6. ***That all batteries received at all waste depots be correctly stored.***

7. ***That Council include the correct disposal of gas cylinders and bottles in future community educational material and promote the drop-off of these materials at each waste disposal facility.***

8. ***That Council continue to support the operation of reuse facilities at all waste disposal facilities.***

9. ***Council ensures the community is informed about household hazardous collection programs.***

10. ***That Council continue to promote the current practice of source-separation and free delivery of recyclables at all waste facilities.***

11. ***That Council should introduce a new fully commingled recycling service in a 240-litre bin collected fortnightly to all of its residents.***

12. ***That Council should introduce a garden service in a 240-litre bin collected fortnightly to all single residential dwellings in townships.***

13. ***That Council offers an optional garden waste service to all medium-density and multiple-occupancy residential buildings.***

14. ***That Tweed Council offer residents a 140-litre bin as the standard service with the option of a differential service rate for an 80-litre or 240-litre in the interests of social equity. The price differential for these service options will be assessed once the tender for domestic waste management services is completed.***

15. ***That new lids in accordance with the Australian Standard 4123 Mobile Waste Container be provided to all existing and new domestic waste, recycling and garden organics bins as part of the collection contract.***

16. ***Council should continue to monitor developments by other local governments which have introduced or are proposing to introduce organic waste collection programs, in particular, Coffs Coast and Hastings Councils, to learn from their experiences. Council should also assess new and emerging technologies and processes which have applicability for the area.***

17. ***That Council introduce dedicated collections for specific materials, that is, metals / whitegoods and continue with the bi-annual household cleanup service.***

18. ***Should Council maintain its own MRF, then the future collection contract should specify a maximum compaction for the collection of recycling at 180 kg/m^3 and in accordance with best practice.***

19. ***That Council enter into discussions with third parties in relation to the acceptance of Tweed Shire Council recyclables.***

20. ***That a two-bin system – garbage and 'containers only' or alternate litter bin system be trialed in key strategic areas.***

21. That a performance review of the system be undertaken three months after the system is introduced.

22. Recycling stations should be provided in strategic visitor locations to reduce the incidence of visitors using private or commercial bins.

23. That the existing blue litter bins should be replaced with green bins with red lids for rubbish and yellow lids for recycling.

24. That Council develop a Waste Not DCP and place a notation or condition on all Development Approvals requiring the source separation and containerisation of all waste on building sites to minimise waste generation and prevent unintended pollution.

25. That source-separation of loads prior to delivery is desirable due to the differential pricing policy to be applied to mixed loads at Stotts Creek and Murwillumbah landfills.

26. That Council undertakes a community education and industry information campaign to promote source-separation of all loads delivered to the Stotts Creek landfill.

27. That Council directly approaches the significant users of its landfills on a personal basis to inform and educate them regarding the role of source-separation and of Council's intention to introduce a substantial change to the future fee structure and charges for disposal of waste.

28. That Council resolves to introduce differential landfill fees for sorted and unsorted loads and offer a significant price variation to create the necessary motivation for source-separation within the community.

29. That council introduces a significant differential pricing policy to encourage source – separation by waste generators of building materials.

30. That the current education and communication program delivered by the contractor be reviewed to assess and evaluate the effectiveness and value for money prior to developing the new contract specification.

31. Given the high proportion of visitors to the area, that the use of graphic images supported by the English words must be incorporated into all communication modes

32. That Council must commit sufficient and ongoing budgetary resources to continue the education of both residents and visitors.

33. That the waste depots should be renamed as Resource Recovery Centres.

34. That Council ensure that the new waste education centre is a demonstration site for green building and sustainable living and be called The Sustainable Living Centre.

35. That concurrently with developing plans for the local landfill, Council reviews other long-term disposal options for the Shire's waste as identified in the Strategy having regard to transport and disposal costs, method and number of vehicle.

15.4 Action Plan and Timeline

To implement the Waste Management Plan and recommendations outlined above, the following key actions are required**.** It should be noted that this Action Plan is not exhaustive and the timelines provided are indicative only. Many items will be worked on over a period of time, and many rely on others and are inter-related. The purpose of the table is to consolidate the actions, given the further research and review of the indicative costings proposed in this study.

To prepare for the new contract for services, the NSW DECC has developed a Model Waste and Recycling Collection Contract toolkit with the intention of helping councils to develop quality contract documents that will assist in delivering an efficient and effective waste and resource recovery collection system. The Model Contract is a comprehensive tendering package comprising the following sections:

Section A	Information for Tenderers
Section B	Conditions of Tendering
Section C	Conditions of Contract
Section D	Specification
Section E	Sample Advertisement
Section F	Tender Return Schedules
Section G	Attachments

A User Guide has been prepared to provide additional information for councils and highlight key issues and decisions that are required to be made when customising the Model Contract documents for a particular application. The benefits of using the Model Waste and Recycling Collection Contract include:

- Improved quality of documents
- Time and money saved on preparation costs for tenders and contracts.
- A greater focus on the results and outcomes sought to be achieved
- Reduced time spent on contract administration through adoption of consistent approaches.

The Model contract clearly articulates the steps and length of time required to develop, prepare and award a new collection contract. It recommends a period of 24 months be allowed. Council should use the above documentation to develop new contract documentation and tender for services based on the outcomes of this Strategy**.** However, prior to this, Council should hold discussions with Gold Coast City Council regarding co-tendering for the collection and possible processing options.

Table 65 - NSW DECC Model Contract Management Timeline

Activity	Time
Consultation and Planning	9 months
Prepare Tender Documents	3 months
Tendering	4 months
New Service Commissioning	8 months
Total	**24 months**

16. CONCLUSION

Unlike many other councils throughout NSW, Tweed Shire finds itself in a very sound financial position in relation to waste management, with over $6 million currently in the reserve fund and a modest domestic waste management charge of $189 per year.

Council is facing a number of challenges in the future to achieve the state government waste strategy target of 60% diversion by the year 2014, as current diversion is 22%. The current collection contract expires in November 2009 and therefore this strategy is timely to provide guidance to Council on the type of services which could be offered in the future.

To meet both community needs and state government obligations, it is strongly recommended that Council introduce a separate waste and recycling collection program. The waste collection service should offer the residents the option of garbage bin size with a corresponding differential charge. This allows smaller and single-person households to pay a minimal fee for a 80-litre bin, whilst those with larger families pay for either the standard 140-litre or larger 240-litre bin.

The introduction of a 240-litre bin for recyclables collected fortnightly and the option of a fortnightly garden organic service for single residential premises in townships will greatly enhance the current diversion rate from landfill.

Many councils, nationally, are pioneering the co-collection of garden waste and food waste. It is strongly recommended that Council keeps a watching brief on the developments that are occurring in relation to this organics collection program and makes provision in the collection contract to include the collection of food in the organics bin when processing capacity is available.

Council is in the fortunate position of having Gold Coast City Council to its north, and a relatively seamless council boundary between Tweed Heads and Coolangatta. Gold Coast City Council's current collection contract for domestic waste also expires in 2009. This is a unique opportunity for Tweed Shire to enter into discussions with Gold Coast regarding the letting of a sub-regional collection contract for domestic collection and the processing of recyclables.

The recyclables collected for Council's kerbside program should be processed at the Visy Facility located at Carrara, which also has adjacent to it a glass refining processing facility. By processing all kerbside collected recyclables at this facility, almost 100% of the material placed in the bin will recovered, whereas currently less than 60% of the material is currently recovered, due to the high levels of contamination from garbage in the divided bin system and the generation of glass fines during the collection and MRFing stages.

The opportunity is also available to explore processing of the entire organics stream. The increasingly stringent requirement imposed by the regulators requires significant capital investment and infrastructure, which requires throughput to reduce the processing costs to a level that is sustainable and cost-effective for the community to

bear. Tweed Council, by aligning with Gold Coast City Council, would benefit financially given the economy of scale which Tweed Shire cannot achieve alone.

Due to the geographic location of Tweed and the abundance of landfill space in South East Queensland, Council also has the opportunity to benefit from low landfill gate prices of between $25–$30 per tonne at existing fully engineered landfills or bio-reactors. It is proposed that the existing Materials Recovery Facility at Stotts Creek be converted to a transfer station, and that the waste generated from the council area be potentially hauled to a landfill located in South East Queensland for a total cost of around $50 per tonne.

The Department of Environment and Conservation has expressed areas of concerns about leachate generation and groundwater contamination at both Murwillumbah and Stotts Creek Landfills. It is strongly recommended that the Council close Murwillumbah landfill and centralise all activities at Stotts Creek, which is centrally located in the council area.

We believe that the research undertaken and the recommendations in this report provide clear direction to Council as to what is the most socially responsible, economic viable and environmentally sustainable outcome to meet both the community's needs and state government's expectations in relation to waste management for Tweed Shire Council.

APPENDIX 1 – SOCIO-DEMOGRAPHICS TWEED SHIRE

Demographic and Social Indicators for Tweed Shire

1. Population (all people)

	Number
Males	35,943
Females	37,878
People	73,821

Source: ABS Census 2001

2. Age and gender (all people excluding overseas visitors)

	Males	Females	People	Percentage
0–4	2,129	2,017	4,146	5.6%
5–9	2,573	2,357	4,930	6.7%
10–14	2,655	2,547	5,202	7.0%
15–19	2,371	2,123	4,494	6.1%
20–24	1,387	1,280	2,667	3.6%
25–29	1,472	1,636	3,108	4.2%
30–34	1,780	2,042	3,822	5.2%
35–39	2,243	2,517	4,760	6.4%
40–44	2,586	2,905	5,491	7.4%
45–49	2,392	2,598	4,990	6.8%
50–54	2,401	2,344	4,745	6.4%
55–59	2,002	2,229	4,231	5.7%
60–64	2,046	2,298	4,344	5.9%
65+	7,906	8,985	16,891	23.0%
Total	35,943	37,878	73,821	100.0%
Median age	42	44	43	

3. Individual weekly income (people aged 15 and over)

	Males	Females	People	Percentage
Up to $79	1,923	2,769	4,692	7.8%
$80–$199	6,139	7,540	13,679	22.8%
$200–$299	4,605	6,877	11,482	19.1%
$300–$399	2,892	3,850	6,742	11.2%
$400–$499	2,503	2,719	5,222	8.7%
$500–$599	2,471	1,738	4,209	7.0%
$600–$699	1,651	1,002	2,653	4.4%
$700–$799	1,234	626	1,860	3.1%
$800–$999	1,437	698	2,135	3.6%
$1,000–$1,499	1,356	599	1,955	3.3%
$1,500 or more	498	161	659	1.1%
Not stated	1,875	2,374	4,249	7.1%
Overseas visitors	197	251	448	0.8%
Total	28,781	31,204	59,985	100.0%
Median individual weekly income	$324	$258	$281	

4. Family type (all families)

	Number	Percentage
Couple family with children	7,163	35.8%
Couple family without children	9,129	45.6%
One parent family	3,503	17.5%
Other family	234	1.1%
Total	20,029	100.0%

5. Dwelling structure (all private dwellings)

	H'hlds	People	Pers/H'hld
Separate house	19,107	51,551	2.7
Semi-detached, townhouse etc	4,599	9,153	1.99
Flat, unit or apartment	3,857	6,573	1.7
Other dwelling	2,611	4,519	1.73
Not stated	109	228	2.09
Unoccupied private dwellings	2,691	–	–
Total	32,974	72,024	2.18

6. Dwelling nature of occupancy (all households, i.e., occupied private dwellings)

	Number	Percentage
Fully owned	14,560	48.1%
Being purchased	5,701	18.8%
Rented from housing authority	786	2.6%
Rented: private/other	7,217	23.8%
Other occupancy type	835	2.8%
Occupancy type not Stated	1,187	3.9%
Total	30,286	100.0%

7. Labour Force Status (people aged 15 and over)

	Males	**Females**	**People**
Employed	12,847	11,033	23,880
Unemployed	2,124	1,330	3,454
Not in the labour force	12,551	17,129	29,680
Labour force status not stated	1,064	1,463	2,527
Total	28,586	30,955	59,541
Unemployment rate	14.2%	10.8%	12.6%
Participation rate	54.4%	41.9%	47.9%

8. Number of vehicles (all households)

	Number	Percentage
None	3,210	10.6%
One	14,933	49.3%
Two	8,043	26.6%
Three or more	2,337	7.7%
Not Stated	1,760	5.8%
Total	30,283	100.0%
Average vehicles	1.6	

9. Household income (all households)

	Number	Percentage
Negative/Nil income	167	0.6%
$1–$199	1,407	4.9%
$200–$299	3,405	12.0%
$300–$399	4,065	14.3%
$400–$499	3,371	11.8%
$500–$599	1,975	6.9%
$600–$699	2,159	7.6%
$700–$799	1,357	4.8%
$800–$999	2,362	8.3%
$1,000–$1,199	1,707	6.0%
$1,200–$1,499	1,500	5.3%
$1,500–$1,999	1,236	4.3%
$2,000 or more	679	2.4%
Partial income stated(b)	1,787	6.3%
All incomes not stated(c)	1,310	4.5%
Total	28,487	100.0%
Median household income	$514	

10. Comparison of Tweed LGA and NSW total for key demographic and social indicators

Indicator	Tweed LGA	NSW
Population	73,821	6,311,168
Households	30,286	2,343,677
Median age	43	35
Median weekly individual income	$281	$387
% of households in separate houses	63.1%	70.3%
% unoccupied dwellings	8.2%	8.9%
People per household	2.18	2.39
% of households owned or purchasing	66.9%	64.4%
% of households rented from housing authority	2.6%	4.9%
Unemployment rate	12.6%	7.2%
Average vehicles per household	1.6	1.8
Median weekly household income	$514	$829

APPENDIX 2

URBAN RESIDENT SURVEY

Tweed Resident Survey – Urban

Hello, I'm conducting a survey on behalf of the Tweed Shire Council. Do you have a couple of minutes to answer some questions? Council will be using these results to develop a new waste plan for the community.

Q1. Do you live in an area with a kerbside garbage collection service? *Circle correct one* **Yes / No**
If yes, continue, if no, go to rural survey.

Q2. How often do you put your rubbish bin out for collection?

☐ Weekly
☐ Fortnightly
☐ Monthly
☐ Other
NB some high-rise units have a bulk bin

Q3 Does your rubbish bin have a divider? *Circle correct one* **Yes / No**
If NO, did it have a divider? Yes / No

Other _____

Q4. Can you tell me what goes in which side of the rubbish bin?

Front when facing the bin: rubbish / recycling *Circle correct one.*

Back when facing the bin: rubbish / recycling *Circle correct one.*

Q5. On average, how full is your rubbish side each time you put it out?

☐ < 25%
☐ 25–50%
☐ 50–75%
☐ 75–100%
☐ > 100%

Q6. On average, how full is your recycling side each time you put it out?

☐ < 25%
☐ 25–50%
☐ 50–75%
☐ 75–100%
☐ > 100%

Q7. Does your rubbish or recycling side fill up first? *Tick one only.*

Rubbish	☐
Recycling	☐
About the same	☐

Q8. Do you put your rubbish/recycling in plastic bags before putting them in the bin. *Tick if yes only.*

	Yes	No
Rubbish	☐	☐
Recycling	☐	☐

Q9. Which materials do you separate for recycling?
☐ Glass bottles

- [ ] Aluminium cans
- [ ] Metal food cans
- [ ] Plastic drink containers
- [ ] Detergent and shampoo containers
- [ ] Paper/cardboard
- [ ] Milk cartons
- [ ] Other: specify

Q10. What do you do with any excess recyclables ?

- [ ] Stotts Creek waste depot
- [ ] Murwillumbah waste depot
- [ ] Tyalgum transfer station
- [ ] Rubbish bin
- [ ] Other: specify

_____

Q11. Do you think Council should introduce a separate bin just for recycling collected every fortnight?

- [ ] Yes
- [ ] No

Q11a. Why _____

Q11b. Would you be willing to pay additional charges for this service ?

Q12. Do you have a wheelie bin for garden waste collected fortnightly?

- [ ] Yes
- [ ] No

Q12a. If no, did you know Council provides this service for an additional cost of $35 per year (some rural areas excluded)?

- [ ] Yes
- [ ] No

Q13. Do you think Council should introduce this service as a standard service for every property?

- [ ] Yes
- [ ] No

Q14 What do you do with leaves, prunings & grass clippings?

- [ ] Garden waste wheelie bin
- [ ] Take to waste depot [ ] Stotts Creek [ ] Murwillumbah [ ] Tyalgum
- [ ] Compost/mulch
- [ ] Burn
- [ ] Other

Q15. Do you use Council's bulky household clean-up service?

- [ ] Yes
- [ ] No

Q15a. If yes, how often?

☐	1 per year
☐	2 per year

Q16. Do you visit the waste depots or transfer station *Circle one* **Yes / No** ***(go to Q22)***

If yes, which one? – *tick box*

☐	Stotts Creek waste depot
☐	Murwillumbah waste depot
☐	Tyalgum transfer station
☐	Other_____

Q17. If yes, how frequently

	Stotts Creek,		**Murwillumbah ,**		**Tyalgum**
☐	Weekly	☐	Weekly	☐	Weekly
☐	Fortnightly	☐	Fortnightly	☐	Fortnightly
☐	Monthly	☐	Monthly	☐	Monthly
☐	Six times per year	☐	Six times per year	☐	Six times per year
☐	4 times per year	☐	4 times per year	☐	4 times per year
☐	3 times per year	☐	3 times per year	☐	3 times per year
☐	Twice per year	☐	Twice per year	☐	Twice per year
☐	Once per year	☐	Once per year	☐	Once per year

Q18. What size load do you normally deliver ?

	Stotts Creek		**Murwillumbah**		**Tyalgum**
☐	Car, station wagon	☐	Car, station wagon	☐	Car, station wagon
☐	Ute	☐	Ute	☐	Ute
☐	Small trailer	☐	Small trailer	☐	Small trailer
☐	Large trailer	☐	Large trailer	☐	Large trailer
☐	Truck	☐	Truck	☐	Truck

Q19. What type of materials do you take to the waste depot ?

	Stotts Creek		**Murwillumbah**		**Tyalgum**
☐	Household waste	☐	Household waste	☐	Household waste
☐	Metals/whitegoods	☐	Metals/whitegoods	☐	Metals/whitegoods
☐	Garden waste	☐	Garden waste	☐	Garden waste
☐	Wood and timber	☐	Wood and timber	☐	Wood and timber
☐	Building material	☐	Building material	☐	Building material
☐	Furniture/mattresses	☐	Furniture/mattresses	☐	Furniture/mattresses
☐	Paper/cardboard	☐	Paper/cardboard	☐	Paper/cardboard
☐	Glass bottles	☐	Glass bottles	☐	Glass bottles
☐	Plastic bottles	☐	Plastic bottles	☐	Plastic bottles
☐	Aluminium cans	☐	Aluminium cans	☐	Aluminium cans
☐	Car batteries	☐	Car batteries	☐	Car batteries
☐	Motor oil	☐	Motor oil	☐	Motor oil
☐	Tyres	☐	Tyres	☐	Tyres
☐	Reuse shop	☐	Reuse shop	☐	Reuse shop
☐	Other	☐	Other	☐	Other

If answered *Murwillumbah* to Q17, ask:

Q20. If Council were to close Murwillumbah landfill, would you travel to Stotts Creek Landfill which is open 7 days per week?

Circle **Yes / No**

Q21 Do you think the current opening hours at Stotts Creek Landfill Mon–Fri 7 a.m. – 4 p.m. , Sat–Sun, public holidays 10 a.m. – 4 p.m. are adequate ? *Circle* **Yes / No**

Q21a. If NO, what should they be ? _____

Q22. What do you do with any food waste?

☐	Garbage bin	☐	Chooks
☐	Compost bins	☐	Other
☐	Worm farm	☐	

Q23. Are you aware that Council provides FREE mulch at the Murwillumbah depot ?
Circle **Yes / No**

Q23a Are you aware that Council provides mulch at Stotts Creek Landfill for $15/trailer load?
Circle **Yes / No**

Q24. Do you have any suggestions on how waste management could be improved in Tweed?
Write in answers.

_____

_____

_____

_____

_____

Finally, just some questions about yourself …

Q25. How many people in your household? _____

Q26. What type of home do you live in?

☐	Single house in township	☐	Home Unit *see below*
☐	Single house on rural land	☐	How many in complex?
☐	Villa, townhouse	☐	Caravan park
☐		☐	Other

Q27. In what age range do you fall?
Tick box

☐	16–24	☐	45–54
☐	25–34	☐	55+
☐	35–44	☐	

Q28. Gender/Tick box

	Male	☐
	Female	☐

Thank you for participating.

APPENDIX 3

RURAL RESIDENT SURVEY

Tweed Council Resident Survey – Rural

Hello, I'm conducting a survey on behalf of your local council. Do you have a couple of minutes to answer some questions? The Council will be using the results of the survey in developing a new waste strategy.

Q1. Do you live in an area with a garbage collection service *Circle correct one* **Yes / No**
If yes (urban) and if no (rural).

Q2. Please indicate how you dispose of your general household waste? (*tick one or more)*

- ☐ Burn it – go to Q3
- ☐ Bury it – go to Q3
- ☐ Take to landfill/transfer station – go to Q4
- ☐ Compost – go to Q4
- ☐ Other – go to Q4

Q3. How often would you burn or bury your waste? (*tick one*)

- ☐ Weekly
- ☐ Fortnightly
- ☐ Monthly
- ☐ Other – please specify:

Q4. Do you visit the waste depots or transfer station *Circle one* **Yes / No *(Go to Q10)***
If yes, which one? – *tick box(es)*

- ☐ Stotts Creek Landfill
- ☐ Murwillumbah Landfill
- ☐ Tyalgum Transfer Station
- ☐ Other_____

Q5. How frequently – *tick box*

Stotts Creek,	**Murwillumbah,**	**Tyalgum**
☐ Weekly	☐ Weekly	☐ Weekly
☐ Fortnightly	☐ Fortnightly	☐ Fortnightly
☐ Monthly	☐ Monthly	☐ Monthly
☐ Six times per year	☐ Six times per year	☐ Six times per year
☐ 4 times per year	☐ 4 times per year	☐ 4 times per year
☐ 3 times per year	☐ 3 times per year	☐ 3 times per year
☐ Twice per year	☐ Twice per year	☐ Twice per year
☐ Once per year	☐ Once per year	☐ Once per year

Q6. What size load do you normally deliver? – *tick box*

Stotts Creek	**Murwillumbah**	**Tyalgum**
☐ Car, station wagon	☐ Car, station wagon	☐ Car, station wagon
☐ Ute	☐ Ute	☐ Ute
☐ Small trailer	☐ Small trailer	☐ Small trailer
☐ Large trailer	☐ Large trailer	☐ Large trailer
☐ Truck	☐ Truck	☐ Truck

Q7. What type of materials do you take to the waste depot ? – *tick box*

	Stotts Creek		Murwillumbah		Tyalgum
☐	Household waste	☐	Household waste	☐	Household waste
☐	Metals/whitegoods	☐	Metals/whitegoods	☐	Metals/whitegoods
☐	Garden waste	☐	Garden waste	☐	Garden waste
☐	Wood and timber	☐	Wood and timber	☐	Wood and timber
☐	Building material	☐	Building material	☐	Building material
☐	Furniture/mattresses	☐	Furniture/mattresses	☐	Furniture/mattresses
☐	Paper/cardboard	☐	Paper/cardboard	☐	Paper/cardboard
☐	Glass bottles	☐	Glass bottles	☐	Glass bottles
☐	Plastic bottles	☐	Plastic bottles	☐	Plastic bottles
☐	Aluminium cans	☐	Aluminium cans	☐	Aluminium cans
☐	Car batteries	☐	Car batteries	☐	Car batteries
☐	Motor oil	☐	Motor oil	☐	Motor oil
☐	Tyres	☐	Tyres	☐	Tyres
☐	Reuse shop	☐	Reuse shop	☐	Reuse shop
☐	Other	☐	Other	☐	Other

Q8 If council were to close Murwillumbah landfill would you travel to Stotts Creek Landfill which is open 7 days per week?
Circle **Yes / No**

Q9 Do you think the current opening hrs at Stotts Creek Landfill Mon – Fri 7am – 4pm, Sat – Sun, public holiday 10 a.m. – 4 p.m. are adequate? ***Circle*** **Yes / No**

Q9a. If NO what should they be ? _____

Q10. Do you separate any materials for recycling? *Circle one* **Yes / No** ***If no, go to Q13***

Q11. What materials do you separate for recycling ? (*tick all that apply*)

☐ Glass/bottles
☐ Aluminium cans
☐ Plastic drink containers
☐ Metal food cans
☐ Paper/cardboard/milk cartons
☐ Other *(please list)*_____

Q12. What do you do with your separated recyclables? (*tick all that apply*)

☐ Landfill
☐ Transfer station
☐ Other _____

Q13. What do you do with any garden waste like leaves, prunings & grass clippings?

☐ Take to waste depot ☐ Stotts Creek ☐ Murwillumbah ☐ Tyalgum
☐ Compost/mulch
☐ Burn
☐ Other

Q14. What do you do with any food waste? (*tick all that apply*)

- ☐ Compost
- ☐ Worm farm
- ☐ Chooks & pigs
- ☐ Other

Q15. Are you aware that Council provides FREE Mulch at the Murwillumbah depot?
Circle **Yes / No**

Q15a. Are you aware that Council provides mulch at Stotts Creek Landfill for $15/trailer load?
Circle **Yes / No**

Q16. Do you have any suggestions on how waste management could be improved in Tweed?
Write in answers.

Finally, just some questions about yourself …

Q17. How many people in your household? _____

Q18. What type of home do you live in?

- ☐ Single house on rural land
- ☐ Caravan park
- ☐ Other

Q19. in what age range do you fall? *Tick box*

- ☐ 16–24
- ☐ 25–34
- ☐ 35–44
- ☐ 45–54
- ☐ 55+

Q20. Gender/Tick box

- ☐ Male
- ☐ Female

Thank you for participating.

APPENDIX 4

TWEED COUNCIL VISITOR SURVEY

Tweed Council Visitor Survey

Hello, I'm conducting a survey on behalf of the Tweed Shire Council. Do you have a couple of minutes to answer some questions. Council will be using these results to develop a new waste plan for the community.

Screening question – Are you a visitor/resident/holiday-home owner?
If not visitor, use resident survey form.

Q1. As a visitor, are you on: *Tick box*

☐ Self-drive
☐ Tour

☐ Day visitor – *go to Q6*
☐ Overnight – *go to Q3*

Q2. What type of accommodation are you staying in? *(tick all that apply)*

☐ Hotel/motel/resort
☐ Self contained cottage/house
☐ Self contained unit
☐ Hosted accommodation – farmstay, bed and breakfast
☐ Backpacker hostel
☐ Camp or caravan
☐ Family/friends – e.g,. residential or holiday home
☐ Other _____

Q3. At your accommodation what did you do with the rubbish generated during your stay?

☐ Bin inside accommodation – go to Q9
☐ Bin outside accommodation refer to *Q6–Q8*
☐ Litter bin in public area – go to Q9
☐ Other _____

Q4 Did your rubbish bin have a divider in the middle? *Circle one* **Yes / No**

Q4a If yes, had you seen this type of bin before? *Circle one* **Yes / No**

Q4b If yes, where? _____

Q5. Did you find the bin easy to understand regarding the two compartments? *Circle one*
Yes / No

Q6. Can you recall what goes in which side of the rubbish bin?

Front when facing the bin: rubbish / recycling *Circle one.*

Back when facing the bin: rubbish / recycling *Circle one.*

Q7. Did your rubbish or recycling side fill up first? *Tick one only.*

☐ Rubbish
☐ Recycling
☐ Neither
☐ About the same

Q8 Did you put your rubbish/recycling in plastic bags before putting them in the bin?

Tick if yes only.

	Yes	No
Rubbish		
Recycling		

Q9. Where did you typically consume food?

	Accommodation	Restaurant/Café	Outdoors/parks
Breakfast			
Lunch			
Dinner			

Q10. Did you separate any recyclable items such as bottles, cans and paper from your general rubbish? *Tick box.*

☐ Yes
☐ No *go to Q10*

Q11. What did you do with the recyclables generated during your stay?

_____

Q12. Did you actively look for a place to recycle your bottles/cans/plastic?

☐ Yes
☐ No

Q13. Did you find any, and if so, where?
Tick box and write in

☐ Did not find any
☐ Found some at _____

Q14. Have you seen or used a public litter bin while in the area ?

☐ Used Where?_____
☐ Seen
☐ Not used or seen

Q15. Would you have expected recycling facilities to be available?

☐ Yes
☐ No

Q16. Do you have any suggestions on how waste management could be improved?
Write in answers.

_____

_____

_____

_____

_____

Finally, just some questions about yourself …

Q17. How many people are there in your party? *Write in number* ☐

Q18. How many nights did you stay in the Tweed area? *Write in number* ☐

Q19. In what age range do you fall?

Tick box

	16–24
	25–34
	35–44
	45–54
	55+

Q20. Where do you normally live?

	Postcode if in Australia
	Country name if not Australia

Q21. Gender/Tick box

Male	
Female	

APPENDIX 4

Tweed Link Promotion

THE TWEED TWEED SHIRE COUNCIL

Tweed Link

Postage Paid

A TWEED SHIRE COUNCIL PUBLICATION ISSUE 491 NOVEMBER 21, 2006 ISSN 1327-8630

Setting a 20-year vision for Murwillumbah

THE Tweed community is invited to participate in the Murwillumbah Town Centre Project, a planning and development process designed to set the course for the town over the next 20 years.

Brisbane-based design consultancy firm Architectus recently won the tender to undertake the project, which is scheduled for completion by May next year.

The project is made up of three components: a Scoping Study, the Murwillumbah Locality Plan and a Masterplan for Knox Park.

The Scoping Study will identify issues and recommendations that will go into a new Development Control Plan (DCP) for the greater area of Murwillumbah - that is, within a five-kilometre radius of the CBD.

Council's landscape architect Leigh Abernethy said the Locality Plan would concentrate on the CBD area - including the business area in South Murwillumbah - to set a vision for the next 20 years.

Issues to be considered in the Locality Plan include: analysing traffic and parking, urban design, land use, pedestrian networks, economic development, open space and heritage.

"The scope of the Locality Plan will include integrating existing projects such as Proudfoots Lane, Wollumbin Street and the swimming pool upgrade and multi-storey carpark project," Ms Abernethy said.

"We're combining our existing capital works projects with our strategic vision," she said.

Meanwhile, the future uses, potential problems and development of Murwillumbah's Knox Park will be studied in the development of the Knox Park Masterplan.

"The Town Centre project will involve quite an intensive consultation process, with many opportunities for people to become involved in the process," Ms Abernethy said.

Four public workshop sessions are planned in the new year, as well as a comprehensive survey.

Any individual who would like to contribute to one or all of the planning component stages is asked to nominate themselves for a community committee by calling Ruth Hussey on (02) 6670 2503 or by email to rhussey@tweed.nsw.gov.au by December 4.

Relevant community and business groups will be sent invitations to participate in a separate formal steering committee.

"We'd especially like to hear from young people and school students who'd like to get involved," Ms Abernethy said.



What direction should Murwillumbah take over the next 20 years? Residents are invited to have their say.

Have your say on waste

RESIDENTS will be able to have their say about the current and future waste management programs offered by Council over the coming weeks.

Council's Waste Management Coordinator Ian Percy said the current waste management program was being reviewed and a plan was being prepared to cater for the future needs of the area.

"It is imperative that we match the community's expectations with service delivery at a price the community is prepared to pay," Mr Percy said.

Council has appointed APC Environmental Management to review the program, and the company will be conducting telephone surveys over the next couple of weeks and face-to-face interviews at key shopping centres on Saturday, 25 November. Visitors to the Tweed will also be interviewed about the provision of litter bins and recycling opportunities.

APC director Anne Prince said her company would contact 200 residents by phone to gauge their opinions on waste.

"We know there has been a big increase in telemarketing in recent years but the researchers will clearly identify themselves as calling on behalf of Council regarding the development of a waste management plan," Ms Prince said.

A draft Waste Management Plan will be submitted to Council for consideration early next year, with detailed community consultation during February and March next year. A final report will be presented to Council at the end of March 2007.

Building better roads

FOUR local roads will be upgraded following an allocation of funds from the Roads to Recovery Supplementary Program, a grant from the Federal Government.

The road surface on Tyalgum Road (2.4 kilometres from Tyalgum) will be rehabilitated for 0.8 kilometres at an estimated cost of $185,000.

At Bilambil Road, Terranora, the road will be upgraded along a one-kilometre stretch from Gladioli Avenue to Naponyah Road, at an estimated cost of $275,000.

At Pottsville, improvements will be made from Phillip Street west for 0.4 kilometres, estimated to cost $190,000.

Another $378,110 of grant funds will be used for the road widening and strengthening of Wardrop Valley Road in South Murwillumbah to the new industrial precinct, with co-funding from developer contributions. This will be along the 0.75-kilometre section from Lundberg Drive to the Pistol Club.

These four roads were selected on the basis of surface deterioration and maintenance demands.

APPENDIX 5

Community Consultation Handout

Tweed Council's Waste Management Strategy
Community Consultation

The State Government has set an ambitious target for Councils statewide to divert 66% of all waste arising from households from landfill by 2014. Our Council area currently generates 23,394 tonnes of rubbish which is landfilled. We are recycling 6,560 tonnes of recyclables and 2,109 tonnes of garden waste which is made into mulch locally. Our current diversion rate from landfill is just 27% well short of the 66% target which is just 8 years away.

Council's Waste Management Contract commenced in 2004 and expires at the end of November 2009. This contract includes the collection of rubbish, recyclables, garden waste and public litter bins and the day to day operation of the Stotts Creek Landfill.

Council has engaged experienced waste management consultants to research, review, recommend and guide the future direction for waste management in the Tweed given our growing population and increasing waste quantities.

This document provides a summary of the key research findings and recommendations contained in the draft Waste Strategy which is detailed below:

Market Research

Telephone and face to face interviews were conducted with 215 randomly selected residents to ascertain the communities views on the current and future waste service. In total 116 suggestions for improvements were made. The key outcomes were as follows:

- 36% stated the rubbish side of the waste bin was overflowing each collection
- 37% stated the recycling side of the waste bin was overflowing each collection
- 59% supported introducing a separate container just for recycling collected fortnightly
- 50% of dwellings in townships supported the introduction of a garden organics bins collected fortnightly.

Waste Audit

A random sample of household rubbish and recycling bins were collected and sorted in 2005 as part of a regional project with neighbouring NSW councils to determine the type and quantity of material generated on a weekly basis. The study found that:

- 23% of the rubbish bin contained recyclables which could have been separated
- 48% of the rubbish bin was organic garden and food waste
- The recycling bin contained 15% of material that was not recyclable

In total 71% of the rubbish bin could be recovered and the state government targets achieved. However, new and improved systems and infrastructure would be required.

Key Recommendations

Rubbish, Recycling and Garden Waste Service

1. **Recycling bin** - Council should introduce a separate 240-litre bin collected fortnightly for all recyclables including paper, cardboard, alunimium cans, glass bottles and jars, plastic containers, steel cans and liquidpaperboard cartons.

2. **Rubbish bin** - Council should introduce a "user pays" service for waste based on the size of the bin each family needs. A 140 litre bin is the standard service option, however with a larger bin option at a higher fee i.e. 240 litre.

3. **Garden waste bin** – households - Council should introduce a garden service in a separate 240-litre bin collected on the alternate fortnight to the recycling bin to all single residential dwellings in an agreed service area.

4. **Garden waste bin** – units and villas - Council should offer an optional garden waste service to all medium-density and multiple-occupancy residential buildings

5. **Bulky household waste collection** – Council maintain the current biannual collection service.

Contracts

6. **Contract for collection** - Tweed Council and Gold Coast City Council both have collection contracts that expire in 2009. We suggest that Council enters into discussions with Gold Coast to consider co-tendering for the next collection contract given the economies of scale that may result in an optimal cost structure. The contract should include all rubbish, recycling, garden waste, public litter bins and bulky household collection program

7. **Contract for sorting recyclables** - Council should consider tendering with Gold Coast City Council for the processing of recyclables post collection.

8. **Contract for processing garden waste** – Council should investigate options for the processing of organics (garden waste and food waste) both on its own and in conjunction with neighbouring Gold Coast City Council.

Landfill Charges

9. Council should introduce differential landfill fees for delivered sorted and unsorted loads at a significant price variation to create the incentives necessary to encourage source-separation or beneficial reuse.

Education and Promotion

10. That Council undertakes a community wide education and information campaign to promote source-separation of all loads delivered to the waste depots.

Landfill Options

11. Council's Stotts Creek household waste landfill will be filled by 2010. Council is currently seeking to develop a new landfill adjacent to the current site. It is suggested that Council close the Murwillumbah operation and centralize all activities at Stotts Creek, which is centrally located in the Council area. In addition Council should investigate options for the transport and disposal of the Shires waste into South East Queensland's world-class fully engineered landfills given the abundance of landfill space. This appears to be a more economically viable alternative rather than develop a new local landfill for the foreseeable future.

For Further Information

A more detailed Executive Summary of the Waste Strategy is available from Council by contacting (02) 6670 2677 or on the council web site www.tweed.nsw.gov.au/Events/WhatsOnCommunity.aspx

Meet the Consultants

We encourage you to read the documents, and to meet with the consultants who are available from March 5 – 12th to discuss issues, concerns or for you to seek clarification on matters that might affect you, your household or business. Contact Anne Prince directly on 0425 251 271 to arrange a time

Have your Say

All comments will be considered and incorporated into a report for Council to consider before the draft Strategy is formally endorsed by Council. Submit your comments, views, opinions and feedback on the draft Strategy by **4:00pm Friday 30th March, 2007.**

Please mark correspondence as Feedback on Waste Strategy.

FEEDBACK

Feedback options include:

- Post: Feedback on Waste Strategy, Tweed Shire Council, PO Box 816, Murwillumbah NSW 2484
- Fax: Feedback on Waste Strategy, (02) 6670 2590
- Email: waste@tweed.nsw.gov.au

APPENDIX 6

DRAFT REPORT
EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Tweed Shire Council (TSC) appointed APrince Consulting (APC) to prepare a Waste Management Strategy for the council area. APC has previous experience in developing waste plans for similar coastal areas which are experiencing substantial population growth, balancing equitable service delivery for rural and urban areas and meeting the expectations of the 'sea and tree changers' as well as those of long-term residents.

The Tweed area is a popular island holiday destination for visitors from NSW, other Australian states and overseas. It has over 30 kilometres of coastline which attracts visitors all year round but particularly in the summer school-holiday period, a time which places strain on resources and services. The region is also one of the State's fastest growing areas with increasing numbers of 'sea and tree changers' and retirees choosing to live permanently in the area. The airport at Coolangatta also allows professional people to base themselves in the area and still have easy access to the capital cities.

Tweed Shire Council and the Department of Environment and Conservation's National Parks and Wildlife Branch control and manage the land assets of the area, including the 19 National Parks, five of which are World Heritage areas.

The recommendations in this Waste Strategy are based on sound quantitative and qualitative research. A review of previous studies, reports and correspondence on waste management relating to the past and current systems were made available to the consultants for review and provided invaluable background information. In addition, the consultants undertook:

- Extensive stakeholder consultation
- Market research to determine the current attitudes, views, opinions and behaviour of local residents and visitors
- Detailed analysis of historical and current data to determine usage patterns at waste disposal facilities
- Exploration of a range of options for the collection, treatment and disposal of the various waste streams generated.

There are a number of factors that influence waste generation and therefore hinder our efforts towards waste avoidance; these include:

- Economic activity and consumption – as people achieve higher social economic status or as positive economic conditions occur, there is a higher level of consumption of goods and services, leading to more waste.
- Population – an increase in waste generated has been shown to have proportional links to population increases.

Tweed Shire is currently experiencing and is expected to continue to experience both of these conditions.

Council currently contracts out the collection of household waste, recycling and optional green waste services and public litter bins, and provides a bi-annual bulky household waste collection. The contractor also undertakes the day-to-day management of the Stotts Creek Landfill and all activities on that site, including the operation of the current putrescible and inert landfill cell and composting operations. The contractor sub-contracts the operations of the tip shop and Materials Recovery Facility.

The current Waste Management Services Contract commenced in 2004 and expires on 30th November 2009, and Council is seeking guidance and direction on the provisions which should be contained in the new contract. The NSW DEC has developed a Model Waste and Recycling Collection Contract, which specifies that a period of 24 months should be allowed from the commencement of the preparation of the tender documents to the service implementation.

Council introduced a divided 240-litre garbage and recycling service for which the divider was originally positioned for a 70:30 division with 70% of the space for garbage and 30% for recycling. A community survey in 2003 clearly indicated that there was insufficient room for recyclables with the current configuration and, as a result, Council required the new contractor to reposition the divider to a 50:50 position.

Council provides domestic waste services to 31,566 premises. In 2005–06 Council collected 23,394 tonnes of domestic waste, 6,560 tonnes of recyclables and 2,109 tonnes of garden waste representing a diversion rate of 27%.

The current waste management program has been audited as part of a North East Waste Forum waste characterisation project, and it was found that, on average, 15% of the recycling stream contained material unsuitable for recycling which is termed contamination. This is consistent with an annual audit conducted in September 2006 by the contractor, which found 17.9% contamination.

Based on data provided by the contractor for the performance of the Materials Recovery Facility (MRF), where all kerbside-collected recyclables are sorted using a mix of mechanical and manual methods, only 60% of what the householder places in the recycling section of the bin is recovered. The remaining 40% is lost as glass fines and contamination, therefore just 2.5 kg per household are recovered.

The NSW State Waste Strategy has set a target of 66% diversion for municipal waste by 2014. The regional audit found that currently the garbage bin comprises 48% organic material and a further 23% consists of undiverted recyclables. Up to 70% of the Tweed Shire garbage stream can be classified as potentially recoverable resources, leaving a residual waste of 30%, or 3.5 kg per household per week. Clearly, Council has to address the organics stream and improve its current performance and be aligned to the state target.

Results from neighbouring Councils Clarence and Lismore indicate that it is possible to reduce the quantity of garden organics in the garbage stream by up to 80%, and food organics by up to 50%.

As part of this project a community survey was undertaken, in which 215 residents were randomly selected and interviewed. The key results reveal that 36% of people indicated the rubbish side of their domestic waste bin was full to overflowing each collection, while 37% indicated the recycling side was full to overflowing and 28% indicated that both sides of the bin were overflowing. When asked what people did with any excess recyclables, the majority placed it in the rubbish bin, kept it until the next collection, used the neighbour's bin or took it to work.

When asked if Council should introduce a dedicated kerbside recycling container the majority of the residents, 59%, supported this outcome. When the analysis was undertaken based on household size, households with 1–2 people were fairly equally represented, with 47% supportive and 49% opposed to its introduction. However, in families with three or more people, the results were very clear, with 82% in support and only 18% in disagreement. Clearly Council has a mandate to introduce a separate recycling bin.

Council provides a voluntary user-pays garden organics service in a 240-litre bin on a fortnightly collection schedule. Currently 25% of households have signed up for the service. During the survey, 47% of respondents indicated they did not know about the service. When asked if this should become a standard service, overall 42% supported this. However, when the results were analysed by type of dwelling and location, 50% of single households in townships supported the introduction, while those living on acreage mulched their garden waste, and medium-density dwellings tended to contract garden services.

Council offers free mulch at Murwillumbah depot, however, 62% of survey respondents said they did not know about this option while 58% did not know mulch was offered for sale at Stotts Creek. Several comments were made about the poor quality of the mulch, particularly at the Murwillumbah depot.

In total, 116 suggestions for improvements to the waste management programs were offered by the survey participants, with the key common emerging themes relating to the need for greater recycling and waste capacity, the need for a three-bin system, the quality of the mulch and the need for continued education of the community.

The consultants recommend that Council enter into discussions with Gold Coast City Council, as its domestic contract expires in a similar time frame. The option of a regional collection contract should be fully explored, as it is considered that Tweed Council would benefit from the economies of scale achieved by joining with a larger council, particularly when the boundary between the two councils is indistinguishable at Tweeds Heads and Coolangatta. Council should offer a standard 240-litre commingled recycling service fortnightly, a user-pays garbage service based on the size of the bin, with 80-litre, 140-litre and 240-litre options and a compulsory garden waste service for all single residential premises in townships, and an optional service for multi-unit dwellings.

Currently, Council will retain ownership of the MRF at Stotts Creek at the expiration of the contract in 2009, however, the plant is old and antiquated, and will require a significant and costly upgrade. Based on Ballina Council's investigations, Tweed Council may need to spend $1 million to upgrade the current facility to process the 6,500 tonnes collected per year, with a processing cost of up to $200 per tonne.

Visy Recycling purchased the Cleanaway MRF at Carrara, which currently processes all Gold Coast, Beaudesert, Ballina and Lismore Councils' dry recyclables. This plant is currently the only one in Australia that has a glass refining operation attached, so that all glass placed in the bin by the householder is either recovered for reuse in glass manufacture or is processed and used in a variety of other applications. It is recommended that Tweed Council enter into discussion with Gold Coast City Council to co-tender both the collection and processing of kerbside-collected recyclables and discuss processing options directly with Visy, which is indicating a processing cost of $15 per tonne up to 6,000 tonnes and $10 per tonne between 6,000–10,000 tonnes per year plus transport. Tweed Council could not compete with the Visy costs and this option will remove the need to undertake the $1 million dollar upgrade of the current facility.

The Stotts Creek landfill current putrescible cell is nearing capacity and is expected to fill by 2010. Council has acquired a nearly site for future landfill and quarrying activities and is proceeding with site investigation and designs. The site development and operating costs are unknown at the time of writing this report, however, we have determined that Council has a number of other options available in addition to developing the proposed new site, including:

- entering into discussions with Gold Coast City Council regarding jointly developing a regional landfill at Reedy Creek
- Council could export waste from the area at a cost of $50 per tonne which removes the necessity of Council developing its own landfill for the foreseeable future. Both companies below offer long-term contracts and can provide disposal for $25–$30 per tonne and transport for $25 per tonne:
    - Veolia Environmental Services (formerly Collex), in partnership with JJ Richards, has constructed the Ti-Tree Bio-energy Landfill Facility at Willowbank, located west of Ipswich, where the bio-reactor rapidly breaks down waste by re-circulating leachate, and gas produced is used in renewable power generation.
    - Thiess Services operates a secure fully engineered landfill at Swanbank near Ipswich.

The current MRF at Stotts Creek could be converted to a transfer station for loading directly into 100-m^3 walking-floor transfer trailers.

Council also owns and operates a transfer station at Tyalgum and a landfill at Murwillumbah. The NSW Department of Environment and Conservation (formerly the NSW EPA) is concerned about ground waste contamination at both landfill sites. In recent communication the DEC is suggesting Council establish post-closure plans for the Murwillumbah site. The DEC is particularly concerned about the green waste processing operations exacerbating leachate issues. It is suggested that Council close the Murwillumbah operation and centralise all activities at Stotts Creek, which is centrally located in the council area.

Council recovers its operating costs for waste management through the Domestic Waste Management Charge applied to the council rates which for the 2006–07 financial year is set at $189. Council, through careful planning and good financial management, has a reserve fund of over six million dollars to allow for expected

future changes in both the domestic service and also the need to establish a new local landfill before the end of this decade. Therefore, there are adequate funds to explore and implement the 47 recommendations contained within this report.

We believe that the approach recommended in this report provides Tweed Shire Council with the most socially responsible, economically viable and environmentally sustainable outcome to achieve both community expectations and that of the state government.

Outlined below are the 47 recommendations in the order as they appear within this report which does not necessarily reflect their priority.

1. ***That Council continue to monitor the activities of the South East Queensland Waste and Recycling Network Group and the NEWF. It would appear that Tweed Shire has more in common with the Queensland group and its activity better reflects the immediate and long-term needs of Council.***

2. ***That Council request the waste contractor to have trained staff available at all times to receive and process DrumMUSTER containers.***

3. ***That the contractor uses the service of the free DrumMUSTER training program.***

4. ***That Council continue to support the efforts of DrumMUSTER through community education and promotion of either continuous receipt of containers or one-off collection programs.***

5. ***Council continue to promote that asbestos should be removed, handled and stored in accordance with the Work Cover Regulation.***

6. ***That all batteries received at all waste depots be correctly stored.***

7. ***That Council introduces a significant differential pricing policy to encourage source-separation by waste generators of building materials.***

8. ***That Council include the correct disposal of gas cylinders and bottles in future community educational material and promote the drop-off of these materials at each waste disposal facility.***

9. ***That Council continue to support the operation of reuse shops at all waste disposal facilities.***

10. ***Council ensures the community is informed about household hazardous collection programs.***

11. ***Council should consider purchase of a chemical storage cabinet and offer to receive and store chemicals from the public prior to scheduled collection programs.***

12. ***That approval be requested from the DEC and the LEMP modified to allow for the installation of a chemical storage unit at the Stotts Creek facility.***

13. ***That Council require the existing and future contractors to train an adequate number of staff so that a staff member can be available at all times to receive and process chemicals and paints.***

14. ***That Council continue to promote the current practice of source-separation and free delivery of recyclables at all waste facilities.***

15. ***That Council should introduce a new fully commingled recycling service in a 240-litre bin collected fortnightly to all of its residents.***

16. ***That Council enters into discussions with Gold Coast City Council in relation to it co-tendering the waste and recycling collection contracts on a sub-regional basis when they are due in 2009.***

17. ***That Council should introduce a garden service in a 240-litre bin collected fortnightly to all single residential dwellings in townships.***

18. ***That Council offers an optional garden waste service to all medium-density and multiple-occupancy residential buildings.***

19. ***That Council enters into discussions with Gold Coast City Council in relation to co-tendering for the collection of the garden waste, commencing in 2009.***

20. ***Council should investigate options for a processing the entire organics stream both independently and in conjunction with neighbouring Gold Coast City Council.***

21. ***Council should continue to monitor developments by other local governments which have introduced or are proposing to introduce organic waste collection programs, in particular, Coffs Coast and Hastings Councils, to learn from their experiences.***

22. ***Council should seek approval from the DEC to conduct a food waste collection trial, using both qualitative and quantitative research methods to measure the impacts, community willingness to participate, use of food waste receptacles and costs to process this material at the Stotts Creek organics processing area.***

23. ***That Tweed Council offer residents a 140-litre bin as the standard service with the option of a differential service rate for an 80-litre or 240-litre in the interests of social equity.***

24. ***That new lids in accordance with the Australian Standard 4123 Mobile Waste Container be provided to all existing and new domestic waste, recycling and garden organics bins as part of the collection contract.***

25. ***That Council introduce dedicated collections for specific materials, that is, metals/whitegoods and general waste once per year.***

26. ***Should Council maintain its own MRF, then the future collection contract should specify a maximum compaction for the collection of recycling at 180 kg/m^3.***

27. ***That Council enter into discussion with Gold Coast City Council in relation to co-tendering the processing of its kerbside-collected recyclables.***

28. ***That Council enter into discussions with Visy in relation to the acceptance of Tweed Shire Council recyclables at the Carrara MRF.***

29. ***Council should seek approval from the DEC to co-process food and garden waste at the Stotts Creek site.***

30. ***Should the DEC refuse co-composting of food and garden waste, Council should consider including, in the forthcoming tender documentation, outsourcing the construction and operation of a in-vessel composting system at the Stotts Creek Waste Depot for all organic material.***

31. ***That a two-bin system – garbage and 'containers only' – litter bin system be trialled in key strategic areas.***

32. ***That a performance review of the system be undertaken three months after the system is introduced, by way of a waste audit.***

33. ***If the trial is successful, that a complete evaluation of the current location of all litter bins be undertaken, with the view of consolidating and rationalising individual bin locations into central recycling stations offering both waste and recycling opportunities to the public. Recycling stations should be provided in strategic visitor locations to reduce the incidence of visitors using private or commercial bins.***

34. ***That the existing blue litter bins should be replaced with green bins with red lids for rubbish and yellow lids for recycling.***

35. ***That Council place a notation or condition on all Building Application approvals requiring the containerisation of all waste on building sites to prevent unintended pollution.***

36. ***That source-separation of loads prior to delivery is desirable due to the differential pricing policy to be applied to mixed loads at Stotts Creek and Murwillumbah landfills.***

37. ***That Council undertakes a community education and industry information campaign to promote source-separation of all loads delivered to the Stotts Creek landfill.***

38. ***That Council directly approaches the significant users of its landfills on a personal basis to inform and educate them regarding the role of source-separation and of Council's intention to introduce a substantial change to the future fee structure and charges for disposal of waste.***

39. ***That Council resolves to introduce differential landfill fees for sorted and unsorted loads and offer a significant price variation to create the necessary motivation for source-separation within the community.***

40. That prior to the next contract being prepared, a full review of the current education and communication program be undertaken as part of the contract to assess and evaluate the effectiveness of the education program and value for money. This review should not be carried out by the contractor or Council, but by a third party.

41. Given the high proportion of visitors to the area, that the use of graphic images supported by the English words must be incorporated into all communication modes

42. That Council must commit sufficient and ongoing budgetary resources to continue the education of both residents and visitors.

43. That the waste depots should be renamed as Resource Recovery Centres.

44. That Council ensure that the new waste education centre is a demonstration site for green building and sustainable living and be called The Sustainable Living Centre.

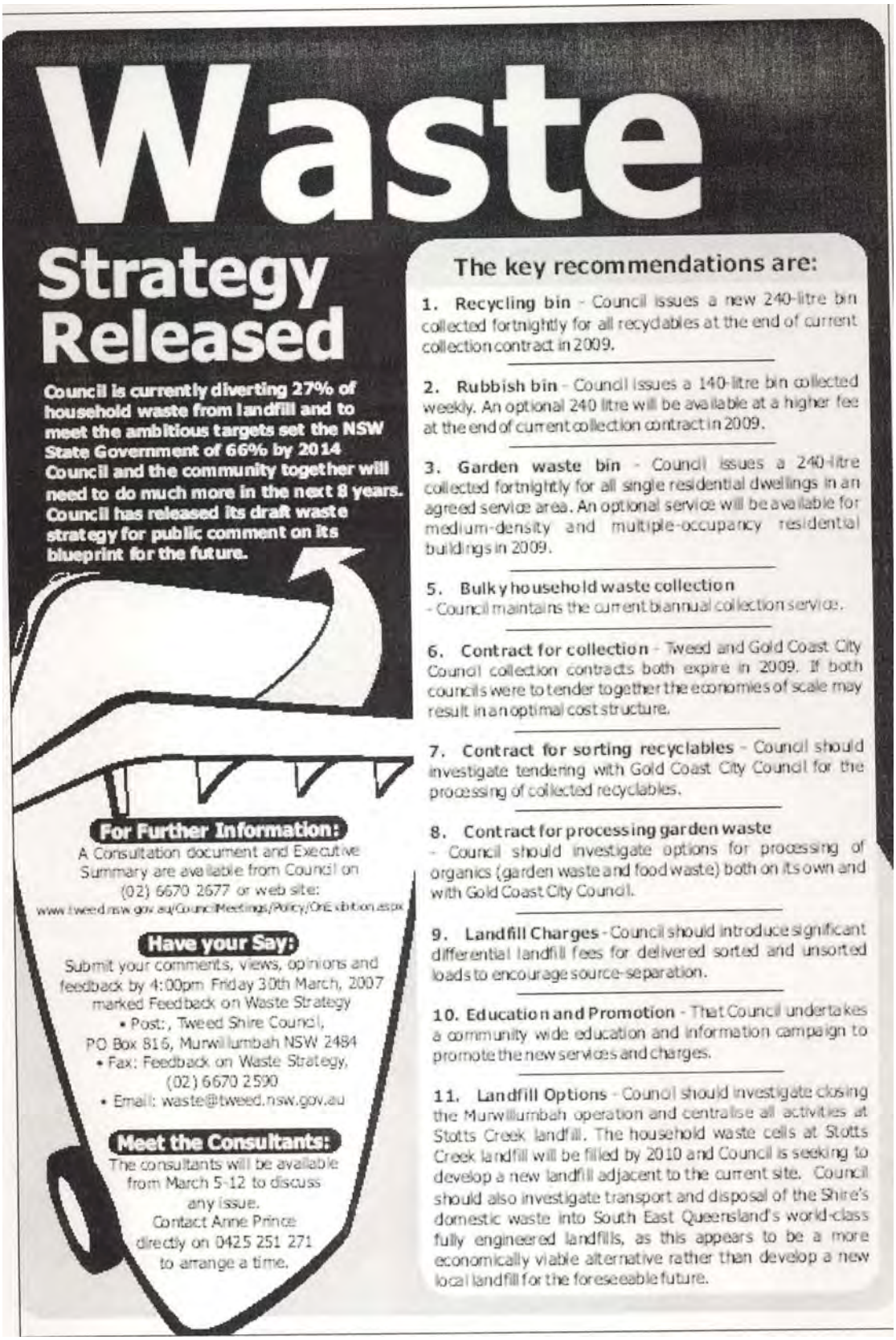
45. That concurrently with developing plans for the local landfill, Council seeks an expression of interest from companies that can offer long-term disposal for the Shire's waste. Such a proposal should provide transport and disposal costs based on current fuel pricing and detail the method and number of trips to accurately assess traffic impact.

46. That Council formally commence discussions with the Gold Coast City Council regarding joint venture opportunities to develop the Reedy Creek Waste Facility.

47. ***That Council, prior to developing its new 2009 collection tenders, in conjunction with the Gold Coast City Council, formally seek through an expression of interest process from interested parties, the establishment of a long-term viable processing alternative for the region's organics and residuals waste, inclusive of pricing, market sustainability and, market developments, with a list of preferred sites for establishing such a facility within the region***

APPENDIX 7

TWEEDLINK ARTICLES



Waste Strategy Released

Council is currently diverting 27% of household waste from landfill and to meet the ambitious targets set the NSW State Government of 66% by 2014 Council and the community together will need to do much more in the next 8 years. Council has released its draft waste strategy for public comment on its blueprint for the future.

The key recommendations are:

1. **Recycling bin** - Council issues a new 240-litre bin collected fortnightly for all recyclables at the end of current collection contract in 2009.

2. **Rubbish bin** - Council issues a 140-litre bin collected weekly. An optional 240 litre will be available at a higher fee at the end of current collection contract in 2009.

3. **Garden waste bin** - Council issues a 240-litre collected fortnightly for all single residential dwellings in an agreed service area. An optional service will be available for medium-density and multiple-occupancy residential buildings in 2009.

5. **Bulky household waste collection** - Council maintains the current biannual collection service.

6. **Contract for collection** - Tweed and Gold Coast City Council collection contracts both expire in 2009. If both councils were to tender together the economies of scale may result in an optimal cost structure.

7. **Contract for sorting recyclables** - Council should investigate tendering with Gold Coast City Council for the processing of collected recyclables.

8. **Contract for processing garden waste** - Council should investigate options for processing of organics (garden waste and food waste) both on its own and with Gold Coast City Council.

9. **Landfill Charges** - Council should introduce significant differential landfill fees for delivered sorted and unsorted loads to encourage source-separation.

10. **Education and Promotion** - That Council undertakes a community wide education and information campaign to promote the new services and charges.

11. **Landfill Options** - Council should investigate closing the Murwillumbah operation and centralise all activities at Stotts Creek landfill. The household waste cells at Stotts Creek landfill will be filled by 2010 and Council is seeking to develop a new landfill adjacent to the current site. Council should also investigate transport and disposal of the Shire's domestic waste into South East Queensland's world-class fully engineered landfills, as this appears to be a more economically viable alternative rather than develop a new local landfill for the foreseeable future.

For Further Information:
A Consultation document and Executive Summary are available from Council on (02) 6670 2677 or web site:
www.tweed.nsw.gov.au/CouncilMeetings/Policy/OnExhibition.aspx

Have your Say:
Submit your comments, views, opinions and feedback by 4:00pm Friday 30th March, 2007 marked Feedback on Waste Strategy
- Post:, Tweed Shire Council, PO Box 816, Murwillumbah NSW 2484
- Fax: Feedback on Waste Strategy, (02) 6670 2590
- Email: waste@tweed.nsw.gov.au

Meet the Consultants:
The consultants will be available from March 5-12 to discuss any issue. Contact Anne Prince directly on 0425 251 271 to arrange a time.



PUBLIC NOTICES

Waste Strategy Feedback Required

Last week Council announced the key recommendations from the new draft Waste Strategy. Some of the recommendations can be acted on effective July 1, 2007 while the majority will occur in 2009 when the current contract expires. This will include new collection bins and service options.

For Further Information:
A Consultation document and Executive Summary are available from Council on (02) 6670 2677 or web site: www.tweed.nsw.gov.au/CouncilMeetings/Policy/OnExibition.aspx

Have your say:

Submit your comments, views, opinions and feedback by 4pm Friday 30 March, 2007 marked Feedback on Waste Strategy

Post: Tweed Shire Council, PO Box 816, Murwillumbah NSW 2484

Fax: Feedback on Waste Strategy, (02) 6670 2590

Email: waste@tweed.nsw.gov.au

ISSUE 505

APPENDIX 8

LETTER TO PROGRESS ASSOCIATIONS

Council letterhead

Re: Community Consultation on Draft Waste Management Strategy

Tweed Council appointed APC Environmental Management in late 2006 to review council's current waste management program and to develop a new Waste Management Strategy.

As part of the development of this strategy, the consultants have undertaken stakeholder and community consultation to determine the needs and priorities of residents in the area. The Draft Report has now been submitted to Council who are currently considering its recommendations.

We are offering Resident Groups, Progress Associations and Chambers of Commerce the opportunity to meet with the consultants to discuss the proposed recommendations contained within the Draft Strategy. The Consultants accompanied by Council staff will be available to attend meetings scheduled from Monday 5th March – Friday 9th March. However, if your scheduled meeting does not occur during this time, the consultants will be available to meet with you or a representative of your committee or any interested members at a mutually convenient time between Friday 2nd March and Saturday 10th March, 2007.

A summary of the report will be posted on Council's website and will be forwarded to you upon request. Council is encouraging the community to review the document and submit comments in writing by letter, fax or email by Friday 23rd March, 2007.

Should you wish to meet the consultant, please contact Anne Prince, Director of APC Environmental Management on 0425 251 271.

Yours sincerely,

Ian Percy
Waste Management Coordinator

APPENDIX 9

E-MAIL FEEDBACK

-----Original Message-----
From: Barry Longland [mailto:barrylongland@hotmail.com]
Sent: Friday, 30 March 2007 4:13 PM
To: Waste Waste
Cc: philipcarr@westnet.com.au
Subject: Waste Strategy

General Manager
Tweed Shire Council

On behalf of the Uki Village & Districts Residents Association I want to commend Council on the key recommendations of the draft Waste Strategy. The strategy was explained to us by your Mr Percy and Ms Anne Prince at our March meeting.

Generally, the recommendations were welcomed by the members of the Association, in particular those measures that provide incentives for residents to reduce the amounts going to landfill. The proposed community education program was also seen as essential to changing attitudes about individual responsibility for waste management.

There has been some ongoing discussion within the Association about the control of garden/green waste within the strategy. It is understood that, within our region, there is considerable unmet demand for organic waste that can be converted into saleable compost material. If this is the case, we think that Council should exploit the potential to have that waste processed locally before entering into arrangements for its transportation into the Gold Coast or beyond (recommendation 8).

Yours faithfully

Barry Longland
President, Uki Village & Districts Residents Association

-----Original Message-----
From: Dianne Rowles
Sent: Friday, 30 March 2007 11:55 AM
To: Adam Faulkner
Subject: COMMENTS - DRAFT WASTE MANAGEMENT PLAN
Mr Peter Harding 6676 3084 - 76 Overall Drive Pottsville.

Proposal is on the right track.
He used to live in the Hawkesbury Shire. They had multi bin system operating there. he Council had a a4 card printed with the "do's & dont's" of the multi bin system. It emphasised not to contaminate the various bins with the wrong stuff. This card was to be left permanently at the residence for the next owner/tennant to read. Mr Harding stresses that forward planning for an shire wide education programme before this multi bin system comes into effect will be necessary.

Regards
Dianne

From: Sandra Grayson [mailto:sandyg1@tadaust.org.au]
Sent: Thursday, 29 March 2007 12:27 PM

To: Waste Waste
Subject: feedback on waste strategy

Sirs,
I note with concern, but no surprise, that 15% of recyclable materials are contaminated. This would indicate that an important strategy would be education and enforcement. Undoubtably a separate bin for recyclable would assist, but I believe this needs to be an uncovered crate-style container, thus discouraging thoughtless individuals from dumping garbage in them.
I live on my own and have no need of a garbage service. I compost all my food waste, and weekly place recyclable plastics, tins, bottles and newspapers and half a small bag of garbage in my neighbour's bin - with his permission of course.
I firmly believe that with thought, even a family could compact their true garbage to two (environmentally friendly) plastic bags each week - I used to when I lived in a household of four adults.
Perhaps a solution could be to offer a free - or very cheap - worm farm to those households who would use one.
As with most things, the younger a person is educated, the better. School visits to the recycling depot could be organised and the children taught about the importance of recycling on a local and global level. They could be encouraged to take charge of their family's recycling, perhaps, and the school could continue to foster their interest with regular prizes and projects on the subject.

Yours sincerely,
Sandra Grayson

From: julia newsome [mailto:petrie@qldnet.com.au]
Sent: Wednesday, 21 March 2007 6:42 PM
To: Waste Waste
Subject: Feedback on Waste Strategy

I have feedback only on the first three points which appeared in the 'Tweed Link.'

1. Fortnightly recycling bin would be OK with me. However my daughter [whose house this is] fully intends to resume residing here. In all the years she lived here she found the current bin barely enough for a week. I'm blessed if I can fathom how she could find so much rubbish/recycling in only seven days.

2. Weekly collection of rubbish quite acceptable. Was it this bin which would be replaced with a smaller one? If so, much the same as paragraph 1 regarding my daughter. I have serious doubts she could cope with a smaller rubbish bin. At present I am putting out the rubbish/recycling bin fortnightly, the same weeks the two green organics bins are emptied.

3. As my daughter, on my prompting, successfully applied for a second green organics bin I cannot see that 1 bin would suit at this address. Every fortnight both bins go out and, while not always packed solid, there is still too much garden litter in each to think one bin would be adequate.

To sum up: I would rather there not be any change to the current bins or collection days.

Yours faithfully,
[Mrs.] J. Newsome
1 Elsie Street Phone [07] 5524 3865
BANORA POINT 2486
-----Original Message-----
From: thali@bigpond.net.au [mailto:thali@bigpond.net.au]
Sent: Monday, 19 March 2007 11:15 AM

To: Waste Waste
Subject: Feedback on New Waste Strategy.

Greetings,

I have some questions and feedback regarding the recommendations for the Waste Strategy for the Shire:

If the goal is to reduce waste by 66%, how is offering 280lt of rubbish collection and 240 lt of recycle per fortnight going to move towards this goal? It seems a step backwards from the current 240L (50-50% split bin, implying 240 lt rubbish and 240L recycle per fortnight, please correct me if I am wrong...) And in fact offering residents the ability to increase their rubbish collection capacity to 240L per week is bizarre!

From what I have humbly observed of human nature, people only change their habits if they are forced to or if there is a significant financial incentive to do so (rewards work, just ask any parent!) and they will generally expand to fill the available space (certainly works with spending of incomes). For example, if you build more roads, more people will use cars. If you encourage the building of energy inefficient bigger houses, people will use more energy and buy more consumables to fill the house. Because they can!

Likewise if you provide the option to householders of bigger bins for more rubbish, there will be no incentive to think about packaging when items are bought or indeed their role in cutting down their consumption to help the planet. They will fill them and if more bin space is offered, even if it means paying for it, they will fill those too!

Can the council please put all considerations aside other that our planet's desperate need to reduce consumption, and do for instance the following:

Supply bins that for instance have 66% recycle, 34% rubbish which makes it clear to everyone that we have a target to meet, together.

Rewards work! (just look at the Coles dockets success!) So how about providing incentive for those of us who do the right thing (a carrot on a stick). For instance, giving households the option of a blue recycle/rubbish bin (picked up fortnightly) at a substantially reduced cost to say a green recycle/rubbish bin (picked up weekly). So the more you waste, the more you pay. The less in the bin, the greater saving on collection charges, the more incentive to compost paper and scraps at home, on site, saving all that wasteful petrol to have it leave the property and then sorted and then transferred to goodness knows where to have it recycled. It makes common sense right? (note - perhaps not for the collection company in terms of the most profitable configuration of services for their bottom line, but then we're all realising its time to reprioritise profits against looking after the planet, aren't we?)

I am hoping also the garden waste bin is an optional household collection as many of us out bush simply utilise our green waste on the property (and townies should be encouraged to do likewise by composting or chipping to mulch garden beds) Instead of collection of cuttings and prunings can you have a bi annual bring a chipper around and chip on site straight onto gardens. Saves all that petrol on transporting to tip, householder then coming to tip to recollect.

I also think and have always thought the bi annual bulk waste collection is a little indulgent and a waste of resources. One collection per year is enough.

Overall I'm a little bemused that you are not asking householders to take more individual personal responsibility for their own waste by providing incentives to change behaviour,

rather than accommodating the same behaviour (and indeed encouraging more wasteful behaviour) by suggesting more services. The collection company may benefit in terms of greater charges, but I doubt the earth will.

Yours in good faith,
Thali Bower-Williams

-----Original Message-----
From: ktyr [mailto:ktyr1302@bigpond.net.au]
Sent: Wednesday, 7 March 2007 11:39 AM
To: Waste Waste
Subject: waste strategy

Try weekly for recyclables.I can't put all the recyclables in each week as it is - no room! so ends up in rubbish.

Otherwise - good on you!

Kelly Tyrrell, 20 Norman St., Tweed Heads.

-----Original Message-----
From: michael_dodd@dreamworld.com.au
Sent: Wednesday, 7 March 2007 4:22 PM
To: Waste Waste
Subject: new bin service

to wait until the current agreement expires in 2009 is not necessary - in today's commercial world if there are pressures on the service standards now you can viod the contract or renegotiate.

We live in the tweed shire, have a family of 2 adults and 2 babies and find it extremely difficult to fit all our waste (general + recycles) all in one split 240 litre bin - the issue isn't only general waste as we also fill the recycle section easily each week. When you have 2 babies and are going through over 100 nappies per week we really need a 240 litre general waste bin and a separate recycle bin - like most other councils in NSW regional towns. I would like to see this issue resolved sonner than 2009 as the cost/time of going to the rubbish dumop each week is not available.

MD

-----Original Message-----
From: m.hancock.11@scu.edu.au
Sent: Thursday, 8 March 2007 2:04 PM
To: Waste Waste
Subject: waste strategy

The draft waste strategy is an excellent waste reduction scheme and i hope it is introduced and rolled out as soon as possible. We are all aware the strategy is long overdue for the Tweed region and I completely support the initiative.
Regards,
Megan Hancock, Southern Cross University
From: Liz & Ian Brookes [mailto:brookes@norex.com.au]
Sent: Thursday, 8 March 2007 4:39 PM
To: Waste Waste
Subject: Feedback on Waste Strategy

Waste Recycling Recommendations:

- We fully agree with items 1, 2, 3, 5, 9 and 11.
- Other issues are Council's normal responsibilities
- Recommendation 4 is a mystery!

Liz and Ian Brookes
19 Grassmere Ct
Banora Point.

-----Original Message-----
From: Wendy Fulford [mailto:wendybird@bigpond.com]
Sent: Friday, 9 March 2007 5:28 AM
To: Waste Waste
Subject: Waste Strategy

Re: Waste Strategy:

Has council given any thought to having a green waste collected every week instead of fortnightly ?

I have been trying to access the Consultation document and Executive Summary on Waste Strategy on the web site which was given in the latest Tweed Link. All I get is a message tell me that this document is not available on the web site?

Wendy Fulford

-----Original Message-----
From: Barbara Deece [mailto:bsdeece@iprimus.com.au]
Sent: Friday, 9 March 2007 12:00 PM
To: Waste Waste
Subject: WASTE STRATEGY RELEASED

The recommendations for waste collection and disposal are a vast improvement on the current arrangements
The divided bins are hopeless.... paper and cardboard cant sit flat and take up much more space

The 3 bin system worked very well in the council area in which I lived in Sydney.... I was able to recycle much more than I can here with the present system.
Bring it on!

Barbara Deece
Banora Point, NSW 2486
bsdeece@iprimus.com.au

From: rob & julie watkins [mailto:rjwatkins@aapt.net.au]
Sent: Tuesday, 13 March 2007 2:27 PM
To: Waste Waste
Subject: waste suggestion

Dear Sir/Madame,

Whilst in Gosford recently we found a notice for the Gosford Shire council waste collections and thought they had some very good ideas that might help us here on the Tweed.

1) Urban properties (with a garden organics bin) can also have three bulk garden organics services per year.

2) You must book in advance

3) Your bulk material must not be placed out for collection more than a day before your service or you could recieve an on-the-spot fine of $200.

We love the green waste bins and would relish the delivery of recycling bins also.

We believe more education should be carried out to Householders in regard to the proper way to recycle houshold waste.

Thank you for your time and the oportunity to have our say.

Regards
Rob and Julie Watkins

-----Original Message-----
> From: Dianne Rowles
> Sent: Wednesday, 14 March 2007 12:49 PM
> To: Adam Faulkner
> Subject: Draft Waste Management Study
>
> Bronwyn Trathen 1/44 Brisbane Street Mbah suggested that instead of or as well as 2 x Council Clean Ups a year, ratepayers were given 2 vouchers to have a clean up themselves and take rubbish to tip. Previous council area she resided in had this system running.
>
> Dianne

-----Original Message-----
From: jaap roskam [mailto:jaaproskam@bataviaphotos.com]
Sent: Thursday, 15 March 2007 7:11 PM
To: Waste Waste
Subject: Waste strategy

Re: your call for feedback in the Tweed Link weekly news letter.

To whom it may concern

We , my wife and I life since 1996 in Australia , we came from the Netherlands. Over there we lived in the most progressive town for garbage recycling of the country. Many recycling ideas were born in our town 'Baarn'. Situated about 35 km SE from Amsterdam.

In the 1980's and 1990's we had a photo studio and a photo one hour service. We also sold batteries. One day I came with the idea to trade old batteries in for new ones. So people could get 10-20 cents rebate for their old batteries when they bought new ones. We are talking about normal camera and other related batteries. Just the ones you can buy in super markets and petrol stations etc. etc.
The reason was to keep batteries out of the general waste cycle and make people aware that batteries are a time bomb in the waste depot.

Anyway, what happened exceeded our expectations: Greenpeace heard about it , they arranged a press release, that ignited radio and newspaper interviews and we were temporarily famous and could not buy enough batteries from our supplier. The idea was seeded and other shops took over. So the marketing advantage was diluted. But what stayed was that people realized that batteries are very dangerous chemical waste.

The council picked up the idea and distributed to EVERY retail point were batteries were sold a special battery-bin. Those battery bins were emptied once a week in a special drum on the rubbish truck. Then the batteries were stored in those drums. Eventually the council had a whole 'battery' of full battery drums. Lucky enough more councils started to pick up the idea and then a battery recycling company stood up. They devised a system to extract the metals and chemicals .

Nowadays (almost 25 years later) the battery-bins have been replaced by real fancy ones in every shop all over the country. No one will ever throw the batteries in the waste. It is so easy : when people go to buy new batteries they take the old ones and at the check-out they dump them in the bin. It is even so that if the bin is full that the customers get upset if there is no room for their old batteries.

So my challenge to you : Let the Tweed make headlines by introducing this good system into Australia. Start collecting used batteries at every sales checkout were batteries are sold and worry about the final storage / recycling of the batteries later. That solution will come. !!!

Best regards:
Jaap Roskam
273 Mount Burrell Road
Mount Burrell 2484

-----Original Message-----
From: magp [mailto:magp@aapt.net.au]
Sent: Wednesday, 14 March 2007 10:31 AM
To: Waste Waste
Subject: Waste Strategy

Hi,
I would like to have 2 bins ,one especially for recycling as at the moment I recycle everything but I know a lot of people just throw anything in both sides of the split bin and it all gets mixed together,sometimes I wounder if it is worth the effort with the split bin,I keep my hopes up that it does
Margaret Poole
2/26 Shallow Bay Drive
Tweed Heads South

From: Jan Bidstrup [mailto:jan.bidstrup@bigpond.com]
Sent: Thursday, 15 March 2007 11:29 AM
To: Waste Waste
Subject: feedback on waste strategy

I would like to have 1 dedicated rubbish bin and 1 recycling bin. Having used this combination before(in Townsville) I found it worked well ,with rubbish emptied weekly and recycling every other week.The system in place at present is useless for a family of 2 adults and 3 young adolescents because the separator limits the amount in each chamber as it is unable to 'settle'. If recycling is to be encouraged,a system needs to be in place that allows this to happen 100%. I find if we recycle everything during 1 week at our address,the

compartment is full after a few days.I look forward to having the above system,the sooner the better.

Yours sincerely
Jan Bidstrup

Original Message-----
From: Lorraine Atkinson [mailto:lorri48@bigpond.net.au]
Sent: Wednesday, 14 March 2007 8:38 AM
To: Waste Waste
Subject: Feedback on Waste Stategy

I believe Item 10 to be vital to the further success of the recycling program.

As I walk around many of the streets in Banora Point I am constantly amazed & disgusted with the apparant lack of responsible recycling that occurs. For many I am sure no amount of education will alter their bad habits. For the rest of us, we could all benefit from increased education as to the correct methods when disposing of our garage. I have seen adds on Gold Coast TV which demonstrate the correct way to sort & dispose.

A close neighbour of mine will often have his lid not closed due to extra garbage protruding out, I'm sure he is unaware of the consequences this causes as the contractor explained to me one time when mine partly tipped over the road, as it was being collected. This person is a reasonable thinking person& wouldn't realise the design of the truck dictates that our bins are closed on pick up. My suggestion is for a flyer taped to our bins, not to be confused with "junk mail" followed by a sticker that is permantly on the bin to remind us or visitors of correct "best practices".

How many people know that there is no market for plastic lids eg off soft drink bottles or lids off beer stubbies? That message has never been sent to the public, that lids be removed, seperated from the bottle & the bottle quashed to avoid in some households the lid not able to be closed.
It may be evident that I am passionate about responsible recycling. Our household is quite happy with the current arrangement with the bin the size it is along with the "green bin" fortnightly.
Regards
Lorraine Atkinson
14 Bosun Blvd
Banora Point

-----Original Message-----
From: gordon davidson [mailto:gorxlu@yahoo.com]
Sent: Friday, 16 March 2007 10:46 AM
To: Waste Waste
Subject: Waste Bins

To Tweed Council,
I would like to see the present Bins go BACK to the way they were before the last change of divisions. Since bins werechanged to smaller rubbish area and bigger recycleing, I have had to place rubbish in the recycleing area because there not enough room in the rubbish area. I would like to see the present bins rubbish area made bigger and the recycleing area made slightly smaller and maybe picked up twice per week rather than one pick up a week this way residents would not have overflowing bins etc.
Gordon T Davidson.
PS: I struggle every week to make room for all my rubbish

APPENDIX 10

FEEDBACK LETTERS

TWEED SHIRE COUNCIL
FILE No. .....
Doc. No. .....
REC'D 12 MAR 2007
ASSIGNED TO: .....
HARD COPY ☐ IMAGE ☐

NEVILLE CHIVERS
57 VULCAN STREET
KINGSCLIFF. 2487
TEL 66742095

RE WASTE STRATEGY
AS PROPOSED FOR COMMENT
IN TWEED LINK 6.3.07

DEAR SIR OR MADAM,

THE FIRST THING THAT SHOULD BE EXPLAINED IS WHAT THE EXTRA COSTS TO RATEPAYERS THESE RECOMMENDATIONS WOULD INCUR.

PERSONALLY I AM HAPPY WITH THE STATUS QUO, AS WE ARE 2 PERSONS AT THIS ADDRESS WHO WOULD RARELY NEED A RECYCLING CAPACITY LARGER THAN WE NOW USE. WE CERTAINLY DON'T REQUIRE A GARDEN WASTE BIN AS WE MULCH ALL OUR KITCHEN SCRAPS AND SHRUB PRUNEING.

I WOULD CONSIDER IT AN IMPOSITION TO PAY FOR SERVICES I DO NOT REQUIRE AS ONE SIZE DOES NOT FIT ALL!

EXTRA SERVICE SHOULD ONLY BE OFFERED TO THOSE WHO REGISTER AND PAY FOR IT.

YOURS FAITHFULLY Neville Chivers.

To:
Tweed Shire Council.

Copies to:
Murwillumbah Ratepayers and Residents Association
Tweed District Residents & Ratepayers Assoc.
Cabarita Beach/Bogangar Resident's Association Inc.

From:
Richard Hann
15 George Street
Murwillumbah
Email - richardhann2@hotmail.com

28th March 2007

Waste Strategy - an objection

This is an objection in response to the Waste Strategy key recommendations as presented in the Tweed Link 6th March 2007, and Council documents Draft Waste Management Strategy *Executive Summary* and *Community Consultation*.

I am satisfied with the current 'one divided bin' for our household, and have no problem with a system which is efficient and cost effective.
I have absolutely no need for a garden waste bin and object to the proposal that I be required to accommodate three bins next to my house, and also object to the additional cost that would result.

It appears Council has a predetermined position to introduce a three bin system and has made use of a flawed community consultation process.

On the basis of a survey poll of 215 residents showing 59% in favour, Council claims to have a clear mandate *(page 3 Executive Summary).*
It seems the positive responses of 21 residents (10% of 215 surveyed) are good enough for Council.

However, we know polls are not reliable, that results will depend on how a question is asked, that a respondent who is unsure may provide the reply the interviewer wants to hear, or respondents can mislead, and so on.
Indeed not even our Commonwealth Government would claim a mandate based on a survey.

Presently 25% of households make use of the garden waste bin service. When these 25% are subtracted from the residents surveyed *(because they would know of the service)* there remain 75% of residents that do not make use of a garden waste bin, and accordingly 72% claimed not to know of the existence of the service.
With an uptake rate of 25% there are green lid bins in almost every urban street of the shire. Is it extremely unlikely that such a large proportion of residents have never noticed or speculated on the purpose of their neighbour's extra bin.
It is difficult to believe in the accuracy or the intention of Council's *(or Council's consultants)* survey.

The principle of user-pays and choice appears to have been abandoned by Council in its waste management strategy.

During 2005 divided bins were changed from the 30/70 to a 50/50 divide. It is very probable that this change was not entirely popular, or practical, for many households and the volume of contaminants entering the recycling section increased as a result.

It would be reasonably simple to adapt garbage trucks to handle variably divided bins, and allow residents to decide what is most suitable for their needs. With divided bins, for example, being either 30/70, 40/60, 50/50. 60/40 or 70/30.
The exercising of a choice could assist in involving unmotivated residents.

For what purpose is a garden waste bin service?
Clearly the garden waste bin is not large enough for real-garden-excess such as tree/shrub pruning or palm fronds. What can be accommodated in the garden waste bin are smaller green leaf type items, which, of course, can also be easily composted away within household gardens.

Many residents recognise organic material as a resource and retain it in their gardens. Why should residents who compost within their gardens be compelled into an unnecessary service?

It appears that volume of waste food entering landfill is significant, and reducing landfill is the agenda *(an agenda which is Sydney-centric, and a chase for 'ambitious targets')*.
With the expectation of a separate food waste collection service proving unpopular for domestic use, and food waste receptacles are not introduced, food wastes would be placed in the proposed garden waste bin.
Would food waste be thrown in loose or is it likely that a significant amount would be wrapped, or in containers?
Households with gardens have the capacity to compost food waste, and many do. For medium-density residences the disposal of food waste is more problematic.
Yet, Council wants to require households with gardens to have a bin for organic waste, while for medium-density properties the service is to be optional!

There is already criticism about the quality of council mulch, a mulch which is presumably in part, derived from the optional garden waste service.

It seems reasonable to predict that a compulsory 'garden waste bin' will result in very high levels of non-organic contamination entering the system.

If Council's survey is to be believed, about 36% of the rubbish side of divided bins are overflowing. It seems inevitable there will be households with excess rubbish, and an under-utilised garden waste bin, that will not pay a higher fee to receive a second, or larger, rubbish bin.

The efficiency of a recycling system depends on the level of public cooperation.

In addition to the objections presented it is the contention of this submission that public cooperation will be best achieved when residents receive services that provide choice with flexibility and helpful information.

While the Sydney area may indeed have a severe shortage of landfill sites, it is contended that Tweed Shire Council should not be overly influenced by such external factors in its waste management strategy.

Similarly, to attach the Tweed's waste management to the much larger Gold Coast system, although an obviously attractive soft opportunity, would be undesirable for choice, future options and the retention of resources and expertise within Tweed Shire.

The prospect of Tweed's non-recoverable waste being trucked to landfill near Ipswich seems environmentally illogical, and should be considered only as an option of last resort.

It is also suggested that the NSW Government needs to pursue measures to reduce the amount of waste entering households.

Conceivably a levy on packaging could both reduce and fund the transport *(by rail)* of landfill to distant sites. Or the problem of hundreds of tons of unsolicited mail and ad/news/print could be addressed
(elsewhere?).

The closure of the Murwillumbah landfill may be necessary, however it should remain open as a collection depot. Indeed Council should consider establishing additional collection points around the Shire, particularly for bulky garden waste.
The biannual collection of bulky household waste is a good service and needs to be continued, or even expanded to include bulky garden waste.

Yours sincerely

Richard Hann

BANORA POINT & DISTRICT RESIDENTS ASSOCIATION INC

Registered No Y1827609

Correspondence to the Secretary
PO Box 936
Banora Point 2486

President
Rod Bates
Tel 5524 2761

Secretary
Fran Beisler
Tel 5524 2080

Treasurer
Warren Shardlow
Tel 5523 1357

GARBAGE - WASTE MINIMISATION & WASTE MNGMT

WASTE DATA REPORTING PROJECT

TWEED SHIRE COUNCIL
FILE No ...
Doc No ...
REC'D - 5 APR 2007
ASSIGNED TO PERCY, I
HARD COPY ☐ IMAGE ☑

Council Ref – Waste Management

The General Manager
Tweed Shire Council
PO Box 816
Murwillumbah NSW 2484

Dear Sir
Community Consultation on Waste Management Strategy.

Following our phone conversations with members of Mr Ian Percy's Dept., & our letter requesting extra time to reply, the Banora Point Association would like you to take into consideration the following points:

- We oppose any suggestion that we amalgamate with the Gold Coast for the purposes of waste disposal. We feel that any financial gains would be only short term & in the longer term may be detrimental to our region. We would be the very junior partner in this arrangement & could in the future become the dumping ground for the region given our greater area of undeveloped land & our smaller population. Apart from that we wish the Tweed to remain independent so that any decisions made are done so by our own Council.
- We oppose any increase in the number of bins & feel that the system of the divided bin we use at the moment is sufficient.
- We congratulate the Council on the introduction of the green waste bin but are satisfied that those people who want one will request it. Members who do not use a green waste bin did not want to have one as a matter of course. The storage problem associated with extra bins was an important factor in these considerations.
- We oppose any extra charges for different sized bins for recycling or general garbage but are quite happy for those who wish to have a green waste bin to pay for it.
- It was unanimously decided that the present system is quite satisfactory.

On the matter of the **bi-annual cleanups**, many members expressed dissatisfaction with the length of time between notification & the actual removal of the rubbish. Some streets were described as "dumps" for a period of several weeks. Vandals throwing items all over the road & pathways made the streets unsightly & sometimes dangerous. Long term residents described the previous system of Council collecting bulky goods on request at a small cost. This was felt to be a better system. We feel that the Council should give serious consideration to the reintroduction of this system.
We appreciate the opportunity to have input regarding these processes.

Yours Faithfully

Fran Beisler, Secretary.

1

MURWILLUMBAH RATEPAYERS AND RESIDENTS ASSOCIATION INC. WASTE DATA REPORTING PROJECT
GARBAGE - WASTE MINIMISATION + WASTE MANAGEMENT

26/03/2007

TWEED SHIRE COUNCIL
FILE No GARBAGE - GENERAL
Doc No
REC'D 28 MAR 2007
ASSIGNED TO FAULKNER, A
HARD COPY ☐ IMAGE ☑

The General Manager,
Tweed Shire Council,
PO Box 816,
Murwillumbah 2484
NSW.

Draft Waste Management Strategy

Dear Sir,

After listening to the proposals put forward at two community consultation meetings with

- Ian Percy – Waste Management Coordinator –TSC
- Anne Prince- Director, APC Environmental Management
- Adam Faulkner- Waste management Officer TSC

our members and our committee have obtained further information and opinions from a number of sources namely-

- Lesley Trott – Waste Management spokesperson, Lismore City Council NSW
- Ian Barnes - Waste Management Services spokesman, City of Whitehorse, Victoria.
- Bionatural Sales and Service, Vermont, Victoria- suppliers of Bokashi bio-fermentation systems
- David Stratton – Manager of Organic Recycling, Regenesis, Myocum, NSW.
- Ken Forster, retired Manager Health and Building Services TSC

1) The members came to the conclusion that the proposed collection of the different types of household rubbish in separate bins is an improvement on the existing split bin system and in line with what many other Councils are doing.
2) However the proposal to co-tender with Gold Coast Council for a new mega waste management contract appears to have many negative aspects and should be reassessed

.

Our objections to the idea of partnering with the Gold Coast are.

- We shouldn't tie ourselves to a larger Council who will call the shots

2

- We should keep control of our own waste within the Shire as there are complications with 2 sets of state laws.
- We will have little control over escalating costs
- If you get tied up with a multinational waste operator the level of service goes down. We have much more control over our own service.
- We are a growing Shire and expect to have another 10,000 households at least in another 10 years, so we have the capability to handle our own waste
- There is no advantage in combining with the Gold Coast Council ; their track record is not good in several areas and they have a totally different approach to waste management
- It is foolish to say that transporting organic waste to Ipswich and recyclables to Carrarra is cheaper when you haven't considered the environmental cost of the transport. The exhaust emissions from dozens of trucks doing a weekly round trip of nearly 300 km, as well as the deposits of rubber and oil on the roads are significant. Treating our own waste locally would slash these very real costs by 1/10 We are supposed to be trying to reduce greenhouse gases these days.

3) We also consider that the issue of composting our own organic waste here on the Tweed has been brushed aside as being too difficult and potentially too expensive without any serious efforts investigate how these difficulties could be overcome.

David Stratton the" Compost Manager" at Regenesis Organic Farm, Myocum spoke to us about the possibilities of large scale composting. The farm collects organic waste from businesses in Byron Bay and converts it into high grade compost on the farm. This operation has EPA approval. David has been negotiating with Solo Waste on a proposal to combine and provide a larger composting service to TSC. Solo Waste is keen to be involved. Council has at this stage rejected the idea. David is confident that EPA requirements at Stotts Creek can be met and commercial organic waste has little contamination from non compostibles. David's arguments are below

- NSW Government has set a goal that the amount of waste going to landfill be reduced by 66% by 2014.
- By composting all organic waste we can reduce the amount of waste going to landfill by 50%. It is the only strategy that enables a council to achieve a large part of their target. They can create a product from local waste which is distributed locally

- Waste recycling is essential for soil health (the Chinese have been doing it for thousands of years).
- Composting organic waste creates an income stream instead of incurring transport costs to distant landfill.
- Water weeds and rampant environmental weeds can be turned into high grade compost and all seeds are killed in the high heat generated during the process.
- A pilot scheme is feasible.
- It can extend the life of our tip.
- At present Regenesis can produce 400 cubic metres /week from business waste.
- They would be able to set up at Stotts Creek –need 8 acres plus some capital investment

4) Finally we wish you to continue to encourage households to compost their own waste by providing affordable compost bins and worm farms, but also to extend the choice to Bokashi fermentation bins. Many people find them easier to use than the worms and compost bins. Both of those need fine tuning to work really well. Also quality Bokashi bins can be kept indoors and will also ferment meat and oils. The City of Whitehorse has been offering vouchers to households to help defray the cost of this more expensive alternative.

We hope that this submission is helpful in stimulating you to look at a wider set of possibilities.

Yours Faithfully

(Louise O'Shea)

MRRA
PO Box 651
Murwillumbah
NSW 2484,

APPENDIX 11

STAKEHOLDER SUBMISSION

21 March 2006

Anne Prince Consulting
PO Box 54
TERRY HILLS NSW 2084

Solo Resource Recovery

10-12 Chinderah Bay Drive
Chinderah NSW 2487
P.O. Box 1427
Kingscliff NSW 2487
AUSTRALIA.

Services: 02 6676 7647
Admin: 02 6674 7656
Fax: 02 6674 7657
Email: solorr@solo.com.au
Web: www.solo.com.au

Dear Anne,

RE: Tweed Council Draft Waste Management Strategy

Thank you for our meeting on 2 March 2007 and a copy of the Draft Waste Management Strategy. We offer the following information in response which may assist in the development of the final strategy.

Executive Summary

The following comments are specific to the Draft Executive Summary.

Tender Preparation Period

In relation to the NSW DEC's suggestion that a period of 24 months be allowed for tender preparation and service implementation, we respectfully suggest Council be mindful of the potential cost premium tenderers are likely to include in their tender prices if the service commencement date is more than 9-12 months from the tender close date. This is likely to arise as a result of the uncertainty and risk surrounding the inevitable increase in costs between the tender close date and service commencement date and the potential for circumstances to change over a 24 month period eg. significant reduction in paper prices or increase in landfill charges which generally increase at a rate much faster than CPI.

Presumably the waste management contract will include a rise and fall provision to adjust the tender prices for any cost increases/decreases from the tender close date. This provision is normally sufficient if the tender period is kept to a 9-12 month period. A longer tender period of up to 2 years I believe is unnecessary in terms of time required by the successful tenderer to prepare for contract commencement and would require a broader rise and fall provision in the tender specification to compensate for all cost increases over and above standard CPI or equivalent movements.

Any removal of uncertainty in the tender and contract process will ensure tenderers prices and therefore Council's costs are kept to an absolute minimum from the outset and the best way to achieve this is to keep the commencement date as close as practically possible to the tender close date.

Community Survey / Separate 240L Recycling MGB

In relation to the survey findings, I don't think some of these results accurately reflect the facts or the wider population but I guess this can occur with any random and small survey.

For example, bin inspections we have carried out over many years indicate the percentage of Residents with an overflowing bin problem to be significantly less than one third. This in itself is not a particularly significant finding but it does indicate that survey results to other questions may also be exaggerated or not representative of the wider population.

In relation to the high percentage of Residents in favour of a dedicated 240L Recycling MGB, a different result may have been received if Residents were aware of the significant increase in cost associated with the supply and service of an additional bin.

In addition, there may be a misconception among many Residents that a separate 240L MGB for Recycling means additional storage space. Whilst being a larger and dedicated bin, the fact the bin would be collected fortnightly means the recycling capacity is 120 litres per week ie. the same Recycling capacity as per Council's current collection system.

The three (3) bin system proposed in the Draft is becoming increasingly popular among many Councils and whilst we broadly support this initiative, we believe the main thrust of Council's strategy should be:

- A Recycling service is extended to all Tenements including Commercial and Industrial in a MGB for automated collection on at least a fortnightly basis.
- A Green Organics service is extended to all Residential Tenements and an option service to Commercial and Industrial Tenements in a MGB for automated collection on at least a fortnightly basis.
- A Garbage service is extended to all Tenements including Commercial and Industrial in a MGB for automated collection on a weekly basis.
- Whilst Council may propose separate MGB's for each waste stream, Council should allow tenderers to submit alternative options that meet the above criteria that may involve the use of more or fewer bins that provide other advantages to Council in relation to reduced costs or other benefits.

Regional Collection Contract with Gold Coast

Please refer to our comments in response to Draft Recommendation 16.

Proposed MRF Strategy

- The Stotts Creek MRF is twelve (12) years old and will be 15 years old by contract end.

- Notwithstanding its age, the MRF is currently fully operational and successfully processing and selling all marketable Recyclables.

- The current contractor is obligated and committed to ensure the MRF is fully operational at contract end.

- The treatment of glass fines is an Industry wide issue with technology and markets/outlets still being developed.

- The Draft Executive Summary inadvertently includes several errors of fact in relation to the Visy Carrara (Gold Coast) MRF. Visy's Recycling plant at Carrara (Gold Coast) is not the only MRF in Australia that has a glass refining operations attached. EarthCare

operate a MRF in Somesby (NSW) which includes a glass refining operation and processes recyclables from the City of Gosford and Solo Resource Recovery collected recyclables from the Cities of Lake Macquarie, Cessnock and Maitland. The EarthCare glass refining operation commenced approximately 5 years prior to the Visy Carrara MRF.

- Cleanaway and/or Visy's claim that all glass fines from the Carrara MRF are recovered for reuse or other applications is incorrect. In fact the glass fines processing system at the Carrara MRF has not been fully functional since its inception. Thousands of tonnes of glass is stockpiled at Gold Coast Council's Molendinar landfill and has been for years. Cleanaway won the current recycling contract (now three years old) largely on the predication it would introduce advanced technology to process and market all glass fines. To their credit Cleanaway invested significant capital into the project but failed to deliver on its promise to Council. The stockpile continues to grow on a daily basis. The degree of the failure of the Carrara MRF can be measured by the fact Cleanaway recently assigned the sorting component of the contract to Visy and elected to pay another contractor, JJ Richards to take over the collection component for the remaining two (2) years of the contract.

- To further demonstrate the Industry wide problem with glass fines, we have a close association with another waste company that purchased two (2) state of the art MRF's including the latest glass fines processing technology twelve months ago for two (2) NSW Regional Councils of similar size to Tweed Shire. Both have failed to deliver in relation to the processing of glass fines into a marketable or usable product. The evidence appears clear in that glass fines processing technology is still in its development stage and there are no simple or quick solutions.

- We respectfully suggest Council treat with caution low indicative processing prices apparently sourced from Visy. The $10-$15/tonne indicative processing price in the Draft is at best based on record high paper prices (double the average) being paid by countries such as China and Indonesia. These record prices can not continue forever and will eventually fluctuate up and down in a cyclical manner as they have consistently for the past 50 years.

- We, like most other participants in the Recycling Industry have had extensive dealings with Visy Recycling over many years and whilst the purpose of this information is not to criticise opponents, the reality is being such a dominant player in the Recycling Industry, they have a track record of dishonouring written agreements particularly when Industry conditions change as they do regularly in relation to Recycling Markets.

- In Victoria, Visy to their credit have invested millions of dollars in high technology glass fines sorting equipment called the Binder system but with only moderate success. Due to the practical difficulties associated with processing this material into a reusable or marketable product and the enormous volumes involved, Visy have tens of thousands of tonnes stockpiled at its facility that it has no use for and prior to Christmas 2006, gave all producers of glass fines and MRF operators in Victoria one months notice that effective from 1 January 2007, the price paid for glass fines would reduce from $30/tonne to $0/tonne.

- The purpose of this report is not to criticise competitors particularly given companies like Visy have contributed an enormous amount to the Industry over many years. However as detailed in our comments in response to Draft Recommendation 16, we believe it would be a mistake for Council to rely exclusively on Visy Recycling and/or its MRF at Carrara for the reasons outlined.

Stotts Creek Landfill

In relation to the proposal to enter into discussions with Gold Coast Council to develop a regional landfill at Reedy Creek, we believe Tweed Council would lose its independence under this proposal and the potential consequences associated with that. Tweed Council has an enviable track record particularly compared to other northern NSW Councils and the Gold Coast Council in relation to planning for its landfill requirements.

Some years ago, Gold Coast Council was forced to prematurely close its major landfill at Molendinar due to poor planning, well before it reached its designed capacity. This has resulted in an enormous cost increase to all Gold Coast Ratepayers for many years as all collected putrescible waste has to be transported further north to its secondary landfill at Staplyton.

In relation to use of alternate landfills west of Brisbane, the use of the MRF at Stotts Creek as a transfer station and disposal generally, we recommend these issues be incorporated in the collection tender to maximise efficiencies between collection, processing and disposal and allow tenders to submit holistic and innovative proposals incorporating all facets of waste management from collection through to disposal.

If Council locks itself into disposal contracts prior to the collection tender process, we believe it would restrict the options available to Council when evaluating collection tenders.

Draft Recommendation 15

We suggest the proposed Recycling Service be extended to all tenements in the Shire including all Commercial and Industrial tenements. All Commercial and Industrial tenements produce domestic recyclables from their offices and workshop lunchrooms etc. Providing the Recycling service to all occupied buildings in the Shire will:

- Maximise recycling yields;
- Reduce waste to landfill;
- Allow for a simple and consistent recycling message to be promoted throughout the Shire as the entire population at home and work will use the same Recycling collection system.

In relation to multi-unit dwellings, it has been our experience 1 bin shared between 2 units to be a well received policy from unit occupiers as it provides sufficient Recycling bin capacity and therefore maximises recycling yields whilst still allowing the Council to maintain a simple Rating policy by rating each unit for a recycling service.

Draft Recommendation 16

We believe the Tweed Council contract is large enough in its own right to achieve critical mass and economies of scale, as it has done so in the past and that any contract let with the Gold Coast Council, albeit separate to the Gold Coast contract, is likely to result in a loss of control to the Tweed Council and a reduction of service levels given the geographic location of Tweed to the Gold Coast and its comparatively small size.

Tweed Council has developed a self sufficient culture and has always retained control of its own destiny particularly in relation to waste management. Not having to rely on others has led to disciplined management practises by Council over many years leading to the provision of high quality services to Ratepayers at comparatively low cost notwithstanding the Council geographic area is extremely large and scattered including a large rural area and number of

villages, mountainous and unsealed roads. Through this self dependency and good management, the Council has planned well ahead in relation to its long term landfill requirements including accumulating land for future landfill and buffers whilst accumulating significant financial reserves in the process.

It would be fair to say Tweed's track record to date in many areas including Waste Management is the
envy of most other non-metropolitan Councils in NSW.

In relation to economies of scale, in our experience of tendering for Local Government waste management contracts, we have found the critical mass for Council's like Tweed, which are comprised of a relatively large and scattered rural area, to be approximately 20,000 tenements and greater.

Tweed is currently comprised of more than 33,400 tenements and therefore well exceeds the number of tenements we believe are required to achieve critical mass and economies of scale.

For the past 20 years Tweed has been one of the fastest growing Shires in NSW. This pattern of high growth over many years is set to increase dramatically again as it did in the early 90's with massive residential developments in Kings Forest and Cobaki Lakes (approximately 11,000 tenements) set to come on over the forthcoming years. Therefore the current economies of scale Tweed enjoys is set to continue.

When it is considered the major cost component of any waste management collection service is the collection and bin supply component, generally 90%+ and the fact the nature of the Waste Industry is that one collection vehicle generally services approximately 4000 urban tenements (much lower in rural areas) per week, then there is no reduction in the cost of collection on a per service basis whether a Council area is comprised of 4,000 or 100,000 tenements as the collection costs are the same per service.

The only potential cost saving for larger contracts is in relation to Administration/Management cost which generally only accounts for approximately 10% of the total collection and bin supply cost and only a small portion of the 10% is subject to economies of scale benefits as the administration/management costs also move in line pro rata to the increase in the number of tenements being serviced eg. more tenements means more phone calls, missed services, new service bin deliveries, bin repairs, vehicle accidents, drivers, workshop and driver facilities therefore additional call centre, driver foreman, mechanics and administration/management staff are required.

In our 75 years experience, any small potential administration cost saving with a large contract is outweighed by additional costs and practical issues associated with large contracts eg. public relations and associated advertising costs, industrial disputes given large contracts attract militant trade union activities often holding Councils and Contractors to ransom as is the case in the City of Brisbane, poor service levels particularly given the enormity and composition of the geographical area of the Tweed and Gold Coast. This is a real practical issue because even if the contracts for the two Council areas are individually let, the Contractor will manage them as one and the quality of service to the Tweed will be, by sheer numbers and location, the poorer of the two particularly in the Murwillumbah and Coastal areas and the southern villages.

Combining the Councils in the one tender process is also likely to reduce the number of tenderers submitting bids. This is due to the capital intensive nature of the Waste Industry and the fact large contracts are usually out of the financial reach of smaller waste Contractors.

It is likely under a combined tender process, the only tenderers would be large multinational companies the majority of which are foreign owned and have contributed little to the Australian Waste Industry over the years by way of new technology or service levels.

In summary, any proposal for Tweed to join with the Gold Coast Council in a joint tender process by inference suggests Tweed Ratepayers have been paying a premium for their waste management services in the past or have missed out on receiving technological improvements in the Waste Industry or high quality services. A study of Tweed Council's waste management history will indicate the contrary.

In relation to waste management charges to Ratepayers, Tweed Council is generally below the NSW State average waste management charge. A comparison of current Tweed and Gold Coast waste management expenditure budgets reveal Gold Coast charge their Residents 41% higher than Tweed Council notwithstanding Tweed provide its Ratepayers with a bi-annual Clean-Up campaign.

Some of Tweed Council's achievements include :

- One of the first Council's in Australia to adopt the now widely accepted Mobile Garbage Bin (MGB) and one of the first Council's to adopt the automated collection of the MGB and pass the economic benefits of such technology back to the Ratepayers.

- One of the first Council's in Australia to adopt the automated collection of Recyclables in an MGB including a divided MGB and to build a Materials Recovery Facility (MRF) to process the collected Recyclables.

- Tweed Council is one of a minority of Council's to provide a bi-annual Clean-up campaign.

- Tweed Council was the first Council in Australia to introduce a Utility Packer, a collection vehicle capable of collecting sanitary pans (from rural villages), automated collection of MGB's and bulk bin collection for rural commercial and industrial Ratepayers.

- Tweed Council is the only non-metropolitan Council in Australia to have a reputed manufacturer of waste collection bodies and associated equipment located within its boundaries over a period spanning more than 50 years. This has facilitated Tweed Council to implement new collection and recyclables processing technology before any other Council.

The Gold Coast City Council has lagged Tweed Shire Council in all these areas.

The fact Tweed Shire Council has succeeded in the above achievements, established comparative high quality infrastructure at the Stotts Creek Waste Management Facility and associated MRF, planned and provided for its future landfill and buffer requirements, provided a personalised high quality automated waste, recycling and organics collection service to its Ratepayers including to those located in remote and mountainous rural areas, at Rates consistently below that of the NSW State Average and accumulated over the same period significant financial reserves in the millions, I believe best sums up the need or lack thereof to join forces with the Gold Coast City Council, a Council with a track record of political instability and lack of investment in key infrastructure ie. Water storage.

Draft Recommendation 17 & 18

Similar to the Recycling Service, we recommend a fortnightly Green Organics service be extended to all Residential tenements in the Shire and an optional service to Commercial and Industrial tenements. Providing a fortnightly Organics service to all Residential buildings in the Shire will:

- Maximise organics yields;
- Reduce waste to landfill;
- Increase the economies of scale of the Organics service by extending the service to all Residents and therefore minimise the cost to the Community on a per service basis.

In relation to multi-unit dwellings, it has been our experience 1 bin shared between 3 units to be a well received policy from unit occupiers as it provides sufficient Organics bin capacity and therefore maximises organics yields whilst still allowing the Council to maintain a simple Rating policy by rating each unit for a organics service.

Our experience with other Councils that have extended a Green Organics service to all Residential Ratepayers, as against an optional service, is that the service is very popular with Residents given the tangibility of receiving a separate 240L Organics MGB and extremely effective in terms of waste reduction to landfill. As mentioned, extending the service to all Residents provides for economies of scale in relation to truck logistics and collection productivity thus ensuring the cost to Council on a per service basis is kept to a minimum.

Draft Recommendation 19 & 20

Refer comments in Draft Recommendation 16.

Draft Recommendation 23

Our experience has been a 140L MGB serviced weekly is sufficient capacity for householder's waste needs if all householders are provided with a minimum of 120L per week of Recycling capacity and a 240L MGB for organics collected fortnightly. Hence the need for an optional 240L MGB is abated.

In the unlikely event additional waste capacity is required, we recommend the householder have the option to take up a second 140L MGB and pay a second garbage rate. This is the current system in place with the divided 240L MGB's and the current take up is extremely low.

Introducing multiple sized garbage bins adds what we believe to be unnecessary costs to the service eg. additional bin stocks, higher administration/bin changeover costs and potential loss of collection vehicle economies of scale and productivity.

Draft Recommendation 26

Having experience as an operator of Materials Recovery Facilities in addition to being a collection contractor and manufacturer of recycling bodies, we recommend a maximum compaction limit of 200 kg/m^3.

A compaction ratio lower than this will result in significantly higher collection costs to Council particularly given the large rural areas in Tweed Shire where larger (6x4) vehicles are likely to be required. If collection vehicles are not permitted to collect a full legal payload by weight, then as mentioned the cost of collection to Council will increase significantly.

These comments are made in light of the fact significant technological improvements have been made over recent years in relation to sorting technology and also the collection bodies where the 'compaction effect' has been significantly reduced.

In our opinion, the additional impact on glass by increasing the compaction ratio from 180 to 200 kg/m3 is negligible.

Draft Recommendation 27

Refer comments in Draft Recommendation 16.

Draft Recommendations 28, 29 & 30

Our experience over a ten (10) year period in another Council area of similar size and make-up to Tweed ie. popular holiday coastal destination was high contamination of recyclables to the point the Council withdrew the recycling receptacles.

The majority of public place litter bins are in parks and main streets used by holiday makers and unfortunately but understandably the majority of holiday makers appear to have little interest in separating their recyclables from garbage. The biggest problem is actually ensuring the rubbish makes its way into a bin and not on the ground or around the bin.

Notwithstanding the challenges, with the aid of a comprehensive education campaign incorporating letting agents, tourist authorities and hotel/apartment and caravan park proprietors, this initiative may succeed albeit contamination rates are likely to be high.

Draft Recommendations 42, 43, & 44

Refer comments in Draft Recommendation 16.

In summary, Tweed Shire Council has demonstrated over a long period of time that its best interests are served by retaining control of its own destiny in relation to all facets of waste management ie. collection, processing, disposal and education.

The quality of service the Council has provided to Ratepayers, the high level of technological advancement in waste management practises it has introduced particularly when compared to the Gold Coast, and the low waste management cost and charges to Ratepayers notwithstanding the large rural areas in Tweed Shire, are all testimony to the fact there appears to be little to be gained to Tweed Council by joining forces with neighbouring Councils, particularly a much larger and politically unstable Council like the Gold Coast.

Due to the lopsided number of tenements between the two Councils, the massive task of managing the Gold Coast's holiday boom periods and high rise units, and the comparative remote location of Tweed Shire, any successful contractor would have little choice but to focus its attention on the Gold Coast at the expense of the Tweed Shire.

Our final recommendation is in relation to the generally prescriptive nature of the proposed collection system in the Draft Waste Management Strategy and in relation to the process of handling the Shire's waste, recyclables and organics materials.

In relation to the collection system, we respectfully suggest the Waste Management Strategy also provide for Council to consider alternate collection systems and proposals from tenderers. Historically, the Australian Waste Industry has generally been very innovative so placing the onus on prospective tenderers or at least allowing prospective tenderers to submit alternate and/or lower cost collection and processing systems and bin configurations, may be advantageous to the Tweed Shire Council as it has been in the past.

In relation to the processing of the Shire's waste, recyclables and organics, we recommend the Council not lock itself into such contracts prior to the collection tender, but combine the processing options with the collection tender. This way, the onus is placed on tenderers to submit innovative and holistic proposals encompassing collection, disposal and processing components as Council is best served if all these components are integrated to minimise waste to landfill and minimise the total cost of waste management to Council.

In addition, combining all components with the collection tender will reduce Council's tender and evaluation costs and ensure any innovative and/or cost effective waste handling and processing systems are not locked out.

Thank you for the opportunity to provide feedback to the Draft Waste Management Strategy.

I am available to discuss any queries you may have or provide further information.

Yours faithfully,
Solo Resource Recovery

Robert Richards
Director

Appendix F

AWT Situational Analysis

Benjas (2008)

This report was researched and prepared by

The Ralph Family Trust trading as Benjas Pty Ltd

ACN 064 101 015

Email: rick.ralph@optusnet.com.au

Brisbane
PO Box 1163
Kenmore Qld 4069
Phone: (07) 3375 6961
Fax: (07) 3375 6941

For

Tweed Shire Council

Post Office Box 816

Murwillumbah NSW 2484

Responsible Officer – Mr Adam Faulkner

The company wishes to acknowledge the assistance provided by the following persons in conducting this assessment:
Mr Adam Faulkner – Tweed Shire Council
Mr Ian Percy – Tweed Shire Council

© November 2008: Benjas Pty Ltd

DISCLAIMER

Any representation, statement, opinion or advice, expressed or implied in this publication is made in good faith, but on the basis that Benjas Pty Ltd shall not be liable (whether by reason of negligence, lack of care or otherwise) to any person or company for any damage or loss whatsoever, which has occurred or may occur in relation to that person or company taking or not taking (as the case may be) action in respect to any representation, statement of advice referred to herein.

Table of Contents

1.0 Background 1

2.0 Project Objectives 1

3.0 Project Methodology 1

4.0 Tweed Shire Council Base Line Information for Consideration 2

5.0 Tweed Shire Council Waste Statistics 4

6.0 Waste Composition 5

6.1 Regional Municipal Waste Characterisation Study 5

6.2 Composition of the Residential Garbage Stream 5

6.2.1 Composition of the Domestic Waste Stream 6

6.3 Greenwaste General Composition 7

6.4 Commercial and Industrial Streams Composition by Volume 7

6.5 Construction and Demolition Streams Composition by Volume 8

6.0 Alternate Waste Treatment Facilities 8

6.1 Situation Analysis 8

8.0 Australian Context 9

8.1 Mechanical Biological Treatment (MBT) 10

8.2 Thermal Treatment or Waste-To-Energy (WTE) 11

8.2.2 Co Generation 11

8.2.3 New Thermal Processes 11

8.2.4 Pyrolysis 12

8.2.5 Gasification 12

8.3 Combination of both WTE and MBT 12

9.0 Currently Operating AWT Plants in Australia 12

9.1 Australian AWT Plants and their Location 13

10.0 AWT Processed Waste Inputs and Outputs 14

11.0 Applicability of AWT technologies for Tweed Shire Council 17

11.1 AWT Facility Waste Acceptance Criteria..... 17

11.2 Tweed Shire Council Waste Composition Applicability for Possible AWT Treatment. 18

11.3 Percentile Breakdown of AWT Treatable Tonnes and Residuals requiring management 19

12.0 Conclusion 20

1.0 Background

Tweed Shire Council has a Concept Plan and Stage 1 Project Application before the New South Wales Department of Planning that incorporates a landfill component with an estimated life span to the year 2025, based on current waste generation projections. The proposal is located on three allotments on Eviron Road, a site located adjacent to the current landfill operations at Stotts Creek.

The Department of Environment and Climate Change (DECC) in their response to the Department of Planning have provided a preliminary environmental assessment of the project.

In this response the DECC has provided comment that Council is to include as part of its submission a more detailed consideration to the investigation and reporting of available alternate waste treatment technologies or pre-treatment to landfill. As a result of this, Council commissioned an independent report to determine the validity, inclusive of the effectiveness and efficiency of and expected cost of the currently operating parameters and / or emerging alternative waste technologies that may be of use and applicable to Council to consider into the future in support of the application.

2.0 Project Objectives

The intent of the report was to conduct a desktop audit on these alternate waste processing facilities (AWT) now operating in Australia and identify any possible emerging facilities that provide Council with an independent assessment of the practicality of incorporating such alternatives into its current planning phase.

This report provides Council with a summary of the available options, and assessment of the alternate technologies.

3.0 Project Methodology

Benjas Pty Ltd has conducted a desktop assessment of the available information on alternate waste technologies operating and currently on offer to Councils in Australia with an update to potentially available but as yet non commercially proven operations. The analysis includes commentary provided for in published articles, including company annual reports, Australian Stock Exchange information, commentary obtained directly from stakeholders of some of the technology providers as well as internet and other available reports of substance and relevance.

The report provides Council with a summary of the latest information and project status for its consideration and possible inclusion as part of the forward planning process.

4.0 Tweed Shire Council Base Line Information for Consideration

It is of fundamental importance and core to the outcomes of this report that a thorough investigation and analysis of the current as well as planned waste volumes Council has control and responsibility of be completed.

The importance of this not only rests with providing guidance to Council of its range of possible options but the core requirement was to determine the specific sources and volumes of wastes available that can be processed utilising an alternate waste processing facility (AWT).

Council provides that over the last three years it has land filled on average 60,000 tonnes per annum of waste material. In 2006, the figure was 63,000 tonnes, 2007, 67,000 tonnes and 2008 projected to fall to 62,000 tonnes. The reduced total in 2007-08 is primarily due to Council's education program which has significantly increased the amount of recyclable material diverted from the domestic waste stream aligned with the introduced differential waste disposal charges for customers using its facilities particularly from outside the Council area. This has directly resulted in a major increase in the separation of green waste and of the diversion of construction and demolition waste recovered for beneficial reuse. The estimated percentage of wastes recycled has increased from an average 24% to approximately 36% of the totals. The majority of wastes being land filled are from the domestic waste sector (kerbside weekly collection) from households, and from commercial and industrial sources delivered by the private sector operators. (C&I) .

The majority of all waste managed by Council, apart from Commercial and Industrial streams, is sourced from inside the Tweed Shire Council area. It is estimated that as much as 60 % of the Commercial and Industrial waste land filled at Councils' facilities is generated directly from the adjacent Gold Coast City Council (GCC) precinct. It is noted that Councils' landfill is more centrally located to service the Southern Gold Coast Council area than for waste transporters to travel to the main GCC landfill and transfer station infrastructure, which is located at Reedy Creek and further north, at the City Links and Labrador areas.

In 2007 Council completed an extensive and comprehensive waste management strategy for the Shire. The strategy contains 35 recommendations, the majority of which involve measures to increase the diversion of recyclable materials from landfill for more beneficial reuse. The current year projected waste diversion statistics are testament to this strategy being implemented, which has seen the increase in the percentage of waste diverted from landfill.

Council is committed to continuing to implement all of the recommendations in the strategy, but it is also cognisant of the reality that not all wastes in its control can or will be recycled or reused.

Council continues to monitor the development of alternate waste and pre-treatment technologies to divert further proportions of waste from landfill, but is also acutely aware that

a one size, or solution that fits all communities, may not necessarily be practical, either for cost, or volumes of product available.

It has significant funds held in reserve which would prove adequate to finance the construction of an Alternate Waste Treatment Facility when such a technology was commercially proven and economically viable to it, but it is also mindful that regardless of the technology currently in use, all AWT facilities rely at some stage on landfill for the residuals or other technical or process failures. Until such AWT technologies are both commercially viable and proven reliant for its limited volumes of waste Council is committed to continue to implement its waste diversion initiatives but it also must rely on landfill as a core disposal option for the estimated 60,000 tonnes it manages every year.

It has identified that it must have at its disposal for perpetuity, an environmentally sound and fully engineered landfill for all of the wastes it is responsible for that are generated by its residents, thus the imperative to develop the new and expanded landfill option for this community generated waste. Council may decide and opt at some point in time to use private industry owned facilities located to the North of its boundary (SE QLD) but any decision in this regards must be both community acceptable and in the best interest long term of them, both on long term environmental and financial grounds.

Council's existing landfill at Stotts Creek has approximately two years of landfill capacity left based on current projections. Its future domestic waste collection and disposal contract commences in December 2009, and will offer a short term Contract (1 x 1 year) to complete landfilling operations by 2011. Council will then offer a longer term Contract (7 to 10 years with possible extensions) to conduct landfill operations at the proposed new site at Eviron Road. It is anticipated that Council will require landfill space to dispose of up to ten years of waste currently estimated at 60,000 tonnes per annum but reducing, following the closure of the existing Stotts Creek Landfill expected in 2010 / 11.

Allowing for a compaction ratio of 0.7 tonnes per cubic metre with cover material an additional 10%, the volume of airspace required is between 560,000 and 600,00 cubic metres. Council proposes that the Stage 1 Project Application will provide adequate landfill airspace for the future long term Contract.

5.0 Tweed Shire Council Waste Statistics

The following waste statistical information was provided by Council for consideration and is used in assessing Alternate Waste Treatment options

Solid Waste Streams 2007/08	Total Tonnes Managed	Tonnes to Landfill	Tonnes Recycled	Percentage Recycled
Domestic Waste	32,697	23,356	9,341	28.57
Commercial and Industrial	26,692	26,692	0	0
Construction and Demolition	15,365	4,274	11,091	72
Green Waste	9,537	0	9,537	100
Hazardous	694	694	0	0
Kerbside Hard Waste Collections	1,877	877	1000	53.27
Other	4,691	4,691	0	0
Bio Solids	N/A	N/A	N/A	100%
Total Waste Managed	**91,557.02**	**60,584**	**30,970**	**33.83**

6.0 Waste Composition

Prior to reporting the available AWT options to Council, it was important to review the baseline information to identify specific components of the available wastes that might be diverted to an alternate treatment plant rather than for disposal to landfill. Such an assessment can only be confirmed if the opportunity is sound, both commercially, (best value to the community) and such technology is environmentally sustainable, robust and commercially proven.

Waste auditing, or characterising the waste stream, is imperative for accurately understanding the current composition and to be able to accurately plan, predict and undertake a cost benefit analysis on various system options for improving resource recovery and increasing diversion from landfill.[1]

Tweed Council was one of the participating councils in a Regional Municipal Waste Characterisation Study co-ordinated by the North East Waste Forum for domestic waste and recycling collections in February and March 2005.

The objectives of the study at the time were to:

- determine the composition of each of the six participating councils
- determine the composition of the region as a whole and ,
- determine current performance of recycling and organics collection programs.

In addition the Council's Waste Management Services Contract requires its current waste collections contractor to conduct quarterly waste audits.

The findings of the audits have been used to identify the streams available and if diverted to an AWT facility expected to be processed at such an operation.

6.1 Regional Municipal Waste Characterisation Study

This study was co-ordinated by the North East Waste Forum and conducted by Full Circle Environmental Solutions.

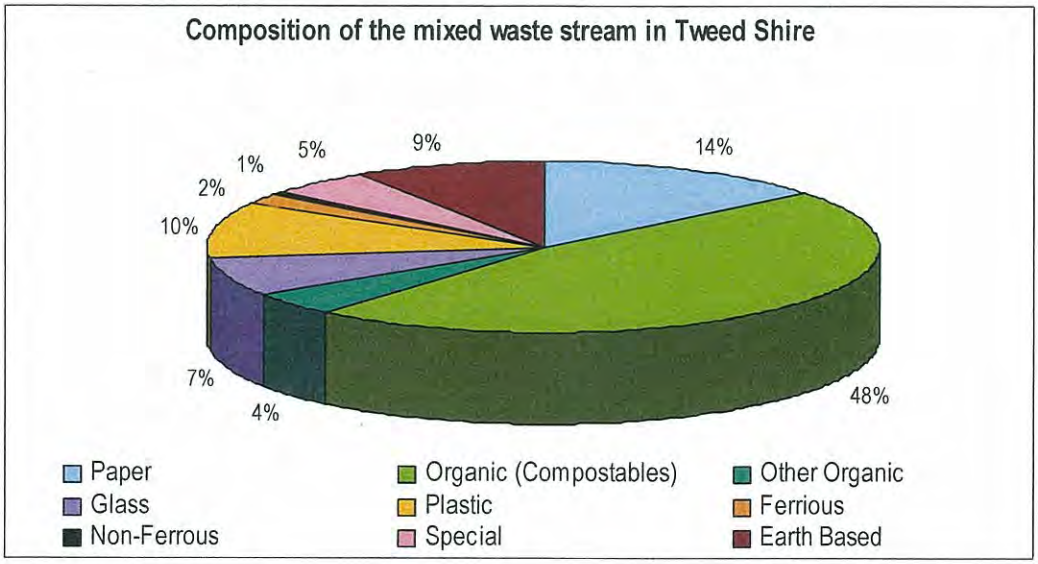
The audit at the time found that the average resident places out 17.2 kilograms of waste for collection weekly, of which 11.7 kilograms consist of garbage and 5.4 kilograms consist of recyclables, representing a diversion rate at the time of almost 27%.

6.2 Composition of the Residential Garbage Stream[2]

Organic materials were estimated to be 52%, representing the largest component of the bin contents, followed by recyclable paper and cardboard, at 14%, and glass containers at 7%.

[1] Tweed Shire Council Waste Strategy 2007
[2] Chart from Full Circle Environmental Solutions' 2005 Waste Characterisation Study of Tweed Shire Council.

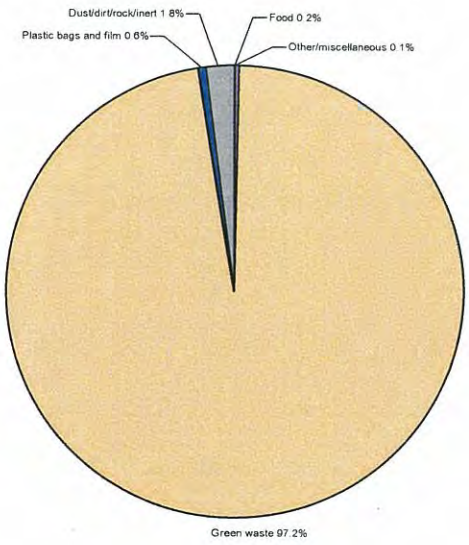
6.2.1 Composition of the Domestic Waste Stream



The audit conducted by the North East Waste forum focussed on domestic streams only, thus for the purposes of completing this report additional data for the other streams has been used from alternate waste audits which have been conducted in other New South Wales local Government jurisdictions.

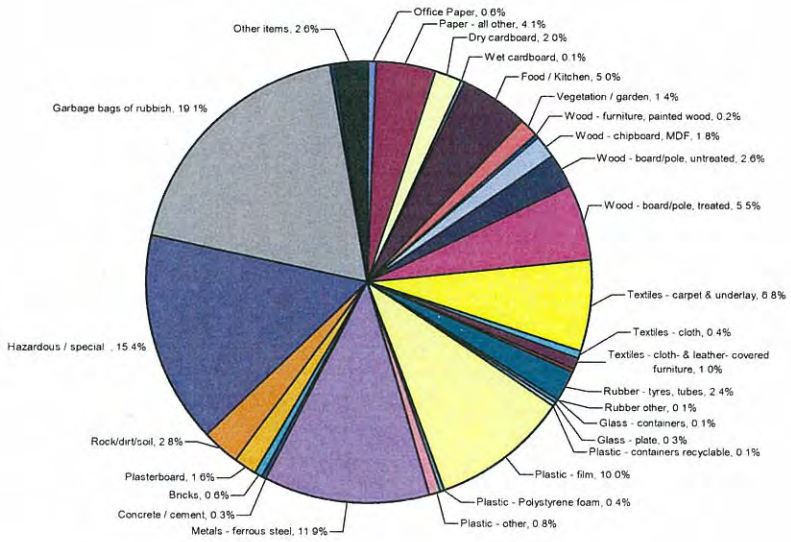
All data reviewed was been benchmarked to DECC own audit information and was found to be comparable and robust in nature for this assessment and applicable to Tweed Shire Council's waste streams.

6.3 Greenwaste General Composition



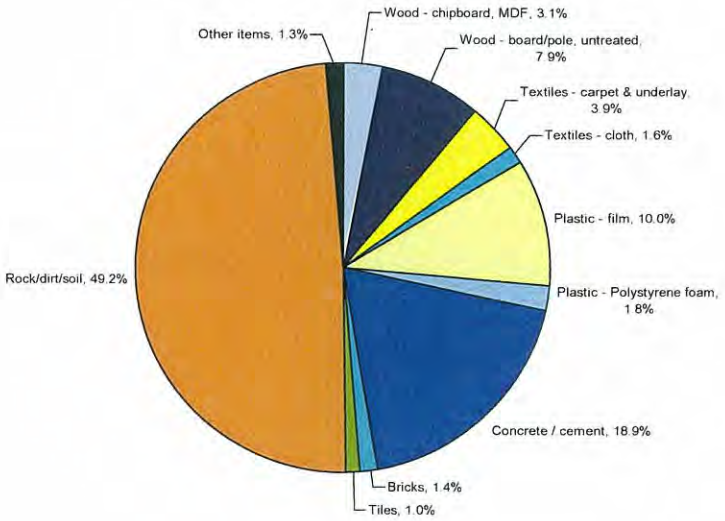
Organic composition is 97.2% of the total.

6.4 Commercial and Industrial Streams Composition by Volume



Organic streams contribute 25.5% of the total composition

6.5 Construction and Demolition Streams Composition by Volume



No significant organics stream data is reported.

Limited data is available on the actual composition of kerbside hard waste collections, however no putrescibles or green organics are collected as part of this biannual campaign. It is assumed that the other category is made up by items such as those collected by its contractor in litter and park bins thus these would be 100% processable in AWT facilities. Typically kerbside hard waste collections are items householders deem to be waste ie old whitegoods, garden items or timber and furniture thus also for the purpose of this report have been excluded from AWT options. They have no organic value to such an AWT operation, but rather are more likely to be a cost burden on such an operation.

6.0 Alternate Waste Treatment Facilities

6.1 Situation Analysis

United Kingdom specialist Juniper Consultancy Services LTD in 2007 reported that the independent review completed by it of all currently available waste technologies, assessed from more than 300 separate waste processes operating in 25 countries globally, only 43% had limited operational experience and that 25% of the total had not been operationally demonstrated[3].

The Juniper group, regarded as the world's leading independent specialist organisation on Alternate Waste Treatment processes, released a ratings report that outlined parameters for

[3] Juniper Consultancy LTD UK 2007

assessing technologies and confidence levels of commercially viable and proven outcomes and of the levels of risk associated with each.

Juniper reported that whilst there are credible technology providers, two more recent applications aside of traditional incineration processes have the greater focus and ongoing commercial development. These were:

- anaerobic digestion for bio gas applications and
- plasma systems designed to manage household waste.

In respect to the plasma technologies, Juniper's ratings unequivocally confirm none of the 39 companies' technologies are commercially proven or have been fully proven for MSW treatment, although for hazardous waste processing some have strong credentials but that very high processing costs can be expected.

It also reports that the situation is far more complex for the bio gas sector, the sector most prevalent from an Australian context for AWT processing. It found that whilst there are many proven anaerobic digestion systems available that are capable of processing singular waste streams, great care must be taken with respect to matching the technology to the feedstock to which it purports capable of processing. Municipal waste by its very nature being heterogeneous in composition provides extended complexities when advanced waste treatment is carried out. The most successful anaerobic outcomes to date have been demonstrated on single stream organic composed materials.

The best anaerobic outcomes assessed by Juniper were from single streams eg offal generated at abattoirs, or bio gas generation from farmed crops. It reports that many local authorities globally were making long term commercial decisions for managing their wastes based on largely non-commercially proven technologies[4] and cautioned against this.

8.0 Australian Context

In 2000, in response to a perceived crisis of landfill capacity and of its availability in New South Wales the State Government at the time commissioned and a report into the use and practices of Alternative Waste Treatment options.

Released and referred to as the Wright Report, the report laid claims as to the fundamental importance of developing and changing the paradigm for waste processing and disposal in Australia from landfill, to alternate treatment options and from this moment some states have with much vigour pursed this objective.

Unlike its European drivers where Alternate Waste Technologies have been driven from a crowded Europe and limited landfill expansion, in Australia the drivers have been to reduce the quantity of waste to landfill (some claims to be as high as 80 %), stabilise the organic materials, that in turn reduces long term methane generation and thus leachate formation in

[4] www.WasteReports.com

landfill. Outputs from these processes are commonly reported to be energy capture (internal plant methane generation from the process itself) compost derivatives, gas (methane) conversion for use in power generation and expanded recyclables generation.

Typically, Alternate Waste Technologies for the treatment of waste in Australia can be characterised into the following three (3) processes

- *Mechanical Biological Treatment (MBT)*
- *Thermal Treatment or Waste-To-Energy (WTE)*
- *Combination of both WTE and MBT*

8.1 Mechanical Biological Treatment (MBT)

This technology essentially splits the as received waste into 3 fractions:

- a recyclable stream (glass, mixed plastics, metals),
- converts the organic fractions into a biological stream (for composting or for anaerobic digestion or similar hybrid systems)
- the fuel stream for energy recovery.

The majority of Australian AWT facilities are hybrid operations utilising this core MBT technology. — Aerobic ; or — Anaerobic.

Typically an MBT facility is designed to operate its organic processes according to either aerobic or anaerobic processes.

8.1.1 Aerobic

This type of technology is used in a bioreactor landfill. Leachate is removed from the bottom layer of the placed waste, and is piped to a liquids storage tank, and is then re-circulated into the landfill in a controlled manner. Air is injected into the waste mass, using vertical or horizontal wells, which promote aerobic activity and accelerate waste stabilization. and gas production?.

8.1.2 Anaerobic

In an anaerobic situation, moisture is added to the waste mass in the form of re-circulated leachate and other sources to obtain optimal moisture levels. Biodegradation occurs in the absence of oxygen (anaerobically) and produces methane gas. The methane is captured to minimize greenhouse gas emissions and can be used for power generation.

It is important to note that the core technology used in these facilities relies on processing organic waste streams specifically and unless the plant is designed to produce a product directly for use in a WTE facility, the residuals or non organic streams contained in the waste inputs must be landfilled as per normal disposal practices.

8.2 Thermal Treatment or Waste-To-Energy (WTE)

Thermal waste treatment technologies are well established in Europe and North America. The first facility of this type was commissioned in Hamburg, Germany in 1890. WTE or incineration as it is more commonly known is the most widely used alternate waste treatment process commercialised globally. Energy is recovered in the form of heat and electricity, quite often used to generate and drive steam turbines that in turn are used to generate electricity. There are no mixed waste AWT thermal plants (WTE) currently operating in Australia, the closet being the application of the technology by the cement industry that uses limited and singular forms of waste material ie used tyres.

In the global perspective the standard categories for these WTE operations usually take the form of one of the following

8.2.1 Incineration

These mature technologies recover the calorific energy contained in residual waste streams. Conventional 'mass burn' incinerators use reciprocating grates to move waste through the combustion chamber, usually with a design capacity of between 200–400 tonnes per day. The stages of combustion are usually:

- drying and preheating the solid waste,
- emission and combustion, and
- burnout and residual removal.

Solid incombustible material is removed as a slag, and is typically reliant on landfill for the disposal. Flue gas from combustion contains water, combustion gases, oxygen and nitrogen. Air pollution is a critical consideration in incineration because particulates and dust, NOx acid gases and dioxins, furans, polyaromatic hydrocarbons and heavy metals may be generated depending on the process, combustion temperatures and feedstocks[5]. Some limited use of the ash or slag is used in secondary applications but in general residuals are landfilled.

8.2.2 Co Generation

Cogeneration harnesses waste heat from electricity production for useful purposes. It captures the heat that comes out of the steam or gas turbine for use in other parts of the process usually in the form of heating. The Visy Paper Mill in Brisbane utilises this technology and is an example of a company using cogeneration to capture 'waste' heat for power generation purposes. [6]

8.2.3 New Thermal Processes

Several new thermal treatment processes including gasification, pyrolysis and combinations of these, have recently been adapted and are being developed to handle municipal solid waste. These technologies require a homogeneous input stream to ensure reliable operation. For mixed municipal wastes, some form of sorting/separation pre-treatment is usually required to remove unsuitable materials and ensure consistency[7].

[5] Alternate Waste Technologies – Zero Waste SA
[6] Alternate Waste Technologies – Zero Waste SA
[7] Alternate Waste Technologies – Zero Waste SA

8.2.4 Pyrolysis

Pyrolysis treatment involves indirect heating of carbon rich material with the specific aim of achieving thermal degradation of the material typically at temperatures of approximately 500°C in the absence of oxygen and under pressure. Useable energy of some 200–400 kilowatt hour per tonne of waste is generated. Energy production and greenhouse gas production are lowered in the absence of oxygen. Heavy metals that are less volatile remain as char, while volatile species need to be captured by gas cleaning systems and treated as hazardous materials. A liquid fraction is produced which may be used, with additional processing, as a synthetic fuel oil[8]

8.2.5 Gasification

Gasification heats carbon rich material in an atmosphere with slightly reduced oxygen Most of the carbon is converted to a gaseous form, leaving an inert residue. Very high temperatures are used – around 1000° C in air or 1200° C in oxygen. Gasification is considered an energy efficient technique for reducing the volume of solid waste and for recovering energy with a heating value 10–15% that of natural gas (Environmental Engineering Corporation at www.eeco.net)9 The failed Brightstar Environmental SWERF plant attempted to commercialise a hybrid type of technology in Wollongong New South Wales in 2004. It failed due to the heterogeneous nature of the waste inputs and the inability to process and clean these effectively.

8.3 Combination of both WTE and MBT

Typically this type of facility generates two streams from the waste inputs. Outputs from the process are similar in nature to each other, the differences are one is of low calorific value, the other high. These types of facilities are common practice in Europe but as yet are not operating in Australia. The closest to such an operation in Australia is the Refuse Derived Fuel operation in Adelaide, South Australia, operated by Adelaide Brighton Cement.

The low calorific value fuel is usually land filled as it has a high inert or similar structure, the high calorific value product generated from the timber, plastic and textile, paper and cardboard streams is used for a fuel to co fire or single fire a facility, eg cement kiln or furnace.

9.0 Currently Operating AWT Plants in Australia

For the purpose of this report the context of AWT reporting in Australia is focussed on treatment options for Council controlled wastes only. Some single stream Waste Treatment plants are operating in some states but these are largely used to power internal and on site operations only. They are not covered nor reported in the context of this report.

Australia currently has 13 operating Alternate Waste Treatment facilities that are treating Council generated and other commercially mixed wastes. The facilities are located in four States. New South Wales has the greatest concentration with six, Western Australia has four

[8] Alternate Waste Technologies – Zero Waste SA
[9] Alternate Waste Technologies – Zero Waste SA

with a fifth currently being commissioned, Victoria one with a second facility announced and Queensland one.

All of the assessed technologies use a hybrid of, or single MBT technology of Aerobic or Anaerobic processes. The principal driver for these being the high cost of landfill disposal and in the Western Australia example the geographical challenges the state has with respect to locating landfills in water table impacting environs being pivotal for these developments.

9.1 Australian AWT Plants and their Location

Company	Location and Capacity	Waste Streams Managed	Technology
Global Renewables ***WSN Environmental***	Eastern Creek 150,000 -250,000 tonnes MSW Streams	MSW Only Limited Wet C&I Streams	Hybrid Anaerobic / Aerobic processing
Veolia Environmental Transpacific Joint Venture	Camellia 50,000 tonnes	Market wastes and, commercial organic streams only	Anaerobic Only
Sita Environmental	Port Stephens, and Cairns 110,000	MSW organic streams, Biosolids and Organics in C&I waste streams	Anaerobic in vessel
Remondis	Port Macquarie 20,000 Clean Organics only	Source Separated garden waste and commercially sourced organics and biosolids	Aerobic Processing
Bio Mass Solutions	Coffs Harbour 40,000 tonnes MSW Garden Organics Tunnel Composting	MSW mixed waste autoclaved Green Waste for rehabilitation purposes	Autoclaving of MSW, and in tunnel Composting for Green waste.
Commercial Organics	Dandenong Victoria Unknown Capacity	Household Green Waste and source separated Organics	Aerobic MBT
Sita Environmental	Kwinana Food Organics and Biosolids Only Unknown Throughput	Food Organics and Biosolids Only	Aerobic MBT

EMRC Perth WA	Canning Vale 100,000 Capacity	MSW Organics, Biosolids only	Anaerobic in vessel
Anaeco ***Under Construction***	Shenton Park 55,000 tonnes MSW Only	MSW Organics only	Hybrid Aerobic / Anaerobic
Atlas	City of Stirling 60,000 MSW only, limited C&I	MSW Organics	Aerobic MBT
Arrow Bio ***(WSN Environmental)***	Jacks Gully Facility New South Wales	MSW Streams Only Composting in Tunnel	Anaerobic Water based Technology
SITA Environmental Solutions	Elizabeth Drive Landfill 40,000 Tonne Food and Separated Organics 80,000 Residual Waste	Food and separated organics Mixed MSW wastes	Mechanical Biological Treatment Hybrid in vessel Tunnel composting operation

Under pinned by the substantive waste disposal levy in New South Wales, Sydney currently has the highest concentration of AWT facilities of any region in the world. Melbourne is catching up with the Victorian Government announcing it wants two additional facilities under construction by 2010, supporting this policy directive with a $10 million 'Victorian Advanced Resource Recovery Initiative [10].

10.0 AWT Processed Waste Inputs and Outputs

All of the operating and under construction AWT facilities investigated have been commissioned on the basis of them processing only Council controlled and generated organic

[10] Inside Waste September - October 2008

waste streams (MSW as well as select garden wastes and bio solids).



Several of the facilities investigated do receive commercial and industrial waste streams and one in Sydney has been purpose built to process specific organic wastes only, ie market and city restaurant streams. Wastes of this type are delivered directly by private commercial sector operators to select facilities but wastes received from these sources are *sorted for their organic streams only* prior to treatment.

In all typical AWT facilities built to process MSW or similar Council managed streams , those that are capable of receiving and processing some wastes from the C&I delivered loads, separation of the organic streams must be done by an operator and an excavator in the facilities receivals hall eg SITA Bedminster facilities, prior to the plant processing these. Typically of the non processable wastes separated these are hauled to landfill for their disposal. Processing of organic streams are core to all of the technologies operating and assessed, although when researched and investigated in depth ie conversations made directly with stakeholders and reports reviewed,[11] limited real commercial information as to the full mass balance equation could be confirmed. All stakeholders contacted at select operations cited 'Commercial in Confidence' the reasons for not supplying the mass balance information, although all provided comment waste diversion from landfill was always higher than 70%.

One stakeholder stated a landfill diversion figure as high as 86% from their technology was possible (currently 70%) but when questioned regards which materials contributed to this figure over and above the organics estimate no confirmation was provided to this statement on the basis the information was 'commercial in confidence' and that recyclables were collected. Whereas another facility operator confirmed 65% diversion current with an expected estimate as high as 70%.

[11] Richard Adams , WSN, Martin Gravett, Anaeco,



Residuals for landfill

Residual waste streams requiring disposal post organic processing operations.

None of the stakeholders contacted or information obtained in a public forum [12] provided any real and actual mass balance outputs with respect to where the processed organic streams post the MBT or anaerobic treatment went, although a number reported and confirmed that these were being used for onsite remediation at landfills, and in the agricultural sector. It could not be confirmed if the organic outputs were in fact being used as a value add in these operations, although it has been confirmed that most operations post the stabilising process do send the organic fractions to either old mine sites, existing landfills and other similar sites where the materials are used for a variety of cover purposes[13]

[12] WSN, ANAECO, Individual company web sites and published marketing documents, including annual reports

[13] Pers Comms with general industry stakeholders and landfill operators



Processed Waste with Organic and Residuals Mixed

Stakeholders contacted did confirm that where separate green waste processing was being done as a part of the facility operations and separate to MSW processing, the outputs were generally sold or given to the landscape and other local agricultural markets.

The Remondis facility at Port Macquarie reports all of its organics are sold and used locally by either landscapers or in other agricultural locations. Out of specification or contaminated streams are sent to landfill. The input streams at Remondis are specialised, single organics streams such as bio solids, green waste and food waste thus contamination of these is limited as compared to mixed MSW generated operations.

A similar result has been confirmed at the SITA facility in Perth, Western Australia. Similar single stream inputs ie bio solids, green and garden wastes, food and vegetable market generated streams are processed at the facility, with quality product outputs easily marketed and used in the agricultural sector. Out of specification or contaminated batches are land filled.

11.0 Applicability of AWT technologies for Tweed Shire Council

Prior to establishing the validity for Tweed Shire Council to consider AWT, it is important to establish specifically which wastes currently land filled would be applicable and available for such technology use.

11.1 AWT Facility Waste Acceptance Criteria

All AWT facilities in Australia are confirmed as being capable of processing Domestic Waste (MSW) streams either in total or elements of these. Most facilities accept green wastes and bio solids for processing within or as separate to the core facility. Where it is processed

separately 'tunnel or in vessel' technology is used and design capability is usually in excess of 30,000 tonne modules.

Limited AWT facilities or technologies exist that accept and process mixed commercial and industrial waste streams. Where such a facility does accept these streams only the organic fraction contained within the mix is considered processable. All other components are currently land filled. Most of the identified AWT facilities accept street litter and other wastes typically under Council control. No facilities accept Construction and Demolition Wastes as a part of the product mix as they have no organic value to such an operation.

Most AWT facilities accept and use bio solids (wastes generated from Sewerage and Water Treatment Plants) as a part of their waste stream process mix. These are not considered a waste requiring possible AWT management by Tweed Shire Council as none of these wastes are currently land filled by Council. Long standing commercial arrangements ongoing are in place for the management and controlled disposal (recycling) of this particular stream.

Council has ongoing commercial arrangements in place for the processing of its green garden and other wood wastes and these are not considered available for possible processing at an AWT facility. No facility was identified as being capable of accepting for processing Hazardous or Kerbside hard wastes.

11.2 Tweed Shire Council Waste Composition Applicability for Possible AWT Treatment.

According to Council's own waste and other industry audit advice, organic percentages identified as being suitable for treatment in an AWT facility for wastes managed by Tweed Shire Council were confirmed as follows:

- *Domestic Waste (MSW)* — *52.0% Organic Streams*
- *Commercial and Industrial Wastes* — *18.5% Organic Streams*
- *Construction and Demolition Wastes* — *Nil Organic Stream*
- *Hazardous (Regulated) Wastes* — *Nil Organic Stream*
- *Kerbside Collected Hard Waste (Bulky Household)* — *Nil Organic Stream*
- *Other (including street litter bins)* — *100% AWT Suitability*

Using Council's own data and other industry benchmark percentiles the total tonnes available for possible treatment at an AWT facility have been identified as follows

Solid Waste Streams 2007/08	Total Tonnes Available	Percentile of Organic Streams	Organic Stream Tonnes	Tonnes Remaining for non AWT treatment and disposal
Domestic Waste	*23,356*	52 0 %	14,563	***8,793***
Commercial and Industrial	*26,692*	18.5 %	4,938	***21,754***
Construction and Demolition	4,274	N/A	Nil	***4274***
Hazardous	694	N/A	Nil	***694***
Kerbside Hard Waste Collections	877	N/A	Nil	***877***
Other	4,691	100%	4,691	***N/A***
Bio Solids	N/A	N/A	N/A	***N/A***
Total Tonnes Breakdown	**60,584**		**24,192**	***36,392***

11.3 Percentile Breakdown of AWT Treatable Tonnes and Residuals requiring management

The following waste quantities are managed for land fill by Council.

- *Domestic Waste (MSW)* — *23,356 Tonnes per annum*
- *Commercial and Industrial Wastes* — *26,692 Tonnes per annum*
- *Construction and Demolition Wastes* — *4,274 Tonnes per annum*
- *Hazardous (Regulated)Wastes* — *694 Tonnes per annum*
- *Kerbside Collected Hard Waste (Bulky Household)* — *877 Tonnes per annum*
- *Other non descript wastes* — *4,691 Tonnes per annum*

Total tonnes under management for land filling are estimated at 60,584 tonnes per annum

12.0 Conclusion

Of the potentially available 60,584 tonnes of wastes Tweed Shire Council landfills annually only 24,192 tonnes or 40 % of the total have been identified as being of appropriate composition for possible processing at an AWT facility.

The remaining 43,220 tonnes of mixed and general wastes representing 60 % of the total, including regulated waste streams (excluding the green organics which are processed in separate operations), all require long term sound and safe management with proper disposal by Council to maintain and protect community health standards.

Furthermore, of the possible 24,192 organic tonnes available for AWT treatment, a sustained and viable option for further reuse or treatment must be required post any AWT operation if these processed wastes are not to to be reliant on site remediation or other applications at landfills, as is mostly the case with AWT outputs in operation around Australia.

None of the commercialised AWT facilities operating in Australia have been identified as being capable of commercially operating below a 50,000 tonne design threshold limit. The current processing costs of facilities in the Sydney basin with a design capacity in excess of 100,000 tonnes throughput per annum has been confirmed at more than $100 per tonne processing cost according to stakeholder interviews..[14].

Only the Anaeco technology facility currently under development in Perth, Western Australia was deemed to be capable of being modularised to around 50,000 tonne annual capacity, and as yet the first plant has not been commercially commissioned or demonstrated. Its design capability in the future will require a single MSW stream of 50,000 tonnes and the technology cannot use biosolids , green organics en masse, or C&I streams in its operation.

Future Anaeco plants with 50,000 tonnes capacity of MSW only streams will incur a processing cost of around $100 per tonne, conditional on contractual matters such as land provision for siting operations, residual disposal costs and length of contract periods.

Process rates at other facilities where stakeholders were contacted again claimed 'commercial in confidence' actual processing costs and it is publicly reported that a fee of around $ 100-$120 tonne is an industry benchmark for operations of this nature in the Sydney metropolitan area, with a design capacity of more than 100,000 tonnes.

Based on all the available evidence assessed, stakeholders interviewed reports and other research undertaken into AWT operations internationally as well as those operating within Australia, no commercial, environmental or community best value grounds can be concluded for pursuit by Council for disposing of its wastes utilising this type of technology at this point in time.

[14] Pers Comms Anaeco and WSN

Issues aside of the technology applicability itself for the available volumes, that requires finite resolution are the core facts that Council has more than 43,000 tonnes of wastes incapable of being processed at or through an AWT facility that still will require long term sound environmental disposal solutions. Residual disposal of the processed waste remains pivotal to the economics of an AWT operation, in addition to back up options in the event of facilities technical breakdown.

On the basis of the review until such time as a facility design capacity for Tweeds limited organic streams can be commercially proven and financially afforded it cannot be proven that AWT treatment is viable either on the basis of environmental or any other commercial or sound grounds.

Council should maintain a watching brief on the development of these plants for small communities but it is unlikely that in the short to medium term solutions other than sound fully engineered landfills will be proven for these small communities.

Council should also continue to maintain & build upon financial reserves in the event that an appropriate treatment technology should become available.

Council however should also be cognisant of the facts , that it may find itself in a difficult position with respect probity of the full analysis for AWT implementation in its community, alternate to using landfill for waste disposal when this is compared to using best practice landfill design and operations including gas capture.

All AWT operations have been identified as being reliant on landfill for residuals management, their process failures and in the event facilities have technical problems or are unable in some circumstances to accept and process wastes as collected, either for a day, week or longer. It is proven that in these possible and likely events a disposal solution ie sound landfill practices will always be required, regardless of the technical solution available to manage a communities wastes.

Appendix G

Community Consultation Materials

CLIENTS | PEOPLE | PERFORMANCE

17 March 2009

ADDRESS

Our ref: 41/20806/13/4491

Dear Sir/Madam,

Tweed Shire Council- Eviron Road Quarry and Landfill Proposal

GHD has been engaged by Tweed Shire Council (TSC) to undertake the Environmental Assessment (EA) associated with the Eviron Road Quarry and Landfill proposal. .

To help facilitate the exchange of information related to this project, TSC and GHD are engaging with interested stakeholders, including land owners within the Eviron Road and surrounding area. Through this process, it is hoped that an open and transparent means of communication can be established and feedback from this can be used in the decision making process to influence the outcomes of this proposal.

Attached is an information sheet outlining GHD's proposed scope of works and methodology for the EA for your review. Should you have any further queries the information sheet provides several options for your input.

Yours faithfully
GHD Pty Ltd

Alison Marszalek
Principal Environmental Engineer

Attachment: Information Sheet- Eviron Road Quarry and Landfill Environmental Assessment

GHD Pty Ltd ABN 39 008 488 373 Suite 3, 54-58 Nerang Street Nerang QLD 4211 PO Box 124 Nerang QLD 4211 Australia
T 61 7 5557 1000 **F** 61 7 5557 1099 **E** goldcoastmail@ghd.com.au **W** www.ghd.com.au

CLIENTS | PEOPLE | PERFORMANCE

17 March 2009

ADDRESS

Our ref: 41/20806/13/4489

Dear Sir/Madam,

Tweed Shire Council- Eviron Road Quarry and Landfill Proposal

GHD has been engaged by Tweed Shire Council (TSC) to undertake the Environmental Assessment (EA) associated with the Eviron Road Quarry and Landfill proposal. .

To help facilitate the exchange of information related to this project, TSC and GHD are engaging with interested stakeholders, including land owners within the Eviron Road and surrounding area. Through this process, it is hoped that an open and transparent means of communication can be established and feedback from this can be used in the decision making process to influence the outcomes of this proposal.

Attached is an information sheet outlining GHD's proposed scope of works and methodology for the EA for your review.

GHD and TSC are planning to visit landholders in the Eviron Road vicinity during the week of 6 to 9 April, 2009 and are interested in meeting with landholders to discuss the EA process, details of the project and any other issues/ or concerns residents may have in relation to this project.

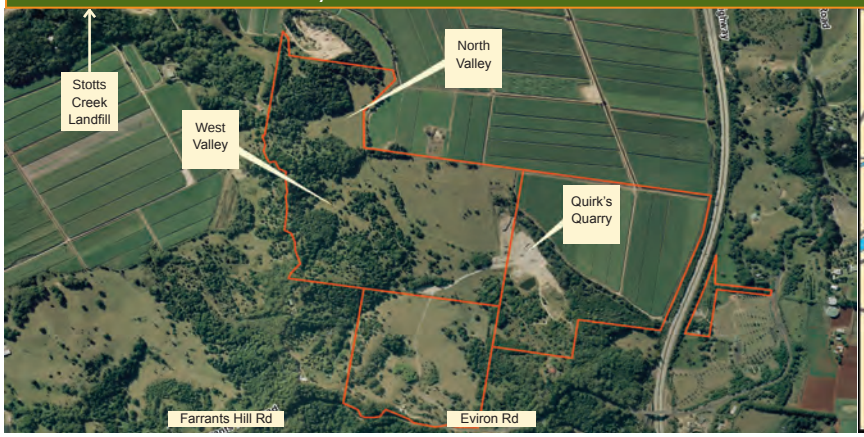
If you are interested in a meeting to discuss this proposal please contact the toll free information line on 1800 108 807.

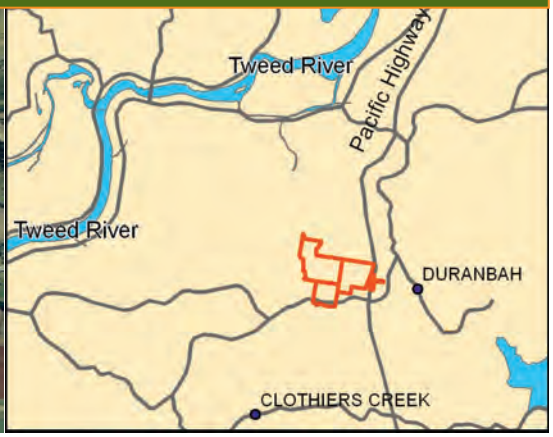
Yours faithfully
GHD Pty Ltd

Alison Marszalek
Principal Environmental Engineer

Attachment: Information Sheet- Eviron Road Quarry and Landfill Environmental Assessment

GHD Pty Ltd ABN 39 008 488 373 Suite 3, 54-58 Nerang Street Nerang QLD 4211 PO Box 124 Nerang QLD 4211 Australia
T 61 7 5557 1000 **F** 61 7 5557 1099 **E** goldcoastmail@ghd.com.au **W** www.ghd.com.au





Eviron Road Quarry and Landfill

What is the proposed Project?

Introduction

As a result of the expanding population in the Tweed area increasing pressures are being placed on local resources and infrastructure. In particular, there is increasing demand being placed on waste management services. As such, this is an area that Tweed Shire Council has identified as being of high priority to address.
Based upon Council data, it is predicted that Council's existing landfill, Stott's Creek landfill, is nearing capacity and is expected to be full by 2011. Council has been acquiring land in close proximity to this site for the purposes of investigation for use for future landfill area. Under the Tweed Local Environmental Plan 2000 (LEP) the land owned by Council is appropriately zoned (5(a) Special Purposes) for the purposes of developing a landfill. Tweed Shire Council is proceeding with investigation and design. This land is earmarked for the future Tweed Botanic Gardens.

The Landfill

A new landfill is proposed to be situated within the void created by the completion of excavations at Quirk's Quarry (just east of the Pacific Highway, off Eviron Road at Eviron). This quarry is currently in use, however is expected to exhaust the rock resources within the next two years. The landfill design will be undertaken in accordance with Best Practice Environmental Management and the NSW EPA Solid Waste Landfill Guidelines (1996) and will include:

- A fully engineered liner system;
- A leachate extraction system;
- A landfill gas extraction system;
- A comprehensive closure, post closure and site rehabilitation plan taking into account the Botanic Gardens Master Plan.

The landfill project also includes the construction of an internal haul road from the existing Stotts Creek landfill such that the existing resource recovery facilities and weighbridge at the landfill can be utilised at the new Quirk's Quarry landfill site. Council plans to fully rehabilitate the landfill at the end of its life, and the area will eventually become part of the Tweed Botanic Gardens.

The Quarry

As the existing Council quarry, Quirks Quarry will become a landfill, the proposal will also investigate situating a new Council quarry within the land at Eviron. Studies are currently underway to determine the most appropriate location and size of this new quarry, taking into particular consideration the environmental sensitivity of the area and availability of quarry resource. The proposed location of this quarry is to be either within North Valley or West Valley within the site (see map) depending upon the outcome of the initial studies. The new haul road will also service this new quarry, serving to reduce heavy vehicle traffic on Eviron Road and nearby roads.

Future Development

While Tweed Shire Council is currently applying for the landfill and quarry as described above, future development of the site is also being considered. It is intended once the resource at the first new quarry is exhausted and the Quirks Quarry landfill is at capacity, the void created by the first quarry would then be utilised as a landfill similar to the process undertaken at Quirks Quarry. Again, concurrently, a second new quarry will be developed and eventually used as a landfill. This part of the project is not expected to proceed until after 2018. Ultimately the entire site is intended to become the location for the Tweed Botanic Gardens, and site rehabilitation will consider this future landuse.

Continued over page

THE TWEED
TWEED SHIRE COUNCIL





Eviron Road Quarry and Landfill continued

Why this site?

This site was identified by Tweed Shire Council as a site suitable for quarrying and landfill in the late 1990s. While it is recognised that the site has some physical characteristics and constraints, Council has no other suitable site available for the quarry and landfill requirements of the Shire. However, as a requirement of the Environmental Assessment, alternatives and justification of the project will be investigated and addressed in the final EA report.

What has been done so far?

Council has prepared a Preliminary Environmental Assessment including an overall Concept Plan for the site which was submitted to the Department of Planning in 2008. The project was designated as a Major Project under Part 3A of the NSW Environmental Planning and Assessment Act, 1979 (EP&A Act). The Director-General of the Department of Planning has outlined a targeted assessment regime by defining key environmental issues within Director-General's Requirements. The investigation of these issues will be presented within an Environmental Assessment. The key issues are outlined in the section below.

Tweed Shire Council has engaged consultants GHD to undertake the Environmental Assessment to address the Director-General's Requirements environmental impacts of the proposed quarrying and landfilling activities. The Director-General's Requirements and the Preliminary Environmental Assessment are available online through the Department of Planning's website (www.planning.nsw.gov.au).

What studies will be undertaken for this project?

The Environmental Assessment will address general requirements of the Director-General's Requirements as well as comprise more detailed investigations from a number of disciplines including:

- Waste Management – concept design of landfill
- Quarry – preliminary quarry planning and investigations
- Soils and Water
- Stormwater Management and Erosion Control
- Noise Blasting and Vibration
- Air Quality and Odour
- Greenhouse Gas
- Biodiversity
- Transport
- Heritage (Aboriginal and Non-Indigenous)
- Visual
- Hazards
- Rehabilitation

Throughout the investigations community consultation will be conducted with various stakeholders.
Once all the studies have been undertaken, an Environmental Assessment document will be prepared. This document will be on public exhibition online and at Tweed Shire Council in Murwillumbah.

Tell us what you think

Tweed Shire Council values the Tweed community's views and thoughts and together with GHD, invite public input to the assessment process for the Eviron Road Quarry and Landfill Project.

How to have your say

If you would like further information on this project please visit Council's website or contact the Community Consultation team
Phone: 1800 108 807;
Email: waste@tweed.nsw.gov.au
Postal Address:
Tweed Shire Council
C/- The General Manager
PO Box 816,
Murwillumbah, NSW, 2484

THE TWEED
TWEED SHIRE COUNCIL

Postage Paid

TWEED shire council

Tweed Link

A TWEED SHIRE COUNCIL PUBLICATION (02) 6670 2400 ISSUE 605 MARCH 24, 2009 ISSN 1327-8630

Climb the Pinnacle of Terror at Youth Week

YOUTH Week 2009 begins with a bang with 'The Pinnacle of Terror', a free event featuring rock climbing and other activities, to be held at Murwillumbah's Knox Park from 10am-4pm on Sunday 29 March.

The five-part comprehensive program developed by ADRA (Adventist Development Relief Agency) challenges participants through adventure, team building, motivation and personal development, health and wellbeing.

The program has been designed for teenagers and is free. The only requirement is for participants to wear closed-in shoes.

Youth Homeless Matters Day is on Wednesday 1 April from 7.30am at Chris Cunningham Park next to Jack Evans Boat Harbour, Tweed Heads.

The number of homeless young people across the Tweed and Gold Coast will be symbolised by the placement of balloons by representatives of local youth services.



The Hot Chili Drummers will perform at the Chillingham Chillout Festival on Sunday, 5 April.

Sales of pancakes will go towards providing services for the Tweed's youth.

Don't miss the Tweed Youth Expo on Thursday 2 April at the PCYC and Recreation Park in Tweed Heads from 10am-4pm.

The aim of the day is to provide information on the region's youth services, activities and bands.

The Chillingham Chillout Festival is on Sunday 5 April with food, activities and performances by bands StoneMasons, Six Minutes to Midnight, Johnathon Harvey, Ill-Nation, Hot Chili Drummers and Rick Havenstein.

See next week's *Tweed Link* for more Youth Week information.

Council decides to continue with 7-Year Plan

COUNCIL has decided to continue with the implementation of the approved 7-Year Infrastructure and Services Plan and increases in the rates for general income.

The proposed increase in the general rate in 2009/10 is 9.5 per cent, subject to formal exhibition and adoption of the Budget.

Despite the proposed increase, the 2009/10 Draft Budget includes a $958,530 reduction in Council service levels due to a funding shortfall.

The particular services and programs which will need to



be deferred or reduced is yet to be confirmed.

The shortfall is the result of uncontrollable expenditure increases such as electricity and street lighting costs and a reduction in income.

It is important to note that the proposed increase is on the general rate only (not sewer and water, waste charges etc which will have increases ranging from 3.06 - 4.06 per cent), so the overall percentage increase for the total rate bill will not be 9.5 per cent.

The Draft 2009/12 Management Plan, Draft 2009/10 Budget and Draft 2009/10 Fees and Charges are being prepared for consideration at the 21 April 2009 Council meeting.

The community will have the opportunity to comment on these documents when they go on exhibition.

IN BRIEF

Author gives library Talk

EACH month, the Tweed Heads Library offers community members a chance to get together to meet others for free coffee and cake from 10am to noon and listen to informative talks and demonstrations.

On Tuesday 21 April critically-acclaimed and award-winning author Brian Ridden will talk about his life as a writer and his latest novel *Your Darling, Em.*

Bookings are essential on (07) 5569 3150.

No public holiday for WRC Rally

COUNCIL has decided not to approve a public holiday for part of all of the Tweed Shire on Friday 4 September to coincide with the proposed World Rally Championships. The holiday was seen by the event organisers as a way to support the possible revival of the Speed on Tweed event day in Murwillumbah during the Championships. Twelve submissions were received during the consultation period, with all of these opposed to the public holiday.

Restoration workshop

UPPER Tweed River Restoration Projects will hold a workshop at 3221 Kyogle Road, Mount Burrell (opposite Sphinx Rock Café) on Saturday 4 April from 9am to noon. There will be an opportunity to view two adjacent sections of creek bank being restored - one using planting, the other natural regeneration. To register call 0409 244 294 or (02) 6621 9588.

INSIDE: Two-page information sheet on Council's recycled water reuse strategy



FREE

Electronic Waste Drop Off Days

When and where:

• 8am – 3pm, Friday 3 - Saturday 4 April, 2009 at Stotts Creek Resource Recovery Centre, Leddays Creek Road, Eviron.

• Monday 30 March - Friday 3 April, 2009 at Solo Resource Recovery, 86-88 Chinderah Bay Drive, Chinderah (ph: 02 6674 7656).

Recycle your e-waste at Tweed Shire Council's free e-waste drop off days

The following items will be accepted on the drop off days:

- **computer equipment** - desktop PCs, laptops, monitors, hard drives, keyboards, computer mice, computer power supplies, network and memory cards, floppy disc and CD drives
- **business & home office equipment** - printers, scanners, mobile phones, photocopiers, fax machines, answering machines, telephones electronic games and toys - joysticks and computer game consoles
- **entertainment equipment** - televisions, videos, DVD players, hi-fi equipment, stereos, speakers, digital cameras and video cameras

The following items will not be accepted on the drop off days:

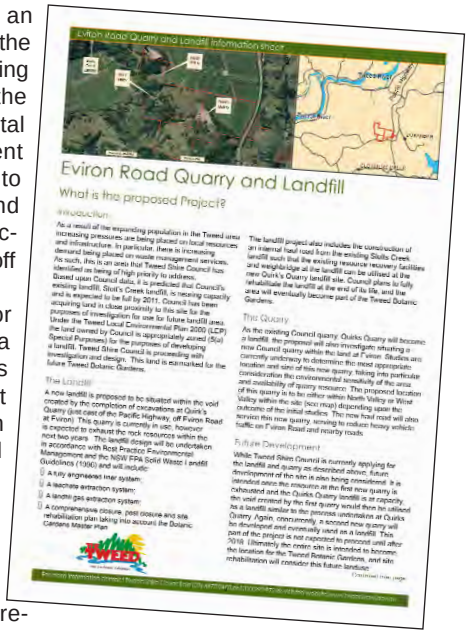
- gas bottles*, batteries*, whitegoods*,
- Smoke detectors, flourescent light tubes, vacuum cleaners, microwaves and other kitchen and household appliances

*Note: Council provides permanent facilities for the drop-off of whitegoods, gas bottles and batteries for recycling at Stotts Creek Landfill and Murwillumbah Landfill.

Enquiries (02) 6670 2694

Eviron Road quarry and landfill proposal on line

COUNCIL has an application with the Department of Planning under Part 3a of the NSW Environmental Planning Assessment Act 1979 relating to quarry, landfill and associated infrastructure at Council land off Eviron Road.


Eviron Road Quarry and Landfill

What is the proposed Project?

The Director General has issued a set of requirements that Council must address in the form of an Environmental Assessment.

Council has engaged consultants GHD to undertake the investigations to address the requirements.

Those residents deemed directly affected by the proposal will receive a letter and an opportunity to meet with Council.

However, all residents can access a fact sheet detailing further information by visiting Council's website http://www.tweed.nsw.gov.au/Waste/EvironRoad.aspx

Alternatively a fact sheet can be posted out by contacting Council's Waste Management Unit on (02) 6670 2694.

Comments on the proposal are welcomed and can be directed to Council in writing C/- General Manager, PO Box 816, Murwillumbah, 2484 or to waste@tweed.nsw.gov.au.

Residents can also make comment to Council's consultants GHD via a hotline on 1800 108 807.

Residents are advised that a formal community consultation process will commence when the Environmental Assessment is completed.

Parks may swap names

THE Tweed Heads Historical Society is campaigning to swap the names of two riverside parks at Tweed Heads.

The parks are Ebenezer Park, which runs along the Tweed River along Keith Compton Drive, and John Follent Park, near Duranbah Beach.

In a letter to Council, the Society said the Ebenezer tragedy occurred adjacent to what is now known as Follent Park and it would be more appropriate for this park to be re-named Ebenezer Park.

The Ebenezer was a 90-ton schooner which hit rocks while grounded on low tide on the north spit (near Duranbah Beach) on 30 July 1859. That night the weather deteriorated and the schooner was driven onto rocks. The crew escaped but the Ebenezer broke up so quickly that four members of the pioneering Boyd family were drowned.

John Follent Park honours Dr John Follent (1913-1996) a long-standing general practitioner in Tweed Heads and Coolangatta who was a driving force behind the establishment of a public hospital at Tweed Heads. He was also an honorary Anglican priest at St Cuthbert's Anglican Church.

According to the Society, the close proximity of both The Tweed Hospital and St Cuthbert's to the currently named Ebenzer Park is more fitting and it should be renamed Follent Park.

Comment on the proposal is welcome until 21 April. See the park renaming advertisement in this issue of the *Tweed Link*.

POSITIONS VACANT

Position Title	Ref No	Unit	Salary	Closing Date
Plant and Materials Coordinator	09-012	Works	Salary ranges between $67K - $77K per annum (dependent upon experience) *Salary is inclusive of 9% superannuation*	4:00pm 3/4/2009
Reticulation Assistant	09-013	Water	Salary ranges between $677.60 - $771.39 per week (dependent upon experience) plus 9% superannuation	4:00pm 3/4/2009
Fitter Welder Technician	09-014	Works	Salary ranges between $798.46 - $914.81 per week (dependent upon experience) plus 9% superannuation	4:00pm 3/4/2009

Applicants must obtain the vacancy information package, (AD/PD), including the Guidelines for Applicants for positions within Council which include the Full Selection Criteria. Vacancy Information packages are available from Council's website www.tweed.nsw.gov.au and the Positions Vacant Noticeboard in the reception area of the Murwillumbah Civic and Cultural Centre, alternatively email Human Resources at hru@tweed.nsw.gov.au or call (02) 6670 2495.

Successful applicants will be subject to a 3 month probationary period.

Tweed Shire Council supports Equal Employment Opportunity and has a smoke free workplace policy.

NOTIFICATION OF DESIGNATED DEVELOPMENT APPLICATION

DEVELOPMENT APPLICATION NO. DA08/1233

A designated Development Application has been lodged by Mr C Chandler seeking development consent for erection of twenty (20) power poles for supply to wholesale nursery adjacent to Clothiers Creek Road (from Sliprails Road to existing power pole on Clothiers Creek Road) located in unzoned and other zones including 7(l), 8(a), 1(c) and 2(d) at Lot 2 DP 804276; Lot 1 Road 5075; Lot 1 Road 1160, Clothiers Creek Road Bogangar; Sliprails Road and Clothiers Creek Road Tanglewood. Tweed Shire Council is the consent authority for the application.

The proposed development constitutes "Designated Development" pursuant to Section 77A of the Environmental Planning and Assessment Act, 1979 (as amended) and Clause 4(1) and Schedule 3 of the accompanying Regulation.

The development involves:

- Erection of twenty (20) power poles for the supply of electricity to private wholesale nursery
- Clearing of vegetation
- Excavation for individual footings up to 2.2 metres

The development application and the documents accompanying it, including the relevant environmental impact statement may be inspected at Council's Murwillumbah and Tweed Heads Civic Centres. The application will also be available at the Department of Planning's offices in Grafton and Sydney.

Inspection may be undertaken during ordinary office hours for a period of thirty (30) days from **Wednesday 25 March 2009 to Tuesday 28 April 2009.**

Any person may, during the above period, make a written submission to the General Manager of Council. Any person may, during the above period, make a written submission to the General Manager of Council. It should also be noted that Council has adopted a policy whereby, on request, any submission including identifying particulars will be made public. Council will give consideration to the "Public Interest" and requests for confidentiality by submitters in determining access to submission letters. However, the provisions of the Freedom of Information Act, 1989 may result in confidential submissions being released to an applicant.

Any submission objecting to the proposed development must state the ground upon which such objection is made. Further, any person who makes a submission by way of objection and who is dissatisfied with Council's determination in relation to the matter may appeal to the Land and Environment Court in accordance with Section 98 of the Environmental Planning and Assessment Act, 1979 (as amended). If a Commission of Inquiry is held, the Minister's determination of the application is final and not subject to appeal.

Please Note - Requirements regarding Disclosure of Political Gifts and Donations

A disclosure is required to be made in a statement accompanying the relevant development or planning application by a person who makes the application. In addition, a person who makes a written submission either objecting to or supporting a relevant development or planning application must also make a disclosure if the person has made a reportable political donation.

Disclosure forms are available on Councils' website http://www.tweed.nsw.gov.au/OnExhibition/DisclosureOfDonations.aspx. Further information is available on the Department of Planning's website http://www.planning.nsw.gov.au/planning_reforms/donations.asp.



Council implements recycled water reuse strategy

Commitment

Tweed Shire Council is committed to the development of viable recycled water schemes where possible. The Tweed Shire Council Recycled Water Initiative is part of Council's Integrated Water Cycle Management Strategy. This strategy includes the preparation of an Effluent Reuse Opportunites Report.

Recycled Water Opportunities

The above report identifies several potential reuse projects:

- Arkinstall Park Municipal Oval and Tweed Heads Cemetery.
- Barry Sheppard Oval, Cabarita Beach Pony Club and the Les Burger Field at Bogangar.
- The Chinderah Golf Course and the Chinderah Ti Tree Plantation.
- Council's nursery at Uki.
- Turf farm at Round Mountain Road.

Sustainability benefits

With the rapid increase in population occurring in the Tweed Shire Council area, there is an increase in demand on the potable supply system. Recycled water use will have a number of important water conservation and sustainability benefits, the key ones being:

- Substitution of potable water currently used for irrigating Council parks and reserves.
- Reduction in ground water extraction by private land owners.
- Economic benefits from developments in irrigated agriculture and industry able to access a reliable recycled water supply for restricted (non-potable) uses.
- Redirection of the nutrient loads from discharging into local waterways to a beneficial application to irrigated pastures and crops.
- Reduction in the volume of treated water released into local waterways.
- Reduction in the volume of raw water extracted from river and groundwater sources, providing enhanced protection of environmental flows and dependent ecosystems.

Continued over page





THE TWEED
TWEED SHIRE COUNCIL

- Tweed Shire Council Recycled Water Initiative is a part of Council's Integrated Water Cycle Management Strategy

Water reuse strategy continued

Existing recycled water users

Recycled water projects already in use include:

- Irrigation of the Coolangatta-Tweed Heads Golf Club which has been using recycled water for more than 20 years.
- Irrigation of the Chinderah Golf Course which was approved in January 2009 using recycled water direct from the Kingscliff Wastewater Treatment Plant.
- Council operated koala feed tree eucalyptus plantation at Uki.
- Irrigation of pasture at Tyalgum.
- Use of recycled water for cooling at Murwillumbah Sugar Mill reusing up to 100 per cent at dry weather flow from Murwillumbah Wastewater Treatment Plant.

What is recycling?

Recycling is the use of treated wastewater for beneficial use other than drinking, such as irrigation of parks, sports fields and crops, domestic garden watering and toilet flushing.

What does it involve?

There are a number of non-potable recycling options available including:

- Providing water for irrigation to local farmers, through the development of a treatment, storage and delivery system.
- Developing schemes to irrigate council-owned lands such as parks and sports fields with recycled water rather than from the drinking water supply.
- Installing 'third-pipe' systems in new developments. These systems provide recycled water to homes for use in toilets, laundries and gardens. 'Third pipe' refers to the additional pipe installed to each home, along with drinking water and sewerage pipes.



Community consultation process

This includes:

- Providing factual information to explain what recycled water is.
- Seeking feedback and allowing time for community questions to be answered.
- Providing a **FREECALL** phone line to register interest.
- Calling for submissions and feedback.
- Holding presentations, meetings and discussion days with groups and individuals.

For further information on the Recycled Water Reuse Strategy contact the FREECALL inquiry line on 1800 826 267.
Write to:
Recycled Water Reuse Strategy,
Reply Paid 1130,
Murwillumbah NSW 2484.
email:
tsc@tweed.nsw.gov.au
or visit the website:
www.tweed.nsw.gov.au

THE TWEED
TWEED SHIRE COUNCIL

- Tweed Shire Council Recycled Water Initiative is a part of Council's Integrated Water Cycle Management Strategy

PUBLIC NOTICES

COUNCIL COMMITTEES

EXPRESSIONS OF INTEREST FOR COMMUNITY REPRESENTATION

Council is calling for further expressions of interest for community representation for the following committees:

1. Sports Advisory Committee
2. Banora Point Community Centre Advisory Committee
3. Tweed River Regional Museum Advisory Committee

Council is also inviting expressions of interest for community representation for the following committees:

1. Floodplain Management Committee
2. Koala Beach Wildlife and Habitat Management Committee

For more information about the committees, go to the website www.tweed.nsw.gov.au/councilcommittees or view hard copies of the Council report 'Council Committees - Delegations to September 2012' at the Murwillumbah or Tweed Heads Council offices.
Applications close on Thursday 9 April 2009.
Please send to:
The General Manager
Tweed Shire Council
PO Box 816
Murwillumbah 2484

NAMING OF RESERVES
PROPOSAL TO INTERCHANGE PARK NAMES EBENEZER PARK AND JOHN FOLLENT PARK

Council invites comments for the proposed name interchange of "Ebenezer Park" and "John Follent Park" at Tweed Heads. Submissions or comments regarding the proposed interchange of names are requested to be lodged no later than 4.30 pm on 21 April 2009 to:

The General Manager
Tweed Shire Council
PO Box 816
MURWILLUMBAH 2484.

HOW TO ADDRESS COUNCIL

To find out how to address the Operations or Planning Committees on matters at the next Council agenda, phone (02) 6670 2540.
To book to speak at a Community Access session on matters of concern to you, also phone (02) 6670 2540. For all other Council inquiries, call (02) 6670 2400.

OPENING HOURS - TWEED SHIRE COUNCIL GARBAGE DEPOTS

Stotts Creek: Monday-Friday 7am-4pm; weekends and public holidays 10am-4pm. **Murwillumbah:** Friday, Saturday, Sunday, Monday - 10am-4pm. **Tyalgum**: Saturday and Sunday, 10am-4pm. All garbage depots are closed on Christmas Day and Good Friday. Please note last loads accepted at 3.45pm all days.

INFORMATION NEEDED?

Do you have a question about Council or its operations? You may find the answer on Council's website www.tweed.nsw.gov.au. If not, call (02) 6670 2400 or 1300 292 872.

AFTER HOURS EMERGENCIES

After hours - all Council services contact 1800 818 326

DEVELOPMENT APPLICATION DETERMINATIONS

Notification of Development Application Determinations for the purposes of Section 101 of the Environmental Planning and Assessment Act, 1979 (as amended).

LOCATION & DA NUMBER	TYPE OF DEVELOPMENT	DECISION
Lot 1 Section 1DP 20361, No. 10 Eveleigh Street, Murwillumbah DA08/0528	Childrens soft indoor play centre and kiosk (Tumbletown) ancillary to Place of Worship	Approved
Lot 10 DP 255274, No. 5 Bindaree Place, Chillingham DA08/1005	Granny flat	Approved
Lot 20 DP 873920, No. 9-11 Hall Drive, Murwillumbah DA09/0087	Shade cover for outdoor basketball court	Approved

The above development applications are available for public inspection free of charge at the Development Services Division, Murwillumbah Civic Centre, during ordinary office hours. In addition to the above applications, since the last issue of the Tweed Link a further 9 development approvals have been issued for applications that would have only required Building Approval prior to 1 July, 1998.

COMMUNITY MEETINGS

Tweed Heads Residents and Ratepayers Association meets Monday, 30 March at 7.30pm at the Opal Room at Tweed Heads Bowls Club.
Pottsville Community Association meets Tuesday, 31 March at 7.30pm at the Pottsville Community Centre. Pottsvilleca.googlepages.com

KINGSCLIFF LIONS BEACHSIDE MARKET

Always 2nd and 4th Saturday of month. Next market 28 March.

KINGSCLIFF TOWN CENTRE (SUNDAY) MARKET

29 March 2009 - Enquiries 0421 584961
All proceeds to Cudgen Headland Surf Life Saving Club

NEXT COUNCIL MEETING

The next Council meeting will be Tuesday 21 April from 4.30pm at the Council Chambers in Tumbulgum road, Murwillumbah. To book to speak at Community Access phone (02) 6670 2540. For all other Council enquiries, call (02) 6670 2400. Business papers for the 21 April meeting will be available on Council's website www.tweed.nsw.gov.au (click on *meeting information*) on Thursday 16 April.

OFFICE OPENING HOURS

Council offices at the Civic Centres at Murwillumbah and Tweed Heads are open Mondays 8am-4.45pm and Tuesdays to Fridays, 8am to 4.30pm.

The Tweed Link is published weekly by Tweed Shire Council PO Box 816, Murwillumbah NSW 2484. It is delivered free to residents and is available on audio tape. Subscriptions: non-residents $15 for six months, $30 for 12 months.
Editor Tiffany Stodart, email tweedlink@tweed.nsw.gov.au. Phone (02) 6670 2400 or 1300 292 872; Fax: (02) 6670 2429. Council's main email address is tsc@tweed.nsw.gov.au Council's agendas and minutes are available at Kingscliff, Murwillumbah or Tweed Heads libraries, council offices or through www.tweed.nsw.gov.au Council's main office is located in Tumbulgum Road, Murwillumbah. The Tweed Heads office is in Brett Street.

Appendix H

Stormwater Report

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council

Report for Eviron Road Quarry and Landfill Proposal

Stormwater and Sediment Management

November 2010



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

Contents

1. Introduction 1
   - 1.1 Project Background 1
   - 1.2 Location and Site Description 1
   - 1.3 Topography and Drainage 5
   - 1.4 Downstream Environment 5
   - 1.5 Data Collection and Review of Background Information 5
2. Catchment Delineation 6
   - 2.1 LPD A1 6
   - 2.2 LPD A2 6
   - 2.3 LPD B 6
   - 2.4 LPD C 6
   - 2.5 LPD D 6
3. Hydrologic Assessment 12
   - 3.1 Model Description 12
   - 3.2 Model Data 12
   - 3.3 Sensitivity Analysis / Model Validation 14
   - 3.4 Detention Basin Requirements 15
   - 3.5 Model Assumptions 17
   - 3.6 Model Results 17
   - 3.7 Haul Road Infrastructure Requirements 18
4. Hydraulic Assessment 20
   - 4.1 Model Description 20
   - 4.2 Model Results under Normal Conditions 21
5. Water Quality Assessment 28
   - 5.1 Objectives 28
   - 5.2 Water Quality Objectives 28
   - 5.3 Water Quality Modelling 29
   - 5.4 Water Quality Options 32
   - 5.5 Stormwater Quality Improvement Devices (SQIDs) Design Requirements 37
6. Erosion and Sediment Control Measures 41

6.1 Treatment Measure Options & Selection Criteria 41
6.2 Proposed Erosion and Sediment Control Measures 44
6.3 Maintenance Requirements 53
6.4 Monitoring Checklist 55

7. Conclusions 56

8. References 57

Table Index

Table 3-1 XP-Storm Sub-Catchment Properties Pre Development Conditions 13
Table 3-2 XP-Storm Sub-Catchment Properties Post Development Conditions 13
Table 3-3 Existing Development Comparison of XP-Storm and Rational Method 14
Table 3-4 Post Development Comparison of XP-Storm and Rational Method 15
Table 3-5 Required Area and Volume for Stage 2 Stormwater Treatment Devices for Quality and Quantity Purposes 16
Table 3-6 Total Peak Flows (m^3/s) for the Pre and Ultimate Development Conditions at the LPDs 16
Table 4.1 Hydraulic Modelling Results 21
Table 5-1 Water Quality Objectives for the Quarry / Landfill Project 28
Table 5.2 MUSIC Impervious Area Reduction Factors (Brisbane City Council, 2003) 30
Table 5.3 MUSIC Rainfall / Runoff Parameters (Brisbane City Council, 2003 & TSC USQMP) 31
Table 5.4 MUSIC Base and Stormflow Concentration Parameters (BCC, 2003 & TSC USQMP) 31
Table 5.5 Meteorological and Global MUSIC Parameters 32
Table 5.6 Mean Concentration Values at Catchment Outlets to the Drainage Channel (Existing) 35
Table 5.7 Mean Concentration Values at Catchment Outlets to the Drainage Channel (Stage 2 Ultimate) 35
Table 6.1 Erosion and Sediment Control Installation Sequence 44
Table 6.2 Required Sediment Basin Dimensions 45
Table 6.3 Potential Sediment Basin Configurations 46

Table 6.4	Mean Concentration Values at Catchment Outlets to the Drainage Channel (Existing)	47
Table 6.5	Mean Concentration Values at Catchment Outlets to the Drainage Channel (Stage 1 Ultimate)	47
Table 6.6	Open Channel Dimensions for DB 001 & 002	48
Table 6.7	Erosion and Sediment Control Maintenance Requirements	53

Figure Index

Figure 1-1	Project Extent of Works Area - Quarry and Landfill Site	3
Figure 2-1	Pre Development Delineation Plan	9
Figure 2-2	Post Development Delineation Plan	11
Figure 4-1	Pre Development Regional Flood Inundation Line	23
Figure 4-2	Post Development Regional Flood Inundation Line	25
Figure 4-3	Ultimate Development Regional Flood Inundation Line	27
Figure 5-1	MUSIC Screen Capture of Treatment Train	36
Figure 5-2	Stormwater Treatment Device Locations Plan	39
Figure 6-1	Erosion and Sediment Control Plan	49
Figure 6-2	Erosion and Sediment Control Details Plan	51

Appendices

A Rational Method Calculations

B XP Storm Results Tables

C Typical Sections Detention Areas

1. Introduction

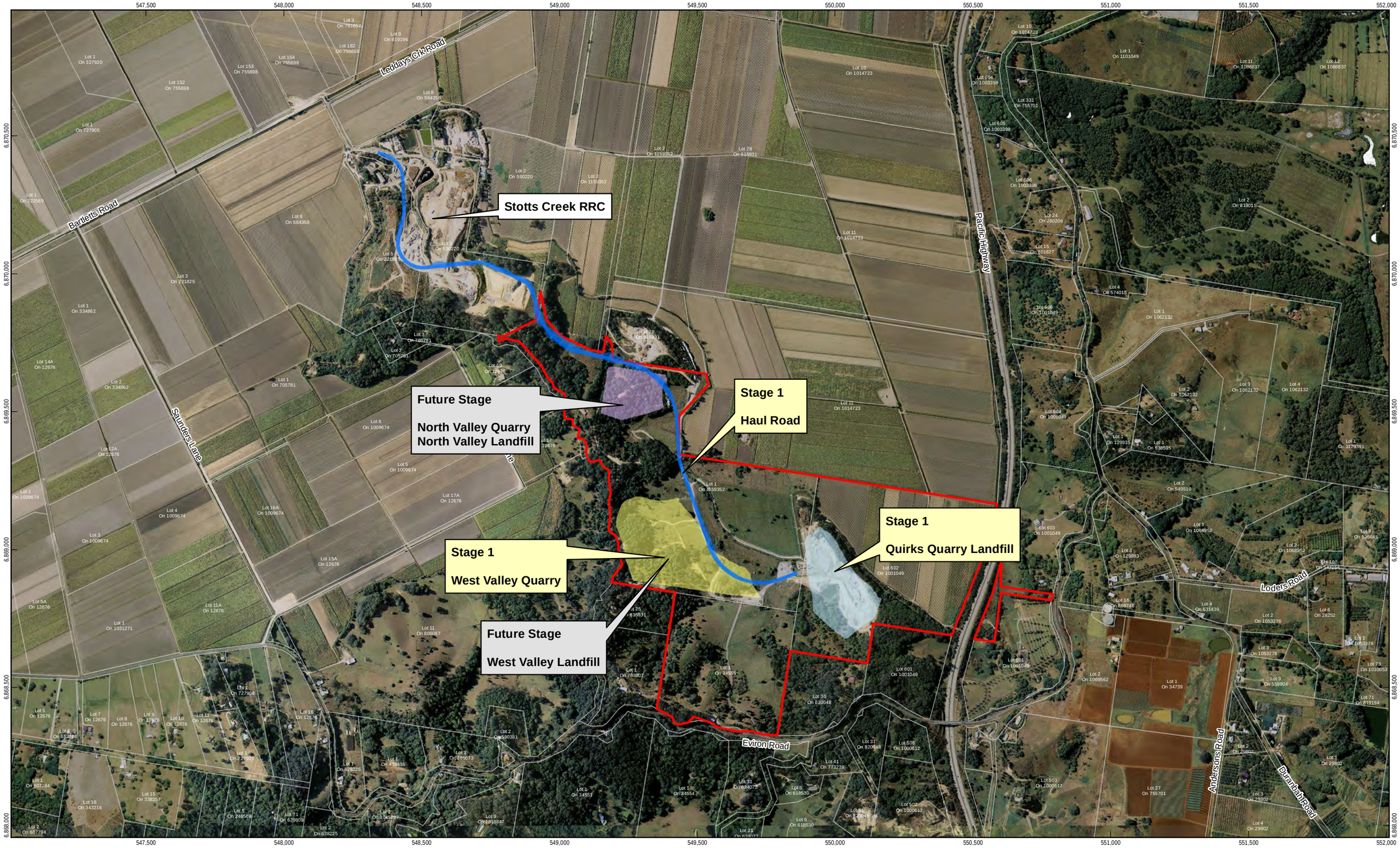
1.1 Project Background

GHD has been commissioned by Tweed Shire Council to Prepare an Environmental Assessment in accordance with the *Environmental Planning and Assessment Act 1979* for the proposed Eviron Road Quarry and Landfill site.

The report identifies potential impacts of the construction and operation of the quarry and measures required for mitigation. This report addresses the stormwater quality and quantity aspects for the proposal as well as the conceptual sediment and erosion management requirements.

1.2 Location and Site Description

The location of the quarry and landfill site falls within the Tweed Shire Council Shire adjacent to the Pacific Highway at Eviron. The council owned site is situated south of Chinderah and approximately 11.3 Kilometres northeast of Murwillumbah and 22 kilometres south of Tweed Heads (Refer to Figure 1.1 below). Specifically the quarry and landfill sites are within Lot 1 DP1159352. The quarry sites are referred to as North and West Valley which fall within Council's Special Purpose Zone 5(a). Council also owns Lot 1 on DP 34555 and Lots 601 & 602 on DP 1001049 which also falls within Zone 5(a).



1:12,500 (at A3)

0 100 200 300 400 500

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

LEGEND

- Site Boundary
- Cadastre boundary
- Landfill footprint
- West Valley footprint
- North Valley footprint
- Haul Road

GHD
CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council
Eviron Road Quarry and Landfill Environmental Assessment

Job Number 41-20806
Revision 1
Date 27 MAY 2011

Concept Plan

Figure 1.1

N:\AU\Toowoomba\Projects\41\20806\GIS\Maps\4120806_60.mxd

© 2011. While GHD has taken care to enable the accuracy of this product, GHD makes no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: Tweed Shire Council - Proposed Haul Road (2011), Aerial Photography (2008), Cadastre boundary (2010). GHD - North Valley footprint (2011), Site Boundary (2011), Landfill footprints (2009), West Valley footprint (2009).

54-58 Nerang Street Nerang QLD 4211 Australia T 61 7 5557 1000 F 61 7 5557 1000 E goldcoastmail@ghd.com.au W www.ghd.com.au

1.3 Topography and Drainage

The North Valley site consists of 3 drainage flow paths that convey surface water to a drainage channel just outside the central northern portion of Lot 1 DP1159352. Site topography varies from approximately 60 m AHD in the northwest to 3 m AHD in the east. The West Valley consists of 2 drainage flow paths that convey surface water to the same drainage channel as the North Valley where flow continues southeast until dispersing into the Stott's Channel. Site topography varies from approximately 78 m AHD in the southwest of Lot 1 DP1159352 to 3 m AHD in the northeastern portion.

Council Flood Mapping shows the 100 year ARI to be 3.9 m AHD. The eastern portion of Lot 1 DP1159352 is therefore inundated with flood back waters from the Tweed River in a regional event.

Detailed catchment information is provided in Section 2 of this report.

1.4 Downstream Environment

The ultimate receiving body is the Tweed River. Stormwater from the North and West Valley Sites flows into natural and man-made drainage channels before entering the Tweed River.

1.5 Data Collection and Review of Background Information

Contour information for the study area was obtained from the following sources:

- GIS property data supplied from Tweed Shire Council;
- Topographic map sheet of the external catchments from the Department of Natural Resources New South Wales; and
- Director Generals and State Agency Requirements.

The following previous studies for the site were also reviewed:

- Site Investigation Addressing Soils, Stratigraphy and Proposed Measures in Relation to Council Land at Eviron, NSW, April 2007, Prepared by Gilbert & Sutherland.
- Eviron Road Quarry and Landfill Proposal – Concept Plan, Stage 1 Application and Preliminary Environmental Assessment, February 2008, Engineering & Operations, Tweed Shire Council.
- Domestic Solid Waste management Strategy for Tweed Shire Council, APrince Consulting environmental management, January 2007;

GHD conducted stormwater quantity analysis to develop the mitigation measures required to maintain Pre development flow rates and minimise local and regional flooding impacts for the proposed construction works. This analysis can be viewed in sections 2 to 4.

2. Catchment Delineation

Catchments for the Landfill and Quarry sites were divided according to each Legal Point of Discharge within Lot 1 DP1159352. Existing external catchments to the west and south of the North and West Valley are referred to as Ext and the Quarry catchment boundaries which contribute to each LPD are referred to as Q. The Post development catchment delineation varies due to the reshaping of the site according to the landfill. The External catchment properties are the same for the Pre and Post development conditions and are diverted around the site to the existing drainage channel that traverses the site. The report calculations and figures cover three development conditions, Pre (Existing), Post (prior to landfill) and Ultimate (at landfill completion) Development conditions.

2.1 LPD A1

This Legal Point of Discharge is located in the North Valley site at the northern boundary line. A small external catchment contributes to the drainage flow path that traverses the north valley site in a North West direction until converging with another tributary that travels north toward Tweed River.

Refer to Figure 2.1 and 2.2 for Pre and Post Development catchment plans.

2.2 LPD A2

This Legal Point of Discharge is located in the North Valley site at the eastern boundary line. A small external catchment contributes to the drainage flow path that traverses the north valley site in a south east direction until converging with the drainage channel that travels toward Stott's Channel.

Refer to Figure 2.1 and 2.2 for Pre and Post Development catchment plans

2.3 LPD B

This Legal Point of Discharge is also located in the North Valley site at the eastern boundary line. The site sub-catchment contributes to the drainage flow path that traverses the north valley site to the east until converging with the drainage channel that travels toward Stott's Channel.

Refer to Figure 2.1 and 2.2 for Pre and Post Development catchment plans.

2.4 LPD C

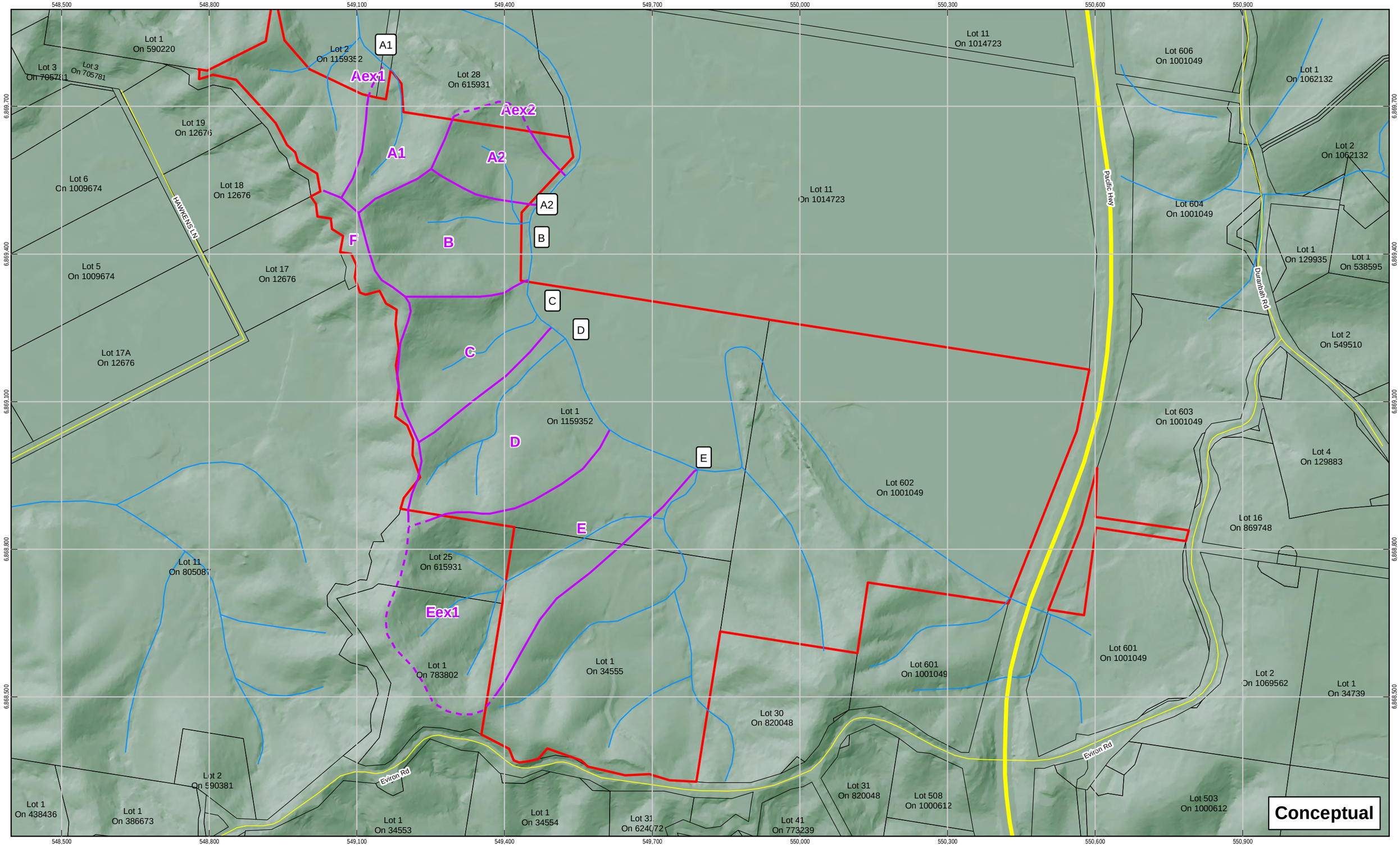
This Legal Point of Discharge is located in the West Valley site in the central portion of Lot 1 DP1159352. The site sub-catchment contributes to the drainage flow path that traverses the West Valley site to the northeast until converging with the drainage channel that travels toward Stott's Channel.

Refer to Figure 2.1 and 2.2 for Pre and Post Development catchment plans.

2.5 LPD D

This Legal Point of Discharge is also located in the West Valley site in the central portion of Lot 1 DP1159352. The site sub-catchment contributes to the drainage flow path that traverses the west valley site to the northeast until converging with the drainage channel that travels toward Stott's Channel.

Refer to Figure 2.1 and 2.2 for Pre and Post Development catchment plans.



0 100 200 300

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Site Boundary
- Existing Drainage Lines
- External Catchment Boundaries
- Quarry Catchment Boundaries
- B — Legal Point of Discharge

GHD
CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council
Eviron Quarry & Landfill Site

Job Number	41-20806
Revision	2
Date	31 OCT 2011

Pre Development Catchment Delineation Plan

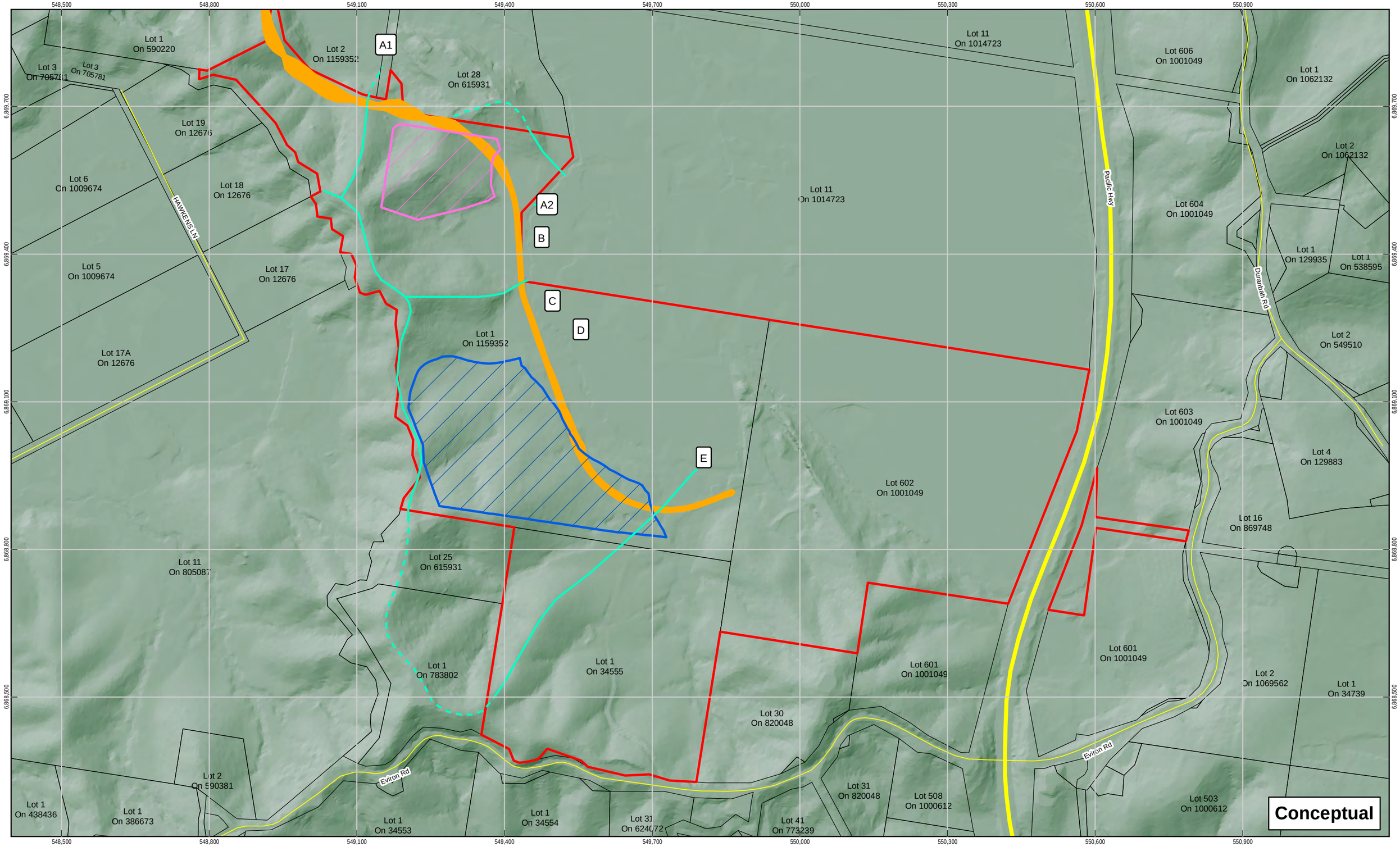
Figure 2.1

N:\AU\Toowoomba\Projects\41\20806\GIS\Maps\4120806_50.mxd

© 2011. While GHD has taken care to enable the accuracy of this product, GHD makes no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: Tweed Shire Council - Cadastre boundary (2010). GHD - Site Boundary (2011), Roads, Existing Drainage Lines, Catchment Boundaries, Legal Point of Discharge, Hillshade (Derived from Tweed Shire Council ALS data) (2010).

54-58 Nerang Street Nerang QLD 4211 Australia T 61 7 5557 1000 F 61 7 5557 1000 E goldcoastmail@ghd.com.au W www.ghd.com.au



0 100 200 300

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Site Boundary
- North Valley
- West Valley
- Existing Drainage Lines
- External Catchment Boundaries
- Quarry Catchment Boundaries
- Haul Road
- B — Legal Point of Discharge

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council
Eviron Quarry & Landfill Site

Job Number	41-20806
Revision	2
Date	31 OCT 2011

Post Development Catchment Delineation Plan

Figure 2.2

N:\AU\Toowoomba\Projects\41\20806\GIS\Maps\4120806_51.mxd

54-58 Nerang Street Nerang QLD 4211 Australia **T** 61 7 5557 1000 **F** 61 7 5557 1000 **E** goldcoastmail@ghd.com.au **W** www.ghd.com.au

© 2011. While GHD has taken care to enable the accuracy of this product, GHD makes no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: Tweed Shire Council - Haul Road (2011), Cadastre boundary (2010). GHD - Site Boundary (2011), Roads, Existing Drainage Lines, Catchment Boundaries, Legal Point of Discharge, Hillshade (Derived from Tweed Shire Council ALS data) (2010), West Valley (2010), North Valley (2011).

3. Hydrologic Assessment

Hydrologic assessment of the quarry sites has been undertaken to identify peak flow rates for the catchments under Pre, Post and Ultimate development conditions. The Pre development scenario or existing scenario is what happens in the catchments currently, Post development is what will occur after quarrying / construction, without provisions of mitigation to match existing conditions; and Ultimate development is the Post development catchments that are mitigated with devices to mimic Pre development conditions. Due to the development having two stages, quarrying and landfill, the devices proposed for mitigation will have different roles; however the sizes will remain the same. Prior to quarrying commencing sediment basins will be built to control sediment dispersion and increase in surface flows running off the cleared catchment. Upon completion of landfill, the sediment basins will be converted into wetlands. Due to the site almost replicating pre development conditions in the Ultimate scenario, requirements for detention will be minimal, however, the size of the wetland systems have been determined by the necessary water quality objectives and environmental values such as aesthetics and habitat production as well as preventing further oxidation of PASS (Potential Acid Sulphate Soils). This scenario is also concurrent with the Botanical Gardens theme of the area.

XP-Storm modelling was used to determine the critical storm durations using 10, 15, 20, 25, 30, 45, 60, 90, 120 and 180 mins to determine peak flows for the 1 year ARI up to and including the 100 year ARI of all catchments contributing to each LPD.

3.1 Model Description

XP-Storm is a runoff routing link-node model that performs hydrology and hydraulics of stormwater drainage systems. XP-Storm generates flow hydrographs, flood levels, pollutant loads or concentrations and analyses water quality control devices. The software offers all the commonly accepted methods for generating stormwater runoff and is capable of modelling and comparing multiple storm events.

3.2 Model Data

XP-Storm estimates the runoff hydrograph from an individual sub-catchment based on rainfall intensities and temporal patterns, and the definition of a series of parameters that describe the sub-catchment characteristics. These parameters include the sub-catchment area, slope, roughness, infiltration and fraction of impervious area.

Sub-catchment outflow hydrographs are routed downstream through the model via links. In XP-Storm, links take the form of either lag links or routing links. Lag links delay the hydrograph by a user specified time interval representing the time it takes for the flow to travel downstream to the next node. Routing links perform Muskingum-type channel routing calculations and require channel cross sectional dimensions and the slope, roughness and the length of the channel.

Sub-Catchment Data:

The sub-catchment areas are shown in Figures 2.1 and 2.2 are presented in the XP-Storm model by nodes at the outlet of the sub-catchment. Junction nodes are used to combine hydrographs at the junction of two or more flow paths.

Sub-catchment areas were determined digitally using ACAD software.

Sub-catchment equal-area slopes were determined using the Contour and Topographic information referenced in Section 1.5.

Sub-catchment roughness was determined based on an area-weighted average of the roughness values shown in Table 3.1.

Table 3-1 XP-Storm Sub-Catchment Properties Pre Development Conditions

Node	Area (ha)	% Impervious	Manning's (Impervious)	Slope %	IL	CL
Aex1	0.61	0	0.045	17.0	10	2
A1	2.31	0	0.045	19.5	10	2
Aex2	0.9	0	0.045	7.0	10	2
A2	3.13	0	0.045	11.5	10	2
B	6.09	0	0.045	6.5	10	2
C	6.06	0	0.045	6.5	10	2
D	8.58	0	0.045	13	10	2
Eex1	7.47	0	0.045	21.5	10	2
E	9.72	0	0.045	11	10	2

Note: IL = Initial Loss (mm), CL = Continuing Loss (mm).

Table 3-2 XP-Storm Sub-Catchment Properties Post Development Conditions

Node	Area (ha)	% Impervious	Manning's (Impervious)	Slope %	IL	CL
Aex1	0.61	0	0.045	17.0	10	2
A1	0.37	0	0.045	19.5	10	2
Aex2	0.90	0	0.045	7.0	10	2
A2	2.34	0	0.045	11.5	10	2
B	10.38	3	0.015	6.5	10	2
CD	16.76	3	0.015	4	10	2
Eex1	7.47	0	0.045	4	10	2
E	8.33	0	0.045	11	10	2

Note: IL = Initial Loss (mm), CL = Continuing Loss (mm).

As mentioned in Section 2 and depicted in Tables 3.2 and 3.3 above, external catchment properties remain unchanged other than a bypass channel conveying flows around the quarry / Landfill sites and into the drainage channel that flows to Stott's Channel. The significant changes between Pre and Post Development is the Manning's properties, existing vegetation is cleared and therefore provides less attenuation and retention of stormwater which creates an increase in flow rates.

3.3 Sensitivity Analysis / Model Validation

The XP-Storm model results were compared to the rational method results as a cross check to determine whether the parameters adopted within the Runoff Routing model are reasonable. While the Rational method is only an estimation of the Peak flow rate exiting the catchment, the runoff routing results should be in the same range as the magnitude of the XP-Storm hydrographs for each catchment.

A comparison of the XP-Storm and Rational Method peak flow rates for the 2, 50 and 100 year ARI event can be viewed in Tables 3.3 and 3.4 below.

Full Rational method calculation details and XP Storm Results are Presented within Appendix A and B respectively at the end of this report.

Table 3-3 Existing Development Comparison of XP-Storm and Rational Method

Catchment	Peak Flow (m3/s)					
	2 Year ARI		50 Year ARI		100 Year ARI	
	XP	Rational	XP	Rational	XP	Rational
Aex1	0.165	0.08	0.337	0.20	0.383	0.24
A1	0.7	0.31	1.378	0.78	1.555	0.94
Aex2	0.266	0.12	0.527	0.29	0.596	0.35
A2	0.863	0.44	1.751	1.09	1.986	1.30
B	0.97	0.81	2.262	2.03	2.626	2.43
C	0.998	0.76	2.351	1.91	2.723	2.28
D	1.345	1.10	3.123	2.77	3.627	3.30
Eex1	1.875	1.04	3.91	2.59	4.453	3.11
E	1.299	1.16	3.079	2.93	3.532	3.52

Table 3-4 Post Development Comparison of XP-Storm and Rational Method

Catchment	Peak Flow (m3/s)					
	2 Year ARI		50 Year ARI		100 Year ARI	
	XP	Rational	XP	Rational	XP	Rational
Aex1	0.165	0.08	0.337	0.20	0.383	0.24
A1	0.147	0.06	0.259	0.14	0.288	0.17
Aex2	0.266	0.12	0.527	0.29	0.596	0.35
A2	0.644	0.33	1.308	0.81	1.483	0.97
B	2.887	1.60	5.826	3.94	6.603	4.71
CD	2.79	2.37	6.685	5.91	7.726	7.09
Eex1	1.875	1.04	3.91	2.59	4.453	3.11
E	1.114	1.00	2.641	2.51	3.029	3.02

As can be seen in Table 3-1 to 3-4, there is a reasonable level of increase between the flow rates predicted by XP-Storm and those derived using the Rational Method. It is concluded that the XP-Storm model produces more conservative results to an acceptable level of accuracy for the purposes of this report.

3.4 Detention Basin Requirements

Detention areas were modelled within the XP-Storm model to attenuate the increase in runoff from the additional development works for the quarrying and landfill processes. Percentage increase values can be viewed within Appendix B of this report. The initial sizes of these systems were determined by the sediment production yield and water quality results presented in sections 5 and 6 of this report.

To maintain Water Quality Objectives, minimum sizes of treatment devices were proposed according to the capacity requirement of the calculated sediment accumulation volumes as well as supported by MUSIC modelling. The XP-Storm models were run various times to achieve both stormwater quantity and quality objectives. Detention basin locations can be viewed in Figure 5.2 and 5.3. Cross section details can be viewed in Appendix C of this report. The detention basins have 100 Year ARI regional flood immunity. All basins will be fenced to prevent access due to depth and size of the systems.

Ultimate (Mitigated) flows and water levels are shown in Table 3.5. A summary of the total peak flow rates from the Pre and Ultimate development at each LPD can be viewed in Table 3.6. As depicted in Table 3.6 the proposed detention areas Presented in Table 3.5 maintain Pre development flow rates in the Ultimate development scenario.

Table 3-5 Required Area and Volume for Stage 2 Stormwater Treatment Devices for Quality and Quantity Purposes

					100 yr ARI Peak flows m3/s			WL 20yr	WL 100yr
Legal Point of Discharge	**Minimum Area (m^2)**	**Treatment Depth (m)**	**Storage Depth (m)**	**Total Volume (m^3)**	Pre	Ultimate	Diff	Depth* (m)	Depth* (m)
B	6,835	0.25	0.80	5,040	2.625	2.525	-3.77%	0.61	0.70
C & D	9,500	0.25	0.80	7,310	6.345	4.15	-34.67%	0.63	0.69

Table 3-6 Total Peak Flows (m^3/s) for the Pre and Ultimate Development Conditions at the LPDs

Legal Point of Discharge	**1 year ARI**			**2 year ARI**			**10 year ARI**			**20 year ARI**			**50 year ARI**			**100 year ARI**		
	Pre	Ult	Diff %	Pre	Ult	Diff %	Pre	Ult	Diff %	Pre	Ult	Diff %	Pre	Ult	Diff	Pre	Ult	Diff %
A1	0.59	0.21	-63%	0.83	0.29	-64%	1.30	0.45	-65%	1.55	0.54	-65%	1.68	0.58	-65%	1.90	0.65	-65%
A2	0.76	0.61	-19%	1.09	0.88	-19%	1.72	1.38	-19%	2.06	1.66	-19%	2.24	1.80	-19%	2.54	2.04	-19%
B	0.68	0.42	-38%	0.97	0.71	-27%	1.60	1.23	-23%	1.93	1.64	-14%	2.26	2.06	-8%	2.62	2.53	-3%
CD	1.64	0.52	-68%	2.34	0.76	-67%	3.86	1.96	-49%	4.67	2.64	-43%	5.48	3.36	-38%	6.35	4.15	-34%
E	1.95	1.84	-5%	2.77	2.59	-6%	4.58	4.29	-6%	5.55	5.20	-6%	6.46	6.05	-6%	7.44	6.96	-6%

Note: * This is the depth above the permanent standing water level of the wetland / sediment pond system.

Detention Basin Sections showing weir heights, length, basin stage storage characteristics etc, can be viewed in Appendix C of this report.

3.5 Model Assumptions

Channel USIL and DSIL data not supplied by the data mentioned in section 1.5 was interpolated based on the closet contour to the channel. All entry and exit losses to all proposed pipes have been modelled as 0.5 and 1.0 respectively as a conservative approach. All proposed caged riser inlets have been modelled with a 50% blockage factor and weirs have been sized to convey the 100 year ARI event.

3.6 Model Results

XP-Storm results for the critical storm duration and peak flow rates for the 1 Year ARI up to and including the 100 Year ARI are presented in Appendix B.

A summary of the XP-Storm modelling results in the Post-Mitigated scenario is provided in Table 3.4.

A summary of the required area for local flood mitigation and treatment can be viewed in Table 3.5. As depicted in Table 3.6 the proposed detention areas presented in Table 3.5 maintain Pre Development (existing) flow rates in the Ultimate development scenario.

3.6.1 Model breakdown:

LPD A1 – In the pre development case, a 0.94ha catchment flows north toward LPD A1 where Aex1 joins the flow path near the central northern boundary of Lot 1 DP1159352 as indicated in Figure 2.1.

In the Post Developed and Ultimate scenarios the external catchments remain the same however catchment A1 is reduced significantly due to the most of this catchment now converging with catchment B for quarrying and land fill purposes. The proposed haul road cuts through catchment A1 and what is left north of the haul road is unchanged and contributes to LPD A1, the area within to the south of the road contributes to LPD B. Refer to Figure 2.2.

Due to an overall catchment reduction no mitigation is required for catchment A1.

LPD A2 – In the pre development case catchments Aex2 and A2 flow south east toward LPD A2 as depicted in Figure 2.1.

In the Post Developed and Ultimate scenarios the external catchments remain the same however catchment A2 is reduced due to the proposed haul road that cuts through catchment A2 and as above in catchment A1, what is to the left north of the haul road is unchanged and contributes to LPD A2, the area within to the south of the road contributes to LPD B. Refer to Figure 2.2.

Due to an overall catchment reduction no mitigation is required for catchment A2.

LPD B – In the pre development scenario, flows from catchment B travel east along the existing drainage flow path to LPD B on the northern lot boundary as indicated in Figure 2.1.

There are no external catchments associated with this catchment.

In the Post Developed and Ultimate scenarios catchment B is increased in area by including parts of Catchment A1, A2 and F. Mitigation is required in the form of a detention area of which consists of two functions. In the “Stage 1” process the detention area will act as a sediment basin to collect all sediment that flows off the cleared land during quarrying and land filling. Upon completion of the landfill “Stage 2” and rehabilitation of the area is complete, the sediment basins will be converted into wetlands. The size of the system remains the same in both stages and was determined by sediment volume requirements

shown in Section 6 of this report. Final sizes have been confirmed using runoff routing software XP Storm. The pre development flow rates are maintained in both Stages 1 and 2 as shown in Table 3.5 and Appendix B of this report. The outlet of this detention system disperses into the existing channel through 4 x 375mm culverts at a 100 year ARI flow of 0.9m3/s and velocity of 2m/s. The remaining flows pass over the road which will be designed as a spillway at the basin weir location. Refer to Appendix C for detention basin section details.

All outlets are to be scour protected up to a distance of 4 x diameter of the outlet pipe.

LPD C and D – In the pre development scenario, flows from catchments C and D travel north east along the existing drainage flow paths to LPD C and D in the western portion of the council owned lot. Refer to Figure 2.1.

There are no external catchments associated with this catchment.

In the Post Developed and Ultimate scenarios catchments C & D are combined in area and includes part of catchment E and the remaining portion of catchment F. Mitigation is also required in the form of a detention area as per catchment B of which consists of two functions. In the “Stage 1” process the detention area will act as a sediment basin to collect all sediment that flows off the cleared land during quarrying and land filling. Upon completion of the landfill “Stage 2” and rehabilitation of the area is complete, the sediment basins will be converted into wetlands. The size of the system remains the same in both stages and was determined by sediment volume requirements shown in Section 6 of this report. Final sizes have been confirmed using runoff routing software XP Storm. The pre development flow rates are maintained in both Stages 1 and 2 as shown in Table 3.5 and Appendix B of this report. The outlet of this detention system disperses into the existing channels through 2 x 2 x 375mm culverts at a 100 year ARI flow of 0.475m3/s and velocity of 2.2m/s per pair. The remaining flows pass over the road which will be designed as a spillway at the basin weir location. Refer to Appendix C for detention basin section details.

All outlets are to be scour protected up to a distance of 4 x diameter of the outlet pipe.

LPD E – In the pre development case catchments Eex1 and E flow north east toward LPD E as depicted in Figure 2.1.

In the Ultimate case the drainage regime is the same except with the reduction to catchment E which in affect reduces the peak runoff and ameliorates the need for a mitigation device.

A summary of the XP-Storm modelling results in the Ultimate scenario is provided in Table 3.4.

3.7 Haul Road Infrastructure Requirements

A number of road culverts have been proposed to pass under the proposed haul road from the quarry areas and into the existing drainage channel. These include:

- 4 x 600mm RCPs at the tributary crossing between the Stott’s Creek landfill Site and proposed North valley Site (approx. 5ha catchment, tc of 18mins with approach flow of 2m^3/s);
- 4 x 375mm RCPs at LPD B;
- 2 x 375mm RCPs at LPD C;
- 2 x 375mm RCPs at LPD D; and
- 4 x 600mm RCPs at LPD E.

Refer to Section 4 for hydraulic assessment. The first 4 x 600mm RCPs are not included in the hydraulic modelling. Upon design finalisation of the proposed haul road, peak flow rates will be determined and culvert sizing will be performed for this catchment, however due to it being outside the proposed quarrying / landfill site, detailed calculations have not been performed.

4. Hydraulic Assessment

An hydraulic assessment has been undertaken to identify the affects of peak flood levels and the extent of flooding inundation at the quarry sites under Pre, Post and Ultimate development conditions. The XP-Storm hydraulic model was used for the hydraulic assessment. The hydraulic assessment was undertaken for the 100 year local ARI flood events during the Tweed Shire Council (TSC) recorded Regional peak flood level of 3.9 m AHD.

While the haul road has been designed to act as a levee bank preventing back water from the Tweed River from entering the quarry sites, the outlets of the sediment basins / Wetlands will be affected by the tail water level of the regional flood. These basins will be checked through modelling to assess whether the system is adequately sized to prevent flooding of the quarry sites from the contributing local catchments and can still drain accordingly.

4.1 Model Description

XP-Storm was used for the hydraulic modelling of the 4 major flow paths passing underneath the proposed haul road from the catchments upstream and into the existing drainage channels that are situated within flood prone land.

Ground Roughness Values

Ground roughness was represented by the Manning's 'n' parameter. Manning's roughness values were assigned on the basis of vegetation density as observed during field inspections and/or aerial photography. The assumed roughness values varied from 0.015 for pavement areas, 0.045 for grassed areas, 0.07 for densely vegetated areas and 0.1 for forest areas.

Hydraulic Structures

A number of road culverts have been proposed to pass under the proposed haul road from the detention areas and into the drainage channel. These include:

- 4 x 375 mm RCPs at LPD B, The proposed US/IL 3.2 m AHD and DS/IL 3.1 m AHD length of 25 m and proposed road height of 4.2m.
- 2 x 375 mm RCPs at LPD C, The proposed US/IL 3.2 m AHD and DS/IL 3.1 m AHD length of 25 m and proposed road height of 4.2m.
- 2 x 375 mm RCPs at LPD D, The proposed US/IL 3.2 m AHD and DS/IL 3.1 m AHD length of 25 m and proposed road height of 4.2m.
- 4 x 600 mm RCPs at LPD E, The proposed US/IL 9.0 m AHD and DS/IL 8.7m AHD length of 25 m and proposed road height of approximately 10.0 m.

Flow Rates

Flows for the Ultimate Development 50 & 100 Year ARI Local flood events from:

- Catchment B – 2.06 m^3/s and 2.52 m^3/s respectively.
- Catchment CD – 3.364 m^3/s and 4.5 m^3/s respectively.
- Catchment E – 6.06 m^3/s & 6.96 m^3/s respectively.

Flows for 50 & 100 year ARI flood events were obtained from the XP-Storm model results.

4.2 Model Results under Normal Conditions

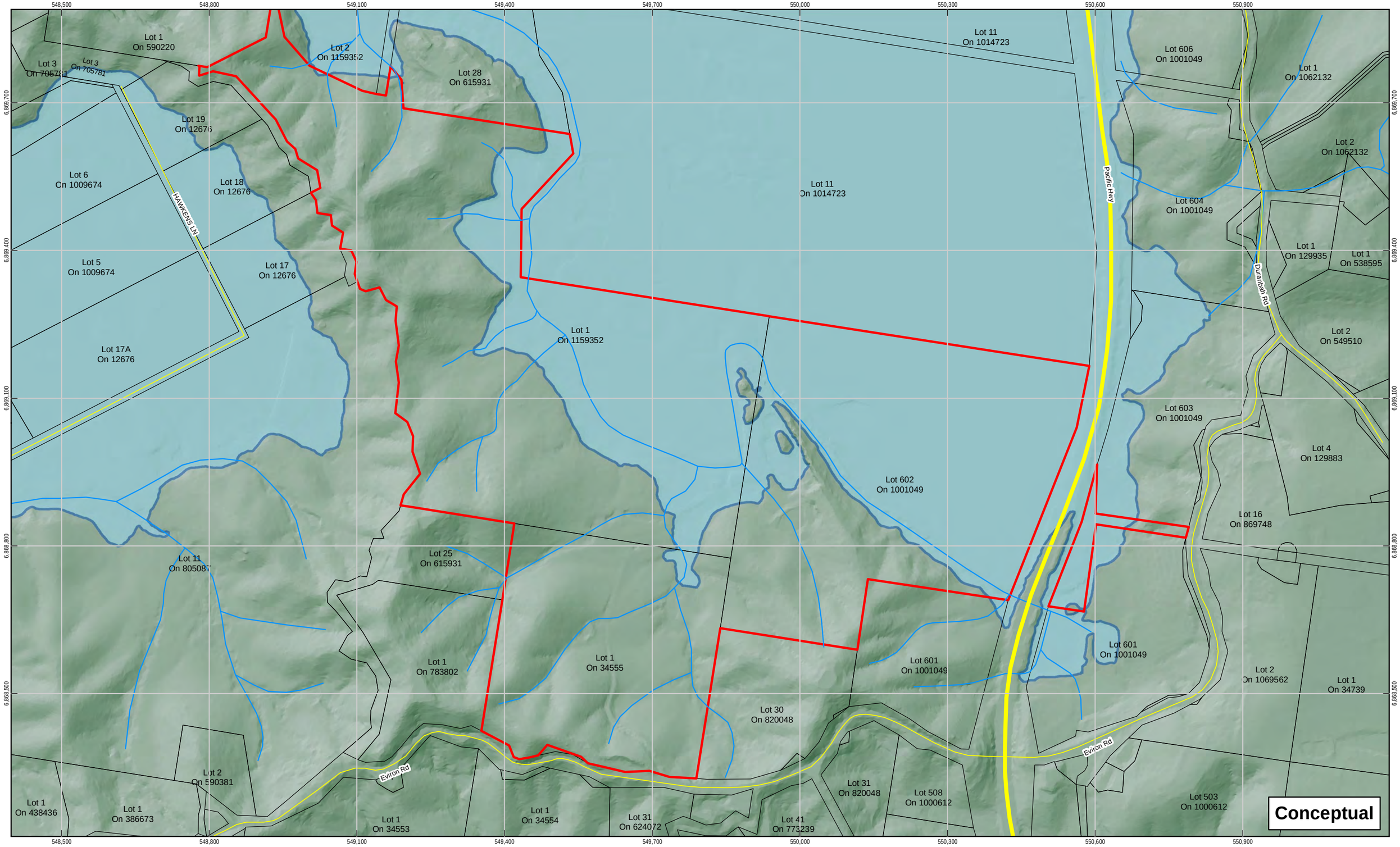
Ultimate Development case:

Table 4.1 Hydraulic Modelling Results

50 Year ARI				100 Year ARI			
Culvert	Discharge	Water Level	Weir Flow	Culvert	Discharge	Water Level	Weir Flow
B	0.9	4.36	1.585	B	0.9	4.395	1.585
C	0.45	4.36	1.964	C	0.47	4.39	2.58
D	0.45	4.36	1.964	D	0.47	4.39	2.58
E	3.425	10.25	2.52	E	3.52	10.3	3.53

A full investigation of the regional flood inundation affects are not part of the scope of this report, however regional flood levels have been shown in Figures 4.1 to 4.3 and backwater conditions at the LPD of the detention areas have been assessed through hydraulic modelling for drainage adequacy. Weir levels of the detention areas have been set 300 mm above the regional Flood level and therefore can drain adequately and are unaffected by the regional flood event tail water effects.

A flood area balance is required due to the haul road encroaching and reducing the flood storage area of Lot 1 DP1159352. It is proposed to provide cut volumes to the east of the proposed haul road to balance the difference; however, flood modelling has not been performed to verify the effects of the haul road.



0 100 200 300
Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

LEGEND

- Site Boundary
- Existing Local Flood Lines
- Existing Regional Flood Area (100 Year ARI)

GHD
CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council
Eviron Quarry & Landfill Site

Job Number 41-20806
Revision 1
Date 27 MAY 2011

Pre Development
Flood Inundation Area

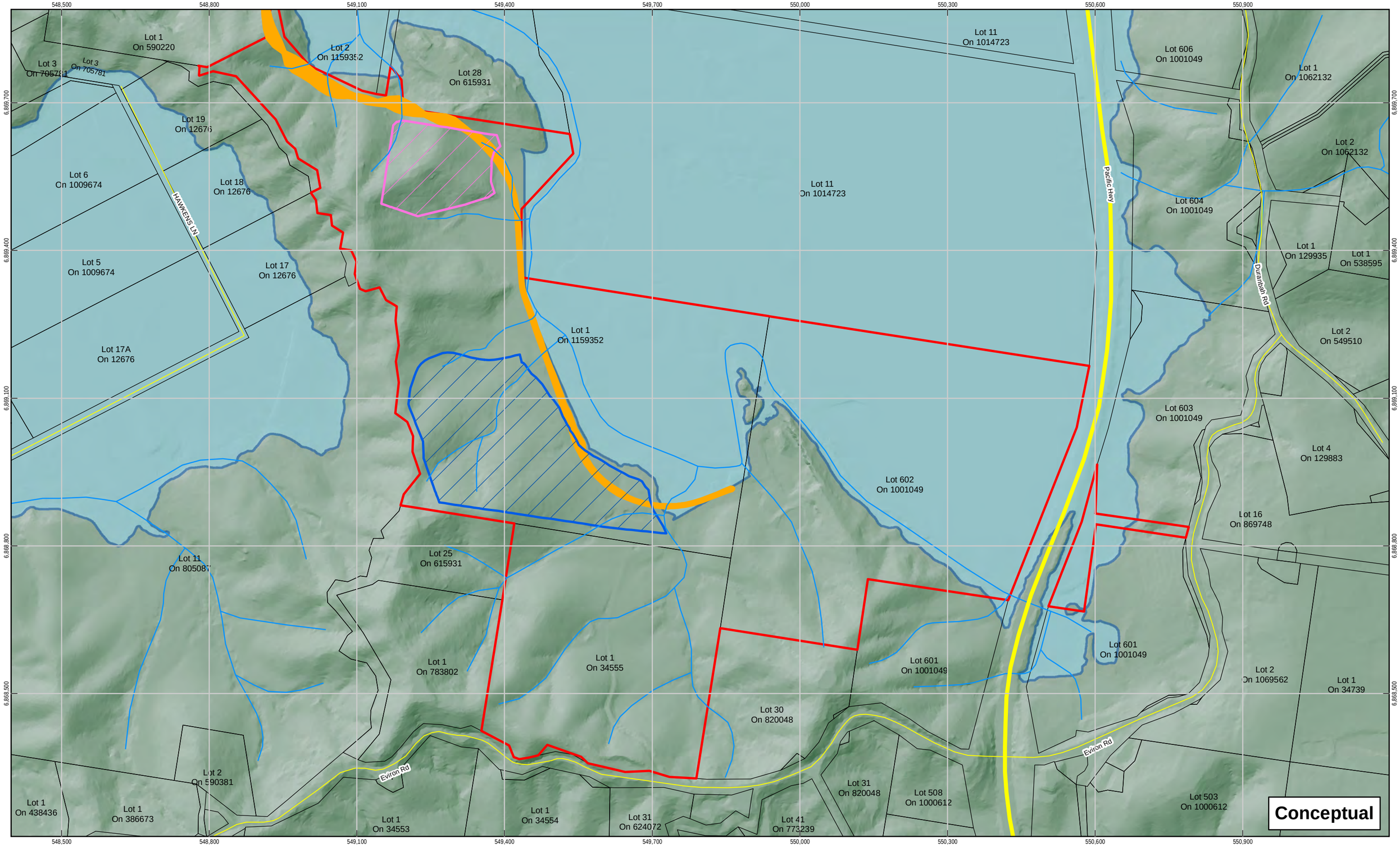
Figure 4.1

N:\AU\Toowoomba\Projects\41\20806\GIS\Maps\4120806_52.mxd

© 2011. While GHD has taken care to enable the accuracy of this product, GHD makes no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: Tweed Shire Council - Cadastre boundary (2010). GHD - Site Boundary (2011), Roads, Existing Drainage Lines, Hillshade (Derived from Tweed Shire Council ALS data), Flood Area (2011).

54-58 Nerang Street Nerang QLD 4211 Australia T 61 7 5557 1000 F 61 7 5557 1000 E goldcoastmail@ghd.com.au W www.ghd.com.au



0 100 200 300
Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

LEGEND

- Site Boundary
- North Valley
- West Valley
- Haul Road
- Developed Local Flood Line
- Developed Regional Flood Area (100 Year ARI)

Tweed Shire Council
Eviron Quarry & Landfill Site

Job Number 41-20806
Revision 1
Date 27 MAY 2011

Post Development Flood Inundation Area

Figure 4.2

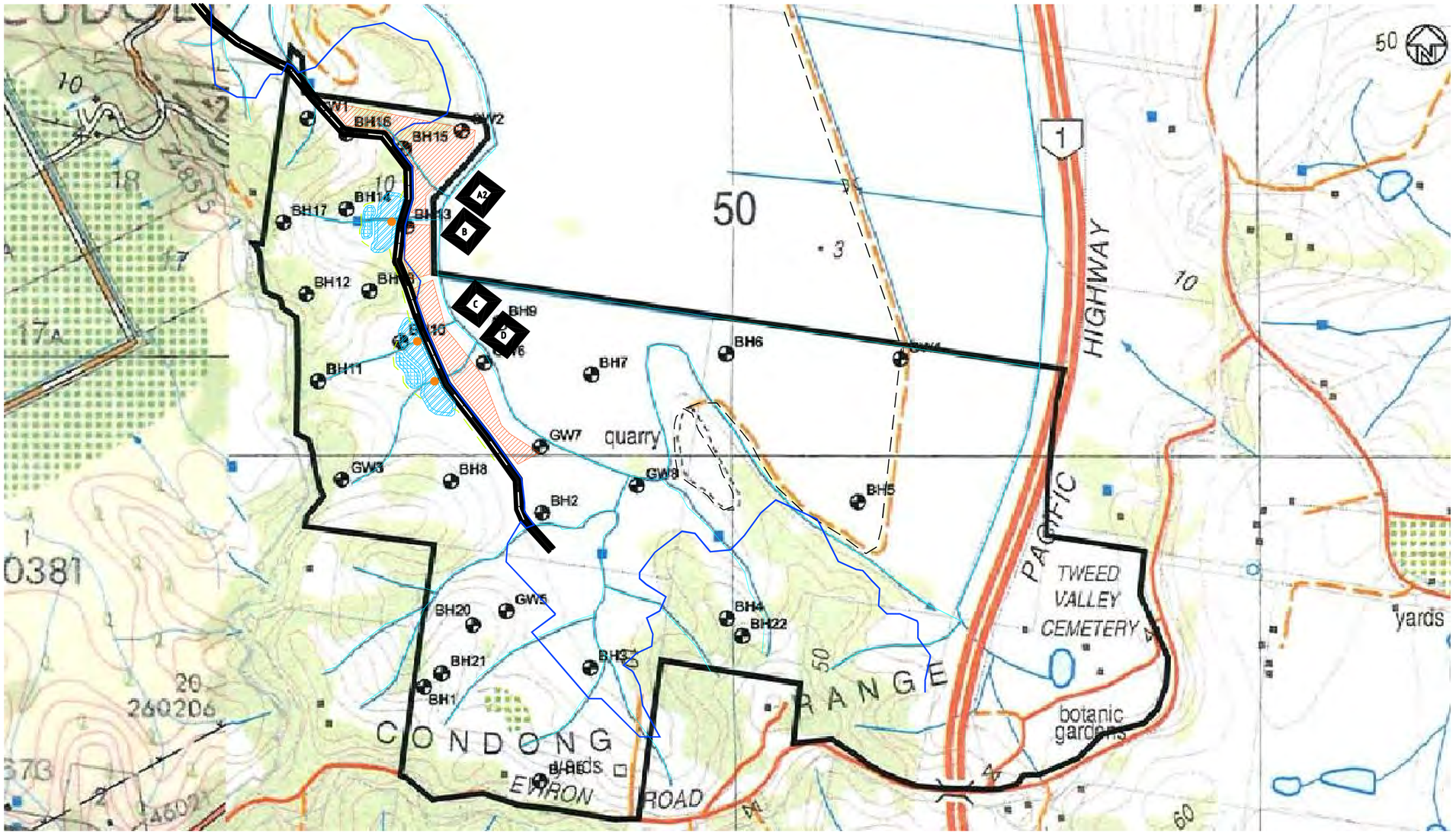
N:\AU\Toowoomba\Projects\41\20806\GIS\Maps\4120806_53.mxd

© 2011. While GHD has taken care to enable the accuracy of this product, GHD makes no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: Tweed Shire Council - Haul Road (2011), Cadastre boundary (2010). GHD - Site Boundary (2011), Roads, Existing Drainage Lines, Hillshade (Derived from Tweed Shire Council ALS data), Flood Area, West Valley (2010), North Valley (2011).

CLIENTS | PEOPLE | PERFORMANCE

54-58 Nerang Street Nerang QLD 4211 Australia **T** 61 7 5557 1000 **F** 61 7 5557 1000 **E** goldcoastmail@ghd.com.au **W** www.ghd.com.au



LEGEND

ULTIMATE REGIONAL FLOODLINE

ULTIMATE LOCAL FLOODLINE

FLOOD CUT BALANCE ZONE

CONCEPTUAL

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Checked	Approved	Date

GHD CLIENTS | PEOPLE | PERFORMANCE
Suite 3 On the Park
54-58 Nerang Street Nerang QLD 4211 Australia
PO Box 124 Nerang QLD 4211
T 61 7 5557 1000 **F** 61 7 5557 1099
E goldcoastmail@ghd.com.au **W** www.ghd.com.au

DO NOT SCALE

Conditions of Use.
This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Drawn	NJC	Designed	NJC
Drafting Check		Design Check	
Approved			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client **TWEED SHIRE COUNCIL**

Project **EVIRON QUARRY & LANDFILL SITE**

Title **Ultimate Development Flood Inundation Lines**
Lot 26 on DP 615931 Eviron Road, Eviron

Original Size **A1**

Drawing No: 41-20806-G001-Fig 4.3 **Rev: A**

Plot Date: 9 December 2008 - 9:27 AM Cad File No: G:\41\20806\Tech\Stormwater Quality and Quantity\ACAD\41-20608-G001_DRAI_REV0.dwg

5. Water Quality Assessment

5.1 Objectives

The overall objectives of the water quality assessment are to:

- Define appropriate water quality objectives for the catchments;
- Estimate stormwater quality for fully developed catchment conditions using recognised software;
- Assess the level of stormwater quality infrastructure required to treat runoff from the developed catchment; and
- Propose stormwater treatment measures to meet agreed water quality objectives.

This section of the report outlines the development of the water quality model for the catchments.

5.2 Water Quality Objectives

Stormwater Quality Improvement Devices (SQIDs) will be required to mitigate the impacts of additional pollutant loads generated by the proposal. The Director Generals Requirements for the proposal requires the waters discharged from the site or from any water quality treatment device must comply with the ANZECC 2000 guidelines.

Table 5.1 shows the Water Quality Objectives for the proposal. This assessment aims to meet the ANZECC criteria and the Tweed Shire Council interim values shown in the table.

Table 5-1 Water Quality Objectives for the Quarry / Landfill Project

Pollutant	TSC Interim Values[3]	ANZECC Trigger Values[1]
suspended solids	<20 mg/L	<22 mg/L[1]
chlorophyll *a*	<10 mg/L	<5 µg/L[2]
total nitrogen	<750 µg/L	<500 µg/L[2]
oxidised N	-	<40 µg/L[1]
ammonia N	-	<20 µg/L[1]
total phosphorus	<100 µg/L	<50 µg/L[1]
filterable reactive phosphorus (FRP)	-	<20 µg/L[2]
dissolved oxygen	>6 mg/L	85% saturation[1]
pH	6.5 – 9.0	6.5 – 8.0[2]

1. *Australia and New Zealand Guidelines for Fresh and Marine Water Quality Volume 2*, Australia and New Zealand Environment and Conservation Council / Agriculture and Resource Management Council of Australia and new Zealand, October 2000.

2. *Australia and New Zealand Guidelines for Fresh and Marine Water Quality*, Australia and New Zealand Environment and Conservation Council / Agriculture and Resource Management Council of Australia and new Zealand, October 2000.
3. *Tweed Shire Council – Urban stormwater Quality Management Plan*- interim Water Quality Objectives. This is for comparison purposes only.

5.3 Water Quality Modelling

The industry standard water quality model MUSIC (Model for Urban Stormwater Improvement Conceptualisation) was used to determine stormwater quality for existing and fully developed catchment conditions. MUSIC was developed by the Cooperative Research Centre (CRC) for Catchment Hydrology. MUSIC provides the ability to simulate both stormwater quantity and quality from catchments ranging from a single house block up to many square kilometres in area, and the effect of a wide range of treatment facilities on the quantity and quality of runoff downstream using a range of time steps from daily down to 6 minutes.

The model was used to determine a set of appropriate mitigation options to meet the WQOs defined for the catchments. Modelled pollutants included total suspended solids, total nitrogen, total phosphorous and gross pollutants.

5.3.1 Modelling Scenarios

The following catchment development scenarios were assessed:

- Existing conditions;
- Ultimate development conditions Stage 1 (with sediment basins); and
- Ultimate development conditions Stage 2 (with wetlands).

5.3.2 Land Use Classification

Two types of land use nodes (source node) are available to characterise the hydrologic and pollutant export properties of each sub-catchment area in MUSIC. These are Forest and Urban. The User Defined option can be used to simulate any type of land use by specifying impervious areas, soil properties and pollutant concentrations. This land use nodes were used to simulate industrial and forest land use.

5.3.3 Pervious and Effective Impervious Proportions

The effective percentage (%) impervious values for each MUSIC sub-catchment (source node) were adopted from the TSC Urban Stormwater Quality Management Plan (Chapter 7.13.3 Table 1). Were no information was available for other nodes the Draft Guidelines for Pollutant Export Modelling in Brisbane (Brisbane City Council, 2003) and listed in Table 5.2 was used.

Table 5.2 MUSIC Impervious Area Reduction Factors (Brisbane City Council, 2003)

Source Node	% Impervious of Total Impervious Area
Urban Residential	31
Commercial	50
Industrial	76
Rural Residential	55
Agricultural	55
Forested	0

5.3.4 Soil Properties

The soil properties of each land use type were selected in accordance with TSC Urban Stormwater Quality Management Plan (Chapter 7.13.3 Table 1). Were no data existed for other land use types the Draft Guidelines for Pollutant Export Modelling in Brisbane (Brisbane City Council, 2003) was used.

Table 5.3 reproduces the soil parameters adopted in the MUSIC model. These soil properties are used in the rainfall-runoff generation calculations.

5.3.5 Pollutant Generation Parameters

MUSIC generates pollutant concentrations for both the storm flow and base flow components of runoff from the rainfall runoff model. The pollutant generation parameters used in the MUSIC model were selected in accordance with the TSC Urban Stormwater Quality Management Plan and the Draft Guidelines for Pollutant Export Modelling in Brisbane (Brisbane City Council, 2003) and are reproduced in Table 5.4.

5.3.6 Meteorological and Global MUSIC Parameters

The meteorological and global parameters used in the MUSIC model are presented in Table 5.5.

Table 5.3 MUSIC Rainfall / Runoff Parameters (Brisbane City Council, 2003 & TSC USQMP)

Parameter	Urban Residential	Industrial	Rural	No Development
Field Capacity (mm)	50	80	50	50
Infiltration Capacity Coefficient a	50	200	50	50
Infiltration Capacity Coefficient b	2	1	2	2
Rainfall Threshold (mm)	1	1	1	1
Soil Capacity (mm)	150	120	150	150
Initial Storage (%)	25	25	25	25
Daily Recharge Rate (%)	65	25	65	65
Daily Drainage Rate (%)	5	5	5	5
Initial Depth (mm)	50	50	50	50

Table 5.4 MUSIC Base and Stormflow Concentration Parameters (BCC, 2003 & TSC USQMP)

		TSS (Log_{10} mg/L)		Total Phosphorus (Log_{10} mg/L)		Total Nitrogen (Log_{10} mg/L)	
Source Node		**Base Flow**	**Storm Flow**	**Base Flow**	**Storm Flow**	**Base Flow**	**Storm Flow**
Urban Residential	Mean	0.80	2.00	-1.00	-0.68	-0.10	0.193
	Std. Dev.	0.20	0.145	0.34	0.28	0.05	0.05
Industrial	Mean	0.78	1.92	-1.11	-0.59	0.14	0.25
	Std. Dev.	0.45	0.44	0.48	0.36	0.20	0.32
Rural Residential	Mean	0.60	1.627	-1.40	-0.95	-1.50	-0.25
	Std. Dev.	0.20	0.20	0.40	0.10	0.40	0.197
Forested	Mean	0.80	1.20	-1.00	-1.47	-0.10	0.90
	Std. Dev.	0.20	0.145	0.34	0.30	0.05	0.10

Table 5.5 Meteorological and Global MUSIC Parameters

Parameter	Data Used
Rainfall	Jan 1978-Dec 1978 Rainfall Period
Rainfall Station	Murwillumbah. (Station No. 58158)
Potential Evapo-Transpiration	Mean Monthly ET
Model Time Step	6 Minute
Pollutant export	Stochastic Generated Default Values.

5.4 Water Quality Options

The selection of water quality treatment measures typically depends on a wide range of criteria. Common stormwater treatment methods should be assessed against a number of categories with particular emphasis on the following:

- Availability of suitable sites and site topography;
- Available hydraulic head loss at the selected site;
- Site geology;
- Site groundwater levels;
- Effectiveness of the treatment measure to achieve desired pollutant retention;
- Compatibility with existing site constraints;
- Aquatic and wild-life habitat;
- Public safety;
- Capital cost and maintenance; and
- Aesthetic appeal.

The water quality treatment devices selected for the quarry / landfill project consist of grass filter strips, grassed diversion drains, sediment basins and wetlands. These measures have been selected for the following reasons:

- These are the most effective devices in meeting government Water Quality Objectives and Environmental Value requirements.
- Vegetated Swales and Buffers are effective in both treatment and conveyance of stormwater to secondary and tertiary treatment devices.
- Planted Detention devices can be aesthetically pleasing if appropriately designed and landscaped.

A brief description of each of the recommended water quality treatment devices is provided below.

5.4.1 Swales

Can be an alternative to the roadside kerb and channel system. Swales are also used as drainage channels that direct flows from a sag point to the secondary treatment device such as a wetland. Swales slow down the flow and allow sediment to be captured in the vegetation area.

Advantages

- Improved water quality as sediments are captured near the source;
- Encourages local groundwater recharge;
- Reduced runoff peak flows; and
- Reduced infrastructure costs compared with traditional systems

Disadvantages

- Potential erosion problems, particularly f the channel invert is unprotected; and
- Difficulty in integrating swales with driveway or road access points

5.4.2 Buffer Areas

Buffer areas are grasses or vegetated areas where stormwater flows as sheet flow, trapping sediment and some nutrients prior to entering other stormwater treatment devices.

Advantages

- Improved water quality as sediment is captured near the source
- Encourages local groundwater recharge; and
- Improves visual aesthetics and can promote native fauna to gather.

Disadvantages

- Limited removal of fine sediments and soluble pollutants; and
- Potential formation of preferential pathways.

5.4.3 Sediment Basins

Sediment Basin systems are depressions where stormwater ponds on the surface and allows sediment to settle to the base of the pond while the increased water level slowly recedes to a defined level. Various processes are involved in extracting the nutrients from the stormwater including absorption, biological uptake, evapo-transpiration and deposition.

Advantages

- Treats sediment filled stormwater close to source;
- Treatment at the surface and within 200 mm of the surface hence performance is not impacted by presence of high groundwater;
- Water storage for irrigation and wash down demands; and
- Decreases flow rates to downstream system;

Disadvantages

- Requires flocculation by application of gypsum (or equivalent) to promote aggregation of small flocs to larger ones. This promotes increased settlement in highly dispersive soils.
- Requires regular maintenance of outlets and dredging of settled sediment after significant rainfall events.

5.4.4 Wetlands

Wetland systems are landscaped depressions where stormwater ponds on the surface and slowly recedes to a defined water level. Various processes are involved in extracting the nutrients from the stormwater including absorption, biological uptake, evapo-transpiration and deposition.

Advantages

- Treats stormwater close to source;
- Treatment at the surface and within 200 mm of the surface hence performance is not impacted by presence of high groundwater.
- Decreases flow rates to downstream system;
- Has the potential to reduce the size of stormwater structures;
- Self propagates;
- Provides treatment for fine sediments, particulate pollutants, and dissolved pollutants; and
- Can be used to provide a setback buffer to existing waterways.

Disadvantages

- Outlets can accumulate clutter and rubbish after major storm events.

Refer to Figure 5.1 for MUSIC Screen Capture.

- Refer to Figures 5.2 and 5.3 for stormwater treatment device locations.

5.4.5 Supporting Devices

- The devices not modelled but do contribute to minimising sediment decomposition in natural waterways or major drainage flow paths are sediment fences and straw bales. These devices will be in abundance during the quarrying and landfill processes to capture sediment closer to the source prior to entry into the sediment basins. These devices are discussed further in Section 6 of this report.
- Should they be incorporated into the detail design of the landfills in the North and West Valleys leachate ponds could become another significant device to collect seepage flows from the fill layers and drain any infiltration waters and prevent these flows from entering the mainstream flow paths. However Council's preference at this stage is not to have landfill leachate ponds.
- The amphitheatre shape has also been maintained in this detailed analysis as depicted in the Gilbert & Sutherland Report (April 2007).

Table 5.6 Mean Concentration Values at Catchment Outlets to the Drainage Channel (Existing)

Receiving Node - All Data Statistics

Inflow	mean	standard deviation	median	maximum	minimum	10 percentile	90 percentile
Flow (cubic metres/sec)	0.007	0.099	0.001	7.670	0.000	0.000	0.006
TSS Concentration (mg/L)	**7.090**	2.610	6.640	35.600	1.360	4.290	10.400
Log [TSS] (mg/L)	0.824	0.151	0.822	1.550	0.134	0.633	1.020
TP Concentration (mg/L)	**0.135**	0.089	0.113	1.820	0.009	0.053	0.242
Log [TP] (mg/L)	-0.946	0.258	-0.948	0.260	-2.070	-1.280	-0.616
TN Concentration (mg/L)	**0.795**	0.088	0.796	1.120	0.086	0.713	0.887
Log [TN] (mg/L)	-0.104	0.073	-0.099	0.049	-1.070	-0.147	-0.052

Table 5.7 Mean Concentration Values at Catchment Outlets to the Drainage Channel (Stage 2 Ultimate)

Receiving Node - All Data Statistics

Inflow	mean	standard deviation	median	maximum	minimum	10 percentile	90 percentile
Flow (cubic metres/sec)	0.006	0.081	0.000	6.300	0.000	0.000	0.009
TSS Concentration (mg/L)	**3.070**	3.210	0.000	20.500	0.000	0.000	6.010
Log [TSS] (mg/L)	0.786	0.054	0.779	1.310	0.778	0.778	0.779
TP Concentration (mg/L)	**0.030**	0.030	0.000	0.099	0.000	0.000	0.060
Log [TP] (mg/L)	-1.220	0.014	-1.220	-1.010	-1.420	-1.220	-1.220
TN Concentration (mg/L)	**0.496**	0.502	0.000	1.020	0.000	0.000	1.020
Log [TN] (mg/L)	-0.005	0.068	0.005	0.007	-0.905	0.000	0.007

Comparison of the predicted pollutant loads from the Ultimate development catchment (with treatment measures) given in Table 5.8 against the WQOs listed in Table 5.1 demonstrates that the stormwater quality treatment measures proposed for the project are sufficient to achieve the WQOs for the catchment. The proposed measures will ensure that the suspended solids, total phosphorus and total nitrogen that will be discharged to the drainage channels will meet the required concentration values.

The existing pollutant loads produced from the quarry / landfill catchment in Table 5.7 has been added as a comparison to the WQOs listed in Table 5.1. Results show that the proposed measures also improve upon the existing situation and meet both concentration production value criteria.

The water quality treatment strategy proposed in this report is a preliminary estimate of the location and minimum total size of the treatment measures required to reduce mean annual loading of stormwater generated pollutants from the quarry / landfill catchment. A more detailed assessment of each recommended treatment measure will be required to determine the final locations, numbers, sizes, and arrangements of each of the proposed stormwater quality treatment measures during the civil design stage.

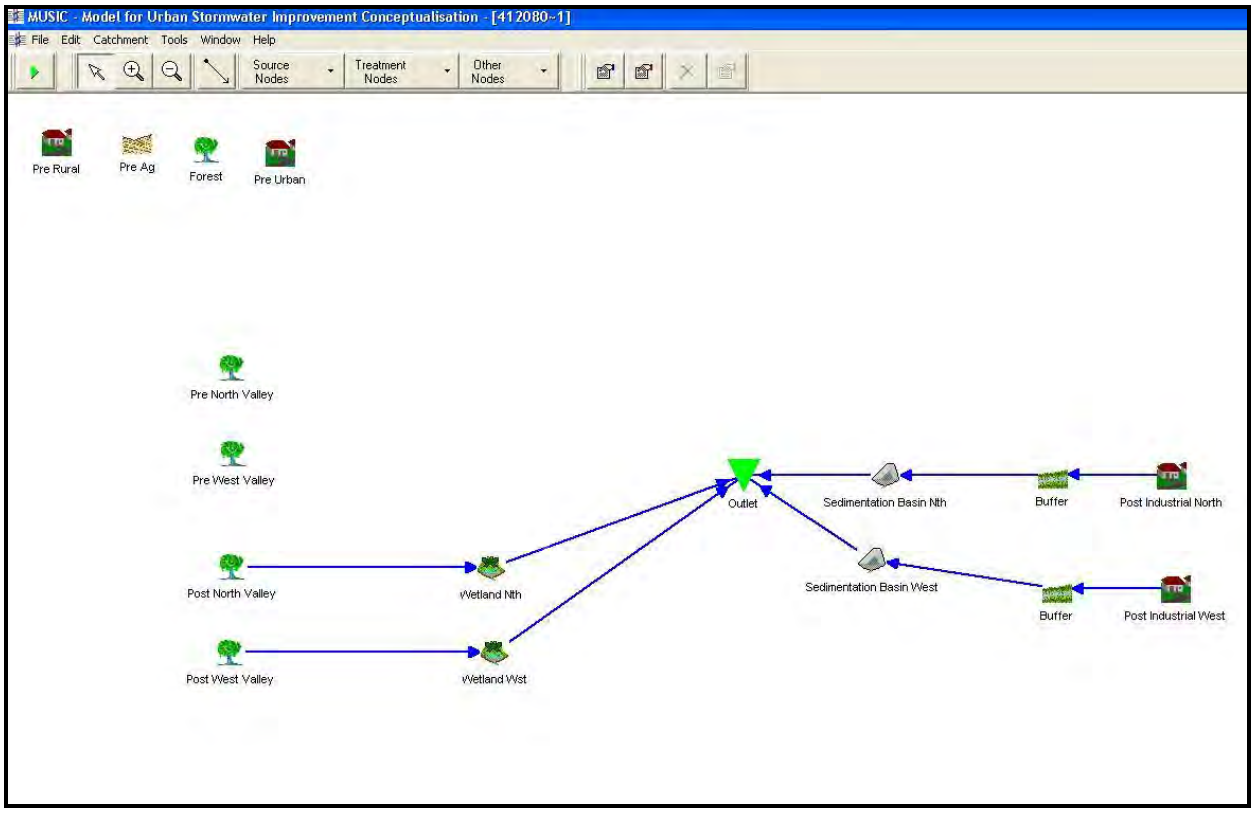


Figure 5-1 MUSIC Screen Capture of Treatment Train

5.5 Stormwater Quality Improvement Devices (SQIDs) Design Requirements

The land use of the proposed site requires some specific design criteria. These criteria include:

- Impermeable layer at the base of the sediment / wetland basins to prevent seepage (Refer to Appendix C Typical Section Details);
- Diversion drains on the upstream side of disturbed areas to divert surface runoff into the sediment basins (refer to Figures 5.2 and 5.3);
- Grass filter strips / vegetative buffers at base of last fill layer and upon layer batters that are complete (refer to Figures 6.1 and 6.2);
- Provide a layer of compacted gravel on the base of the sediment basins to prevent backhoes from digging too deep and impacting upon the impermeable layer upon dredging of the sediment basins;
- Protect the batters of the roadway (proposed haul road) at the proposed sag points to be a spillway for the basins weir flow in major storm events to prevent pavement failure;
- Detention ponds / basins shall be stabilised immediately after completion and densely plated with native drought tolerant ephemeral species. No mulching to internal batters; and
- All proposed sediment fences depicted in Figure 6.1 to remain until the completion of the wetlands and the landscape has been rehabilitated.

Insets not to scale

Lot 1 On 590220
Lot 2 On 1159352
Lot 3 On 705781
Lot 3 On 705781
Lot 28 On 615931
Lot 1 On 705781
Lot 19 On 12676
Lot 6 On 1009674
Lot 18 On 12676
HAWKENS LN
Lot 5 On 1009674
Lot 17 On 12676
Lot 17A On 12676
Lot 11 On 1014723
See Insets 1 & 2
See Insets 3 & 4
Lot 1 On 1159352
Lot 602 On 1001049
Lot 603 On 1001049
Pacific Hwy
Lot 16 On 869748
Lot 601 On 1001049
Lot 1 On 34555
Lot 601 On 1001049
Lot 2 On 1069562
Lot 1 On 34739
Lot 30 On 820048
Eviron Rd
Lot 31 On 820048
Lot 508 On 1000612
Lot 503 On 1000612
Lot 1 On 34554
Lot 31 On 624072
Lot 41 On 773239
On 34553

Inset 1: Operative

Inset 2: Rehab

Inset 3: Operative

Inset 4: Rehab

Inset Legend

- Rised Outlet
- Diversion Channel
- Sediment Basin
- Wetland
- Revegetation
- Haul Road Footprint
- Haul Road
- Drainage Lines

Conceptual

0 100 200 300
Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

LEGEND

- Site Boundary
- North Valley
- West Valley
- Haul Road
- Drainage Lines

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council
Eviron Quarry & Landfill Site

Job Number	41-20806
Revision	2
Date	27 MAY 2011

Quarry Stormwater Treatment Device Locations

Figure 5.1

N:\AU\Toowoomba\Projects\41\20806\GIS\Maps\4120806_54.mxd

54-58 Nerang Street Nerang QLD 4211 Australia T 61 7 5557 1000 F 61 7 5557 1000 E goldcoastmail@ghd.com.au W www.ghd.com.au

© 2011. While GHD has taken care to enable the accuracy of this product, GHD makes no representations or warranties about its accuracy, completeness or suitability for any particular purpose. GHD cannot accept liability of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred as a result of the product being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: Tweed Shire Council (2011) - Haul Road, Haul Road Footprint, Cadastre boundary (2010). GHD (2010) - Site Boundary (2011), Roads, Drainage Lines, Hillshade (Derived from Tweed Shire Council ALS data), Rised Outlet, Diversion Channel, Leachate Pond, Sediment Basin, Revegetation, Wetland, Irrigation Pond, West Valley, North Valley (2011).

6. Erosion and Sediment Control Measures

6.1 Treatment Measure Options & Selection Criteria

There are a number of treatment measure options available for selection and use. The appropriate selection is important to best achieve the desired outcomes. Prior to selection of treatment measures, desired outcomes and principles of effective erosion and sediment control are:

- Minimise the extent and duration of soil disturbance;
- Control the location and velocity of drainage flow;
- Minimise soil erosion initiated by wind, rain or concentrated flow;
- Minimise sediment flow from the site;
- Promptly revegetate/stabilise all exposed and/or unstable soil surfaces; and
- Appropriately install, operate and maintain all ESC measures.

Depending on the improvement to stormwater quality achieved by the treatment measure and approach,

ESC can be divided into three sets of control measures:

- Erosion control measures.
- Drainage control measures.
- Sediment control measures.

The particular types of ESC measures considered for the site are briefly described for the following Erosion, Drainage and Sediment controls.

6.1.1 Erosion Control

Erosion control measures are principally used to minimise movement and loss of sediments at the

source. Typical measures include:

- Minimise soil and stockpile erosion caused by wind and rain.
- Minimise turbidity levels in stormwater runoff by minimising the exposure of soil to rain and stormwater flow.

Revegetation and Mulching

Vegetation or revegetation of a site provides:

- A physical protection against raindrop impact;
- A barrier between the earth and flow;
- Increased surface roughness that reduces erosive flow velocities; and
- Increased absorption of rainfall by the soil profile, reducing the volume of runoff.

Revegetation should be carried out on any exposed soil surface that has the potential to erode and cause sediment movement into the surrounding environment during rain events. Revegetation is an effective long term ESC measure. Ideally, plants should be native to the area, have good soil binding

capability and compete successfully with weed species. Temporary sediment fences should be incorporated at the downstream edge of revegetation until establishment and stabilisation have been achieved.

6.1.2 Drainage Control

Drainage control measures are principally used to:

- Divert 'clean' upslope water around any soil disturbances.
- Contain and transport potentially contaminated stormwater through disturbed areas to treatment measure(s), minimising contact with erodible soils.

Open channels are economical where large flows are to be carried and space is not restricted. They provide for the continuous collection of surface runoff. Where surcharging occurs, general shallow flow results, rather than concentrated flooding upstream of a closed drainage system.

Bunds are utilised to divert or contain flow when the flow is desired to be on the natural surface and the site has a cross-fall such that the contained flow does not lead to an extensive width of flow. The flow is contained on the natural surface by a raised bank (the bund) formed by raising compacted earth on the surface.

The channel or bund lining is specified to protect the subsoil from erosion, and can additionally provide treatment benefits to the flow for low-flows.

Diversion Bunds

Diversion Channels are excavated channels often incorporating a diversion bank on the down slope side. Typical gradients are flat, ranging between 0.2% and 0.6% as bare earth readily erodes. Use of rock check dams can reduce the effective channel gradient during flow conditions for steeper channels up to typically 5%.

Diversion channels can be placed above batters, borrow pits, exposed and disturbed surfaces to protect them from upslope stormwater runoff. They can also be incorporated at the base of cut and fill slopes and disturbed/exposed areas (sediment fences are often appropriate to install between the slope and channel) to direct sediment laden flows to treatment measures.

NB. Excavated channels within highly erosive soils require a suitable channel lining such as grass or rock where infiltration is desirable and plastic sheeting, concrete or asphalt where it is not.

Rock Lined Channel

Rock-lined channels are used to convey concentrated flows on grades of up to 10% and in critical sections of other types of channels (grassed, earth) such as bends and stormwater outlets where localised high velocities are likely to occur. The increased channel roughness provided by the rock lining slows flow velocities providing sediments opportunity to settle out. Design criteria include:

- Appropriately sized and graded rock is specified to resist movement (including on the channel embankments) by the anticipated flow velocity in the channel;
- The thickness of the rock protection layer is at least twice the nominal rock diameter;

- A geo-textile or rock filter layer is used underlying the rock layer to protect underlying fine/ erodible soils entering the flow (generally required unless the rock layer is at least three times the nominal rock diameter); and
- Particular attention must be given to the crest, toe and side details to avoid edge effects of seepage undermining the drain and to ensure the flow does not scour, easily erodible soils

6.1.3 Sediment Controls

Sediment controls are measures that trap and retain sediments, removing sediment from the stormwater flow. Where practical, sediment should be trapped close to its source, reducing breakdown of soil particles and the release of dispersive clays (if present). Additionally, a final control is usually required immediately prior to the site discharge. This combination, plus the other treatment measures lead to the "treatment train" concept.

Sediment controls have the greatest maintenance requirements of ESC measures as their primary function is to accumulate sediments. If a sediment control measures does not need sediment removal (maintenance) after a storm event, it may not be working properly.

Sediment Fences

Sediment fences provide physical filtration of sheet flow as it passes through the filter material, and allows settling of suspended sediments by the ponding of water behind the fence. Sediment fences typically:

- Consist of a filter fabric attached to a wire and post fence at a maximum height of 700mm with an additional 200mm (min) buried and compacted into an upstream trench;
- Should be constructed along a contour with turn-ups at either end to prevent runoff flowing around the fence;
- Are most effective for coarse fraction sediments as a source control of sheet flow;
- Trap sediment larger than 0.14 mm, and have little impact on fine silts;
- May be used in the control of sediment runoff from exposed land, unsealed roads, batters and
- stockpiles; and
- For large areas on moderate slopes, may be placed at intervals down slope with a catch drain on their downstream side to trap flow will contain sediments at the source and minimise concentration of flow.

Sediment Basins

A sediment basin is an effective sediment containment system to trap and retain a wide range of sediment particle sizes down to 0.045 mm depending on its hydraulic characteristics (retention time and flow distribution). It is noted that:

- Sediment basins are usually required when the disturbed area is greater than (1) hectare, the soils are dispersible, and/or when there is a need to control runoff turbidity;
- Sediment basins should be located upstream of water bodies, bushland and major stormwater systems;

- Sediment basins are sized to either contain and slowly settle fine particles, or to slow the flow's velocity allowing settlement of coarser particles during flowthrough; and
- Both the coarse sediment concentration and turbidity levels can be reduced.

6.2 Proposed Erosion and Sediment Control Measures

This sub-section provides Sediment and Erosion Control (ESC) measures presented in Figure 6.1, installation sequence and maintenance requirements.

6.2.1 Installation Sequence

The erosion and sediment works described in chapter 6 are for construction, operation and revegetation / rehabilitation of the Quarry / Landfill sites. The timing in this sequence of the control measures are itemised in Table 6.1 below.

Table 6.1 Erosion and Sediment Control Installation Sequence

Item	Figure	Installation	Removal
Diversion Bund / swale drain	6.1	Pre - construction	N/A
Sediment Fences and Straw Bales	6.1	Pre - construction and upon completion of each fill layer on the downstream batter	After rehabilitation of Site
Grass / Vegetation Filter Strip	6.1	Pre - construction and upon completion of each fill layer on the downstream batter	N/A
Hydro-mulching of Batters	6.1	Upon completion of detention areas & each fill layer on the batter	N/A
Sediment Basins	6.1	Pre-construction	converted to a wetland at rehabilitation stage

6.2.2 Explanatory Notes and Calculations

Vegetation Management

Clearing of remaining trees should only occur where necessary and/or revegetation can take place immediately upon completion of operations.

Revegetation is to occur pre-construction in areas not needed for construction access.

Revegetation is to continue throughout the development as soon as practical. This will reduce impact erosion and help to re-establish the natural landscape as early as possible.

Hydroseeding / mulching is a efficient form of erosion control. Any areas being revegetated will have planted native grass species in between plants. This will give additional impact erosion protection and act as a weed suppressant, thus improving revegetation rates and coverage.

All exposed batter slopes are to be hydro-mulched, as shown in Figure 6.1.

Sediment Basins

The catchment to SB Nth is approximately 9 ha and SB Wst is 14.5 ha. The required settling volumes were estimated using the procedures listed in the *Managing Urban Stormwater* (Landcom) as follows:

$Vs\ [m^3] = 10 \times Cv \times Area\ [ha] \times R_{(y5,5\text{-}day)}$

The above formula is for Type D & F soils, applicable when there is greater than 33% of the soil with an average diameter less than 0.02 mm. Table 6.2 provides a summary of the required dimensions for the sediment basin.

Table 6.2 Required Sediment Basin Dimensions

Basin	$R_{(y5,5\text{-}day)}$ ℵ	Cv	Area	Required Settling Volume	Sediment Storage Volume (50%Vs)	Total volume
	(mm)		**(ha)**	**(m^3)**	**(m^3)**	**(m^3)**
SB Nth	62.5	0.79	9.0	3,938	1,969	5,907
SB Sth	62.5	0.79	14.5	6,344	3,172	9,516

Table 6.3 provides a potential configuration of the sediment basin to meet the required dimensions as set out in Table 6.2.

ℵ 1-year, 5- day 85% Rainfall Depth for Tweed Heads. Table 6.3a, *Managing Urban Stormwater (*Landcom 2004).

Table 6.3 Potential Sediment Basin Configurations

Basin	Surface Area	Average Depth	Length	Width
	(m^2)	**(m)**	**(m)**	**(m)**
SB Nth	6,835	1.5	95	47
SB Sth	9,500	1.5	125	60

The MUSIC model determined minimum size for water quality objectives for each site was 4500m^2 for the North Valley site and 7500m^2 for the West Valley site. Concentration values of sediment and nutrients to be compared to existing values can be viewed in Tables 6.4 & 6.5 below. The larger calculated surface areas in Table 6.3 have been selected for each device due to its dual function requirement.

A sediment accumulation depth post should be installed that will clearly indicate when the sediment storage volume is at its capacity and cleanout is required.

Sediment fences are to be installed where indicated in Figure 6.1. Sediment fences are to install as per the "*Managing Urban Stormwater: Soils and Construction*" (Landcom), specification standards. The total length of Sediment fencing required is estimated to be approximately 2000m.

As can be seen from the two tables below, TP and TN are improved upon from existing concentration values. Although TSS is higher than the existing value it is still within the government standard range of below 20mg/L

Table 6.4 Mean Concentration Values at Catchment Outlets to the Drainage Channel (Existing)

Receiving Node - All Data Statistics

Inflow	mean	standard deviation	median	maximum	minimum	10 percentile	90 percentile
Flow (cubic metres/sec)	0.007	0.099	0.001	7.670	0.000	0.000	0.006
TSS Concentration (mg/L)	**7.090**	2.610	6.640	35.600	1.360	4.290	10.400
Log [TSS] (mg/L)	0.824	0.151	0.822	1.550	0.134	0.633	1.020
TP Concentration (mg/L)	**0.135**	0.089	0.113	1.820	0.009	0.053	0.242
Log [TP] (mg/L)	-0.946	0.258	-0.948	0.260	-2.070	-1.280	-0.616
TN Concentration (mg/L)	**0.795**	0.088	0.796	1.120	0.086	0.713	0.887
Log [TN] (mg/L)	-0.104	0.073	-0.099	0.049	-1.070	-0.147	-0.052

Table 6.5 Mean Concentration Values at Catchment Outlets to the Drainage Channel (Stage 1 Ultimate)

Receiving Node - All Data Statistics

Inflow	mean	standard deviation	median	maximum	minimum	10 percentile	90 percentile
Flow (cubic metres/sec)	0.005	0.076	0.000	6.310	0.000	0.000	0.004
TSS Concentration (mg/L)	**8.980**	10.200	0.000	83.600	0.000	0.000	20.000
Log [TSS] (mg/L)	1.300	0.032	1.300	1.920	1.300	1.300	1.300
TP Concentration (mg/L)	**0.058**	0.065	0.000	0.262	0.000	0.000	0.130
Log [TP] (mg/L)	-0.884	0.016	-0.886	-0.581	-0.887	-0.886	-0.886
TN Concentration (mg/L)	**0.625**	0.701	0.000	2.320	0.000	0.000	1.400
Log [TN] (mg/L)	0.148	0.020	0.145	0.366	0.138	0.141	0.146

Diversion Bunds

Diversion channels have been specified to convey concentrated flows into the sediment basins.

The diversion channels (DB 001 & DB 002) have been sized to cater for more than the 1 in 100 year ARI storm event. Table 6.6 gives the channel dimensions, which have been standardised for ease of construction and maintenance.

Table 6.6 Open Channel Dimensions for DB 001 & 002

Base Width (m)	Depth (m) (includes 0.15 m freeboard)	Batter Slope (Vertical: Horizontal)	Top Width (m)
4.5	0.5	1:2	6.5
7	0.5	1:2	9.0

These dimensions are based on the channels having a grade of 1.5% and the base lined with grouted riprap.

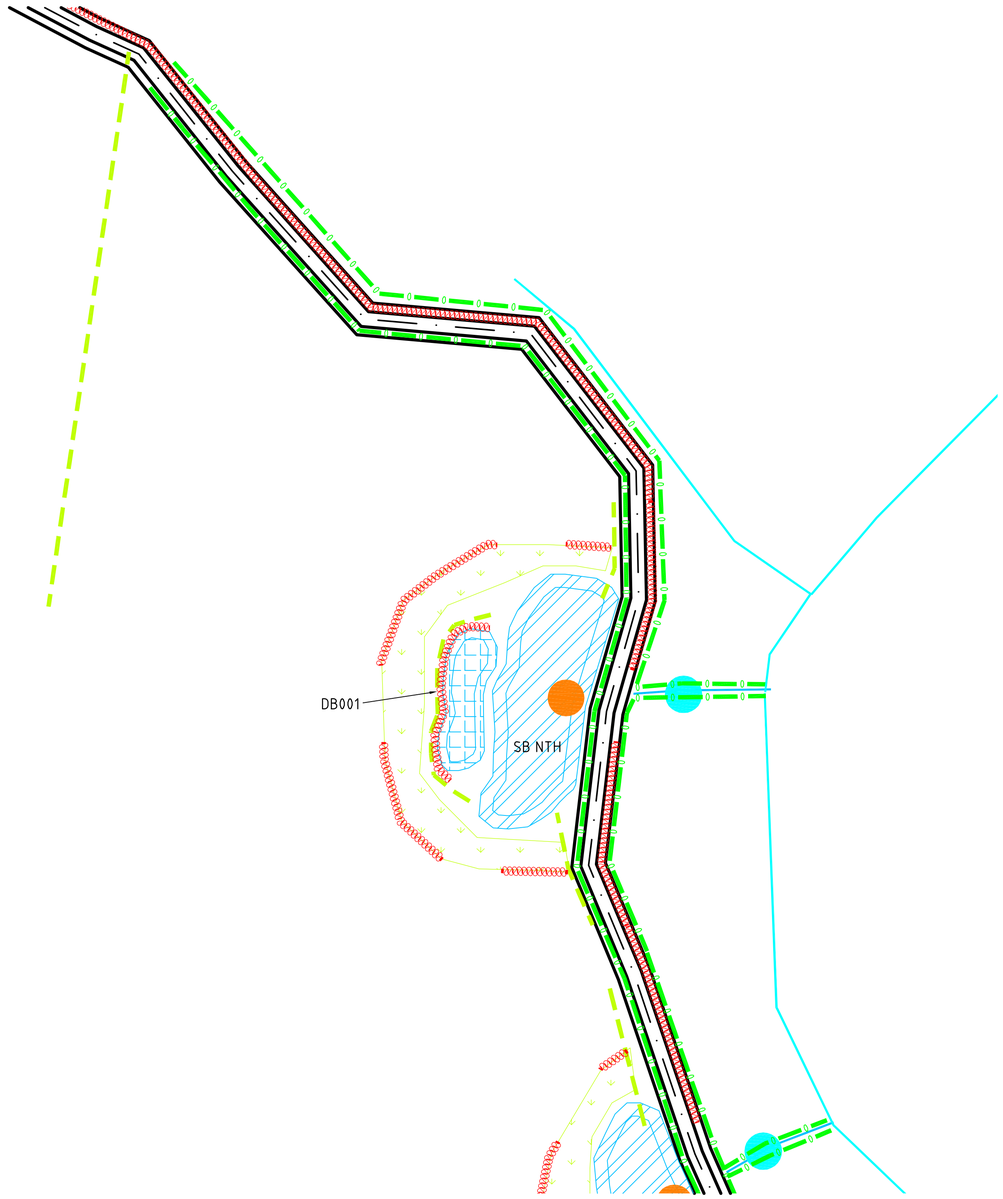
Roads

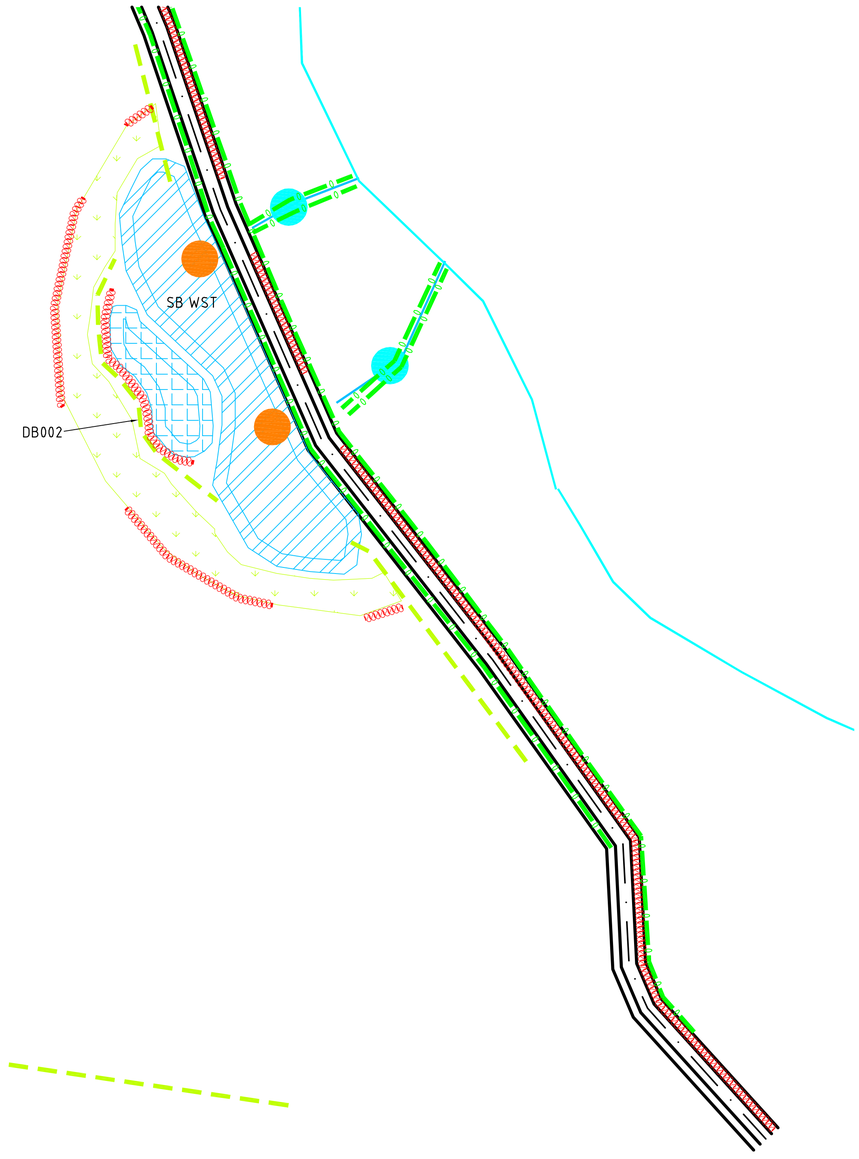
All internal roadway and track surfaces (used by reuse traffic) are to be stabilized by maintaining a hard compacted gravel surface to minimize soil erosion and sediment discharge (Refer to figure 6.1).

The proposed haul road should be sealed and batters stabilized prior to quarry construction.

Sag points should be located at the spill crests of the sediment basins (Stage 2 wetlands) to allow the road to convey major storm flows over it and to each LPD.

The roadway at the weir locations shall be one way cross fall to allow unrestricted sheet flow.





LEGEND

- SEDIMENT BASIN
- LEACHATE POND
- DIVERSION CHANNEL / SWALE
- EXISTING DRAINAGE CHANNELS
- RISED OUTLET STRUCTURE
- SEDIMENT FENCE
- STRAWBALE WEIR
- GRASS STRIP
- HYDROSEED / MULCH

0 10 20 30 40 50mm
SCALE 1:1 AT ORIGINAL SIZE

CONCEPTUAL

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Checked	Approved	Date

GHD CLIENTS | PEOPLE | PERFORMANCE
Suite 3 On the Park
54-58 Nerang Street Nerang QLD 4211 Australia
PO Box 124 Nerang QLD 4211
T 61 7 5557 1000 **F** 61 7 5557 1099
E goldcoastmail@ghd.com.au **W** www.ghd.com.au

DO NOT SCALE

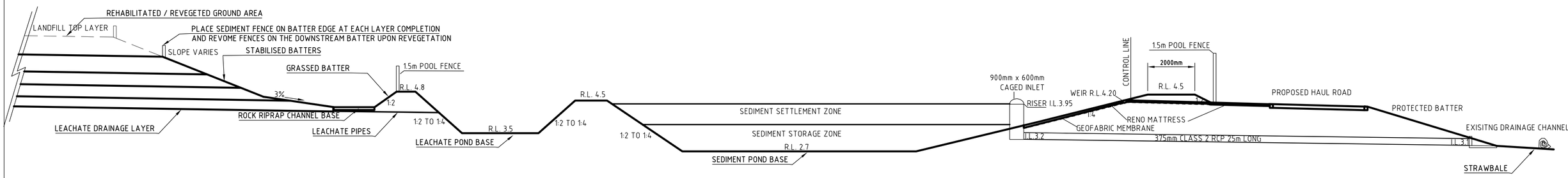
Conditions of Use.
This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Drawn	NJC	Designed	NJC
Drafting Check		Design Check	
Approved			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client **TWEED SHIRE COUNCIL**
Project **EVIRON QUARRY & LANDFILL SITE**
Title **Erosion and Sediment Control Plan**
Lot 26 on DP 615931, Eviron Road, Eviron

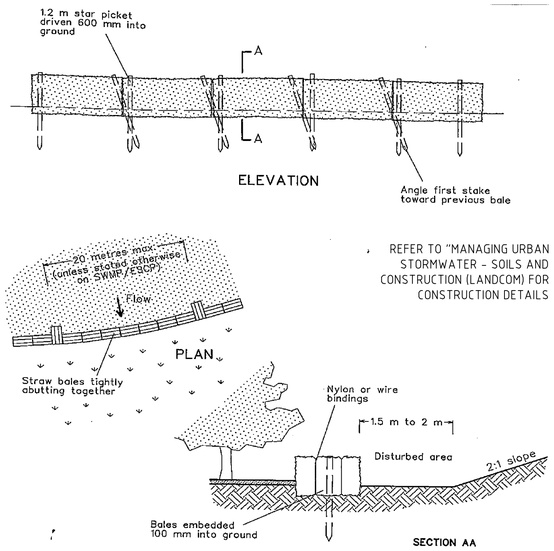
Original Size **A1**
Drawing No: 41-20806-G001-Fig 6.1 **Rev: A**

Plot Date: 11 December 2008 - 9:18 AM
Cad File No: G:\41\20806\Tech\Stormwater Quality and Quantity\ACAD\41-20608-G001_DRAI_REV0.dwg

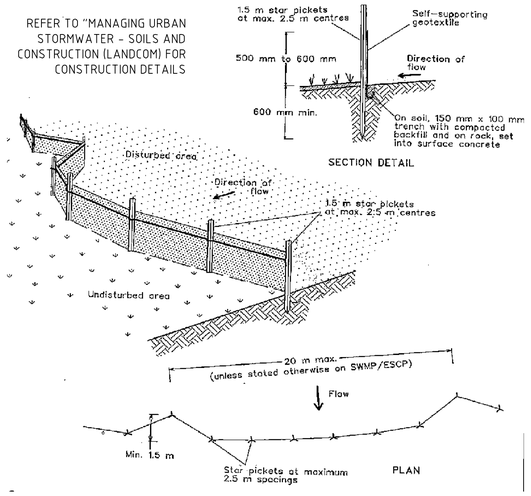


TYPICAL SEDIMENT BASIN SECTION

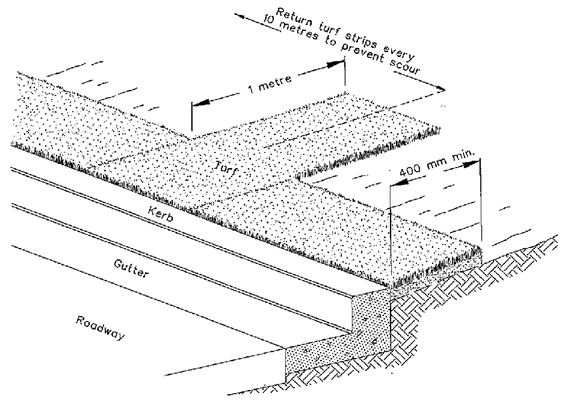
NTS



TYPICAL STRAW BALE DETAILS



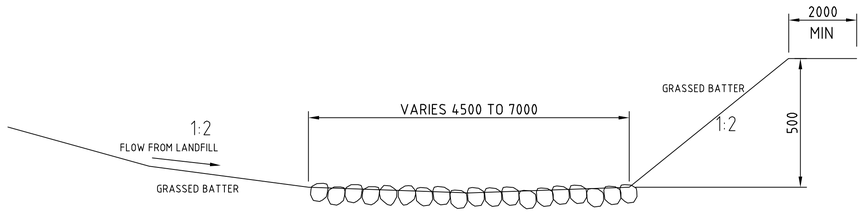
TYPICAL SEDIMENT FENCE DETAILS



TYPICAL GRASS STRIP DETAILS

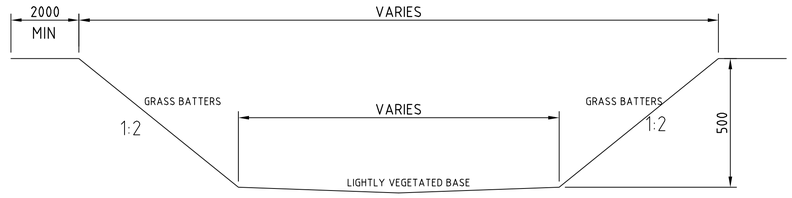
NOTES

SOIL STOCKPILES SHALL HAVE SEDIMENT FENCES SURROUNDING THE BASE OF THE DOWNSTREAM SIDE. ANY STOCKPILE THAT WILL REMAIN FOR MORE THAN 4 WEEKS SHALL BE STABILISED WITH HYDROSEED OR EQUIVALENT



TYPICAL SEDIMENT DIVERSION CHANNEL SECTION

NTS



TYPICAL CLEAN WATER DIVERSION CHANNEL SECTION

NTS

CONCEPTUAL

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Checked	Approved	Date

GHD CLIENTS | PEOPLE | PERFORMANCE
Suite 3 On the Park
54-58 Nerang Street Nerang QLD 4211 Australia
PO Box 124 Nerang QLD 4211
T 61 7 5557 1000 **F** 61 7 5557 1099
E goldcoastmail@ghd.com.au **W** www.ghd.com.au

DO NOT SCALE

Conditions of Use.
This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Drawn	NJC	Designed	NJC
Drafting Check		Design Check	
Approved			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client **TWEED SHIRE COUNCIL**
Project **EVIRON QUARRY & LANDFILL SITE**
Title **Erosion and Sediment Control Details Plan Lot 26 on DP 615931, Eviron Road, Eviron**

Original Size **A1**
Drawing No: 41-20806-G001-Fig 6.2 **Rev: A**

Plot Date: 11 December 2008 - 9:21 AM Cad File No: G:\41\20806\Tech\Stormwater Quality and Quantity\ACAD\41-20608-G001_DRAI_REV0.dwg

6.3 Maintenance Requirements

The proposed erosion and sediment controls for the site has been prepared with the following maintenance philosophy in mind:

- Selection of mitigation measures requiring minimal regular maintenance or simple maintenance procedures.
- If maintenance is required on any structure, access must be provided.

A maintenance program for all elements of this ESC is outlined in Table 6.7. A checklist should be developed that lists the maintenance problems likely to occur for each of the ESC measures adopted on site. This will assist the site personnel in making a thorough inspection.

Maintenance of the primary mitigation measures is discussed in detail below. Erosion and sediment control devices that fail on a regular basis should be investigated by experienced personnel with the aim of either modifying the design or replacing such measures with an alternative treatment.

Inspection frequency will need to be adjusted according to the prevailing weather conditions, i.e. increased during wet periods and reduced during dry periods. During minor runoff events weekly inspections will be sufficient. However, an inspection is required after any major runoff event.

Inspection and maintenance requirements will be documented within the Landfill Environmental Management Plans and Quarry Plans of Management as appropriate.

Table 6.7 Erosion and Sediment Control Maintenance Requirements

ESC Element	Inspection Frequency	Maintenance Frequency	Maintenance Activities
		Erosion Control	
Revegetation	Weekly during minor runoff events and after every major runoff event	When areas of grass or vegetation have been eroded or damage of channel banks has occurred	Treat channelling or erosion, replace grass, and take action to prevent future damage Application of additional mulch or rock stabilisation
		Drainage Control	
Diversion Bund	Weekly during minor runoff events and after every major runoff event	When litter has accumulated or sediment has filled 30% of the drain depth Damage of channel banks has occurred	Remove accumulated litter and sediment Reform channel or bund

ESC Element	Inspection Frequency	Maintenance Frequency	Maintenance Activities
		Sediment Control	
Sediment Basin	Weekly during minor runoff events and after every major runoff event	When litter has accumulated or sediment has filled 30% of the sediment basin volume.	Remove accumulated litter and sediment, spreading it well away from drainage lines

6.3.1 Erosion Control

Revegetation

Inspection of revegetation zones should be undertaken regularly to assess vegetation condition and to identify if any erosion, channelling or weed problems are occurring.

Maintenance activities typically include:

- Watering, reseeding and weeding to maintain a dense, vigorous growth of vegetation. Fertiliser application should be kept to a minimum. Regular watering during establishment period with possible soil conditioning;
- Application of additional mulch as required;
- Maintenance of any upslope diversion channels or protective fences; and
- Re-firming of plants loosened by wind or rock.

6.3.2 Drainage Control

Diversion Bunds

Diversion bunds require regular inspections; this should identify any damaged or eroded areas due to sediment accumulated in the channel, vehicular damage to the banks, settlement of banks and/or scour due to excessive flow velocity.

Maintenance to diversion channels typically include:

- Reformation of channel banks to design grade;
- Removal of litter and debris from the channel surface; and
- Removal of sediment upstream of check dams (if applicable).

6.3.3 Sediment Control

Sediment Basin

Regular inspections and maintenance of sediment basin is required to ensure proper operation occurs.

Maintenance to sediment basin may include:

- Removal of accumulated sediment;
- Pump-out of retained water to maintain capacity for subsequent inflow events; and

- Repair of any scouring damage to inlet and outlet and embankment vegetation.

Sediment Fences

Regular inspection and maintenance of sediment fences is necessary to repair damage caused by on-site vehicles or excessive sediment movement. Inspections should occur after each storm event that generates runoff.

Maintenance to sediment fences may include:

- Remove excessive sediment deposit; and
- Repair damage done by vehicles;

6.4 Monitoring Checklist

A monitoring checklist should be kept of all erosion and sediment control measures with entries made weekly and after rainfall events on:

- Removal of ESC measures;
- Condition of ESC structures and stabilised surfaces;
- Repair of any damage to ESC structures; and
- Rainfall, including duration and times.

Where findings of the ESC monitoring indicate a non-conformance, corrective actions will be investigated and implemented within 24 hours where practicable.

7. Conclusions

A Soil and Water Assessment for Stormwater and Sediment has been developed for the Quarry / Landfill site catchment at Eviron. The report identifies the potential impacts of proposed future development in the catchment on stormwater quantity and quality. Stormwater infrastructure to mitigate and accommodate these impacts has been determined.

The outcomes and recommendations from the study are as follows:

- The philosophy of the *Site Investigation Addressing Soils, Stratigraphy and Proposed Management Measures* report by Gilbert & Sutherland regarding amphitheatre design and leachate drainage layout has been maintained as part of this soil and water assessment.
- Hydrologic and hydraulic modelling performed as part of this drainage assessment showed the quarry / landfill design can maintain water quality objectives and reduce localised flooding.
- The Stage 1 and 2 Ultimate development flow rates from 1 up to and including 100 Year ARI are equal to or better than the Pre development flow rates due to the incorporation of detention areas for flood mitigation and stormwater treatment. These results have been showed in Table 3.5 of Section 3.6 of this report and in detail in Appendix B.
- Water quality controls required to mitigate the impacts of the proposed land use on stormwater quality have been assessed using a MUSIC model of the catchment. Water quality controls proposed for the catchments include vegetated buffers, swales and Constructed Wetland devices at the legal point of discharge (LPD) for each catchment. Minimum sizes and locations of the proposed water quality controls are shown in Figures 5.2 and 5.3. A more detailed design of each recommended treatment measure can be viewed in Appendix C of this report. A final design will be required to determine the exact locations, batter encroachment, sizes, and arrangements of each of the proposed stormwater quality treatment measures. This will be completed during detailed civil design.
- Proposed infrastructure passing under the proposed haul road has been determined and can be viewed in section 3.7.
- It is proposed to reuse stormwater captured onsite from the proposed leachate ponds and detention areas to reduce water demands from council reservoirs.
- The proposed detention areas are regional flood immune with a weir height 300 mm above the designated flood level of 3.9 m AHD. These systems can still drain under a regional event without causing flooding of the quarry site.
- A Stormwater Quality Improvement Device Design criterion has been recommended and can be viewed in Section 5.5.
- A minimum of 1% and maximum of 4% grade shall apply to fill platform layers and must flow toward proposed basins.

8. References

CRC for Catchment Hydrology (2005), *MUSIC User Manual*, April 2005.

Gilbert & Sutherland (April 2007), *Site Investigation Addressing Soils, Stratigraphy and Proposed Management Measures in relation to Council Land at Eviron, NSW.*

Landcom (2004), Managing Urban Stormwater – Soils and Construction.

The Institution of Engineers, Australia (1987), *Australian Rainfall and Runoff: A Guide to Flood Estimation. Volume 2*.

The Institution of Engineers, Australia (1999), *Australian Rainfall and Runoff: A Guide to Flood Estimation. Volume 1*.

Tweed Shire Council, Engineering and Operations Design Unit (February 2008), *Eviron Road Quarry and Landfill Proposal – Concept Plan, Stage 1 Application, and Preliminary Environmental Assessment.*

Appendix A

Rational Method Calculations

Table A1

Rational Method Calculations for Existing Development Catchments											
			Friends Formula as per QUDM				Additional Flow QUDM				
Catchment	Area (ha)	Flow length (m)	Friends length	Mannings 'n'	Friends S (%)	Friends Tc	Flow length - friends length	S (%)	Velocity m/s	Tc	Total Tc
Aex1	0.61	260	50	0.07	11	17.06	210	17	3	1.17	18.23
A1	2.31	220	50	0.07	14	16.26	170	19.5	3	0.94	17.20
Aex2	0.9	140	50	0.07	9.5	17.57	90	7	0.9	1.67	19.23
A2	3.13	210	50	0.07	25	14.48	160	11.5	1.5	1.78	16.25
B	6.09	315	50	0.07	49	12.65	265	6.5	0.9	4.91	17.56
C	6.06	290	50	0.07	16.5	15.73	240	6.5	0.9	4.44	20.17
D	8.58	465	50	0.07	22	14.85	415	13	1.5	4.61	19.46
Eex1	7.47	240	50	0.07	21	14.99	190	21.5	3	1.06	16.05
E	9.72	595	50	0.06	7	16.01	545	11	1.5	6.06	22.06
F	2.43	50	20	0.07	7.5	13.57	30	7.5	0.9	0.56	14.13

Table A2

Rational Method Calculations for Post Development Catchments											
			Friends Formula as per QUDM				Additional Flow QUDM				
Catchment	Area (ha)	Flow length (m)	Friends length	Mannings 'n'	Friends S (%)	Friends Tc	Flow length - friends length	S (%)	Velocity m/s	Tc	Total Tc
Aex1	0.61	260	50	0.07	11	17.06	210	17	3	1.17	18.23
A1	0.37	65	20	0.07	14	11.98	45	19.5	3	0.25	12.23
Aex2	0.9	140	50	0.07	9.5	17.57	90	7	0.9	1.67	19.23
A2	2.34	210	50	0.07	25	14.48	160	11.5	1.5	1.78	16.25
B	10.38	315	50	0.029	4	8.65	265	6.5	0.9	4.91	13.56
CD	16.76	465	50	0.029	4	8.65	415	6.5	0.9	7.69	16.34
Eex1	7.47	240	50	0.07	21	14.99	190	21.5	3	1.06	16.05
E	8.33	595	50	0.06	7	16.01	545	11	1.5	6.06	22.06

Flow Details:

Existing Development Flow Rates

Catcht.	Ac =	tc	I_{100}	C	Q100	I_{50}	C	Q50	I_{20}	C	Q20	I_{10}	C	Q10	I_2	C	Q2	I_1	C	Q3month
ID	(ha)	(min)	(mm/hr)		(cumec)	(mm/hr)		(cumec)	(mm/hr)		(cumec)	(mm/hr)		(cumec)	(mm/hr)		(cumec)	(mm/hr)		(cumec)
Aex1	0.61	18.23	193.00	0.74	**0.24**	175.00	0.68	**0.20**	151.00	0.62	**0.16**	132.00	0.59	**0.13**	95.00	0.50	**0.08**	74.00	0.47	**0.03**
A1	2.31	17.20	198.00	0.74	**0.94**	179.00	0.68	**0.78**	155.00	0.62	**0.62**	136.00	0.59	**0.51**	97.00	0.50	**0.31**	76.00	0.47	**0.12**
Aex2	0.9	19.23	188.00	0.74	**0.35**	171.00	0.68	**0.29**	147.00	0.62	**0.23**	129.00	0.59	**0.19**	92.00	0.50	**0.12**	72.00	0.47	**0.04**
A2	3.13	16.25	203.00	0.74	**1.30**	184.00	0.68	**1.09**	159.00	0.62	**0.86**	139.00	0.59	**0.71**	100.00	0.50	**0.44**	79.00	0.47	**0.16**
B	6.09	17.56	195.00	0.74	**2.43**	177.00	0.68	**2.03**	153.00	0.62	**1.60**	134.00	0.59	**1.34**	96.00	0.50	**0.81**	75.00	0.47	**0.30**
C	6.06	20.17	184.00	0.74	**2.28**	167.00	0.68	**1.91**	144.00	0.62	**1.50**	126.00	0.59	**1.25**	90.00	0.50	**0.76**	71.00	0.47	**0.28**
D	8.58	19.46	188.00	0.74	**3.30**	171.00	0.68	**2.77**	147.00	0.62	**2.17**	129.00	0.59	**1.81**	92.00	0.50	**1.10**	72.00	0.47	**0.40**
Eex1	7.47	16.05	203.00	0.74	**3.11**	184.00	0.68	**2.59**	159.00	0.62	**2.04**	139.00	0.59	**1.70**	100.00	0.50	**1.04**	79.00	0.47	**0.39**
E	9.72	22.06	177.00	0.74	**3.52**	160.00	0.68	**2.93**	138.00	0.62	**2.31**	121.00	0.59	**1.93**	86.00	0.50	**1.16**	67.00	0.47	**0.43**
F	2.43	14.13	215.00	0.74	**1.07**	195.00	0.68	**0.89**	168.00	0.62	**0.70**	148.00	0.59	**0.59**	107.00	0.50	**0.36**	84.00	0.47	**0.13**

Post Development Flow Rates

Catcht.	Ac =	tc	I_{100}	C	Q100	I_{50}	C	Q50	I_{20}	C	Q20	I_{10}	C	Q10	I_2	C	Q2	I_1	C	Q3month
ID	(ha)	(min)	(mm/hr)		(cumec)	(mm/hr)		(cumec)	(mm/hr)		(cumec)	(mm/hr)		(cumec)	(mm/hr)		(cumec)	(mm/hr)		(cumec)
Aex1	0.61	18.23	193.00	0.74	**0.24**	175.00	0.68	**0.20**	151.00	0.62	**0.16**	132.00	0.59	**0.13**	95.00	0.50	**0.08**	74.00	0.47	**0.03**
A1	0.37	12.23	228.00	0.74	**0.17**	207.00	0.68	**0.14**	179.00	0.62	**0.11**	158.00	0.59	**0.10**	114.00	0.50	**0.06**	90.00	0.47	**0.02**
Aex2	0.90	19.23	188.00	0.74	**0.35**	171.00	0.68	**0.29**	147.00	0.62	**0.23**	129.00	0.59	**0.19**	92.00	0.50	**0.12**	72.00	0.47	**0.04**
A2	2.34	16.25	203.00	0.74	**0.97**	184.00	0.68	**0.81**	159.00	0.62	**0.64**	139.00	0.59	**0.53**	100.00	0.50	**0.33**	79.00	0.47	**0.12**
B	10.38	13.56	218.00	0.75	**4.71**	198.00	0.69	**3.94**	170.50	0.63	**3.10**	150.00	0.60	**2.60**	108.50	0.51	**1.60**	85.50	0.48	**0.59**
CD	16.76	16.34	203.00	0.75	**7.09**	184.00	0.69	**5.91**	159.00	0.63	**4.66**	139.00	0.60	**3.88**	100.00	0.51	**2.37**	79.00	0.48	**0.88**
Eex1	7.47	16.05	203.00	0.74	**3.11**	184.00	0.68	**2.59**	159.00	0.62	**2.04**	139.00	0.59	**1.70**	100.00	0.50	**1.04**	79.00	0.47	**0.39**
E	8.33	22.06	177.00	0.74	**3.02**	160.00	0.68	**2.51**	138.00	0.62	**1.98**	121.00	0.59	**1.65**	86.00	0.50	**1.00**	67.00	0.47	**0.37**

Appendix B

XP Storm Results Tables

Q1 Results

Peak Discharges (Existing Conditions)												
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge
Aex1	0.076	0.088	0.101	0.116	0.106	0.077	0.111	0.095	0.087	0.081	25	0.116
A1	0.329	0.39	0.427	0.497	0.456	0.327	0.465	0.389	0.358	0.321	25	0.497
LPD A1	0.384	0.454	0.517	0.587	0.539	0.396	0.558	0.476	0.439	0.397	25	0.587
Aex2	0.124	0.146	0.162	0.188	0.172	0.124	0.177	0.149	0.136	0.124	25	0.188
A2	0.396	0.46	0.53	0.605	0.555	0.405	0.578	0.494	0.452	0.421	25	0.605
LPD A2	0.498	0.585	0.677	0.76	0.7	0.519	0.733	0.637	0.586	0.539	25	0.76
B	0.365	0.451	0.546	0.586	0.538	0.485	0.648	0.678	0.626	0.61	90	0.678
LPD B	0.363	0.451	0.545	0.585	0.538	0.485	0.649	0.678	0.626	0.609	90	0.678
C	0.389	0.476	0.579	0.622	0.572	0.503	0.673	0.702	0.644	0.629	90	0.702
D	0.498	0.619	0.748	0.8	0.735	0.671	0.899	0.938	0.867	0.846	90	0.938
LPD CD	0.883	1.093	1.324	1.42	1.305	1.173	1.566	1.638	1.511	1.473	90	1.638
Eex1	0.843	0.965	1.155	1.299	1.193	0.88	1.266	1.115	1.032	0.97	25	1.299
E	0.424	0.548	0.652	0.689	0.689	0.634	0.865	0.887	0.835	0.817	90	0.887
LPD E	1.043	1.392	1.646	1.768	1.651	1.413	1.952	1.95	1.812	1.707	60	1.952

Q1 Results

Peak Discharges (Developed Conditions)													
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.076	0.088	0.101	0.116	0.106	0.077	0.111	0.095	0.087	0.081	25	0.116	0.00%
A1	0.076	0.101	0.096	0.111	0.101	0.071	0.097	0.078	0.074	0.056	25	0.111	-77.67%
LPD A1	0.144	0.176	0.183	0.213	0.198	0.14	0.2	0.167	0.155	0.135	25	0.213	-63.71%
Aex2	0.124	0.146	0.162	0.188	0.172	0.124	0.177	0.149	0.136	0.124	25	0.188	0.00%
A2	0.296	0.343	0.395	0.451	0.414	0.302	0.432	0.369	0.338	0.314	25	0.451	-25.45%
LPD A2	0.398	0.469	0.545	0.614	0.564	0.417	0.592	0.512	0.471	0.433	25	0.614	-19.21%
B	1.332	1.567	1.762	2.031	1.864	1.348	1.939	1.659	1.511	1.399	25	2.031	199.56%
LPD B	1.33	1.561	1.76	2.025	1.858	1.349	1.933	1.658	1.511	1.402	25	2.025	198.67%
CD	1.168	1.346	1.681	1.851	1.7	1.414	1.906	1.97	1.796	1.772	90	1.97	20.12%
LPD CD	1.168	1.347	1.681	1.85	1.699	1.414	1.909	1.971	1.798	1.773	90	1.971	20.33%
Eex1	0.843	0.965	1.155	1.299	1.193	0.88	1.266	1.115	1.032	0.97	25	1.299	0.00%
E	0.364	0.47	0.559	0.592	0.591	0.544	0.742	0.761	0.716	0.701	90	0.761	-14.21%
LPD E	0.993	1.325	1.565	1.682	1.569	1.326	1.838	1.825	1.695	1.593	60	1.838	-5.84%

Q1 Results

Peak Discharges (Ultimate - Mitigated Stage 1 Conditions) (i)													
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.076	0.088	0.101	0.116	0.106	0.077	0.111	0.095	0.087	0.081	25	0.116	0.00%
A1	0.076	0.101	0.096	0.111	0.101	0.071	0.097	0.078	0.074	0.056	25	0.111	-77.67%
LPD A1	0.144	0.176	0.183	0.213	0.198	0.14	0.2	0.167	0.155	0.135	25	0.213	-63.71%
Aex2	0.124	0.146	0.162	0.188	0.172	0.124	0.177	0.149	0.136	0.124	25	0.188	0.00%
A2	0.296	0.343	0.395	0.451	0.414	0.302	0.432	0.369	0.338	0.314	25	0.451	-25.45%
LPD A2	0.398	0.469	0.545	0.614	0.564	0.417	0.592	0.512	0.471	0.433	25	0.614	-19.21%
B	0.794	0.907	1.136	1.249	1.147	0.894	1.266	1.243	1.124	1.097	60	1.266	86.73%
LPD B	0.095	0.111	0.137	0.15	0.138	0.106	0.274	0.391	0.424	0.422	120	0.424	-37.46%
CD	1.425	1.641	1.969	2.214	2.034	1.499	2.19	1.996	1.828	1.753	25	2.214	35.00%
LPD CD	0.309	0.352	0.426	0.475	0.437	0.327	0.465	0.54	0.595	0.598	180	0.598	-63.49%
Eex1	0.843	0.965	1.155	1.299	1.193	0.88	1.266	1.115	1.032	0.97	25	1.299	0.00%
E	0.364	0.47	0.559	0.592	0.591	0.544	0.742	0.761	0.716	0.701	90	0.761	-14.21%
LPD E	0.993	1.325	1.565	1.682	1.569	1.326	1.838	1.825	1.695	1.593	60	1.838	-5.84%

(i) flows developed from a cleared site prior to revegetation during quarrying and filling.

Q1 Results

Peak Discharges (Ultimate - Mitigated Stage 2 Conditions) (ii)													
Node	10min	15min	20min	0.111	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.076	0.088	0.101	0.116	0.106	0.077	0.111	0.095	0.087	0.081	25	0.116	0.00%
A1	0.076	0.101	0.096	0.111	0.101	0.071	0.097	0.078	0.074	0.056	25	0.111	-77.67%
LPD A1	0.144	0.176	0.183	0.213	0.198	0.14	0.2	0.167	0.155	0.135	25	0.213	-63.71%
Aex2	0.124	0.146	0.162	0.188	0.172	0.124	0.177	0.149	0.136	0.124	25	0.188	0.00%
A2	0.296	0.343	0.395	0.451	0.414	0.302	0.432	0.369	0.338	0.314	25	0.451	-25.45%
LPD A2	0.398	0.469	0.545	0.614	0.564	0.417	0.592	0.512	0.471	0.433	25	0.614	-19.21%
B	0.767	0.883	1.102	1.209	1.111	0.879	1.23	1.223	1.102	1.082	60	1.23	81.42%
LPD B	0.119	0.137	0.164	0.183	0.169	0.126	0.262	0.383	0.418	0.416	120	0.418	-38.35%
CD	0.914	1.063	1.322	1.453	1.335	1.136	1.504	1.585	1.453	1.433	90	1.585	-3.35%
LPD CD	0.304	0.348	0.425	0.473	0.435	0.325	0.465	0.443	0.523	0.518	120	0.523	-68.07%
Eex1	0.843	0.965	1.155	1.299	1.193	0.88	1.266	1.115	1.032	0.97	25	1.299	0.00%
E	0.364	0.47	0.559	0.592	0.591	0.544	0.742	0.761	0.716	0.701	90	0.761	-14.21%
LPD E	0.993	1.325	1.565	1.682	1.569	1.326	1.838	1.825	1.695	1.593	60	1.838	-5.84%

(ii) flows from a rehabilitated revegetaetd catchment into a wetland system. Catchments Aex1, Aex2, A1, A2, Eex1 & E are reduced in size or untouched and therefore require no mitigation.

Q2 Results

Peak Discharges (Existing Conditions)												
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge
Aex1	0.107	0.126	0.14	0.165	0.154	0.11	0.154	0.132	0.121	0.111	25	0.165
A1	0.461	0.556	0.582	0.7	0.652	0.456	0.638	0.534	0.497	0.432	25	0.7
LPD A1	0.547	0.654	0.71	0.832	0.776	0.558	0.769	0.654	0.608	0.539	25	0.832
Aex2	0.174	0.209	0.222	0.266	0.247	0.174	0.244	0.205	0.19	0.167	25	0.266
A2	0.561	0.664	0.731	0.863	0.805	0.572	0.803	0.684	0.631	0.571	25	0.863
LPD A2	0.708	0.84	0.938	1.093	1.02	0.734	1.022	0.877	0.811	0.732	25	1.093
B	0.54	0.658	0.797	0.88	0.823	0.693	0.922	0.97	0.887	0.874	90	0.97
LPD B	0.537	0.658	0.795	0.879	0.823	0.693	0.922	0.97	0.887	0.874	90	0.97
C	0.574	0.691	0.841	0.932	0.871	0.714	0.954	0.998	0.907	0.895	90	0.998
D	0.737	0.904	1.092	1.204	1.126	0.96	1.275	1.345	1.232	1.214	90	1.345
LPD CD	1.307	1.594	1.93	2.134	1.996	1.674	2.229	2.341	2.14	2.108	90	2.341
Eex1	1.206	1.404	1.613	1.875	1.749	1.261	1.778	1.546	1.416	1.326	25	1.875
E	0.633	0.811	0.962	1.048	1.02	0.92	1.233	1.299	1.214	1.198	90	1.299
LPD E	1.559	2.035	2.373	2.608	2.466	1.988	2.761	2.766	2.55	2.428	90	2.766

Q2 Results

Peak Discharges (Developed Conditions)													
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.107	0.126	0.14	0.165	0.154	0.11	0.154	0.132	0.121	0.111	25	0.165	0.00%
A1	0.1	0.136	0.129	0.147	0.136	0.098	0.128	0.105	0.1	0.074	25	0.147	-79.00%
LPD A1	0.2	0.242	0.245	0.294	0.274	0.194	0.267	0.226	0.213	0.183	25	0.294	-64.66%
Aex2	0.174	0.209	0.222	0.266	0.247	0.174	0.244	0.205	0.19	0.167	25	0.266	0.00%
A2	0.419	0.495	0.546	0.644	0.601	0.427	0.6	0.511	0.471	0.427	25	0.644	-25.38%
LPD A2	0.571	0.676	0.754	0.877	0.818	0.592	0.82	0.705	0.653	0.589	25	0.877	-19.76%
B	1.878	2.243	2.428	2.887	2.691	1.901	2.685	2.292	2.116	1.896	25	2.887	197.63%
LPD B	1.873	2.236	2.425	2.88	2.685	1.899	2.68	2.292	2.115	1.895	25	2.88	196.91%
CD	1.697	1.941	2.419	2.736	2.556	1.998	2.763	2.79	2.521	2.512	90	2.79	19.08%
LPD CD	1.698	1.942	2.415	2.729	2.551	1.999	2.763	2.789	2.521	2.51	90	2.789	19.14%
Eex1	1.206	1.404	1.613	1.875	1.749	1.261	1.778	1.546	1.416	1.326	25	1.875	0.00%
E	0.544	0.696	0.826	0.9	0.876	0.79	1.058	1.114	1.042	1.028	90	1.114	-14.24%
LPD E	1.485	1.934	2.253	2.478	2.343	1.859	2.594	2.584	2.382	2.261	60	2.594	-6.22%

Q2 Results

Peak Discharges (Ultimate - Mitigated Stage 1 Conditions) (i)													
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.107	0.126	0.14	0.165	0.154	0.11	0.154	0.132	0.121	0.111	25	0.165	0.00%
A1	0.1	0.136	0.129	0.147	0.136	0.098	0.128	0.105	0.1	0.074	25	0.147	-79.00%
LPD A1	0.2	0.242	0.245	0.294	0.274	0.194	0.267	0.226	0.213	0.183	25	0.294	-64.66%
Aex2	0.174	0.209	0.222	0.266	0.247	0.174	0.244	0.205	0.19	0.167	25	0.266	0.00%
A2	0.419	0.495	0.546	0.644	0.601	0.427	0.6	0.511	0.471	0.427	25	0.644	-25.38%
LPD A2	0.571	0.676	0.754	0.877	0.818	0.592	0.82	0.705	0.653	0.589	25	0.877	-19.76%
B	1.153	1.313	1.622	1.839	1.718	1.265	1.819	1.73	1.586	1.531	25	1.839	89.59%
LPD B	0.095	0.111	0.137	0.15	0.138	0.106	0.274	0.391	0.424	0.422	120	0.424	-56.29%
CD	2.042	2.38	2.77	3.209	2.995	2.164	3.096	2.758	2.538	2.414	25	3.209	36.96%
LPD CD	0.442	0.512	0.59	0.682	0.637	0.464	0.742	0.802	0.826	0.807	120	0.826	-64.72%
Eex1	1.206	1.404	1.613	1.875	1.749	1.261	1.778	1.546	1.416	1.326	25	1.875	0.00%
E	0.544	0.696	0.826	0.9	0.876	0.79	1.058	1.114	1.042	1.028	90	1.114	-14.24%
LPD E	1.485	1.934	2.253	2.478	2.343	1.859	2.594	2.584	2.382	2.261	60	2.594	-6.22%

(i) flows developed from a cleared site prior to revegetation during quarrying and filling.

Q2 Results

Peak Discharges (Ultimate - Mitigated Stage 2 Conditions) (ii)													
Node	10min	15min	20min	0.147	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.107	0.126	0.14	0.165	0.154	0.11	0.154	0.132	0.121	0.111	25	0.165	0.00%
A1	0.1	0.136	0.129	0.147	0.136	0.098	0.128	0.105	0.1	0.074	25	0.147	-79.00%
LPD A1	0.2	0.242	0.245	0.294	0.274	0.194	0.267	0.226	0.213	0.183	25	0.294	-64.66%
Aex2	0.174	0.209	0.222	0.266	0.247	0.174	0.244	0.205	0.19	0.167	25	0.266	0.00%
A2	0.419	0.495	0.546	0.644	0.601	0.427	0.6	0.511	0.471	0.427	25	0.644	-25.38%
LPD A2	0.571	0.676	0.754	0.877	0.818	0.592	0.82	0.705	0.653	0.589	25	0.877	-19.76%
B	1.116	1.268	1.577	1.784	1.666	1.23	1.772	1.706	1.56	1.513	25	1.784	83.92%
LPD B	0.17	0.198	0.226	0.261	0.244	0.275	0.557	0.684	0.707	0.698	120	0.707	-27.11%
CD	1.331	1.539	1.909	2.153	2.011	1.615	2.189	2.258	2.053	2.043	90	2.258	-3.63%
LPD CD	0.438	0.507	0.59	0.682	0.637	0.464	0.649	0.738	0.756	0.758	180	0.758	-67.62%
Eex1	1.206	1.404	1.613	1.875	1.749	1.261	1.778	1.546	1.416	1.326	25	1.875	0.00%
E	0.544	0.696	0.826	0.9	0.876	0.79	1.058	1.114	1.042	1.028	90	1.114	-14.24%
LPD E	1.485	1.934	2.253	2.478	2.343	1.859	2.594	2.584	2.382	2.261	60	2.594	-6.22%

(ii) flows from a rehabilitated revegetaetd catchment into a wetland system. Catchments Aex1, Aex2, A1, A2, Eex1 & E are reduced in size or untouched and therefore require no mitigation.

Q5 Results

Peak Discharges (Existing Conditions)												
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge
Aex1	0.146	0.176	0.19	0.226	0.211	0.152	0.213	0.18	0.171	0.152	25	0.226
A1	0.621	0.765	0.774	0.944	0.879	0.619	0.868	0.723	0.69	0.589	25	0.944
LPD A1	0.742	0.902	0.954	1.136	1.059	0.762	1.054	0.886	0.843	0.736	25	1.136
Aex2	0.236	0.288	0.297	0.36	0.335	0.237	0.332	0.278	0.265	0.228	25	0.36
A2	0.765	0.923	0.985	1.178	1.098	0.788	1.104	0.934	0.884	0.782	25	1.178
LPD A2	0.971	1.173	1.269	1.495	1.394	1.014	1.405	1.195	1.133	1.004	25	1.495
B	0.768	0.924	1.134	1.261	1.179	0.962	1.318	1.359	1.255	1.254	90	1.359
LPD B	0.767	0.925	1.133	1.259	1.177	0.962	1.318	1.36	1.255	1.254	90	1.36
C	0.814	0.966	1.192	1.331	1.244	0.986	1.381	1.391	1.291	1.278	90	1.391
D	1.05	1.272	1.556	1.728	1.616	1.336	1.813	1.889	1.742	1.746	90	1.889
LPD CD	1.859	2.236	2.744	3.055	2.857	2.322	3.195	3.278	3.032	3.021	90	3.278
Eex1	1.659	1.97	2.198	2.585	2.41	1.756	2.47	2.125	1.997	1.826	25	2.585
E	0.91	1.157	1.389	1.521	1.423	1.308	1.735	1.862	1.757	1.761	90	1.862
LPD E	2.224	2.856	3.341	3.68	3.471	2.756	3.893	3.858	3.61	3.473	60	3.893

Q5 Results

Peak Discharges (Developed Conditions)													
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.146	0.176	0.19	0.226	0.211	0.152	0.213	0.18	0.171	0.152	25	0.226	0.00%
A1	0.128	0.177	0.17	0.19	0.176	0.131	0.167	0.139	0.135	0.099	25	0.19	-79.87%
LPD A1	0.262	0.328	0.325	0.397	0.369	0.26	0.364	0.306	0.292	0.248	25	0.397	-65.05%
Aex2	0.236	0.288	0.297	0.36	0.335	0.237	0.332	0.278	0.265	0.228	25	0.36	0.00%
A2	0.571	0.689	0.736	0.879	0.819	0.588	0.825	0.698	0.661	0.584	25	0.879	-25.38%
LPD A2	0.779	0.94	1.02	1.204	1.122	0.815	1.13	0.96	0.91	0.807	25	1.204	-19.46%
B	2.551	3.104	3.266	3.93	3.661	2.612	3.683	3.123	2.959	2.596	25	3.93	189.18%
LPD B	2.548	3.095	3.265	3.92	3.653	2.61	3.679	3.119	2.956	2.595	25	3.92	188.24%
CD	2.382	2.755	3.404	3.87	3.614	2.749	3.97	3.876	3.604	3.573	60	3.97	21.04%
LPD CD	2.373	2.753	3.398	3.86	3.607	2.749	3.971	3.875	3.603	3.57	60	3.971	21.14%
Eex1	1.659	1.97	2.198	2.585	2.41	1.756	2.47	2.125	1.997	1.826	25	2.585	0.00%
E	0.781	0.993	1.192	1.305	1.221	1.122	1.489	1.598	1.507	1.51	90	1.598	-14.18%
LPD E	2.118	2.708	3.161	3.489	3.288	2.599	3.653	3.597	3.369	3.226	60	3.653	-6.16%

Q5 Results

Peak Discharges (Ultimate - Mitigated Stage 1 Conditions) (i)													
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.146	0.176	0.19	0.226	0.211	0.152	0.213	0.18	0.171	0.152	25	0.226	0.00%
A1	0.128	0.177	0.17	0.19	0.176	0.131	0.167	0.139	0.135	0.099	25	0.19	-79.87%
LPD A1	0.262	0.328	0.325	0.397	0.369	0.26	0.364	0.306	0.292	0.248	25	0.397	-65.05%
Aex2	0.236	0.288	0.297	0.36	0.335	0.237	0.332	0.278	0.265	0.228	25	0.36	0.00%
A2	0.571	0.689	0.736	0.879	0.819	0.588	0.825	0.698	0.661	0.584	25	0.879	-25.38%
LPD A2	0.779	0.94	1.02	1.204	1.122	0.815	1.13	0.96	0.91	0.807	25	1.204	-19.46%
B	1.613	1.868	2.26	2.584	2.413	1.806	2.584	2.362	2.227	2.144	25	2.584	90.14%
LPD B	0.192	0.223	0.264	0.405	0.528	0.615	0.932	0.979	0.981	0.979	120	0.981	-27.87%
CD	2.82	3.341	3.806	4.449	4.15	3.042	4.333	3.817	3.557	3.346	25	4.449	35.64%
LPD CD	0.605	0.716	0.802	0.936	0.874	0.793	1.119	1.464	1.585	1.594	180	1.594	-51.37%
Eex1	1.659	1.97	2.198	2.585	2.41	1.756	2.47	2.125	1.997	1.826	25	2.585	0.00%
E	0.781	0.993	1.192	1.305	1.221	1.122	1.489	1.598	1.507	1.51	90	1.598	-14.18%
LPD E	2.118	2.708	3.161	3.489	3.288	2.599	3.653	3.597	3.369	3.226	60	3.653	-6.16%

(i) flows developed from a cleared site prior to revegetation during quarrying and filling.

Q5 Results

Peak Discharges (Ultimate - Mitigated Stage 2 Conditions) (ii)													
Node	10min	15min	20min	0.19	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.146	0.176	0.19	0.226	0.211	0.152	0.213	0.18	0.171	0.152	25	0.226	0.00%
A1	0.128	0.177	0.17	0.19	0.176	0.131	0.167	0.139	0.135	0.099	25	0.19	-79.87%
LPD A1	0.262	0.328	0.325	0.397	0.369	0.26	0.364	0.306	0.292	0.248	25	0.397	-65.05%
Aex2	0.236	0.288	0.297	0.36	0.335	0.237	0.332	0.278	0.265	0.228	25	0.36	0.00%
A2	0.571	0.689	0.736	0.879	0.819	0.588	0.825	0.698	0.661	0.584	25	0.879	-25.38%
LPD A2	0.779	0.94	1.02	1.204	1.122	0.815	1.13	0.96	0.91	0.807	25	1.204	-19.46%
B	1.564	1.806	2.203	2.512	2.346	1.76	2.525	2.337	2.199	2.124	60	2.525	85.80%
LPD B	0.233	0.277	0.305	0.385	0.506	0.593	0.917	0.964	0.971	0.969	120	0.971	-28.60%
CD	1.871	2.159	2.695	3.053	2.852	2.234	3.157	3.154	2.919	2.922	60	3.157	-3.75%
LPD CD	0.604	0.714	0.801	0.936	0.874	0.643	0.9	1.255	1.397	1.452	180	1.452	-55.70%
Eex1	1.659	1.97	2.198	2.585	2.41	1.756	2.47	2.125	1.997	1.826	25	2.585	0.00%
E	0.781	0.993	1.192	1.305	1.221	1.122	1.489	1.598	1.507	1.51	90	1.598	-14.18%
LPD E	2.118	2.708	3.161	3.489	3.288	2.599	3.653	3.597	3.369	3.226	60	3.653	-6.16%

(ii) flows from a rehabilitated revegetaetd catchment into a wetland system. Catchments Aex1, Aex2, A1, A2, Eex1 & E are reduced in size or untouched and therefore require no mitigation.

Q10 Results

Peak Discharges (Existing Conditions)												
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge
Aex1	0.169	0.204	0.218	0.259	0.244	0.175	0.247	0.21	0.2	0.177	25	0.259
A1	0.713	0.882	0.882	1.076	1.013	0.711	1.001	0.841	0.807	0.686	25	1.076
LPD A1	0.857	1.045	1.091	1.298	1.226	0.878	1.22	1.032	0.989	0.858	25	1.298
Aex2	0.271	0.333	0.338	0.41	0.386	0.273	0.384	0.323	0.31	0.266	25	0.41
A2	0.883	1.07	1.129	1.349	1.272	0.91	1.279	1.089	1.039	0.913	25	1.349
LPD A2	1.125	1.357	1.454	1.716	1.619	1.173	1.63	1.391	1.329	1.173	25	1.716
B	0.905	1.075	1.334	1.477	1.4	1.116	1.569	1.602	1.493	1.493	90	1.602
LPD B	1.511	1.074	1.333	1.476	1.399	1.117	1.569	1.601	1.494	1.494	90	1.601
C	0.959	1.121	1.4	1.557	1.475	1.141	1.639	1.635	1.531	1.518	60	1.639
D	1.239	1.481	1.833	2.025	1.92	1.552	2.16	2.228	2.074	2.081	90	2.228
LPD CD	2.194	2.601	3.229	3.576	3.391	2.692	3.801	3.862	3.605	3.596	90	3.862
Eex1	1.924	2.292	2.532	2.973	2.807	2.041	2.874	2.485	2.354	2.137	25	2.973
E	1.078	1.357	1.646	1.791	1.7	1.534	2.045	2.22	2.091	2.12	90	2.22
LPD E	2.621	3.318	3.913	4.283	4.091	3.24	4.575	4.541	4.269	4.133	60	4.575

Q10 Results

Peak Discharges (Developed Conditions)													
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.169	0.204	0.218	0.259	0.244	0.175	0.247	0.21	0.2	0.177	25	0.259	0.00%
A1	0.144	0.199	0.193	0.212	0.198	0.149	0.19	0.16	0.157	0.114	25	0.212	-80.30%
LPD A1	0.301	0.378	0.37	0.452	0.425	0.298	0.42	0.356	0.342	0.289	25	0.452	-65.18%
Aex2	0.271	0.333	0.338	0.41	0.386	0.273	0.384	0.323	0.31	0.266	25	0.41	0.00%
A2	0.659	0.798	0.843	1.007	0.95	0.68	0.955	0.813	0.776	0.682	25	1.007	-25.35%
LPD A2	0.902	1.092	1.171	1.378	1.302	0.943	1.309	1.119	1.069	0.943	25	1.378	-19.70%
B	2.942	3.59	3.742	4.496	4.238	3.017	4.264	3.638	3.473	3.03	25	4.496	180.65%
LPD B	2.937	3.581	3.741	4.485	4.233	3.017	4.261	3.635	3.468	3.032	25	4.485	180.14%
CD	2.792	3.229	3.986	4.507	4.267	3.219	4.698	4.55	4.269	4.239	60	4.698	21.49%
LPD CD	2.785	3.226	3.98	4.496	4.258	3.22	4.697	4.549	4.267	4.236	60	4.697	21.62%
Eex1	1.924	2.292	2.532	2.973	2.807	2.041	2.874	2.485	2.354	2.137	25	2.973	0.00%
E	0.926	1.164	1.413	1.538	1.46	1.316	1.754	1.904	1.794	1.818	90	1.904	-14.23%
LPD E	2.496	3.143	3.697	4.056	3.87	3.053	4.291	4.229	3.98	3.836	60	4.291	-6.21%

Q10 Results

Peak Discharges (Ultimate - Mitigated Stage 1 Conditions) (i)													
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.169	0.204	0.218	0.259	0.244	0.175	0.247	0.21	0.2	0.177	25	0.259	0.00%
A1	0.144	0.199	0.193	0.212	0.198	0.149	0.19	0.16	0.157	0.114	25	0.212	-80.30%
LPD A1	0.301	0.378	0.37	0.452	0.425	0.298	0.42	0.356	0.342	0.289	25	0.452	-65.18%
Aex2	0.271	0.333	0.338	0.41	0.386	0.273	0.384	0.323	0.31	0.266	25	0.41	0.00%
A2	0.659	0.798	0.843	1.007	0.95	0.68	0.955	0.813	0.776	0.682	25	1.007	-25.35%
LPD A2	0.902	1.092	1.171	1.378	1.302	0.943	1.309	1.119	1.069	0.943	25	1.378	-19.70%
B	1.887	2.188	2.632	3	2.838	2.123	3.04	2.763	2.615	2.527	60	3.04	89.76%
LPD B	0.223	0.259	0.393	0.552	0.711	0.812	1.02	1.169	1.223	1.239	180	1.239	-22.61%
CD	3.278	3.89	4.404	5.132	4.848	3.552	5.062	4.477	4.209	3.926	25	5.132	32.71%
LPD CD	0.7	0.831	0.923	1.077	1.018	0.971	1.68	2.061	2.157	2.176	180	2.176	-43.66%
Eex1	1.924	2.292	2.532	2.973	2.807	2.041	2.874	2.485	2.354	2.137	25	2.973	0.00%
E	0.926	1.164	1.413	1.538	1.46	1.316	1.754	1.904	1.794	1.818	90	1.904	-14.23%
LPD E	2.496	3.143	3.697	4.056	3.87	3.053	4.291	4.229	3.98	3.836	60	4.291	-6.21%

(i) flows developed from a cleared site prior to revegetation during quarrying and filling.

Q10 Results

Peak Discharges (Ultimate - Mitigated Stage 2 Conditions) (ii)													
Node	10min	15min	20min	0.212	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.169	0.204	0.218	0.259	0.244	0.175	0.247	0.21	0.2	0.177	25	0.259	0.00%
A1	0.144	0.199	0.193	0.212	0.198	0.149	0.19	0.16	0.157	0.114	25	0.212	-80.30%
LPD A1	0.301	0.378	0.37	0.452	0.425	0.298	0.42	0.356	0.342	0.289	25	0.452	-65.18%
Aex2	0.271	0.333	0.338	0.41	0.386	0.273	0.384	0.323	0.31	0.266	25	0.41	0.00%
A2	0.659	0.798	0.843	1.007	0.95	0.68	0.955	0.813	0.776	0.682	25	1.007	-25.35%
LPD A2	0.902	1.092	1.171	1.378	1.302	0.943	1.309	1.119	1.069	0.943	25	1.378	-19.70%
B	1.831	2.117	2.569	2.919	2.762	2.073	2.973	2.725	2.585	2.506	60	2.973	85.58%
LPD B	0.269	0.319	0.373	0.528	0.684	0.786	1.005	1.15	1.206	1.225	180	1.225	-23.49%
CD	2.196	2.532	3.161	3.561	3.372	2.589	3.743	3.712	3.468	3.474	60	3.743	-3.21%
LPD CD	0.7	0.83	0.924	1.075	1.016	0.751	1.278	1.76	1.904	1.959	180	1.959	-49.27%
Eex1	1.924	2.292	2.532	2.973	2.807	2.041	2.874	2.485	2.354	2.137	25	2.973	0.00%
E	0.926	1.164	1.413	1.538	1.46	1.316	1.754	1.904	1.794	1.818	90	1.904	-14.23%
LPD E	2.496	3.143	3.697	4.056	3.87	3.053	4.291	4.229	3.98	3.836	60	4.291	-6.21%

(ii) flows from a rehabilitated revegetaetd catchment into a wetland system. Catchments Aex1, Aex2, A1, A2, Eex1 & E are reduced in size or untouched and therefore require no mitigation.

Q20 Results

Peak Discharges (Existing Conditions)												
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge
Aex1	0.202	0.246	0.257	0.311	0.291	0.21	0.294	0.249	0.238	0.21	25	0.311
A1	0.843	1.053	1.033	1.282	1.198	0.845	1.185	0.993	0.955	0.809	25	1.282
LPD A1	1.02	1.256	1.282	1.553	1.453	1.048	1.446	1.221	1.172	1.014	25	1.553
Aex2	0.321	0.399	0.397	0.49	0.458	0.325	0.455	0.382	0.367	0.314	25	0.49
A2	1.052	1.286	1.332	1.618	1.514	1.089	1.523	1.29	1.233	1.079	25	1.618
LPD A2	1.34	1.633	1.718	2.063	1.932	1.404	1.943	1.648	1.577	1.387	25	2.063
B	1.108	1.298	1.626	1.826	1.717	1.342	1.927	1.917	1.795	1.799	60	1.927
LPD B	1.107	1.297	1.624	1.822	1.714	1.342	1.925	1.917	1.794	1.798	60	1.925
C	1.171	1.351	1.702	1.921	1.806	1.399	2.008	1.952	1.835	1.825	60	2.008
D	1.517	1.791	2.236	2.507	2.357	1.869	2.656	2.671	2.496	2.511	90	2.671
LPD CD	2.68	3.14	3.932	4.421	4.157	3.24	4.666	4.621	4.329	4.333	60	4.666
Eex1	2.303	2.769	3.005	3.587	3.36	2.459	3.439	2.954	2.806	2.532	25	3.587
E	1.328	1.655	2.024	2.234	2.102	1.871	2.493	2.691	2.514	2.584	90	2.691
LPD E	3.205	4.004	4.742	5.254	4.973	3.972	5.548	5.431	5.108	4.982	60	5.548

Q20 Results

Peak Discharges (Developed Conditions)													
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.202	0.246	0.257	0.311	0.291	0.21	0.294	0.249	0.238	0.21	25	0.311	0.00%
A1	0.171	0.23	0.226	0.247	0.229	0.176	0.222	0.188	0.183	0.134	25	0.247	-80.73%
LPD A1	0.355	0.45	0.432	0.539	0.503	0.354	0.499	0.422	0.406	0.341	25	0.539	-65.29%
Aex2	0.321	0.399	0.397	0.49	0.458	0.325	0.455	0.382	0.367	0.314	25	0.49	0.00%
A2	0.785	0.96	0.995	1.208	1.13	0.814	1.137	0.964	0.921	0.807	25	1.208	-25.34%
LPD A2	1.079	1.314	1.381	1.656	1.55	1.13	1.56	1.324	1.269	1.116	25	1.656	-19.73%
B	5.116	5.131	5.133	5.15	5.144	5.118	5.145	5.131	5.128	5.118	25	5.15	167.25%
LPD B	3.493	4.3	4.408	5.383	5.028	3.607	5.07	4.303	4.117	3.58	25	5.383	179.64%
CD	3.393	3.943	4.831	5.537	5.198	3.971	5.734	5.424	5.107	5.09	60	5.734	22.55%
LPD CD	3.331	3.939	4.822	5.523	5.188	3.97	5.733	5.427	5.106	5.089	60	5.733	22.87%
Eex1	2.303	2.769	3.005	3.587	3.36	2.459	3.439	2.954	2.806	2.532	25	3.587	0.00%
E	1.14	1.42	1.737	1.918	1.804	1.605	2.139	2.308	2.156	2.216	90	2.308	-14.23%
LPD E	3.046	3.792	4.474	4.967	4.697	3.738	5.198	5.053	4.758	4.62	60	5.198	-6.31%

Q20 Results

Peak Discharges (Ultimate - Mitigated Stage 1 Conditions) (i)													
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.202	0.246	0.257	0.311	0.291	0.21	0.294	0.249	0.238	0.21	25	0.311	0.00%
A1	0.171	0.23	0.226	0.247	0.229	0.176	0.222	0.188	0.183	0.134	25	0.247	-80.73%
LPD A1	0.355	0.45	0.432	0.539	0.503	0.354	0.499	0.422	0.406	0.341	25	0.539	-65.29%
Aex2	0.321	0.399	0.397	0.49	0.458	0.325	0.455	0.382	0.367	0.314	25	0.49	0.00%
A2	0.785	0.96	0.995	1.208	1.13	0.814	1.137	0.964	0.921	0.807	25	1.208	-25.34%
LPD A2	1.079	1.314	1.381	1.656	1.55	1.13	1.56	1.324	1.269	1.116	25	1.656	-19.73%
B	2.285	2.668	3.167	3.665	3.439	2.598	3.684	3.313	3.1	3.016	60	3.684	91.18%
LPD B	0.268	0.359	0.585	0.8	0.927	0.986	1.364	1.589	1.617	1.666	180	1.666	-13.45%
CD	3.939	4.708	5.256	6.219	5.828	4.306	6.085	5.336	5.034	4.664	25	6.219	32.91%
LPD CD	0.839	1.001	1.094	1.297	1.216	1.328	2.502	2.941	2.922	3.063	180	3.063	-34.35%
Eex1	2.303	2.769	3.005	3.587	3.36	2.459	3.439	2.954	2.806	2.532	25	3.587	0.00%
E	1.14	1.42	1.737	1.918	1.804	1.605	2.139	2.308	2.156	2.216	90	2.308	-14.23%
LPD E	3.046	3.792	4.474	4.967	4.697	3.738	5.198	5.053	4.758	4.62	60	5.198	-6.31%

(i) flows developed from a cleared site prior to revegetation during quarrying and filling.

Q20 Results

Peak Discharges (Ultimate - Mitigated Stage 2 Conditions) (ii)													
Node	10min	15min	20min	0.247	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.202	0.246	0.257	0.311	0.291	0.21	0.294	0.249	0.238	0.21	25	0.311	0.00%
A1	0.171	0.23	0.226	0.247	0.229	0.176	0.222	0.188	0.183	0.134	25	0.247	-80.73%
LPD A1	0.355	0.45	0.432	0.539	0.503	0.354	0.499	0.422	0.406	0.341	25	0.539	-65.29%
Aex2	0.321	0.399	0.397	0.49	0.458	0.325	0.455	0.382	0.367	0.314	25	0.49	0.00%
A2	0.785	0.96	0.995	1.208	1.13	0.814	1.137	0.964	0.921	0.807	25	1.208	-25.34%
LPD A2	1.079	1.314	1.381	1.656	1.55	1.13	1.56	1.324	1.269	1.116	25	1.656	-19.73%
B	2.219	2.584	3.095	3.57	3.351	2.54	3.608	3.264	3.069	2.993	60	3.608	87.23%
LPD B	0.319	0.382	0.56	0.768	0.899	0.969	1.334	1.556	1.595	1.642	180	1.642	-14.70%
CD	2.672	3.095	3.839	4.382	4.116	3.158	4.58	4.438	4.162	4.183	60	4.58	-2.12%
LPD CD	0.837	1.001	1.094	1.296	1.215	0.999	2.001	2.425	2.568	2.644	180	2.644	-43.33%
Eex1	2.303	2.769	3.005	3.587	3.36	2.459	3.439	2.954	2.806	2.532	25	3.587	0.00%
E	1.14	1.42	1.737	1.918	1.804	1.605	2.139	2.308	2.156	2.216	90	2.308	-14.23%
LPD E	3.046	3.792	4.474	4.967	4.697	3.738	5.198	5.053	4.758	4.62	60	5.198	-6.31%

(ii) flows from a rehabilitated revegetaetd catchment into a wetland system. Catchments Aex1, Aex2, A1, A2, Eex1 & E are reduced in size or untouched and therefore require no mitigation.

Q50 Results

Peak Discharges (Existing Conditions)												
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge
Aex1	0.251	0.287	0.301	0.337	0.32	0.242	0.332	0.27	0.257	0.225	25	0.337
A1	1.047	1.216	1.202	1.378	1.307	0.965	1.33	1.067	1.021	0.865	25	1.378
LPD A1	1.269	1.457	1.494	1.679	1.594	1.202	1.631	1.316	1.259	1.087	25	1.679
Aex2	0.399	0.461	0.463	0.527	0.5	0.372	0.512	0.411	0.393	0.336	25	0.527
A2	1.309	1.497	1.558	1.751	1.663	1.253	1.72	1.395	1.327	1.157	25	1.751
LPD A2	1.668	1.911	2.008	2.235	2.124	1.616	2.195	1.785	1.699	1.488	25	2.235
B	1.401	1.615	1.956	2.047	1.948	1.6	2.262	2.164	2.018	1.974	60	2.262
LPD B	1.401	1.615	1.954	2.045	1.947	1.6	2.262	2.164	2.018	1.973	60	2.262
C	1.48	1.676	2.044	2.148	2.044	1.661	2.351	2.198	2.057	1.997	60	2.351
D	1.919	2.23	2.693	2.813	2.677	2.231	3.123	3.019	2.81	2.759	60	3.123
LPD CD	3.337	3.903	4.73	4.957	4.717	3.857	5.476	5.216	4.867	4.753	60	5.476
Eex1	2.876	3.247	3.531	3.909	3.714	2.846	3.91	3.213	3.038	2.722	60	3.91
E	1.686	2.078	2.456	2.528	2.407	2.255	2.95	3.079	2.875	2.873	90	3.079
LPD E	4.023	4.876	5.678	5.919	5.655	4.694	6.46	6.097	5.711	5.471	60	6.46

Q50 Results

Peak Discharges (Developed Conditions)													
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.251	0.287	0.301	0.337	0.32	0.242	0.332	0.27	0.257	0.225	25	0.337	0.00%
A1	0.203	0.255	0.249	0.259	0.244	0.197	0.244	0.197	0.192	0.143	25	0.259	-81.20%
LPD A1	0.44	0.518	0.503	0.579	0.548	0.404	0.561	0.454	0.434	0.365	25	0.579	-65.52%
Aex2	0.399	0.461	0.463	0.527	0.5	0.372	0.512	0.411	0.393	0.336	25	0.527	0.00%
A2	0.977	1.117	1.164	1.308	1.242	0.936	1.285	1.042	0.991	0.865	25	1.308	-25.30%
LPD A2	1.34	1.533	1.615	1.798	1.708	1.3	1.765	1.433	1.365	1.197	25	1.798	-19.55%
B	4.354	5.001	5.16	5.826	5.529	4.15	5.726	4.651	4.428	3.84	25	5.826	157.56%
LPD B	4.348	4.994	5.157	5.822	5.528	4.149	5.724	4.649	4.425	3.838	25	5.822	157.38%
CD	4.279	4.697	5.789	6.162	5.859	4.7	6.685	6.103	5.723	5.563	60	6.685	22.12%
LPD CD	4.277	4.695	5.778	6.149	5.848	4.699	6.682	6.105	5.722	5.561	60	6.682	22.02%
Eex1	2.876	3.247	3.531	3.909	3.714	2.846	3.91	3.213	3.038	2.722	60	3.91	0.00%
E	1.447	1.783	2.108	2.17	2.066	1.934	2.53	2.641	2.466	2.464	90	2.641	-14.23%
LPD E	3.82	4.601	5.346	5.579	5.329	4.411	6.046	5.663	5.311	5.067	60	6.046	-6.41%

Q50 Results

Peak Discharges (Ultimate - Mitigated Stage 1 Conditions) (i)													
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.251	0.287	0.301	0.337	0.32	0.242	0.332	0.27	0.257	0.225	25	0.337	0.00%
A1	0.203	0.255	0.249	0.259	0.244	0.197	0.244	0.197	0.192	0.143	25	0.259	-81.20%
LPD A1	0.44	0.518	0.503	0.579	0.548	0.404	0.561	0.454	0.434	0.365	25	0.579	-65.52%
Aex2	0.399	0.461	0.463	0.527	0.5	0.372	0.512	0.411	0.393	0.336	25	0.527	0.00%
A2	0.977	1.117	1.164	1.308	1.242	0.936	1.285	1.042	0.991	0.865	25	1.308	-25.30%
LPD A2	1.34	1.533	1.615	1.798	1.708	1.3	1.765	1.433	1.365	1.197	25	1.798	-19.55%
B	2.871	3.169	3.767	4.051	3.852	3.05	4.254	3.664	3.439	3.27	60	4.254	88.06%
LPD B	0.333	0.563	0.856	0.992	1.087	1.223	1.873	2.092	2.065	2.052	90	2.092	-7.52%
CD	4.933	5.538	6.21	6.813	6.473	5.014	6.96	5.839	5.486	5.031	60	6.96	27.15%
LPD CD	1.041	1.174	1.284	1.414	1.862	2.274	3.511	3.868	3.76	3.878	180	3.878	-29.18%
Eex1	2.876	3.247	3.531	3.909	3.714	2.846	3.91	3.213	3.038	2.722	60	3.91	0.00%
E	1.447	1.783	2.108	2.17	2.066	1.934	2.53	2.641	2.466	2.464	90	2.641	-14.23%
LPD E	3.82	4.601	5.346	5.579	5.329	4.411	6.046	5.663	5.311	5.067	60	6.046	-6.41%

(i) flows developed from a cleared site prior to revegetation during quarrying and filling.

Q50 Results

Peak Discharges (Ultimate - Mitigated Stage 2 Conditions) (ii)													
Node	10min	15min	20min	0.259	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.251	0.287	0.301	0.337	0.32	0.242	0.332	0.27	0.257	0.225	25	0.337	0.00%
A1	0.203	0.255	0.249	0.259	0.244	0.197	0.244	0.197	0.192	0.143	25	0.259	-81.20%
LPD A1	0.44	0.518	0.503	0.579	0.548	0.404	0.561	0.454	0.434	0.365	25	0.579	-65.52%
Aex2	0.399	0.461	0.463	0.527	0.5	0.372	0.512	0.411	0.393	0.336	25	0.527	0.00%
A2	0.977	1.117	1.164	1.308	1.242	0.936	1.285	1.042	0.991	0.865	25	1.308	-25.30%
LPD A2	1.34	1.533	1.615	1.798	1.708	1.3	1.765	1.433	1.365	1.197	25	1.798	-19.55%
B	2.791	3.073	3.687	3.953	3.759	2.986	4.174	3.617	3.409	3.249	60	4.174	84.53%
LPD B	0.396	0.539	0.826	0.96	1.063	1.189	1.84	2.061	2.043	2.026	90	2.061	-8.89%
CD	3.373	3.747	4.611	4.889	4.649	3.748	5.357	5.009	4.678	4.584	60	5.357	-2.14%
LPD CD	1.041	1.174	1.284	1.414	1.344	1.605	2.914	3.348	3.364	3.337	120	3.364	-38.57%
Eex1	2.876	3.247	3.531	3.909	3.714	2.846	3.91	3.213	3.038	2.722	60	3.91	0.00%
E	1.447	1.783	2.108	2.17	2.066	1.934	2.53	2.641	2.466	2.464	90	2.641	-14.23%
LPD E	3.82	4.601	5.346	5.579	5.329	4.411	6.046	5.663	5.311	5.067	60	6.046	-6.41%

(ii) flows from a rehabilitated revegetaetd catchment into a wetland system. Catchments Aex1, Aex2, A1, A2, Eex1 & E are reduced in size or untouched and therefore require no mitigation.

Q100 Results

Peak Discharges (Existing Conditions)												
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge
Aex1	0.284	0.328	0.337	0.383	0.364	0.273	0.377	0.305	0.292	0.256	25	0.383
A1	1.175	1.386	1.341	1.555	1.478	1.083	1.505	1.205	1.159	0.982	25	1.555
LPD A1	1.425	1.666	1.671	1.903	1.811	1.351	1.85	1.487	1.427	1.234	25	1.903
Aex2	0.449	0.526	0.517	0.596	0.567	0.418	0.579	0.465	0.446	0.381	25	0.596
A2	1.477	1.715	1.746	1.986	1.89	1.413	1.953	1.577	1.509	1.314	25	1.986
LPD A2	1.886	2.187	2.251	2.538	2.416	1.823	2.494	2.019	1.933	1.69	25	2.538
B	1.613	1.856	2.244	2.375	2.267	1.84	2.626	2.461	2.313	2.268	60	2.626
LPD B	1.606	1.856	2.24	2.371	2.263	1.839	2.624	2.462	2.312	2.267	60	2.624
C	1.701	1.923	2.341	2.488	2.375	1.917	2.723	2.495	2.353	2.291	60	2.723
D	2.211	2.566	3.092	3.266	3.118	2.537	3.627	3.436	3.224	3.171	60	3.627
LPD CD	3.897	4.486	5.426	5.75	5.487	4.455	6.354	5.931	5.577	5.458	60	6.354
Eex1	3.258	3.735	3.974	4.452	4.24	3.223	4.453	3.639	3.464	3.096	60	4.453
E	1.951	2.409	2.837	2.952	2.819	2.575	3.406	3.532	3.297	3.325	90	3.532
LPD E	4.623	5.599	6.486	6.824	6.536	5.386	7.441	6.935	6.533	6.289	60	7.441

Q100 Results

Peak Discharges (Developed Conditions)													
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.284	0.328	0.337	0.383	0.364	0.273	0.377	0.305	0.292	0.256	25	0.383	0.00%
A1	0.223	0.285	0.277	0.288	0.272	0.22	0.274	0.222	0.217	0.161	25	0.288	-81.48%
LPD A1	0.493	0.59	0.561	0.653	0.621	0.455	0.635	0.513	0.494	0.415	25	0.653	-65.69%
Aex2	0.449	0.526	0.517	0.596	0.567	0.418	0.579	0.465	0.446	0.381	25	0.596	0.00%
A2	1.103	1.28	1.304	1.483	1.412	1.055	1.459	1.178	1.128	0.982	25	1.483	-25.33%
LPD A2	1.515	1.759	1.811	2.042	1.944	1.466	2.006	1.621	1.552	1.359	25	2.042	-19.54%
B	4.909	5.72	5.781	6.603	6.282	4.678	6.496	5.257	5.035	4.36	25	6.603	151.45%
LPD B	4.905	5.717	5.778	6.602	6.27	4.677	6.494	5.256	5.032	4.359	25	6.602	151.60%
CD	4.904	5.458	6.616	7.117	6.787	5.413	7.726	6.924	6.54	6.377	60	7.726	21.67%
LPD CD	4.903	5.451	6.607	7.101	6.774	5.411	7.724	6.927	6.539	6.374	60	7.724	21.56%
Eex1	3.258	3.735	3.974	4.452	4.24	3.223	4.453	3.639	3.464	3.096	60	4.453	0.00%
E	1.675	2.067	2.435	2.534	2.42	2.208	2.923	3.029	2.827	2.851	90	3.029	-14.24%
LPD E	4.385	5.286	6.101	6.424	6.153	5.058	6.958	6.437	6.071	5.821	60	6.958	-6.49%

Q100 Results

Peak Discharges (Ultimate - Mitigated Stage 1 Conditions) (i)													
Node	10min	15min	20min	25min	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.284	0.328	0.337	0.383	0.364	0.273	0.377	0.305	0.292	0.256	25	0.383	0.00%
A1	0.223	0.285	0.277	0.288	0.272	0.22	0.274	0.222	0.217	0.161	25	0.288	-81.48%
LPD A1	0.493	0.59	0.561	0.653	0.621	0.455	0.635	0.513	0.494	0.415	25	0.653	-65.69%
Aex2	0.449	0.526	0.517	0.596	0.567	0.418	0.579	0.465	0.446	0.381	25	0.596	0.00%
A2	1.103	1.28	1.304	1.483	1.412	1.055	1.459	1.178	1.128	0.982	25	1.483	-25.33%
LPD A2	1.515	1.759	1.811	2.042	1.944	1.466	2.006	1.621	1.552	1.359	25	2.042	-19.54%
B	3.28	3.674	4.281	4.657	4.44	3.491	4.888	4.174	3.909	3.733	60	4.888	86.14%
LPD B	0.379	0.742	0.97	1.118	1.38	1.554	2.316	2.557	2.522	2.548	90	2.557	-2.55%
CD	5.605	6.384	7.017	7.786	7.417	5.703	7.953	6.626	6.27	5.73	60	7.953	25.24%
LPD CD	1.179	1.349	1.444	1.975	2.658	2.935	4.343	4.729	4.598	4.894	180	4.894	-22.98%
Eex1	3.258	3.735	3.974	4.452	4.24	3.223	4.453	3.639	3.464	3.096	60	4.453	0.00%
E	1.675	2.067	2.435	2.534	2.42	2.208	2.923	3.029	2.827	2.851	90	3.029	-14.24%
LPD E	4.385	5.286	6.101	6.424	6.153	5.058	6.958	6.437	6.071	5.821	60	6.958	-6.49%

(i) flows developed from a cleared site prior to revegetation during quarrying and filling. Catchments Aex1, Aex2, A1, A2, Eex1 & E are reduced in size or untouched and therefore require no mitigation

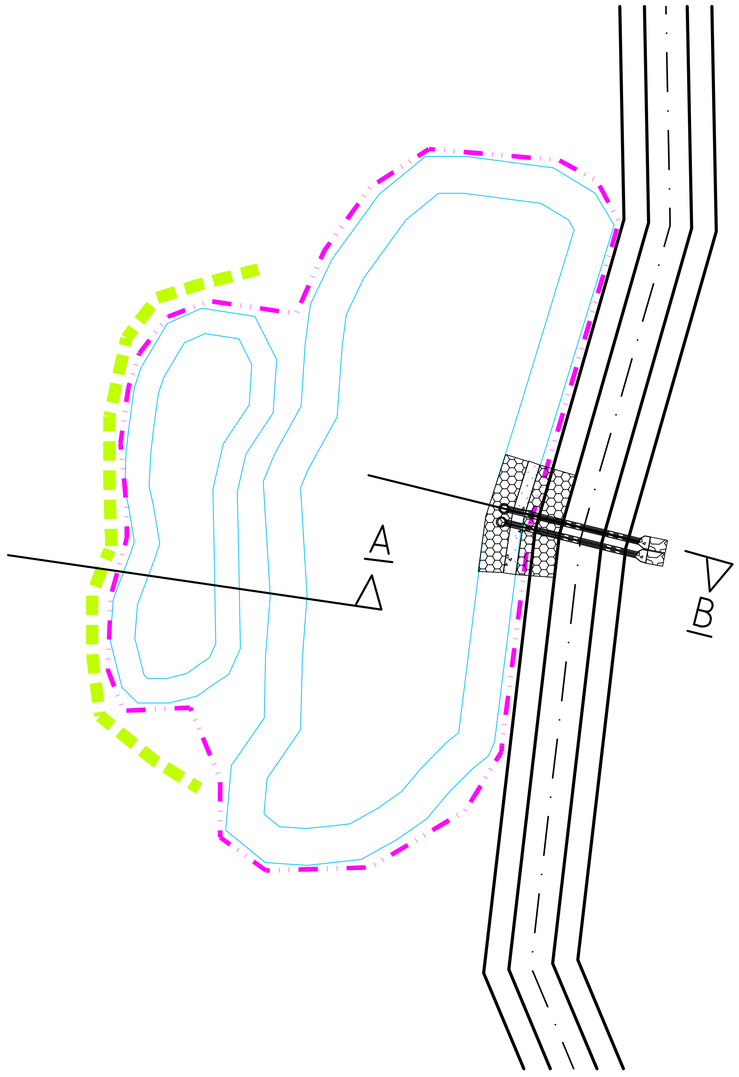
Q100 Results

Peak Discharges (Ultimate - Mitigated Stage 2 Conditions) (ii)													
Node	10min	15min	20min	0.288	30min	45min	60min	90min	120min	180min	Critcal Duration	Max Discharge	% Increase over Existing Conditions
Aex1	0.284	0.328	0.337	0.383	0.364	0.273	0.377	0.305	0.292	0.256	25	0.383	0.00%
A1	0.223	0.285	0.277	0.288	0.272	0.22	0.274	0.222	0.217	0.161	25	0.288	-81.48%
LPD A1	0.493	0.59	0.561	0.653	0.621	0.455	0.635	0.513	0.494	0.415	25	0.653	-65.69%
Aex2	0.449	0.526	0.517	0.596	0.567	0.418	0.579	0.465	0.446	0.381	25	0.596	0.00%
A2	1.103	1.28	1.304	1.483	1.412	1.055	1.459	1.178	1.128	0.982	25	1.483	-25.33%
LPD A2	1.515	1.759	1.811	2.042	1.944	1.466	2.006	1.621	1.552	1.359	25	2.042	-19.54%
B	3.191	3.566	4.194	4.548	4.337	3.422	4.801	4.123	3.875	3.711	60	4.801	82.83%
LPD B	0.447	0.711	0.937	1.073	1.332	1.515	2.275	2.525	2.516	2.517	90	2.525	-3.77%
CD	3.87	4.302	5.279	5.655	5.393	4.324	6.204	5.694	5.357	5.263	60	6.204	-2.30%
LPD CD	1.179	1.348	1.444	1.609	1.763	2.263	3.674	4.135	4.07	4.151	180	4.151	-34.67%
Eex1	3.258	3.735	3.974	4.452	4.24	3.223	4.453	3.639	3.464	3.096	60	4.453	0.00%
E	1.675	2.067	2.435	2.534	2.42	2.208	2.923	3.029	2.827	2.851	90	3.029	-14.24%
LPD E	4.385	5.286	6.101	6.424	6.153	5.058	6.958	6.437	6.071	5.821	60	6.958	-6.49%

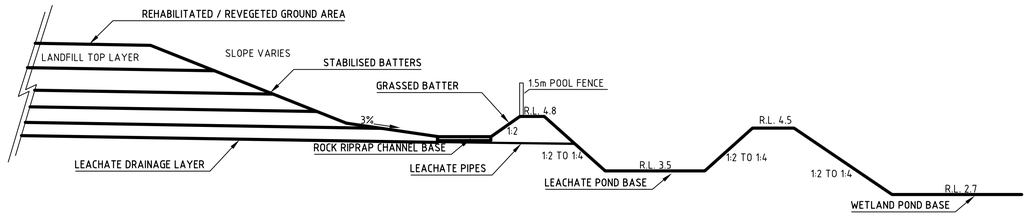
(ii) flows from a rehabilitated revegetaetd catchment into a wetland system. Catchments Aex1, Aex2, A1, A2, Eex1 & E are reduced in size or untouched and therefore require no mitigation.

Appendix C

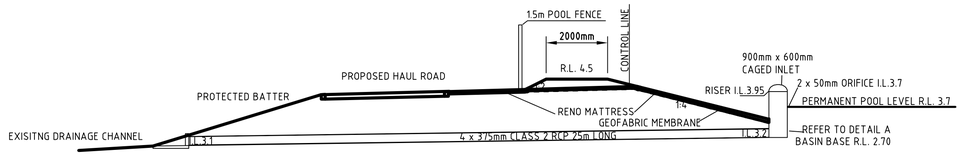
Typical Sections Detention Areas



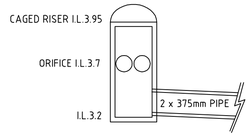
SCALE 1:500



SECTION A
NTS



SECTION B
NTS



DETAIL A
N.T.S.

LEGEND

- CONCRETE WIER
- SCOUR PROTECTION
- RENO MATTRESS
- PROPOSED CONDUITS
- PROPOSED DIVERSION DRAINS
- 1.5m POOL FENCE (OR EQUIVALENT)

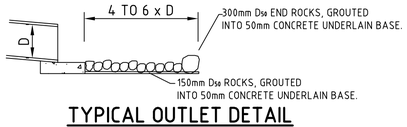
NOTES

BASINS TO BE DENSELY PLANTED WITH EMPHEMERAL NATIVE SPECIES AS PER DLWC CONSTRUCTED WETLAND DESIGN MANUAL.

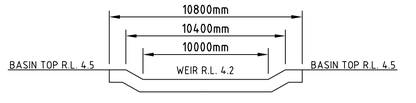
NO MULCHING TO INTERNAL BATTERS

BASIN TO BE STABILISED WITH HYDROSEED OR EQUIVALENT AFTER EARTHWORKS AND PRIOR TO PLANTING AT THE REQUIRED DENSITIES.

BASIN OUTLET TO BE BLOCKED WITH HESSIAN / GEOFABRIC MEMBRANE DURING THE INITIAL CONSTRUCTION STAGE AND REMOVED AFTER BASIN HAS BEEN PLANTED.



TYPICAL OUTLET DETAIL



WEIR CONTROL LINE ELEVATION
N.T.S.

BASIN A STAGE STORAGE TABLE

ELEVATION (RL)	DEPTH (m)	AREA(m)	VOLUME (m3)
2.7	0.00	4,500	0.00
3.7	1.0	5,770	0.00
3.95	1.25	6,100	1,485
4.2	1.5	6,430	3,050
4.5	1.8	6,835	5,040

CONCEPTUAL

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Checked	Approved	Date

GHD CLIENTS | PEOPLE | PERFORMANCE
Suite 3 On the Park
54-58 Nerang Street Nerang QLD 4211 Australia
PO Box 124 Nerang QLD 4211
T 61 7 5557 1000 **F** 61 7 5557 1099
E goldcoastmail@ghd.com.au **W** www.ghd.com.au

DO NOT SCALE

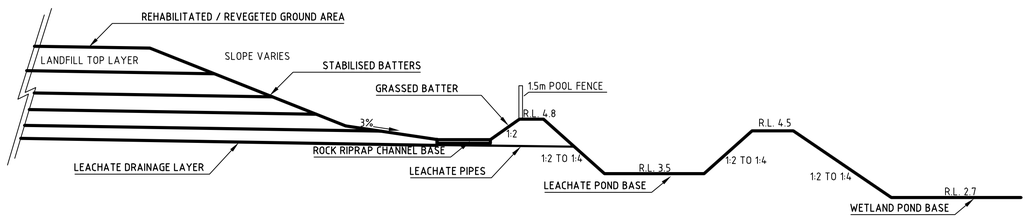
Conditions of Use.
This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Drawn	NJC	Designed	NJC
Drafting Check		Design Check	
Approved			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

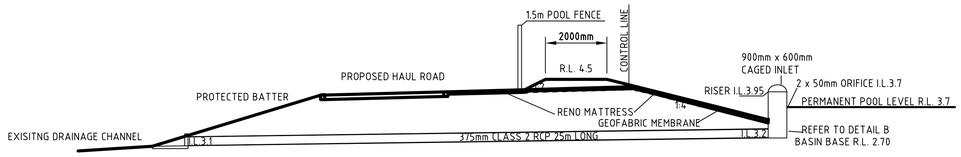
Client **TWEED SHIRE COUNCIL**
Project **EVIRON QUARRY & LANDFILL SITE**
Title **Typical Section Details - Sheet 1 of 2**
Lot 26 on DP 615931 Eviron Road, Eviron

Original Size **A1**
Drawing No: 41-20806-G001-Fig C.1 Rev: A

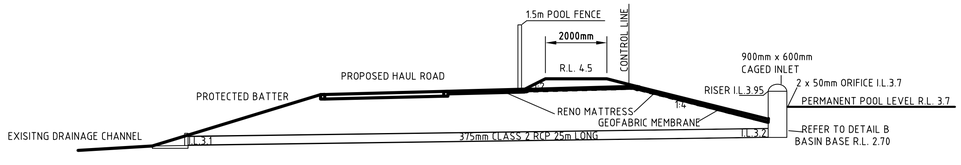
Plot Date: 9 December 2008 - 10:32 AM Cad File No: G:\41\20806\Tech\Stormwater Quality and Quantity\ACAD\41-20608-G001_DRAI_XSECTS.dwg



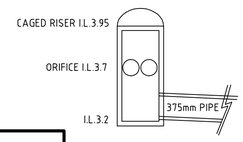
SECTION A
NTS



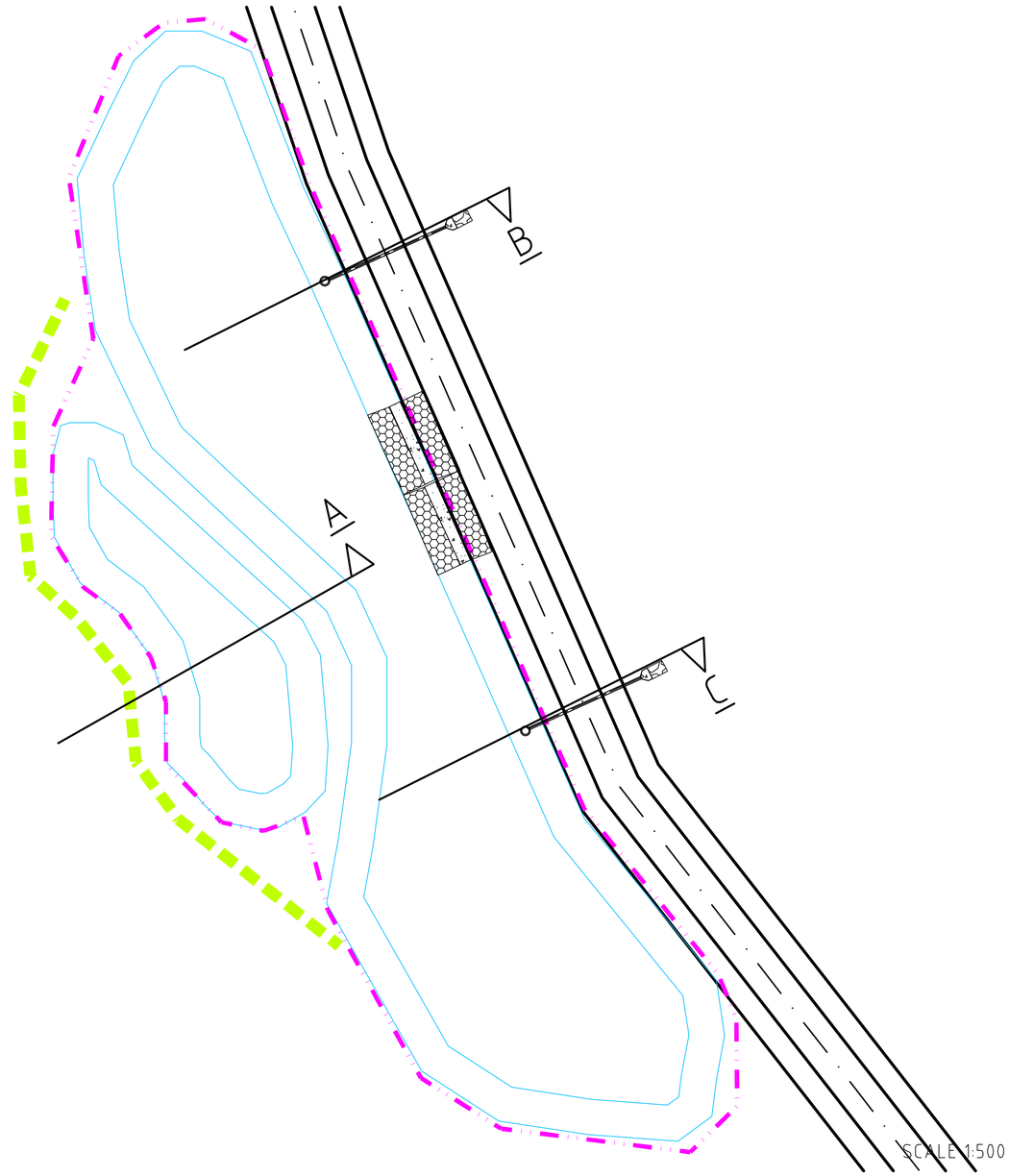
SECTION B
NTS



SECTION C
NTS



DETAIL B
N.T.S.



LEGEND

- CONCRETE WIER
- SCOUR PROTECTION
- RENO MATTRESS
- PROPOSED CONDUITS
- PROPOSED DIVERSION DRAINS
- 1.5m POOL FENCE (OR EQUIVALENT)

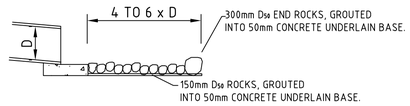
NOTES

BASINS TO BE DENSELY PLANTED WITH EMPHEMERAL NATIVE SPECIES AS PER DLWC CONSTRUCTED WETLAND DESIGN MANUAL.

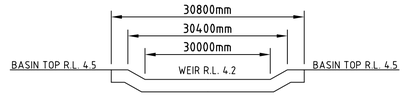
NO MULCHING TO INTERNAL BATTERS

BASIN TO BE STABILISED WITH HYDROSEED OR EQUIVALENT AFTER EARTHWORKS AND PRIOR TO PLANTING AT THE REQUIRED DENSITIES.

BASIN OUTLET TO BE BLOCKED WITH HESSIAN / GEOFABRIC MEMBRANE DURING THE INITIAL CONSTRUCTION STAGE AND REMOVED AFTER BASIN HAS BEEN PLANTED.



TYPICAL OUTLET DETAIL



WEIR CONTROL LINE ELEVATION
N.T.S.

BASIN A STAGE STORAGE TABLE

ELEVATION (RL)	DEPTH (m)	AREA(m)	VOLUME (m3)
2.7	0.0	7,500	0.00
3.7	1.0	8,775	0.00
3.95	1.25	9,070	2,225
4.2	1.5	9,360	4,500
4.5	1.8	9,500	7,310

CONCEPTUAL

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Checked	Approved	Date

GHD CLIENTS | PEOPLE | PERFORMANCE
Suite 3 On the Park
54-58 Nerang Street Nerang QLD 4211 Australia
PO Box 124 Nerang QLD 4211
T 61 7 5557 1000 F 61 7 5557 1099
E goldcoastmail@ghd.com.au W www.ghd.com.au

DO NOT SCALE

Conditions of Use.
This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.

Drawn	NJC	Designed	NJC
Drafting Check		Design Check	
Approved			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client **TWEED SHIRE COUNCIL**
Project **EVIRON QUARRY & LANDFILL SITE**
Title **Typical Section Details - Sheet 2 of 2**
Lot 26 on DP 615931 Eviron Road, Eviron

Original Size **A1**
Drawing No: 41-20806-G001-Fig C.2 Rev: A

Plot Date: 10 December 2008 - 10:07 AM
Cad File No: G:\41\20806\Tech\Stormwater Quality and Quantity\ACAD\41-20608-G001_DRAI_XSECTS.dwg

GHD

Suite 2, 54-58 Nerang St
Nerang QLD 4211 Australia
T: 61 7 5557 1000 F: 61 7 5557 1099 E: goldcoastmail@ghd.com

© GHD 2010

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	N Cooper	B Regan		A Marszalek		