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

Volume 3: Appendix I-N

GHD

November 2011

Appendix I

Noise, Blasting and Vibration Report

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council

Report on Eviron Road Quarry and Landfill Concept Plan

Noise and Vibration Assessment

May 2011

Revision 0

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

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A Long Term Noise Monitoring Results

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Glossary

Noise Glossary	
dB	Decibel, which is 10 times the logarithm (base 10) of the ratio of a given sound pressure to a reference pressure; used as a unit of sound.
dB(A)	Unit used to measure 'A-weighted' sound pressure levels.
L_N	Statistical sound measurement recorded on the linear scale.
L_{AN}	Statistical sound measurement recorded on the "A" weighted scale.
$L_{A10\ (Time)}$	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
$L_{A10\ (1\ hour)}$	The L_{10} level measured over a 1-hour period.
$L_{Aeq\ (Time)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{Aeq\ (15\ hr)}$	The L_{Aeq} noise level for the period 7 am to 10 pm.
$L_{Aeq\ (9\ hr)}$	The L_{Aeq} noise level for the period 10 pm to 7 am.
$L_{Aeq\ (1\ hr)}$	The L_{Aeq} noise level for a one-hour period. In the context of the NSW DEC environmental criteria for road traffic noise, it represents the highest tenth percentile hourly A-weighted L_{eq} during the period 7 am to 10 pm, or 10 pm to 7 am, (whichever is relevant). If this cannot be defined accurately, use the highest A-weighted L_{eq} noise level.
$L_{A90\ (Time)}$	The A-weighted sound pressure level that is exceeded for 90 per cent of the time over which a given sound is measured. This is considered to represent the background noise e.g. $L_{A90\ (15\ min)}$.
Rating Background Level (RBL)	The overall single-figure background level representing each assessment period (day / evening / night) over the whole monitoring period (as opposed to over each 24 hour period used for the assessment background level). This is the level used for assessment purposes. It is defined as the median value of: ◗ All the day assessment background levels over the monitoring period for the day. ◗ All the evening assessment background levels over the monitoring period for the evening. ◗ All the night assessment background levels over the monitoring period for the night.

Vibration Glossary	
Vibration	The variation of the magnitude of a quantity which is descriptive of the motion or position of a mechanical system, when the magnitude is alternately greater and smaller than some average value or reference. Vibration can be measured in terms of its displacement, velocity or acceleration. The common units for velocity are millimetres per second (mm/s).
Ground borne Vibration	Ground borne vibration is vibration transmitted from source to receiver via the medium of the ground.
Ground borne Noise	Ground borne noise describes noise transmitted as vibration through the ground and into structures, radiated as low frequency rumbling noise.
Peak Particle Velocity	Current practice for assessments of the risk of structural damage to buildings use measurements of Peak Particle Velocity (PPV) ground vibration (v_p), which is the maximum vector sum of three orthogonal time-synchronized velocity components. When not directly measured by an instrument, PPV may be determined by: $v_p = \sqrt{(v_x^2 + v_y^2 + v_z^2)}$ Where v_x, v_y, v_z are the instantaneous components of particle velocity of the x, y, z primary axes, respectively.
RMS	Root mean square.

1. Introduction

GHD was engaged by Tweed Shire Council (TSC) to assess the potential for noise and vibration impacts from the proposed Eviron Road Quarry and Landfill development, Eviron, NSW.

1.1 Context

Council has developed an overall Concept Plan for the site which comprises a staged project to develop a waste disposal facility within the existing void created by Quirks Quarry, develop two further extractive industries to be used as waste disposal facilities after exhaustion of the quarry resource, and install necessary operational infrastructure such as a haul road and other minor associated facilities. The site and study area can be seen in Figure 1-1.

This proposed method of landfilling in quarry voids is consistent with the method of landfill creation in the Tweed Shire to date. Material won from quarrying is used for road building and other Council civil projects, and overburden stockpiled for road construction, clay liners (where appropriate) and site rehabilitation purposes.

Chronologically, the overall Concept Plan will involve:

- Stage 1 (Project Application):
  - Establishment of a new haul road from Stotts Creek RRC to Quirks Quarry, and development of a landfill within the Quarry void.
  - Progressive rehabilitation of Quirks Quarry landfill.
  - Development of a new quarry in West Valley.
- Future stages may include:
  - Development of a landfill within the void formed from quarrying West Valley.
  - Progressive rehabilitation of the West Valley landfill.
  - Development of a new quarry within North Valley.
  - Development of a landfill within the void formed from quarrying North Valley.
  - Progressive rehabilitation of the North Valley landfill.

The landfills and quarry will operate in sequence and there will be no overlap between landfilling in the Quirks Quarry, West Valley and North Valley, this will also be the case for the quarry operations.

Based on the concept design work and studies undertaken to date the following operational periods have been adopted for the purposes of assessing the potential environmental impacts:

- Quirks Quarry Landfill: 10 years (2012 – 2021).
- West Valley Quarry: 10.5 years (2012-2021).
- West Valley Landfill: 12 years (2022-2033).
- North Valley Quarry: 3.5 years (2022-2026).
- North Valley Landfill: >10 years (2034 -2045).

1:10,000 (at A3)

0 50 100 200 300 400 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

Site Boundary

Study Area

GHD

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Tweed Shire Council

Eviron Road Quarry and Landfill Environmental Assessment

Job Number	41-20806
Revision	0
Date	10 AUG 2010

The Site

Figure 1

G:\41\20806\GIS\Maps\41120806_00.mxd

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Data source: Tweed Shire Council - Aerial Photography (2008). Department of Lands - Cadastre boundary (2009). GHD (2010) - Site Boundary, Study Area.

1.2 Scope of Work

The scope of work undertaken by GHD for the assessment of noise and vibration emissions from the proposed development is outlined in the points below. These points are described in greater detail in the subsequent sections of this report.

- Initial desk top review to identify key environmental noise and vibration catchment areas and sensitive receivers from aerial photography and a site visit.
- Unattended noise monitoring for a period of one week at each of two noise receiver locations identified as being indicative of the local ambient noise environment.
- Attended noise measurements at each of the unattended noise logging locations to supplement the unattended measurements and to determine the existing ambient noise levels from Quirks Quarry and Stott's Creek Landfill at the identified sensitive receivers.
- Noise data was assessed and filtered to remove invalid data due to extraneous noise or adverse weather conditions.
- Establish project specific noise and vibration goals for the operation of the proposed quarries and landfills.
- Identify and characterise the likely principal noise and vibration sources.
- Noise modeling using Computer Aided Noise Abatement (Cadna-A) software to predict emitted operational noise levels at the nearest identified noise receivers for individual quarry and landfill sites and combined operations with consideration to the project development planning.
- Assessment of blasting noise and vibration impact.
- Recommend noise and vibration (including blasting) mitigation measures.

The abovementioned scope of work has been conducted with consideration to the following NSW Office and Environment and Heritage (OEH) guidelines:

- Industrial Noise Policy (INP).
- Assessing Vibration: a technical guideline.
- Environmental Criteria for Road Traffic Noise (ECRTN)
- Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (ANZECC).

2. Project Description

2.1 Quarry Activities – West Valley and North Valley

2.1.1 Level of Production

It is assumed that the maximum rate or level of production will total approximately 200,000 tonnes per year at each quarry. 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.

2.1.2 Hours of Operation

The hours of operation for each quarry will be the same as those currently at Quirks Quarry, as outlined in Table 2-1.

Table 2-1 Quarry Operating Hours

Operation	Operating Days	Start Time	Finish Time
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

2.1.3 Description of Operations

The operations in extracting rock from the proposed quarries typically involve the following tasks:

- Pre strip activities and topsoil stockpiling activities.
- Blast-hole Drilling and Blasting (if required).
- Extraction:
  - Primary screening.
  - Primary crushing.
  - Secondary Screening and crushing where required.
- Stockpiling.
- Product Loading and Hauling.

Material extraction will typically be undertaken using a bulldozer or excavator. Blasting would be undertaken on a periodic basis depending upon demand for the resource and when manual extraction becomes too difficult or dangerous. Drilling would be required as part of blasting operations.

Material will then be loaded into a series of mobile crushers and screens for on-site processing or loaded directly into haul trucks and taken off site. Processed products will be segregated and stockpiled ready for use and/or delivery. Based on current operations at Quirks Quarry, all material will be processed on-site unless requested otherwise.

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).
- Screened Sand (Rescreened from imported spoil).

The exact products to be available from the West Valley and North Valley Quarries have not been determined at this stage, however these products are currently available from the Quirks Quarry site and due to their close proximity should reflect that available at West Valley and North Valley quarries.

Typical quarry operations are shown in Figure 2-1, depicting Quirks Quarry in 2008.

Figure 2-1 Quirks Quarry Operations – 2008

2.2 Landfill Activities – Quirks Landfill, West Valley Landfill and North Valley Landfill

2.2.1 Hours of Operation

The hours of operation at each landfill is expected to be identical to the existing Stotts Creek RRC and will be seven days per week between 7:00 am and 4:00 pm Monday to Friday and between 9:00 am and 4:00 pm Saturday and Sunday.

2.2.2 Facility Layout

Access to each landfill will be via a haul road constructed between the existing Stott's Creek facility and the Quirks Quarry Landfill. Small vehicular traffic (i.e. domestic and small commercial customers) will continue to utilise the transfer station facility at the Stotts Creek RRC.

The main features of the landfill site include the following:

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

2.2.3 Waste Acceptance Rates

The levels of waste that are likely to be accepted at each landfill throughout their lifespan are shown in Table 2-2. These figures have been utilised in the noise model.

Table 2-2 Landfills – Levels of Waste Acceptance

Landfill	Years of Operation	Waste (tonnes per annum)
Quirks	2012 – 2021	Up to 70,000 tpa
West Valley	2022 – 2033	From 58,000 to 100,000 tpa
North Valley	2034 – 2045	From 100,000 to 145,000 tpa

3. Existing Environment

3.1 Study Area

Existing land uses in the vicinity of the Eviron Quarry and Landfill site include:

- Stott's Creek RRC.
- Quirks Quarry.
- The Pacific Highway.
- Pasture and agricultural land.

The site is bordered to the north by generally flat areas of agriculture and sugar cane fields. The proposed quarries and landfills are located in areas of undulating topography.

A number of residential properties are located around the proposed site. Details of identified sensitive receivers are also shown below in Table 3-1. There is also a property on Hawkens Lane that has recently been purchased by Tweed Shire Council and is currently unoccupied. The future use for this property is not expected to be residential and it has therefore been excluded from the assessment.

An aerial photograph showing the location of the proposed project footprint, the existing landfill and quarry and nearby sensitive receivers is shown in Figure 3-1. It is noted that Lot 25 on DP 615931 (Receiver 3) was not considered a sensitive receiver as this property was acquired by Council in early 2011, however for completeness it is included in this version of the assessment report.

Table 3-1 Identified Sensitive Receivers

Sensitive Receivers	Address Details	Property Details
Receiver 1	751 Eviron Rd, Eviron	Lot 30 on DP 820048
Receiver 2	157 Hawkens Ln, Eviron	Lot 2 on DP 705781
Receiver 3	656 Eviron Rd, Eviron	Lot 25 on DP 615931
Receiver 4	657 Eviron Rd, Eviron	Lot 1 on DP 783802
Receiver 5	726 Eviron Rd, Environ	Lot 30 on DP 706846
Receiver 6	10 Donalyn Crt, Duranbah	Lot 501 on DP 1000612
Receiver 7	Eviron Rd, Duranbah	Lot 603 on DP 1001049

Figure 3-1 Study Area

3.2 Local Meteorology

Local meteorological conditions, such as wind and temperature inversions, may increase noise levels when favourable to noise propagation.

The INP states that wind effects on noise propagation need to be assessed when source-to-receiver wind speeds of 3 m/s or below occur for 30% of the time or more in any assessment period (day, evening or night) in any season. The assessment of temperature inversions is confined to the night noise assessment period (10 pm to 7 am), hence, inversion effects were not considered in this assessment because the quarries and landfills would not be operating during the night period.

The nearest Automatic Weather Station (AWS) is located at Coolangatta Airport (approximately 10 km to the north-west of the site), and is operated by the Bureau of Meteorology (BoM). Data from this weather station was obtained but due to the intervening topography and coastal location, this data alone was considered insufficient to be used to represent meteorological conditions at the site.

Therefore, GHD utilised a regional-scale prognostic meteorological model, The Air Pollution Model (TAPM V 4), to simulate the wind climate over the subject site with consideration to DECCW *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, August 2005. Weather data from the Coolangatta AWS was used as input to TAPM to assist in calibrating the model. TAPM was used to produce representative hourly surface and upper air meteorological data at the project site as part of the air quality assessment also conducted by GHD and the resulting data was used for input in the noise assessment. Further information on the use of TAPM can be found in the Air Quality Assessment report (GHD document number 90344, 2011).

Figure 3-2 displays the daytime (7 am to 6 pm) annual and seasonal wind roses for study area.

Analysis of wind data indicated that that source-to-receiver wind of 3 m/s or below does not occur for greater than 30% of the time in any period (day, evening, night) in any season. Therefore, with consideration to the requirements of the INP, wind was not included in the noise-prediction calculation.

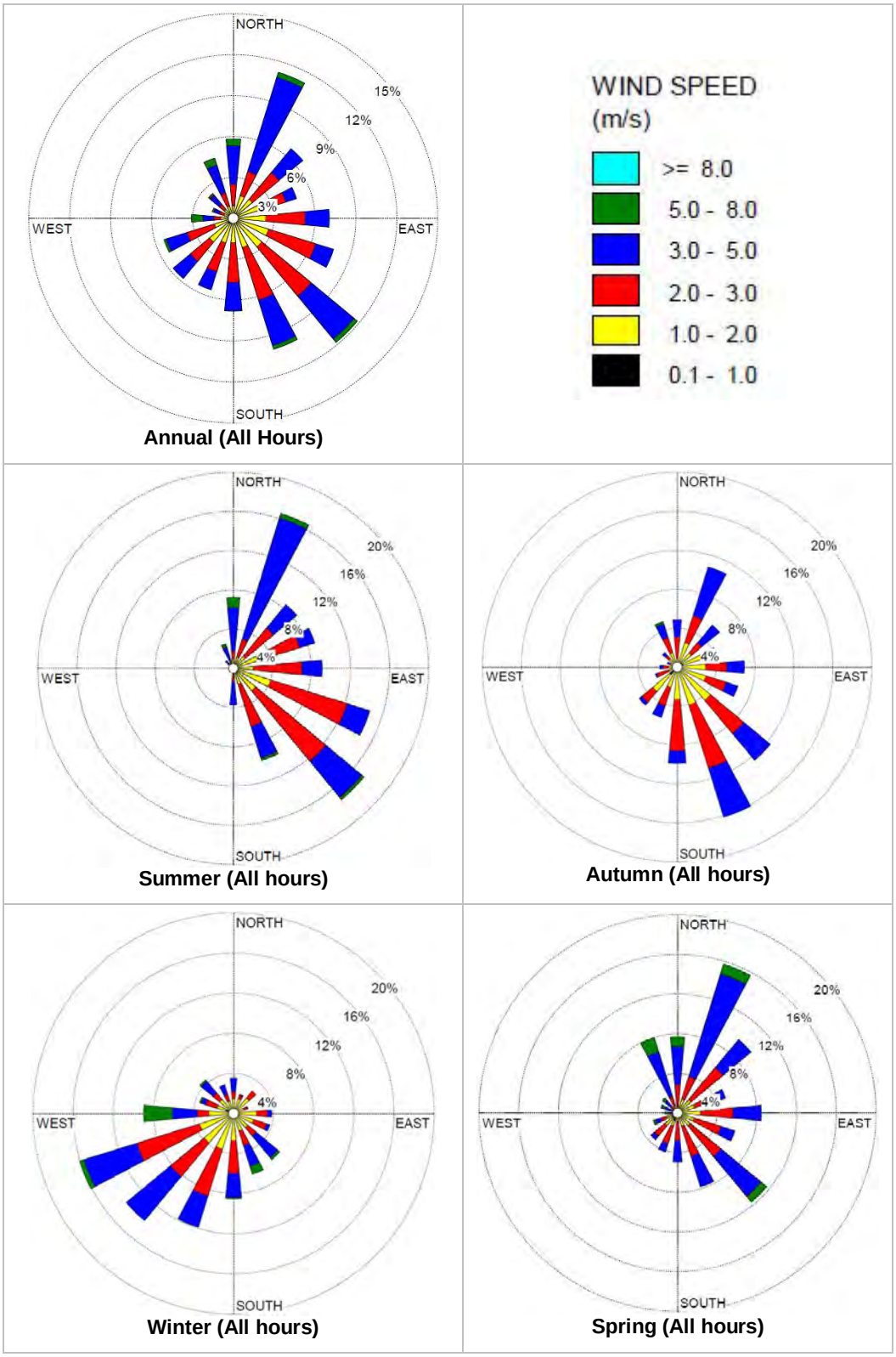


Figure 3-2 Daytime Seasonal Wind Roses

3.3 Existing Noise Environment

Attended and unattended noise monitoring was conducted by GHD in the area surrounding the proposed site. The purpose of noise monitoring was to determine the existing noise levels in the area, which will assist in setting operational noise goals for the project.

Long-term unattended noise monitoring was undertaken between 4 March 2011 and 21 March 2011. Monitoring was undertaken at two residential properties surrounding the project area. These locations were chosen as good locations to represent the ambient noise environment of the area and also to provide a secure location to noise monitoring equipment. Short-term attended noise monitoring was also undertaken at the same locations.

Concurrent weather data was obtained from the Bureau of Meteorology's AWS located at the Coolangatta Airport, which is situated approximately 10 km north-east of the subject site.

3.4 Unattended Noise Monitoring Results

Unattended noise monitoring was undertaken using two Rion NL-22 environmental noise loggers. These loggers are capable of measuring continuous sound pressure levels and are able to record L_{A90}, $L_{A10,}$ L_{Aeq} and L_{Amax} noise descriptors. The instruments were programmed to accumulate environmental noise data continuously over sampling periods of 15 minutes for the entire monitoring period.

Prior to deployment, the loggers were calibrated with a sound pressure level of 94 dB at 1kHz using a Bruel and Kjaer Type 4231 sound level Calibrator (serial number 2542101). At completion of the monitoring period, the loggers were retrieved and calibration was rechecked. The data collected by the loggers was downloaded and analysed, and any invalid data removed. Invalid data generally refers to periods of time where average wind speeds were greater than 5 m/s at ground level, when rainfall occurred, or for when anomalous noise levels occurred. Table 3-2 displays the detail of each noise logger.

Table 3-2 Unattended Noise Logger Details

Noise Logger	Logger 1	Logger 2
Monitoring Location	Residence Lot 19 Hawkens Lane	Receiver 3 656 Eviron Road
Logger Serial No.	852196	762857
Measurement Started	04/03/2011 09:00	04/03/2011 12:30
Measurement Ceased	13/03/2011 18:00	18/03/2011 18:00
Pre-measurement Calibration	93.8 dB(A)	94.0 dB(A)
Freq. Weighting	A	A
Time response	Fast	Fast

Table 3-3 and Table 3-4 present a summary of the long-term noise monitoring data. Statistical noise results are also presented in graphical format in Appendix A.

Table 3-3 Summary of Noise Monitoring Results – Logger 1 dB(A)

Logger	Background L_{A90} dB(A)			Ambient L_{Aeq} dB(A)		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Friday-4-Mar-11	42	43	43	47	56	46
Saturday-5-Mar-11	43	-	43	50	-	48
Sunday-6-Mar-11	43	44	43	47	54	50
Monday-7-Mar-11	44	43	42	49	48	53
Tuesday-8-Mar-11	42	44	42	50	53	46
Wednesday-9-Mar-11	42	42	42	49	51	47
Thursday-10-Mar-11	42	43	42	49	53	45
Friday-11-Mar-11	42	43	41	49	51	45
Saturday-12-Mar-11	41	43	41	51	52	44
Sunday-13-Mar-11	42	-	-	47	-	-
RBL and L_{eq} Overall	**42**	**43**	**42**	**49**	**53**	**48**

Note: '-' refers to invalid data that has been excluded from the data set.

Table 3-4 Summary of Noise Monitoring Results – Logger 2 dB(A)

Logger	Background L_{A90} dB(A)			Ambient L_{Aeq} dB(A)		
	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)	Day (7 am to 6 pm)	Evening (6 pm to 10 pm)	Night (10 pm to 7 am)
Friday-4-Mar-11	42	43	42	52	51	46
Saturday-5-Mar-11	43	-	41	52	-	49
Sunday-6-Mar-11	42	46	40	48	54	50
Monday-7-Mar-11	46	42	40	52	51	50
Tuesday-8-Mar-11	44	42	39	53	51	44
Wednesday-9-Mar-11	42	42	37	-	-	43
Thursday-10-Mar-11	43	43	38	53	51	44
Friday-11-Mar-11	43	45	36	52	57	44
Saturday-12-Mar-11	42	43	37	54	49	49
Sunday-13-Mar-11	41	42	38	57	53	44
Monday-14-Mar-11	42	43	36	53	-	46
Tuesday-15-Mar-11	43	42	35	51	51	43
Wednesday-16-Mar-11	42	41	36	54	54	45
Thursday-17-Mar-11	39	41	-	51	50	-
RBL and L_{eq} Overall	**42**	**42**	**38**	**53**	**53**	**47**

Note: '-' refers to invalid data that has been excluded from the data set.

3.4.1 Attended Noise Monitoring Results

Attended noise monitoring was conducted over 15-minute periods at each of the long term monitoring locations. Attended measurements were undertaken using a Bruel and Kjaer 2250 sound level meter (SLM) (serial number 2506887). This SLM is capable of measuring continuous sound pressure levels and is able to record L_{Amin}, L_{A90}, L_{A10}, L_{Amax} and L_{Aeq} noise descriptors. On-site calibration conducted immediately before and after the measurements showed negligible variation. Details of the existing noise environment were also recorded during these monitoring periods. The results of attended monitoring are shown in Table 3-5.

Table 3-5 15-Minute Attended Noise Monitoring Results

Monitoring Location and Description	Start time	L_{Aeq}, 15 minute	L_{A90}, 15 minute	Comments on Noise Environment
Logger 1 Lot 19 Hawkens Lane	09:30 04/03/11	43	41	◗ Temp 24 °C, calm wind, 8/8 cloud cover. ◗ Rural environment with local animals and nearby insects audible at times. ◗ Distant traffic noise on Pacific Highway was audible during measurements (approx. 40 – 43 dB(A)). ◗ Quirks Quarry not audible during measurements. ◗ Landfill operations were generally barely audible but were audible on occasions for short bursts i.e. less than one minute (approx. 43 – 48 dB(A)).
	13:30 22/03/11	52	40	◗ Temp 33 °C, wind NW <1 m/s, cloud 4/8. ◗ Quirks Quarry occasionally audible but generally not measureable above background (approx. 40 dB(A)). ◗ Local insect/bird noise approx. 45 – 55 dB(A). ◗ Distant traffic noise on Pacific Highway was audible during measurements (approx. 39 – 43 dB(A)).

Monitoring Location and Description	Start time	L_{Aeq}, 15 minute	L_{A90}, 15 minute	Comments on Noise Environment
Logger 2 Receiver 3 656 Eviron Road	12:15 04/03/11	53	44	◗ Temp 26 °C, calm wind, 8/8 cloud cover. ◗ Local animals and nearby insects were audible. ◗ Distant traffic noise on Pacific Highway was audible during measurements (approx. 41 – 43 dB(A)). ◗ Quirks Quarry trucks and loader reverse alarm audible but generally not measureable above background noise level (approx. 43 – 45 dB(A)). ◗ Landfill operations not audible.
	13:00 04/03/11	52	42	
	14:00 22/03/11	49	41	◗ Temp 34 °C, wind calm to NW <1 m/s, cloud 4/8. ◗ Distant traffic noise on Pacific Highway was audible during measurements (approx. 39 – 43 dB(A)). ◗ Quirks Quarry trucks and loader reverse alarm audible but generally not measureable above background noise level (approx. 40 – 45 dB(A)). ◗ Local insect/bird noise approx. 45 – 55 dB(A). ◗ Landfill operations not audible.

4. Noise and Vibration Assessment Criteria

4.1 Operational Noise Criteria

Operational noise criteria, applicable to site noise sources, were determined with consideration to the INP.

The INP provides guidance on the assessment of operational noise impacts. The guidelines include both Intrusive and Amenity criteria that are designed to protect receivers from noise significantly louder than the background level and to limit the total noise level from all sources near a receiver.

Intrusive noise limits set by the INP control the relative audibility of operational noise compared to the background level. The amenity criteria limit the total level of extraneous noise. Both sets of criteria are calculated and the more stringent of the two in each time period applies with consideration to the OEH Application Notes pertaining to Section 2.4 of the INP. Table 2.2 in the INP provides modifications to the amenity criteria for existing levels of industrial noise.

As mentioned in Section 3.3 of this report, attended observations noted that existing levels of industrial noise in the area are not a significant contributor to the existing ambient noise level in the vicinity of the development. Therefore adjustments are not necessary for the amenity noise criteria.

The amenity criteria are determined based on the overall acoustic characteristics of the receiver area and the existing level of noise excluding other noises that are uncharacteristic of the usual noise environment. Residential receiver areas are characterised into 'urban', 'suburban', 'rural' or other categories based on land uses, the existing level of noise from industry, commerce, and road traffic. The nearest residential receivers to this development were classified as rural.

The project specific noise levels for the proposed development at individual identified sensitive receivers are provided in Table 4-1. Given there are no night time activities proposed, only the daytime criterion would apply to the site operations.

Table 4-1 Project Specific Noise Levels

Criterion	Day 7 am to 6 pm	
	Logger 1	Logger 2
A: Rating Background Level	42 $L_{A90(day)}$	42 $L_{A90(day)}$
B: Intrusiveness Criteria (A + 5dB)	47 $L_{Aeq(15min)}$	47 $L_{Aeq(15min)}$
C: Rural Amenity Criteria (Table 2.1 INP)	50 $L_{Aeq(day)}$	50 $L_{Aeq(day)}$
D: Amenity Criteria: (INP Table 2.2 Adjusted)	-	-
Project Specific Noise Level (Page 21 INP)	**47 $L_{Aeq(15min)}$**	**47 $L_{Aeq(15min)}$**

Site observations indicated that the existing Quirks Quarry was audible, at times, during operations. However, noise levels from the above sources would typically be intermittent, resulting in no applicable noise penalty over the daytime period. This intermittency of noise is highly unlikely to effect the RBL's measured by the noise loggers, which is evident in Table 3-4 that shows no difference in daytime L_{A90} levels between Sunday (quarry not operating) and Weekdays (quarry operating normally). As the RBL's were unaffected and with the planned closure of the existing quarry, no Table 2.2 adjustments were made in determining noise goals with consideration to the NSW INP.

For the purpose of this assessment, the daytime noise criterion derived in Table 4-1 was applied to all the sensitive receivers identified as part of this assessment.

4.2 Road Traffic Noise Criteria

All changes in traffic flows on public roads must be assessed with consideration to the OEH's Environmental Criteria for Road Traffic Noise (ECRTN).

The proposed site has the potential to increase traffic on the Pacific Highway as well as Leddays Creek Road and Tweed Valley Way. These roads could be considered both local roads (Leddays Creek Road) and freeway/arterial roads (Tweed Valley Way and Pacific Highway). Therefore, the specific project falls under more than one of the ECRTN development types. Table 4-2 lists the "base" target road traffic noise criteria, as per Table 1 of the ECRTN.

Table 4-2 Road Traffic Noise Criteria

Type of Development	Criteria		
	Day (7am–10pm)	Night (10pm–7am)	Where Criteria are Already Exceeded
7. Land use developments with potential to create additional traffic on existing freeways/arterials.	$L_{Aeq(15hr)}$ 60 dB(A)	$L_{Aeq(9hr)}$ 55 dB(A)	Where feasible and reasonable, existing noise levels should be reduced to meet the noise criteria. Possible applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments.
13. Land use developments with potential to create additional traffic on local roads	$L_{Aeq(1hr)}$ 55 dB(A)	$L_{Aeq(1hr)}$ 50 dB(A)	Where feasible and reasonable, existing noise levels should be reduced to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using 'quiet' vehicles; and using barriers and acoustic treatments.

Additionally where the existing criteria have already been exceeded the ECRTN recommends that, *"…In all cases, traffic arising from the development should not lead to an increase in existing noise levels by more than 2 dB."*

4.3 Vibration Criteria

Guidance of limiting vibration values for general quarry activities is attained from reference to the following standards and guidelines:

- OEH *Assessing Vibration: A Technical Guideline.*
- British Standard BS 7385.2 - 1993 *Evaluation and Measurement for Vibration in Buildings, Part 2 - Guide to damage levels from ground borne vibration.*
- British Standard BS 6472 - 1992 *Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)*.

The BS 6472 human comfort peak vibration limits are shown in Table 4-3 for the frequency range of 1 Hz to 80 Hz, which is applicable to quarry activities. These values are limits that may cause loss of amenity to the occupant of a building.

Table 4-3 BS 6472 Human Comfort Vibration Limits from 1 Hz to 80 Hz (mm/s PPV[1])

Receiver type	Period[2]	Continuous Vibration		Intermittent and Impulsive Vibration	
		Preferred	Maximum	Preferred	Maximum
Residential	Day	0.28	0.56	8.6	17
	Night	0.2	0.4	2.8	5.6

[1] Based on sinusoidal vibration sources.

[2] Day is between 7 am and 10 pm and night is between 10 pm and 7 am.

4.4 Blasting Criteria

The ANZECC *Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* has been adopted for assessment of blasting noise and vibration impacts in this report. This guideline specifies recommended human comfort criteria for blasting activities.

The ANZECC recommended maximum level for airblast overpressure is 115 dB(L) peak. This level may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the airblast overpressure must not exceed 120 dB(L) peak for any blast.

Ground-borne vibration level should not exceed 5 mm/sec Peak Particle Velocity (PPV). The recommended PPV level may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the level should not exceed 10 mm/sec at any time.

ANZECC guideline recommends that blasting should only be permitted during the following hours:

- Monday to Saturday, 9am to 5pm.
- No blasting on Sundays or Public Holidays.

The frequency of blasting should not take place more than once per day. This requirement does not apply to minor blasts.

The abovementioned restrictions on times and frequency of blasting do not apply to premises where the effects of the blasting are not perceived at noise sensitive sites.

When a temperature inversion is known to exist, blasting should be avoided if practicable.

5. Assessment of Operational Noise Impacts

5.1 Noise Model Configuration

Acoustic modelling was undertaken using Computer Aided Noise Abatement (Cadna-A) to predict the noise levels generated from the proposed Quarry and Landfill activities forming part of the Stage 1 Project Application and future stages proposed in the Concept Plan.

Cadna-A is a computer program for the calculation, assessment and prognosis of noise propagation. Cadna-A calculates environmental noise propagation according to ISO 9613-2, *"Acoustics – Attenuation of sound during propagation outdoors*". Ground absorption, reflection, terrain and relevant shielding objects are taken into account in the calculations.

Modelling results are based on the information available and assumptions made at the time of the assessment.

5.1.1 Ground Contours

Detailed ground topography data was supplied for the project site and surrounding area as well as existing ground levels of Quirks Quarry. The vertical resolution of the topographic contours varied between 0.25 and 10 metres. Where required, ground topography data was manipulated to provide a reasonable representation of future quarry or landfill sites.

5.1.2 Nearest Sensitive Receivers

Noise and Vibration sensitive receivers are shown in Figure 3-1. All sensitive receivers for the purpose of this assessment have been defined as residential premises.

All sensitive receivers were modelled 1.5 m above ground level.

5.1.3 Noise Sources

GHD conducted noise measurements of quarry and landfill equipment during site visits to Quirks Quarry and Stotts Creek RRC. The plant and equipment that would be used at future quarry and landfill sites within the project area has been assumed to be identical to these operating facilities.

Sound power levels (L_W) for all identified noise sources are based on field measurements or, where measurement data could not be taken, typical noise levels produced by equipment anticipated to be used on site were sourced from AS 2436-2010 *Guide to noise and vibration control on construction, demolition and maintenance sites* and from BS 5228-1:2009 *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise.* These standards provide sound measurement data based on measurements of individual plant and equipment at quarry and landfill sites.

Modelled overall sound power levels for quarry and landfill equipment are summarised in Table 5-1 and Table 5-2 respectively. These sound power levels are maximum levels produced when machinery is operating under full load.

Table 5-1 Modelled Noise Sources – Landfill

Noise Source	Sound Power Level (L_W) dB(A)	Modelled Height (m)	% of time operating [1]
Cat 330 Excavator	106	2.5	0
Cat D7 Dozer	114	2.5	100
Cat 350 Dump Truck	108	2.5	100
Cat 826 Compactor	107	2.5	0
Cat 120G Grader	114	2.5	0
Water Truck	110	2.5	0

[1] See comments in Section 5.1.4 below.

Table 5-2 Modelled Noise Sources – Quarry

Noise Source	Sound Power Level (L_W) dB(A)	Modelled Height (m)	% of time operating [1]
Excavator	106	2.5	80
Cat IT 62 Wheeled Loader	105	2.5	80
Cat D7 Dozer	114	2.5	80
Volvo L180 Wheeled Loader	101	2.5	80
Daewoo Mega 300V Wheeled Loader	100	2.5	80
Pneumatic Hard Rock Drill [2]	118	2.5	100 (when operating)
Primary Crusher	116	2.0	100
Secondary Crusher	112	2.0	100
Screening Plant – Finlay 683	111	2.0	100
Screening Plant – Finlay 542	102	2.0	100
Screening Plant – Finlay 640	108	2.0	100
Conveyor	81	1.0	100
Water Truck	110	3.0	50
Haul/Dump Truck	110	3.0	50

[1] See comments in Section 5.1.4 below.

[2] As the hard Rock Drill is only required for blasting preparations, it is not considered part of 'normal' day-to-day operations and therefore has been included in a separate model run for noise model predictions.

5.1.4 Model Assumptions

The noise model was configured based on the following assumptions:

- Layout of fixed processing plant (e.g. crushers, screens and conveyors) at each of the proposed quarries was based on the layout at the existing Quirks Quarry.
- Landfill and quarry plant and equipment were modelled as operating a various percentages of time based on current 'worst-case' operations.
- A maximum of two mobile plant items at each Landfill would operate simultaneously and continuously over a 15-minute assessment period. Based on existing landfill operations at Stotts Creek, only one of the following pairs of equipment would operate at any time:
  - Dozer and dump truck.
  - Excavator and dump truck.
  - Dozer and compactor.

  As a conservative measure, the worst-case pair of one dozer and one dump-truck was modelled.
- Heavy vehicles on the internal haul road between Stotts Creek RRC and Quirks Landfill would be within the site boundaries and have been considered as part of site noise and been included in the assessment against the INP. Due to the low vehicle numbers, vehicles along the haul road were modelled as a series of point sources, rather than a roadway. A maximum of up to 15 heavy vehicles per hour was modelled along the haul road. A more detailed description of traffic generation is discussed in Section 6.

5.1.5 Validation of Noise Model Predictions

In order to validate the noise model and assumptions made, model sound pressure level predictions were compared against attended measurement data taken near the Quirks Quarry site office during operations of the existing quarry. Although this assessment is focused on noise from future activities on this site (Quirks Landfill) and quarry/landfill activities on different sites (West Valley and North Valley) validating the noise model under existing conditions will provide confidence in predicting future noise levels from the site.

Attended noise measurements were taken on 22 March 2011 over 15 minute periods to capture quarry noise. Table 5-3 below summarises the noise monitoring results.

The noise model was configured to represent the operations during measurements based on the sound power data supplied in Table 5-2. A comparison of the measured and predicted noise levels under the same site operations show a close correlation (less than 1 dB difference). Therefore, the noise model is shown to have an acceptable degree of accuracy and predictions can be made of future operations with confidence.

Table 5-3 Quirks Quarry Attended Measurements

Location	Time	Notes	Measured $L_{Aeq\ (15\ minute)}$ dB(A)	Predicted $L_{Aeq\ (15\ minute)}$ dB(A)
Site office	14:40	◗ Screening plant operating. ◗ 2 x Front end Loaders moving between screening plant and stockpiles. ◗ 1 x 45 tonne excavator feeding screening plant. ◗ Plant and equipment operating continuously throughout the 15 minute period. ◗ Plant and equipment located towards south-eastern section of site. ◗ Calm winds.	54.2	54.7
Site office	15:00	◗ Screening plant operating. ◗ 2 x Front end Loaders moving between screening plant and stockpiles. ◗ 1 x 45 tonne excavator feeding screening plant. ◗ Plant and equipment operating continuously throughout the 15 minute period. ◗ Plant and equipment located towards south-eastern section of site. ◗ Haul truck entered past site office (30 seconds) during measurement. ◗ Calm winds.	55.5	56.4

5.1.6 Modelling Scenarios

Noise modelling was undertaken for each of the possible site configurations as outlined in the Concept Plan project description. Based on the proposed time line of the Concept Plan, only one quarry and one landfill would operate at any given time. Therefore, three site configurations were modelled:

◗ Configuration 1: Quirks Landfill and West Valley Quarry. Stage 1 of the proposed Concept Plan (2012 – 2021).

- Configuration 2: West Valley Landfill and North Valley Quarry. Stage 2 of the proposed Concept Plan (2022 – 2033).
- Configuration 3: North Valley Landfill only (2034 – 2045).

5.2 Predicted Noise Levels

Table 5-4 summarises the predicted noise levels at each identified sensitive receiver under neutral weather conditions. Noise levels have been predicted with and without the use of the hard rock drill. Noise levels for normal operations (without hard rock drill) have also been predicted at the end of each Stage of the project (i.e. quarry pit at lowest point and landfill at full capacity). This has provided a guide as to the change in noise levels at the landscape of the quarry and landfill change and noise sources become more or less exposed to sensitive receivers.

The adopted project specific noise goal at all receivers is 47 dB(A) L_{Aeq}.

Table 5-4 Predicted Operational Noise Levels – dB(A)

Model Configuration	Scenario (1, 2)	Receiver						
		R1	R2	R3	R4	R5	R6	R7
1 (West Valley Quarry and Quirks Landfill)	Without drill at open	44	40	**49**	39	27	34	43
	With drill at open	44	41	**50**	40	27	34	43
	Without drill at close	46	37	45	37	26	40	46
2 (West Valley Landfill and North Valley Quarry)	Without drill at open	40	36	46	39	26	35	40
	With drill at open	41	41	**48**	41	27	36	41
	Without drill at close	39	34	**47**	38	22	33	39
3 (North Valley Landfill only)	Open	32	27	38	32	16	28	34
	Close	32	36	38	34	21	28	35

[1] Open scenario refers to the equipment height at quarry and landfill opening. i.e. Quarry is at existing ground level and landfill is at previous quarry pit level.

[2] Close scenario refers to the equipment height at quarry and landfill close. i.e. Quarry is at lowest pit level and landfill is at maximum capacity (assumed to be approximately natural ground height).

The predicted noise contours for each modelled scenario are provided in Appendix C.

The separate contribution of the quarry and landfill at each of the sensitive receivers has also been analysed. A comparison of contribution levels show that, upon opening, the quarry is generally the controlling noise source when compared to the landfill. However, as the landscape of the quarry and landfill change into the future, the noise contributions are shown to reverse, with the landfill becoming the controlling noise source at most sensitive receivers. This change is purely due to the level of exposure of equipment as they are increasingly or decreasingly shielded by local topographical features, such as the active quarry face.

5.3 Discussion of Noise Model Results

The noise model results indicate the following:

5.3.1 Configuration 1 (West Valley Quarry and Quirks Landfill)

- Configuration 1 indicates that noise levels from normal operations of the West Valley Quarry and Quirks Landfill are expected to meet the daytime criteria at all identified residential receivers, except for at Receiver 3 where a potential 2 dB exceedance is predicted. Analysis of the noise contribution data shows the quarry processing plant to be the dominant source of noise at this receiver. It is noted however that Receiver 3 has been acquired by Council and is no longer considered a sensitive receiver.
- The operation of the hard rock drill has potential to increase noise levels by up to 1 dB(A), causing a further exceedance at Receiver 3. Noise levels at all other receivers are predicted to remain below the adopted criteria.
- As the landscape of the quarry and landfill change, the contributions of individual sources are also changed. As the quarry pit deepens and the quarry processing plant becomes more shielded by the active wall, noise levels at all receivers are predicted to reduce and comply with the adopted goals.
- Options for noise control are provided in Section 8 of this report.

5.3.2 Configuration 2 (North Valley Quarry and West Valley Landfill)

- Configuration 2 indicates that noise levels from normal operations from the North Valley Quarry and West Valley Landfill are expected to meet to adopted criteria at all identified residential receivers.
- The operation of the hard rock drill at North Valley Quarry has potential to increase noise levels by up to 5 dB(A), causing a 1 dB exceedance at Receiver 3. Noise levels at all other receivers are predicted to remain below the adopted criteria.
- As the landscape of the quarry and landfill change, the contributions of individual sources are also changed. As the quarry pit deepens and the quarry processing plant becomes more shielded by the active wall, noise levels at all receivers are generally predicted to reduce and comply with the adopted goals.

5.3.3 Configuration 3 (North Valley Landfill only)

- Configuration 3 indicates that noise levels from operations of the North Valley Landfill are expected to readily comply with the adopted criteria at all identified residential receivers.
- As the landscape of the landfill changes, noise levels at receivers are predicted to increase slightly, but remain under the adopted noise goals.

For all scenarios, it should be borne in mind that mobile machinery would likely move about, variously altering the directivity of the noise source with respect to individual receivers. During any given period the machinery items to be used on site would operate at maximum sound power levels for only brief stages. At other times the machinery may produce lower sound levels while carrying out activities not requiring full power. It is highly unlikely that all equipment would be operating at their maximum sound power levels at any one time. Therefore, the model results are considered to be conservative (i.e. potential to overestimate noise impacts). Furthermore, the final layout of fixed plant at each quarry will be determined during detail design, therefore the modelled results should only be used as a guide for comparative purposes at this point in time. The model will be revised with future stages of development.

This Concept Plan study is based on the processes and technologies used in quarry and landfill activities at the time of this assessment. The assessment does not take into consideration emerging technologies in heavy vehicle machinery, resource recovery, alternatives to land filling and increased regulation of waste minimisation and landfill diversion targets. As the Concept Plan has an expected life of approximately 30 years, it is highly likely that improvements in technology will see a reduction in site noise emissions associated with the proposed activities.

6. Road Traffic Noise Assessment

6.1 Existing Traffic

With only a few residential houses within the Leddays Creek road catchment area background traffic is limited with the majority of traffic being from the existing Stotts Creek RRC. Peak traffic along Tweed Valley Way occurs at 8:00 – 9:00 AM and 3:00 – 4:00 PM.

Traffic data was provided by Council for the following locations:

- Entrance to Stotts Creek RRC (Leddays Creek Road).
- Eviron Road (off Duranbah Road).
- Tweed Valley Way (north of the southern entrance to Tumbulgum).

Key statistics for these three locations including the average daily traffic (ADT), morning and afternoon peak hour traffic volumes and the percentage of heavy vehicles is provided in the following table.

Table 6-1 Existing Two-Way Traffic Conditions (Source: GHD Traffic Study[1])

Time Period	Entrance to Stotts Creek RRC (Leddays Creek Road)	Eviron Road	Tweed Valley Way
ADT – Weekday	625	345	10698
ADT – Weekend	425	390	10449
ADT – 7 days	568	358	10321
% Heavy Vehicles [2]	31%	12%	6%
AM Peak	75	38	893
PM Peak	79	43	1001

[1] GHD report number 843355994, dated November 2010.

[2] Class 3 and above. Heavy Vehicles generated as part of landfill and quarry activities are considered Class 4 and above. E.g. Kerbside waste collection vehicles and quarry haul trucks.

6.2 Site Access

The existing access point for Quirks Quarry onto Eviron Road will be discontinued. For this reason the access on to Eviron Road has not been included in this assessment. The access point for all activities associated with the Concept Plan (including Stage 1) will be through the existing Stotts Creek RRC via Tweed Valley Way and Leddays Creek Road.

As described above, the expected hours of operation of the landfill sites are 7 am to 4 pm Monday to Friday and 9 am to 4 pm Saturday and Sunday, whilst quarrying activities will operate between 7 am and 5 pm Monday to Friday and 7 am to 12 pm Saturday. All heavy vehicles would be expected during these times. Light vehicular traffic from site staff may occur before and after opening hours.

Waste collection vehicles and quarry haul trucks will proceed through the Stotts Creek facility and along the proposed haul road to the landfill or quarry, whilst light vehicular traffic (i.e. domestic and small commercial customers) will continue to utilise the transfer station facility at the Stotts Creek RRC and will not access the proposed haul road.

6.3 Traffic Generation

Traffic generation is discussed in detail in the GHD Traffic Impact Assessment[1] and the predictions made in this report have been adopted as part of the traffic noise impact assessment. Traffic generation data was derived based on traffic data provided by Council for the existing quarry and landfill operations and the traffic counts for nearby intersections. Overall it is noted that the traffic generation has been assumed based on information on expected maximum quarry outputs and expected maximum landfill intake. All facilities as part of the Concept Plan will use the same access and route to Tweed Valley Way, via the Stotts Creek RRC and Leddays Creek Road.

6.3.1 Landfill

The expected traffic generated from Landfill activities has been assumed to be directly proportional to the maximum landfill waste acceptance rates. Table 6-2 shows the expected traffic generation from each of the three proposed landfills. Note that the maximum landfill waste acceptance rates increases over time due to the expected increase in population and associated need for waste disposal. This traffic would travel on Leddays Creek Road and Tweed Valley Way.

Table 6-2 Expected Landfill Traffic Generation

Landfill	Operating years	Maximum Waste Acceptance Rates (tonnes per annum)	Peak Hour(1) Heavy Vehicles(2)	Peak Hour(1) Light vehicles
Quirks	2012 – 2021	70000	7	48
West Valley	2022 – 2033	100000	10	69
North valley	2034 – 2045	150000	15	103

[1] Peak hour was assumed to comprise of 10% of daily traffic.

[2] Class 4 vehicles and above.

The traffic levels associated with the landfill component are currently already accounted for within the existing road network (i.e. due to the presence and use of the existing Stotts Creek RRC). The expected growth rate would be consistent with traffic on any road network.

Traffic associated with waste disposal facilities both at Stotts Creek will remain the dominant source of traffic on Leddays Creek Road.

[1] GHD report number 843355994. Tweed Shire Council Report for Eviron Road Quarry and Landfill Proposal, Traffic Impact Assessment, November 2010.

6.3.2 Quarry

It is expected that a maximum of 200,000 tonnes will be extracted and removed from the operating quarry each year. It has been assumed that haulage vehicles are truck and dog trailers with an average 25 tonnes per load capacity. Whilst the quarry haulage regime will be highly variable and dependent of the availability and demand for quarry resource an average traffic generation of 26 vehicles a day has been adopted. This has been derived from the expected tonnages and average capacity of a truck and dog trailer. Based on the traffic count provided by Council for Eviron road, the number of heavy vehicles generated by the proposed quarry is consistent with the existing traffic counts. As the maximum capacity for future quarries will be the same as the existing Quirks Quarry, there is not expected to be any additional traffic generated from quarry activities. A daily traffic generation of 26 trucks would equate to 3 vehicles during peak hour. Traffic associated with site employees would contribute ten vehicles during peak hour.

The proposed haulage route from all quarries will be through the internal haul road to Stotts Creek RRC, then right onto Leddays Creek Road and on to Tweed Valley Way.

Heavy vehicle traffic on Eviron Road associated with quarrying activities will be eliminated upon establishment of the proposed haul road and closure of the current Quirks Quarry site access road. However this traffic will be diverted to Leddays Creek Road and Tweed Valley Way via the new haul road. The split of traffic travelling east or west on Tweed Valley Way will be dependent on the required destination of quarry materials, however it is assumed that this is a 50/50 split. The addition of on average 26 heavy vehicles a day associated with the quarry, will impact upon Leddays Creek Road increasing heavy vehicles by approximately 13% (or 3 heavy vehicles during peak hour). This increase indicates that the landfill activities will still largely be responsible for the bulk of the traffic generation along Leddays Creek Road.

6.4 Expected Increase in Road Traffic Noise

Table 6-3 shows the existing and expected increase in road traffic during AM and PM peak hour periods at project opening.

Table 6-3 Predicted Increases in Road Traffic Noise at Project Opening

Roadway	Peak Hour	Existing		Generated [1]		% Increase in Total Traffic[2]	Increase in Noise Emission Level (dB)
		HV	LV	HV	LV		
Leddays Creek Road	AM	23	52	3	10	17%	0.7
	PM	25	54	3	10	16%	0.7
Tweed Valley Way	AM	54	839	3	10	1%	0.1
	PM	60	941	3	10	1%	0.1

[1] Generated traffic was derived from Quarry operations only since Landfill traffic is part of existing vehicles. HV denotes Heavy vehicles and LV denotes Light Vehicles.

[2] Generated traffic during peak hour is expected to comprise of the same proportion of heavy vehicles as currently exist (approximately 30% on Leddays Creek Road).

Long term road traffic noise monitoring was not undertaken in the areas surrounding the site. Therefore, in order to gain an understanding of the existing levels of traffic noise along these roadways, traffic noise modelling was undertaken. Road traffic noise modelling was undertaken with consideration to the Calculation of Road Traffic Noise (CoRTN) algorithm, developed by the United Kingdom Department of Transport (1998).

There is only one identified receiver in the vicinity of Leddays Creek Road, which is located close to the entrance to the Stotts Creek RRC. It is understood this property is owned by Tweed Shire Council but is used for residential purposes.

Predictive modelling (including a 2.5 dB façade correction factor) indicated an existing daytime traffic noise level of 53 dB $L_{Aeq(1\ hour)}$, which is below the 55 dB $L_{Aeq(1\ hour)}$ traffic noise goal for local roads. Allowing for the expected increase in road traffic noise due to quarry vehicles entering and exiting via Leddays Creek Road results in a daytime road traffic noise level of approximately 54 dB $L_{Aeq(1\ hour)}$. Therefore, road traffic noise is expected to comply with the NSW ECRTN criteria for local roads and is expected to increase by less than 1 dB under Stage 1 of the Concept Plan.

The NSW ECRTN also requires that road traffic noise levels be assessed at a period of 10 years after project opening. At this point it is expected that the Concept Plan would be at Configuration 2 (Stage 2) stage. The expected traffic noise increase for the 10 year predicted levels are shown in Table 6-4. The predicted increase in road traffic noise is expected to be less than 2 dB and total traffic noise levels should remain below the NSW ECRTN criteria for local roads.

Table 6-4 Predicted 10-Year Increase in Road Traffic Noise

Roadway	Peak Hour	Existing [1]		Generated [2]		% Increase in Total Traffic[3]	Increase in Noise Emission Level (dB)
		HV	LV	HV	LV		
Leddays Creek Road	AM	23	52	6	31	49%	1.7
	PM	25	54	6	31	47%	1.7
Tweed Valley Way	AM	54	839	6	31	4%	0.6
	PM	60	941	6	31	4%	0.6

[1] Existing traffic volumes were assumed to be equal to existing since the Concept Plan would generate the majority of traffic on Leddays Creek Road. This is conservative foe Tweed Valley Way as it does not account for annual traffic growth.

[2] Generated traffic was derived from West Valley Landfill and North Valley Quarry operations. The existing Stotts Creek Landfill traffic volumes were subtracted from the expected North Valley Landfill traffic to derive the growth in traffic from existing conditions. HV denotes Heavy vehicles and LV denotes Light Vehicles.

[3] Generated traffic during peak hour is expected to comprise of the same proportion of heavy vehicles as currently exist (approximately 30% on Leddays Creek Road).

With an increase in traffic volumes of approximately 1% on Tweed Valley Way, additional traffic generated as part of the Concept Plan is expected to have negligible impact on traffic noise levels.

7. Blasting Vibration Assessment

7.1 Quirks Quarry Blast Monitoring Results

TSC provided GHD with a blast monitoring report from vibration monitoring of blasts from the existing Quirks Quarry. Blast monitoring was undertaken during July 2008. The blast design and evaluation report can be found in Appendix B.

A summary of the site blast design and site parameters is provided below in Table 7-1.

Table 7-1 Measured Vibration Levels and Parameters

Parameter	
Blast hole diameter	89 mm
Stemming length	3 m
Rock density	2.6 tonnes/m^3
Number of holes	54
Average hole length	10 m
Maximum charge mass per hole	55 kg
Distance from blast to monitor	400 m
Maximum measured airblast at monitor	**109 dB(L)**
Maximum measured PPV at monitor	**1.97 mm/sec**

The above results indicate that, based on the parameters of these blasts, the vibration criteria are met at the monitoring location (400 metres from the blast) for both ground vibration and airblast overpressure.

GHD have adopted the results of the above blast monitoring reports to use in predictions of the ground vibration and airblast overpressure over varying distances on the assumption that the blast parameters at Quirks Quarry would be representative of the conditions at the proposed West Valley Quarry and North Valley Quarry. GHD has adopted this information assuming that the blast procedure and vibration monitoring were undertaken with consideration to the relevant publications and standards, including:

- Australian and New Zealand Environment Conservation Council (ANZECC), "*Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*" (1990).
- Australian Standard AS 2187.2 – 2006, "*Explosives – Storage, transport and use. Part 2: Use of explosives*".

7.2 Blast Predictions

Estimations for ground vibration and airblast overpressure during blasting have been made with consideration to Australian Standard AS2187.2–2006.

7.2.1 Airblast Calculations

Airblast radiates outwards from the blast site and attenuates with distance.

Airblast levels have been estimated using the following cube root scaling formula:

$$P = K_a \left(\frac{R}{Q^{1/3}} \right)^a$$ **Equation (2)**

Table 7-2 summarises the constants in Equation (2) and the values that have been assumed to estimate airblast levels, based on the provided monitoring results.

AS2187.2–2006 states that for confined blasthole charges, which would most likely be the case for blasting associated with the proposed quarries, a good estimation may be obtained by using a site exponent (a) of -1.45.

Table 7-2 Airblast Parameters and Assumptions

Parameter	Definition	Assumed Value
P	Pressure (kPa)	N/A
Q	Explosive charge mass per hole (kg)	55 (1)
R	Distance from charge (m)	Range: 200 to 700
a	Site exponent	-1.45
K_a	Site constant	5 (2)

(1) Charge mass has been adopted from the blast design and evaluation report provided in Appendix B.

(2) K_a site constant has been determined by using the known airblast pressure level, site exponent, charge mass and distance for the Quirks Quarry blast results provided.

7.2.2 Ground Vibration Calculations

Ground vibration radiates outwards from the blast site and gradually reduces in magnitude with distance from the blast.

Factors that affect the level of ground vibration arriving at a point from a blast typically include:

- Charge mass fired per hole.
- Distance.
- Ground transmission characteristics.

As many site factors will affect the transmission of vibration through the ground, the most accurate assessment of ground vibration from a site will be from vibration measurements taken on-site. Ground vibration levels have been estimated using the following formula.

$$V = K_g \left(\frac{R}{Q^{1/2}} \right)^{-B}$$ **Equation (3)**

Table 7-3 summarises the constants in Equation (3) and the values that have been assumed to estimate ground vibration levels.

AS2187.2–2000 states that when blasting is carried out to a free face in average field conditions, the mean vector peak particle velocity may be estimated by assuming the value of the site exponent (B) to be 1.6.

Table 7-3 Ground Vibration Parameters and Assumptions

Parameter	Definition	Assumed Value
V	Ground vibration in Vector Peak Particle Velocity (VPPV) (m/s)	N/A
R	Distance from charge (m)	Range: 200 to 700
Q	Maximum charge mass (kg)	55 (1)
K_g, B	Constants related to site and rock properties for estimation purposes	K_g = 1167 (2) B = 1.6

(1) Charge mass has been adopted from the blast design and evaluation attached as Appendix B.

(2) K_g site constant has been determined by using the known ground vibration level, site exponent, charge mass and distance.

7.3 Blast Prediction Results

Figure 7-1 displays a plot of airblast overpressure and ground vibration against distance from the blast. These plots have been based on the assumptions and values outlined above in Table 7-2 and Table 7-3.

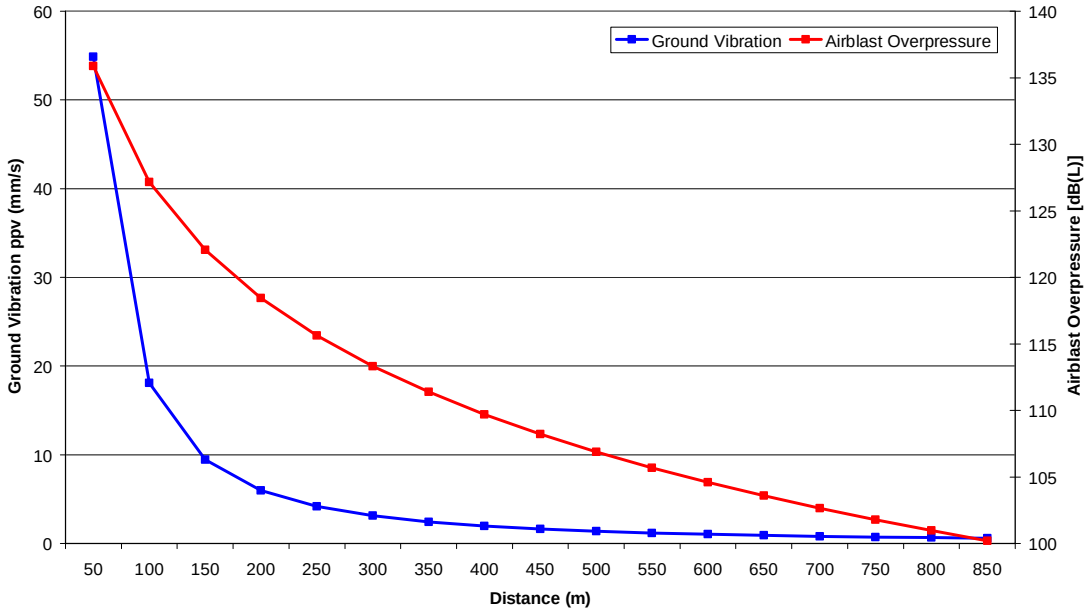


Figure 7-1 Estimated Ground Vibration and Airblast Overpressure Levels from Blasting

Based on the assumptions outlined above, estimated ground vibration and airblast levels from blasting suggest that the recommended limits of 5 mm/sec and 115 dB(L) would be achieved at a minimum distance of approximately 230 m and 260 m respectively from the blast location. Therefore, the blasting guidelines should be met under the assumed conditions at all receivers, except for at Receiver 3, if blasting occurs close to the south-western boundary of West Valley Quarry. The occupants of Receiver 3 should be notified of any blast events within West Valley Quarry. Further options for mitigating impacts from blasting are discussed in Section 8.

Adverse meteorological conditions such as temperature inversions and wind direction can significantly increase airblast overpressure levels. Temperature inversions are most common during night and early morning periods, therefore should not affect blasting during the recommended standard operating hours. Prevailing winds are generally from the southeast and southwest, which are generally away from the residential premises except for Receiver 2 when blasting occurs at West Valley Quarry. To assist in the reduction of airblast overpressure propagation, blasting should not be conducted when the prevailing winds are blowing towards residential receivers.

8. Recommendations

8.1 General Control Measures

- All activities on site should be confined between the hours of 7:00 am to 6:00 pm from Monday to Saturday. In particular, haul trucks should not arrive on site (or depart it) before 7:00 am.
- All equipment used on site should be in good condition and good working order.
- Plan to use equipment which is appropriate for the required tasks in terms of power requirements.
- All engine covers should be kept closed while equipment is operating.
- As far as possible, materials dropping heights into or out of trucks should be minimised.
- All combustion engine plant should be checked to ensure they produce minimal noise with particular attention to residential grade exhaust silencers.
- Vehicles should be kept properly serviced and fitted with appropriate mufflers. The use of exhaust brakes should be eliminated, where practicable.
- Where practical, machines should be operated at low speed or power and should be switched off when not being used rather than left idling for prolonged periods.
- Machines found to produce excessive noise compared to industry best practice should be removed from the site or stood down until repairs or modifications can be made.
- Although the model assumptions were deemed conservative, it is recommended that equipment noise levels be monitored once the Quarry and Landfill are operating to verify noise emissions are in line with the model assumptions.
- It is also recommended that attended noise measurements be undertaken under a variety of weather conditions at identified noise receivers upon commission of the Eviron Landfill and Quarry Site. Attended noise measurements will allow for the validation of predicted noise levels. This, in turn will more accurately represent the site noise levels and confirm whether or not specific noise control measures are required.

8.2 Specific Control Measures

- The hard rock drill has been identified as a significant noise source within the quarry equipment list. Although its operation is expected to be limited, it has potential to cause short-term noise impacts at the nearest receivers. Therefore, the use of other quarry equipment, such as the processing plant and dozer should be limited (or ceased) during times when drilling is occurring. This will assist in minimising the cumulative noise impact on nearby receivers.

- The quarry processing plant is also identified as a significant noise source during normal operations. This is particularly the case when quarrying activities are at West Valley. Therefore, it is recommended that specific noise mitigation measures be implemented at West Valley Quarry to reduce the impacts of noise from the processing plant. Mitigation options could include:
  - A mobile or fixed noise wall. This could either be in the form of an artificial wall (i.e. shipping container or noise wall) or natural wall (i.e. earth bund). The wall should be located with the aim to block the line of sight between the processing plant and Receiver 3. A potential reduction of approximately 5 dB could be achieved through the use of a noise wall. However it is noted that as Receiver 3 is now owned by Council, this option is unlikely to be required.
  - Locating the processing plant in locations on site which are naturally shielded by the existing topography will also assist in minimising noise impacts. A potential reduction of up to 5 dB is likely to be achieved through this method.
  - As a last resort, treating the building facades of affected receivers will assist in minimising internal noise. Building treatments should generally be considered only when other measures, such as noise barriers are impractical or not cost-effective. Approaches to the acoustic treatment of buildings include improved window glazing and insulation to external walls.

8.3 Blasting

Blasting should only occur from 10 am to 4 pm, Monday to Friday and should not generally take place more than once per day.

Blasting can cause noise and vibration impacts; however counteractive measures such as reducing the Maximum Instantaneous Charge (MIC) can be used to reduce the impact 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. Therefore, potentially affected receivers should be notified in advance of blasting occurring at quarries.

Blasting will not occur at night and should 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.
- Orientation of blast face.

All blasting designs should contain considerations to minimise factors such as ground vibration and air blast. It is recommended that the drilling and blasting at the quarry is under taken by qualified contractors to reduce risks associated with these activities. The blast design should include an assessment of noise and vibration impacts based on blast specific parameters.

It should also be noted that the blast parameters provided in this report are indicative only and different charges should be tested and monitored in the planning phase to provide overpressure and vibration data specific to the effect of blasting on this site. If test blasts exceed or approach the criteria levels, then this should be taken as a benchmark, overriding charge limitations advised in this report.

9. Conclusions

An assessment of potential noise and vibration impacts on the surrounding environment associated with the proposed activities within the overall Concept Plan and Stage 1 Project Application has been undertaken. The findings and conclusions are summarised below.

Industrial Noise

- Based on the assumptions made in this assessment, it is predicted that the operational noise goals should be met at identified receivers surrounding the development under all stages of the Concept Plan, except for at Receiver 3 under worst-case operations of West Valley Quarry, however as this property is now owned by Council it is not considered to be a sensitive receiver. It should be noted that noise predictions are considered to be conservative and it is recommended that actual impacts be quantified through attended measurements upon commissioning of the quarry.
- The hard rock drill and processing plant at the quarry were identified as the most significant noise sources. Noise control options for these items have been provided in Section 8 of this report. The implementation of these control measures should allow for the adopted noise goals to be met at all receivers.

Road Traffic Noise

- A comparison of existing and project-generated traffic noise levels show a relatively small increase in vehicle numbers due to the proposed Concept Plan. The additional vehicles are expected to cause an increase of less than 1 dB on local roads and the ECRTN traffic noise goals are predicted to be met under all operating configurations.

Blasting Impacts

- Representative vibration monitoring reports provided to GHD and subsequent predictions of airblast overpressure and ground vibration levels from blasting at the Quarry indicate that the ANZECC blasting criteria should be achievable at the nearest sensitive receivers if recommended management measures are implemented.

10. Limitations

This Noise Impact Assessment ("Report"):

- Has been prepared by GHD Pty Ltd ("GHD") for Tweed Shire Council (TSC).
- May only be used and relied on by TSC.
- Must not be copied to, used by, or relied on by any person other than TSC without the prior written consent of GHD.
- May only be used for the purpose of the scope of work outlined in Section 1.2 of this report (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 TSC 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.

The services undertaken by GHD in connection with preparing this Report were limited to those specifically detailed in Section 1.2 of this Report.

The findings of this report represent the findings apparent at the date and time of the assessment. It is the nature of environmental assessments that all variations in environmental conditions cannot be accessed and all uncertainty concerning the conditions of the ambient noise environment cannot be eliminated. Professional judgement must be exercised in the investigation and interpretation of observations.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing the Report, including (but not limited to):

- Noise prediction modelling assumptions detailed in Section 5, 6 and 7 of this report.

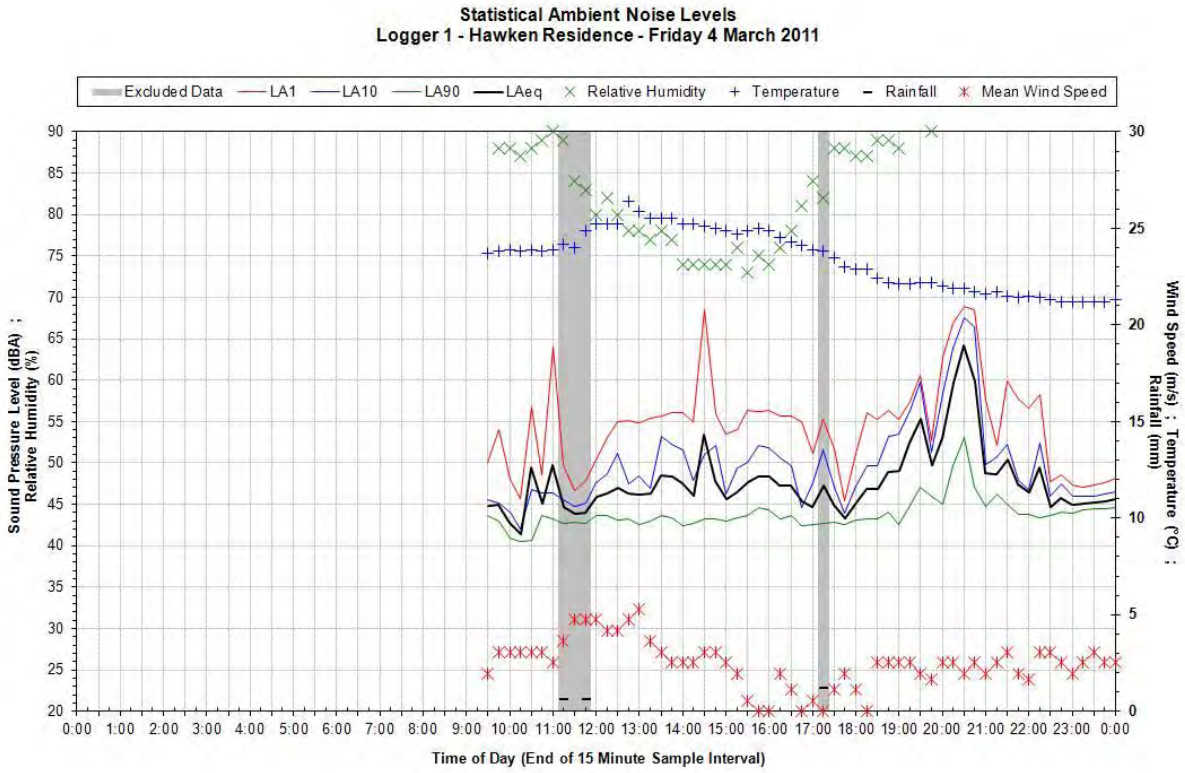
GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the Assumptions being incorrect.

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 of this Report.

Appendix A

Long Term Noise Monitoring Results

Statistical Noise Data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Logger 1 - Hawken Residence - Friday 4 March 2011
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LA10
LA90
LAeq
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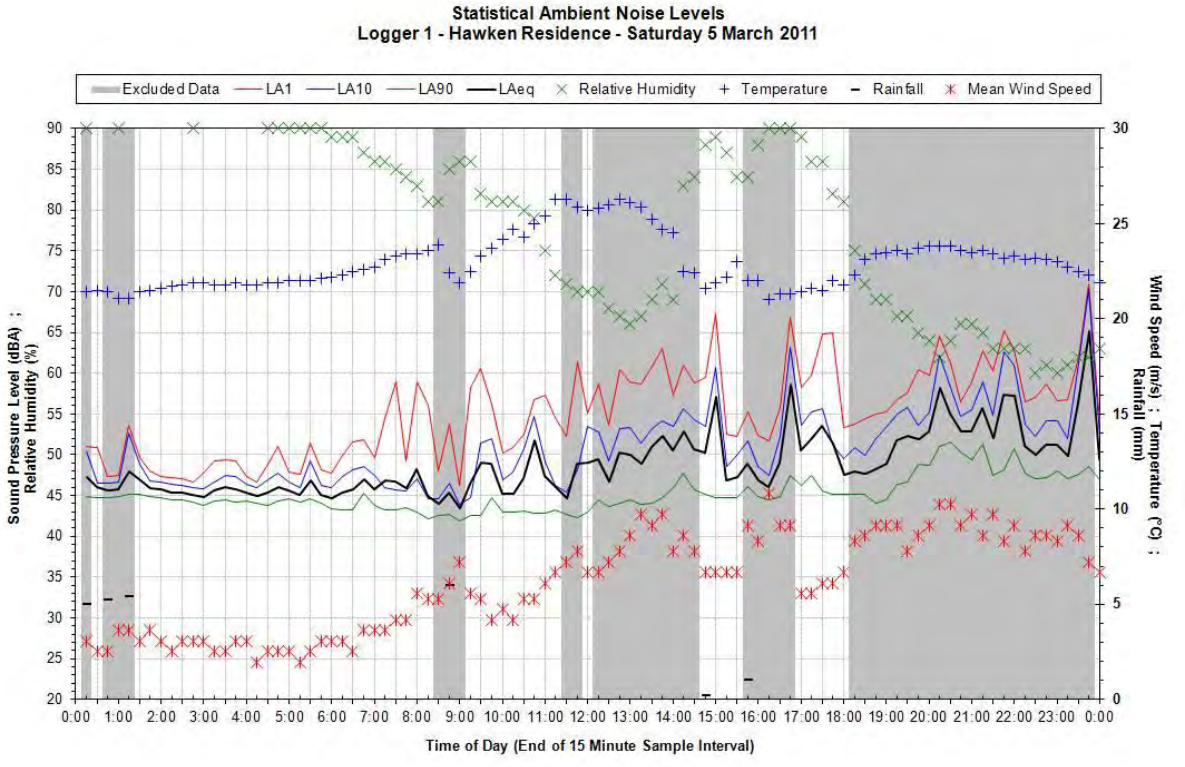
Temperature
Rainfall
Mean Wind Speed
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Rainfall (mm) ; Temperature (°C) ;
Time of Day (End of 15 Minute Sample Interval)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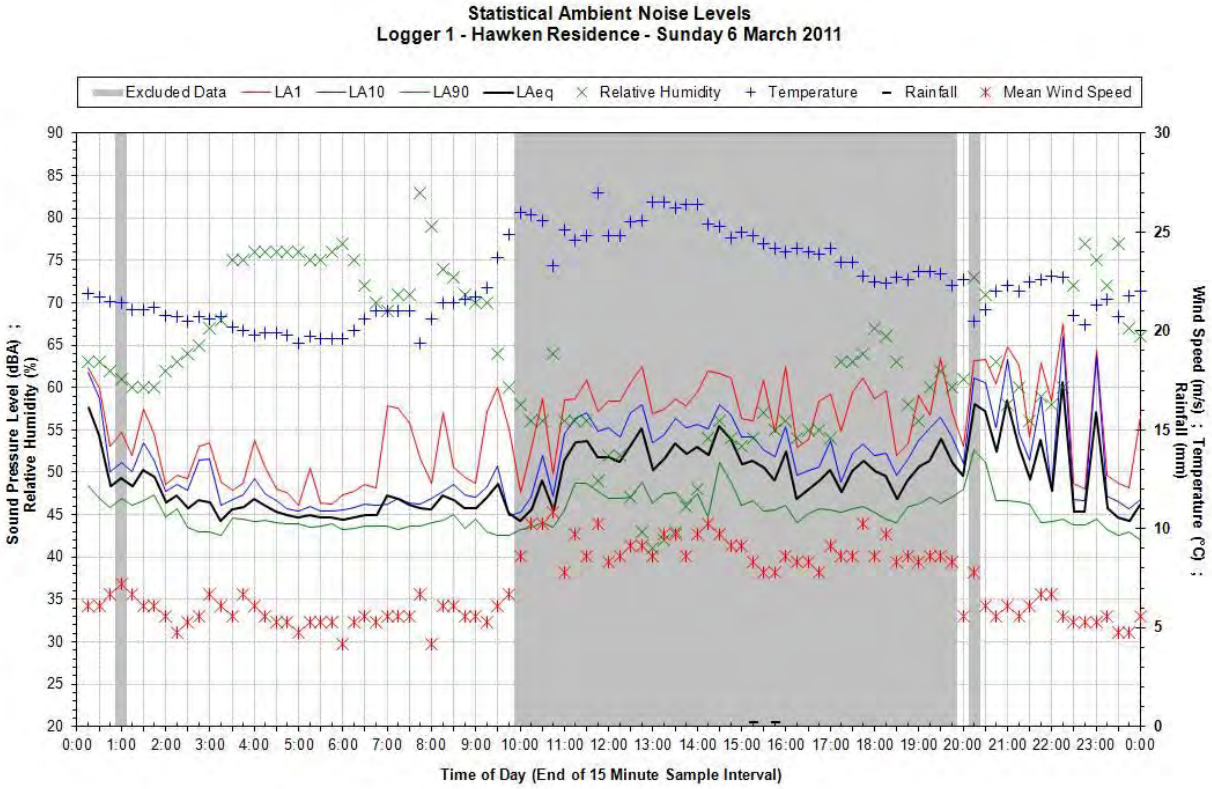
Time of Day (End of 15 Minute Sample Interval)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LA90
LAeq
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Temperature
Rainfall
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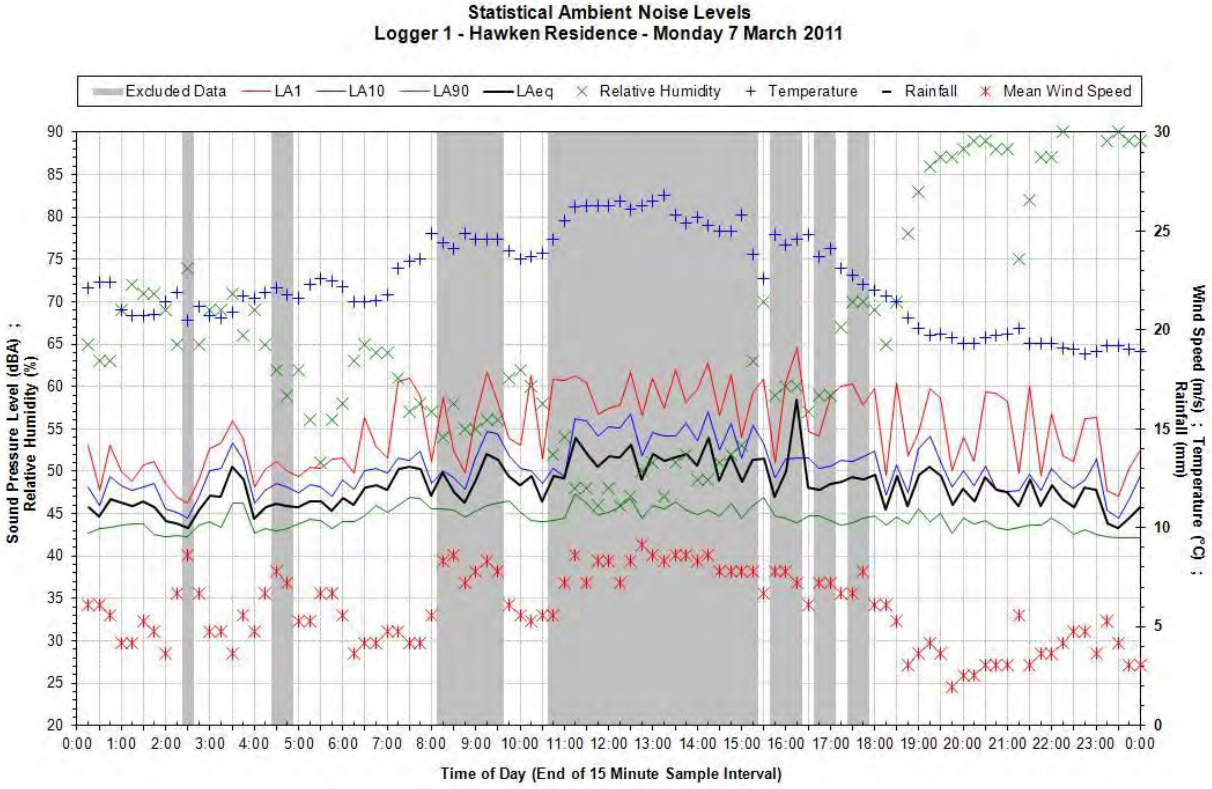
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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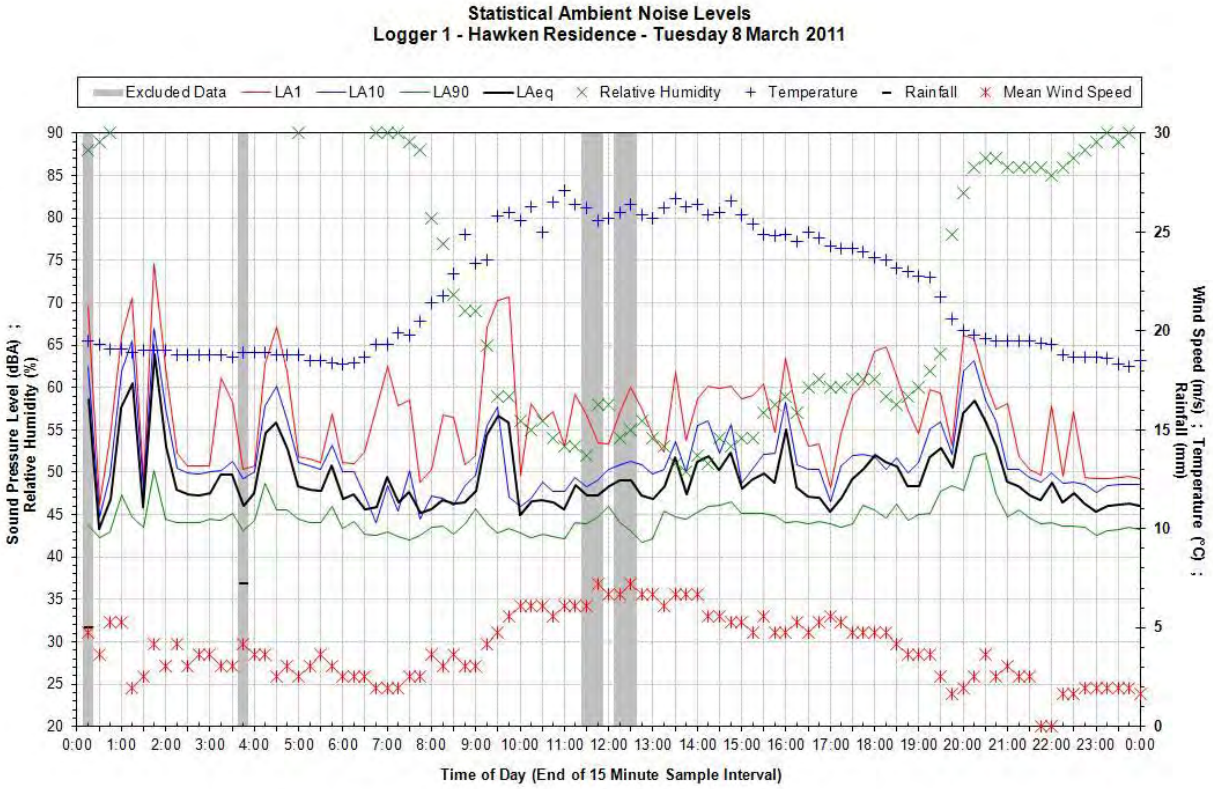
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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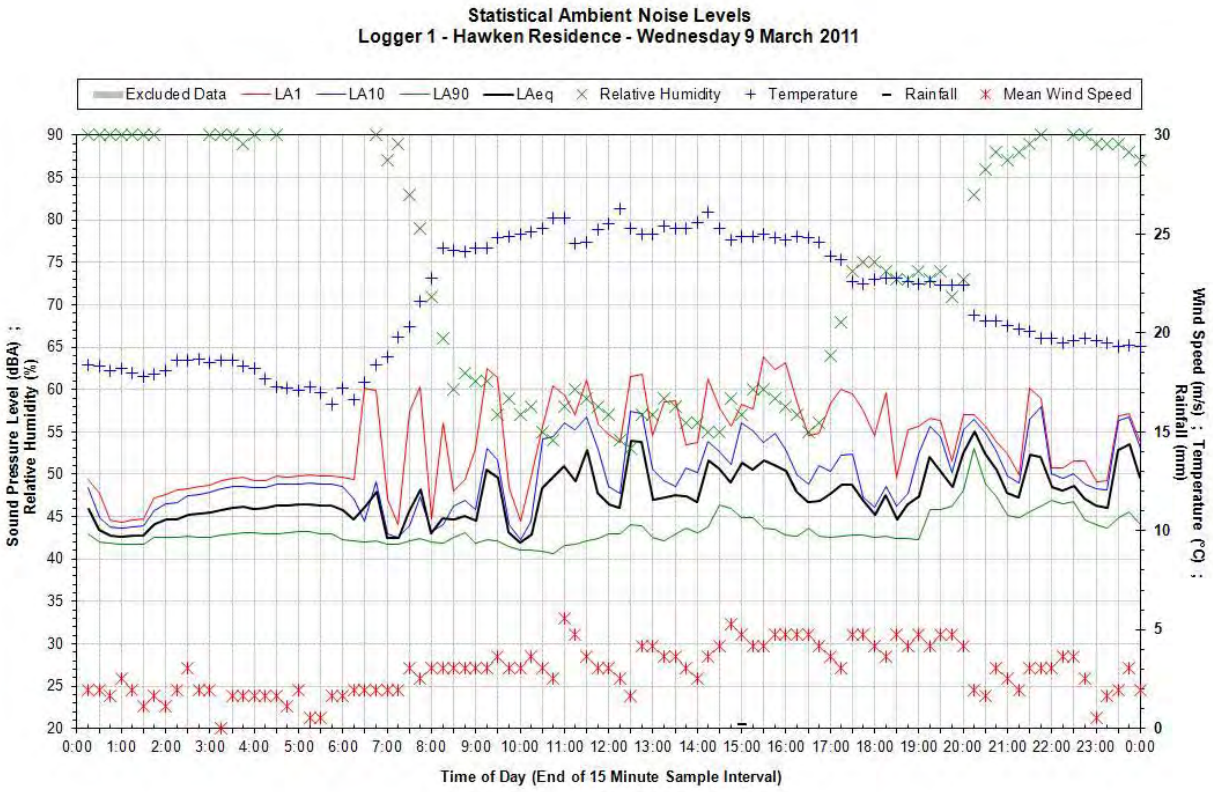
Time of Day (End of 15 Minute Sample Interval)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Temperature
Rainfall
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Time of Day (End of 15 Minute Sample Interval)

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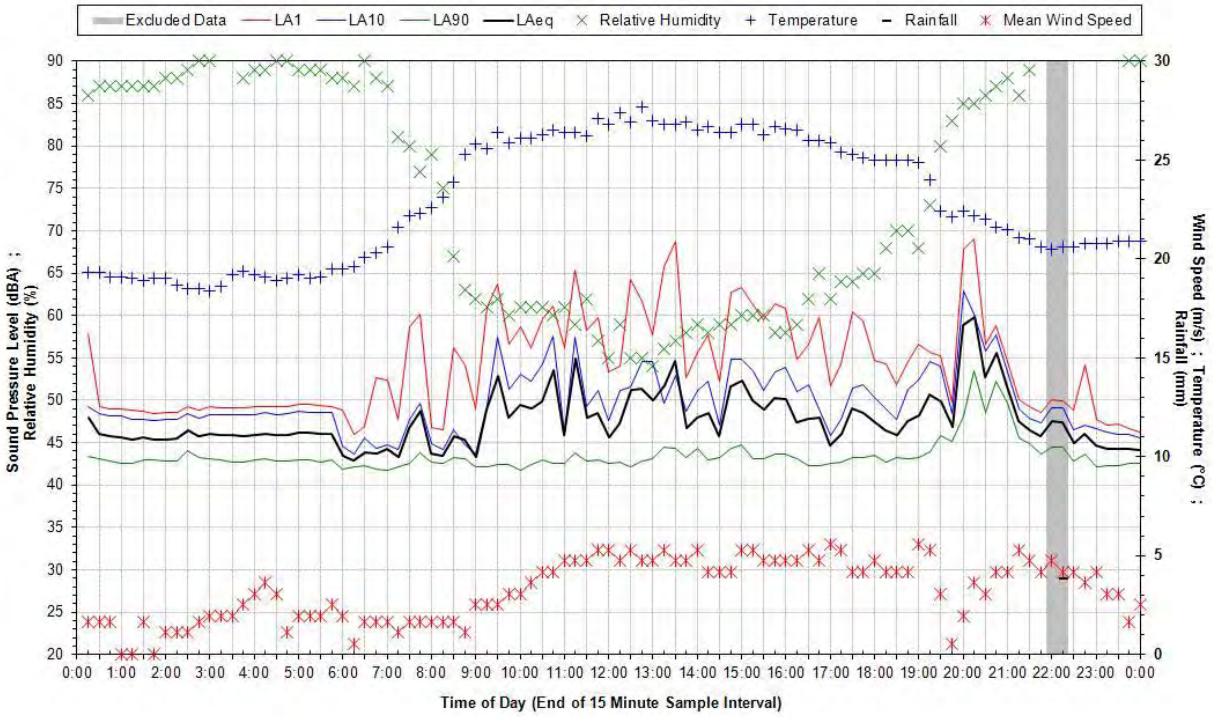

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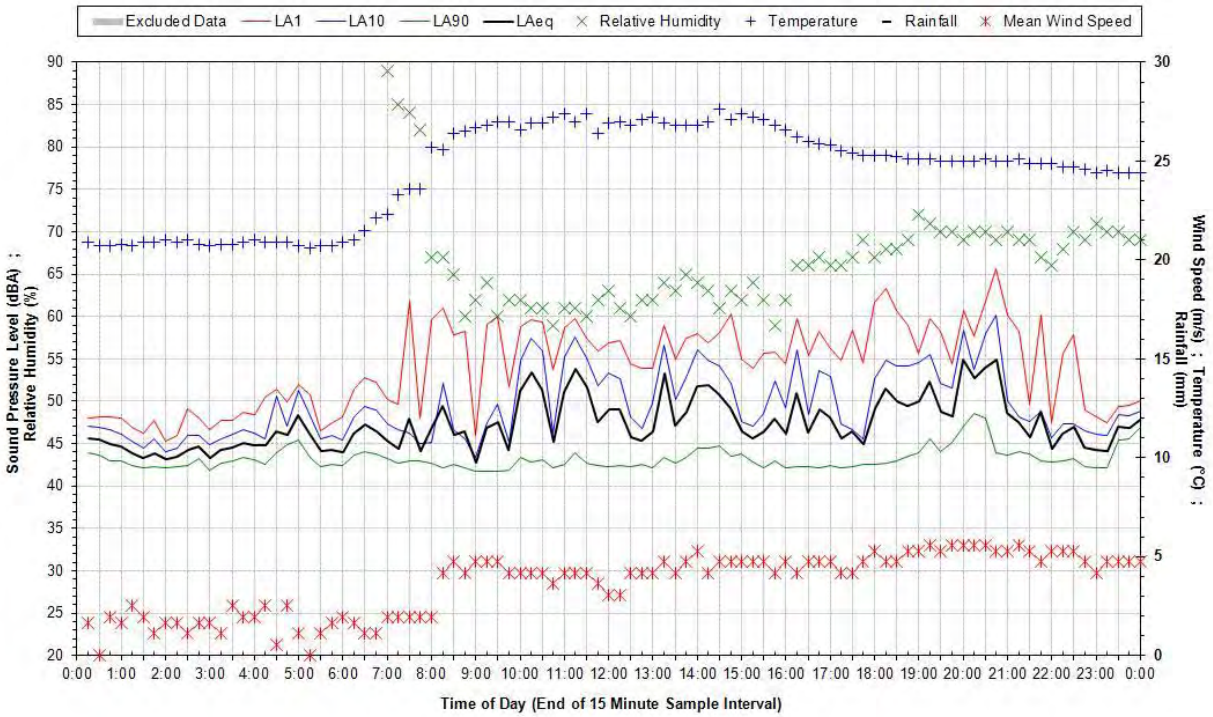

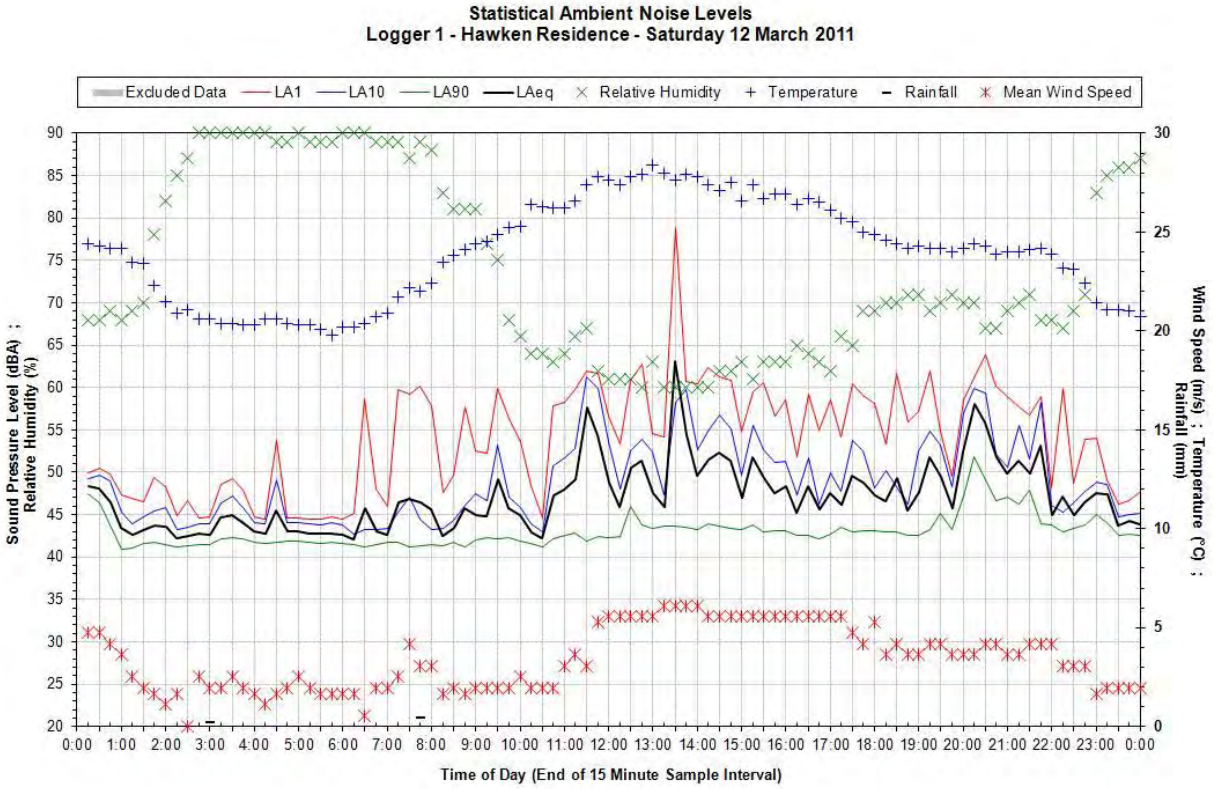
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Temperature
Rainfall
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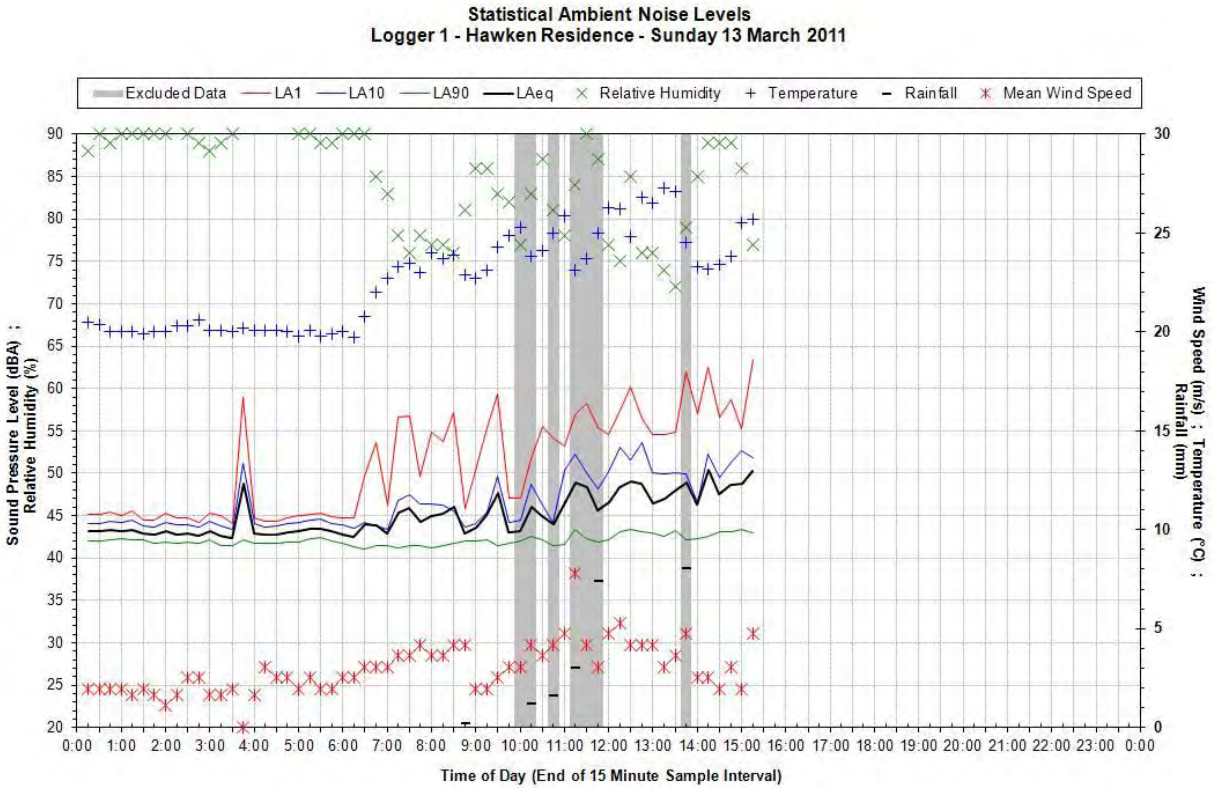
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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Temperature
Rainfall
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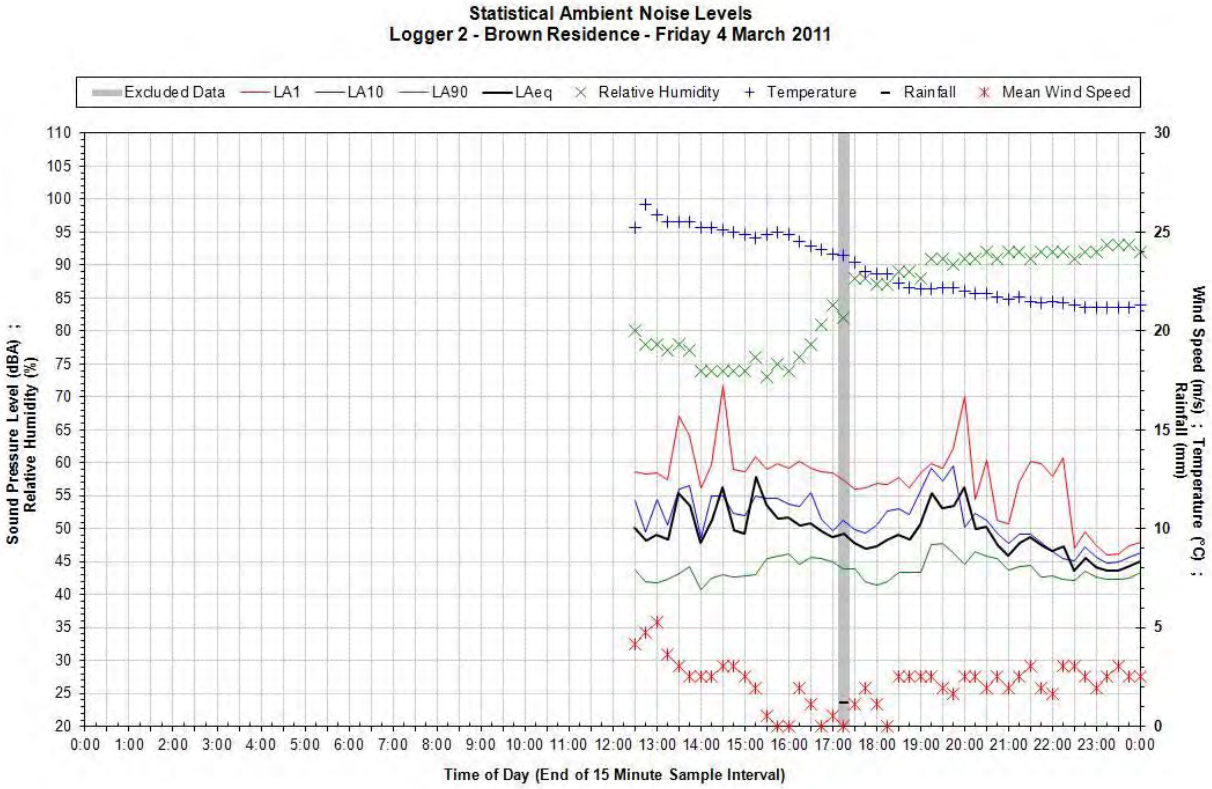
Sound Pressure Level (dBA) ; Relative Humidity (%)
Wind Speed (m/s) ; Temperature (°C) ; Rainfall (mm)
Time of Day (End of 15 Minute Sample Interval)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LAeq
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Temperature
Rainfall
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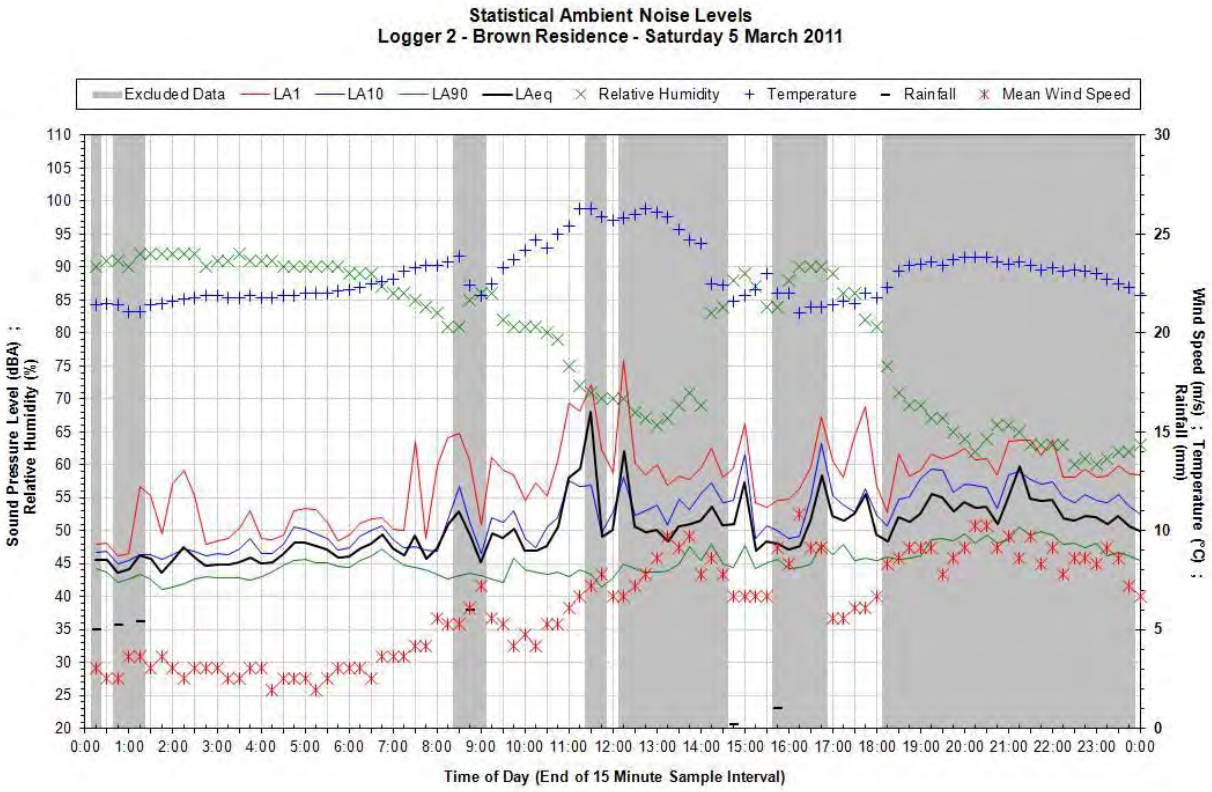
Wind Speed (m/s) ; Rainfall (mm) ; Temperature (°C) ;
Time of Day (End of 15 Minute Sample Interval)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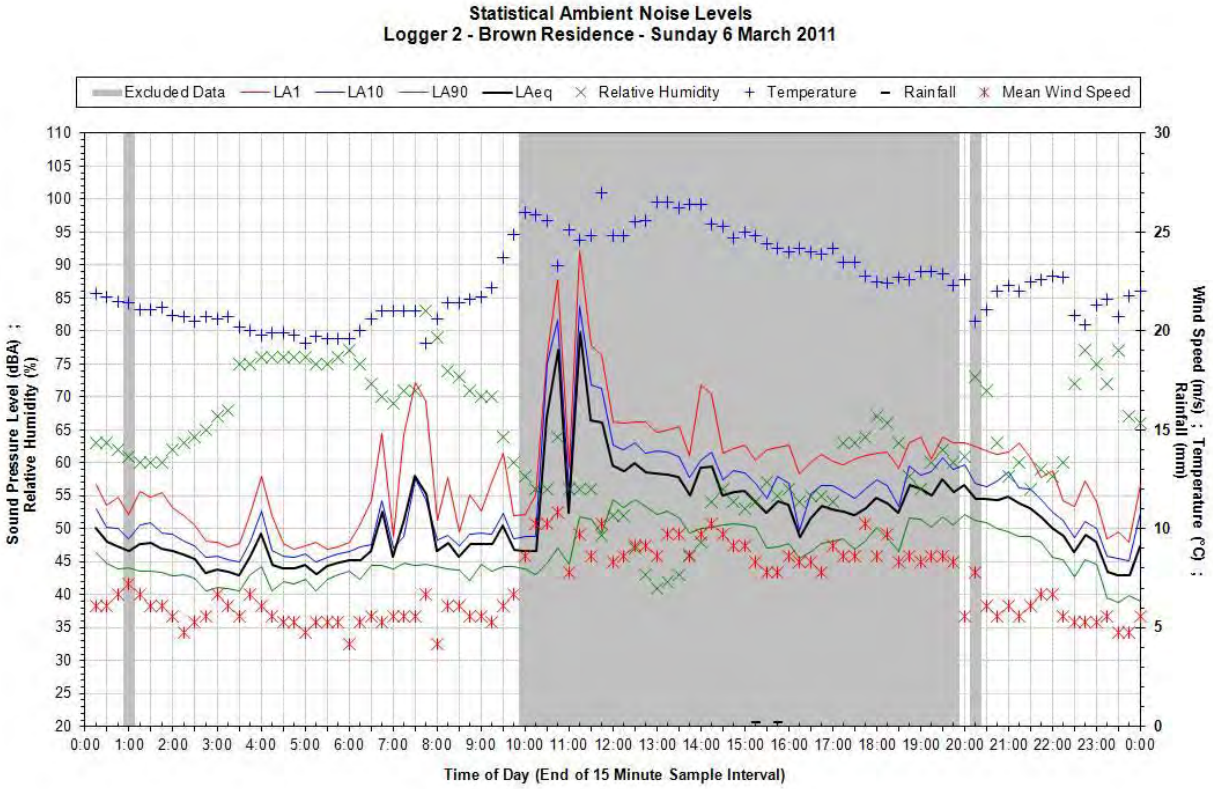
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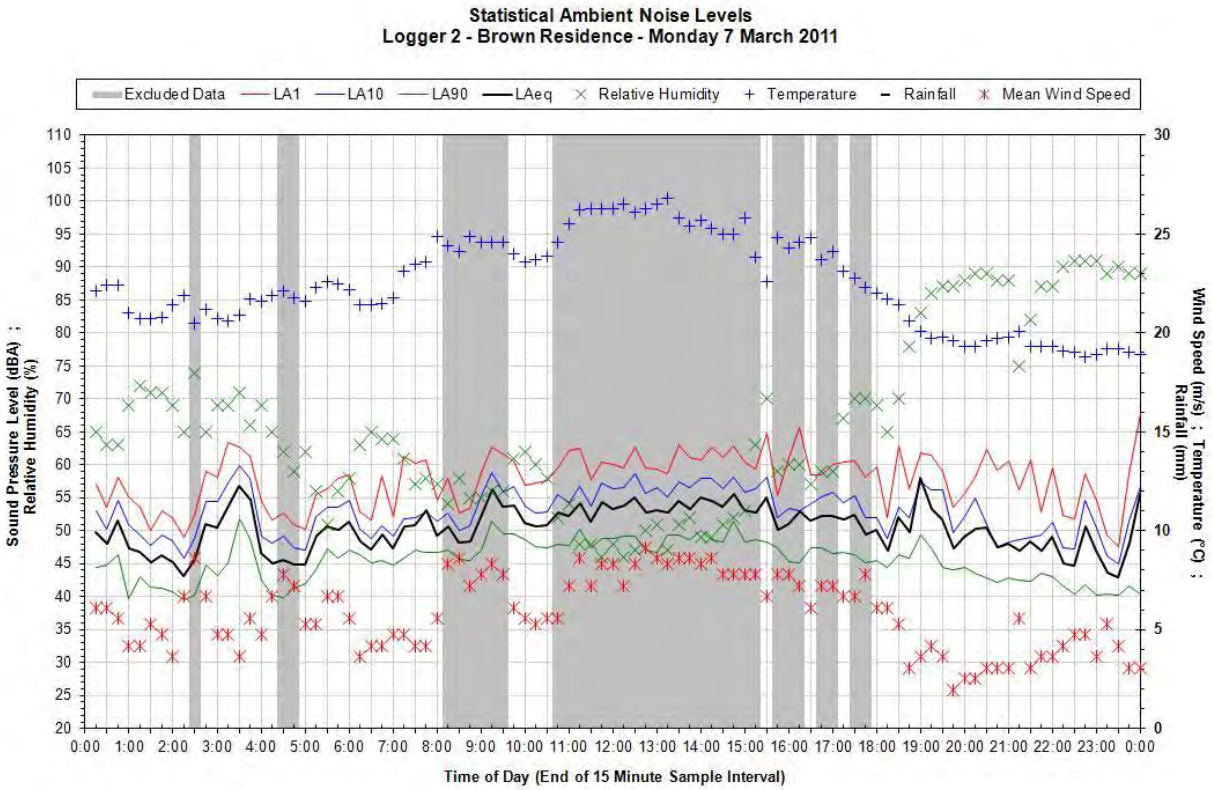
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Wind Speed (m/s) ; Rainfall (mm) ; Temperature (°C) ;
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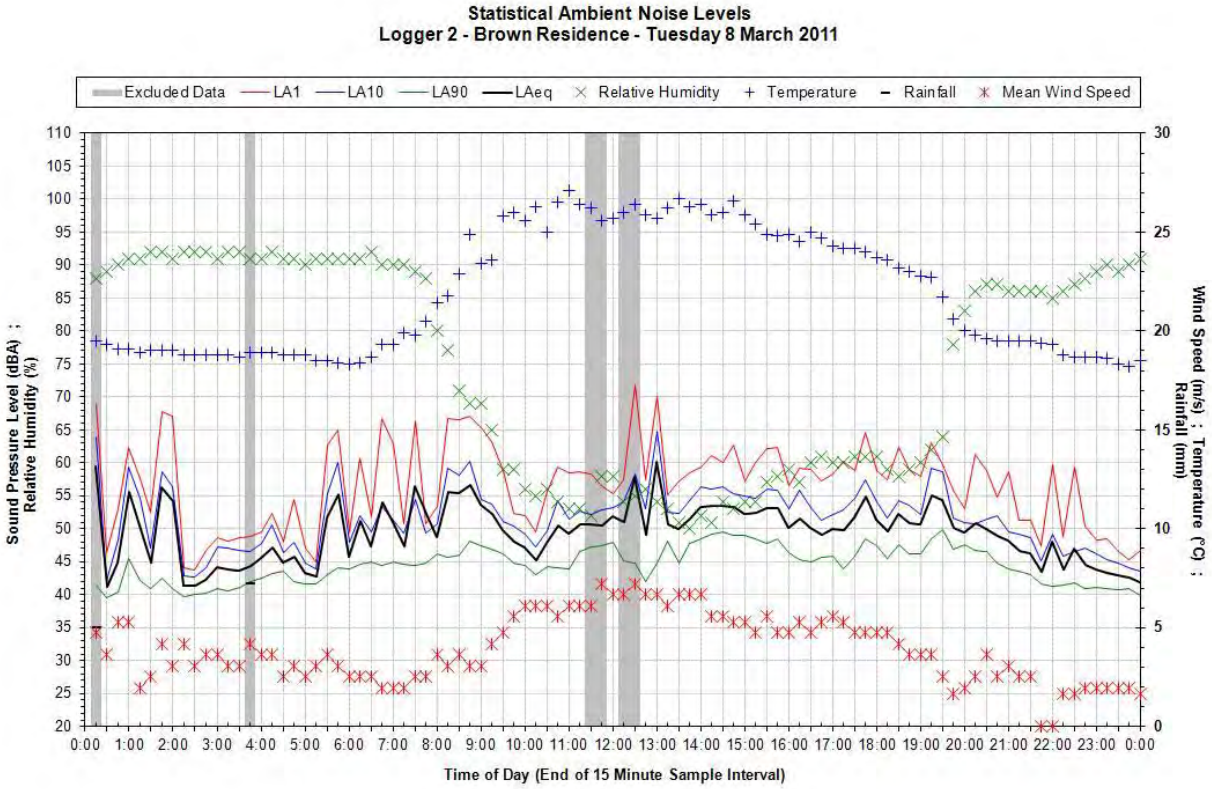
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Temperature
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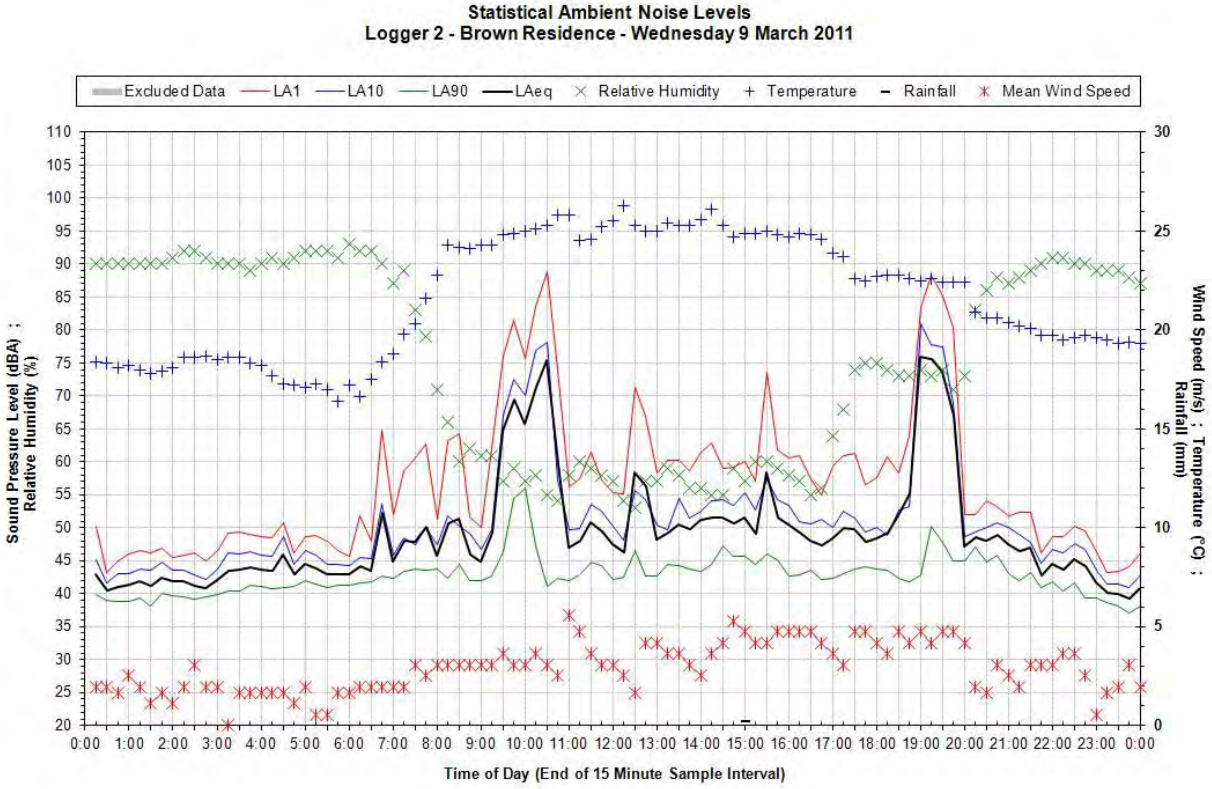
Wind Speed (m/s) ; Rainfall (mm) ; Temperature (°C) ;
Time of Day (End of 15 Minute Sample Interval)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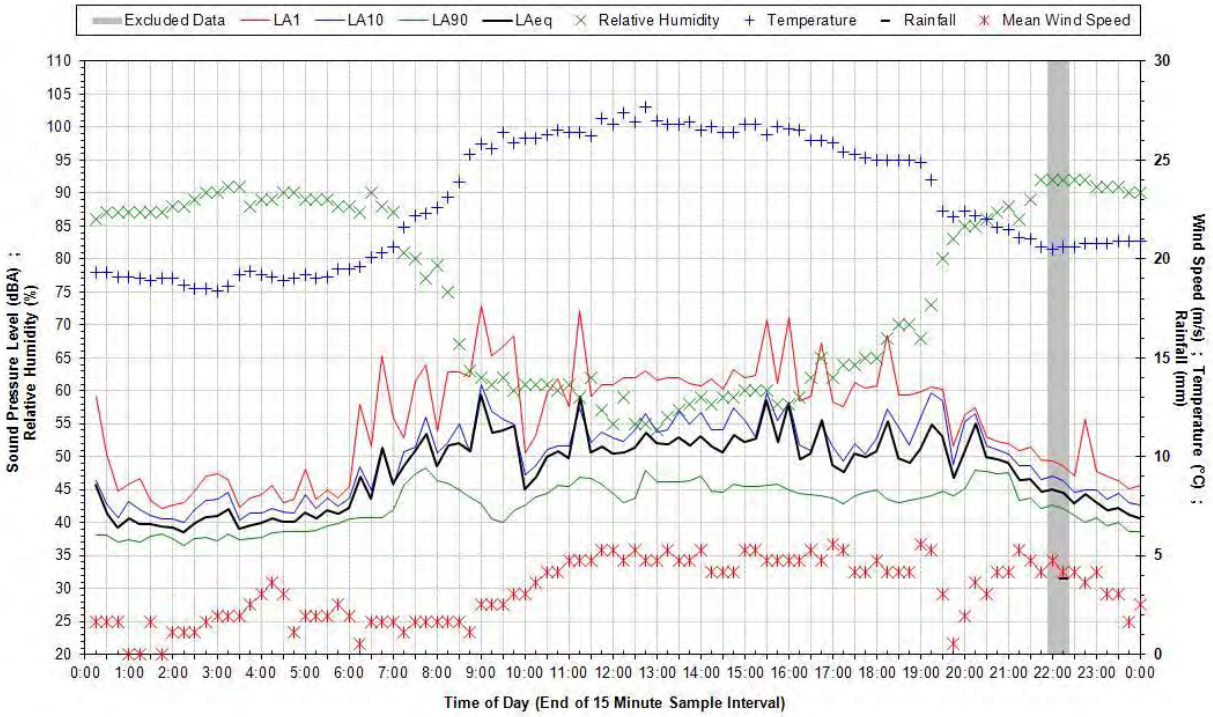
Time of Day (End of 15 Minute Sample Interval)

Statistical Ambient Noise Levels
Logger 2 - Brown Residence - Thursday 10 March 2011



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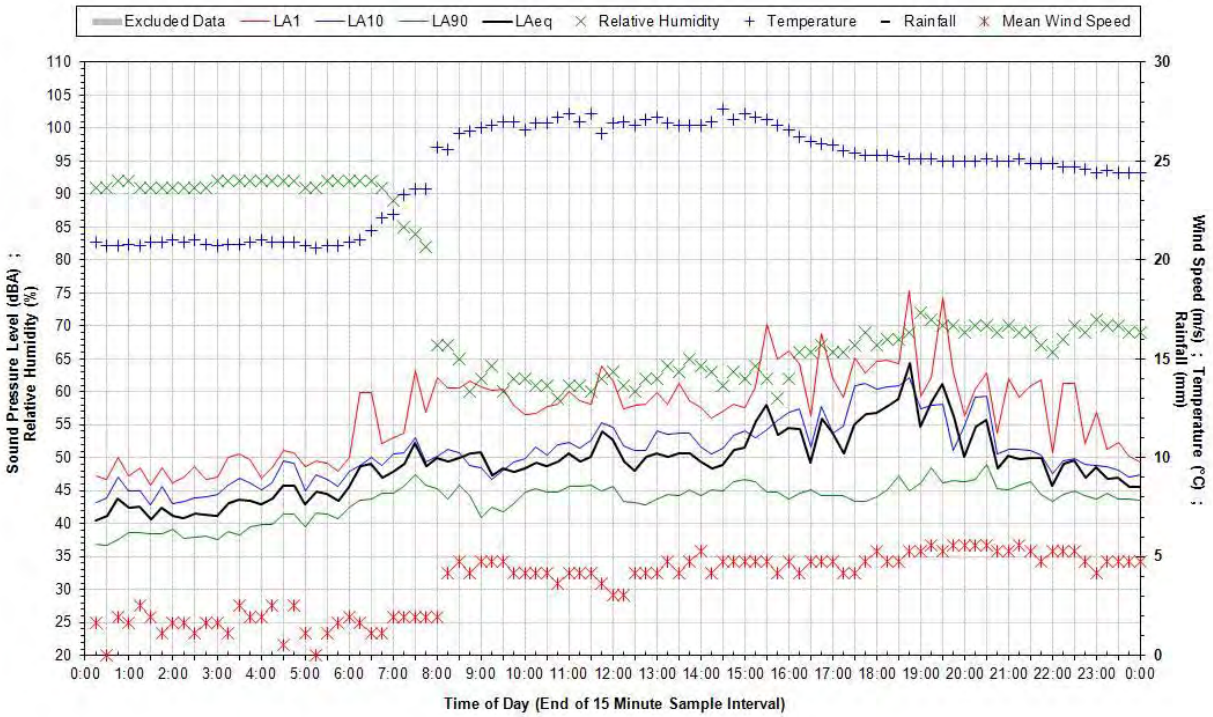

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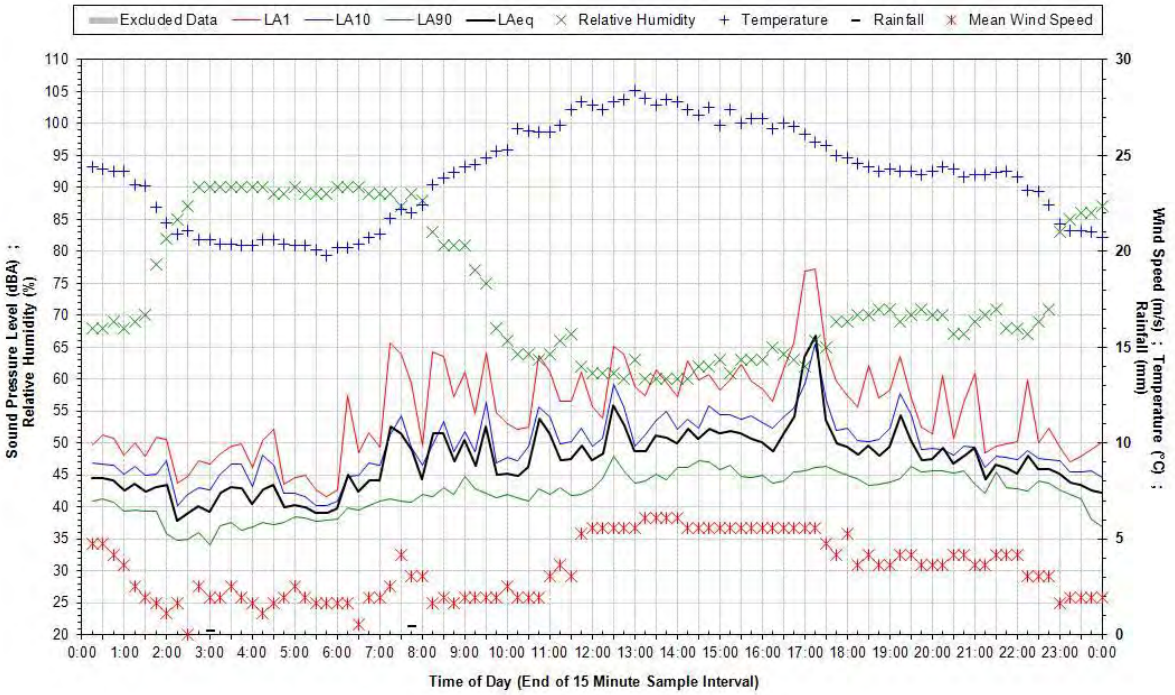

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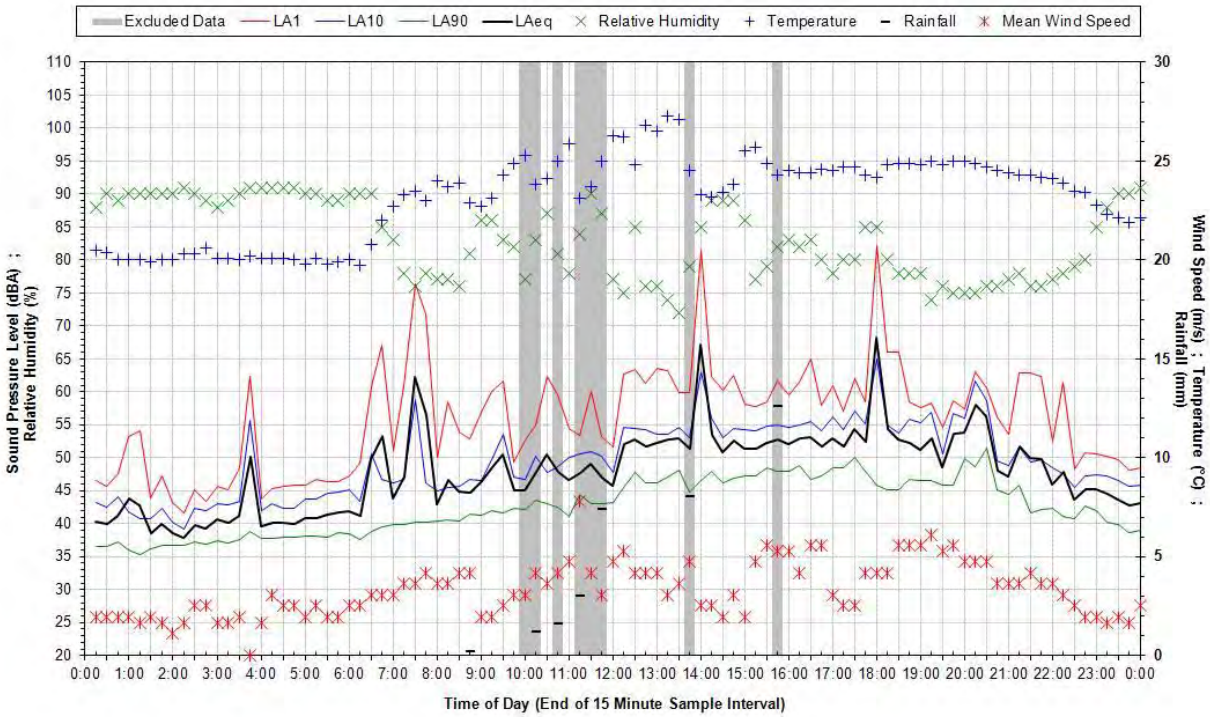

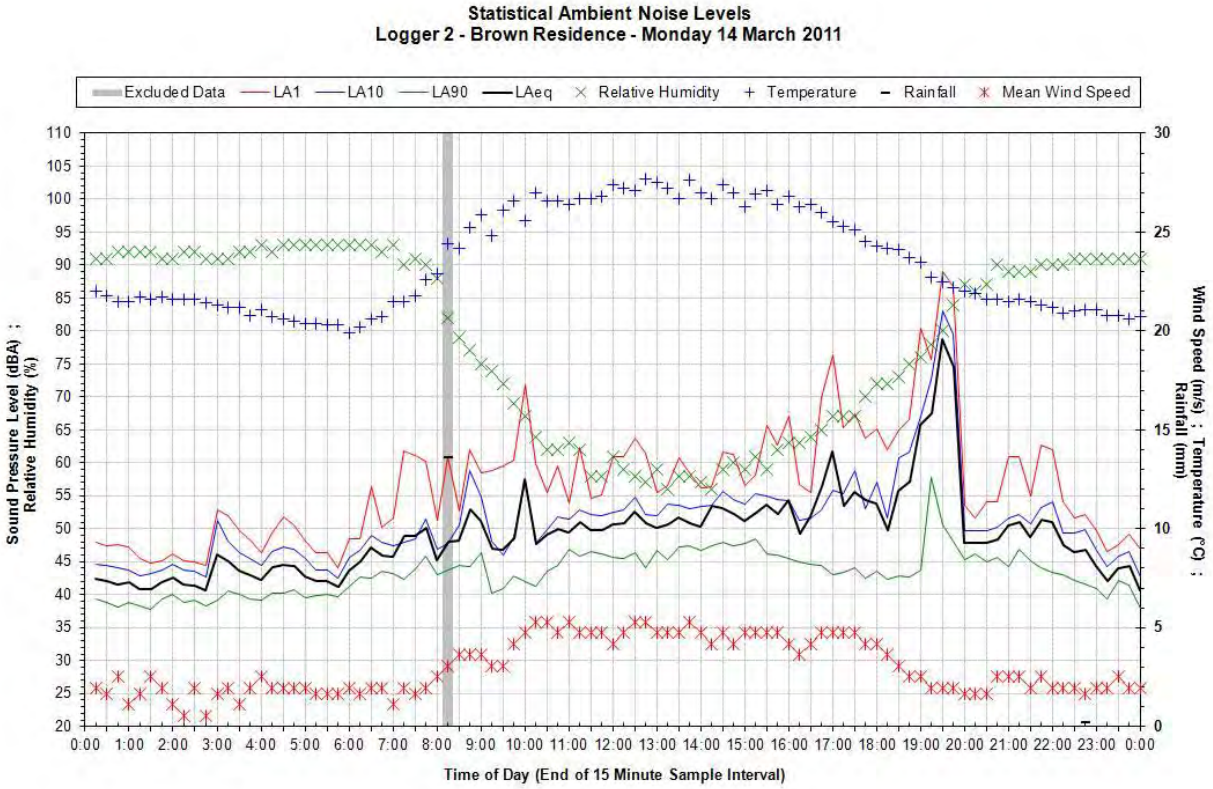
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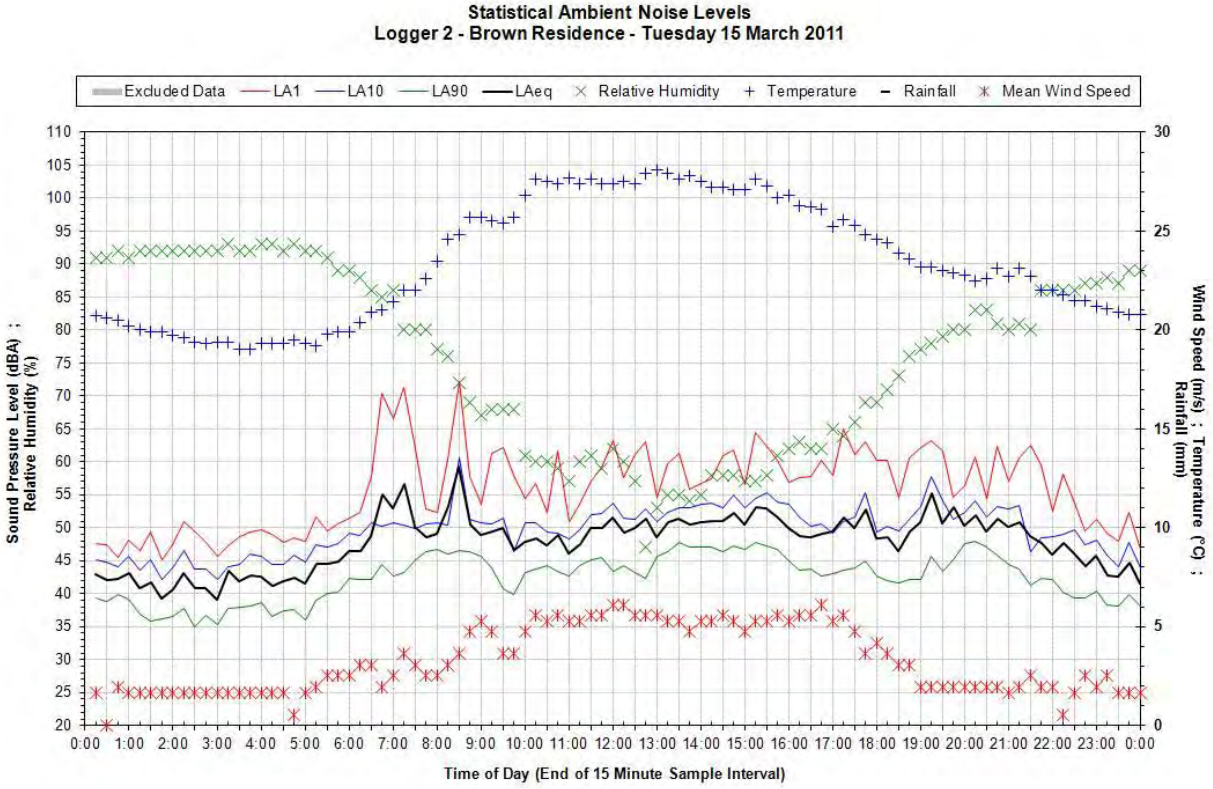
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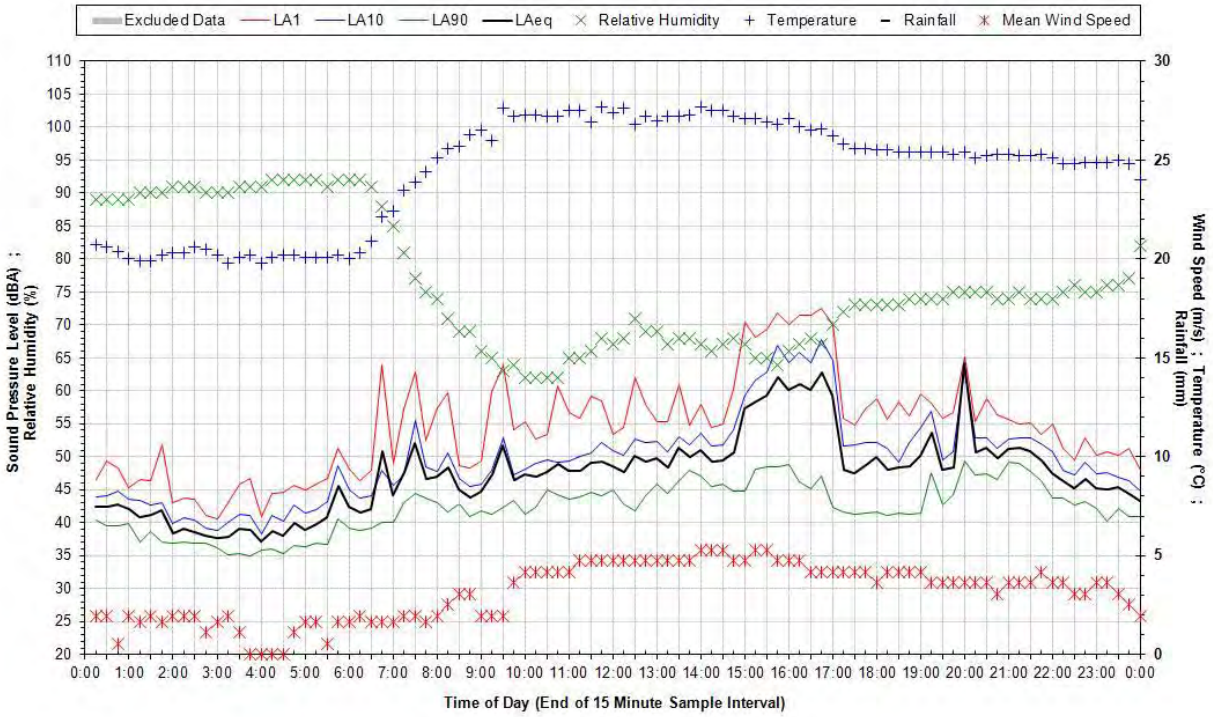
Time of Day (End of 15 Minute Sample Interval)

Statistical Ambient Noise Levels
Logger 2 - Brown Residence - Wednesday 16 March 2011



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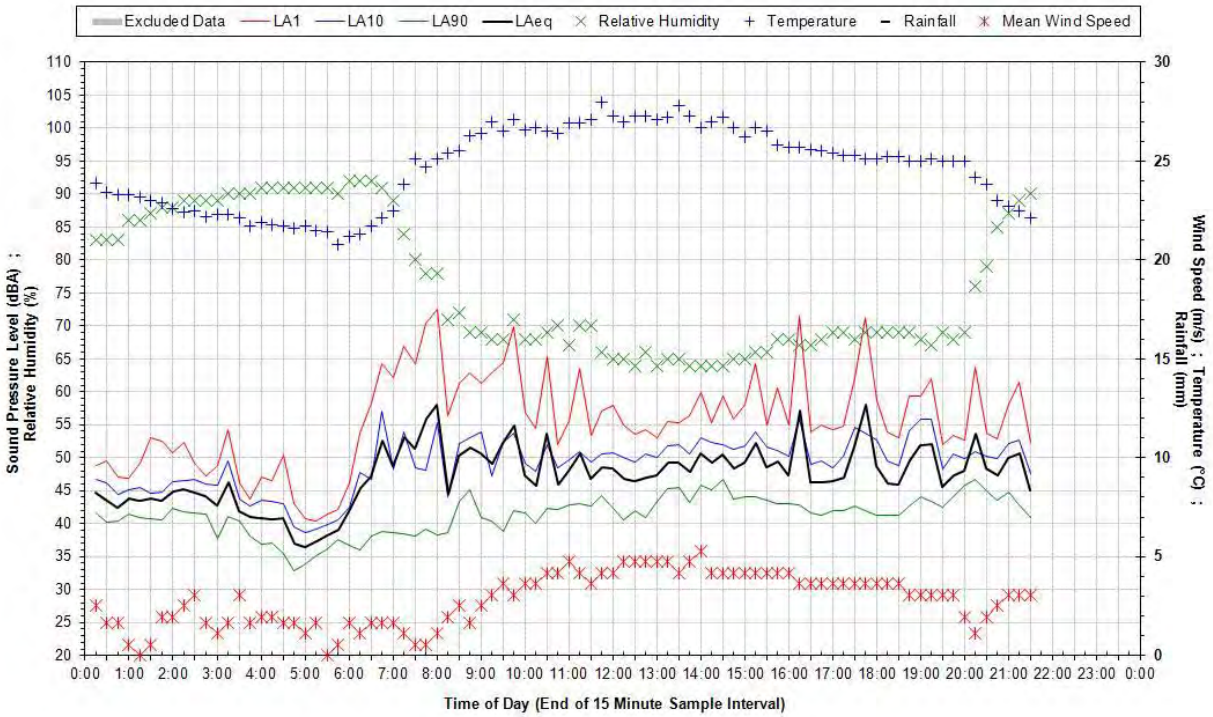
Logger 2 - Brown Residence - Thursday 17 March 2011



Appendix B

Blast Monitoring Report

DRILL SUMMARY

TSC
SHOT No. Q150708.

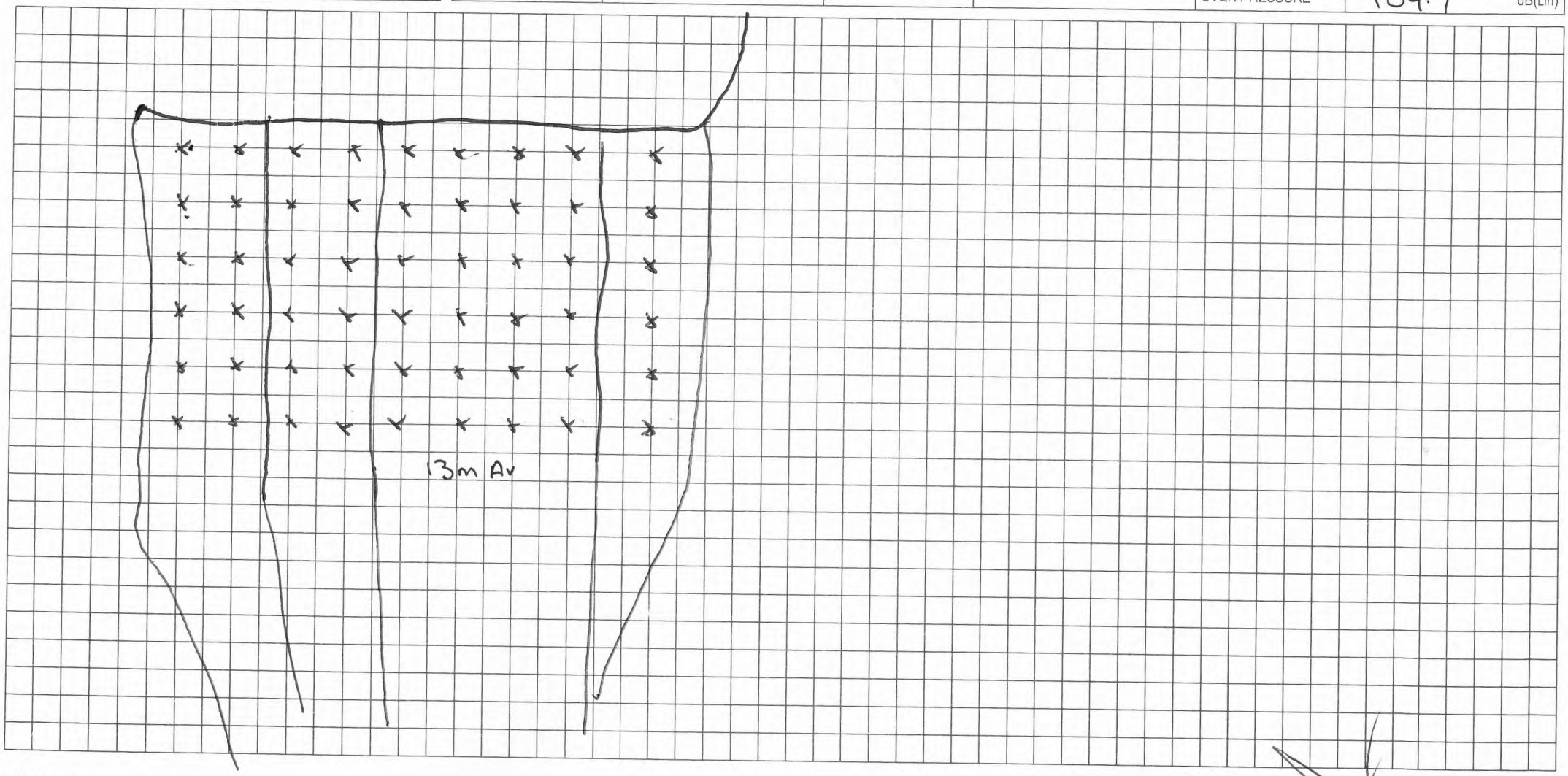
DONNELLY BLASTING SERVICES PTY LTD

ABN 47 103 371 339

• Drilling & Blasting Contractors
• Quarry & Construction Blasting
• Precision Blasting • General Blasting • Vibration Monitoring

29 Kilmore Drive, Tamborine 4270
Fax: (07) 5543 8619 • Mobile: 0407 597 957

CUSTOMER NAME	QUIRKS QUARRIES	LOCATION	TWEED Shire	WEATHER	CLOUDY
SHOT LENGTH		SHOT WIDTH		BENCH NO.	02
BURDEN	3.0m	SPACING	3.6m	TOTAL BCM	7581.6
TOTAL NO. HOLES	54	HOLE DIAMETRE	89mm	AV. DEPTH	13m.
METRES OF CHARGE		METRES STEMMING	3.0m	HOLE DEGREE	5°
ESTIMATED TONNES	19712.16	GROUND VIBRATION	1.97 mm/s	SUBDRILL	1.0m
DATE	15-7-08			ROCK DENSITY	2.6
				OVER PRESSURE	109.7 dB(Lin)



REMARKS: _____

CUSTOMER SIGNATURE	
SHOTFIRER SIGNATURE	

DONNELLY BLASTING SERVICES PTY LTD
BLAST DESIGN AND EVALUATION RECORD

Customer Information

Customer	TWEED SHIRE COUNCIL.	Shotfirer	J.D.
Order No.		Location	QUIRKS QUARRY
		Shot No.	TWCQ150708
Blast Date	15-7-08		
Blast Type	PRODUCTION	Rock Type	QUARTZITE.
Blast Time	12 NOON	Rock Density	2.6.

Attachments (Initial)

1. Blast Geometry	
2. Explosives Docket	/
3. Accessories Docket	
4. Loading Sheet	
5. Initiation Plan	
6. Environmental Report	

Blast Geometry	
No. Blastholes	54
No. Wet	4
Blasthole Diameter (mm)	89mm
Bench Height (m)	13m
Burden (m)	3.0m
Spacing (m)	3.6m
Stemming (m)	3m
Subdrill (m)	1m
Blast Tonnes (Tn)	19712.16
Blast Volume (BCM)	7581.6
Survey Blast Volume (BCM)	
Powder Factor (Kg/m^3) Design	
Powder Factor (Kg/m^3) ACTUAL	0.36

Explosives & Accessories

Explosives	Type/Dia	Dens/Ctgs	Mass (kg)
DRY	ANFO		2,690KG.
WET	BUSTER 55mm x 300mm		75KG.
TOTAL			

Primers	Type	No.	Mass (kg)
	150g	50	

Indicators	Delay	Length	Number
Inhole	#12	15m	54
Inhole			
Inhole			
Inhole			
Surface	9ms	3.6	2
Surface	17ms	3.6	6
Surface	25ms	3.6	1
Surface	42ms	3.6	26
	65ms	3.6.	18

Cord	Type	Length
	—	—

Environmental Readings

Cloud Cover 25% M.I.C. (Kg) 55KG.

Wind (m/S) Direction

(See Map)

Location	PPV(mm/S)	AB (dbL)	Dist (m)
MPY	1.97	109.7	400m.
Test			
Test			

RESULTS

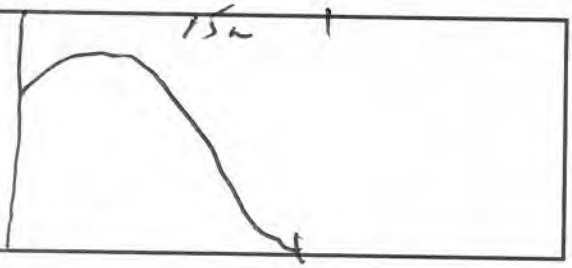
Fragmentation	*Visual Only*
Max Dim (m)	**% Pass**
(<1m)	100%
(1-2m)	
(>2m)	

Comments

Customer

Profile	
Throw (m)	15m
Rockpile Height (m)	12m
Power Trough	
Width (m)	4m
Depth (m)	3m.
Comments	

Sketch



Overbreak		Explanation
Side (m)	1	
Back (m)	1	

Comments

DONNELLY BLASTING SERVICES PTY LTD ABN 47 103 371 339
29 Kilmore Drive, Tamborine 4270 • Fax: (07) 5543 8619 • Mobile: 0407 597 957

JOB SYSTEMS ANALYSIS No. 0136

Job/Task: load AND FIRE SHOT (↓Location and type eg. Black Stup, Hard Rock Quarry↓) Day ☑ Afternoon ☐ Night ☐

Site: QUIRKS QUARRIES, TWEED SHIRE. Weather: (↓eg. Rain, wind↓) OVERCAST Date: 15-7-08

Standard PPE Prerequisite: HARD HAT, Hi VIS CLOTHING, SAFETY BOOTS, GLOVES WHERE REQUIRED, SAFETY HARNESS WHERE REQUIRED

Task	Hazards	Risk Score	Control Measures (Include reference to qualifications / training, other work methods)	Position Responsible (eg. Quarry Mgr)	Residual Risk Score
Loacing shot	• Undulating ground	4	• All persons to exercise extreme care while working on shot	All persons	1
	• Face drop	4	• Flag line along edge for visual barrier • Safety harness if required to go closer than 2 metres	All persons	1
	• Fatigue	3	• Rest periods, drink plenty of fluids	All persons	1
Hose handling	• Slip, trip and fall	4	• Two persons to handle hose	All persons	1
Traffic control	• Fly rock air blast	4	• Clear pit area • As per site plan	Supervisor	1
Firing shot	• Fly rock air blast	4	• Shot firer to nominate their firing point	All persons	1
	•		•		
	•		•		

(↓ Name and Position↓)

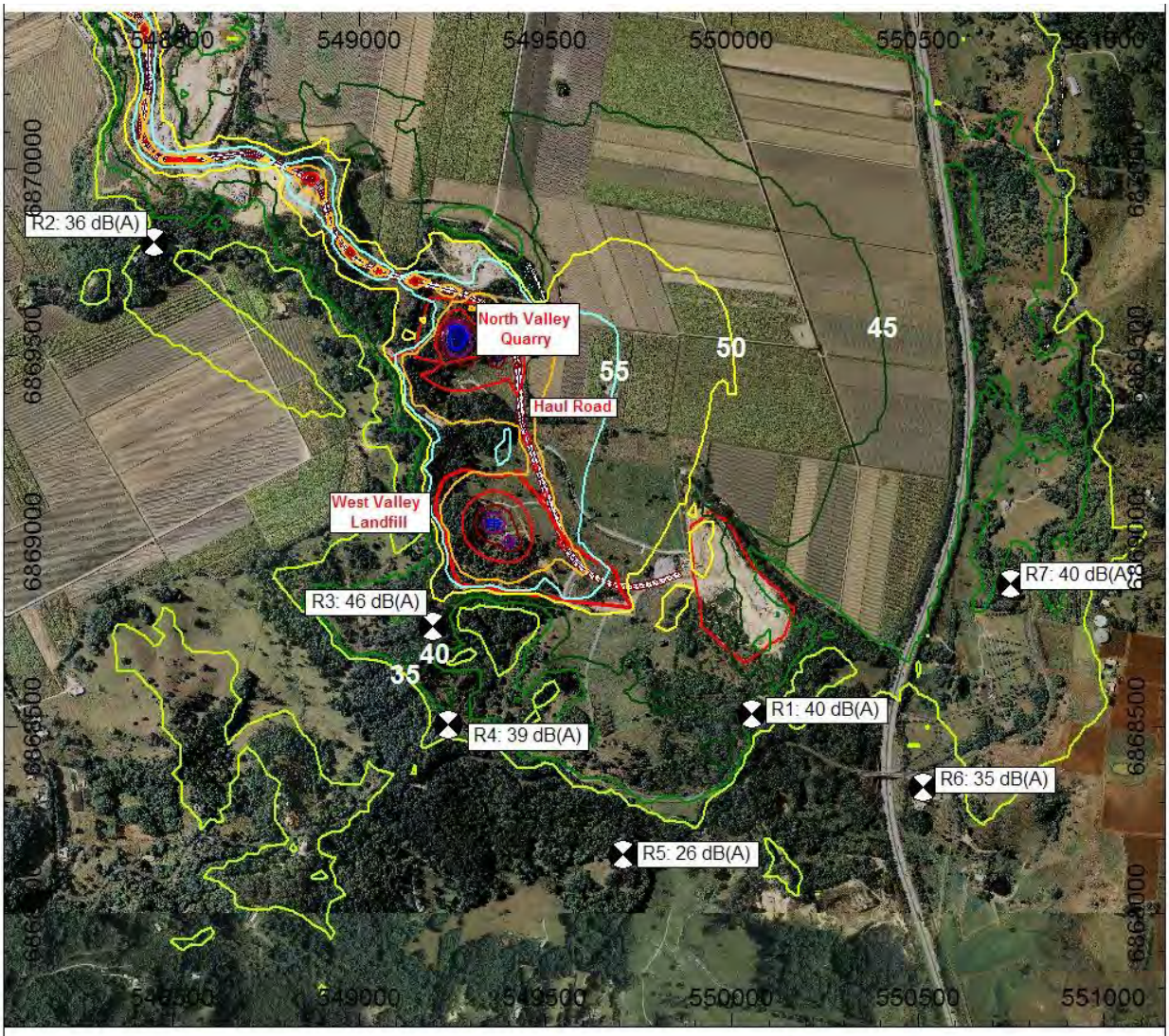
Completed By: P. BRADFORD, W McGHIE.

Approved By: G. GRAY Date: 15-7-08 Review By:

Appendix C

Predicted Noise Level Contour Maps

549000
549500
550000
550500
551000
6870000
6869500
6869000
6868500
6868000
R2: 40 dB(A)
Haul Road
45
50
55
60
West Valley Quarry
Quirks Landfill
R3: 49 dB(A)
R7: 43 dB(A)
55
50
40
R1: 44 dB(A)
R4: 39 dB(A)
R6: 34 dB(A)
R5: 27 dB(A)
Eviron Quarry and Landfill
Configuration 1
Quirks Landfill and West Valley Quarry
Noise Contours: LAeq
Grid height: 1.5m
Neutral Meteorological Conditions
Sound Pressure Level dB(A)

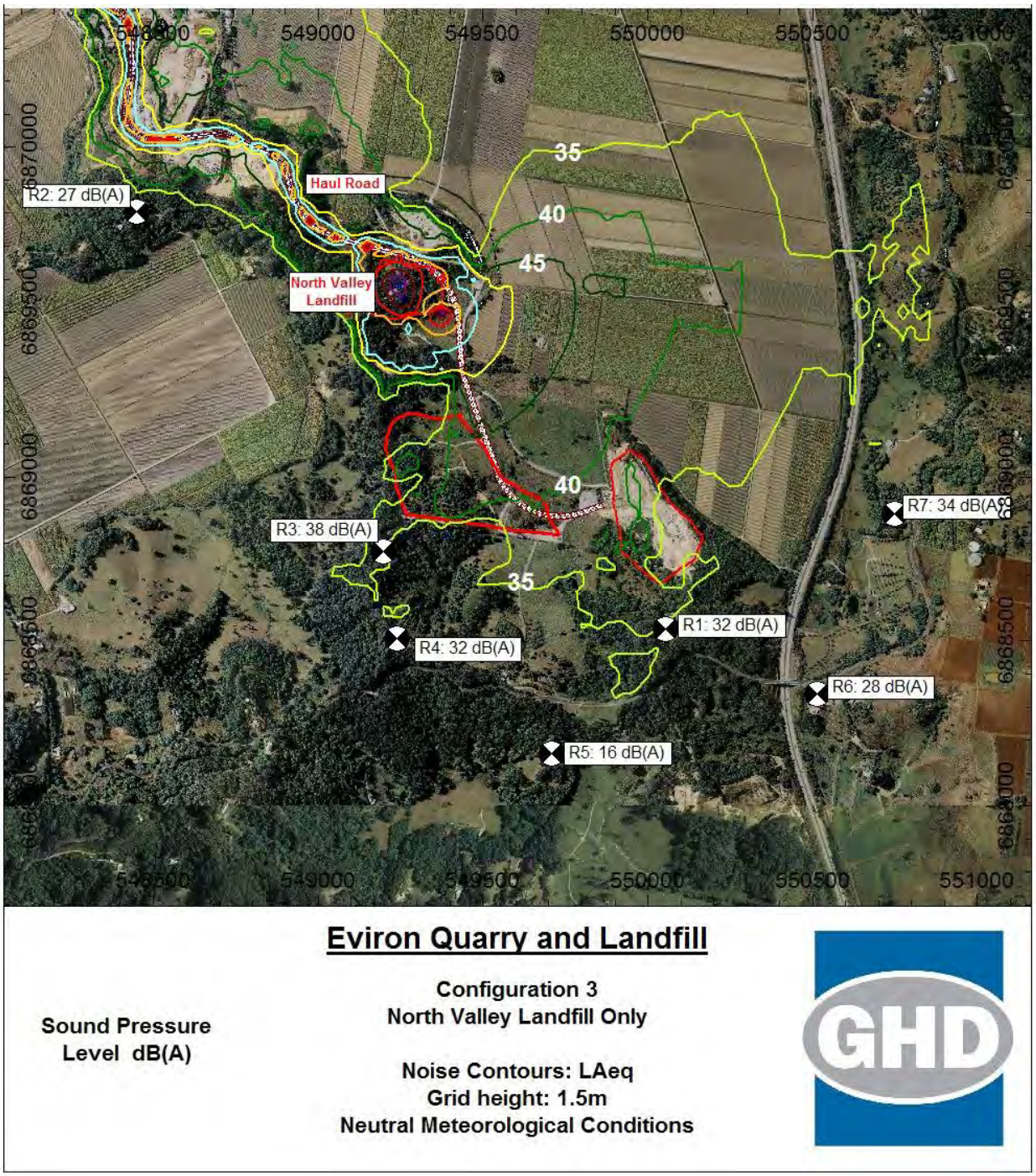


Eviron Quarry and Landfill

Configuration 2
West Valley Landfill and North Valley Quarry

Sound Pressure Level dB(A)

Noise Contours: LAeq
Grid height: 1.5m
Neutral Meteorological Conditions


548500
549000
549500
550000
550500
551000
6870000
6869500
6869000
6868500
6868000
Haul Road
North Valley Landfill
35
40
45
40
35
R2: 27 dB(A)
R3: 38 dB(A)
R4: 32 dB(A)
R1: 32 dB(A)
R7: 34 dB(A)
R6: 28 dB(A)
R5: 16 dB(A)
Eviron Quarry and Landfill
Configuration 3
North Valley Landfill Only
Noise Contours: LAeq
Grid height: 1.5m
Neutral Meteorological Conditions
Sound Pressure Level dB(A)

GHD

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This report should not be altered, amended or abbreviated, issued in part or issued incomplete in any way without prior checking and approval by GHD.

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	T Gribble	V Chavand	V Chavand	V Chavand	V Chavand	18/05/11

Appendix J

Air Quality and Odour Report

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council

Report on Eviron Road Quarry and Landfill

Air Quality Assessment

October 2011

Revision 1

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

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B Predicted Dust Impacts
C Dust Concentration Contours
D Odour Concentration Contours

1. Introduction

GHD was engaged by Tweed Shire Council (TSC) to assess the potential for dust and odour impacts from the proposed Eviron Road Quarry and Landfill development, Eviron, NSW.

1.1 Context

Council has developed an overall Concept Plan for the site which comprises a staged project to develop a waste disposal facility within the existing void created by Quirks Quarry, develop two further extractive industries to be used as waste disposal facilities after exhaustion of the quarry resource, and install necessary operational infrastructure such as a haul road and other minor associated facilities. The site and study area can be seen in Figure 1-1.

This proposed method of landfilling in quarry voids is consistent with the method of landfill creation in the Tweed Shire to date. Material won from quarrying is used for road building and other Council civil projects, and overburden stockpiled for road construction, clay liners (where appropriate) and site rehabilitation purposes.

Chronologically, the overall Concept Plan will involve:

- Stage 1 (Project Application):
  - Establishment of a new haul road from Stotts Creek RRC to Quirks Quarry, and development of a landfill within the Quarry void.
  - Progressive rehabilitation of Quirks Quarry landfill.
  - Development of a new quarry in West Valley.
- Future stages may include:
  - Development of a landfill within the void formed from quarrying West Valley.
  - Progressive rehabilitation of the West Valley landfill.
  - Development of a new quarry within North Valley.
  - Development of a landfill within the void formed from quarrying North Valley.
  - Progressive rehabilitation of the North Valley landfill.

The landfills and quarry will operate in sequence and there will be no overlap between landfilling in the Quirks Quarry, West Valley and North Valley, this will also be the case for the quarry operations.

Based on the concept design work and studies undertaken to date the following operational periods have been adopted for the purposes of assessing the potential environmental impacts:

- Quirks Quarry Landfill: 10 years (2012 – 2021).
- West Valley Quarry: 10.5 years (2012-2021).
- West Valley Landfill: 12 years (2022-2033).
- North Valley Quarry: 3.5 years (2022-2026).
- North Valley Landfill: >10 years (2034 -2045).

1:10,000 (at A3)

0 50 100 200 300 400 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

Site Boundary

Study Area

GHD

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Tweed Shire Council

Eviron Road Quarry and Landfill Environmental Assessment

Job Number	41-20806
Revision	0
Date	10 AUG 2010

The Site

Figure 1

G:\41\20806\GIS\Maps\41120806_00.mxd

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Data source: Tweed Shire Council - Aerial Photography (2008). Department of Lands - Cadastre boundary (2009). GHD (2010) - Site Boundary, Study Area.

1.2 Scope of Work

The scope of work undertaken by GHD for the assessment of dust and odour emissions from the proposed development is outlined in the points below. These points are described in greater detail in the subsequent sections of this report.

The following scope of works was undertaken:

- A site inspection of the study area to gain an understanding of local site features and the operation parameters of the existing quarry and landfill.
- Review of available ambient air quality monitoring data to gain an understanding of existing background air quality.
- Synthesise a site-specific meteorological data file with which to use as model input for conducting atmospheric dispersion modelling.
- Compilation of particulate matter (dust) and odour emission rate data with which to derive the emission inventory for conducting atmospheric dispersion modelling.
- Dispersion modelling was conducted using a regulatory atmospheric dispersion model to predict the maximum incremental impact at the nearest sensitive receptors throughout the life of the proposed concept plan.
- Recommend in-principle measures for managing dust and odour emissions with consideration to technical guidelines.

The abovementioned scope of work has been conducted with consideration to the following NSW Office of Environment and Heritage (OEH) guidelines:

- *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (August 2005).
- *Technical framework – Assessment and management of odour from stationary sources in NSW* (November 2006).

2. Project Description

2.1 Quarry Activities – West Valley and North Valley

2.1.1 Level of Production

It is assumed that the maximum rate or level of production will total approximately 200,000 tonnes per year at each quarry. 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.

2.1.2 Hours of Operation

The hours of operation for each quarry will be the same as those currently at Quirks Quarry, as outlined in Table 2-1.

Table 2-1 Quarry Operating Hours

Operation	Operating Days	Start Time	Finish Time
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

2.1.3 Description of Operations

The operations in extracting rock from the proposed quarries typically involve the following tasks:

- Pre strip activities and topsoil stockpiling activities.
- Blast-hole Drilling and Blasting (if required).
- Extraction:
  - Primary screening.
  - Primary crushing.
  - Secondary Screening and crushing where required.
- Stockpiling.
- Product Loading and Hauling.

Material extraction will typically be undertaken using a bulldozer or excavator. Blasting would be undertaken on a periodic basis depending upon demand for the resource and when manual extraction becomes too difficult or dangerous. It is expected that blasting would occur a maximum of once per week but would typically only be required once every few months. Drilling would be required as part of blasting operations to allow for down-hole placement of explosives.

Extracted material will then be loaded into a series of mobile crushers and screens for on-site processing or loaded directly into haul trucks and taken off site. Processed products will be segregated and stockpiled ready for use and/or delivery. Based on current operations at Quirks Quarry, all material will be processed on-site unless requested otherwise.

Materials would be stockpiled according to size. Stockpiles will be located away from the main excavation area, close to the work area containing screens and crushers.

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).
- Screened Sand (Rescreened from imported spoil).

The exact products to be available from the West Valley and North Valley Quarries have not been determined at this stage, however these products are currently available from the Quirks Quarry site and due to their close proximity should reflect that available at West Valley and North Valley quarries.

Typical quarry operations are shown in Figure 2-1, depicting Quirks Quarry in 2008.

Figure 2-1 Quirks Quarry Operations – 2008

2.2 Landfill Activities – Quirks Landfill, West Valley Landfill and North Valley Landfill

2.2.1 Hours of Operation

The hours of operation at each landfill is expected to be identical to the existing Stotts Creek RRC and will be seven days per week between 7:00 am and 4:00 pm Monday to Friday and between 9:00 am and 4:00 pm Saturday and Sunday.

2.2.2 Facility Layout

Access to each landfill will be via a haul road constructed between the existing Stott's Creek facility and the Quirks Quarry Landfill. Small vehicular traffic (ie domestic and small commercial customers) will continue to utilise the transfer station facility at the Stotts Creek RRC. The waste deposited at the Stotts Creek RRC will subsequently be transferred by TSC to the waste disposal area at the operating landfill via the sealed haul road.

The main features of the landfill site include the following:

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

2.2.3 Waste Acceptance Rates

The levels of waste that are likely to be accepted at each landfill throughout their lifespan are shown in Table 2-2. These figures have been utilised in the air quality impact assessment.

Table 2-2 Landfills – Levels of Waste Acceptance

Landfill	Years of Operation	Waste (tonnes per annum)
Quirks	2012 – 2021	Up to 75,000 tpa
West Valley	2022 – 2033	From 58,000 to 100,000 tpa
North Valley	2034 – 2045	From 100,000 to 145,000 tpa

2.2.4 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.

2.2.5 Leachate Management

A leachate extraction system will be used at the proposed landfills. Leachate will be treated and either transported off-site or disposed of into the active landfill area. The proposed landfills will not use a leachate pond system.

2.2.6 Waste Accepted at Facility

The 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.

Conservatively, as part of the odour impact assessment, it has been assumed that all waste transported to the landfill will be putrescible.

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.

No green waste processing will occur at future landfills. 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.

2.2.7 Covering Layers

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 OEH 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. 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.

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 OEH.

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.

3. Existing Environment

3.1 Study Area

Existing land uses in the vicinity of the Eviron Quarry and Landfill site include:

- Stott's Creek RRC.
- Quirks Quarry.
- The Pacific Highway.
- Pasture and agricultural land.

The site is bordered to the north by generally flat areas of agriculture and sugar cane fields. The proposed quarries and landfills are located in areas of undulating topography.

A number of residential properties are located around the proposed site. Details of identified sensitive receptors are shown below in Table 3-1. There is also a property on Hawkens Lane that has recently been purchased by Tweed Shire Council and is currently unoccupied. The future use for this property is not expected to be residential and it has therefore been excluded from the assessment.

An aerial photograph showing the location of the proposed project footprint, the existing landfill and quarry and nearby sensitive receptors is shown in Figure 3-1.

Table 3-1 Identified Sensitive Receptors

Sensitive Receptors	Address Details	Property Details
Receptor 1	751 Eviron Rd, Eviron	Lot 30 on DP 820048
Receptor 2	157 Hawkens Ln, Eviron	Lot 2 on DP 705781
Receptor 3	656 Eviron Rd, Eviron	Lot 25 on DP 615931
Receptor 4	657 Eviron Rd, Eviron	Lot 1 on DP 783802
Receptor 5	726 Eviron Rd, Environ	Lot 30 on DP 706846
Receptor 6	10 Donalyn Crt, Duranbah	Lot 501 on DP 1000612
Receptor 7	Eviron Rd, Duranbah	Lot 603 on DP 1001049

Figure 3-1 Study Area

3.2 Local Meteorology

The transport and dispersion of the air emissions from the proposed development will be influenced by prevailing synoptic flows and vertical temperature profiles that will alter both diurnally and with wind direction.

The nearest Automatic Weather Station (AWS) is located at Coolangatta Airport (approximately 10 km to the north-northeast of the site), and is operated by the Bureau of Meteorology (BoM). However, this data was considered to be unrepresentative to characterise the transport and dispersion of emissions from the development.

Therefore, the regional-scale prognostic meteorological model, TAPM[1], was used to simulate the meteorology over the subject site. TAPM is an approved model for specialist applications and its use, as part of this assessment, is described in the Section 3.2.1.

[1] Hurley, P. The Air Pollution Model (TAPM) version 4. CSIRO Atmospheric Research Paper No. 55.

TAPM output was then used to derive the meteorological data file used to conduct the dispersion modelling – refer to Section 4.

3.2.1 Meteorological Modelling

TAPM (V 4.0.2) was developed at CSIRO Division of Atmospheric Research and is a PC-based prognostic modelling system that can predict regional scale 3D meteorology. It is suitable for use with complex geographic sites and / or for situations when the available site representative meteorological data are not adequate (as is the case for this assessment). TAPM accesses databases of synoptic weather analyses from the BoM. The model then provides the link between the synoptic large-scale flows and local climatology, which, in this case, includes such factors as local land use, topography, atmospheric stability and mixing height.

TAPM was configured with a nested model grid coverage designed to capture:

- Broad scale synoptic flows.
- Regional to local scale wind channeling.
- The influence of local land use.

TAPM was run for the year 2007 using the synoptic data analyses from the BoM.

Specific model settings were as follows:

- Five nested grids at 300 m, 1,000 m, 3,000 m, 10,000 m and 30,000 m resolution, with 45 x 45 grid points.
- Surface vegetation and precipitation processes were included.

3.2.2 Dispersion Meteorology

Figure 3-2 and Figure 3-3 contain wind roses illustrating the distributions of wind speeds and directions for the simulation year 2007, and for just the Quarry / Landfill operational hours within that year (7 am to 6 pm at the extremes) respectively.

Figure 3-2 shows the annual wind climate in the area is dominated by flows from southeast and north, with less frequent flows from the north and northwest. The average wind speed is 2.3 m/s with the highest winds occurring most frequently from the west.

It is the incidence of daytime winds that are of greatest concern in regards to the transport and dispersion of dust emissions from the Quarry/Landfill. Due to the nature of operations, the majority of dust/odour is generated at the site during operational hours when processing activities are occurring. The daytime distribution of wind directions is not significantly different to that for the entire diurnal cycle, however the average wind speed is higher during the day (2.7 m/s).

Wind erosion or dust lift-off can become significant under strong winds (greater than 5 m/s). These stronger winds were shown to occur infrequently.

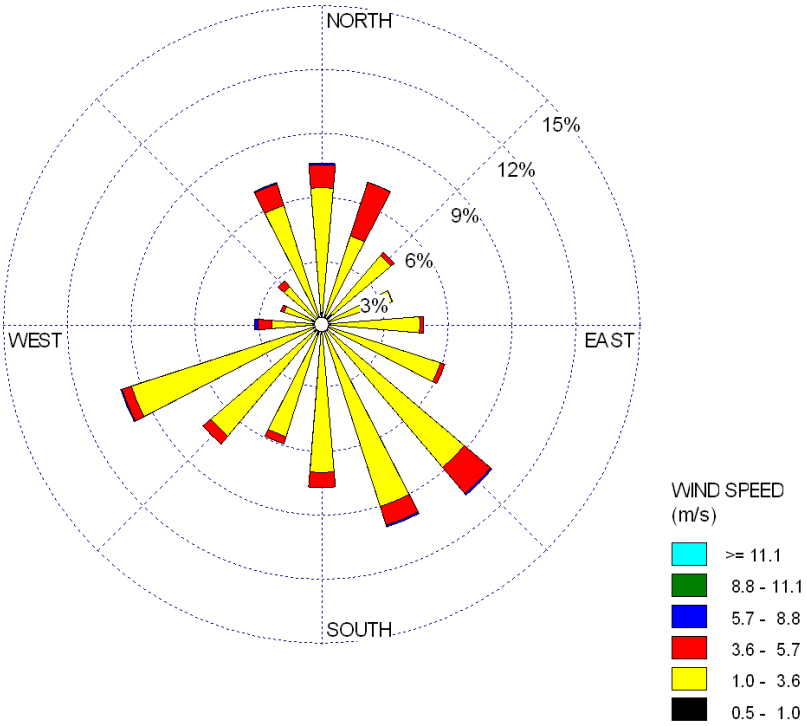

Figure 3-2 Annual Wind Rose – Eviron

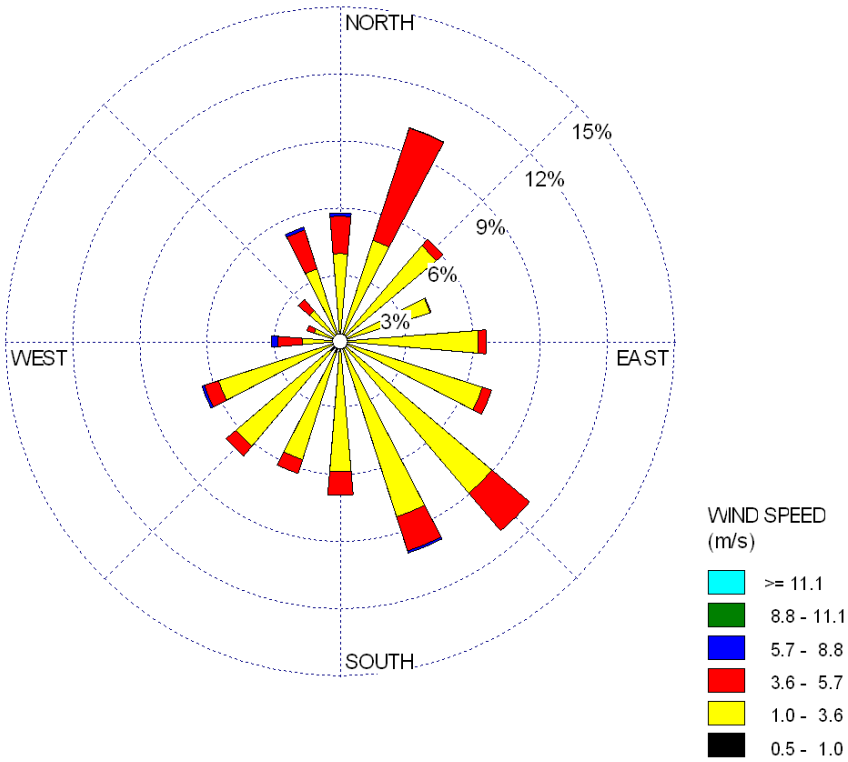

Figure 3-3 Operational Hours Wind Rose – Eviron

A categorised measure of atmospheric stability was also determined by the model. These can be broadly defined as in Table 3-2.

Table 3-2 Atmospheric Stability Classes – Annual

Stability Class	Description	Frequency of Occurrence
A	Extremely unstable atmospheric conditions, occurring near the middle of day, with very light winds, no significant cloud.	<1%
B	Moderately unstable atmospheric conditions occurring during mid-morning/mid-afternoon with light winds or very light winds with significant cloud.	6%
C	Slightly unstable atmospheric conditions occurring during early morning/late afternoon with moderate winds or lighter winds with significant cloud.	13%
D	Neutral atmospheric conditions occurring during the day or night with stronger winds. Or during periods of total cloud cover, or during the twilight period.	43%
E	Slightly stable atmospheric conditions occurring during the night-time with significant cloud and/or moderate winds.	9%
F	Moderately stable atmospheric conditions occurring during the night-time with no significant cloud and light winds.	29%

The occurrence of stable air-flows is of significance as these generally provide the conditions for worst-case dispersion of emissions to air, and hence potentially the highest impact to health and amenity. This is due to the limited mixing in the vertical of these light wind air-flows, and hence lowered dilution in the emission plume.

Stable conditions are not likely to occur during the operational period of the proposed site because operations are restricted to the daytime period. Hence, periods of worst case dispersion during the operational periods will correspond with light wind neutral atmospheric conditions occurring during early morning and late afternoon, and, to a lesser extent, for more moderate wind speeds for the period late-morning to early afternoon.

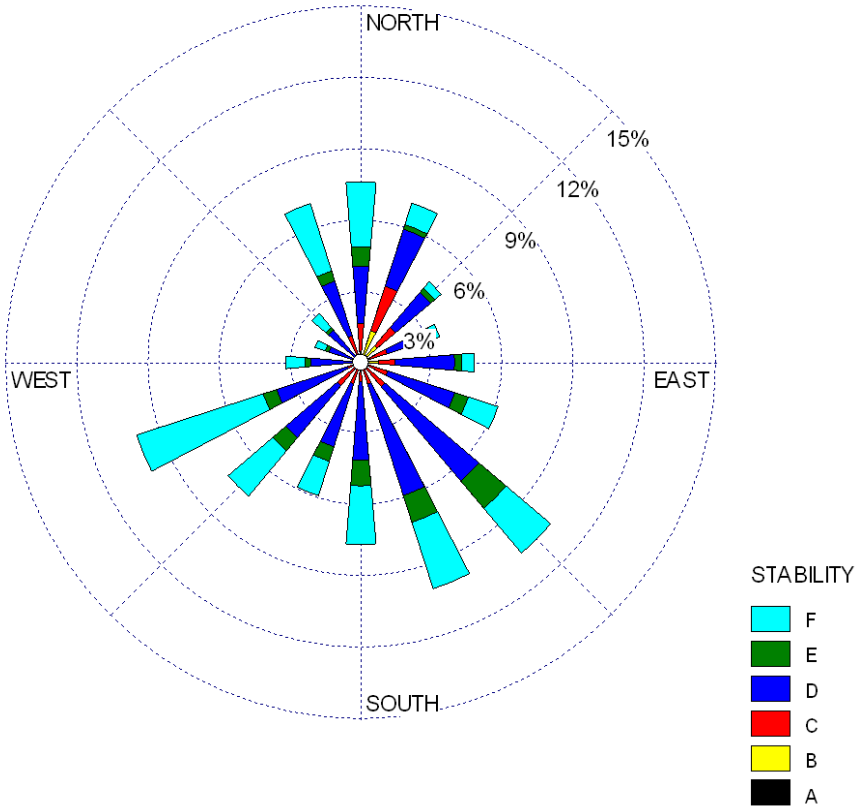

Figure 3-4 Annual Stability Rose – Eviron

3.3 Ambient Air Quality

Site-specific ambient air quality data recorded for total suspended particulate (TSP) matter or fine particulates for the Eviron area was not available at the time of this assessment. The term total suspended particulate (TSP) matter refers to airborne particles typically less than 50 microns (μm) in aerodynamic diameter. The fractions of suspended particles that are less than 10 μm are referred to as PM_{10}.

The NSW OEH does not hold any ambient air quality data available for this region. The closest air quality data for the subject area is in the Lower Hunter Region and Brisbane. These areas typically have an ambient concentration of PM_{10} in the order of 20 – 30 $\mu g/m^3$, however these sites are subjected to additional industrial and urban sources compared to a rural location. In view of this, an ambient concentration 15 – 20 $\mu g/m^3$ for PM_{10} has been assumed for rural coastal NSW areas away from the drier inland, industrial sources and urbanised environments.

It is noted that the study area contains some sugar cane farming land. Harvesting and burning of these crops are likely to cause spikes in the ambient levels of PM_{10} and TSP. As these seasons are generally short in nature, these spikes in ambient levels are not considered representative of typical air quality in the region.

Information regarding ambient odour levels in the areas surrounding the proposed site was not available at the time of this assessment. Ambient levels of odour are expected to be primarily influenced by the existing Stotts Creek Landfill cells and general agriculture in the area.

It is understood there have been no complaints relating to odour from the existing Stotts Creek Landfill. Therefore, it can be assumed that ambient odour levels are not offensive and would be within the OEH recommended limits.

4. Emissions Inventory

4.1 Quarrying

The assessment of air emissions from quarrying activities focuses on dust, being the primary emission with potential for off-site impact. The fractions of interest assessed in this report are airborne concentrations of TSP and fine particulate matter (PM_{10}) as well as total deposited dust.

Quarrying activities will include rock extraction, screening, crushing (to secondary ~7 mm) and transport of the processed rock off-site. Currently, crushing to a tertiary level is not required and is not expected to be required in the future.

The individual processes that generate significant amounts of particulate matter (dust) were identified to be:

- Rock quarrying eg excavation, bulldozer and blasting (if required).
- Material processing and handling eg crushing, screening and loading.
- Vehicle induced dust emissions in pit area.
- Wind erosion of exposed unstable soil surfaces and localised stockpiles.

Emission rates from naturally wind-borne dust and mechanically induced dust were characterised using Emission Factors (EF) provided in the National Pollutant Inventory (NPI) Emission Estimation Technique manual for Mining[2]. The EET used to estimate emissions from mining operations are based primarily on activity rate (e.g. tonnes per hour). The United States Environment Protection Agency Emission Factors and AP 42, *Compilation of Air Pollution Emission Factors* were also utilised, particularly for rock crushing, where they were deemed to be more applicable than the NPI emission factors, which are based on more general mining operations.

Material production at each quarry would be approximately 200,000 tonnes per year, which would include siltstone/conglomerates and overburden (soil and clay material above the base rock).

Based on the operation of the existing Quirk's Quarry, it is understood that the operating quarry could achieve a maximum rock throughput of 400 tonnes per hour (TPH). However, under typical operating conditions the quarry would process between 500 and 1000 tonnes per day, which corresponds to crushers operating at approximately 100 tonnes per hour for 6 hours per day, 6 days per week to process approximately 200,000 tonnes of rock per year.

[2] National pollutant Inventory (NP)I Emission Estimation Technique Manual for Mining, Version 2.3.

Although it is not expected that the quarry will operate at 400 TPH consistently, it is possible that this will occur from time to time, hence, GHD has considered the higher throughput of 400 TPH in this assessment, to represent a worst-case scenario to derive emissions rates with which to assess air quality criteria with short-term averaging periods (eg 24-hour). The average hourly throughput of 100 TPH, which is more representative of the normal production rate, was used to derive dust emission rates with which to assess air quality criteria with long-term averaging periods.

Table 4-1 provides a summary of the quarry equipment considered in this assessment.

Table 4-1 On-Site Equipment Summary

Equipment Type	Number of units
Hard rock drill	1
Excavator	1
Dozer	1
Wheeled loader	2
Primary crusher (including screens, conveyor)	1
Secondary crusher (including screens, conveyor)	1
Water truck	1
Haul trucks (within quarry site at any one time)	2

The following assumptions were made in calculating the emission rates for quarry activities:

- Soil moisture and silt contents were not known at the time of this assessment. Therefore the default emission factor in the NPI Manual for Mining have been adopted.
- Where there was more than one item of the same equipment, the total throughput was split between each item. For example, if there were two loaders operating at once, it was assumed that each loader would have a throughput of 200 TPH under the maximum production rate of 400 TPH.
- The proposed haul road from Stotts Creek RRC to the operating quarry and landfill sites would be sealed, therefore, wheel induced dust emissions from haul trucks along this road were assumed to be negligible and not considered further in this assessment.
- Based on the maximum production rate of 400 TPH, a maximum of 50 haul trucks per day would access the quarry per day. Under normal operations, a total of 26 haul trucks would access the quarry daily. Each haul truck was assumed to travel a 300 metre unsealed path through the quarry before exiting back onto the sealed haul road.
- The use of a water truck has been assumed not to generate dust emissions, as its use will act to suppress emissions. Therefore, the water truck has not been included in the emissions inventory.
- It was assumed that 100% of rock was processed to secondary standard (ie under the maximum production rate 400 tonnes per hour would pass through the secondary crusher).

- Crushing emission factors have been based on low moisture content material because it is understood that water spray systems on crushers and screens have not been proposed.
- GHD has conservatively assumed that the entire quarry pit area consists of unconsolidated areas. Therefore, wind erosion was modelled as acting over the entire pit area.
- It is likely that certain equipment or processes will only operate for short periods throughout each day. It is not known at what times in a shift operations will occur or when there will be stoppages. Therefore, dust emissions for each activity were spread over the full operating day of 10 hours. The scaled emission rates were modelled as occurring uniformly over each shift, sampling the full range of meteorological conditions.
- Conservatively, control factors for pit retention have not been applied (5% PM_{10} and 50% TSP).
- Blasting activities would be an infrequent event at the proposed quarries and as a result have not been included in the dispersion modelling assessment. Further discussion on dust impacts from blasting events can be found in Section 6.2.

Table 4-2 summarises the emission factors adopted and calculated emission rates for each item of equipment and activity within the quarry.

Table 4-2 Process Dust Emission Rates

Equipment and Process	TSP Emission Factor	PM_{10} Emission Factor	Unit	Application	400 TPH		100 TPH [1]	
					TSP Emission Rate (kg/hr)	PM_{10} Emission Rate (kg/hr)	TSP Emission Rate (kg/hr)	PM_{10} Emission Rate (kg/hr)
Crusher – Primary [2]	0.0167	0.0061	kg/t	Operating 6 hours per day	**4.01**	**1.45**	**1.00**	**0.36**
	0.0018 (Controlled)	0.00066 (Controlled)	kg/t	Operating 6 hours per day	**0.42**	**0.16**	**0.11**	**0.04**
Crusher – Secondary [2]	0.0167	0.00605	kg/t	Operating 6 hours per day	**4.01**	**1.45**	**1.00**	**0.36**
	0.0018 (Controlled)	0.00066 (Controlled)	kg/t	Operating 6 hours per day	**0.42**	**0.16**	**0.11**	**0.04**
Loader [1] [3] [4]	0.025	0.012	kg/t	2 loaders, operating 4 hours per day each	**4.00**	**1.92**	**1.00**	**0.48**
Dozer [5]	17	4	kg/h	Operating 5 hours per day	**8.50**	**2.00**	**5.10**	**1.20**
Excavator [1]	0.025	0.012	kg/t	Operating 6 hours per day	**5.00**	**2.40**	**1.25**	**0.60**
Hard rock drill	0.59	0.31	kg/hole	1 hole per hour, 4 hours per day	**0.24**	**0.12**	**0.24**	**0.12**
Trucks [6]	3.88	0.96	kg/VKT	Each truck travels 300 metres	**2.91**	**0.72**	**1.51**	**0.37**
Unloading from stockpiles [3]	0.03	0.013	kg/t	Operating 4 hours per day	**2.40**	**1.04**	**1.20**	**0.26**

1. 100 TPH used to derive emission rate used to assess long-term (i.e. annual) PM10, TSP and dust deposition criteria.
2. Rock crushing emission rates derived from US EPA AP42 Section 11.19.2 Crushed Stone Processing and Pulverised Mineral Processing. Emission factors supplied for tertiary crushing only. Therefore emission rate was adopted for upper limit of primary and secondary crushing. Emission factors include crushing, screening and material transfer (conveyor) process. Process emission rates supplied as uncontrolled (no water sprays) and with controls (standard wet supression techniques).
3. 50% control factor applied when wet suppression used on crushers. Moisture carry over would mean that processed material in stockpiles would also have higher moisture content. Stockpiles are also regularly watered.
4. Loader processes include wheel generated dust emissions and fugitive emissions from loading of material into trucks.
5. Emission factors for PM_{10} and TSP from dozer operations are based on default values of soil moisture content and silt content of 2% and 10% respectively. Without site specific data default factors have been adopted. However, gravel quarries can have much lower silt contents than the default values. For example, if the silt content was 6% and with moisture remaining at 2%, the emissions rates would become 9 kg/h (TSP) and 2 kg/h (PM_{10}). This is approximately half of the adopted emission rates. Therefore, the default emission rates are considered highly conservative.
6. Under the maximum 400 TPH a total of 50 trucks would access the quarry per day. At 100 TPH, 26 trucks were assumed to access the quarry. Each truck to travel 300 metres on unsealed roads. 50% control factor applied for Level 1 watering (2 litres/m^2/hour). Emission rates for wheel generated dust on unpaved roads are based on 10% silt content, 2% moisture content and a gross vehicle mass of 48 tonnes. The average truck mass for the quarry is more likely to be 25 tonnes, therefore, emission factors are considered conservative.

4.2 Landfill

Odour and particulate matter (dust) are generally considered to be the two primary air quality issues associated with waste transfer stations and landfill operations. Other air emissions such as combustion products (eg vehicle exhaust) are generally minimal. In most cases, odour is generally the most significant air quality constraint.

4.2.1 Odour

The most significant potential source of odour will be emissions from mixed putrescibles waste placed at the tipping face of the active landfill cell. The closed landfill cells will continue to contribute as minor odour source via landfill gas release from the restored landfill surface. However, this source is not considered to be a significant odour source, and odorous emissions from the closed (ie capped) landfill cells are not included in the initial assessment of off-site odour impact.

A literature review was performed to ascertain the likely odour emission rates from the identified sources at the proposed facility. Odour emission rates from a similar facility have been sourced from '*Odour Audit: Eastern Creek Stage 2: Holmes Air Sciences, December 2003*'. The Eastern Creek Landfill also accepts putrescible waste (but on a much larger scale) and implements a leachate collection and treatment system, whereby leachate is collected by a series of pipes and biologically treated on site before being either deposited back into the active landfill or safely discharged into the sewer. These adopted odour emission rates are therefore considered representative for the purposes of this assessment.

The odour emission rates adopted for this assessment are summarised in Table 4-3.

Table 4-3 Estimated Odour Emission Rates - Landfill

Landfill	Years of Operation	Waste acceptance (tonnes per annum) (1)	Tipping Face Area (m^2) (2)	Intermediate Cover Area (m^2) (3)	SOER (OU m/s) (4) (5)		
					Tipping face	Daily cover (6)	Intermediate cover (7)
Quirks	2012 – 2021	Up to 75,000	202	13000	7	0.35	0.07
West Valley	2022 – 2033	From 58,000 to 100,000	289	18571	7	0.35	0.07
North Valley	2034 – 2045	From 100,000 to 145,000	418	26929	7	0.35	0.07

1. Upper limit of waste acceptance used in odour modelling.
2. Area of active face was not available. Therefore the area of the active face was based on upper limit of wast acceptance. For example, at Quirks Landfill - 70,000 tonnes/annum divided by 260 days/yr equals approximately 270 t/day to landfill at 0.75 t/m^3 equals ~202 m^3. Assume 1 m high face equals ~202 m^2.
3. Surface area of intermediate cover estimated to be 50% of the total cell area for each stage. Total surface area for the existing Stotts Creek Landfill is 26,100 m^2. Future areas were pro-rated based on waste acceptance rates.
4. Specific odour emission rate as reported in Odour Audit: Eastern Creek Stage 2, Holmes Air Sciences, December 2003. Peak-to-Mean ratios of 2.3 and 1.9 were applied over wind speed/stability times as per Approved methods.
5. The SOER data referenced to Eastern Creek were measured using Isolation flux Chambers (IFCs). Additional odour emission rate data from a Landfill accepting putrescible waste has been compiled by GHD through indirect measurements by downwind profiling and back-calculation using Ausplume in SITA Australia Pty Ltd Proposed SAWT Facility at Hallam Road Landfill, Odour and Dust Impact Assessment, February 2006. Testing was undertaken at SITA's Lyndhurst Landfill. Results showed morning SOER's of ~ 4 OUm/s, and afternoon SOERs of ~ 40 OUm/s. Simulations using these alternative OERs returned off-site odour concentrations almost identical to the reported results.
6. Odour emission rate equal to 5% of the active face odour emission rate was applied to the landfill source in the dispersion modelling outside normal operating hours to account for the application of daily cover over the active face.
7. A specific odour emission rate equal to ~1% of the active face odour emission rate was used to account for emissions from intermediate cover area. This 99% reduction in odour emission rate is based on the relationship between odour emissions from an active face and intermediate cover as reported in Odour Audit: Eastern Creek Stage 2, Holmes Air Sciences, December 2003.

Table 4-3 shows that although the derived odour emission rate from the intermediate cover area is low, the surface area is high, and it is significant odour source. However, in reality it is unlikely that this source would be a major contributor to off-site odour impact because the character and hedonic tone of odour emitted from this source will be less offensive than the emissions from the active tipping face.

It should also be noted that this assessment is inherently conservative because the total waste received per day has been assumed to be 100% putrescible waste and to occupy the entire active face area over the entire duration of operating hours. In reality, there would be a progressive build-up of waste in the active cell over the course of the day.

4.3 Dust

Sources of dust will include:

- Earthworks and waste handling within the landfill.
- Vehicle movements on unsealed roads about the site and on the landfill area.
- Wind erosion from disturbed/unsealed areas on the site.

The following assumptions were made in calculating the dust emission rates for landfill activities:

- It is likely that certain equipment or processes will only operate for short periods throughout each day. It is not known at what times in a shift operations will occur or when there will be stoppages. Therefore, dust emissions for each activity were spread over the full operating day of 9 hours. The scaled emission rates were modelled as occurring uniformly over each shift, sampling the full range of meteorological conditions.
- Wheel induced dust emissions from haul trucks along the sealed haul road from the Stotts Creek RRC were assumed to be negligible and not considered further in this assessment.
- The use of a water truck has been assumed not to generate dust emissions, as its use will act to suppress emissions. Therefore, the water truck has not been included in the emissions inventory.

The emission inventory derived for the Landfill is detailed in Table 4-4.

Table 4-4 Dust Emission Inventory – Landfill

Equipment	Default TSP Emission Factor	Default PM_{10} Emission Factor	Unit	Application	TSP Emission Rate (kg/hr)	PM_{10} Emission Rate (kg/hr)
Stomper	No data	No data				
Dozer	17	4	kg/h	Active 3 hours over 9 hour day	5.7	1.3
Excavator	0.026	0.012	kg/t	Shifting half of waste acceptance per day.	0.6 (1)	0.28 (1)
Trucks	3.88	0.96	kg/VKT	Total operating 2 hours per day at average 20 km/hr equals 40 km. 50% control for watering	8.6	2.1

1. Example for Quirks Landfill - 150 mm of daily cover applied to active face area of 210 m^2 assuming 1.5 t/m^3 equals ~47 tonnes of daily cover per day. Emission rate adjusted based on tipping face area for each stage of the development as per Table 4-3.

5. Dispersion Modelling Methodology

Dispersion modelling was conducted to predict the maximum ground level concentrations of dust (TSP and PM_{10}) and odour resulting from emissions to air from quarry and landfill operations. Dust deposition rates were also predicted. The predicted ground level concentrations (GLC) and dust deposition rates were then assessed against the relevant OEH criteria.

Dispersion modelling of emissions to air requires the selection of an appropriate model and then the selection of three general types of input. These are:

- Hourly site-specific or site representative meteorological data for a period of not less than one year. The meteorological data file used in this assessment is discussed in Section 3.2.
- Source characterisation (which includes an emission rate inventory and source geometry).
- Model configuration – in which the various model settings are selected to best characterise the physical processes specific to this site and to make best use of the available emissions and meteorological data.

The source characterisation and model configuration are detailed below under relevant section headings.

5.1 The Model

Ausplume version 6.0 is a regulatory dispersion model and was used in this assessment.

5.2 Source Characterisation

5.2.1 Mobile and Fixed Plant

Processing equipment and mobile equipment, such as the crushers (with associated screens and conveyors etc), loaders, excavators, the dozer and trucks have been modelled as individual 'volume' sources using the corresponding emission rates presented in Table 4-2. Volume sources are often used to model well mixed fugitive emissions downwind of buildings and stationary plant. Further details of model input are shown in the Ausplume output in Appendix A.

Table 5-1 summarises the source characteristics used as input to the dispersion model.

Table 5-1 Source Characteristics

Source	Horizontal Spread (m)	Vertical Spread (m)	Source Height (m)
Dozer	5	2	0
Crusher	5	3	0
Loader	5	2	0
Excavator	5	3	0

Source	Horizontal Spread (m)	Vertical Spread (m)	Source Height (m)
Haul truck	5	3	0

5.2.2 Wind Erosion

Wind erosion was modelled as an area source over the surface area of the quarry pit area and landfill site based on the proposed footprints for each site. Dust emission rates were set in for each wind speed category proportional to the wind speed cubed as shown in Table 5-2.

Based on current operations at Quirks Quarry, part of the site is regularly watered, especially water spray systems on stockpile areas. However, other parts of the site are unwatered. Conservatively, a control factor for watering has not been applied to wind erosion emission rates.

Table 5-2 Wind Erosion Dust Emission Rates

Wind Speed Category (m/s)	Specific TSP Emission Rate ($kg/hr/m^2$)	Specific PM_{10} Emission Rate ($kg/hr/m^2$)
> 10.80	0.00024	0.00012
8.24 > 10.80	0.00012	0.00006
5.15 > 8.23	0.000041	0.000021
3.10 > 5.14	0.000010	0.000005
1.55 > 3.09	0.0000021	0.0000011
0 > 1.54	0.0000002	0.0000001

5.2.3 Dust Deposition

Dust deposition parameters have been set[3] as provided in Table 5-3.

Table 5-3 Dust Deposition Parameters

Fraction No.	Mass fraction	Particle size (micron)	Particle density (g/cm^3)
1	0.052	1.8	2.6
2	0.140	4.0	2.6
3	0.223	8.0	2.6
4	0.322	17.0	2.6

[3] Based on data provided in the NSW Minerals Council Technical Paper: Particulate Matter and Mining Interim Report, 2000.

Fraction No.	Mass fraction	Particle size (micron)	Particle density (g/cm^3)
5	0.263	31.0	2.6

5.2.4 Model Configuration

Dispersion modelling was undertaken for each of the possible site configurations as outlined in the Concept Plan project description. Based on the proposed time line of the Concept Plan, only one quarry and one landfill would operate at any given time. Therefore, three site configurations were modelled:

- Configuration 1: Quirks Landfill and West Valley Quarry. Stage 1 of the proposed Concept Plan (2012 – 2021).
- Configuration 2: West Valley Landfill and North Valley Quarry. Stage 2 of the proposed Concept Plan (2022 – 2033).
- Configuration 3: North Valley Landfill only (2034 – 2045).

Key components of the Ausplume model configuration used in this assessment are as follows:

- Ground level concentrations (GLC) were predicted over a 2 km by 2 km receptor grid, with a grid resolution of 50 m.
- The depletion option was selected for the TSP model but not selected for PM_{10} model runs (this is a conservative approach and will result in a slight over-estimate of PM_{10} concentration).
- Peak-to-Mean scaling factors for each Pasquill stability category are prescribed in the OEH Approved Methods. These were factored into the component odour emission rates for each relevant source type and for far-field odour assessment to the odour model output (1-hour average) corresponds to peak 1-second average odour concentrations.
- Irwin's 'Rural' wind profile exponents were used.
- Horizontal dispersion was parameterised according to equations for the Pasquill-Gifford curves.
- A roughness height of 0.4 m ('Rolling Rural') was used to represent the land features that surround the site.

Further detail on the Ausplume configuration can be found in the Ausplume output file attached in Appendix A.

5.3 Assessment Criteria

5.3.1 Dust

Air quality impact assessment criteria are prescribed within the NSW OEH Approved methods.

To ensure the environmental outcomes are achieved, emissions from a premise must be assessed against the assessment criteria given in Table 5-4.

Table 5-4 Assessment Criteria for Dust

Pollutant	Averaging Period	Criteria
PM_{10}	24 hours	50 µg/m^3
	Annual	30 µg/m^3
TSP	Annual	90 µg/m^3
Dust deposition	Annual	2 g/m^2/month*

** Maximum Increment. Maximum cumulative impact of 4 g/m^2/month.*

The above criteria are provided as cumulative (incremental plus background) concentration levels.

As there is no background dust level emissions data available for the Eviron area, a background concentration level of 20 µg/m^3 for PM_{10} was assumed, as discussed in Section 3.3. A Background concentration of TSP was assumed to be 40 µg/m^3.

5.3.2 Odour

The impact assessment criterion for complex mixtures of odorous air pollutants, prescribed by the OEH Approved Methods adopts a sliding scale (2 to 7 OU, 99 percentile, 1 second average) – dependent on the size of the affected population P. This is expressed in the equation:

Criterion $OU_c = (\log_{10} P - 4.5) \div -0.6$.

Application of the above equation yields a range of odour performance criteria that should be applied at the nearest off site sensitive receptor, as outlined in Table 5-5.

Table 5-5 NSW DECCW Odour Criteria

Population of Affected Community	Odour Criteria* (OU)
Urban (≥2000)	2
~500	3
~125	4
~30	5
~10	6

*Nose response time average, 99th percentile

Note that the criteria outlined in Table 5-5 are required to be met at the nearest off site sensitive receptors at the 99 percentile and at a 1 second peak averaging time.

The proposed site is located in a primarily rural environment and it is assumed that the existing population that may potentially be effected by odorous emissions is in the order of 10 – 30 people, hence an odour impact assessment criterion of 5 OU would apply. However, parts of the area surrounding the proposed Concept Plan are zoned residential so there is potential for the potentially impacted population to grow throughout the Concept Plan lifetime. Therefore, to account for future development, an odour assessment criterion of 2 OU has been adopted.

6. Predicted Air Quality Impacts

6.1 Dust

A summary of the results of the dispersion modelling assessment are presented in Table 6-1, Table 6-2 and Table 6-3. Full results are presented in Appendix B. The maximum predicted ground level concentration and deposition rates at the most impacted sensitive receptor has been added to the adopted background levels to determine the cumulative impact.

Table 6-1 Configuration 1 - Maximum Predicted Dust Impact at the Most Exposed Sensitive Receptor

Pollutant	Averaging Period	Units	Maximum predicted incremental impact [1]	Adopted Back-ground Level	Cumulative Impact	Criteria
Most Exposed Receptor: Receptor 3						
PM_{10}	24-hour	$\mu g/m^3$	**95**	20	**115**	50
PM_{10}	Annual	$\mu g/m^3$	4	20	24	30
TSP	Annual	$\mu g/m^3$	10	40	50	90
Dust deposition -	Annual	$g/m^2/month$	0.4	2[2]	2.4	4

(1) 24-hour concentration predicted using the maximum quarry throughput of 400 TPH. Annual concentrations predicted using average quarry throughput of 100 TPH.

(2) Conservative background dust deposition level of 2 $g/m^2/month$ adopted.

Table 6-2 Configuration 2 - Maximum Predicted Dust Impact at the Most Exposed Sensitive Receptor

Pollutant	Averaging Period	Units	Maximum predicted incremental impact [1]	Adopted Back-ground Level	Cumulative Impact	Criteria
Most Exposed Receptor: Receptor 3						
PM_{10}	24-hour	$\mu g/m^3$	32	20	**52[2]**	50
PM_{10}	Annual	$\mu g/m^3$	3	20	23	30
TSP	Annual	$\mu g/m^3$	10	40	50	90
Dust deposition -	Annual	$g/m^2/month$	0.4	2[3]	2.4	4

(1) 24-hour concentration predicted using the maximum quarry throughput of 400 TPH. Annual concentrations predicted using average quarry throughput of 100 TPH.

(2) The OEH Approved Methods allows for the PM10 24 hour criterion to be exceeded up to 5 times per year. The second highest prediction at Receptor 3 would result in a cumulative impact under 50 µg/m3.

(3) Conservative background dust deposition level of 2 g/m2/month adopted.

Table 6-3 Configuration 3 - Maximum Predicted Dust Impact at the Most Exposed Sensitive Receptor

Pollutant	Averaging Period	Units	Maximum predicted incremental impact [1]	Adopted Back-ground Level	Cumulative Impact	Criteria
Most Exposed Receptor: Receptor 2						
PM_{10}	24-hour	$\mu g/m^3$	9	20	29	50
PM_{10}	Annual	$\mu g/m^3$	<1	20	21	30
TSP	Annual	$\mu g/m^3$	2	40	42	90
Dust deposition -	Annual	g/m^2/month	<0.1	2[2]	2.1	4

(1) 24-hour concentration predicted using the maximum quarry throughput of 400 TPH. Annual concentrations predicted using average quarry throughput of 100 TPH.

(2) Conservative background dust deposition level of 2 g/m^2/month adopted.

Table 6-1 shows that, based on the adopted background levels and assumptions made in this assessment, all constituents assessed over the relevant averaging periods were below their respective assessment criteria at the nearest sensitive receptors for the modelled emission rate characteristics, with the exception of PM_{10} (24-hour).

Table 6-2 and Table 6-3 indicate that under Configurations 2 and 3, all constituents assessed over the relevant averaging periods were below their respective assessment criteria at the most affected sensitive receptor.

Further detail on the model results, specifically short term impacts of PM_{10}, are provided in the following sub-section. Contour plots of the predicted impacts are shown in Appendix C.

6.1.1 PM_{10}

Table 6-1 shows that under configuration 1, the maximum predicted total (ie 20 $\mu g/m^3$ background + 95 increment = 115 $\mu g/m^3$ total impact) impact for PM_{10} has the potential to exceed the 24-hour average criterion. Note that this is the maximum predicted impact is based on a 400 TPH production rate and worst case meteorological conditions.

The model sensitivity to a reduction in dust emission rates as a result of lower production rates is shown in Table 6-4. Sensitivity runs have been based on Configuration 1 only, as this has been identified as the stage of the project which poses the greatest potential for dust impacts.

Table 6-4 Configuration 1 – PM_{10} 24-hour Concentrations – 400 TPH vs. 100 TPH

Receptor	400 TPH Quarry Throughput		100 TPH Quarry Throughput	
	Incremental Impact (µg/m^3)	Cumulative Impact (µg/m^3)	Incremental Impact (µg/m^3)	Cumulative Impact (µg/m^3)
1	43	**63**	22	42
2	20	40	8	28
3	95	**115**	30	**50** [1]
4	45	**65**	15	35
5	16	36	6	26
6	26	46	16	36
7	18	38	10	30

(1) The OEH Approved Methods allows for the PM10 24 hour criterion to be exceeded up to 5 times per year. The second highest prediction at Receptor 3 would result in a cumulative impact under 50 µg/m3.

Note: Cumulative impact levels based on adopted background concentration of 20 µg/m^3. PM_{10} criterion is 50 µg/m^3.

Table 6-4 shows that when the model configuration is based on the more typical production rate of 100 TPH the predicted PM_{10} 24-hour concentrations are shown to comply with the criterion of 50 µg/m^3. The maximum predicted incremental impact was found to be roughly 60% of the criterion at the most affected receptor.

Further analysis of the model results for the 400 TPH scenario also revealed that the frequency at which the PM_{10} levels are predicted to exceed 30 µg/m^3 (ie the threshold at which the addition of the adopted background level would exceed the criterion) is less than approximately 30 days per year at the most exposed receptor. The frequency that the predicted incremental PM_{10} (24-hour) concentration exceeds 50 µg/m^3 is less than three times per year. Therefore, it is likely that impact of PM_{10} emissions from operations under Configuration 1 on a day-to-day basis would comply with the PM_{10} criterion. The quarry would operate at 400 TPH infrequently, and when it does operate at 400 TPH, it is unlikely that this event would be coupled with the adverse meteorological conditions required to cause maximum impact.

6.2 Impacts from Blast Events

As previously discussed, blasting will take place a maximum of once per week at the quarries but will typically occur once every few months on an as-need basis. Dust plumes generated from a blast event can be significant, however, they are generally well dispersed within a short time period (in the order of seconds to minutes). Therefore, the contribution to off-site dust levels on a 24-hour averaging period would be negligible. There is no criterion set in NSW for exposure to short-term PM_{10} or TSP over this duration.

The Ausplume dispersion model has a minimum emission rate input of 1-hour blocks. Therefore, an accurate representation of a blast event over a period of approximately 1 minute cannot be made. A hypothetical example of potential dust impacts off site from a blast event is provided below. This example utilises the PM_{10} emission factors for blasting provided in the NPI EET Manual for Mining. The following parameters were used:

- Blast Area = 20 m x 20 m = 400 m^2.
- Hole depth = 5 m.
- Soil Moisture = 2%.
- PM_{10} mass emission rate based on the above = 319 kg/blast.
- One blast per 24-hour period.
- Concentration in dust plume (assume 50 m high) = 319/(20 x 20 x 50) = 0.016 kg/m^3.

A test model run indicated that the maximum impact at the nearest receptor occurred under neutral atmospheric conditions and wind of approximately 3 m/sec. Conservatively assuming this plume does not immediately disperse, it will pass over a receptor on the site boundary for a period of 20/3 = 7 seconds. During this time the receptor would experience high concentration levels of PM_{10}, while for the remainder to the 24-hour period it would receive no impact from the quarry. Therefore, the 24-hour average PM_{10} concentration from a blast event becomes $0.016x7/86400^{(4)}$ = 1.29E-6 kg/m^3, or 1.29 $\mu g/m^3$. This concentration is approximately 3% of the PM_{10} 24-hour criterion.

Therefore, due to the short-term duration of blasting and the cessation of other quarry activities during the blast it is highly unlikely that blast dust emissions would have a significant effect on day-to-day dust impacts off site.

6.3 Predicted Odour Impact

The predicted 1-second peak (nose response time) ground level odour concentrations for the proposed landfills under normal operating conditions are shown in Table 6-5. These predicted odour concentrations indicate that the 2 OU criterion would be readily achieved at all sensitive receptors under all three configurations. It is noteworthy that the 1 OU (equivalent to the odour detection threshold) contour is generally confined within approximately 200 metres from the landfill site boundary.

Table 6-5 Predicted Odour Concentration (OU)

Receptor	Odour Concentration (OU)		
	Configuration 1	Configuration 2	Configuration 3
1	<1	<1	<1
2	<1	<1	<1
3	<1	1	<1

[4] Number of seconds in 24 hours.

Receptor	Odour Concentration (OU)		
	Configuration 1	Configuration 2	Configuration 3
4	<1	<1	<1
5	<1	<1	<1
6	<1	<1	<1
7	<1	<1	<1

Compliance with the criterion is such that a conservative safety margin is available to account for potential variations in odorous emissions that may occur, such as changes to the quality of waste or extreme seasonal events.

The 2 OU criterion has been adopted based on the expected future growth of residential areas around the proposed site. Contour plots of the predicted odour concentrations are shown in Appendix D, which may be used for the purposes of guiding future zoning and planning for buffer zones around the landfill areas.

6.4 Summary of Results

A summary of the predicted results are outlined below. Results are based on the assumptions made in the above sections of this report:

- Under Configuration 1, all constituents (dust and odour) assessed over the relevant averaging periods were below their respective assessment criteria at the nearest sensitive receptors, with the exception of PM_{10} 24-hour. The maximum predicted PM_{10} 24-hour average concentration levels have the potential to exceed the OEH criteria at Receptors 1, 3 and 4.
- Under Configuration 2, all constituents (dust and odour) assessed over the relevant averaging periods were below their respective assessment criteria at the nearest sensitive receptors.
- Under Configuration 3, all constituents (dust and odour) assessed over the relevant averaging periods were below their respective assessment criteria at the nearest sensitive receptors.
- Maximum predictions were made using the maximum quarry throughput of 400 TPH. However, based on the more typical throughput of 100 TPH, PM_{10} 24-hour concentration levels were found to comply with the OEH criteria at all receptors under all configurations.
- For maximum impact to occur, the quarry would have to be operating at maximum throughput (400 TPH) during the worst-case meteorological conditions (constant winds throughout the day in the direction of the nearest receptors). While this is possible, it is highly unlikely to occur.
- Options for dust mitigation measures have been provided and analysed in Section 7 of this report.

7. Recommended Mitigation Measures

7.1 Specific Dust Control Measures

Effective management of dust and odour emissions is critical to the successful operations of each quarry and landfill throughout Stage 1 and the Concept Plan. As indicated in the dispersion modelling assessment, dust emissions, in particular fine particulates (PM_{10}) pose the greatest potential for off-site impact during the operations of the Concept Plan. The following sections address some options for further dust control measures with the aim of minimising emissions to achieve compliance with the OEH criteria.

Analysis of the emissions inventory indicates that the major source of dust emissions from the quarry under the maximum throughput of 400 TPH were from activities associated with the processing plant (i.e. crushers, loaders, dozer and excavator). Figure 7-1 shows that contributions from these operations were as high as 79% of total PM_{10} emissions. Therefore, dust mitigation measures as part of these operations will have the biggest impact in reducing overall site emissions.

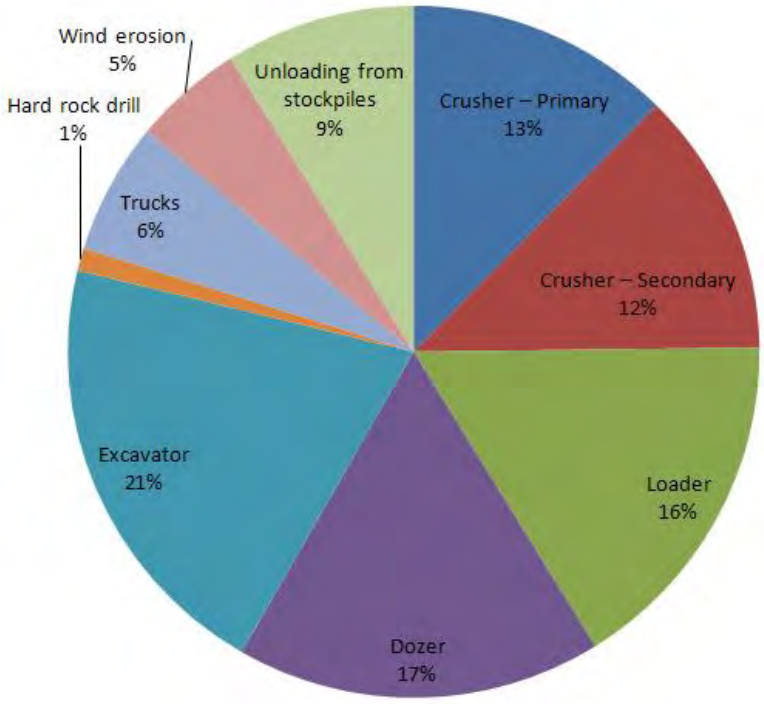

Figure 7-1 Quarry PM_{10} Emissions by Equipment – 400 TPH Operations

The moisture content of the material processed can have a substantial effect on emissions. Water sprays are generally the most simple and effective form of dust suppression on processing activities. Water sprays work by increasing the moisture content of material. The surface wetness causes fine particles to agglomerate on or to adhere to the faces of larger stones, with a resulting dust suppression effect.

While water sprays would be impractical to use with the dozer or excavator, they can be effectively used in crushing and screening plant. Moisture carry over would mean that processed material in stockpiles would also have higher moisture content. In addition, stockpiles are also regularly watered, allowing for a controlled emission factor to be applied to loader and loading operations.

The model sensitivity to reduction in dust emission rates as a result of the implementation of a water spray system on the crushers is shown in Table 7-1. Water sprays would need to increase the moisture content of material to greater than 4% by weight.

Table 7-1 Configuration 1 – PM_{10} 24-Hour Predicted Incremental Concentrations – With and Without Water Sprays on Crushers

Receptor	400 TPH Quarry Throughput – Uncontrolled	400 TPH – Water Spray on Crushers	100 TPH Quarry Throughput – Uncontrolled	100 TPH – Water Spray on Crushers
1	43	28	22	22
2	20	12	8	7
3	95	55	30	23
4	45	25	15	13
5	16	10	6	6
6	26	20	16	16
7	18	12	10	9

Note: Concentration levels that exceed the 24-hour criterion (based on the adopted background levels) are bolded.

Predicted results show that processing high moisture content material (ie moisture content >4% by weight, either naturally or by virtue of added water) could reduce predicted incremental PM_{10} concentrations at the nearest receptors by up to 40%.

Figure 7-2 shows the revised contributions from each operation based on a high moisture content material through the processing plant. The split of contribution indicates that the excavator and dozer become the most significant sources of PM_{10} when dust suppression is implemented in the processing operations.

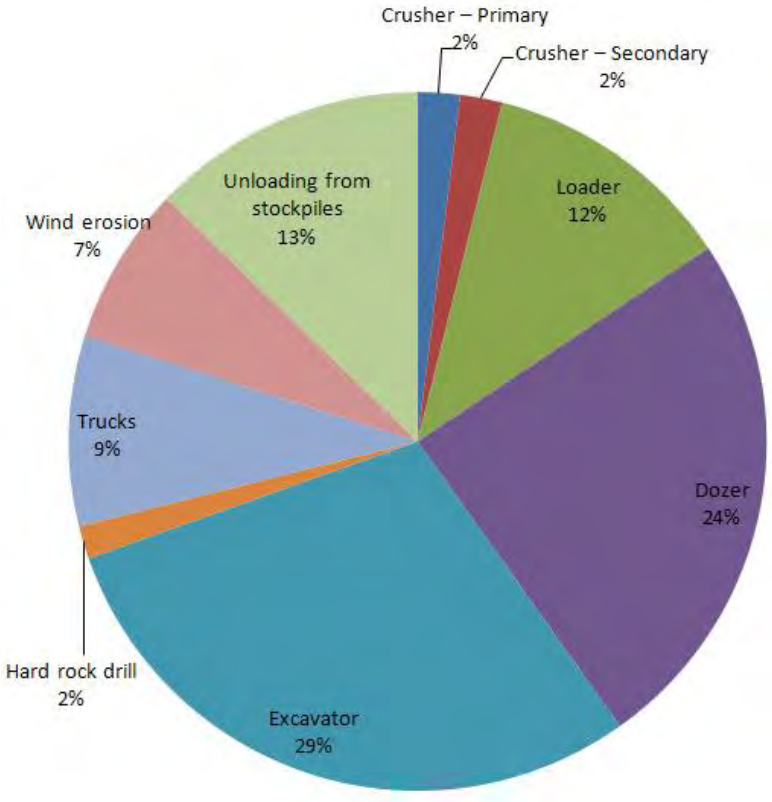

Figure 7-2 Quarry PM_{10} Emissions by Equipment – 400 TPH Operations – with Water Sprays on Crushers

Table 7-1 indicates that even with the use of dust suppression techniques on processing plant, there is still potential for short-term PM_{10} impacts at the nearest receptors under the maximum production rate of 400 TPH. Therefore, improvements to best practice dust management measures should focus on this short-term impact. Examples of additional management measures would be to cease or reduce operations when prevailing winds are in the direction of sensitive receptors, particularly to the south and south-west of the quarry (northerly or north-easterly winds). The use of a real-time reactive dust monitoring at locations representative of the nearest sensitive receptors could also be used to alert the quarry manager when dust levels are high. The quarry manager could then take appropriate actions to ensure dust levels off site are reduced, such as reducing the production rate or excavation and dozer operations until weather conditions are more favourable.

Wind erosion is expected to contribute to approximately 7% of total site emissions. Therefore, in general, over a 24-hour period, wind erosion is not considered to be a problem. However, the sudden onset of weather systems that involve sharp increases in wind speed can have the effect of quickly stripping the fine surface silt content from exposed non-vegetated or non-rehabilitated soil, particularly if the silt content on that soil is high through recent mechanical activity. If not dealt with pro-actively, this can cause short- term (in the order of minutes) peaks in inhalable dust concentrations. It is therefore recommended that the management plan contain a condition that the quarry and landfill managers be provided with daily weather updates (eg the Bureau of Meteorology have a standard daily service) that will contain warnings of the sudden onset of strong winds. In the event of such warning, the quarry and landfill managers could then take steps to ensure that exposed areas that could reasonably be subjected to wind erosion are consolidated by the timely application of water sprays.

7.2 General Dust Control Measures

General measures that will be implemented as part of the existing dust control management plan include:

- Rehabilitated areas will be revegetated as early as possible after completion.
- Newly stripped topsoil stockpiles will be immediately watered and revegetated with a grass cover.
- Access routes to and from the stockpiles will be watered as required, particularly during peak periods of vehicle movements.

Additional dust management measures are provided below in Table 7-2.

Table 7-2 General Management of Air Emissions

Emission Source	Proposed Management
Dust generated from transport activities on-site and off-site	Use of water sprays/trucks and sprays to wet down access roads. Clean sealed roads at access and egress points regularly to minimise the re-suspension of dust on sealed roads
Dust generated from loading, unloading and storage/stockpiling of material on-site	Use water sprays to minimise truck dust emissions. Ensure materials are appropriately stored and contained to prevent releases to the atmosphere (eg wind fences, water sprays)
Dust from movement of fill during operation	Where material is removed from the site or fill brought to the site, trucks will be covered whenever conditions are such that dust nuisance is occurring. This might include windy conditions or when materials being transported have a high level of fine particles.
Dust from Crushing and screening operations	Install spray systems on equipment and the stabilisation of the surface silt content of working surfaces around the processing site through (i) application of water via general wheeled carting and (ii) localised, manually controlled, canon water spraying.

7.3 Odour Mitigation Measures

While adverse odour impacts are not predicted, the following measures should be considered as part of the odour management plant for landfill activities. 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.
- Immediately cover waste which is potentially malodorous.
- Covering all exposed waste at the end of each working day with daily cover material.
- 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 OEH as required in the Annual Return. Investigations into the source of the odour emission giving rise to the complaint and any corrective actions taken to rectify the cause of complaint would also be documented.

8. Conclusions

An assessment of potential air quality impacts associated with the proposed Eviron Landfill and Quarry Concept Plan, located in Eviron, NSW, has been undertaken. The air quality assessment of the proposed development has led to the following conclusions:

- Compilation of an emissions inventory confirms that the main source of dust emissions will be the operating quarry, while the main source of odour emissions will be the operating landfill.
- The dominant source of dust emissions within each quarry was shown to be the processing activities, consisting of the crushers, dozer, loaders and excavator.
- Configuration 1 was shown to pose the greatest potential for off-site dust impacts, particularly concentration levels of fine particulates (PM_{10}) over a 24-hour averaging period. All other constituents (dust and odour) assessed over the relevant averaging periods were predicted to be below their respective assessment criteria at the nearest sensitive receptors.
- Configurations 2 and 3 were shown to have less potential for off-site dust or odour impacts. In fact, all constituents (dust and odour) assessed over the relevant averaging periods were predicted to be below their respective assessment criteria at the nearest sensitive receptors.
- Predicted PM_{10} 24-hour average concentrations, modelled under a maximum quarry throughput of 400 TPH, indicate that PM_{10} concentrations may potentially exceed the 24-hour criterion at three of the identified sensitive receptors. However, when modelled under the anticipated normal production rate of 100 TPH, the model results indicate that PM_{10} concentrations would comply with the 24-hour criterion at all identified receptors.
- Predicted PM_{10} levels could be reduced at nearby sensitive receptors by up to 40% with the implementation of a water spray system to the rock processing area.
- Further options for dust mitigation measures are provided in Section 7. It is anticipated that through the implementation of these dust management measures and a site specific dust management plan, off-site dust impacts can be minimised and adverse impacts would be unlikely.

This Concept Plan study has been based on the processes and technologies used in quarry and landfill activities at the time of this assessment. The assessment does not take into consideration emerging technologies in heavy vehicle machinery, resource recovery, alternatives to land filling and increased regulation of waste minimisation and landfill diversion targets. As the Concept Plan has an expected life of greater than 30 years, it is highly likely that improvements in technology will see a reduction in air emissions associated with the proposed activities.

9. Limitations

This Air Quality Impact Assessment ("Report"):

- Has been prepared by GHD Pty Ltd ("GHD") for Tweed Shire Council (TSC).
- May only be used and relied on by TSC.
- Must not be copied to, used by, or relied on by any person other than TSC without the prior written consent of GHD.
- May only be used for the purpose of the scope of work outlined in Section 1.2 of this report (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 TSC 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.

The services undertaken by GHD in connection with preparing this Report were limited to those specifically detailed in Section 1.2 of this Report.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing the Report, including (but not limited to):

- Air dispersion modelling assumptions detailed in Section 5 and 6 of 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 of this Report.

Appendix A

Ausplume Output File

1

PM10 Quirks Landfill and West Quarry - 400 TPH no moisture in quarry

Concentration or deposition	Concentration
Emission rate units	kg/hour
Concentration units	microgram/m3
Units conversion factor	2.78E+05
Constant background concentration	0.00E+00
Terrain effects	None
Smooth stability class changes?	No
Other stability class adjustments ("urban modes")	None
Ignore building wake effects?	No
Decay coefficient (unless overridden by met. file)	0.000
Anemometer height	10 m
Roughness height at the wind vane site	0.300 m
Use the convective PDF algorithm?	No

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high	Pasquill-Gifford
Vertical dispersion curves for sources <100m high	Pasquill-Gifford
Horizontal dispersion curves for sources >100m high	Briggs Rural
Vertical dispersion curves for sources >100m high	Briggs Rural
Enhance horizontal plume spreads for buoyancy?	Yes
Enhance vertical plume spreads for buoyancy?	Yes
Adjust horizontal P-G formulae for roughness height?	Yes
Adjust vertical P-G formulae for roughness height?	Yes
Roughness height	0.400m
Adjustment for wind directional shear	None

PLUME RISE OPTIONS

Gradual plume rise?	Yes
Stack-tip downwash included?	Yes
Building downwash algorithm:	PRIME method.
Entrainment coeff. for neutral & stable lapse rates	0.60,0.60
Partial penetration of elevated inversions?	No
Disregard temp. gradients in the hourly met. file?	No

and in the absence of boundary-layer potential temperature gradients given by the hourly met. file, a value from the following table (in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035
2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Rural" values (unless overridden by met. file)

AVERAGING TIMES
24 hours

PM10 Quirks Landfill and West Quarry - 400 TPH no moisture in quarry

SOURCE GROUPS

Group No.	Members
1	QWIND QLOAD1 QDOZER QTRUC1 QTRUC2 QDRILL QUNLOA QCRUSH QEXCAV
2	LWIND LDOZER LTRUCK LTRUK2
3	QWIND LWIND LDOZER LTRUCK QLOAD1 QDOZER QTRUC1 QTRUC2 QDRILL QEXCAV QUNLOA QCRUSH LTRUK2
4	QWIND LWIND

1

PM10 Quirks Landfill and West Quarry - 400 TPH no moisture in quarry

SOURCE CHARACTERISTICS

INTEGRATED POLYGON AREA SOURCE: QWIND

X0(m)	Y0(m)	Ground El	No. Vertices	Ver. spread	Height
549285	6869195	0m	4	1m	0m

Integrated Polygon Area Source Vertice Locations (in metres)

No.	X	Y	No.	X	Y
1	549285	6869195	2	549262	6868894
3	549726	6868834	4	549681	6868932

Emission rates by stability and wind speed, in kg/hour per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability B:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability C:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability D:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability E:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability F:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04

No gravitational settling or scavenging.

INTEGRATED POLYGON AREA SOURCE: LWIND

X0(m)	Y0(m)	Ground El	No. Vertices	Ver. spread	Height
549885	6869036	0m	4	1m	0m

Integrated Polygon Area Source Vertice Locations (in metres)

No.	X	Y	No.	X	Y
1	549885	6869036	2	550034	6868683
3	550171	6868821	4	549950	6869083

Emission rates by stability and wind speed, in kg/hour per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability B:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability C:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability D:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability E:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04
Stability F:	1.00E-07	1.10E-06	5.00E-06	2.10E-05	6.00E-05	1.20E-04

No gravitational settling or scavenging.

VOLUME SOURCE: LDOZER

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
550038	6868834	0m	0m	5m	2m

Emission rates by hour of day in kg/hour:

1	0.00E+00	2	0.00E+00	3	0.00E+00	4	0.00E+00
5	0.00E+00	6	0.00E+00	7	0.00E+00	8	1.30E+00
9	1.30E+00	10	1.30E+00	11	1.30E+00	12	1.30E+00
13	1.30E+00	14	1.30E+00	15	1.30E+00	16	1.30E+00
17	1.30E+00	18	0.00E+00	19	0.00E+00	20	0.00E+00
21	0.00E+00	22	0.00E+00	23	0.00E+00	24	0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: LTRUCK

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
550094	6868778	0m	0m	5m	3m

Emission rates by hour of day in kg/hour:

1	0.00E+00	2	0.00E+00	3	0.00E+00	4	0.00E+00
5	0.00E+00	6	0.00E+00	7	1.05E+00	8	1.05E+00
9	1.05E+00	10	1.05E+00	11	1.05E+00	12	1.05E+00
13	1.05E+00	14	1.05E+00	15	1.05E+00	16	1.05E+00
17	1.05E+00	18	0.00E+00	19	0.00E+00	20	0.00E+00
21	0.00E+00	22	0.00E+00	23	0.00E+00	24	0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: QLOAD1

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
549397	6869042	0m	0m	5m	2m

Emission rates by hour of day in kg/hour:

1	0.00E+00	2	0.00E+00	3	0.00E+00	4	0.00E+00
5	0.00E+00	6	0.00E+00	7	0.00E+00	8	1.92E+00
9	1.92E+00	10	1.92E+00	11	1.92E+00	12	1.92E+00
13	1.92E+00	14	1.92E+00	15	1.92E+00	16	1.92E+00
17	1.92E+00	18	0.00E+00	19	0.00E+00	20	0.00E+00
21	0.00E+00	22	0.00E+00	23	0.00E+00	24	0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: QDOZER

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
549419	6869018	0m	0m	5m	2m

Emission rates by hour of day in kg/hour:

1	0.00E+00	2	0.00E+00	3	0.00E+00	4	0.00E+00
5	0.00E+00	6	0.00E+00	7	0.00E+00	8	2.00E+00
9	2.00E+00	10	2.00E+00	11	2.00E+00	12	2.00E+00
13	2.00E+00	14	2.00E+00	15	2.00E+00	16	2.00E+00
17	2.00E+00	18	0.00E+00	19	0.00E+00	20	0.00E+00
21	0.00E+00	22	0.00E+00	23	0.00E+00	24	0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: QTRUC1

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
549378	6869068	0m	0m	5m	2m

Emission rates by hour of day in kg/hour:

1	0.00E+00	2	0.00E+00	3	0.00E+00	4	0.00E+00
5	0.00E+00	6	0.00E+00	7	0.00E+00	8	3.50E-01
9	3.50E-01	10	3.50E-01	11	3.50E-01	12	3.50E-01
13	3.50E-01	14	3.50E-01	15	3.50E-01	16	3.50E-01
17	3.50E-01	18	0.00E+00	19	0.00E+00	20	0.00E+00

21 0.00E+00 22 0.00E+00 23 0.00E+00 24 0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: QTRUC2

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
549533	6868982	0m	0m	5m	3m

Emission rates by hour of day in kg/hour:

1 0.00E+00	2 0.00E+00	3 0.00E+00	4 0.00E+00
5 0.00E+00	6 0.00E+00	7 0.00E+00	8 3.50E-01
9 3.50E-01	10 3.50E-01	11 3.50E-01	12 3.50E-01
13 3.50E-01	14 3.50E-01	15 3.50E-01	16 3.50E-01
17 3.50E-01	18 0.00E+00	19 0.00E+00	20 0.00E+00
21 0.00E+00	22 0.00E+00	23 0.00E+00	24 0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: QDRILL

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
549426	6868896	0m	0m	1m	1m

Emission rates by hour of day in kg/hour:

1 0.00E+00	2 0.00E+00	3 0.00E+00	4 0.00E+00
5 0.00E+00	6 0.00E+00	7 0.00E+00	8 1.20E-01
9 1.20E-01	10 1.20E-01	11 1.20E-01	12 1.20E-01
13 1.20E-01	14 1.20E-01	15 1.20E-01	16 1.20E-01
17 1.20E-01	18 0.00E+00	19 0.00E+00	20 0.00E+00
21 0.00E+00	22 0.00E+00	23 0.00E+00	24 0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: QCRUSH

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
549395	6869042	0m	0m	5m	3m

Emission rates by hour of day in kg/hour:

1 0.00E+00	2 0.00E+00	3 0.00E+00	4 0.00E+00
5 0.00E+00	6 0.00E+00	7 0.00E+00	8 2.90E+00
9 2.90E+00	10 2.90E+00	11 2.90E+00	12 2.90E+01
13 2.90E+00	14 2.90E+00	15 2.90E+00	16 2.90E+00
17 2.90E+00	18 0.00E+00	19 0.00E+00	20 0.00E+00
21 0.00E+00	22 0.00E+00	23 0.00E+00	24 0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: QEXCAV

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
549438	6869055	0m	0m	5m	3m

Emission rates by hour of day in kg/hour:

1 0.00E+00	2 0.00E+00	3 0.00E+00	4 0.00E+00
5 0.00E+00	6 0.00E+00	7 0.00E+00	8 2.88E+00
9 2.88E+00	10 2.88E+00	11 2.88E+00	12 2.88E+00
13 2.88E+00	14 2.88E+00	15 2.88E+00	16 2.88E+00
17 2.88E+00	18 0.00E+00	19 0.00E+00	20 0.00E+00
21 0.00E+00	22 0.00E+00	23 0.00E+00	24 0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: QUNLOA

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
549400	6869050	0m	0m	5m	3m

Emission rates by hour of day in kg/hour:

1	0.00E+00	2	0.00E+00	3	0.00E+00	4	0.00E+00
5	0.00E+00	6	0.00E+00	7	0.00E+00	8	1.04E+00
9	1.04E+00	10	1.04E+00	11	1.04E+00	12	1.04E+00
13	1.04E+00	14	1.04E+00	15	1.04E+00	16	1.04E+00
17	1.04E+00	18	0.00E+00	19	0.00E+00	20	0.00E+00
21	0.00E+00	22	0.00E+00	23	0.00E+00	24	0.00E+00

No gravitational settling or scavenging.

VOLUME SOURCE: LTRUK2

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
549913	6868932	0m	0m	5m	3m

Emission rates by hour of day in kg/hour:

1	0.00E+00	2	0.00E+00	3	0.00E+00	4	0.00E+00
5	0.00E+00	6	0.00E+00	7	1.05E+00	8	1.05E+00
9	1.05E+00	10	1.05E+00	11	1.05E+00	12	1.05E+00
13	1.05E+00	14	1.05E+00	15	1.05E+00	16	1.05E+00
17	1.05E+00	18	0.00E+00	19	0.00E+00	20	0.00E+00
21	0.00E+00	22	0.00E+00	23	0.00E+00	24	0.00E+00

No gravitational settling or scavenging.

1

PM10 Quirks Landfill and West Quarry - 400 TPH no moisture in quarry

RECEPTOR LOCATIONS

The Cartesian receptor grid has the following x-values (or eastings):

548000.m 548050.m 548100.m 548150.m 548200.m 548250.m 548300.m
548350.m 548400.m 548450.m 548500.m 548550.m 548600.m 548650.m
548700.m 548750.m 548800.m 548850.m 548900.m 548950.m 549000.m
549050.m 549100.m 549150.m 549200.m 549250.m 549300.m 549350.m
549400.m 549450.m 549500.m 549550.m 549600.m 549650.m 549700.m
549750.m 549800.m 549850.m 549900.m 549950.m 550000.m 550050.m
550100.m 550150.m 550200.m 550250.m 550300.m 550350.m 550400.m
550450.m 550500.m 550550.m 550600.m 550650.m 550700.m 550750.m
550800.m 550850.m 550900.m 550950.m 551000.m 551050.m 551100.m

and these y-values (or northings):

6868000.m 6868050.m 6868100.m 6868150.m 6868200.m 6868250.m 6868300.m
6868350.m 6868400.m 6868450.m 6868500.m 6868550.m 6868600.m 6868650.m
6868700.m 6868750.m 6868800.m 6868850.m 6868900.m 6868950.m 6869000.m
6869050.m 6869100.m 6869150.m 6869200.m 6869250.m 6869300.m 6869350.m
6869400.m 6869450.m 6869500.m 6869550.m 6869600.m 6869650.m 6869700.m
6869750.m 6869800.m 6869850.m 6869900.m 6869950.m 6870000.m 6870050.m
6870100.m 6870150.m 6870200.m 6870250.m 6870300.m 6870350.m 6870400.m
6870450.m 6870500.m

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	550053	6868543	0.0	0.0	5	549707	6868158	0.0	0.0
2	548449	6869803	0.0	0.0	6	550513	6868341	0.0	0.0
3	549195	6868773	0.0	0.0	7	550750	6868887	0.0	0.0
4	549238	6868509	0.0	0.0					

METEOROLOGICAL DATA : Environ Met Data _ TAPM V4.02.

Appendix B

Predicted Dust Impacts

B1 – Predicted Dust Impacts at Sensitive Receptors

PM10 24hr (based on 400 tph)							
	Configuration 1		Configuration 2		Configuration 3		
Receptor	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	**Criteria**
1	43	63	26	46	5	25	**50**
2	20	40	32	52	9	29	**50**
3	95	115	32	52	5	25	**50**
4	45	65	16	36	3	23	**50**
5	16	36	10	30	2	22	**50**
6	26	46	12	32	3	23	**50**
7	18	38	13	33	3	23	**50**

PM10 Annual							
	Configuration 1		Configuration 2		Configuration 3		
Receptor	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	**Criteria**
1	4	24	<1	20	<1	20	**30**
2	1	21	1	21	<1	20	**30**
3	4	24	3	23	<1	20	**30**
4	2	22	1	21	<1	20	**30**
5	1	21	<1	20	<1	20	**30**
6	1	21	<1	20	<1	20	**30**
7	1	21	<1	20	<1	20	**30**

TSP Annual							
	Configuration 1		Configuration 2		Configuration 3		
Receptor	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	**Criteria**
1	10	50	3	43	<1	40	**90**
2	3	43	4	44	3	43	**90**
3	10	50	10	50	2	42	**90**
4	5	45	3	43	1	41	**90**
5	3	43	2	42	<1	40	**90**
6	3	43	1	41	<1	40	**90**
7	3	43	1	41	<1	40	**90**

Dust deposition	Configuration 1		Configuration 2		Configuration 3		
Receptor	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	**Criteria**
1	0.4	2.4	<0.1	2.0	<0.1	2.0	**4**
2	0.4	2.4	0.1	2.1	<0.1	2.0	**4**
3	0.4	2.4	0.4	2.4	<0.1	2.0	**4**
4	0.2	2.2	0.2	2.2	<0.1	2.0	**4**
5	0.1	2.1	<0.1	2.0	<0.1	2.0	**4**
6	<0.1	2.0	<0.1	2.0	<0.1	2.0	**4**
7	<0.1	2.0	<0.1	2.0	<0.1	2.0	**4**

Appendix C

Dust Concentration Contours

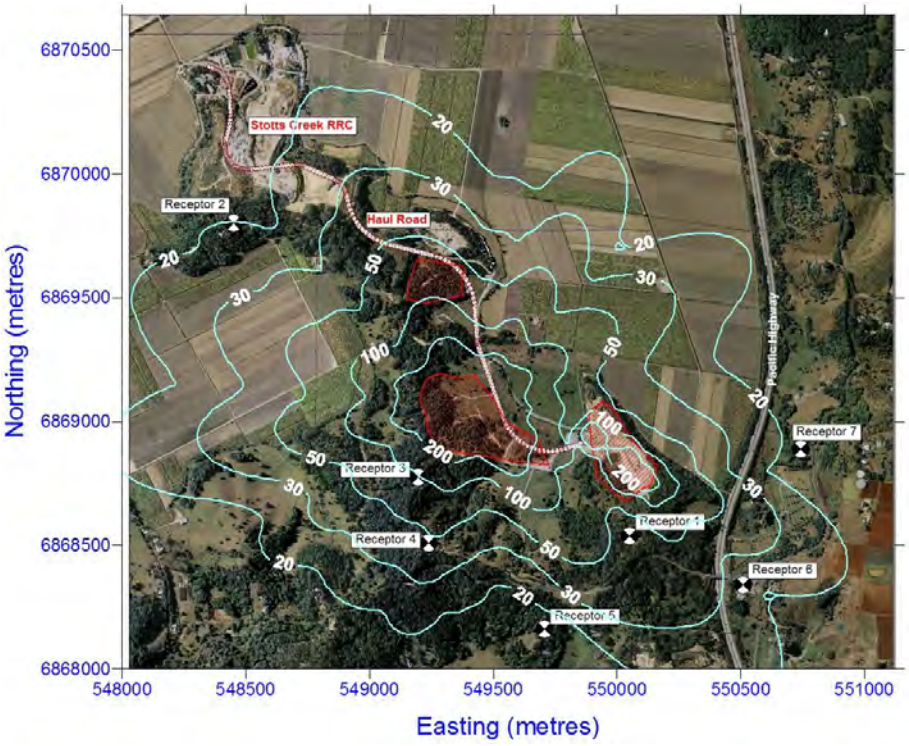

Figure C-1 Configuration 1 – PM_{10} 24 hour Concentration Contours – 400 TPH

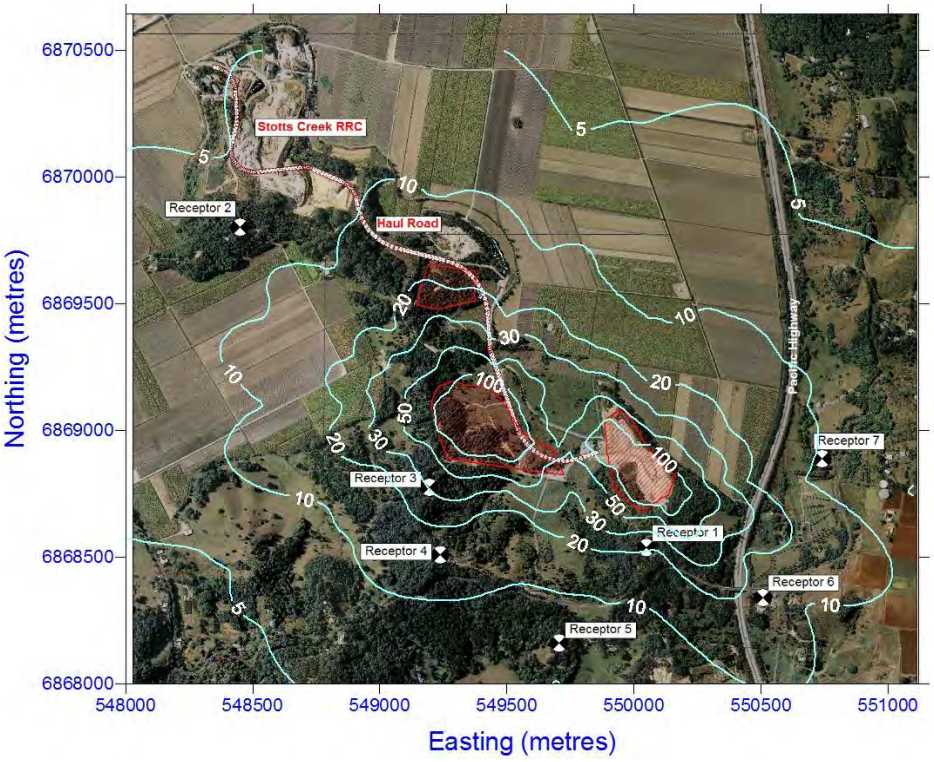

Figure C-2 Configuration 1 – PM_{10} 24 hour Concentration Contours – 100 TPH

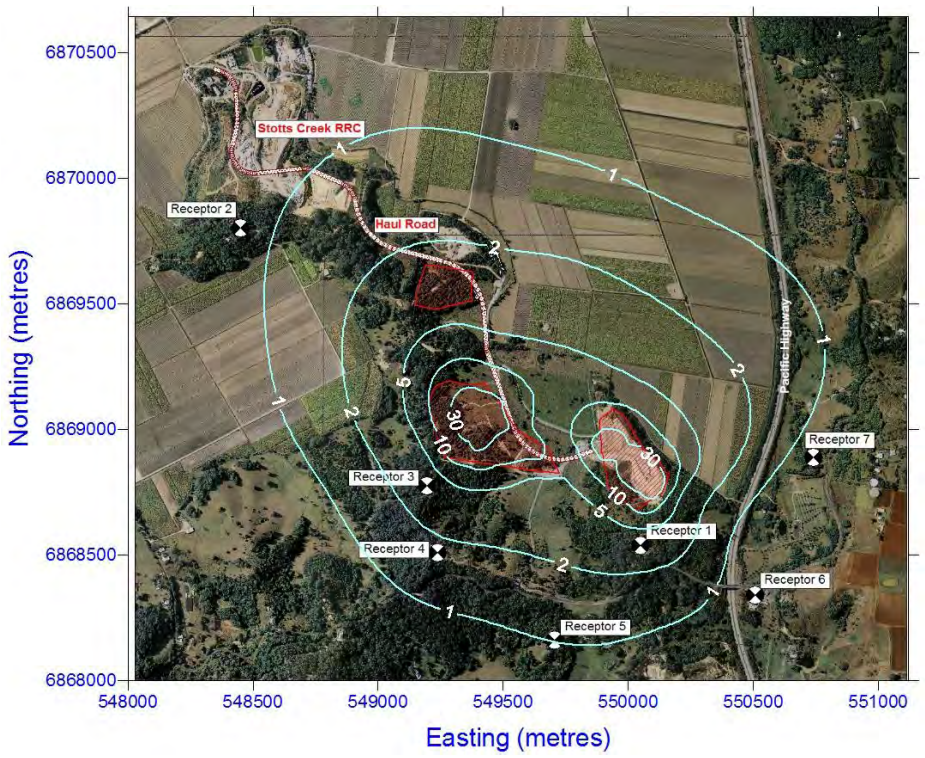

Figure C-3 Configuration 1 – PM_{10} Annual Average Concentration Contours

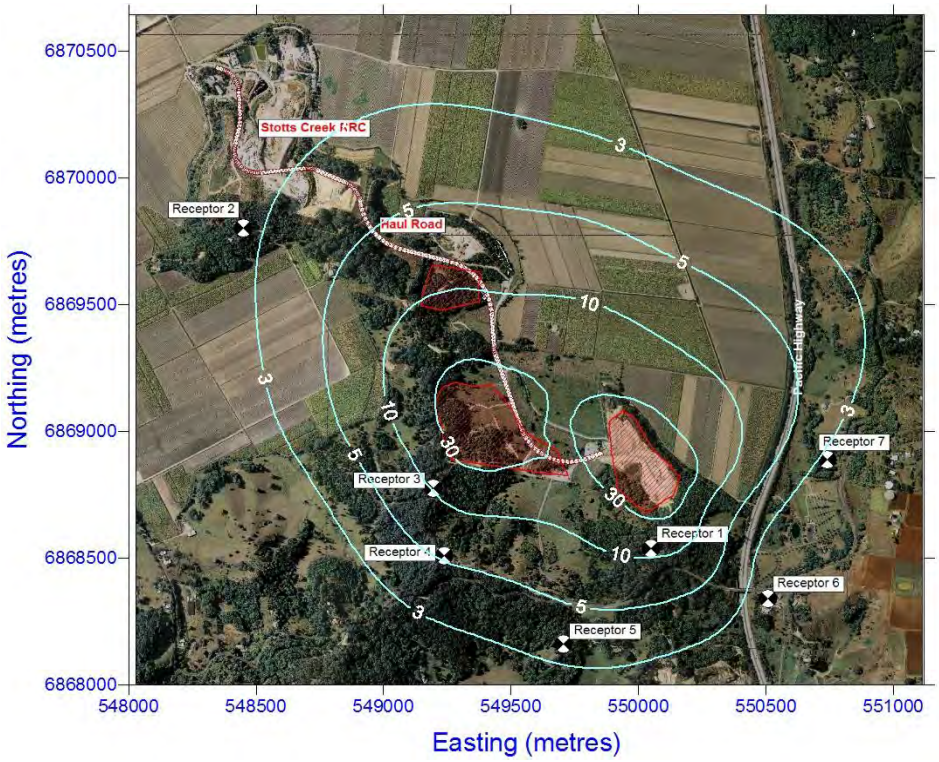

Figure C-4 Configuration 1 – TSP Annual Average Concentration Contours

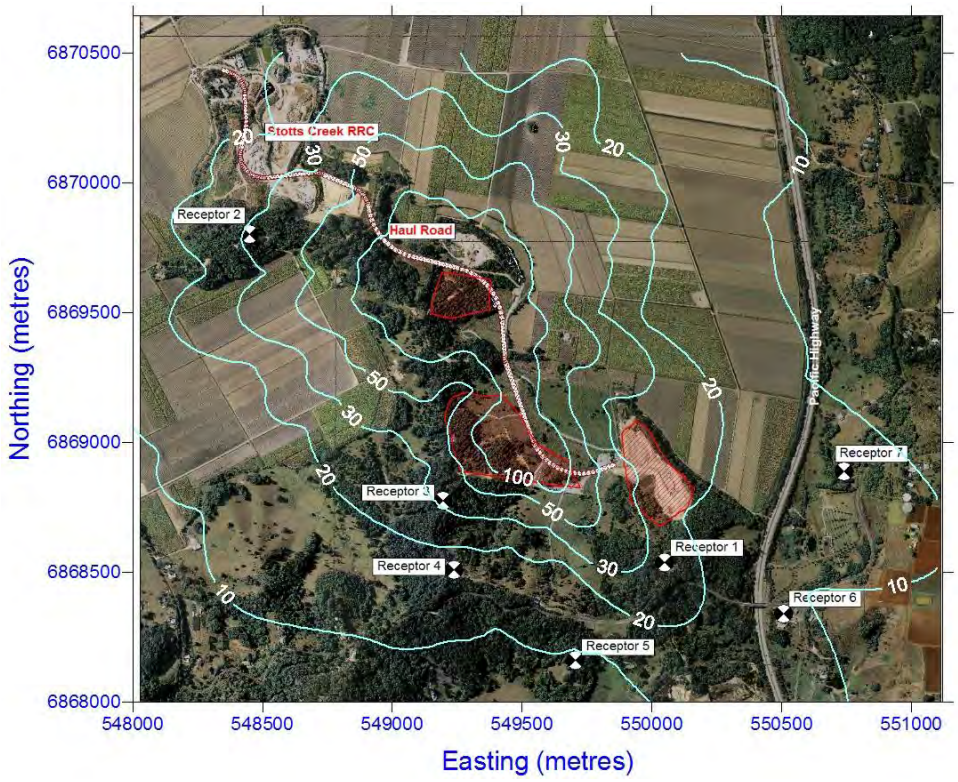

Figure C-5 Configuration 2 – PM_{10} 24 hour Concentration Contours – 400 TPH

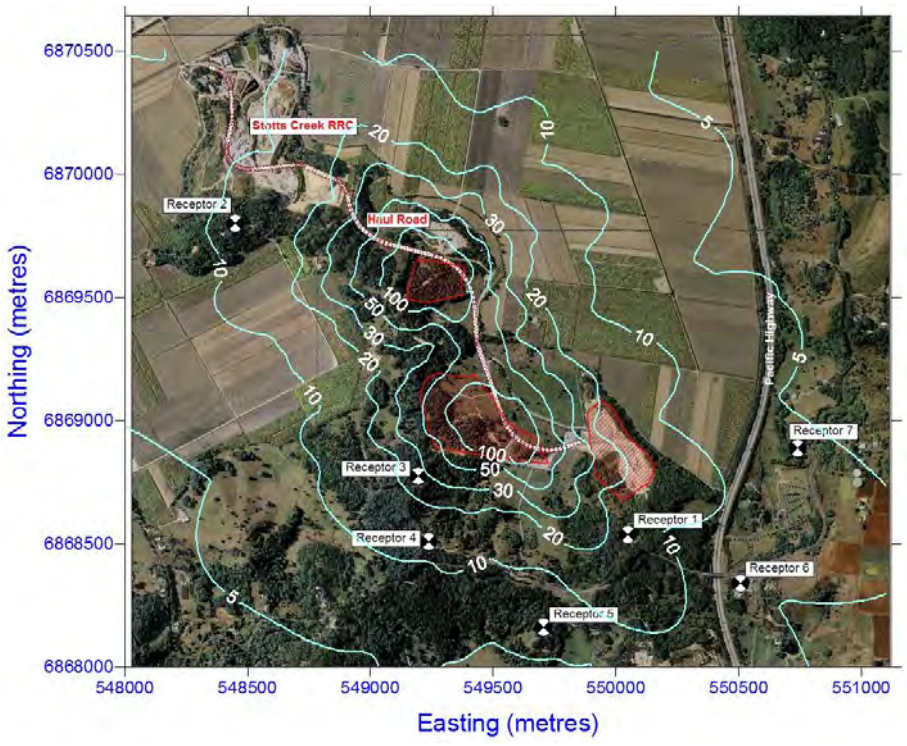

Figure C-6 Configuration 2 – PM_{10} 24 hour Concentration Contours – 100 TPH

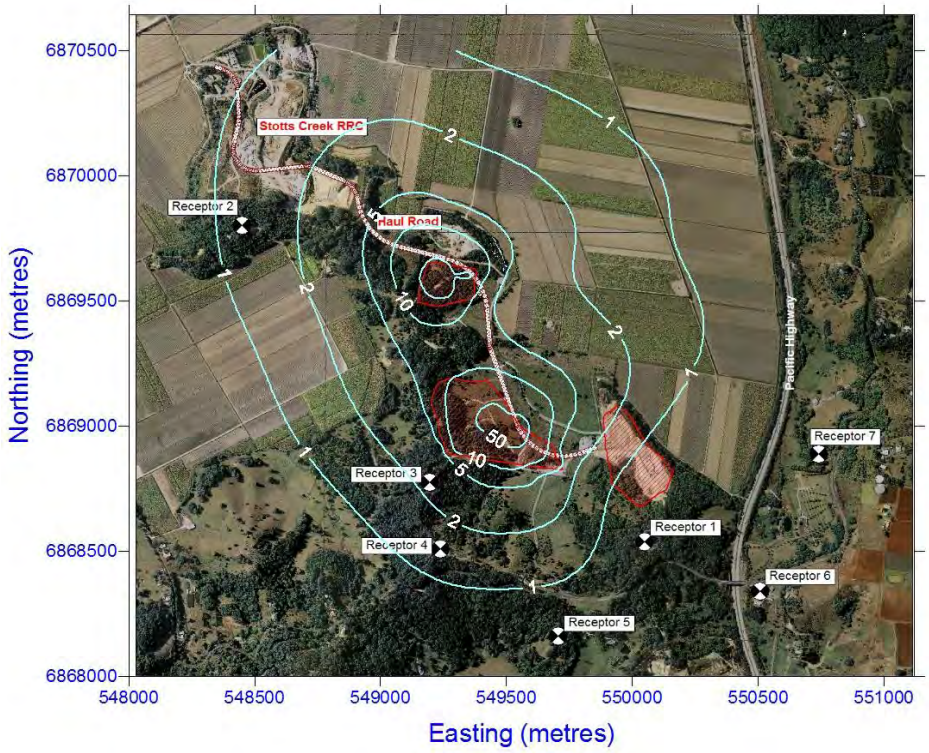

Figure C-7 Configuration 2 – PM_{10} Annual Concentration Contours

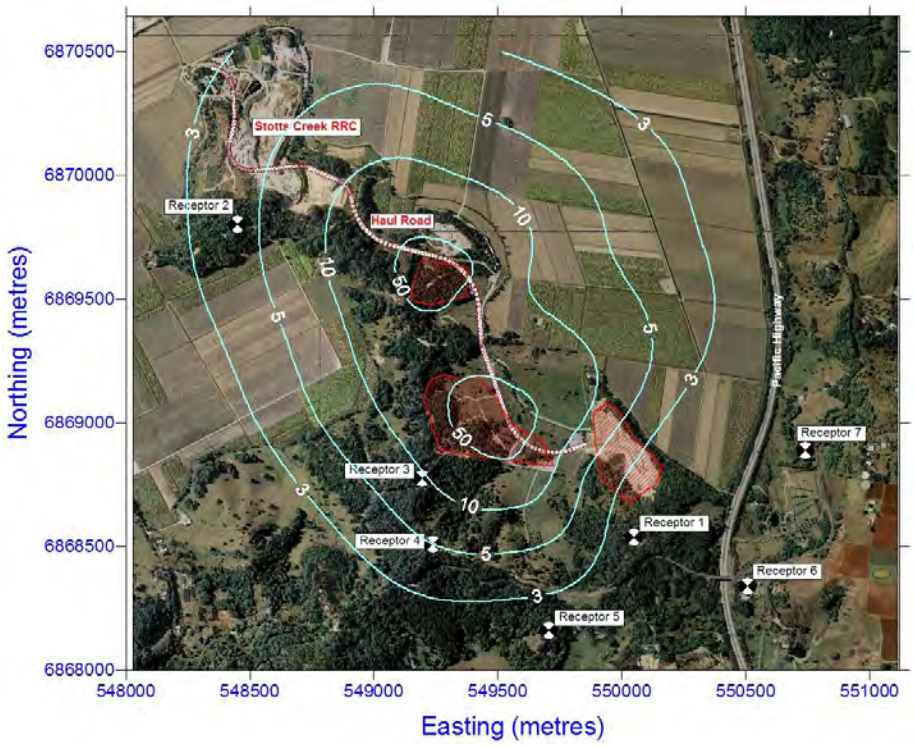

Figure C-8 Configuration 2 – TSP Annual Concentration Contours

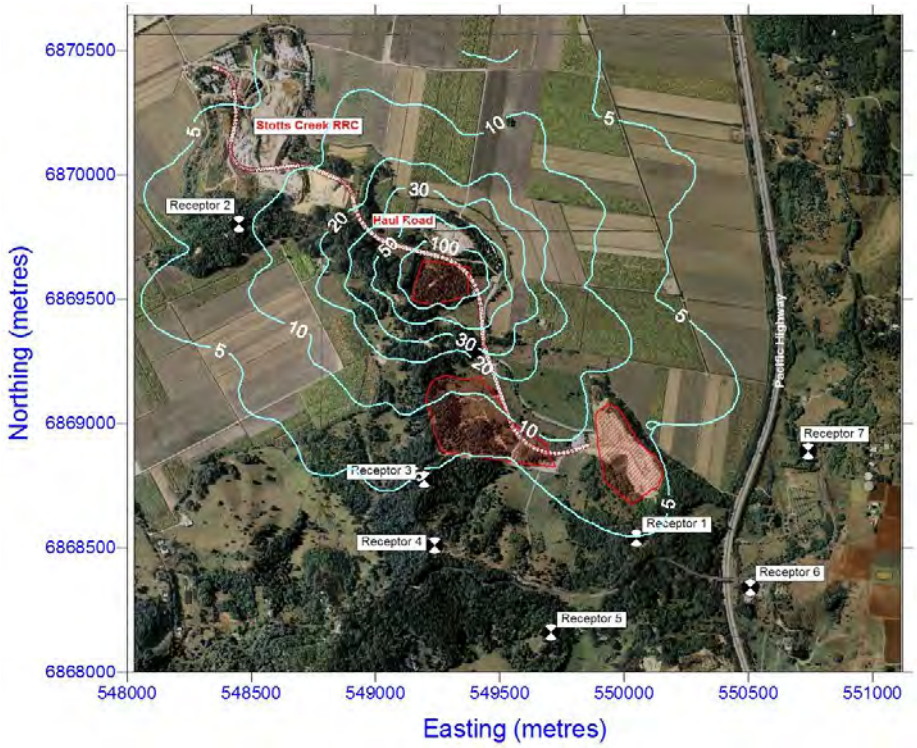

Figure C-9 Configuration 3 – PM_{10} 24 hour Concentration Contours

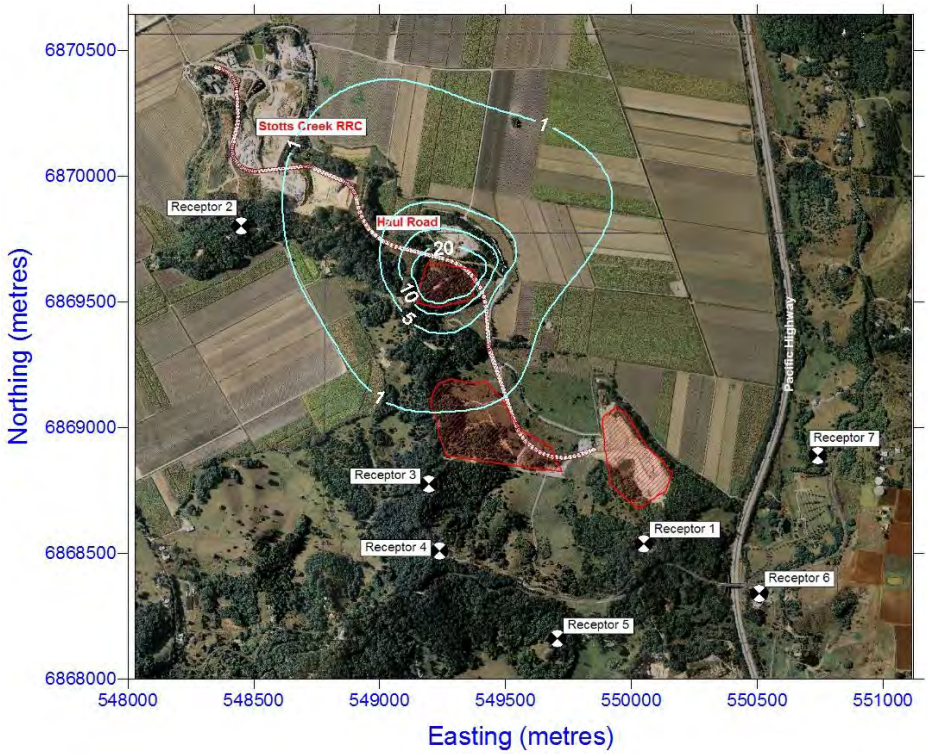

Figure C-10 Configuration 3 – PM_{10} Annual Concentration Contours

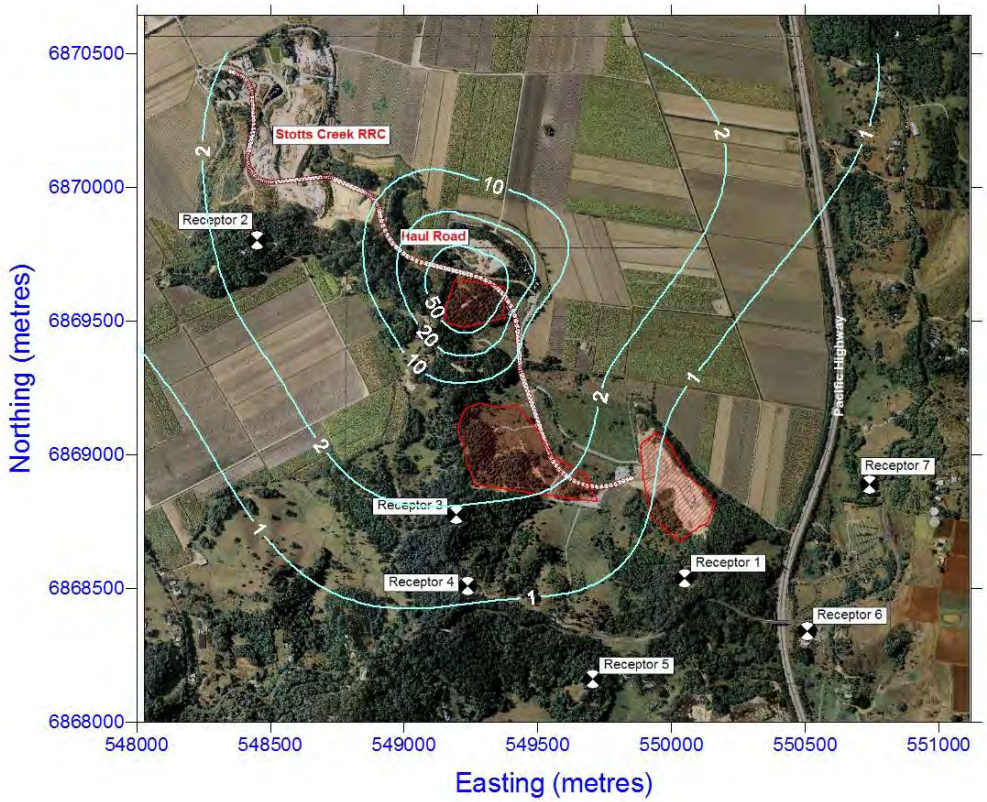

Figure C-11 Configuration 3 – TSP Annual Concentration Contours

Appendix D

Odour Concentration Contours

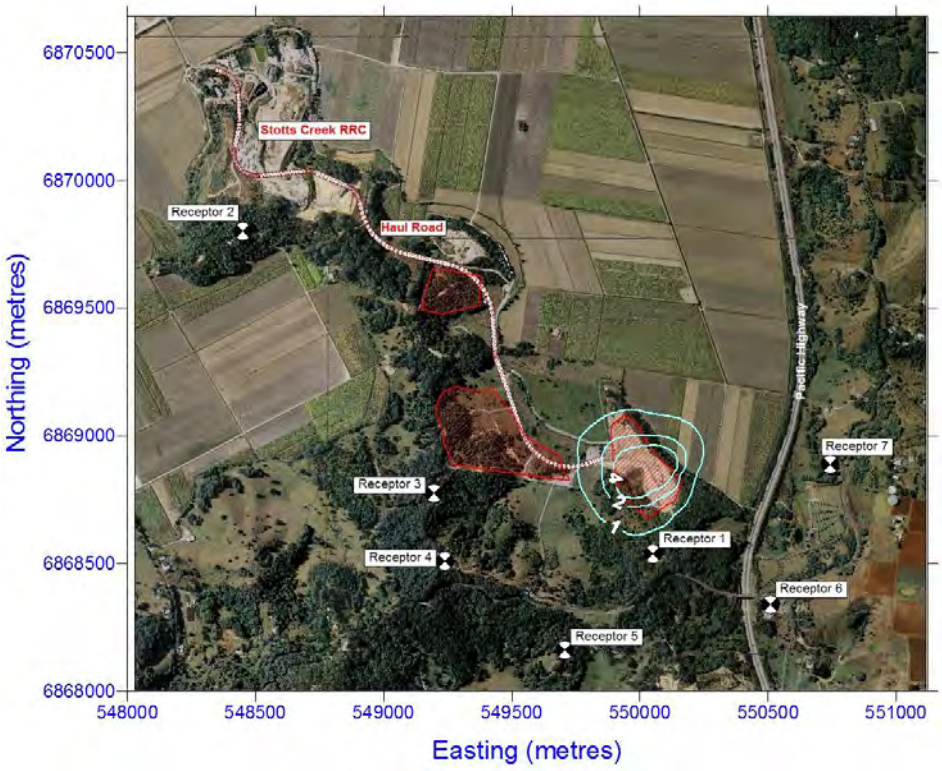

Figure D-1 Configuration 1 – Odour Concentration Contours

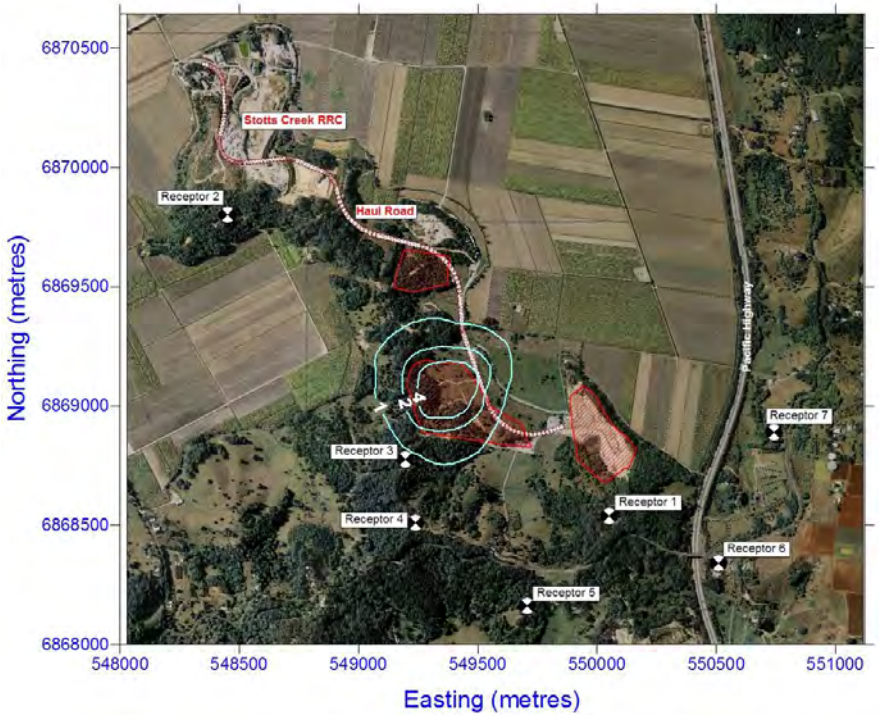

Figure D-2 Configuration 2 – Odour Concentration Contours

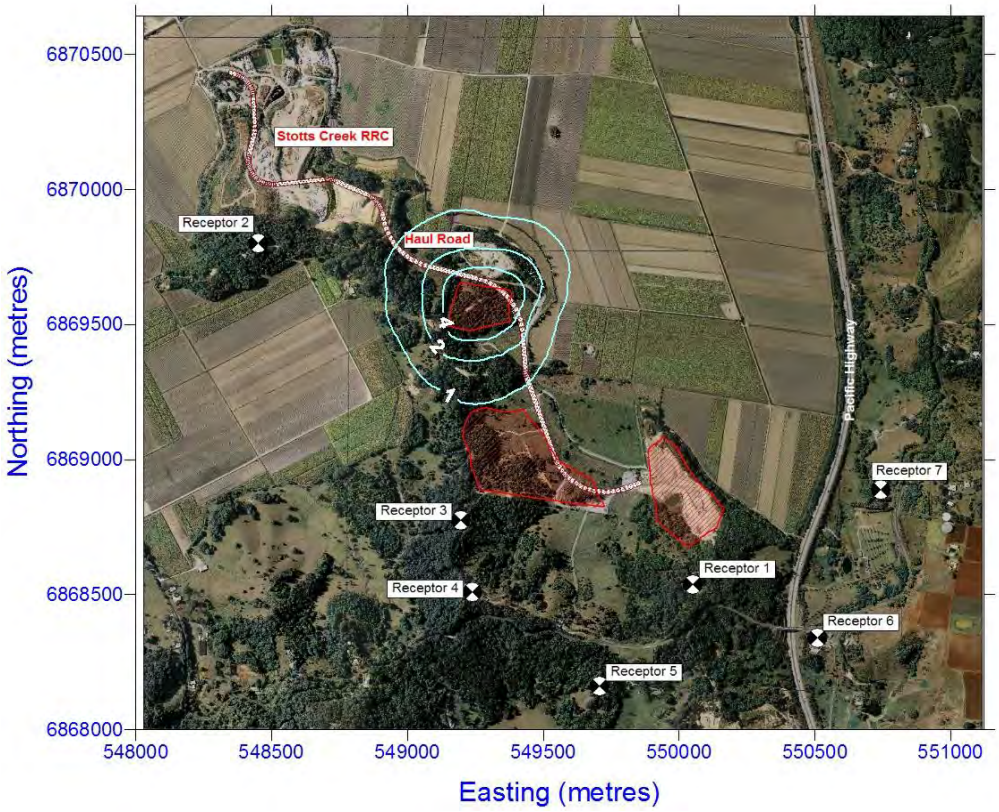

Figure D-3 Configuration 3 – Odour Concentration Contours

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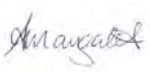
This report has been prepared by GHD in response to a specific brief issued by **Tweed Shire Council** and the Proposal for services presented by GHD. This report is intended for the sole use of the client. It has been prepared in accordance with the Terms of Engagement for the commission and on the basis of specific instructions and information provided by the client. The contents and conclusion of this report cannot be relied upon by any third party.

This report should not be altered, amended or abbreviated, issued in part or issued incomplete in any way without prior checking and approval by GHD.

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	T Gribble	T Pollock	*T Pollock*	A Marszalek	*A Marszalek*	24/05/11
1	T Gribble	A Marszalek		A Marszalek		18/10/11

Appendix K

Greenhouse Gas Emissions Study Report

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council

Report for Eviron Road Quarry and Landfill Proposal

Greenhouse Gas Assessment (Revised) - Stage 1 and Concept Plan

October 2011

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

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1. Introduction

1.1 Project Description

Tweed Shire Council's 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. This outlines a proposed staged project 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. Material won from quarrying is used for road building and other Council civil projects, and overburden stockpiled for road construction, clay liners (where appropriate) and site rehabilitation purposes.

The waste infrastructure proposed by Council was declared by the Department of Planning to be a Major Project, to which Part 3A of the *Environmental Planning and Assessment Act, 1979* applies.

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) throughout this report as Stage 1 (Project Application) and refers to the components of the development that Council intends to develop in the short to medium term; 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 infrastructure.

This environmental assessment has been prepared by GHD Pty Ltd (GHD) in accordance with the requirements of Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to support an application to the NSW Minister for Planning for Concept Plan approval and Stage 1 project approval and to address the requirements of the Director-General of the NSW Department of Planning (the Director-General's Requirements) issued on 31st July 2008.

1.2 Purpose

The purpose of the greenhouse assessment is to calculate the predicted Scope 1 and 2 emissions of greenhouse gases associated with the Stage 1 Project Application and preliminary estimates for the remainder of the activities comprising the Concept Plan.

Emissions are classified into three scopes under the IPCC guidelines; these scopes, adopted by the Department of Climate Change, are:

- **Scope 1** – Direct emissions arising from activities within the boundaries of an organisation, such as the combustion of diesel and methane emissions.
- **Scope 2** – Emissions arising from outside of the boundaries of an organisation, due to the import of energy, such as electricity imported from the grid.
- **Scope 3** – Emissions arising from the wider economy due to an organisation's activities. This includes other life-cycle emissions, such as emissions arising from the oil extraction, processing and transportation of diesel.

This assessment covers only Scope 1 and 2 emissions.

1.3 Boundaries

The system boundaries for the greenhouse gas assessment are the Scope 1 and 2 emissions of the project. The following sources were assessed in developing the assessment:

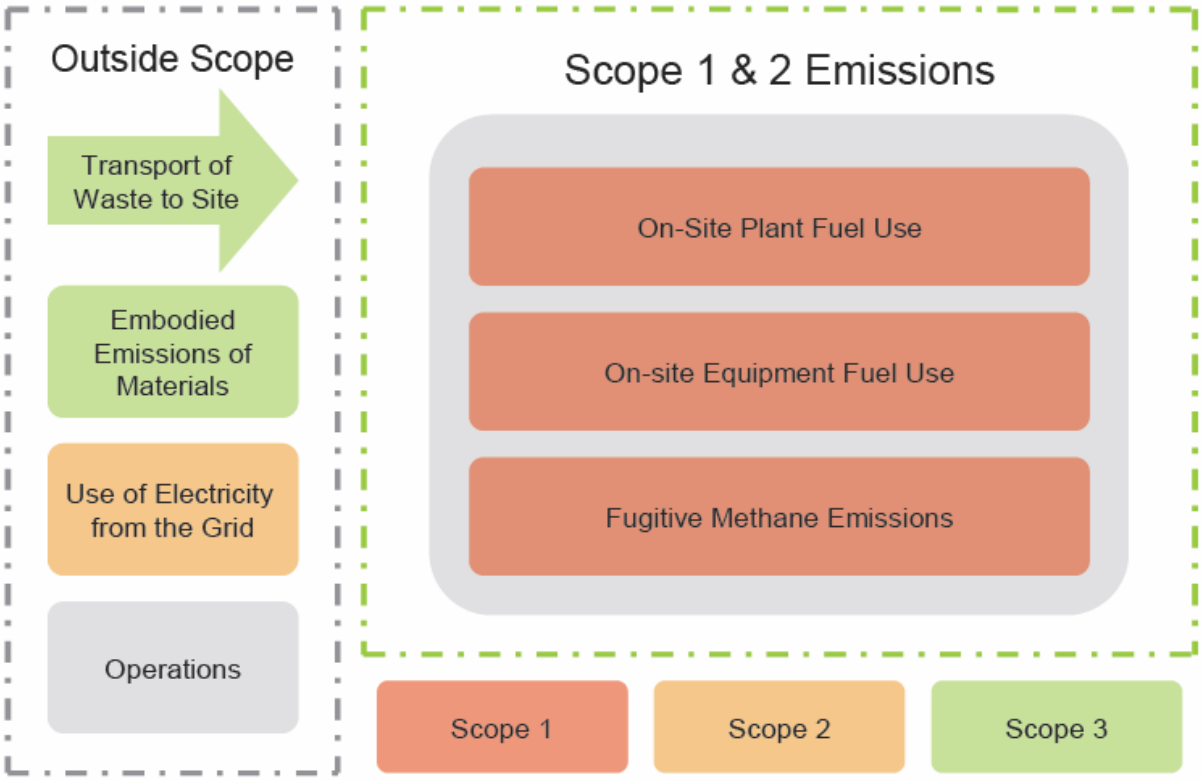
- Methane emissions;
- On-site equipment fuel consumption; and
- On-site plant fuel use.

The following emission sources were not included in this assessment:

- Emissions arising from the leachate were ignored. The Intergovernmental Panel on Climate Change (IPCC) guidelines estimates that the emissions from leachate are in the order of 1% of total emissions and recommends their exclusion.
- Scope 3 emissions such as:
  - Embodied emissions of construction materials
  - Transportation of waste from the source to the transfer stations
- Emissions arising from waste transport to site.
- Use of electricity from the grid, although they are Scope 2 emissions Council verified that the existing infrastructure at Stott Creek would be utilised for this site, therefore there will not be electricity use at Quirks Quarry Landfill.

Figure 1 presents a diagram of the greenhouse gas assessment boundaries. Details of the exclusions and assumptions are provided in *Section 2*.

Figure 1 Boundaries Diagram



1.4 Methodology

The greenhouse assessment was prepared in accordance with the following general principles:

- The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard developed by the World Business Council for Sustainable Development (GHG Protocol). This is a recognised international standard.
- The emissions arising from fuel consumption have been estimated using the factors and methodologies detailed in the *National Greenhouse Accounts (NGA) Factors – June* 2010 published by the Department of Climate Change and Energy Efficiency (DCCEE).
- According to the *National Greenhouse and Energy Reporting System Measurement, Technical guidelines for estimation of greenhouse gas emissions by facilities in Australia – June 2009* published by the then DCC (now DCCEE), after the waste is deposited in the landfill site, a portion of the organic matter within the waste will decompose with time to generate gases including Carbon Dioxide (CO_2) and Methane (CH_4), which are both identified as greenhouse gases. The organic matter within the waste is assumed to be of biogenic origin. This means that it has been generated by vegetation as part of the carbon cycle; hence any CO_2 emissions arising from the disposal of the organic matter are considered part of the carbon cycle and have no net emissions. However, CH_4 has a higher global warming potential (GWP) than CO_2 so CH_4 emissions are considered and converted to CO_2-e units based on the differences between the GWP of CO_2 and CH_4.

- The factors and methodologies used to estimate the methane emissions are from the DCC (2009*) National Greenhouse and Energy Reporting System Measurement Technical Guidelines for the estimation of greenhouse gas emissions by facilities in Australia*, June 2009.
- To estimate the methane emissions arising from the deposition of the waste in the landfill components the calculations were based on the predicted amount of waste to be received during the following
  - Quirks Quarry Landfill: 10 years of operation
  - West Valley Landfill – 12 years of operation
  - North Valley Landfill – 10 years of operation

  Thus the inventory represents present and future emissions arising from activities in the inventory year.

1.5 Data Collection

The data considered for this assessment was taken from the following sources:

- GHD (2009). *Draft Landfill Environmental Management Plan for Quirks Quarry Landfill* prepared for Tweed Shire Council
- GHD (2011). *Quirks Quarry Landfill Concept Design Report*. prepared for Tweed Shire Council
- GHD (2011). *Preliminary Quarry Study for the proposed West Valley Quarry*. prepared for Tweed Shire Council
- Preliminary estimates of landfill airspace and forecast waste acceptances for West Valley and North Valley Landfills.
- Fuel use for existing landfill and quarry operations as provided by Tweed Shire Council.

Wherever possible, estimates with high accuracy were used to calculate greenhouse gas emissions. Details of these assumptions and exclusions are provided in *Section 2.1 and 2.2.*

All emissions data has been converted into quantities of carbon dioxide equivalent and expressed in terms of tonnes of carbon dioxide equivalent (tCO_2-e).

1.6 Data Analysis

1.6.1 Methane Emissions Released from Landfill

- Methane emissions from the landfill were estimated in accordance with **Method 1**, one of the 3 methods available in the *National Greenhouse and Energy Reporting System Measurement – Technical Guidelines for the estimation of greenhouse gas emissions by facilities in Australia June 2009 (Technical Guidelines)*.
- **Method 1** – Methane generation from solid waste disposal is estimated using the tonnage of solid waste materials received at the landfill and a First Order Decay (FOD) model. The FOD model provides default factors such as methane generation constants (k) and degradable organic carbon (DOC) contents of different types of waste. The Determination also provides default percentages for different waste streams (Municipal Solid Waste, Commercial and Industrial, and Construction and

Demolition) for each state and territory and also provides default percentages for each type of waste (e.g. food, garden, paper, wood, inert materials) under each of the waste streams.

- For the purpose of this assessment the default waste stream and waste type percentages for New South Wales as mentioned in the Technical Guidelines were considered. *See* Table 1.
- The modelling included determining landfill gas emissions for predicted waste received for each year of operation from 2012 onwards.

Table 1 Default Waste Stream and Waste Type Mix for New South Wales

	Waste Streams		
	Municipal Solid Waste	Commercial & Industrial	Construction & Demolition
	31%	42%	27%
	Waste Mix Type for each waste stream above		
Food	35	21.5	-
Paper and paperboard	13	15.5	3
Garden and park	16.5	4	2
Wood and wood waste	1	12.5	6
Textiles	1.5	4	-
Sludge	-	1.5	-
Nappies	4	-	-
Rubber and Leather	1	3.5	-
Concrete, metal, plastic and glass	28	37.5	89

(Source: NGER Measurement, Technical Guidelines 2009)

1.6.2 Fuel Use

The emission factors (EF) used for this inventory have been sourced primarily from the *National Greenhouse and Energy Reporting System Measurement Technical Guidelines for the estimation of greenhouse gas emissions by facilities in Australia*, June 2009 published by the Department of Climate Change.

2. Exclusions and Assumptions

2.1 Exclusions

The following items were excluded from this assessment because their contribution to the inventory is anticipated to be neither minor, not relevant, or outside of the scope or because data was not available at the time of the assessment. Exclusions from the greenhouse gas assessment are:

- Emissions associated with electricity use from the grid; Council verified that there would be no requirements for a gate house, weighbridge, workshop, site office, wheelwash, recycling facilities and green waste processing as the existing infrastructure at Stotts Creek RRC would be utilised for this site;
- Emissions associated with the construction of operational infrastructure such as a haul road and other minor associated facilities as required;
- Emissions associated with maintenance of vehicles and equipment and the use of oils, grease, lubricants and replacement parts. Only fuel consumption related emissions have been included;
- Emissions associated with the manufacturing of construction vehicles and equipment and their transportation to site. The construction equipment is not manufactured primarily for this project and hence the emissions associated with manufacturing are not included, neither are the emissions from use of the construction equipment; and
- Emissions arising from the leachate were ignored. The Intergovernmental Panel on Climate Change (IPCC) guidelines estimate that emissions from leachate are in the order of 1% of total emissions and recommend their exclusion.

2.2 Assumptions

2.2.1 Stage 1 Project Application

Methane Emissions Released from Landfill

On the basis of forecast waste acceptance and the concept design for the Quirks Quarry landfill, and the estimated landfill void capacity that the landfill life with projected waste inputs will be approximately 10 years. The assumed landfilling start date is January 2012.

The estimated annual waste tonnages to be handled at Quirks Quarry Landfill are summarised in Table 2 below.

Table 2 Estimated Waste Volumes per Year

Year		Waste Mass (tonnes)
1	2012	47,893
2	2013	48,851
3	2014	50,316
4	2015	51,826
5	2016	53,381
6	2017	54,982
7	2018	56,632
8	2019	58,330
9	2020	75,030
10	2021	77,131

Fuel Use

The total fuel (diesel) used for plant and equipment at Quirks Quarry for the 2008/2009 financial year was 147,394.81 litres. It is therefore assumed that the same amount of fuel will be used per year during the operation of the West Valley Quarry.

Relatively minor amounts of diesel are utilised by Council in operating the landfills, with a report of 88.94 litres only being utilised at Stotts Creek in the 2008/2009 financial year. This is due to the landfill operations being conducted under contract, with the contractor being required to report their fuel usage and greenhouse gas emissions separately. This will continue to be the case during the operation of the landfills at Eviron Road.

Table 3 Predicted Total Fuel Use – Diesel (Stage 1 2012 - 2021)

Source	Fuel Used per Year (kL)	Total Fuel Used (kL)
On-site plant & equipment fuel use	147.5	1622

2.2.2 Concept Plan

Methane Emissions Released from Landfill (West Valley and North Valley)

Utilising the same emissions factors, waste composition, fuel consumption as that adopted for the Stage 1 activities, a preliminary estimate of the GHG emissions associated with the West and North Valley Landfills and North Valley Quarry have been made.

The operational lives of each of these facilities was based on forecast quarry extraction rates and landfill waste acceptance rates provided by Council, which results in the following:

- West Valley Landfill: 2022-2031
- North Valley Landfill: 2031 – 2044

It is noted that at present the GHG assessment has not factored in increased diversion of organic materials, and lower landfilling rates that will be likely following Council's implementation of AWT. The emissions forecast are based on business as usual waste acceptance rates forecast by Council. Therefore the emission rates presented herein are considered to be conservative and overestimate the likely GHG emissions from the West Valley and North Valley landfills.

3. Greenhouse Gas Assessment Results

3.1 Emissions Summary – Stage 1

Taking into account the assumptions and exclusions listed in *Section 2*, the result indicates total emissions of approximately 144,968 tCO_2-e for the Quirks Quarry Landfill. Of this total:

- 82,771 tCO_2-e arise from methane emissions during the landfill operational life; and
- 4,709 tCO_2-e arise from the plant and equipment fuel use for the West Valley Quarry and Quirks Quarry Landfill.

Methane emissions are the largest source contributing 97% of all emissions, with the remaining 3% arising from plant and equipment fuel use. A breakdown of the estimated emissions for the overall project is shown in Figure 2. The detailed sources of emissions are listed in Table 4. It is noted that this table does not account for emissions after closure of the landfill

Table 4 Summary of GHG Emissions Stage 1 Project Application

Source	Greenhouse Gas Emissions (tCO_2-e)
Methane Emissions	140,259
On-site plant & equipment fuel use	4,709
Total	**144,968**

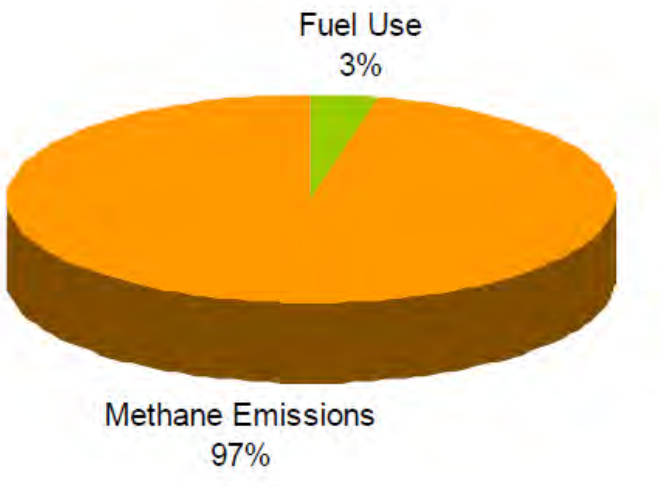


Figure 2 Stage 1 Project Application (Quirks Quarry Landfill and West Valley Quarry) Emission Sources (%)

3.2 Methane Emissions Released from Quirks Quarry Landfill

3.2.1 Methodology

As mentioned above, Method 1 has been used to model methane emissions from the Quirks Quarry landfill site. Method 1 uses the default waste stream and waste type percentages (as shown in Table 1) as outlined in the NGERS Technical Guidelines to characterise the waste that enters the landfill. The waste stream and waste type mix is important in the model calculations, as they determine the amount of degradable organic carbon that is available from which methane can be generated.

3.2.2 Results

The total emissions emitted to the atmosphere are calculated by multiplying the greenhouse gas emissions by a methane oxidation factor of 10%.

The modelling results show that a total of 140,259 tCO_2-e will be generated from decaying organic matter at the Quirks Quarry landfill during its operational life (Table 5).

Table 5 Methane Emissions per Year (tCO_2-e)

Year	Waste Tonnage (per year)	Emissions per Year (tCO_2-e)
2012	47,893	1,700
2013	48,851	4,842
2014	50,316	7,722
2015	51,826	10,395
2016	53,381	12,896
2017	54,982	15,252
2018	56,632	17,988
2019	58,330	20,538
2020	75,030	23,022
2021	77,131	25,904
	TOTAL	140,259
2022		23,263
2023		21,017

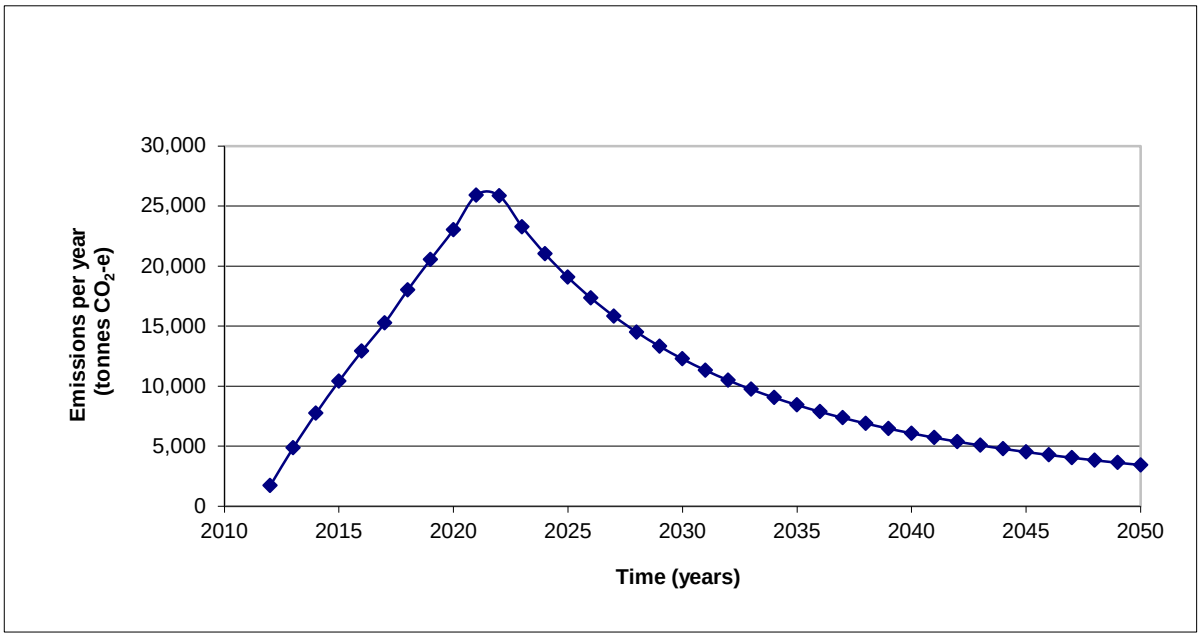


Figure 3 Quirks Quarry Landfill Methane Emissions per Year (tCO_2-e)

The First Order Decay method assumes that biodegradable component in waste decays slowly throughout a few decades, during which CH_4 and CO_2 are formed. If the landfill conditions are constant the rate of methane production will depend on the amount of carbon remaining in the waste.

As a result emissions of CH_4 from waste deposited in a landfill site are highest in the first few years after deposition and then gradually decline as the degradable carbon in the waste is consumed by the bacteria responsible for the decay. Therefore, emissions will continue to be emitted over a long period of time after the landfill has been closed as shown in Figure 3.

The methane emissions model was run for 100 years from 2021 and the results show that 498,055 tCO_2-e will be generated from decaying organic matter at the Quirks Quarry landfill over that period after closure.

3.3 Fuel Use – Stage 1

The total fuel (diesel) used for plant and equipment at Quirks Quarry for the 2008/2009 financial year was 147,394.81 litres. It has been assumed that the same amount of fuel will be used per year during the 11 years of the quarry's life.

Table 6 Predicted Total Fuel Use – Diesel (2012 - 2019)

Source	Fuel Used per Year (kL)	Total Fuel Used (kL)
On-site plant & equipment fuel use	147.4	1621.3

3.4 Emissions Summary Concept Plan

Utilising the same emissions factors, waste composition, fuel consumption as that adopted for the Stage 1 activities (refer Section 2), a preliminary estimate of the GHG emissions associated with the West and North Valley Landfills and North Valley Quarry have been made. The operational life of each of these facilities was based on forecast quarry extraction rates and landfill waste acceptance rates provided by Council.

As was the case with the Stage 1 activities methane emissions from landfilled waste are the largest source of GHG emissions for the remainder of the Concept Plan. Utilising the assumptions outlined above a breakdown of the source and estimated emissions for each of the activities in the Concept Plan beyond Stage 1 activities is provided in Table 9-38.

Table 3-7 Summary of GHG Emissions for Concept Plan (beyond Stage 1)

Source	Greenhouse Gas Emissions (tCO_2-e)
Landfill Methane Emissions (during operational life)	
- West Valley Landfill (2022-2033)	305,295
- North Valley Landfill (2034-2045)	417,807
On-site plant & equipment fuel use	
- West Valley Landfill	3
- North Valley Quarry	1497
- North Valley Landfill	3
Total	**724,605**

The landfill methane emissions models were run for 100 years from the closure date of the West Valley and North Valley landfills. This showed that 926,394 tCO_2-e and 1,271,284 tCO_2-e will be generated from decaying organic matter at the landfills respectively over the period after closure. This is displayed in Figure 4 below for both landfills.

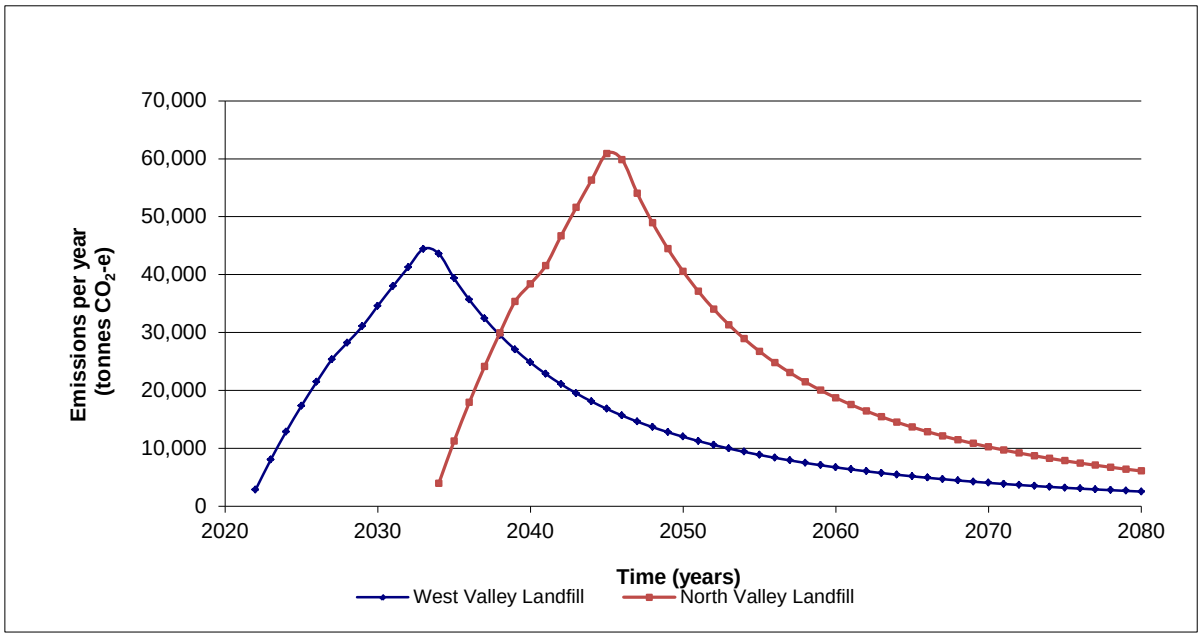


Figure 4 Estimated Landfill Methane Emissions Concept Plan (beyond Stage 1)

4. Recommendations

In addition to the initiatives identified in the Landfill Environmental Management Plan, such as resource recovery activities, diversion of recyclable and reusable items from landfill and the implementation of measures to minimise the potential for environmental impacts from the future waste management operations, GHD recommends the following:

4.1 Methane Emissions

Landfills are the main source of greenhouse gas emissions from the waste management sector. From the results of the inventory it can be seen that the emissions are dominated by methane emissions, to minimise these emissions it is recommended that:

- The landfill should be capped as soon as possible following the deposition of the waste. It is recommended that the cap is designed, constructed and maintained to minimise the leakage of gas from the decomposing waste.
- Reducing biodegradable organic content of waste going into the landfill would also reduce the methane emissions; however the quantity of LFG available for electricity generation along with the amount of carbon sequestered would also be reduced. To quantify the effects on the overall carbon footprint, an assessment would be required that also considers the implications of the emissions arising from the diverted waste.

4.2 Fuel

Diesel combustion is the second main source of greenhouse emissions. The following options may reduce these emissions:

- Switching to fuels with lower carbon intensity, such as biodiesel blends or LNG.
- Switching off equipment and stationary plant when not required.
- Optimising transport routes, payloads and journey timing to minimise fuel consumption.
- Selecting higher efficiency vehicles and stationary plant when making capital purchases and ensuring their size is appropriate for the intended tasks.
- Ensuring that vehicles are well maintained and have optimal tyre pressures.
- Ensuring that the operators and drivers are trained to operate vehicles and plant efficiently.
- Reviewing the current waste network and operational procedures to identity potential opportunities to minimise transportation requirements and double handling of waste.

4.3 Recovering Waste Energy

Depending on the quantity of landfill gas generated and captured infrastructure such as a flare will be installed as a minimum, and investigations into the viability and feasibility of tapping into or replicating the Stotts Creek Renewable Energy Facility will be undertaken once landfill gas flows and compositions can be verified. Council is committed to sustainable landfill gas management. Further investigation of the costs, benefits and logistics of tapping into or expanding (replicating) the existing infrastructure at the

Stotts Creek RRC Facility will be undertaken to identify whether this is a more advantageous solution to the provision of a flare at the future Quirks Quarry landfill. Either way, as a minimum

Based upon previous assessments carried out by GHD it is expected that at a minimum, gas extraction wells and a flare would be comprised 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
- Possible gas extraction flare (initial installation), with the potential for construction of an energy recovery plant depending upon the gas extraction volumes.

Council has a commitment to sustainable landfill gas management and has identified a potential alternative to onsite landfill gas 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 RRC Facility will be undertaken to identify whether this is a more advantageous solution to the provision of a flare at the future Quirks Quarry landfill.

There may also be opportunities to reduce greenhouse emissions by recovering waste energy. In particular, the waste heat from the LFG generators could be used if a local requirement for heat could be found, or cooling (such as office air-conditioning) by the use of waste heat in adsorption chillers. Various regenerator systems are also available to capture and reuse the energy involved in vehicle breaking to reduce fuel consumptions.

4.4 Carbon Offsetting

In addition to the mitigation of greenhouse gases by on-site programs, the carbon footprint of the project could be reduced by the purchase of offsets. These offsets can be generated from a variety of sources such as renewable energy, forestry plantations and energy efficiency projects.

5. References

Department of Climate Change, (2009). *National Greenhouse and Energy Reporting System Measurement - Technical Guidelines for the estimation of greenhouse gas emissions by facilities in Australia, June 2009,* Department of Climate Change, Canberra

Department of Climate Change and Energy Efficiency (2010). *National Greenhouse Accounts (NGA) Factors, June 2010*, Department of Climate Change and Energy Efficiency, Canberra

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Document Status

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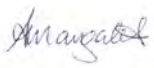
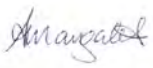
3	C Esquivel	A Marszalek		A Marszalek		3/10/11

Appendix L

Ecological Assessment

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council

Report for Eviron Road Quarry and Landfill

Ecological Assessment

June 2011

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

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Abbreviations

AASS	actual acid sulfate soil
AHD	Australian Height Datum
AKF	Australian Koala Foundation
ARI	Average Recurrence Interval
BoM	Bureau of Meteorology
CMA	Catchment Management Authority
CME	Commonwealth Marine Environment
DEC	NSW Department of Environment and Conservation (now OEH)
DECC	NSW Department of Environment and Climate Change (now OEH)
DECCW	NSW Department of Environment, Climate Change and Water (now OEH)
DEWHA	Commonwealth Department of the Environment, Water, Heritage and the Arts (now SEWPaC)
DGRs	Director-General's Requirements
DoP	NSW Department of Planning
DPI	NSW Department of Primary Industries (Fisheries)
E	Endangered threatened species
EA	Ecological Assessment
EECs	Endangered Ecological Community
EMP	Environment Management Plan
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
ESCP	Erosion and Sediment Control Plan
FM Act	NSW *Fisheries Management Act 1994*
GIS	Geographic Information System
IBRA	Interim Biogeographical Regions of Australia

LEMP	Local Environment Management Plan
LGA	Local Government Area
M	Migratory threatened species
MMS	Migratory marine species
NES	National Environmental Significance
NPW Act	NSW *National Parks and Wildlife Act 1974*
NPWS	National Parks and Wildlife Service
NV Act	NSW *Native Vegetation Act 2000*
NW Act	NSW *Noxious Weeds Act 1993*
OEH	NSW Office of Environment and Heritage
PASS	potential acid sulfate soil
RF Act	NSW *Rural Fires Act 1997*
RL	Reduced Level
RLP Act	*Rural Lands Protection Act 1998*
RRC	Resource Recovery Centre
SEPP	State Environmental Planning Policy
SEPP 14	State Environmental Planning Policy 14 – Coastal Wetlands
SEPP 26	State Environmental Planning Policy 26 – Littoral Rainforests
SEPP 44	State Environmental Planning Policy 44 – Koala Habitat Protection
SEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities
SIS	Species Impact Statement
TSC Act	NSW *Threatened Species Conservation Act 1995*
TSLA	NSW *Threatened Species Legislation Amendment Act 2004*
V	Vulnerable threatened species
WM Act	NSW *Water Management Act 2000*

Executive Summary

Tweed Shire Council proposes to establish infrastructure including two new quarries and three landfills and a haul road in Eviron, in the far North Coast of NSW, in a site adjoining the existing Stotts Creek Resource Recovery Centre. The activity has been designated as a Part 3A Major Project under the *Environmental Planning and Assessment Act 1979.*

A Project Application for Stage 1 of the overall concept, being a landfill within the existing quarry on the site and a new quarry, is sought. In addition approval for the overall development concept as outlined in the Concept Plan is sought. This includes Stage 1 and future stages of waste infrastructure currently proposed. This study investigates the potential ecological impacts of all components of the proposed activity currently outlined in the Concept Plan.

This Ecological Assessment has been prepared to address the Director General's Requirements with respect to biodiversity. These specifically relate to:

- Vegetation clearing estimates;
- Assessment of potential impacts upon threatened species, populations, endangered ecological communities or their habitats; and
- A detailed description of the measures that would be implemented to achieve a 'maintain or improve' outcome for biodiversity values of the surrounding region in the medium to long term.

A survey for flora and fauna species was undertaken in January 2009 in order to identify species occupying or potentially utilising the site on occasion as well as habitat for threatened species and populations. Additional surveys were conducted on the site by Council ecologists in June and July 2010.

A desktop assessment undertaken prior to the field surveys identified that a number of threatened species had previously been recorded within a 5 km radius of the site, and due to the presence of a variety of habitats within the study area, a number of these were considered to be likely to occur.

A flora survey was undertaken through traverse of the site. Eight vegetation types, two of which contained two sub-types, were mapped over the study area. This indicated that over 65% of the site was predominantly cleared or utilised for agricultural purposes, and 27% was camphor laurel (**Cinnamomum camphora*) dominated and thus in a relatively disturbed condition. Some areas of higher ecological value comprised of eucalypt open forest (wet and dry sclerophyll) were also mapped in the site. This included an area containing elements consistent with the endangered ecological community lowland rainforest on floodplain. In addition, a small area of vegetation adjacent to a drainage line showed characteristics of swamp sclerophyll forest on coastal floodplain. The proposed development footprint has been configured such that it predominantly avoids areas of higher ecological value and principally results in removal of camphor laurel dominated vegetation.

Due to the location of the site in the Tweed region along the coastal range, climatic conditions and vegetation occurring in the study area provided suitable habitats for a variety of threatened

rainforest plants. A number of conservation significant plant species were identified in the study area. These included white lace flower *(Archidendron hendersonii*) which is listed as vulnerable under the *Threatened Species Conservation Act 1995* and a number of rare or threatened Australian plants including black walnut *(Endiandra globosa*), long-leaved tuckeroo *(Cupaniopsis newmanii*) and smooth scrub turpentine (*Rhodamnia maideniana*). Five white lace flower plants occur within the development footprint (*Archidendron hendersonii*) will be removed as a result of the proposed activity. This species was also recorded in areas outside of the development footprint.

Fauna surveys were conducted through undertaking a trapping program over the study area, as well as nocturnal and diurnal surveys. A total of 99 fauna species were identified within the study area.

Six threatened fauna species listed under the *Threatened Species Conservation Act 1995* were observed or recorded on site during the survey, these being:

- Birds:
  - Collared kingfisher – (*Todiramphus chloris*) - vulnerable - (presumed to be a dispersing individual).
  - Little lorikeet – (*Glossopsitta pusilla*) - vulnerable.
- Mammals:
  - Koala (*Phascolarctos cinereus*) - vulnerable.
  - Grey-headed Flying-fox (*Pteropus poliocephalus*) – vulnerable.
  - Eastern false pipistrelle – (*Falsistrellus tasmaniensis*) - vulnerable ('almost certain' call identification confidence).
  - Little bentwing-bat – (*Miniopterus australis*) - vulnerable ('definite' call identification confidence).

In addition the following species were tentatively recorded:

- An overflying black-cockatoo species likely to be a Glossy black-cockatoo – (*Calyptorhynchus lathami*) - vulnerable, from the known population in the local area.
- A petaurid glider that was not able to be distinguished, and as such could have been a squirrel glider (*Petaurus norfolcensis*) – vulnerable, or a sugar glider (*P. breviceps*) (species not a listed threatened species).
- A possible record of the eastern long-eared bat (*Nyctophilus bifax*) – vulnerable ('possible' call identification confidence from a poor quality call sequence).

A precautionary approach has been taken to the identification of the tentatively recorded species, and all were considered as likely to at least forage in the study area on occasion.

The grey-headed flying-fox, listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* was recorded from the site, while a number of other federally listed species were considered to have potential to occur. Three migratory species were recorded during the survey.

A range of fauna habitats were recorded over the study area, these were generally consistent with mapped vegetation communities, with higher ecological value areas in the open eucalypt forest areas, and cleared or camphor dominated areas having lower ecological value for fauna species.

Due to the historical clearing and subsequent infestation of the site with exotic camphor laurels (**Cinnamomum camphora*), vegetation within the proposed development footprints generally contained limited habitat features that would provide lifecycle services to hollow-dependant mammals. In addition, only a sparse ground layer was present over areas of the site with a dense canopy cover, and as such provided limited sheltering opportunities for ground dwelling species. No hollow-bearing trees were recorded within the development footprints, although a number of larger eucalypts, likely to have been remnant paddock trees, occurred. Trees with hollows were present along the ridgeline in native vegetation outside of the development footprint.

The site is located on a northern spur of the Condong Range that leads down to the floodplain of the Tweed River which is dominated by canefields. As such, the connectivity for fauna species with low relative mobility is highly limited north of the site. The ridgeline along the western boundary of the site adjoins vegetation to the south and southwest that could potentially connect to the reserve system including Mooball National Park and to Mount Jerusalem National Park further southwest along the ranges. Connectivity to and from the site will be maintained, although the existing vegetated corridor that is currently of variable width and quality along the ridgeline will be narrowed from the current extent (ranging between approximately 140 m to >200 m) to approximately 100 m wide beside the quarry development footprint.

Identification of the potential ecological impacts associated with the activity identified that a number of existing and historical impacts have occurred within the site for a number of years. These relate to existing quarry operations in the site, as well as landfill operations at Stotts Creek Resource Recovery Centre immediately to the north west of the site. These impacts relate to historical habitat loss, degradation and alteration as well as fragmentation.

The proposed activity has a variety of impacts that would relate to impacts associated with the extractive industry or ‘quarry’ type development and the waste disposal facility or ‘landfill’ type development as well as the impact of the haul road.

Quarry impacts would be associated with development activities such as clearing, blasting, extraction, stockpiling and hauling. Associated potential impacts included:

- Habitat loss;
- Habitat fragmentation;
- Loss of biodiversity; and
- Fauna mortality or injury.

The development of the landfill will include a fully engineered liner and leachate management system. Landfill impacts would be associated with active landfilling, with the key associated potential impact being habitat degradation.

Impacts associated with the haul road predominantly relate to vegetation clearing with potential habitat loss and habitat fragmentation as well as potential for direct mortality from vehicle strike.

As required by the Director General's Requirements, an evaluation of the potential impacts of the proposed activity was undertaken in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005). In order to achieve a 'maintain or improve' outcome for the biodiversity values of the site in the medium to longer term, the principal of avoiding and mitigating impacts was employed prior to consideration of offsets if residual impacts remained.. A series of management measures that Council will employ to achieve a 'maintain or improve' outcome has been described in this document. These include:

- Avoid:
  - Quarry development footprints and the haul road have been located and where possible reconfigured or realigned to primarily avoid areas of higher ecological value habitats and predominantly result in clearing of camphor dominated vegetation types.
  - Landfill footprints are wholly contained within the quarry development footprints and will not result in further clearing requirements.
- Mitigate:
  - Design of the quarry and landfill components of the activity will include design features that reduce the potential for environmental impacts, such as leachate management systems, appropriate drainage and flood management systems.
  - All components of the development will be subject to an approved Environmental Management Plan in order to actively manage potential impacts of the development throughout the course of the activity.
  - Although the above measures are considered to largely avoid or mitigate potential loss of biodiversity values of the site, the following values were thought to require further consideration through provision of an offset. These values related to:
- Loss of koala (and other fauna species) foraging habitat – for example, scattered eucalypts occur within the camphor dominated vegetation which could provide browsing habitat for koalas, while camphor laurels may afford foraging habitat for a range of species including the rose-crowned fruit-dove and grey-headed flying-fox.
- Loss of shelter – camphor laurel dominated vegetation provides shelter (e.g. thermal, cover), for a variety of fauna species including the koala.
- Narrowing of connectivity along the ridgeline.
- Clearing of five white lace flower (*Archidendron hendersonii*) plants from within the camphor dominated vegetation and as such, loss of potential habitat for rainforest species.

Council is committed to the implementation of a range of management measures in order to achieve a 'maintain or improve' outcome for biodiversity values at the site in the medium to long term as per the Director General's Requirements. These include:

- A restriction on use on a portion of Lot 1 DP1159352 registered on the title imposing a legal obligation in perpetuity to abide by the management actions of a Habitat Management Plan. A plan showing the habitat areas on Lot 1 DP1159352 would be registered with the s88B

instrument to identify the area burdened by the restriction. The vegetated areas outside of the haul road footprint in this area contain blackbutt open forest (approximately 3 ha). It is anticipated that the vegetated area would be designated as a 'natural area' and be preserved and managed in order to conserve and potentially enhance habitat for fauna species including the koala as well as maintaining and enhancing potential habitat for threatened rainforest plants.

- A target survey will be undertaken for threatened plant species once the final development footprint has been developed in the detailed design phase. A Preliminary Translocation Plan for Threatened Plants has been prepared by Council. Should any additional species be recorded, then this plan will be revised accordingly.
- Corridor planting and enhancement – two areas within the site have been identified for creation of connectivity and reconstruction of habitat including staged removal of camphor laurel and other weed species. These areas are along a drainage line across the eastern portion of Lot 1 DP1159352, which would in the longer term allow for sheltered movement of species such as koalas across the presently cleared lowland area of the site, and planting along the ridgeline along the southern boundary of the site on Lot 1 DP34555 which is presently cleared, which would enhance connectivity directly along the Condong Range for species such as the koala. A Preliminary Restoration Plan has been prepared by Council for the areas identified.
- Supplementary nest box installation – although no hollow-bearing trees will be removed some mature eucalypts with the potential to provide hollows will be lost. Consequently, in recognition of this, a nest box plan for petaurid gliders is proposed.

An assessment of threatened species potentially impacted by the proposed activity against the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) and/or the *Environment Protection and Biodiversity Conservation Act 1999* significant impact guidelines (DEH, 2006), did not identify that the proposed development would result in any adverse impacts that were likely to result in a reduction in the viability of a threatened species, population or ecological community that was recorded or could occur in the study area. Although the project is relatively long term and has some impacts that may be permanent and irreversible, the areas in which the activity footprint have been located do not impact upon important habitat features that could result in localised extinction of any threatened flora or fauna species or endangered ecological communities.

Implementation of the management measures as outlined within this document are expected to adequately manage the potential ecological impacts identified and allow for a development that is sensitive to the conservation significant species and ecological communities present on the site.

1. Introduction

1.1 The Proposed Activity

1.1.1 Overview

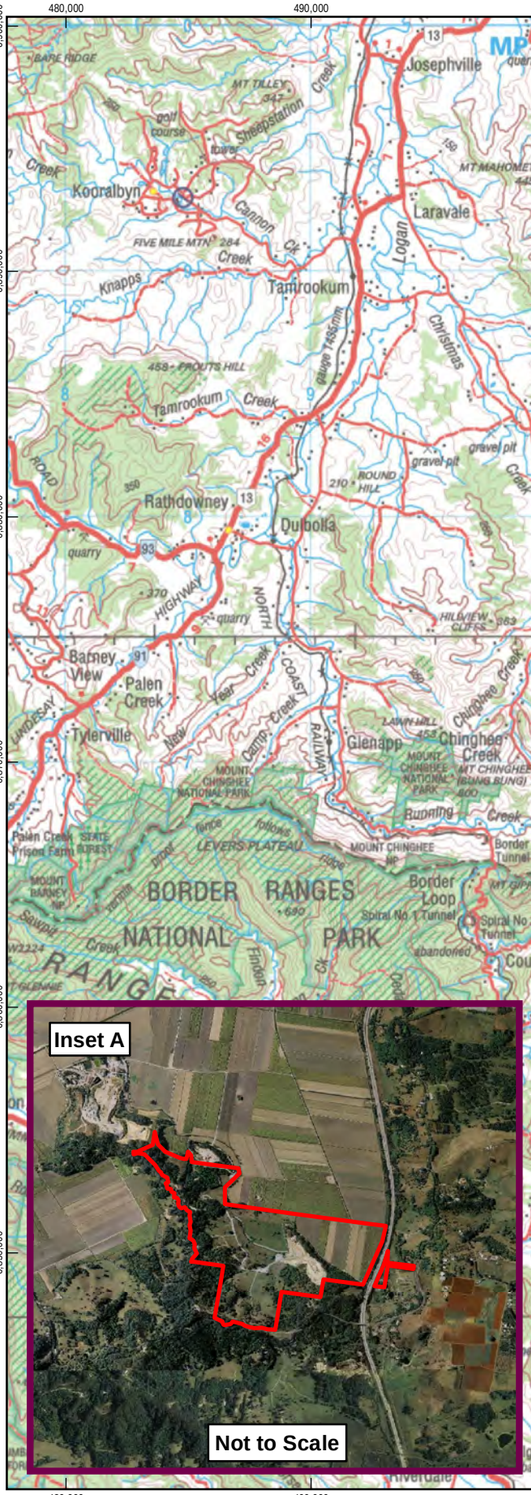
Tweed Shire Council (Council) proposes to establish the Shire's new waste disposal facility on existing Council-owned land (comprising Lot 1 DP34555; Lot 1 DP1159352 Lot 602 DP1001049 – 'the site') at Eviron Road, Eviron, within the Tweed Shire local government area (LGA). The existing Council waste disposal facility, Stotts Creek Resource Recovery Centre (RRC), located immediately to the northwest of the site, is predicted to reach capacity by 2012. The regional location of the site is shown on Figure 1, while Figure 2 provides a general layout of the site.

Council has developed an overall Concept Plan that provides a broad overview of the proposed waste infrastructure. This includes requirements for the Tweed Shire in the short term as well as additional waste infrastructure that may be developed in the future to meet the Shire's projected medium and long term needs.

The Concept Plan (Figure 3) outlines a proposed staged project to develop a landfill within the existing void space created by Quirks Quarry and develop a new quarry at West Valley, as well as necessary operational infrastructure such as a haul road, and other minor associated facilities as required. Further to this, future development may include development of another quarry and development of landfills in the quarry voids. For the purposes of this document, all components of the development associated with the Concept Plan are referred to as the 'proposed activity'.

The waste infrastructure proposed by Council was declared by the NSW Department of Planning (DoP) to be a Major Project, to which Part 3A of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) applies. Under the Part 3A process, the targeted assessment regime for the project has been determined by key environmental issues as defined by the Director-General of DoP in the Director-General's Requirements (DGRs). As identified in Planning Circular, PS 11-014 of 13 May 2011 (DPI, 2001), transitional arrangements in place under the new State Environmental Planning Policy (Major Development) Amendment 2011 (SEPP) allow existing project applications and concept plan applications to continue to be assessed under Part 3A of the Act until the proposed Bill that will repeal Part 3A of the EP&A Act is passed by Parliament and takes effect (Department of Infrastructure and Planning, 2011). As such, this document assumes that the Part 3A process will be maintained. Council intends to undertake a staged approach to the proposed activity, and has sought two approvals from the DoP:

- *Project Approval* for 'Stage 1' of the Concept Plan (Stage 1 Project Application), 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 RRC.
- *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 included in the Concept Plan.



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Grid: Map Grid of Australia 1994, Zone 56

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Site Boundary

Tweed Shire Council
Eviron Road Quarry and Landfill Environmental Assessment

Job Number 41-20806
Revision 1
Date 27 MAY 2011

Locality Plan

Figure 1

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Data source: Tweed Shire Council - Aerial Photography (2008). Geoscience Australia - NATMAP Raster Premium 250k (2005). GHD - Site Boundary (2011).

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Hawkens Ln
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Duranbah Rd
Eviron Rd

1:10,000 (at A3)

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Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Site Boundary

Study Area

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Tweed Shire Council
Eviron Road Quarry and Landfill Environmental Assessment

Job Number	41-20806
Revision	1
Date	27 MAY 2011

The Site

Figure 2

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Data source: Tweed Shire Council - Aerial Photography (2008), Cadastre boundary (2010). GHD - Site Boundary (2011), Study Area (2010).

1.2 Ecological Assessment Scope and Environmental Assessment Requirements

1.2.1 Overview

This ecological assessment report has been prepared as a technical document to address the 'biodiversity' requirements of the DGRs and support the Environmental Assessment for the proposed activity. In accordance with the DGRs, survey and assessment of threatened species, populations, endangered ecological communities or their habitats has been undertaken in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005) under s.75f of the EP&A Act 1979 ('the Part 3A Assessment Guidelines').

The Part 3A Assessment Guidelines identify important factors and key thresholds that must be considered by proponents and consultants when assessing potential impact of an activity on threatened species, populations, ecological communities, or their habitats for development applications assessed under Part 3A. In particular, the decision maker must be certain that the activity will meet the following guiding principles:

- The activity maintains or improves biodiversity values (i.e. there is no net impact on threatened species or native vegetation);
- The activity conserves biological diversity and promotes ecologically sustainable development;
- The activity protects areas of high conservation value (including areas of critical habitat);
- The activity prevents (or does not result in) the extinction of threatened species;
- The activity protects the long-term viability of local populations of a species, population or ecological community; and
- The activity protects aspects of the environment that are matters of national environmental significance.

1.2.2 Approach

The proposed activity described in the Concept Plan will take place over a time period of approximately 40 years. Although the Stage 1 Project Application relates only to Quirks Quarry landfill, West Valley quarry and associated infrastructure, this ecological assessment report assesses the Concept Plan as a whole, as the components associated with the activity are likely to occur concurrently at least during part of the time, and are therefore not able to be assessed independently.

A number of technical studies associated with concept design of components of the proposed activity have been prepared by GHD to support the environmental assessment, including:

- Draft Landfill Environmental Management Plan for Quirks Quarry Landfill (GHD, 2009) – a document that provides details of the conceptual design and management objectives for the landfill proposed for Quirks Quarry and addresses (former) NSW Department of Environment, Climate Change and Water (DECCW) requirements for solid waste landfills.

- Preliminary Quarry Study for the proposed West Valley Quarry (GHD, 2011) – a document that addresses the requirements of Industry and Investment NSW (previously the Department of Primary Industries (DPI)) and the DGRs and describes existing resources, proposed quarry configuration and sequence of construction and quarry operations.

These documents provide specific details with respect to the development footprints associated with Quirks Quarry Landfill and West Valley Quarry, and as such the ecological assessment is able to consider specific details of the impacts of the project application (e.g. areas of clearing).

The future components of the Concept Plan (i.e. West Valley landfill, North Valley quarry and then landfill) have not yet been subject to concept design. The anticipated development footprint and impacts associated with these components have been considered based upon the scale of development proposed for Stage 1 (i.e. it is assumed that the future quarry and landfills associated with future stages of the current Concept Plan would require a development footprint of a similar magnitude and result in similar impacts to that of Stage 1) as well as the type of development (i.e. 'quarry' type or 'landfill' type) for which there are expected to be equivalent impacts to the quarry and landfill type developments from Stage 1.

Consideration of potential ecological impacts of future components of the proposed activity prior to their concept design will allow constraints identified to inform the future design such that impacts to areas of higher ecological value may be avoided if this future stage is developed.

The survey methodology utilised in this assessment was developed with regard to the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (working draft)* (DEC, 2004). The proposed survey methodology was sent to DECCW (Grafton Office) on the 19 December 2008 for review. A letter received on the 7 Jan 2009, signed by Geff Cramb, Acting Head Industry and Waste Unit, North Coast (contact officer Kirsty Sutherland, Regional Biodiversity Conservation Officer), indicated that the proposed methodology was considered by DECCW to generally be consistent with these guidelines.

Assessments of the potential impacts of the proposed activity on threatened species, populations, endangered ecological communities and their habitats were undertaken with regard to the:

- Draft Guidelines for Threatened Species Assessment (DEC and DPI, 2005); and
- Commonwealth EPBC Act Significant Impact Guidelines (V1.1) (DEWHA, 2006).

1.2.3 Objectives

The objectives of this ecological assessment are to:

- Detail the existing environment of the subject site including:

Flora species and vegetation communities occurring or having potential to occur within the subject site and study area;

Fauna species utilising or potentially utilising habitats within or adjacent to the subject site and study area;

- Identify the presence of species of conservation significance including:

  Species, populations and communities listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act);

Species, populations and communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation* Act *1999* (EPBC Act); and

Rare or Threatened Australian Plants (ROTAP) (Briggs and Leigh, 1996);

- Report and map the extent and condition of vegetation communities and fauna habitats in the study area;
- Identify areas of particular conservation significance in or adjacent to the study area;
- Identify the likely impact of the proposed activity on flora and fauna values of the specified study area, in particular threatened species, populations and endangered ecological communities (EECs);
- Assess the likely significance of the impacts of the proposal upon threatened species, populations or EECs with respect to the Part 3A Assessment Guidelines (DEC and DPI, 2005) and, where relevant, the EPBC Act Significant Impact Guidelines (DEH, 2006);
- Identify measures to avoid, minimise or mitigate adverse impacts on the biodiversity values of the study area, including consideration of environmental management and offset requirements if appropriate, to achieve a maintain or improve outcome; and
- Make recommendations as to the need or otherwise for a referral to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) (formerly the Department of Environment, Water, Heritage and Arts (DEWHA)), for a decision on whether assessment and approval is required under the EPBC Act.

1.2.4 Definitions

For clarity, terminology utilised throughout this report aims to be consistent with the *Threatened Species Assessment Guidelines* (DECC, 2007). The following provides key definitions in relation to spatially describing particular areas of the proposed activity.

The Site

The site is made up of a number of land parcels in the ownership of TSC, as well as parcels of land currently under negotiation for acquisition, and covers an area of approximately 113 ha (Figure 2).

- Lot 1 DP34555;
- Lot 602 DP1001049; and
- Lot 1 DP1159352.

Subject Site

The term ‘subject site’ refers to areas **directly affected** by the proposed activity (also referred to as the ‘development footprint’) as shown as shaded areas in Figure 3 including:

- Quirks Quarry landfill footprint (approximately 6.398 ha);
- West Valley Quarry / Landfill footprint (approximately 10.973 ha);
- North Valley / Landfill footprint (indicative footprint approximately 3.551 ha); and
- Haul road footprint (approximately 2.583 ha in site boundary).

Note that the development footprints shown in Figure 3 for the Quirks Quarry landfill and West Valley quarry are based upon concept designs that have been developed for the Stage 1 Project Application.

Study Area

The study area includes the subject site and additional areas potentially indirectly affected by the activity. With respect to the activity, these areas include the subject site and adjoining vegetated areas (Figure 2).

Direct Impacts

Direct impacts are impacts that will specifically impact upon habitat (e.g. clearing) or individuals (e.g. mortality).

Indirect Impacts

Indirect impacts are those impacts related to the proposed activity that may occur as a result of modifications to the environmental conditions that have flow-on effects on species, populations or ecological communities.

Life Cycle

The term 'life cycle' refers to stages of reproduction, growth, development, aging and death of an organism.

Viable

The term 'viable' refers to the capacity of a species or population to successfully complete all stages of their lifecycle under normal conditions.

Local Population

With respect to the proposed activity, the term 'local population' is defined as follows for flora and fauna species:

- Flora - A local population of plant species would include plants within vegetated areas on the western side of the Pacific Highway including areas along the spur of the Condong Range and adjoining vegetation along the Condong Range (along Eviron Road) including vegetated areas adjacent to Quirks Quarry.
- Fauna – A local population of a fauna species would be dependant upon the size, home range requirements and the relative mobility of a species, however in general terms is defined as being species that occupy or occasionally forage within vegetation in the study area and adjoining areas along the Condong Range to the west.

Local Occurrence

'Local occurrence' is a term used in association with an ecological community and refers to the occurrence of the ecological community in the study area, and includes (depending upon the vegetation community) areas of contiguous vegetation that extend along the Condong Range to the west of the Pacific Highway.

Risk of Extinction

The likelihood that a local population or ecological community will become extinct either in the short or long term as a result of direct or indirect impacts of the activity on the viability of the population or changes to ecological function of an ecological community.

Habitat

The area occupied, at least on an occasional basis by a species, population or ecological community, including both the biotic and abiotic aspects.

Extent

The term 'extent' refers to the physical area to be removed (referred to as the development footprint), and/or to the components of the habitat and the degree to which they are affected by the proposed activity.

Importance

The term importance relates to the reliance of a species, population or ecological community upon habitats within the development footprint with respect to their lifecycle.

Locality

The term 'locality' relates to lands within a 5 km radius from the study area.

1.2.5 Nomenclature

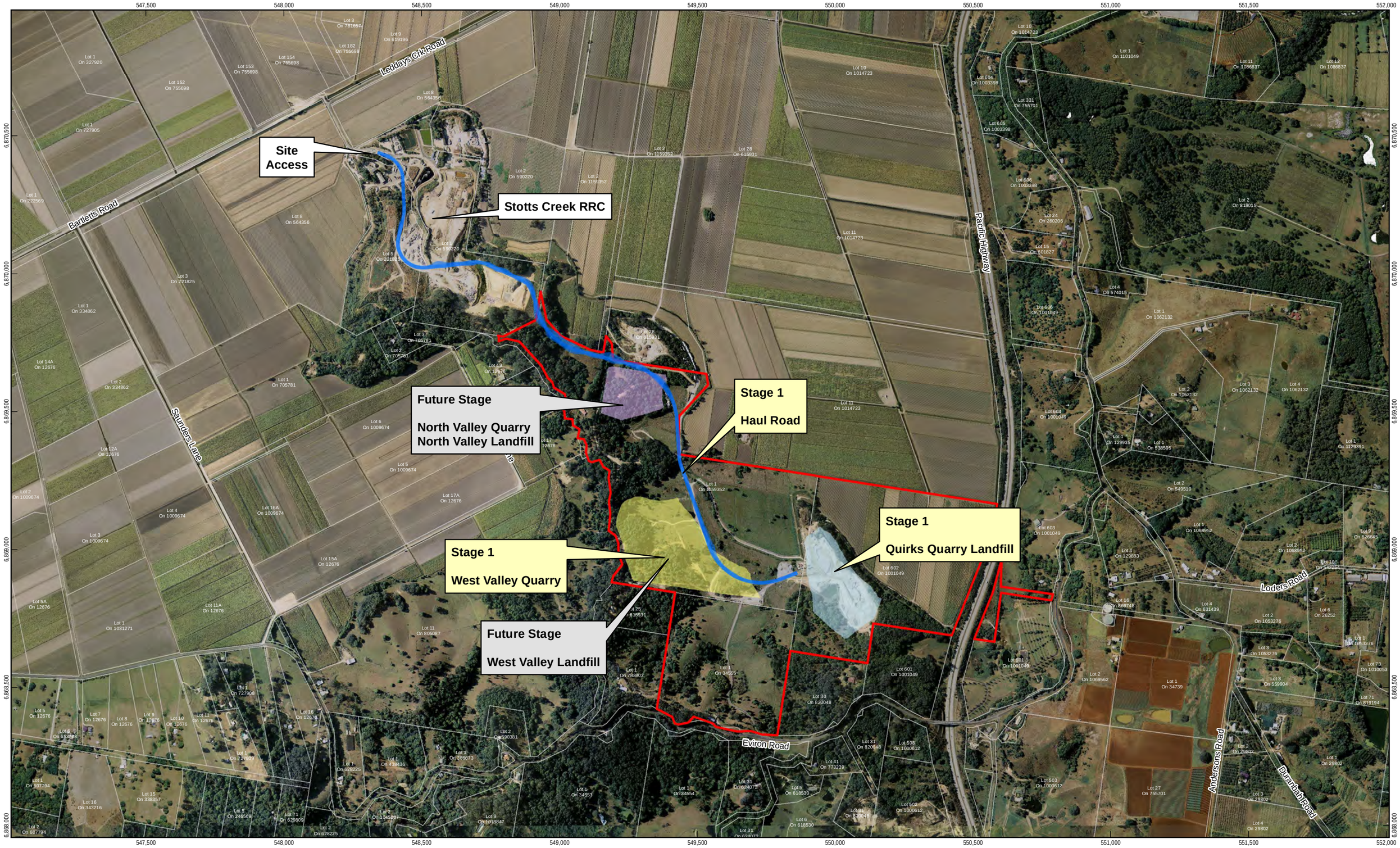
Nomenclature within this assessment generally follows:

- *Handbook of Australian, New Zealand and Antarctic Birds* (HANZAB) Book Series (Higgins et al., 2006);
- *Field Guide to Mammals of Australia* (Menkhorst and Knight, 2004);
- *A Field Guide to Frogs of Australia* (Robinson, 1998 and Cogger, 2000);
- *The Flora of New South Wales* Volumes 1 to 4 (Harden 1990 - 2002) and taxonomic updates in PlantNET - The Plant Information Network System of Botanic Gardens Trust, Sydney, Australia (Version 2.0, http://plantnet.rbgsyd.nsw.gov.au).

Scientific names of exotic species (both flora and fauna) are prefixed throughout this document by an asterisk.

1.2.6 Permit

Flora and fauna surveys for this assessment were undertaken in accordance with Scientific Licence number S11428.



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Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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- Site Boundary
- Cadastre boundary
- Landfill footprint
- West Valley footprint
- North Valley footprint
- Haul Road

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Tweed Shire Council
Eviron Road Quarry and Landfill Environmental Assessment

Job Number	41-20806
Revision	1
Date	27 MAY 2011

Concept Plan

Figure 3

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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).

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2. Legislative Framework

2.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act prescribes the Commonwealth's role in environmental assessment, biodiversity conservation and the management of protected areas and species, populations and communities, and heritage items. The EPBC Act applies to all land, waters, seabed and airspace in, under or above Australia.

Approval under the EPBC Act is required for:

- An action which has, will have or is likely to have a significant impact on 'matters of national environmental significance' (NES);
- An action by the Commonwealth or a Commonwealth agency which has, will have or is likely to have a significant impact on the environment;
- An action on Commonwealth land which has, will have or is likely to have a significant impact on the environment; or
- An action, which has, will have, or is likely to have, a significant impact on the environment on Commonwealth land, no matter where it is to be carried out.

Matters of NES include:

- Listed threatened species and ecological communities;
- Migratory species protected under international agreements;
- Ramsar wetlands of international significance;
- The Commonwealth marine environment;
- World Heritage properties;
- National Heritage places;
- Great Barrier Reef Marine Park; and
- Nuclear actions.

Where the proponent considers that an action will have or is likely to have a significant impact on matters of NES, or on Commonwealth land, a referral is made to SEWPaC for a decision on whether assessment and approval is required under the EPBC Act. The proponent may also, but is not required to, make a referral where they consider that the action will not have or is not likely to have a significant impact, but would like confirmation.

If it is identified through the referral process by SEWPaC that a project is likely to have a significant impact on a matter of national environmental significance, or on Commonwealth land, then the project is a controlled action and approval from the Commonwealth Minister for the Environment would be required.

2.2 NSW Environmental Planning and Assessment Act 1979

The proposed activity was declared by DoP to be a project to which Part 3A of the Environmental Planning and Assessment Act, 1979 applies (DoP Reference S07/01027). Part 3A of the EP&A Act establishes an assessment and approval regime for development. The Minister for Planning is the approval authority for Part 3A projects.

As of May 2011, the NSW State Government announced that it will introduce a Bill to repeal Part 3A of the EP&A Act. As part of the transitional arrangements announced, applications for project types including mining and significant infrastructure proposals that are already in the Part 3A system will continue to be assessed and determined under Part 3A pending its legislative repeal (Planning and Infrastructure, 2011).

The specific requirements of the DGRs with respect to biodiversity as relates to this report are outlined in Table 1, which also indicates the location/s in this document where the specific requirement has been addressed.

Table 1 Director General's Requirements for Biodiversity

DGRs Requirement	Where Addressed
Accurate estimates of any vegetation clearing associated with the project	A vegetation map is provided in Figure 6, while Table 10 indicates specific areas of clearing by vegetation type.
A detailed assessment of the potential impacts of the project on any threatened species, populations, endangered ecological communities or their habitats	Section 1 identifies potential ecological impacts by development type. Part 3A and EPBC Act assessments of significance are provided in Appendix H.
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.	Management measures are provided in Section 1.

In accordance with the requirements of the DGRs this assessment will consider the existing environment, assess the likely impacts of the proposal on flora and fauna and propose appropriate mitigation measures such that biodiversity values of the surrounding region are maintained or improved in the medium to long term.

2.3 NSW Threatened Species Conservation Act 1995

The TSC Act provides legal status for biota of conservation significance in NSW. The Act aims to, *inter alia,* 'conserve biological diversity and promote ecologically sustainable development'. It provides for the listing of 'threatened species, populations and ecological communities' (threatened biota) with endangered species, populations and communities listed under Schedule 1, 'critically endangered' species and communities listed under Schedule 1A, and vulnerable species and communities listed under Schedule 2. The DGRs require a detailed assessment of the potential impacts of the project on any threatened species, populations, endangered ecological communities or their habitats.

2.4 State Environmental Planning Policy 44 – Koala Habitat Protection

The aim of State Environmental Planning Policy 44 - Koala Habitat Protection (SEPP 44) is to properly conserve and manage areas of natural vegetation that provide koala (*Phascolarctos cinereus*) habitat such that populations are maintained over the current range and do not decline. SEPP 44 applies to the Tweed LGA, and although the activity is being dealt with under Part 3A of the EP&A Act, the policy is relevant due to its inclusion as a relevant policy in the DGRs. An assessment of the vegetation in the study area with respect to the requirements of SEPP 44 has been made in Section 7.2.4. Scheduled Koala Feed Trees under SEPP 44 are listed in Table 2.

Table 2 Scheduled Koala Feed Trees

Scientific Name	Common Name
Eucalyptus tereticornis	Forest red gum
Eucalyptus microcorys	Tallowwood
Eucalyptus punctata	Grey gum
Eucalyptus viminalis	Ribbon or manna gum
Eucalyptus camaldulensis	River red gum
Eucalyptus haemastoma	Broad leaved scribbly gum
Eucalyptus signata	Scribbly gum
Eucalyptus albens	White box
Eucalyptus populnea	Bimble box or poplar box
Eucalyptus robusta	Swamp mahogany

3. Site Description

3.1 Location and Description

The site is situated on the northern side of Eviron Road, Eviron, in the Tweed Shire on the Far North Coast of NSW. Surrounding localities include Tumbulgum and Stotts Creek to the north, Duranbah to the east, Clothiers Creek, Farrants Hill and Nunderi to the south, and Condong to the west (see Figure 1).

The site is made up of a number of land parcels in the ownership of Council:

- Lot 1 DP34555;
- Lot 602 DP1001049; and
- Lot 1 DP1159352.

These parcels cover an area of approximately 110 ha (shown by the site boundary on Figure 2). The area to the west of the Pacific Highway covers an area of approximately 108.5 hectares.

Approximately 55% of the site is vegetated. The lower slopes are predominantly cleared and contain areas of sugar cane or open grassy areas with isolated trees. The upper slopes and ridges along the western boundary are vegetated, as are the hills to the south and the area immediately adjacent to the eastern side of Quirks Quarry. Lot 1 DP34555, the central southern lot adjoining Eviron Road, contains only scattered vegetated areas. The existing haul road to Quirks Quarry traverses this lot.

It is likely that historical clearing of vegetation for agricultural purposes has occurred on a large proportion of the site. Removal or reduction in grazing or other ongoing management practices has allowed dense establishment of camphor laurels (**Cinnamomum camphora*), with only small pockets of native vegetation evident. Occasional emergent eucalypts within the camphor open forest and woodland are most likely to have been remnant isolated paddock trees. This pattern of historical clearing and regrowth of camphor laurels is evident over the ridgelines in much of the local area. Prior to this ecological survey, camphor laurel management was progressively being undertaken on the site, and has ceased for the purposes of the assessment.

Vegetation in surrounding areas on the western side of the Pacific Highway follows a similar pattern to that in the site, having vegetated mid to upper slopes with cleared lower slopes and floodplain, while areas on the eastern side of the Pacific Highway along Eviron Road have been more substantially cleared, although similarly contain areas of regenerating camphor laurels.

3.2 Topography

The site is located along a northern spur of the Condong Range where the range meets the floodplain of the Tweed River and is separated from the coastal plain to the east by the northern extent of the Condong Range which extends further to the northeast of the site. The natural ground surface within the site rises relatively steeply from the floodplain from <2 m AHD up to around 40 m AHD in the north west and >60 m AHD in the south of the site. The proposed west

valley and north valley footprint areas are located on the side of a minor flank of a series of ridges which are cut at lower elevations by the flood plains related to the Tweed River estuary system.

3.3 Geology

3.3.1 Regional 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 Tweed River 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 and south of the site and 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 (Department of Mines and Energy, 1967).

3.3.2 Site Specific Geology

Studies by Gilbert and Sutherland (2007 and 2008) identified two predominant geological units over the site, these being unconsolidated alluvial and marine deposits, and are broadly characterised as clay (including marine clay) and silty clay material containing limited and variable proportions of gravel and sand and occasional lenses of sandy clay; and bedrock, mapped as the Neranleigh-Fernvale Beds including weathered siltstone, quartzite, chert, greywacke and basalt. This was for the most part confirmed through a drilling program undertaken as part of the planning for this assessment, which identified the presence of siltstone, sandstone, clay, gravel and conglomerate (GHD, 2011).

3.4 Soils

3.4.1 Soil Landscapes

Soil landscape mapping of the Murwillumbah – Tweed Heads 1:100,000 Sheet (Morand, 1996) indicates that three soil landscapes occur on the slopes of the site, these being the Burringbar, Billinudgel and Ophir Glen soil landscapes, while the Tweed soil landscape group extends along the floodplain.

The ridges of the site are predominantly comprised of an erosional landscape which is mapped as the Burringbar soil landscape. This is described as being of high rolling to steep hills with narrow to moderately broad ridges and crests which reflects the topographic character of the site. For this soil landscape group, crests and some slopes are typically comprised of grey earths, upper slopes of moderately well-drained red podsolic soils, poorly drained yellow podsolic soils with moderately well-drained red earths on lower slopes and footslopes. The soil landscape is described as being erodible, strongly acid, hardsetting and dispersive (Morand, 1996).

The Billinudgel soil landscape is also comprised of rolling hills with localised steep slopes and typically occurs downslope from the Burringbar soil landscape on the margins of the Burringbar Hills Region (which extends over much of the eastern side of the Shire). Crests of this soil landscape are comprised of red podsolic soils with yellow earths and yellow podsolic soils on slopes. This soil landscape extends over the northern end of the spur of the Condong Range upon which Stotts Creek RRC is situated (Morand, 1996).

The transferral soil landscape of Ophir Glen, comprised of sheet-flood fans, alluvial fans and valley infills, is mapped predominantly on the lower slopes of Lot 1 DP34555. The soils of this landscape are described as poorly drained yellow podsolic soils, moderately well-drained minimal prairie soils and deep poorly drained minimal brown podsolic soils which occur on the lower portions of some coastal fans. Soil limitations are described in terms of waterlogging, high watertables, flood hazard, high run-on and water erosion hazard. They are strongly acidic, highly erodible and hardsetting. Small areas of this soil landscape group are mapped in similar between-slope areas throughout the region and generally have been extensively cleared (as on the site), and adjoin the Tweed soil landscape group downslope (Morand, 1996).

An estuarine/alluvial soil landscape comprised of an extensive marine plain comprised of deep Quaternary alluvium and estuarine sediments extends throughout the floodplain of the Tweed River which generally delineates the limits of the soil landscape (Morand, 1996).

3.4.2 Acid Sulfate Soils

Acid Sulfate Soil Risk Mapping, prepared by the (former) NSW Department of Land and Water Conservation (DLWC) predicts the distribution of acid sulfate soils (actual acid sulfate soil (AASS) and potential acid sulfate soil (PASS) based on an assessment of the geomorphic environment (DLWC, 1998)). This mapping indicates that the north and eastern portions of the site are mapped as *high probability of occurrence* of acid sulfate soils within 1 m of ground surface whilst the remainder of the site is mapped as *no known occurrence* of acid sulfate soils. The mapping indicates an alluvial plain environment at an elevation of 1 to 2 m AHD and the environmental risk is described as ‘severe environmental risk if acid sulfate soil materials are disturbed by activities such as shallow drainage, excavation or clearing’.

Tweed Shire Digital Acid Sulfate Soil Planning Mapping indicates that the area identified as having a High Probability of Occurrence is mapped as Class 2 for planning purposes (i.e. will require consent for development of works below natural ground surface and works where the water table is likely to be lowered).

A preliminary acid sulfate soils characterisation based upon the regional scale mapping and limited investigation data supported the regional-scale Acid Sulfate Soil Risk Mapping (NSW Department of Land and Conservation, 1988) and suggested that acid sulfate soil materials (AASS and PASS) are likely to be present in lower lying parts of the site (GHD, 2010).

3.5 Hydrology and Drainage

A number of small ephemeral drainage channels (also referred to as ‘drainage lines’) flow from the site in a north/north east direction into a larger un-named channel along the northern site boundary which flows from southeast to northwest through the site. It is understood that this

channel has been previously excavated to improve drainage at the site. This larger channel continues to the north close to the edge of the Tweed River floodplain and discharges to Leddays Creek, eventually discharging into the Tweed River approximately 4 km to the north of the site. Locally, several cane channels are used for water drainage associated with the low lying flood plain area.

A drainage channel has also been excavated in bedrock within Quirks Quarry as part of the quarrying operations to 1 to 2 m below the quarry floor. This drainage channel skirts the eastern side of the quarry and ultimately conveys flow to the main surface water channel through the site. Some water is captured on the Quirks Quarry site in a holding dam and used in quarry operations (including for dust suppression).

The preliminary conceptual understanding from the hydrogeological and acid sulfate soils desktop study (GHD, 2010) with respect to hydrology indicated that:

- Vertical percolation of precipitation through up to approximately 30 m of unsaturated bedrock via fissures and fractures to the water table, and lateral groundwater flow, preferentially along zones of fractures and fissures, towards the north east, north and the River Tweed;
- Vertical percolation of precipitation through a relatively thin (typically <3.5 m) zone of unsaturated alluvial/marine deposits via primary porosity pathways to the water table, and lateral groundwater flow within these superficial deposits towards the north east, preferentially along more permeable layers such as those with a component of sand and, or, gravel;
- Discharge of groundwater from bedrock to the overlying alluvial deposits is considered likely to occur in the vicinity of the floodplain. However the lack of groundwater level data for the bedrock and the overlying alluvial deposits at the same location means that this cannot currently be confirmed; and
- Shallow groundwater in the alluvial deposits is likely to discharge to the surface water channel close to the edge of the floodplain.

3.6 Groundwater

Based upon groundwater levels at Quirks Quarry, which were investigated for development of the landfill concept design, is currently understood that groundwater at the site flows from the south west to the north east (GHD, 2009). It was 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.

3.7 Climate

The Tweed region has a warm temperate climate and generally receives higher than average rainfalls than other areas of NSW. Summer and autumn are when higher rainfall occurs, while winter and spring are more typically dry, with average rainfall decreasing towards the west as a result of the rainshadow effect of the ranges and Mount Warning (Morand, 1996).

Climate data is not recorded at the site, although records have been kept at Stotts Creek RRC. The closest Bureau of Meteorology (BOM) weather station to the site is Murwillumbah (station number 058158), is located approximately 9 km south west of the site at Bray Park. Published statistics from the BOM website for this weather station give long-term averages from the period 1972 – 2008.

The annual rainfall for the Murwillumbah weather station is 1,573 mm/annum. Daily rainfall data are available for Stotts Creek RRC for the period September 2007 to August 2008 with the total rainfall in this period being 2,084.5 mm (data provided by Council 2008). The BOM website data indicates that mean average rainfall is highest in February and March, and the lowest mean average rainfall occurs in September.

The mean highest maximum temperature of 29.6°C was occurs in January, while the mean lowest minimum is 8.5°C in July.

3.8 Site History

Quirks Quarry, located in the eastern portion of the site (see Figure 3) has been operating since the 1950s. Council purchased the Quarry in 1996 and has development consent to remove 577,000 tonnes in total of material at a maximum annual rate of 100,000 tonnes per annum. It is predicted that the resource at the quarry will be exhausted in 2010.

Prior to quarry activities, the site was predominantly utilised for agricultural purposes including sugar cane farming on the floodplain and grazing on the slopes. A small mango (**Mangifera indica*) orchard is also located in the southern portion of the site. The vegetation pattern occurring on the site suggests that most of the remainder of the site has been cleared historically, as vegetation over much of the site is dominated by regrowth camphor laurels, with occasional emergent eucalypts.

The north eastern portion of the site is still utilised for the purposes of sugar cane growing and is leased for this purpose. In addition, grazing has occurred in the lower lying areas of the site on agistment.

3.9 Surrounding Landuse

Land use within the region is predominantly agricultural, with a large proportion of surrounding lands zoned for rural purposes. Much of the existing farmland is used for grazing of beef and dairy cattle while sugar cane crops dominate the floodplains. Other regional agricultural pursuits include bananas, horticultural and market gardens.

In the immediate vicinity of the site, land uses include agriculture (primarily sugar cane farming), waste management, and extractive industries. In addition a number of residential dwellings are located principally along the ridgelines. A summary of land uses in the immediate vicinity of the site is provided in Table 3.

Table 3 Land use surrounding the site

Direction	Land use
North	Sugar cane farming, extractive industry (quarry - O'Keeffes No. 2)
North west	Sugar cane farming, waste disposal facility (Stotts Creek RRC)
West	Sugar cane farming
South west	Dwellings (on land zoned 1a) Rural)
South	Eviron Road, dwellings (on land zoned 1a) Rural), extractive industries
South east	Dwellings (on land zoned 1a) Rural), Pacific Highway and Tweed Shire Cemetery
East	Pacific Highway, Tweed Shire Cemetery, agriculture (croplands)

Sugar cane farming is the predominant agricultural land use locally, with cane fields extending north from the Condong Range to the Tweed River and extensively along the floodplain. As indicated previously, part of the site (Lot 602 DP1001049) contains an area of sugar cane which is leased to a local cane grower.

The Pacific Highway extends along the eastern boundary of the site, with a small area of Lot 602 DP1001049 having been bisected by the upgrade of the highway. The land to the south of this (Lot 601 DP1001049) contains Council's lawn cemetery and crematorium. Agricultural lands are located further along the Condong Range which continues east of the highway. The highway extends through a large cutting in a north south direction through the Condong Range.

A private quarry known as O'Keeffes No. 2 adjoins the northern boundary of Lot 1 DP1159352 and another quarry is situated to the south of Eviron Road adjacent to the Pacific Highway.

4. The Proposed Activity

4.1 Concept Plan

4.1.1 Overview

The proposed activity involves the establishment of two new quarry sites (referred to as West Valley and North Valley) and working these consecutively until around 2024. The quarry sites are intended to be used progressively as Tweed Shire Council's primary putrescibles landfill facility once the quarry resource is exhausted.

Concept or preliminary planning has only been undertaken for the parts of the proposed activity for which the project approval is sought (i.e. Stage 1). These plans provide details of volumes and areas of direct impacts (i.e. development footprint) for Stage 1 of the project only.

The quarry and landfill developments associated with future development are expected to be of a similar scale and nature to those investigated in Stage 1. While no specific details have been determined for the future stages of the project, estimates for clearing are able to be made with respect to the likely impacts of the future works based upon the indicative footprint (see Figure 3).

Separate to the application, the site is earmarked as the location of the future Far North Coast Regional Botanic Gardens. As such it is intended that all areas of the site affected by the quarry and landfill developments will be rehabilitated in a manner consistent with this intended future use.

4.1.2 Stage 1

Stage 1 of the project will involve:

- Construction of a haul road from Stotts Creek RRC to the Eviron Quarry and Landfill site;
- Development of a waste disposal facility (i.e. 'landfill') within the Quirks Quarry site (an estimated ten year life span based on the current concept design); and
- Quarrying at the West Valley site (an estimated 10.5 year life span based upon a production rate of 200,000 total material tonnes per year).

4.1.3 Future Stages

The scope of future staged application/s would be reviewed at a later stage prior to the submission of an application, and take into consideration emerging technologies in resource recovery, alternatives to landfilling and increase regulation of waste minimisation and landfill diversion targets. The current intent for future staging includes:

- Development of a landfill in West Valley;
- Development of a quarry in North Valley; and
- Development of a landfill in North Valley.

4.2 Project Application Detail

4.2.1 Landfill – Quirks Quarry

Overview

A landfill will be constructed in the void left by Quirks Quarry. This will be designed and operated in accordance with the (former) NSW Environmental Protection Authority (EPA) Environmental Guidelines: Solid Waste Landfills (EPA, 1996).

The landfill will accept Class 1 solid waste (as is currently accepted at Stotts Creek RRC). Class 1 solid waste is defined as 'non-hazardous, solid, degradable material', and includes putrescible wastes, garden wastes, uncontaminated bio-solids, and clinical and related waste (including contaminated waste). The waste contains a hazardous waste fraction of less than 5% by weight.

Disposal of Class 1 solid waste results in the likely generation of leachate, odours and potentially volatile gases as a result of the degradable content. The design of the landfill thus provides for the containment and management of the emissions from the waste mass through liners, leachate collection systems, and landfill gas management systems. Appropriate rehabilitation works will also be undertaken such that the waste mass can remain in a stable condition in the long term.

Establishment of the landfill in Quirks Quarry will include development of:

- Stormwater management works;
- A leachate management system; and
- A landfill gas containment system.

In addition, the landfill operations will be guided by a Landfill Environmental Management Plan (LEMP), a draft of which has been prepared to support the Environmental Assessment (Appendix C of the Environmental Assessment).

Stormwater Management Works

The current stormwater drainage system at Quirks Quarry comprises a dam, sediment basins and perimeter stormwater drains. These will be retained where possible throughout the development stages of the proposed landfill. These will collect stormwater runoff from the current vegetated ground cover areas not associated with the proposed landfill area.

A new stormwater drainage system will be designed for the new landfill. This 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.

All drainage works will be designed and constructed in accordance with the requirements of the determining authority. All stormwater diversion and collection drains shall be sized to convey run-off from the 1 in 10 year average recurrence interval (ARI) rainfall event. Where necessary the drains will be armoured or lined to prevent erosion.

Leachate Management System

A leachate collection system will be designed and installed in accordance with the quality requirements of an approved Construction Quality Assurance Program. This will comprise 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 (wherever possible) to the leachate treatment plant for disposal by irrigation.

Landfill Gas

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

Council has a commitment to sustainable landfill gas management and has identified a potential alternative to onsite landfill gas 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 RRC Facility will be undertaken to identify whether this is a more advantageous solution to the provision of a flare at the future Quirks Quarry landfill.

Environmental Management

As indicated above, in order to demonstrate how Council will manage the landfill to meet environmental requirements, a draft Landfill Environmental Management Plan has been prepared (GHD, 2009). This identifies key management actions including:

- How the landfilling operations will be staged;
- Requirements and timing of covering and capping of the landfill area;
- Environmental management for:
  - Water quality – stormwater and leachate;
  - Air quality– landfill gas, odour and dust;
  - Litter;
  - Vermin; and
  - Noise.

4.2.2 Quarry – West Valley

Configuration

A preliminary quarry pit design and extraction plan has been developed for the proposed West Valley quarry. The quarry footprint covers an approximate area of 11 ha (Figure 3). A minimum pit base level of reduced level (RL) 4.0 m corresponding to an estimated 100 year flood level event was adopted as the limit of extraction and general alignment for the connecting haul road between existing and proposed extraction areas. The first stage of quarry operations will commence in the south western corner of Lot 1 DP1159352. Full details of the preliminary design are available in the Preliminary Quarry Study for the proposed West Valley Quarry (GHD, 2011).

Ecological constraints were identified prior to the development of the quarry footprint, such that the preliminary design was able to take into account the location of the blackbutt open forest / higher value koala habitat areas (identified from this ecological assessment). In addition, a 30 m barrier zone was situated between adjoining land titles and the pit outline below the existing crest line along the western boundary.

As noted further in this document, Council has committed to avoiding clearing of an area of vegetation that falls within the eastern section of the quarry footprint currently shown. The quarry footprint will be revised to reflect this during detailed design.

Quarry Schedule

A 10.5 year life-of-quarry production schedule, based on a 200,000 tonnes total material moved per year, was developed for the West Valley Quarry and is included within the Preliminary Quarry Plan (GHD, 2011).

Proposed Operating Methodology

Quarry production and operation is divided into a number of elements:

- Site planning and development.
- Extraction involving:
  - Drill and blast - to provide fragmented rock for crushing; however the 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.
  - Quarry operations consist of a “top-down” approach to material removal with movement from higher bench levels such that completion of upper benches precludes any further material removal and/or access to the higher levels of the quarry.

Proposed Ancillary Structures

Haul Road

A haul road will be constructed from Stotts Creek RRC to the new landfill at Quirks Quarry for the purposes of heavy vehicle access for both quarry and landfill vehicles. Council's concept design for the haul road is shown in Figure 4. The road is approximately 8 m in cross section with variable width batters up to approximately 30 m in some areas (due to the undulating topography of the land), although considerably lower in other areas. Within the site boundary, the footprint of the haul road covers an area of approximately 2.583 ha (approximately 2.269 ha, or 88% of which is located within cleared land).

It is intended that the new haul road will become the primary access to the site (rather than the existing haul road off Eviron Road). The haul road will provide a direct link from the existing infrastructure at Stotts Creek RRC to the new landfill, and will also maintain existing landfill traffic routes.

Buildings

The existing demountable/temporary site office and amenities currently based at Quirks Quarry will be utilised for both the new landfill and Quarry site office.

Other Waste Infrastructure

Existing waste infrastructure currently located at Stotts Creek RRC will continue to be utilised and it is not intended to develop any further ancillary waste infrastructure within the site. In particular, the existing green waste facility at Stotts Creek will be utilised, and green waste will not be disposed of at the new landfill.

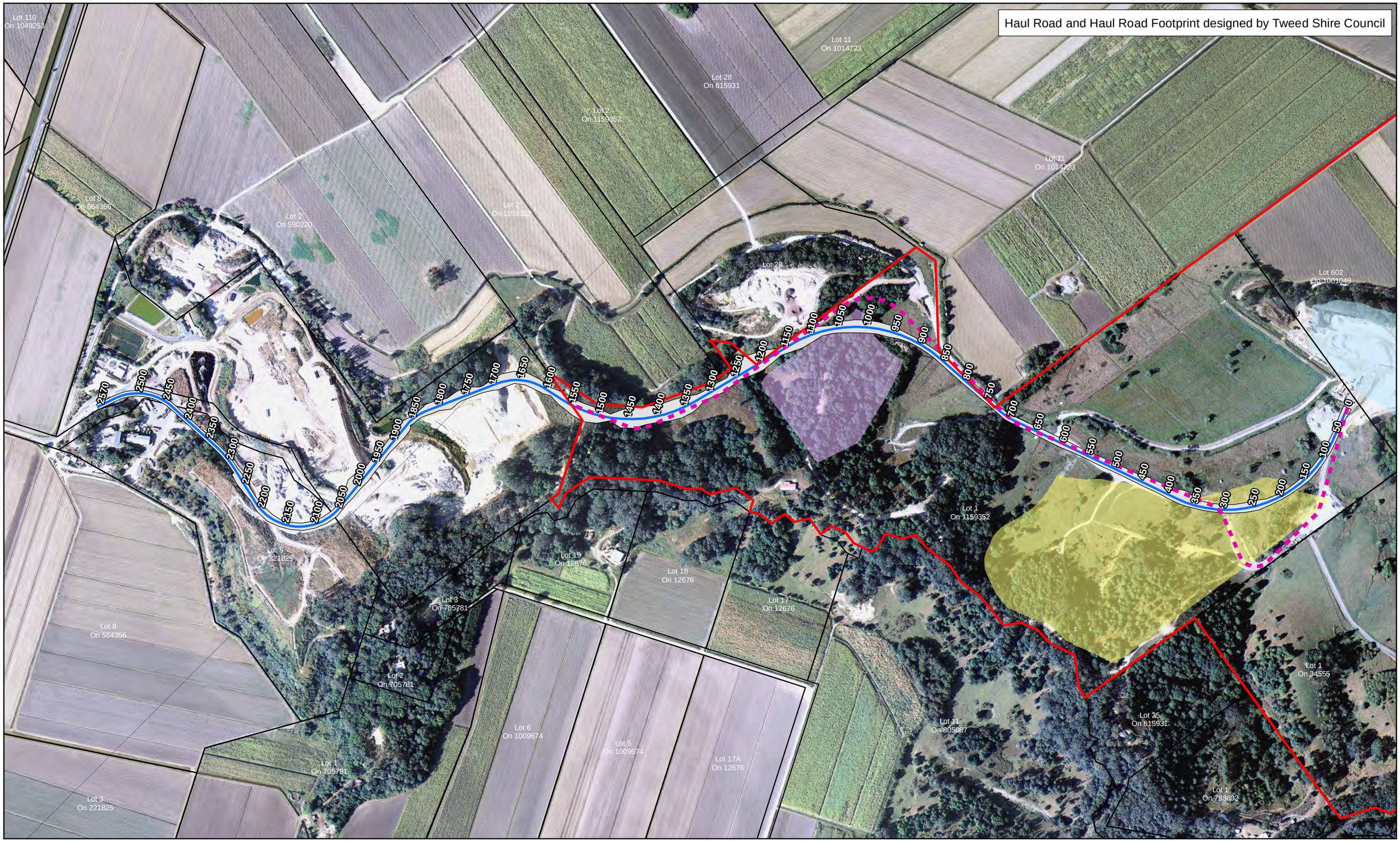
4.2.3 Rehabilitation

The final landuse of the entire site will be for the proposed Tweed Shire Botanic Gardens. Quirks Quarry landfill will be subject to rehabilitation for this purpose on closure, while the future use of West Valley Quarry is intended for landfill, and as such will be 'rehabilitated' to meet this intention.

In accordance with the landfill environmental management plan for Quirks Quarry landfill, a Closure Plan would be submitted to the determining authority three months prior to closure. This would include:

- Final landform, land use and landscaping/revegetation;
- Final capping; and
- Post closure management and maintenance.

Haul Road and Haul Road Footprint designed by Tweed Shire Council



1:6,000 (at A3)

0 75 150 225 300

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

LEGEND

- Site Boundary
- Cadastre boundary
- Old Haul Road Alignment
- Haul Road Centreline
- Haul Road Footprint
- Quirks Quarry Footprint
- North Valley Footprint
- West Valley Footprint

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council
Eviron Road Quarry and Landfill Environmental Assessment

Job Number	41-20806
Revision	1
Date	27 MAY 2011

Haul Road Concept Design

Figure 4

N:\AU\Toowoomba\Projects\41\20806\GIS\Maps\4120806_61.mxd

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Data source: Tweed Shire Council - Haul Road Design (2011), Aerial Photography (2008), Cadastre boundary (2010). GHD - North Valley footprint (2011), Site Boundary (2011), Quirks Quarry (2010), West Valley footprint (2010).

4.2.4 Future Development - Landfill, Quarry and Landfill

Outline

The components of the future activities included in the Concept Plan (landfill to West Valley, quarry in North Valley and then landfill in North Valley), are intended to be developed from approximately 2021. As for Stage 1, development would occur progressively, with the projected timeframe extending to around 2045. As mentioned previously, the future components of the Concept Plan are not part of the Stage 1 Project Application, and as such have not yet been subject to conceptual or preliminary design (although an indicative size of footprint for the West Valley landfill can be inferred from the quarry footprint). It is expected however, that the extent of future landfill and quarry developments upon the site would be on a similar scale to the landfill and quarry design for the Stage 1 project application. That is, all future elements would be subject to design and environmental standards at least that of those for Stage 1 and in accordance with legislative requirements and design standards of the time.

An indicative footprint for both the West Valley landfill and North Valley quarry/landfill are shown in Figure 3.

Landfill – West Valley

It is intended that as landfill space within Quirks Quarry is exhausted, the West Valley quarry would progressively be transitioned into a landfill consistent with that described in Section 4.2.1 for the new landfill at Quirks Quarry. This transition from working quarry to landfill has previously been practiced at Stotts Creek RRC.

Quarry – North Valley

A quarry would be established at North Valley from approximately 2022. This would operate in a similar manner to that of West Valley quarry.

Landfill – North Valley

As for the previous landfills, once landfill space is exhausted in the West Valley landfill, the North Valley Quarry would be transformed into a landfill.

Proposed Ancillary Structures

It is not anticipated that any further buildings or infrastructure associated with this project would be required for future development.

Rehabilitation

As for Stage 1, rehabilitation of future components of the activity will be undertaken in accordance with a Closure Plan. The final landuse of the site is intended to be for the Tweed Shire Botanic Gardens, and both West Valley and North Valley will be subject to rehabilitation for this purpose on closure.

5. Literature Review

5.1 Existing Records and Online Mapping Searches

The desktop component of the ecological assessment involved searches of State and Commonwealth databases and review of previous flora and fauna surveys and assessments undertaken in the vicinity of the subject site.

5.1.1 Searches

Searches were conducted within a 5 km radius from the study area to identify fauna species that have been historically recorded in or surrounding the study area. A 5 km radius was selected with the aim to identify species occurring in similar environs to the south of the Tweed River in relatively close proximity to the coast. The radius selected was considered to be appropriate for the location as the site is essentially bounded by the coast approximately 6.5 km to the east, while the Tweed River is situated approximately 4 km to the north and 7 km to the west.

Data was obtained from the following sources:

- The Office of Environment and Heritage (OEH) Atlas of NSW Wildlife database search for a 5 km radius from 549250 E, 6869200 N (zone 56 J). An updated data requests was submitted on the 26 March 2010 as well as 15 February 2011.
- The SEWPaC Protected Matters Search Tool to identify species listed under the EPBC Act (search area 5 km radius from point -28.301535 S, 153.506204 E) that are predicted to occur in the study area (note that the EPBC database search gives details of species that are predicted to occur on site based on bioclimatic modelling. As such, these species have not necessarily been recorded within the search area. An updated search was undertaken on 19 May 2011.
- A search was undertaken of the Fisheries website for listings of threatened species listed under the *Fisheries Management Act 1994* (FM Act) in the Northern Rivers CMA.
- Information was sought on corridors from the NPWS Key Habitats and Corridors in North East NSW Mapping Project (NPWS, undated).

5.1.2 Database Search Results

Threatened Species

The results of the database searches and the EPBC Protected Matters Report are provided in Appendix A. A list of the threatened species retrieved from the database searches is provided in tabular format in Appendix B. The table provides information on each species including their current status (e.g. vulnerable, endangered) under State and/or Commonwealth legislation, the species' known preferred habitat and distribution as well as the position of local records with respect to the study area. The table also identifies a 'likelihood of occurrence' for each species (see Section 5.3). Note that this table only includes terrestrial fauna, as the marine reptiles

listed in the EPBC protected matters report will not be impacted as a result of the proposed activity.

Threatened Flora

A total of 26 threatened flora species were retrieved from the Atlas of NSW Wildlife database (i.e. previous records within a 5 km radius), while the EPBC Protected Matters Report identified 22 flora species (note that *Bosistoa selwynii* is considered to be a synonym of *B. transversa*) (Table B1, Appendix B). Of these, 10 species were recorded from both database searches.

The updated OEH search in February 2011 did not identify any additional threatened flora species in the search area.

The DECCW adequacy assessment suggested that marblewood (*Acacia bakeri*), which is listed as vulnerable, may occur within the proposed West Valley quarry area, however subsequent inquiry on this matter with the DECCW Wildlife Data Team did not indicate any record of this species in the GIS System (pers. comm. Cassandra Martiensen, 15 February 2011). Notwithstanding this, the species has been included for consideration in the threatened species table (Table B1, Appendix B).

Threatened Fauna

A total of 20 threatened fauna species were retrieved from the Atlas of NSW Wildlife database (including records of the Cobaki Lakes long-nosed potoroo endangered population), while the EPBC Protected Matters report contained a list of 20 threatened species (Table B2, Appendix B). Of these, five species were recorded from both databases.

The updated OEH search in February 2011 did not identify any additional threatened fauna species in the search area. The updated EPBC protected matters report identified one additional threatened fauna species (the New Holland mouse), and this has been included in Table B2 in Appendix B.

Threatened Fish, Aquatic invertebrates and Marine Plants

Two sharks, four fish and an algae species listed under the *Fisheries Management Act 1994* were identified as occurring within the Northern Rivers CMA (Table B3, Appendix B). None of these species are likely to occur in habitats in the study area.

Migratory Species

The EPBC protected matters report identified 40 migratory species that could occur in the region (Appendix A).

Endangered Ecological Communities

The study area is located within the Murwillumbah (Qld - Southeast Hills and Ranges) sub-region of the Northern Rivers Catchment Management Authority (CMA) region. Nine EECs are known to occur within this area (Table B4, Appendix B).

5.1.3 Key Habitats and Corridors

The DECCW Key Habitats and Corridors in North East NSW Mapping Project (by the former NSW National Parks and Wildlife Service) mapped key habitats and linkages across northern NSW. The mapped corridors comprise areas that are predicted to be of high conservation value for forest fauna, and include large areas of vegetated lands and important vegetation remnants as well as a framework of corridors that provide connectivity between key habitat areas across the landscape (NPWS 2005). The habitat corridors are intended to identify areas that may facilitate important ecological processes such as migration, colonisation and interbreeding of plants and animals between two or more larger areas of habitat (NPWS 2005).

The relationship of key habitats and corridors to the site was investigated. This indicated that a subregional corridor is mapped along the spur along the western side of the study area.

5.2 Existing Studies Review

A number of previous studies were reviewed that relate to the study site or the local area. These included:

- Tweed Shire Council, (2009). Eviron Road Quarry and Landfill Proposal Concept Plan, Stage 1 Application and Preliminary Environmental Assessment: Design Unit, Engineering and operations, Tweed Shire Council.
- Brian J. Mackney and Associates Pty Ltd (1995). Quirks Quarry Environmental Impact Statement.
- Phillips, S., & Callaghan, J. (1996). *Koala Habitat Atlas Project Number 4: Tweed Coast. Draft.* Brisbane: Australian Koala Foundation.
- Woodward Clyde, & Landmark Ecological Services Pty Ltd. (1998a). *Flora and Fauna Assessment Working Paper No. 7 for the Upgrade of the Pacific Highway Yelgun to Chinderah*;
- Woodward Clyde, & Landmark Ecological Services Pty Ltd. (1998b). *Species Impact Statement. Pacific Highway Upgrade Yelgun to Chinderah*;
- Phillips, S. and Hopkins, M. (2009). Ecological status and viability of koala populations in the Tweed LGA. Biolink Ecological Consultants.
- Kingston, M.B, Turnbull, J.W. and Hall, P.W. (2004). Tweed Vegetation Management Strategy. Prepared by Ecograph for Tweed Shire Council.

In addition, the following fauna specialists were consulted in relation to particular species in the local area:

- Steve Phillips was consulted with respect to koala habitats and the local koala population.
- Ross Goldingay and Brendan Taylor were consulted with regard to the plausibility of a squirrel glider record in the study area.

The primary reference utilised to provide additional information on species that could occur in or utilise habitats in the study area was the Species Impact Statement (SIS) undertaken for the Yelgun to Chinderah Pacific Highway upgrade, as this contained the most comprehensive

information on the local area and made specific reference to the study area. It is recognised that this information is over 10 years old, however is still considered relevant, particularly as the Pacific Highway is the key area in which development has occurred in the immediate local area. A summary of the findings of the species impact statement is presented below.

Woodward Clyde, & Landmark Ecological Services Pty Ltd. (1998b). Pacific Highway Upgrade Yelgun to Chinderah. Species Impact Statement.

A flora and fauna survey was undertaken in 1997 for the preferred corridor route for the duplication and deviations for the Pacific Highway between Yelgun and Chinderah. The site is located adjacent to the western side of the Pacific Highway, and as a consequence, relevant sections of this study have been consulted to identify conditions in the local area. A SIS was also undertaken which included an investigation of 'areas identified as being of conservation significance'.

The report noted the following for a study site at the 'Condong Range in the Eviron Road Area':

- Most of the vegetation between the cane fields and Stotts Creek was heavily dominated by camphor laurel with little native vegetation remaining.
- A patch of weeping lilly pilly (*Waterhousea floribunda*) including large diameter at breast height (dbh) trees was located to the north-west of the Tweed Cemetery / Botanic Gardens.
- A small area of brush box (*Lophostemon confertus*) forest was identified to the west of the proposed route.
- A black walnut (*Endiandra globosa*) was recorded from camphor laurel forest and required removal for the alignment.

A detailed fauna survey was undertaken, in all significantly vegetated areas in the SIS study area (Yelgun to Chinderah – an approximate 26 km stretch of the Pacific Highway) which included a site at 'Eviron Road at the Tweed Botanical Gardens'. The findings from this study included:

- No listed frog species,
- No listed reptiles;
- Listed bird species recorded:
  - Rose-crowned fruit dove (*Ptilinopus regina*) – Jones Road, Yelgun and Taggets Hill. Recorded in April 1998 in wet sclerophyll and adjoining disturbed forest at the quarry on Eviron Road
  - Bush hen (*Amaurornis olivaceus*) – Sheens Creek, Sleepy Hollow Golf Course*;*
  - Glossy black-cockatoo (*Calyptorhynchus lathami*) – flock observed flying overhead at Billinudgel;
  - Masked owl (*Tyto novaehollandiae*) – Jones Road, Yelgun and Taggets Hill; and
  - White-eared monarch (*Monarcha leucotis*);
- Listed bird species previously recorded:
  - Osprey (*Pandion haliaetus*);
  - Square-tailed kite (*Lophoictinia isura*) – Jones Road, Yelgun;

- Little lorikeet (*Glossopsitta pusilla*); and

- Mammals
  - Koala (*Phascolarctos cinereus*) – Taggets Hill;
  - Grey-headed flying-fox (*Pteropus poliocephalus*) – various locations;
  - Freetail bat (*Mormopterus sp.*) – Eviron Road;
  - Little bentwing-bat *(Miniopterus australis*) – various locations;
  - Common bentwing-bat (*Miniopterus schreibersii*) – Taggets Hill and Eviron Road;
  - Large-footed myotis (*Myotis macropus*) – Sleepy Hollow; and
  - Northern long-eared bat (*Nyctophilus bifax*) – Eviron Road, Cudgen Road, Kanes Road.

5.3 Target Species and Likelihood of Occurrence

An assessment was undertaken to identify target species for surveys and establish the likelihood of species occurrence of those species retrieved from the database searches and desktop assessments. The 'likelihood of occurrence' was designated to each species based upon information gathered with respect to each species including:

- Species known or inferred habitat requirements and recorded distribution;
- The presence and condition of potential habitats within the subject site (based upon desktop studies and information from the field surveys); and
- Species records within the local area based on DECCW database records from within a 5 km radius of the study area and field survey results. Table 4 lists the factors that were the basis of the designation of a likelihood of occurrence of threatened species in the subject site. Note that a precautionary approach was taken for the analysis.

Table 4 Key to Likelihood of Occurrence

Likelihood of Occurrence	Definition
Known	Species definitely recorded within the study area either from previous records or field survey results.
Likely	Species recorded within a 5 km radius within the last 50 years and suitable habitat occurs within subject site.
Possible	Species previously recorded within a 5 km radius but no suitable habitat recorded within subject site OR species not previously recorded within 5 km radius or historically recorded (i.e. > 50 years prior), but subject site occurs within species known distribution and suitable habitat occurs within the subject site.
Unlikely	Species not previously recorded within a 5 km radius and suitable habitat not recorded within subject site.
Highly Unlikely	Species not previously recorded within a 5 km radius, suitable habitat not recorded within subject site, subject site outside of known distribution.

6. Field Survey Methodology

6.1 Flora Survey

6.1.1 Survey Effort

A reconnaissance site visit was undertaken on the 14th of January 2009 in order to identify major stratification units occurring in the subject site. Flora surveys were undertaken from the 20–22 January 2009 during predominantly fine conditions. A total of 28 person hours was dedicated to flora survey.

6.1.2 Plant Species

A flora survey was undertaken over the study area using the random meander technique of Cropper (1993) to inventory flora species, delineate vegetation communities, and search for locally occurring conservation significant (TSC Act/EPBC Act/ROTAP) listed plant taxa or other locally significant plant species previously recorded and known to occur in the locality.

Plant species encountered were identified and recorded. A sample was collected of any individuals unable to be identified on site, and these were subsequently identified using standard botanical texts, or, on the advice of the Botanical Information Service at the National Herbarium of NSW, specimens were sent to the Queensland Herbarium for identification or confirmation.

6.1.3 Vegetation Mapping

The approximate boundaries of the vegetation communities were delineated using a combination of aerial photo interpretation in combination with field verification with reference to previous vegetation mapping (Council's vegetation layers and mapping in the Quirks Quarry Environmental Impact Statement (Brian J Mackney and Associates, 1995)). Vegetation community mapping was further refined in 2010 using updated high definition aerial photography supplied by Council.

6.1.4 Additional Site Survey

Incidental plant species records were also obtained during field surveys by Council ecologists undertaken in June 2010.

6.2 Fauna Survey

6.2.1 Timing, Survey Effort and Weather Conditions

A preliminary site visit was undertaken on the 14th of January 2009 (in conjunction with the flora survey) during fine weather to identify appropriate trapping locations.

The fauna survey was conducted over five days and four nights between January 19 and 23, 2009. Weather observations recorded from the Murwillumbah weather station are provided in Table 5.

During the survey period the weather was predominantly fine and hot during the day and warm during the evenings. Light rain fell during the afternoon of the 22nd (fourth day of survey), and heavy rain fell overnight on this date. Patchy rain occurred on the last day of survey. A summary table of survey effort is provided in Appendix C.

Table 5 Weather Conditions During the Surveys

Date	Weather Conditions		
	Min (°C)	Max (°C)	Rainfall (mm)
19/01/2009	15.7	27.9	0
20/01/2009	17.1	30	0
21/01/2009	18.5	31.3	0
22/01/2009	24.2	30.8	0
23/01/2009	23.1	32.2	71.6

6.2.2 Vertebrate Fauna

Site Selection

Five fauna survey locations were established in the study area (Figure 5). These were distributed over the study area and preferentially located near to the development footprint.

Trapping Methods

Four full trap lines were established within the Subject Site on the 19th of January (Figure 5) and maintained over four nights in vegetation adjacent to the haul road (HR), to the north and south of North Valley (NV1 and NV2) and in West Valley (WV). Trapping aimed to sample small to medium ground and arboreal mammals. Each full trap line was comprised of the following:

- Elliot traps – twenty-five Elliott A traps were set in a transect. Traps were placed approximately 10 m apart and baited with a standard bait mixture of peanut butter, rolled oats, honey and sardines;
- Cage traps – six cage traps were deployed at each trap line, distributed over the length of the trap line. Cages were alternately baited with apple / standard bait mixture, and chicken wings;
- Hair traps – twenty 'Faunatech' type hair traps were deployed at each site, placed approximately 10 m apart and baited with standard bait mixture. The traps were alternately placed on the ground and taped to trees with the aim to record the presence of ground-dwelling and arboreal mammals.

In addition to the full trap lines, a line of 30 hair traps was placed in vegetation adjacent to the eastern boundary of Quirks Quarry (QQ) on the 14th of January (Figure 5). Twenty-one of these were placed alternately on the ground and taped to trees, while the other nine traps were taped in groups of three around three around three trees in this area. These traps were in place for a period of nine nights.

All traps were checked early each morning. Animals trapped were identified to species level in the field and released at the point of capture.

6.2.3 Bird Surveys

Systematic bird surveys were undertaken at each of the four trap sites on the western side of the study area (HR, NV1, NV2 and WV). Each morning two hours were spent surveying for birds, recording all bird species seen or heard calling within proximity of those locations. Incidental records of other bird species opportunistically observed during the course of field activities, including those flying over the study area were also recorded.

6.2.4 Active Searching

Reptiles and amphibians were surveyed using active search techniques. Each day, 20 minutes was spent actively searching each site for reptiles and amphibians. Searching comprised over-turning rocks and logs, raking through leaf litter and looking under bark and in rock crevices. All scats found were collected for analysis by a specialist subcontractor, Ms. Georgeanna Story of *Scats About*. Any other signs of recent animal presence, such as tracks or bones, were recorded if they could be positively identified to species.

6.2.5 Nocturnal Surveys

Twelve person hours were spent spotlighting throughout the study area on the 20th, 21st and 22nd of January. Spotlighting searches were conducted both on foot and from a vehicle using hand-held 60W spotlights.

On the final survey night, heavy rain provided an opportunity to survey for amphibians, given their increased calling activity. All waterbodies in the study area were surveyed for ten minutes, identifying all amphibian species seen or heard calling. All tracks on the study area were driven, stopping every 200 m to listen for frogs calling in adjacent vegetation.

Each night, a 45-minute call-playback survey was used to detect the presence of nocturnal birds (owls and nightjars). This involved playing the calls of species likely to occur in the region through a hand-held megaphone. Individual calls were played for two minutes, followed by a listening period of three minutes. Species played at each location included:

- southern boobook (*Ninox novaeseelandiae*);
- owlet nightjar (*Aegotheles cristatus*);
- white-throated nightjar (*Eurostopodus mystacalis*);
- barn owl (*Tyto alba*);
- barking owl (*Ninox connivens*);

- powerful owl (*N. strenua*);
- grass owl (*T. capensis*);
- masked owl (*T. novaehollandiae*);
- sooty owl (*T. tenebricosa*); and
- tawny frogmouth (*Podargus strigoides*).

6.2.6 Bat Surveys

The echolocation calls of insectivorous bats were recorded using ultrasonic detectors (Anabat II Bat Detectors®) coupled with Compact Flash Zero Crossing Analysis Interface Modules (CF ZCAIMS; Titley Electronics, Ballina NSW®) and stored on compact flash memory cards for later computer analysis. Detectors were orientated at a 45 degree angle on the ground. The Anabat was set at four locations over three nights. The approximate locations are shown in Figure 5. Anabat recordings were sent to specialist subconsultant Greg Ford for analysis.

6.2.7 Koala and Mitchell's Rainforest Snail Searches

Particular attention was placed on searching the base of trees for koala pellets and the Mitchell's rainforest snail (*Thersites mitchellae*).

The Koala Spot Assessment survey technique of Phillips and Callaghan (undated) was employed within a patch of dry sclerophyll forest located on the lower slopes of the ridge between North Valley and West Valley. A total of 30 trees comprised of eucalypts (26) and brush box (4) was sampled. As this was the only location in the study area that would potentially be cleared that contained adequate numbers of potential koala feed trees, this was the only location in which this technique was employed. In all other areas of the site searches were undertaken opportunistically for koala scats and Mitchell's rainforest snails.

548,000 548,500 549,000 549,500 550,000 550,500 551,000 551,500

6,870,000 6,869,500 6,869,000 6,868,500 6,868,000

QQ - Quirks Quarry
HR - Haul Road
NV - North Valley
WV - West Valley

HR NV1 NV2 WV QQ

Hawkens Rd Pacific Hwy Duranbah Rd Eviron Rd Eviron Rd

1:10,000 (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

N

LEGEND

- Site Boundary
- Study Area
- Cadastre Boundary
- Spotlight Locations
- 25 Elliot Traps and 20 Hair Traps
- Hair Traps
- Anabat Detector
- Koala Spot Assessment

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council
Eviron Road Quarry and Landfill Environmental Assessment

Job Number 41-20806
Revision 1
Date 27 MAY 2011

Fauna Survey Locations

Figure 5

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Data source: Tweed Shire Council - Aerial Photography (2008), Cadastre boundary (2010). GHD - Site Boundary (2011), Anabat Detector (2009), Fauna Trap Lines (2009), Spotlight Locations (2010).

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6.2.8 Habitat Assessment

Terrestrial habitat types were identified and mapped over the study area through undertaking habitat assessments at representative locations within the precinct. The following parameters were recorded during the habitat assessments:

- Structural complexity of vegetation (i.e. tree density, canopy cover, vertical structural complexity);
- Complexity of ground-level microhabitats (i.e. substrate type, vegetation cover, leaf litter, woody debris, presence of rocks);
- Habitat features (i.e. hollows, fallen logs, rock outcrops, nests; particularly raptor nests, waterbodies);
- Abundance of hollow bearing trees and the proportion of trees bearing arboreal mammal scratches;
- Wildlife traces (i.e. scats, tracks, scratches, diggings, burrows, nests, bones, feeding traces (e.g. chewed *Allocasuarina sp.* cones));
- Opportunistic wildlife observations; and
- Sources of disturbance (i.e. adjacent land-use, feral animals, predation, weed infestation).

The relative ecological value of each habitat type was assessed based on features including:

- The relative abundance and diversity of resources;
- The size and relative connectivity of vegetation;
- Habitat condition (i.e. the level of disturbance due to weeds, feral animals, other disturbances);
- Species richness (i.e. the number of fauna species present);
- The presence of conservation significant species (listed under the TSC Act and/or EPBC Act; and
- Key ecological functions - the habitat value as a habitat corridor or breeding, nesting or roosting site.

It is noted that some areas designated as low value habitat for some fauna species, may provide moderate to high habitat values for other species.

Habitat value was evaluated in three categories as follows:

- **High:**

Habitat designated as high value habitat typically contained some or all of the following attributes:

  - Ground flora containing predominantly indigenous species;
  - Vegetation community structure intact;
  - Ground, log and litter layer intact and undisturbed;
  - Breeding, nesting, feeding and roosting resources available; and

- Rich and diverse range of native fauna species recorded.

- **Moderate:**

Habitat designated as moderate value habitat for fauna species typically displayed some or all of the following attributes:

- Ground flora containing a some native species;
- Vegetation community structure somewhat intact;
- Ground log and litter layer somewhat intact and undisturbed;
- Some breeding, nesting, feeding and roosting resources available; and
- A medium richness and diversity of native fauna species.

- **Low:**

Habitat designated as low value habitat for fauna species typically displayed the following attributes:

- Ground flora containing a low number of indigenous species;
- Vegetation community structure altered;
- Ground log and litter layer disturbed and modified or absent;
- Few, limited or no breeding, nesting, feeding and roosting resources available; and
- A poor richness and diversity of native fauna species.

The habitat types were generally consistent with vegetation communities with shared structural and floristic characteristics.

6.2.9 Habitat Trees

Hollow-bearing trees or other large trees were recorded within or in proximity to the subject site on an opportunistic basis during surveys using a handheld GPS.

6.2.10 Additional Site Survey

Incidental records of fauna species were obtained during field surveys by Council ecologists undertaken in July 2010. Details of survey effort associated with this are documented in Table C3 in Appendix C.

6.3 Study Constraints

6.3.1 Survey Design and Study Constraints

Survey Design

As indicated, the field survey methodology was designed in general accordance with the DECCW biodiversity survey guidelines. Variations from the original survey methodology proposed are described below. It is considered that the survey effort employed in the field was adequate with respect to the size of the study area and the habitats present.

Flora

It was initially intended to undertake 20 m x 20 m quadrat surveys in association with 100 m transects, however due to the very steep topography of the site and predominantly disturbed or homogenous vegetation communities present in the study area, the flora survey was undertaken via undertaking traverses and random meanders, predominantly within the expected development footprints. The vegetation of the study area was traversed over three days, covering most of the subject site. Informal transects were able to be undertaken along the linear patches of vegetation in the flatter areas.

Fauna

Faunatech hair tubes were employed rather than 'small' and 'large' hair tubes. Faunatech hair tubes are tapered, and as such can record small and larger-sized animals, much the same as using 'small' and 'large' hair tubes.

Spotlighting was undertaken over three nights, rather than four nights. The koala, being the key target species for spotlighting was detected during this period.

Habitat trees such as larger trees and hollow-bearing trees were only recorded from within the expected development footprint.

Seasonal Constraints

Flora and fauna recorded in any single ecological survey provides only an indication of the ecological values at a moment in time. For example, seasonal habitat utilisation by some fauna and cryptic flora species may not be recorded during a single survey. The appropriate implementation of the precautionary principle has considered those species not recorded within the subject site that may be likely to at least forage or utilise habitats in the local area on an irregular basis as well as those species recorded within the surveys.

Nocturnal survey conditions were appropriate on the initial two evenings for the detection of arboreal and nocturnal species, while rain fell during the evening of the third night of the nocturnal survey, which provided suitable conditions for amphibian survey.

Surveys were considered to be undertaken at a suitable time of year for detecting the presence of the majority of the target fauna species.

7. Field Survey Results

7.1 Flora Survey

7.1.1 Plant Species

A total of 186 plant species were recorded during the surveys. This included 50 exotic species (approximately 27% of total species richness). A plant species list is provided in Appendix D.

7.1.2 Threatened Species

No listed threatened species were recorded during the January 2009 survey. Survey within the study area by Council ecologists identified a stand of five white lace flower plants (*Archidendron hendersonii*), listed as vulnerable under the TSC Act in the south western portion of Lot 1 DP1159352. In addition, a juvenile of this species was recorded from the vegetation to the south of the proposed Haul Road in the north western portion of the lot. The approximate locations of these are indicated on Figure 6.

7.1.3 Rare or Threatened Plant Species

Three ROTAP species were recorded from the site. The most commonly occurring ROTAP species was black walnut, which was recorded from a number of locations in the study area, including at the edge adjacent to the cleared area near the proposed location of the haul road, as well as scattered occurrences in the understorey. A black walnut had previously been recorded during surveys for the Quirks Quarry EIS (Brian J. Mackney and Associates, 1995). This is reported to be located south of Quirks Quarry. According to the quarry plan of management (Tweed Shire Council, 2006) this has been protected. This tree was not located during surveys. It is noted however that flora survey near Quirks Quarry was limited due to the existing approval for vegetation clearing for Quirks Quarry.

Two other ROTAP species, long-leaved tuckeroo *(Cupaniopsis newmanii*) and smooth scrub turpentine (*Rhodamnia maideniana*), were recorded from a small patch of vegetation to the north of the haul road in the north western portion of Lot 1 DP1159352(see Figure 6).

7.1.4 Vegetation Types

Eight vegetation types, two with subtypes, were mapped over the study area. Vegetation type names follow Walker and Hopkins (1990) and are named after dominant species.

A vegetation map is provided in Figure 6. Note that vegetation polygons shown have been primarily limited to the area within the site boundary, however where a vegetation type extended outside of the study area, the extent of the polygon was continued to an obvious boundary. Thus the extents of the vegetation types outside of the site boundary have been determined from aerial photography with limited or no survey. The vegetation types mapped on Figure 6 are not limited to those mapped polygons and it is expected that additional areas of the vegetation types described are distributed in the locality and along the Condong Range.

The vegetation types were as follows:

1. Camphor dominated vegetation:

1a – Camphor laurel (**Cinnamomum camphora*) closed forest.
1b – Camphor laurel (**Cinnamomum camphora*) open forest to open woodland.

2. Blackbutt Open Forest:

2a – Blackbutt (*Eucalyptus pilularis*) wet sclerophyll forest.
2b – Blackbutt (*Eucalyptus pilularis*) dry sclerophyll forest.

3. Camphor laurel – pink bloodwood (**Cinnamomum camphora – Corymbia intermedia*) closed forest.
4. Grassland / cleared areas.
5. Canefield.
6. Broad-leaved paperbark – camphor laurel (*Melaleuca quinquenervia – *Cinnamomum camphora*) open forest.
7. Brush Box – Bennett's ash (*Lophostemon confertus – Flindersia bennettiana*) open forest.
8. Orchard.

Descriptions of the distribution, composition, condition of each vegetation type and subtype and an indication of equivalent mapped vegetation communities are provided in the following sections.

Tree Number	Species	Habitat Type
1	Ironbark	Large Eucalypt
2	Dead Stag	Dead Stag
3	Blackbutt	Hollow-bearing Tree
4	Small-fruited Grey Gum	Hollow-bearing Tree
5	Blackbutt	Large Eucalypt
6	Blackbutt	Large Eucalypt
7	Blackbutt	Large Eucalypt
8	Blackbutt	Large Eucalypt
9	Blackbutt	Large Eucalypt

Vegetation Types

- Camphor Laurel Closed Forest (1a)
- Camphor Laurel Woodland (1b)
- Blackbutt Wet Sclerophyll Open Forest (2a)
- Blackbutt Dry Sclerophyll Open Forest (2b)
- Camphor Laurel - Pink Bloodwood Closed Forest (3)
- Grassland / Substantially Cleared Areas (4)
- Canefield (5)
- Broad-leaved Paperbark - Camphor Laurel Open Forest (6)
- Brush Box - Bennetts Ash Open Forest (7)
- Orchard (8)

1:10,000 (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

N

LEGEND

- Quirks Quarry
- North Valley Footprint
- West Valley Footprint
- Site Boundary
- Study Area
- Cadastre Boundary
- Haul Road

Conservation Significant Plants

- Black Walnut
- White Lace Flower
- Long-leaved Tuckeroo
- Smooth Scrub Turpentine

Habitat Trees

- Dead Stag
- Hollow-bearing Tree
- Large Eucalypt

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council
Eviron Road Quarry and
Landfill Environmental Assessment

Job Number 41-20806
Revision 1
Date 27 MAY 2011

Vegetation Map

Figure 6

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Data source: Tweed Shire Council - Aerial Photography (2008), Haul Road (2011), Cadastre boundary (2010). GHD - Site Boundary (2011), Vegetation Mapping (2010), Habitat Trees (2010), Quirks Quarry, West Valley (2010), North Valley (2011).

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Vegetation Type 1 – Camphor Laurel Dominated Vegetation

1a) Camphor Laurel Closed Forest

Plate 1 Camphor laurel closed forest

Description and Distribution

This vegetation type was dominated by camphor laurel (**Cinnamomum camphora*). Very occasional large emergent eucalypts were observed in the vegetation (likely to represent remnant eucalypts from prior clearing). A very sparse mesic shrub layer was present in some areas. Ground cover was predominantly comprised of weed species and ranged from sparse to quite dense. Occasional ferns or native grasses occurred in patches.

This vegetation subtype is the most common type mapped within the study area and covers most of the mid to upper slopes of the ridgeline that runs along the western boundary.

Upper (Tree) Stratum (Height 15-25 m, Cover 70-90%)

Camphor laurel (**Cinnamomum camphora*) dominant with blackwood (*Acacia melanoxylon*) common in some areas, predominantly at vegetation edges. Individual isolated emergent remnant eucalypts occur (as mapped). A small area containing mature and seedling hoop pines (*Araucaria cunninghamii*) occurred to the north of West Valley.

Mid Stratum

Although sparse, rose myrtle (*Archirhodomyrtus beckleri*) was one of the most common species in the mid stratum. Other species included bolwarra (*Eupomatia laurina*), yellow laurel

(*Cryptocarya bidwillii*), wild yellow jasmine (*Pittosporum revolutum*), and red ash (*Alphitonia excelsa*).

Lower Stratum

The ground layer was generally very sparse (see Plate 1). Some areas were densely covered with mist flower *(*Ageratina riparia),* camphor laurel (**Cinnamomum camphora*) seedlings or other weed species such as coralberry *(*Ardisia crenata*). Bracken *(Pteridium esculentum*), and blady grass (*Imperata cylindrica*) were quite common in some areas.

Extent of Disturbance

This was a highly disturbed and modified community predominantly with a dense cover of camphor laurel.

Equivalent Vegetation Communities

- Vegetation type 1004 'Camphor Laurel Dominant Closed to Open Forests' of the Tweed Vegetation Management Strategy (Kingston *et. al.*, 2004).
- The vegetation subtype could be considered to be included in forest type 221 'introduced scrub' in the non-forest and artificial grouping of the NSW Forestry Commission (1989).

Conservation Status

The vegetation type is dominated by an exotic species and is not considered to be floristically similar to any endangered ecological community listed under the TSC Act or EPBC Act, and is therefore not of concern for conservation. Based upon the patterns of historical clearing in the Tweed Shire, the vegetation type is likely to have previously comprised either eucalypt open forest or rainforest almost entirely cleared for agricultural purposes that has extensively been infested with camphor laurel regrowth.

The vegetation type provides habitat for threatened and rare rainforest flora and fauna species. White lace flower (*Archidendron hendersonii*) and black walnut (*Endiandra globosa*) were recorded from within this vegetation type.

1b) Camphor Laurel Woodland

Plate 2 Camphor laurel woodland

Description and Distribution

In some areas of the study area, predominantly in the vicinity of West Valley and North Valley (see Figure 6), areas that contained more sparsely distributed camphor laurels with a dense scrub of lantana and other weeds were present. Only occasional native species, predominantly brush box (*Lophostemon confertus*), were present.

Upper (Tree) Stratum (Height 10-15 m, Cover 10-30%)

Scattered camphor laurel (**Cinnamomum camphora*), along with brush box (*Lophostemon confertus*).

Mid Stratum

Densely covered with weeds including lantana *(*Lantana camara*), crofton weed (**Ageratina adenophora*), setaria (**Setaria sphacelata*) along with bracken (*Pteridium esculentum*) and false bracken (*Calochlaena dubia*).

Lower Stratum

Generally as for the mid stratum.

Extent of Disturbance

Highly disturbed.

Equivalent Vegetation Types

- As for vegetation subtype 1a, this vegetation subtype is considered to be analogous to Vegetation type 1004 'Camphor Laurel Dominant Closed to Open Forests' of the Tweed Vegetation Management Strategy.
- The vegetation subtype could be considered to be included in forest type 221 'introduced scrub' in the non-forest and artificial grouping of the NSW Forestry Commission (1989).

Conservation Status

- The vegetation type is not considered to be floristically similar to any endangered ecological community listed under the TSC Act and is not of concern for conservation.

Vegetation Type 2 – Blackbutt Open Forest

Vegetation Type 2a *Blackbutt (Eucalyptus pilularis) Wet Sclerophyll Forest*

Plate 3 Blackbutt wet sclerophyll open forest

Description and Distribution

A number of patches of this vegetation subtype occur within the study area. The largest area of this was located on a relatively steep northeast facing ridge alongside the proposed haul road in the northwest of the study area in the north western portion of Lot 1 DP1159352(see Figure 6). Here the vegetation occurred along both sides of the ridgeline (within and to the south of the study area boundary). Areas downslope to the north (in the alignment of the haul road) had been historically cleared, while additional smaller patches of wet sclerophyll vegetation to the north (vegetation type 3) were present below this clearing on the steep lower slopes. A narrow

strip of subtype 2a was located alongside Quirks Quarry on the northeast facing slope. It also occurred on the south facing slope in the very southeast of the study area, along Eviron Road in Lot 1 DP34555 and along the western site boundary.

This community graded downslope into Vegetation Type 3 (Camphor laurel – pink bloodwood closed forest) and elements of this Vegetation Type were evident in the lower elevations of the mapped areas.

Upper (Tree) Stratum (Height 20-25 m, Cover 70-90%)

Blackbutt (*Eucalyptus pilularis*) was dominant, with brush box (*Lophostemon confertus*) a common associate. Narrow-leaved ironbark (*E. crebra*) was also present along the upper slopes (generally in the north west). Camphor laurels (**Cinnamomum camphora*) were also scattered throughout the canopy, and were more common within the vegetation adjacent to Quirks Quarry.

Mid Stratum

The vegetation in the western portion of the study area (adjacent to the proposed haul road), contained a sparse mid stratum that was comprised generally of red kamala (*Mallotus philippensis*), bolwarra (*Eupomatia laurina*), scentless rosewood (*Synoum glandulosum*), and hairy-leaved bolly gum (*Neolitsea dealbata*).

Lower Stratum

Ground layer species included *Oplismenus aemulus* and many-flowered mat-rush (*Lomandra multiflora*). A number of vines were present, including lawyer vine (*Smilax australis*), cockspur thorn (*Maclura cochinchinensis*), supplejack (*Flagellaria indica*), wonga wonga vine (*Pandorea pandorana*), and native yam (*Dioscorea transversa*). Epiphytes were present including both staghorn (*Platycerium superbum*) and elkhorn (*P. bifurcatum*).

Common weeds throughout the ground and low shrub layer included mistflower (**Ageratina riparia*) and coralberry (**Ardisia crenata*), the latter was particularly common adjacent to Quirks Quarry.

Extent of Disturbance

Historical clearing is evidenced by cut stumps, and there is some evidence of selective removal of some trees by poisoning in the western portion. Vegetation was considered to be in good to moderate condition.

Equivalent Vegetation Types

- Forest type 36 Moist Blackbutt of the Forestry Commission of NSW (1989).
- North Coast Wet Sclerophyll Forests vegetation class of Keith (2004).
- Northern Rivers Biometric vegetation type 24 Blackbutt - Tallowwood tall moist forest of the far north east of the North Coast (DECCW, 2008).
- Vegetation Type 201 ‘blackbutt open forest complex’ of the Tweed Vegetation Management Strategy.

Conservation Status

Based upon CRA data, 3795 ha of this vegetation type was mapped in the Tweed Shire in 2002, which represented around 42% of the state-wide occurrence in NSW. It was estimated that approximately 84% of this vegetation type had been retained since 1750, a number consistent with the estimated 15% cleared in the Northern Rivers CMA from the biometric vegetation types table (DECCW, 2008). Within coastal National Parks, a total of 6 ha of this community is reserved within Bundjalung and Yuraygir National Parks (Griffith *et al*., 2002). Due to the relatively high representation of this community in the Tweed Shire, the vegetation type is not currently considered to be of conservation significance.

Vegetation Type 2b Blackbutt (*Eucalyptus pilularis*) Dry Sclerophyll Open Forest

Plate 4 Blackbutt dry sclerophyll open forest

Description and Distribution

Only one small patch of dry sclerophyll blackbutt open forest occurred in the study area. This was located on a lower northeast facing slope in the northwestern portion of the study area. The vegetation was comprised of a mixed aged stand with occasional older remnant trees. Downslope of this vegetation was cleared (see Plate 4), while upslope the vegetation was comprised of camphor laurel closed forest or camphor laurel woodland.

This subtype also occurred in the area surrounding O'Keeffes Quarry over the northern boundary of the study area.

Upper (Tree) Stratum (Height 20-25 m, Cover 30-50%)

The upper stratum comprised blackbutt (*Eucalyptus pilularis*) and brush box (*Lophostemon confertus*) to around 25 m high, along with occasional small-fruited grey gums *(E. propinqua*) and pink bloodwood (*Corymbia intermedia*).

Mid Stratum

The mid stratum was comprised of brush box (*Lophostemon confertus*) saplings along with young camphor laurels *(*Cinnamomum camphora*), along with shrubs such as rose myrtle (*Archirhodomyrtus beckleri*) and sandfly zieria *(Zieria smithii*). Scattered areas of lantana (**Lantana camara*) were also present in the vegetation.

Lower Stratum

The ground layer was comprised of bracken (*Pteridium esculentum*) and false bracken (*Calochlaena dubia*) along with blady grass (*Imperata cylindrica*) and trailing Guinea flower (*Hibbertia dentata*).

Extent of Disturbance

This vegetation type has been subject to previous disturbances including grazing and clearing, however it has predominantly retained native structure and floristics and is considered to be in moderate to good condition. Weed coverage was estimated to be low to moderate (10 – 15% cover).

Equivalent Vegetation Types

- Forest type 34 Dry Blackbutt of the NSW Forestry Commission (1989).
- North Coast Dry Sclerophyll Forests vegetation class of Keith (2004).
- Northern Rivers Biometric vegetation type 22 Blackbutt - Tallowwood dry grassy open forest of the central parts North Coast (DECCW, 2008).
- Vegetation Type 201 Blackbutt Open Forest Complex of the Tweed Vegetation Management Strategy.

Conservation Status

The conservation status of this vegetation type is as for vegetation type 2a, although the 55% is estimated to have been cleared (DECCW, 2008). It is not currently considered to be of conservation significance in the Tweed Shire.

Vegetation Type 3 Camphor laurel – pink bloodwood closed forest

Plate 5 Camphor laurel – pink bloodwood closed forest

Description and Distribution

Two small patches of this wet sclerophyll vegetation type occurred on the sheltered east and north facing very steep slopes to the north of the proposed haul road (see Figure 6). These patches extended down to the cleared floodplain. The vegetation contained a range of species including camphor laurels (**Cinnamomum camphora*), pink bloodwood (*Corymbia intermedia*) and brush box (*Lophostemon confertus*). A suite of species consistent with those typically found in lowland rainforests were recorded including a variety of vines, ferns and epiphytes.

Upper (Tree) Stratum (Height 20-25 m, Cover 70-90%)

As indicated above, this vegetation type contained camphor laurels (**Cinnamomum camphora*), with a number of large pink bloodwoods (*Corymbia intermedia*) and brush box (*Lophostemon confertus*), along with tallowwoods (*Eucalyptus microcorys*) and white mahogany (*E. acmenoides*). Historically this sheltered area may have contained rainforest, or was at the ecotone between the eucalypt wet sclerophyll forest and the lowland rainforest (with much of this having been previously cleared in the location of the proposed haul road).

Other trees in this area included yellow laurel (*Cryptocarya bidwillii*), guioa (*Guioa semiglauca*) and brown kurrajong (*Commersonia bartramia*). In addition, two black walnut trees *(Endiandra globosa*) were recorded from the upper edge of the western vegetation patch adjacent to the cleared area.

Mid Stratum

There was only a relatively sparse mid stratum present comprised of species such as bolwarra (*Eupomatia laurina*), hairy-leaved bolly gum (*Neolitsea dealbata*), veiny wilkea (*Wilkea huegeliana*), red kamala (*Mallotus philippensis*), tree heath (*Trochocarpa laurina*) and rough treefern (*Cyathea australis*). Firewheel tree (*Stenocarpus sinuatus*) was recorded from the eastern patch of the vegetation type.

Lower Stratum

A deep layer of leaf litter was present and thus there was only a relatively sparse understorey. This was comprised predominantly of ferns and vines including false bracken (*Calochlaena dubia*), umbrella fern (*Sticherus flabellatus*), birds nest fern (*Asplenium australasicum*), Giant water vine (*Cissus hypoglauca*), burny vine (*Trophis scandens*) and whip vine (*Flagellaria indica*). Epiphytic plants included both staghorns (*Platycerium superbum*) and elkhorns (*P. bifurcatum*) as well as rock felt fern (*Pyrrosia rupestris*).

Extent of Disturbance

This vegetation type contains a number of quite mature trees and given its sheltered and steep position may have been somewhat protected from clearing. Although the vegetation contains a number of camphor laurels and other weeds it is considered to be structurally intact and in moderate to good condition.

Equivalent Vegetation Types

It is possible that the vegetation present represents an intermediate type that has previously been cleared or disturbed by fire. The existing wet sclerophyll vegetation has potential to develop into a rainforest community and displays rainforest elements that support this. The vegetation types described below reflect the wet sclerophyll type and possible rainforest type.

- Wet sclerophyll forests / subtropical rainforests vegetation classes of Keith (2004).
- Vegetation Type 207 Brush Box Open Forest that may develop into Vegetation Type 104 Lowland Rainforest on Floodplain of the Tweed Vegetation Management Strategy.
- Forest Ecosystem 152 ‘wet bloodwood – tallowwood’ developing to Forest Ecosystem 168 ‘rainforest’ of NSW Forestry Commission (1989).
- Northern Rivers Biometric vegetation type 122 Pink Bloodwood - Tallowwood moist open forest of the far northern ranges of the North Coast (DECCW, 2008).

Conservation Status

The biometric vegetation types table for the Northern Rivers CMA for vegetation type 122 indicates that approximately 40% of this vegetation type has been cleared (DECCW, 2008)

Due to the range of rainforest species contained within the vegetation, its position in the landscape and structural elements (ferns, epiphytes, buttressed trees, scattered eucalypt emergents) it is considered that this vegetation type contains elements of the TSC Act listed EEC ‘lowland rainforest in the NSW North Coast and Sydney Basin Bioregions’, and is therefore considered to be of conservation significance. Although the community does contain a range of species that are found in ‘lowland rainforest on floodplain in the NSW North Coast Bioregion’,

the range of key species characteristic of this ecological community is considered to more consistent with the Scientific Committee final determination for the former EEC than the latter.

The vegetation type has potential to support a range of threatened flora and fauna species.

Vegetation Type 4 Grassland / Substantially Cleared Areas

Plate 6 Grassland / cleared areas looking northeast

Upper (Tree) Stratum (Height 15-20, Cover <5%)

Scattered isolated trees only were present within this vegetation type.

Mid Stratum

Generally absent.

Lower Stratum

Cleared areas comprised of *Imperata cylindrica* and exotic species including balloon cotton bush (**Gomphocarpus fruticosus*), setaria (**Setaria verticillata*), and whisky grass (**Andropogon virginicus*).

Extent of Disturbance

Highly modified.

Equivalent Vegetation Types

- Vegetation type 1099 'Substantially cleared of native vegetation' of the Tweed Vegetation Management Strategy.

- The vegetation type could be considered to be included in forest type 220 ‘cleared/partially cleared’ / 219 ‘settlements, roads, gravel pits, etc.’ in the non-forest and artificial grouping of the NSW Forestry Commission (1989).

Conservation Status

Not of concern for conservation.

Vegetation Type 5 Canefield

Plate 7 Canefields

Description and Distribution

This vegetation type is mapped over the sugarcane (**Saccharum officinarum*) fields in the eastern portion of the study area.

Extent of Disturbance

High. Entirely modified for agricultural purposes.

Equivalent Vegetation Types

- Vegetation type 1006 Exotic plantation of the Tweed Vegetation Management Strategy.
- The vegetation type could be considered to be included in forest type 216 ‘improved pasture and cropland’ in the non-forest and artificial grouping of the NSW Forestry Commission (1989).

Conservation Status

Not of concern for conservation.

Vegetation Type 6 – Broad-leaved Paperbark – Camphor Laurel (Melaleuca quinquenervia – Cinnamomum camphora) Open Forest

Plate 8 Broad-leaved paperbark – camphor laurel open forest along drainage line

Description and Distribution

A small narrow strip of this vegetation type was recorded from the western side of the drainage line in the central portion of the site.

Upper (Tree) Stratum (Height 10-15 m, Cover 30-50%)

The upper stratum was predominantly comprised of broad-leaved paperbark (*Melaleuca quinquenervia*) along with camphor laurels *(*Cinnamomum camphora*). Swamp oaks *(Casuarina glauca*) were occasional at the edges of the vegetation.

Extent of Disturbance

The community is likely to be regrowth however appears to be in moderate condition in the central portion of the study area and poorer condition in the east near Quirks Quarry.

Equivalent Vegetation Types

- Vegetation Type 402 Broad-leaved Paperbark / Swamp She-oak Closed Forest to Woodland of the Tweed Vegetation Management Strategy.
- The vegetation type could be considered to be included in forest type 31 ‘paperbark’ in the maritime league of the NSW Forestry Commission (1989);
- Northern Rivers Biometric vegetation type 120 Paperbark swamp forest of the coastal lowlands of the North Coast.

Conservation Status

According to the Tweed Vegetation Management Strategy, the vegetation type is in general poorly reserved (Griffith 1993), and although adequately reserved state-wide is poorly reserved in Tweed Shire. The biometric vegetation types database indicates that 75% of this vegetation type has been cleared within the Northern Rivers CMA. This vegetation type is considered to be analogous to the TSC Act listed EEC ‘swamp sclerophyll forest on coastal floodplains’ and is thus of conservation significance.

Vegetation Type 7 – Brush Box – Bennetts Ash (Lophostemon confertus – Flindersia bennettiana) Open Forest

Plate 9 Patch of brush box – Bennett’s ash open forest

Description and Distribution

Only one patch of this vegetation community was mapped in the study area. This vegetation type is a small isolated patch of regrowth vegetation on the predominantly cleared floodplain fringing a narrow gully/waterhole adjacent to the existing haul road.

Upper (Tree) Stratum (Height 15-20 m, Cover 30%)

The vegetation in this area was comprised of brush box (*Lophostemon confertus*) with Bennett's Ash *(Flindersia bennettiana*). Other trees included umbrella cheese tree (*Glochidion sumatranum*) and young hoop pine (*Araucaria cunninghamii*). Camphor laurels (**Cinnamomum camphora*) were very common.

Mid Stratum

Bangalow palm (*Archontophoenix cunninghamiana*) occurred in the drain. Small trees included guioa (*Guioa semiglauca*), pink-flowered doughwood (*Melicope elleryana*) and *Homalanthus populifolius.* Only a small number of shrubs were present including rose myrtle *(Archirhodomyrtus beckleri*), muttonwood (*Myrsine variabilis*) and wild yellow jasmine (*Pittosporum revolutum*). Devil's fig (**Solanum chrysotrichum*) was also recorded here.

Lower Stratum

Small shrubs included orange thorn (*Pittosporum multiflorum*) and rough maidenhair fern *(Adiantum hispidulum*) was recorded from the moister gully edges. Vines included burny vine *(Trophis scandens*), wonga wonga vine (*Pandorea pandorana*) and wombat berry (*Eustrephus latifolius*).

Extent of Disturbance

Moderate to high. Only a very narrow band of trees with relatively low structural integrity.

Equivalent Vegetation Types

This vegetation type is most likely entirely regrowth.

- The vegetation type could represent vegetation type 207 'brush box open forest' of the Tweed Vegetation Management Strategy.
- Forest Ecosystem 103 'northern wet brushbox' of the NSW Forestry Commission (1989);

Conservation Status

According to the Tweed Vegetation Management Strategy, there are 206 ha of vegetation type 207 mapped in the Tweed Shire, representing 1.3% of its occurrence in the state. On a statewide basis, approximately 64% of the community had been retained and it was considered to be adequately reserved. Although the Vegetation Management Strategy does note that this community could be an intermediate stage that may eventually revert to rainforest, the high level of disturbance, lack of structural attributes, and the relatively low number of characteristic lowland rainforest species at this location is not considered to meet the Scientific Committee determination for the lowland rainforest EEC.

Vegetation Type 8 - Orchard

A small mango (**Mangifera indica*) orchard was present in the southern section of the study area adjacent to the existing haul road from Eviron Road.

Extent of Disturbance

High.

Equivalent Vegetation Types

- Vegetation type 1006 Exotic plantation of the Tweed Vegetation Management Strategy.
- The vegetation type could be considered to be included in forest type 217 'agricultural plantation, orchards and vineyards.' in the non-forest and artificial grouping of the NSW Forestry Commission (1989);

Conservation Status.

- Not of concern for conservation.

7.2 Fauna Survey Results

7.2.1 Species

In total, 92 species (71 bird species, 6 mammal species, 5 reptile species and 10 amphibian species) were recorded during GHD field investigations at the site between 19 and 23 January 2009. A species list is provided in Appendix E. The Anabat Analysis Summary that provides details of confidence levels for Anabat sequence files provided by specialist subconsultant Greg Ford is also provided in Appendix E.

The subsequent site visit by Council ecologists recorded an additional 1 bird and 2 mammals not recorded from the initial survey. These records have been incorporated into the species list (Appendix E).

7.2.2 Conservation Significant Fauna Species

NSW Listed Species

Five species listed under the TSC Act were confirmed on site during the survey (Table 6).

In addition, there were three other unconfirmed records that may have been threatened species:

- An Anabat record that was unable to be identified to species level could have been the eastern long-eared bat (*Nyctophilus* bifax);
- A black-cockatoo species was observed over-flying the site. This was attributed to being a glossy black-cockatoo (*Calyptorhynchus. lathami*), which are known to have resident populations on the Tweed Coast and hinterlands;
- A petaurid glider was observed during spotlighting that was unable to be identified to species level with a high level of confidence. The gliders observed on the second night of spotlighting displayed physical attributes that were considered to be more characteristic of squirrel gliders than sugar gliders (i.e. lack of a white tip on the tail, fat fluffy tail, white belly and more

pointed facial features). Subsequent discussions with glider expert Dr Ross Goldingay (pers. comm. Dr, Ross Goldingay, 15 July 2010) suggest a record of this species would be unusual for the location. According to the NSW Atlas of Wildlife records, the closest record is from 1992 near Mooball National Park, just over 10 km south of the study area. A number of detailed fauna surveys have been conducted within the region over the past 20 years, and no squirrel gliders have been recorded in the vicinity of the site The squirrel glider is uncommon in northern New South Wales and has not been previously detected in surveys conducted in the vicinity of the site (NPWS, 1998; Woodward Clyde, 1998b, JBA Planning).

Council ecologist David Hannah undertook a targeted follow up spotlighting survey of the site on the 6 and 8 July 2010 with the aim to verify the species of petaurid glider observed on site. This follow up survey recorded three sugar gliders with all observations on the first night of spotlighting from within blackbutt open forest. Two were recorded in the north western portion of Lot 1 DP1159352 and one from the western site boundary, on Lot 25 DP615931 adjacent to the proposed West Valley quarry site. One animal had a prominent white tail tip and all were clearly observed foraging or moving in and around blossom associated with the blackbutt trees.

While sugar and squirrel gliders can co-occur in the same location (Davey, 1984; Quin, 1993), it is uncommon (Rowston and Caterall, 2004). The combination of factors collected subsequent to the survey suggests there is insufficient evidence to definitively confirm the presence of squirrel gliders without undertaking a trapping program or establishment of nest boxes. Nevertheless, given the difficulty in identification of this species, an assessment of significance has been undertaken for the squirrel glider on the assumption that this species may potentially occur at the site. The ecological requirements of the species and potential impacts have been considered in the mitigation section.

Table 6 Listed Species Recorded during the Survey

Scientific Name	Status	Recorded Locations and Habitats in Study Area
Birds		
Calyptorhynchus lathami Glossy black-cockatoo	V	A black-cockatoo species was observed from near West Valley flying over the study area. No substantial foraging or nesting resources for glossy black cockatoos are present at the site. The glossy black cockatoo has specific dietary requirements feeding selectively on cones of *Allocasuarina littoralis* and A. *torulosa* (M. Stock pers. comm.). Although occasional Allocasuarinas are present on site, they occur at low density and do not represent a substantial feeding resource for the species.
Glossopsitta pusilla Little Lorikeet	V	This species was observed from a West Valley bird survey site.

Scientific Name	Status	Recorded Locations and Habitats in Study Area
Todiramphus chloris Collared Kingfisher	V	This species was seen and heard in two locations within the study area. Both sightings were along drainage lines where there are marginal occurrences of mangrove vegetation. This species is generally restricted to more extensive mangroves (Higgins, 1999). Habitats within the study area are therefore considered sub-optimal. The observations are likely to have been attributed to a transient individual rather than a permanent resident of the site.
Mammals		
Falsistrellus tasmaniensis Eastern False Pipistrelle	V	This species was recorded from Anabat records (confidence: 'almost certainly recorded').
Miniopterus australis Little Bentwing-bat	V	This species was recorded from Anabat records (confidence: 'definitely present').
Nyctophilus bifax Eastern long-eared bat	V	This species was a possible record from Anabat records (unreliable record, possibly *Falsistrellus tasmaniensis* or *Scotorepens spp.*).
Petaurid glider Possible *Petaurus norfolcensis* Squirrel Glider	V	At least three petaurid gliders were observed adjacent to the proposed location of the Haul Road in the north western portion of Lot 1 DP1159352 and a further two unidentified petaurid gliders were observed in eucalypts at the top of the West Valley. As noted above, follow up targeted surveys recorded three sugar gliders at similar locations; two in the north and one on the south. One animal had a prominent white tail tip.
Phascolarctos cinereus Koala	V	A koala was observed in eucalypts at the top of West Valley and along the driveway access to the dwelling (north western portion of Lot 1 DP1159352) in blackbutt wet sclerophyll forest. Koalas have been previously recorded from the southern side of the quarry site.
Pteropus poliocephalus Grey-headed Flying-fox	V	Recorded from along the ridgeline by Council ecologists foraging on flowering blackbutts.

EPBC Act Listed Species

Threatened Species

The grey-headed flying-fox, listed as vulnerable was observed foraging over the study area by Council ecologists foraging on flowering blackbutts.

Migratory Species

Three EPBC Act listed migratory species were recorded, these being:

- Great Egret - *Ardea alba (modesta)*
- Spectacled Monarch - *Monarcha (Symposiarchus) trivirgatus*

- Black-faced Monarch - *Monarcha melanopsis*

7.2.3 Fauna Habitat Types

Nine distinct habitat types were identified over the study area. These included:

1. Mature eucalypt woodland
2. Camphor laurel open to closed forest
3. Lantana and bracken
4. Wet sclerophyll forest with rainforest elements
5. Tall grassland
6. Drainage line
7. Quarry
8. Weeds with occasional trees
9. Cane fields

A summary of the ecological characteristics of each habitat type and their relative value for terrestrial fauna are provided in Table 7. This table also describes the distribution of habitat types over the study area and relates these to the vegetation types (Figure 6).

Table 7 Fauna Habitats

Habitat Type 1 - Mature eucalypt open forest

Distribution

Eucalypt open forest is located in the study area as follows:

- north west of the study area
- ridgeline along the western boundary
- lower slopes in the north west
- adjacent to Quirks Quarry

Equivalent Vegetation Type/s

Vegetation type 2a and 2b – blackbutt open forest

Characteristics:

- canopy and understorey layers present
- shrub layer largely absent
- mature eucalypts present
- fallen logs and woody debris
- complex ground cover, native grasses
- nests present in canopy and shrubs
- small ephemeral soaks present

Habitat for:

- arboreal mammals;
- ground mammals;
- forest canopy and understorey nesting birds;
- skinks, dragons and snakes;
- ephemeral pond-breeding frogs.

Listed Species: koala, petaurid gliders

Relative Value:

HIGH

Habitat Type 2 - Camphor laurel open to closed forest

Locations

Predominant vegetation type over the ridgeline along the western boundary of the study area as well as adjacent to the southern side of Quirks Quarry.

Equivalent Vegetation Type/s

Vegetation type 1a – camphor laurel closed forest

Characteristics:

- dominated by one vegetation type
- canopy and understorey layers present
- shrub layer absent
- no hollows or stags
- limited fallen logs and woody debris
- deep leaf-litter
- nests present in canopy

Habitat for:

- forest canopy nesting birds;
- skinks;
- ephemeral pond-breeding frogs.

Relative Value:

LOW - MODERATE

Habitat Type 3 - Lantana and bracken

Locations

Adjacent to tracks and in previously cleared areas predominantly along the ridges

Equivalent Vegetation Type/s

Vegetation type 2a camphor laurel open forest to woodland and vegetation type 4 grassland / cleared areas

Characteristics

- dense shrub and understorey layer present
- no canopy vegetation
- grasses, reeds and ferns in understorey

Habitat for:

- ground mammals
- shrub and understorey nesting birds
- snakes, skinks and dragons

Relative Value:

LOW - MODERATE

***Habitat Type 4* - Wet sclerophyll forest with rainforest elements**

Locations

Two small patches in the north west adjacent to the floodplain on the northern side on very steep lower slope

Equivalent Vegetation Type/s

Vegetation Type 3 Camphor laurel – pink bloodwood (**Cinnamomum camphora – Corymbia intermedia*) closed forest

Characteristics

- canopy, shrub and understorey layer present
- presence of vines and ferns
- ground layer dominated by leaf litter
- fallen logs and woody debris

Habitat for:

- canopy, shrub and understorey nesting birds
- ground mammals
- fossorial skinks

Relative Value:

MODERATE-HIGH

Habitat Type 5 - Tall grassland

Locations

Most lower lying areas in which cane is not present as well as cleared slopes

Equivalent Vegetation Type/s

Vegetation type 4 – grassland / cleared areas

Characteristics

- tree and shrub layer largely absent
- occasional isolated tree
- occasional shrubs
- tall grass
- nests present in grass and shrubs
- no fallen logs or leaf litter

Habitat for:

- grassland birds and raptors
- snakes
- rodents
- burrowing and terrestrial frogs

Listed species: None

Relative Value:

LOW

Habitat Type 6 - Drainage line

Locations

Drainage line extends through centre of study area adjacent to internal road. Small patch of vegetation in central northern area of study area. Other areas unvegetated.

Equivalent Vegetation Type/s

Includes vegetation type 6 Broad-leaved paperbark – camphor laurel open forest and vegetation type 7 broad-leaved paperbark – camphor laurel open forest as well as vegetation type 4 – grassland / cleared areas.

Characteristics

- constructed drain
- isolated vegetated patch
- dense grassy understorey present
- slow-flowing to pooled water
- emergent vegetation along banks
- some floating and submerged macrophytes

Habitat for:

- shrub and grassland nesting birds
- wetland birds and kingfishers
- exotic rodents
- snakes, skinks and water dragons
- a range of frogs

Listed species: None

Relative Value:

LOW - MODERATE

Habitat Type 7 - Quarry

Locations

Quirks Quarry, central eastern portion of study area

Equivalent Vegetation Type/s

Vegetation type 4 grassland / cleared areas

Characteristics

- vegetation cleared
- soil and rock exposed
- frequent machinery noise and traffic

Habitat for:

- cane toads

Listed species: None

Relative Value:

LOW

Habitat Type 8 - Weeds with occasional trees

Locations

Cleared or partially cleared slopes.

Equivalent Vegetation Type/s

Vegetation type 2a camphor laurel open forest to woodland and vegetation type 4 grassland / cleared areas.

Characteristics

- shrub and understorey vegetation present
- occasional isolated tree
- dense grassy understorey
- high weed infestation

Habitat for:

- shrub and understorey nesting birds;
- ground mammals;
- snakes.

Listed species: None

Relative Value:

LOW

Habitat Type 9 - Cane fields

Locations

Floodplain.

Equivalent Vegetation Type/s

Vegetation type 5 – canefield.

Characteristics

- monospecific stands of exotic vegetation
- dense understorey vegetation
- rich food source and shelter

Habitat for:

- grass birds and raptors;
- exotic rodents;
- snakes.

Relative Value:

LOW

7.2.5 Other Habitat Features

Connectivity

The cleared floodplain of the Tweed River essentially surrounds the vegetated areas on the site such that habitats to the north of the study area are extensively isolated for non-flying species.

As can be seen in Figure 6, vegetation in the study area extends along the western ridgeline while scattered vegetation extends along the southern adjoining the southern and eastern sides of Quirks Quarry.

The vegetation on the western ridgeline is of variable width between approximately 140 m – 200 m and is essentially to the northwest to an area of vegetation adjacent to the south of Stotts Creek RRC. This vegetation is mapped as a subregional corridor (NPWS, undated).

Both the vegetation along the western ridgeline and south of and adjacent to Quirks Quarry join vegetation that extends along the Condong Range to the south. This vegetation is entirely disconnected to the south east of the study area where the Range has been cut by the Pacific Highway, which essentially forms a barrier for less mobile terrestrial species.

In the wider area, opportunity for terrestrial fauna movement is present in vegetation along the ridgelines to the south and southwest of the study area (i.e. along Farrants Road, Hammond Drive through Clothiers Creek and Reserve Creek) with generally only minor barriers present such as country roads and some areas of sparser vegetation. The vegetated ridgelines connect along the Burringbar Range to Mooball National Park, with further connectivity south and west to Mount Jerusalem National Park and Nightcap National Park.

Habitat Trees

Although the vegetation has largely been historically cleared, six larger trees, two trees with hollows and a dead stag were recorded opportunistically during traverses within or adjacent to the proposed development footprint (Table 8 and Figure 6). A description of the hollows was not recorded.

Table 8 Habitat Trees Identified in the Study Area

Tree Number	Coordinates (UTM, 56 J)		Species	Habitat Type
	Easting	Northing		
1	549334	6869280	Ironbark	Large eucalypt
2	549141	6869522	Dead stag	Dead stag
3	549360	6869386	Blackbutt	Hollow-bearing tree
4	549210	6868926	Small-fruited grey gum	Hollow-bearing tree
5	549270	6869036	Blackbutt	Large eucalypt
6	549487	6868953	Blackbutt	Large eucalypt
7	549551	6868949	Blackbutt	Large eucalypt
8	549547	6868960	Blackbutt	Large eucalypt
9	550136	6868667	Blackbutt	Large eucalypt

Tree hollows are important for native fauna as diurnal or nocturnal shelter sites, for rearing young, for feeding, for thermoregulation, and to facilitate ranging behaviour and dispersal. An estimated 15% of all terrestrial vertebrate fauna in Australia are dependent upon tree hollows and for many of these species the relationship is obligate i.e. no other habitat resource represents an adequate substitute (Gibbons and Lindenmayer, 2002).

Note that larger trees and hollow bearing trees were recorded on an opportunistic basis within the expected development footprints. Habitat trees do occur in the study area including within the more mature vegetation in the north west alongside adjacent the southern side of the proposed haul road, as well as from within the small patches to the north of the haul road.

Koala Habitat

SEPP 44 – Koala Habitat Protection applies to the activity as it is referred to in the DGRs and therefore an assessment of koala habitat was conducted according to the methodology provided in SEPP 44.

The distribution of vegetation types containing koala feed trees (*Eucalyptus* sp.) was mapped (Figure 6) over the study area as blackbutt open forest (Vegetation Type 2a and 2b, Figure 6) . These areas predominantly contained blackbutt (*Eucalyptus pilularis*) however also contained small-fruited grey gum (*E. propinqua*) and tallowwood *(E. microcorys*), at low densities. Based upon a SEPP 44 assessment of koala habitat, however, none of the vegetation in the study area would be classified as 'potential koala habitat' which is defined as 'an area of native vegetation where the trees of the types listed in Schedule 2 of SEPP 44 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component' (see Table 2). Despite this, targeted surveys for koalas and searches for signs of recent koala activity were conducted and koalas were observed in eucalypt vegetation along the western ridgeline of the study area during surveys in both January 2009 and July 2010. There are also a number of recent records of the species in proximity to the site, suggesting that some areas could be classified as 'core koala habitat'.

The koala habitat class map prepared to support the Tweed Coast Koala Habitat Atlas mapped vegetated areas in the north west of the study area adjacent to Stotts Creek RRC as secondary habitat (class A) (AKF, 1996). The mapping is at a scale of 1:50,000, although shows areas that are somewhat consistent with that mapped as eucalypt open forest in this study. Vegetation in surveyed areas (i.e. within the study area) is considered to be reasonably consistent with the description of this koala habitat class - described as supporting specimens of *E tereticornis, E. microcorys,* and/or *E. propinqua* as sub-dominant components of the overstorey (Phillips and Callaghan, 1996), however the area surveyed for the spot assessment technique contained only two *E. propinqua* out of 30 trees sampled, which could place it in the 'secondary habitat' (class B) category. Notwithstanding this, these areas will be retained.

A discussion with Steve Phillips (27 April 2010) with respect to the Eviron koala population indicated that it was likely that there was a resident, albeit low density, population in the Eviron area, and as such it would be of primary importance to retain as many koala feed trees in the study area as possible (as well as access to these). He indicated that the camphor laurel dominated vegetation would afford thermal shelter to the species.

7.3 Conservation Significance Summary

Figure 7 provides an indication of the key ecological aspects of the site including the distribution of threatened species records and higher ecological value areas in the study area. A summary of conservation significance is provided in Table 9.

Table 9 Study Area Conservation Significance

Attribute	Survey Finding
Threatened Flora Species	White lace flower (*Archidendron hendersonii*) recorded.
Threatened Fauna Species	Five threatened fauna species were recorded, with a further four threatened species (with uncertain identifications) potentially occurring in the study area (Table 6).
Migratory Species	Three migratory species were recorded within or overflying the study area (Section 7.2.2).
Endangered Populations	No endangered populations were recorded from within the subject site or study area.
Endangered Ecological Communities	Two ecological communities that have characteristics consistent with that of EECs were recorded from the study area. These being: ◗ The wet sclerophyll closed forest (Vegetation Type 3) mapped within and adjacent to the northwestern boundary of the site outside of the development footprint contained elements consistent with the lowland rainforest on floodplain EEC. ◗ Vegetation along the drainage line (Vegetation Type 6) was likely to be representative of the swamp sclerophyll forest on coastal floodplains EEC.
Habitats for Threatened Flora and Fauna	◗ Although the vegetation in the study area is predominantly camphor laurel dominated and highly disturbed due to historical clearing and subsequent weed infestation, it contains potential habitat for rainforest species. White lace flower (*Archidendron hendersonii*) was recorded from the development footprint. ◗ Small areas of blackbutt open forest (wet and dry sclerophyll) provide feeding habitat for a resident population of koalas. Areas where this habitat occurs in the study area (outside of that approved for Quirks Quarry) will be retained. ◗ Limited numbers of hollow-bearing trees were recorded within or in close proximity to the subject site, with only two trees containing hollows and one dead stag recorded. Hollow-bearing trees were however recorded in vegetation to be retained in the study area. ◗ Vegetation along drainage lines in the lower lying areas have predominantly been cleared and modified and generally provide only marginal habitat for threatened frog species.

548,000 548,500 549,000 549,500 550,000 550,500 551,000 551,500

6,870,000 6,869,500 6,869,000 6,868,500 6,868,000

1:10,000 (at A3)

0 125 250 375 500

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

Fauna Observations

- Collared Kingfisher
- Grey-headed Flying-fox
- Koala
- Little Lorikeet
- Petaurid Glider
- Rose-crowned fruit-dove

Conservation Significant Plants

- Black Walnut
- Long-leaved Tuckeroo
- Smooth Scrub Turpentine
- White Lace Flower (vulnerable)

Habitat Trees

- Dead Stag
- Hollow-bearing Tree

- Areas of Higher Ecological Value
- Site Boundary

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Tweed Shire Council
Eviron Road Quarry and
Landfill Environmental Assessment

Job Number 41-20806
Revision 1
Date 27 MAY 2011

Key Ecological Aspects

Figure 7

N:\AU\Toowoomba\Projects\41\20806\GIS\Maps\4120806_67.mxd

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Data source: Tweed Shire Council - Aerial Photography (2008), Cadastre boundary (2010). GHD - Site Boundary (2011), Areas of Higher Ecological Value (2010), Fauna Observations (2009), Habitat Trees (2010).

8. Ecological Impacts

8.1 Overview

Both of the quarries and the three landfills are expected to be associated with similar potential ecological impacts as they are all located within close proximity and occur on similar topography and contain similar and connected vegetation types. The potential impacts associated with 'quarry' type and 'landfill' type impacts as well as the haul road are detailed separately below. Management measures for potential impacts are described in Section 9.

8.2 Existing and Historical Impacts

Due to existing and historical impacts in the region, the study area is presently subject to a number of impacts associated with quarry and landfill developments.

8.2.1 Habitat Loss and Fragmentation

The principal existing ecological impact is the historical loss and subsequent fragmentation of habitats. These impacts may have resulted in reduced home range availability, reduction in shelter and foraging resources and possible isolation of populations.

8.2.2 Habitat Degradation

Habitats in the study area have been and are presently subject to localised degradation from anthropogenic impacts such as weed infestation, dust and noise impacts. These influences are likely to have reduced the diversity of fauna and flora occurring locally. Much of the vegetation is weed infested and has lower levels of biodiversity than would be found in an undisturbed area.

8.2.3 Habitat Alteration

Habitats over a large proportion of the study area have been substantially altered through the clearing. Subsequent regrowth habitats predominantly contain a dense regrowth of camphor laurels with sparse understorey and ground level vegetation, dense shrubby weed growth (i.e. lantana), or are open cleared areas. The simplified structure of the habitats as a result of historical clearing may ultimately lead to a homogenisation of local species diversity as forest-reliant species may be replaced by opportunists that can tolerate disturbed environments.

8.2.4 Fragmentation and Barriers to Movement

Opportunities for movement to other habitat remnants within the surrounding regional landscape may have previously been restricted by agricultural development and roads. These would impact upon less mobile fauna species such as arboreal and ground dwelling mammals.

8.3 Vegetation Clearing

As required by the DGRs, estimates of the clearing required for all components of the proposed activity are provided in Table 10. These numbers have been generated based upon calculations

from overlaying the elements of the Concept Plan (Figure 3) over the Vegetation Map (Figure 6). As such, they do not necessarily present an exact figure in relation to clearing, and in many cases the figures will over-represent the area to be cleared. Areas have been rounded in hectares to three decimal places (i.e. nearest 10 m^2). It is anticipated where relatively low areas of clearing are indicated, (e.g. the 60 m^2 of vegetation type 2b and 170 m^2 of vegetation type 3), that these would be able to be avoided or reduced during detailed design. In addition, the 3680 m^2 of vegetation type 7 that currently falls within the concept footprint for West Valley quarry is not likely to require clearing. The concept design assumed a minimum pit level of RL 4 m AHD, however as this eastern section would provide little gain with regard to quarry resource and would intercept elements of Council's botanic gardens concept, Council has committed to avoidance of this area and to minimise clearing of native vegetation in general.

Table 10 Estimated Clearing Areas

		Clearing Area (ha)				
		Approved	Stage 1		Future Stage	
#	Vegetation Type	Quirks Quarry	West Valley	Haul Road	North Valley	Total
1a	Camphor laurel (**Cinnamomum camphora*) closed forest	(1.006)	1.689	0.217	3.170	5.076
1b	Camphor laurel (**Cinnamomum camphora*) open forest to open woodland	(0.255)	3.084	0.015	0.068	3.167
2a	Blackbutt (*Eucalyptus pilularis*) wet sclerophyll forest	(0.367)	0.000	0.066	0.000	0.066
2b	Blackbutt (*Eucalyptus pilularis*) dry sclerophyll forest	(0.000)	0.000	0.006	0.000	0.006
3	Camphor laurel – pink bloodwood (**Cinnamomum camphora – Corymbia intermedia*) closed forest	(0.000)	0.000	0.017	0.000	0.017
4	Grassland / cleared areas	(4.770)	5.831	2.269	0.313	8.413
5	Canefield	(0.000)	0.000	0.000	0.000	0.000
6	Broad-leaved paperbark – camphor laurel (*Melaleuca quinquenervia – *Cinnamomum camphora*) open forest	(0.000)	0.000	0.000	0.000	0.000
7	Brush Box – Bennett's ash (*Lophostemon confertus – Flindersia bennettiana*) open forest	(0.000)	0.368	0.000	0.000	0.368
8	Orchard	(0.000)	0.000	0.000	0.000	0.000

8.4 Quarry Impacts

8.4.1 Overview

This section describes the quarry developments at West Valley and North Valley and outlines the potential ecological impacts. Specific management measures are provided in Section 9.

Development Activities

Rock extraction from the quarries will involve the following activities:

- Pre-strip activities (i.e. clearing) and topsoil stockpiling activities.
- Blast-hole drilling and blasting.
- Extraction:
  - Primary screening.
  - Primary crushing.
  - Secondary screening and crushing where required.
- Stockpiling.
- Product loading and hauling.

Based upon the quarry concept plan for West Valley, the expected operating lifespan is approximately 10 years (based upon modelled production rate of 200,000 tonnes moved per year). Although a concept plan has not been prepared for the North Valley quarry, an equivalent lifespan is anticipated.

Quarry hours of operation will be between the hours of 7 am and 5 pm on weekdays, and 7 am and 12 pm on Saturday, while blasting will be undertaken as required between 9 am – 5 pm on weekdays and 7 am and 12 pm on Saturday.

8.4.2 Activity: Vegetation Clearing

Description

Clearing will be required for the development of the quarries. This will involve the progressive stripping of vegetation from the work area during the lifespan of each of the quarries.

Table 11 details the areas of clearing required for the quarry footprints.

Table 11 Quantity and Timing of Clearing for Quarries

Quarry	Area of Clearing	Timeframe
Quirks Quarry	Clearing associated with Quirks Quarry has been approved.	n/a
West Valley	The West Valley quarry will have a footprint of approximately 10.973 ha. Approximately 5.831 ha of this are presently substantially cleared. The approximate areas of vegetation clearing by type includes: ◗ 1.689 ha of camphor laurel closed forest ◗ 3.084 ha of camphor laurel open forest to woodland ◗ 0.368 ha of Brush Box – Bennett's ash open forest (Council has committed to avoidance of this area - refer to Section 8.3).	The bulk of clearing will occur within the first two years of operation.
North Valley	The indicative outline for North Valley Quarry has a footprint of approximately 3.551 ha. The approximate areas of vegetation clearing will comprise: ◗ 3.17 ha of camphor laurel closed forest ◗ 0.068 ha of camphor laurel open forest to woodland	As above, clearing is likely to occur within the first two years of operation.

Potential Impacts

Potential Impact: Habitat Loss

Clearing of vegetation will predominantly result in a reduced area of camphor dominated vegetation in poor condition and of low to moderate ecological value. Ecological input to the quarry concept plan enabled identification of ecological constraints for the concept location and configuration of the West Valley Quarry. As such the footprint enables retention of areas containing higher ecological value habitats as well as connectivity along the western boundary.

Future development of the North Valley Quarry is likely to be subject to similar concept planning as for the current Project Application and will also take into account any areas of higher ecological value in the North Valley area. An indicative footprint for North Valley is shown on Figures 3 and 6.

A low number of hollow-bearing trees were identified within the subject site indicating that there would be relatively limited denning or nesting opportunities for hollow-dependant fauna species. Large trees and trees containing hollows are shown on Figure 6. Four large eucalypts occurred within the footprint of West Valley quarry and would be removed, while no hollow-bearing trees occurred within or in close proximity to the development footprints.

Areas of dense camphor laurels contained only a sparse understorey and ground layer and thus provide limited opportunities for denning or nesting habitat for ground dwelling mammals.

Vegetation in the development footprint would provide foraging habitat for a variety of species. In particular, the prolific fruiting of the camphor laurels would provide species such as flying-foxes and birds, including the rose-crowned fruit-dove (and other fruit-doves) with feeding resources. Similar habitats will persist in the study area, and the locality, and as such removal of vegetation for the development of the quarries, although removing camphor resources from within the development footprint will not significantly reduce habitat resources available locally.

Although the higher ecological value areas of blackbutt open forest will primarily be retained, the development footprints for the quarries will result in removal of scattered koala feed trees from within the development footprint, and thus the proposed activity will result in a reduction in eucalypts, primarily blackbutts, available in the study area. According to John Callaghan in an email to Council (28 July 2010) blackbutt are utilised as a supplementary food and/or shelter resource in the Tweed Shire.

Potential Impact: Habitat Fragmentation

Clearing can result in reduced connectivity to, or complete isolation of habitats which can lead to isolated populations that may become dependent on local resources and result in population declines. It is assumed that much of the vegetation in the site would have been cleared and fragmented historically although retention of individual eucalypts as well as some patches of native trees may have allowed small populations of species to survive in the site. In addition, regrowth on the site may have enabled it to be colonised post-clearing.

Clearing for the proposed quarry footprints will not result in the fragmentation of habitat in the study area from vegetation along the Condong Range, although it will result in a reduction in the width of the corridor. It is noted that the camphor laurels within the site were being systematically removed in a staged manner prior to the ecological assessment. A large proportion of the vegetated areas shown on (Figure 6) mapped as Vegetation Type 1a and 1b may have been cleared. Over time this may have resulted in a similar reduction in the width of the vegetated corridor along the ridgeline as that resulting from quarry establishment (although eucalypts and native trees would have been retained).

Threatened fauna species found to utilise the site that are most at risk from fragmentation (such as the koala) will be able to maintain movements along the ridgeline as well as to areas of eucalypt vegetation retained in the site. Fragmentation is not likely to impact more mobile species, such as birds and bats. As can be seen in Figure 6, vegetation will be retained along the ridgeline along the western boundary of the site at an approximate 30 m buffer from the crest/site boundary. This is comprised of eucalypt open forest as well as camphor dominated vegetation. Although outside of the site, the vegetation on the adjacent land to the west of the site contains vegetation in a similar configuration to that occurring in the site (i.e. vegetated upper slopes, cleared lower slopes and sugarcane on the floodplain). Given that this adjacent land is zoned for rural purposes, clearing of vegetation on the relatively steep slope is reasonably unlikely. As such, a broader area of vegetation may persist along the ridgeline that would continue to provide connectivity from vegetation adjacent to Stotts Creek RRC through to the Condong Range.

Potential Impact: Loss of Biodiversity

It is likely that historical clearing has previously resulted in a local reduction in biodiversity through substantial modification of habitats. Clearing for the quarry developments will result in loss of vegetation, primarily dominated by camphor laurel and other weeds, from within the development footprint. These areas are considered to be in poor condition and have relatively low ecological value and it is not anticipated that a reduction in species diversity will result from removal of this vegetation.

The West Valley footprint will result in the clearing of a stand of five white lace flower plants. An individual of the species will be retained within vegetation in the north western portion of Lot 1 DP1159352. A Preliminary Translocation Plan has been prepared by Council for this species (Appendix F).

A number of other ROTAP species were also located in the study area, and will persist in vegetated areas outside of the development footprint.

Potential Impact: Fauna Mortality or Injury

Clearing of vegetation could result in the direct mortality of or injury to fauna that occur within the site.

Impact Evaluation for Vegetation Clearing

Will the activity affect areas of high conservation values?

The concept design for the quarry footprint has been configured with the aim to avoid the areas in the study area that have higher ecological value. These areas include Vegetation Type 3 which contains elements of lowland rainforest that is situated in the north west of the study area in the north western portion of Lot 1 DP1159352 and the small patch of swamp sclerophyll forest located along the drainage line (in the central eastern portion of the lot), as well as eucalypt open forest areas that provide habitat for species such as the koala.

In addition, Council has committed to avoiding clearing of Vegetation Type 7. The footprint would be revised at detailed design to avoid this area.

Will the activity affect individual animals and/or plants and/or subpopulations that play an important role in maintaining the long term viability of the species, population or ecological community?

No endangered ecological communities will be cleared as a result of the development.

A stand of five white lace flowers listed as vulnerable will be cleared as a result of development of the West Valley Quarry. A further individual was located within an area to be managed in the north western portion of Lot 1 DP1159352.

Vegetation clearing operations will be managed such that potential for mortality of individual fauna species is minimised.

Will the activity affect habitat features that play an important role in maintaining the long-term viability of the species, population or ecological community?

As indicated previously, due to historical clearing there were very few mature native trees in the vegetation, and where these occurred they were generally emergents from within the camphor

vegetation. Two of these contained hollows, and were located outside of the development footprint, while one dead stag was located along the ridgeline. Searches for trees with hollows were generally restricted to those areas in or in close proximity to the development footprint and trees with hollows were observed to be more common along the ridgeline outside of the development footprint. .

No areas of habitat on which threatened fauna species are dependent for their lifecycle will be removed for the development of the quarry footprints. The camphor vegetation provides potential shelter sites for koalas, and may also provide foraging areas for a number of other threatened species.

No endangered ecological communities will be cleared as a result of the development.

Are the duration of the impacts long term?

The development footprints are expected to be cleared of vegetation for approximately 40 years, during which time they will be progressively rehabilitated to a landform consistent with the future intended landuse (botanical garden). Note that landfills are not typically rehabilitated with vegetation with significant root systems that would penetrate the capping and hence allow rainfall into the landfill mass. The duration of impacts are therefore considered to be permanent, as the vegetation type likely to be present in the future may not necessarily support the suite of native biota that currently utilise the site, although it will support a range of native biota.

Are the impacts permanent and irreversible?

Removal of quarry materials is permanent and irreversible. Notwithstanding this, the footprints may be rehabilitated to support vegetation in the future, albeit limited to vegetation lacking significant root systems that would penetrate capping (as discussed above).

8.4.3 Activity: Movement of Heavy Vehicles

Description

The proposal will result in the movement of heavy vehicles along the haul road and within the quarry area. It is anticipated that roads within the site will be speed limited to below 40 km an hour within the site. Movements of heavy vehicles on the site will only occur during the approved operating hours (see 8.4.1).

Heavy vehicles currently move through the study area from Eviron Road to Quirks Quarry, while movements of landfill vehicles to Stotts Creek RRC are from Leddays Creek Road.

Quarry vehicles on occasion use the existing unsealed road to the north of the study area that extends past West Valley and North Valley. As such to some degree the impacts associated with movement of heavy vehicles may have previously been realised in the study area.

Potential Impacts

Potential Impact: Mortality or Injury to Fauna

Movement of heavy vehicles could result in collision with and direct mortality of fauna species. Note that hours of operation for the quarry are for the most part outside the foraging times of many species, and vehicular impact is not expected to result in significant impacts to fauna.

Potential Impact: Habitat Degradation

Heavy vehicle movements may result in production of noise, localised vibration and dust impacts upon adjacent habitats. Noise can disturb the foraging or nesting habits of fauna. Dust generation can result in smothering of vegetation and habitat degradation for fauna species.

Impact Evaluation for Movement of Heavy Vehicles

Will the activity affect areas of high conservation values?

It is not expected that the movement of heavy vehicles through the site will lead to impacts upon areas of high conservation values. Heavy vehicles have been operating within or in close proximity to the study area for a number of years.

Will the activity affect individual animals and/or plants and/or subpopulations that play an important role in maintaining the long term viability of the species, population or ecological community?

Heavy vehicle movements will occur only within the operating hours of the quarry and landfill. These hours are outside the foraging hours of nocturnal species. Movement of heavy vehicles has been occurring in the site for many years, and diurnal species are not likely to be affected significantly.

Will the activity affect habitat features that play an important role in maintaining the long-term viability of the species, population or ecological community?

Movement of heavy vehicles will not directly affect any habitat features that are important for the viability of any threatened species, population or ecological community in the study area.

Are the duration of the impacts long term?

Movements of heavy vehicles will operate through the life span of the activity.

Are the impacts permanent and irreversible?

No, movement of heavy vehicles will cease once the activity is finalised.

8.4.4 Activity: Drilling, blasting, and processing

Description

The quarry works will require drilling and blasting as well as processing (screening and crushing) which will result in the production of dust, noise, and vibration impacts, which could impact upon native fauna species.

Blasting will generally only take place no more than once per day and requires drilling for the purposes of situating the explosives. Processing would be dependent upon required outputs. Note that given that drilling and blasting currently takes, or has taken place in the site and adjacent areas over a number of years (i.e. former quarry operations at the Stotts Creek RRC site, O'Keeffes Quarry, Quirks Quarry), then it is not anticipated that the blasting and associated impacts will result in any significant ecological impacts.

Potential Impacts

Potential Impact: Habitat Degradation

- Noise and Vibration Impacts - Blasting causes potential noise impacts and usually results in overpressure and ground vibration which could reduce the habitat suitability for fauna species.
- Reduction in Air Quality - Drilling, blasting and processing are likely to generate dust. Dust generation can result in smothering of vegetation and habitat degradation for fauna species.
- Decreased Water Quality - Runoff from the site could result in decreases to water quality as a result of a high sediment load. Decreases to water quality can lead to impacts to aquatic fauna species, macrophytes and riparian vegetation.

Impact Evaluation for Drilling, Blasting, and Processing

Will the activity affect areas of high conservation values?

Impacts associated with drilling, blasting and processing have been operating in the study area for many years. These may impact upon some areas of higher ecological significance as outlined above.

Will the activity affect individual animals and/or plants and/or subpopulations that play an important role in maintaining the long term viability of the species, population or ecological community?

Drilling, blasting and processing associated with the quarries are existing impacts. The proposed activity may result in these being located in closer proximity to some areas of higher ecological significance. It is not however expected that this would affect any individual animals that are important for maintaining the viability of the species locally.

Will it affect habitat features that play an important role in maintaining the long-term viability of the species, population or ecological community?

Habitat degradation has occurred in the study area as a result of previous clearing and quarry and landfill activities consistent with that proposed. Habitat features remaining in the study area will continue to be affected throughout the course of the operation of the quarries.

Are the duration of the impacts long term?

Impacts associated with drilling, blasting and processing will occur during the operation of the quarries.

Are the impacts permanent and irreversible?

The impacts associated with this activity are not considered to be permanent and irreversible.

8.4.5 Activity: Stockpiling

Description

Stockpiles will be required if the raw material exceeds processing capacity.

Potential Impact

Potential Impact: Adverse Impacts to Vegetation

Poorly located stockpiles can result in adverse impacts to vegetation through compaction.

Impact Evaluation for Stockpiling

Will the activity affect areas of high conservation values?

Appropriately located stockpiles will not affect areas of high conservation values.

Will the activity affect individual animals and/or plants and/or subpopulations that play an important role in maintaining the long term viability of the species, population or ecological community?

Stockpiling is not expected to affect any individuals or subpopulations such that their long term viability is compromised.

Will it affect habitat features that play an important role in maintaining the long-term viability of the species, population or ecological community?

As above, appropriately located stockpiles will not affect habitat features important to the long-term viability of any threatened species, population or ecological community.

Are the duration of the impacts long term?

No.

Are the impacts permanent and irreversible?

No.

8.5 Landfill Impacts

8.5.1 Overview

This section provides details of potential activities and associated impacts of the landfill developments proposed for Quirks Quarry, West Valley and North Valley. Specific management measures are outlined in Section 9.

Landfill Development

A conceptual design and a draft landfill environmental management plan have been prepared for the landfill proposed for the Quirks Quarry footprint. The concepts outlined in these documents will also be relevant to the proposed landfills at West Valley and North Valley, however these would be revised in accordance with legislative requirements and design standards at the time of future planning.

The footprint of the landfill at Quirks Quarry is shown on Figure 3. The other two landfills will occur within the West Valley and North Valley quarry footprints.

Development of specific concept designs and environmental management strategies for landfills at West Valley and North Valley closer to time of their development will allow for any new technologies or practices to be incorporated to these designs and strategies.

The operations proposed for landfills in the site will follow on from the existing operations at Stotts Creek RRC. As indicated previously, each landfill will accept Solid Waste Class 1 and be permitted to accept inert waste, solid waste (including putrescible solid waste), asbestos waste and certain clinical waste. Segregated green organic waste will continue to be processed at Stotts Creek and will not be disposed of within the landfills at Eviron Road.

The main features of the landfill site will include:

- An active landfilling area (for Council and contractors access only);
- Sediment basin and stormwater drains; and
- Leachate and landfill gas collection and management systems.

The landfill will be constructed in stages to enable progressive capping to be undertaken after each stage is completed. Details of the staging and filling are provided in the draft LEMP.

The final landform of the landfills will be restored to meet the future intended landuse as the regional botanic gardens.

8.5.2 Activity: Landfilling

Description

Landfilling will involve receipt of waste materials and disposal to a landfill constructed in the void left by the quarries.

Potential Impacts

Potential Impact: Habitat Degradation

- Vermin Attraction and Altered Species Dynamics - Waste disposed of at landfill has potential to impact upon species dynamics through provision of anthropogenic 'foraging resources', which may allow certain species to proliferate. The waste could result in higher numbers of prey species such as insects and small mammals (e.g. the black rat). This could result in the site supporting species that it would not normally support through providing foraging resources and also may provide resources for feral cats (**Felis catus*) and foxes (**Vulpes vulpes*). While pesticides and baits may be occasionally used at the landfill, 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, or leachate, or pose an airborne pollution hazard or nuisance.
- Decreased Water Quality – Landfill operations have the potential to reduce water quality through migration of contaminated water or leachate to the receiving surface water or groundwater environment. Decreases in water quality can also lead to impacts on aquatic fauna, macrophytes and riparian vegetation. However the landfill design allows for a compacted clay liner, overlain by High Density Polyethylene (HDPE) to ensure leachate does not migrate from the basal lining system. Moreover, management of water at the site will seek to minimise the generation of contaminated water and preventing deterioration of ambient water quality in local surface waterways and groundwater in the vicinity of the site.

- Litter - Litter generation can arise from transport of wastes and inadvertent escape of waste materials, as well as movement of waste materials from the landfill site by wind. Litter can enter vegetation and may result in degradation to habitats, increase in nutrient loads and increase potential for weed infestation. Council 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.
- Spread of Exotic Species - Movement of waste materials through the site may result in waste or propagules being spread into retained areas of bushland that may introduce exotic species. As indicated, all segregated green organics will be diverted from landfill disposal and processed at the existing Stotts Creek facility, and co-mingled loads will be segregated where possible.
- Noise Impacts upon Fauna Species - The landfill will result in noise from movements of heavy vehicles. Given that Quirks Quarry site has been utilised for the purposes of a quarry since the 1950s, there are minimal ecological impacts expected as a result of noise generated from the landfill. As for the quarry operations, noise can reduce habitat suitability for fauna species. It is noted as for the quarry, all noise generated from the landfill operations will be within the daytime operating hours, which may limit impacts upon nocturnal fauna species. In addition, it is expected that given the location of the site in close proximity to the Pacific Highway and existing quarry and existing landfill operations, that fauna species may be accustomed to noise generated from these types of activities. All practicable measures will be taken by Council to minimise noise emissions arising from the operations of the landfill and associated activities, including maintaining 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.
- Reduction in Air Quality - Dust may be produced from wastes entering the landfill, or from works to develop the landfill. As for the quarry impacts, ecological impacts related to dust generation can result in smothering of vegetation and habitat degradation for fauna species. Council will operate the landfill in a manner that seeks to minimise dust impacts and will immediately bury and cover dusty loads, use a water cart where required and seal the main haul road between the site and Stotts Creek RRC.

Impact Evaluation

Will the activity affect areas of high conservation values?

Existing landfilling in the local area at Stotts Creek RRC would have resulted in habitat degradation to the adjacent environment and the surrounding species dynamics including that in the study area. In addition, substantial clearing that has occurred historically for agricultural purposes has previously degraded habitats locally including reduction in species diversity and weed infestation. Landfilling will be undertaken outside of areas of higher ecological value in the study area. Management of potential impacts will be required to reduce the potential for additional habitat degradation.

Will the activity affect individual animals and/or plants and/or subpopulations that play an important role in maintaining the long term viability of the species, population or ecological community?

Landfilling presently occurs in close proximity to the study area and it is not anticipated that any of the impacts outlined above associated with habitat degradation would affect individuals or subpopulations such that their viability will be compromised.

Will it affect habitat features that play an important role in maintaining the long-term viability of the species, population or ecological community?

The landfilling activities will not affect habitat features that are important to the viability of species, populations or ecological communities.

Are the duration of the impacts long term?

Impacts will occur in various areas of the site over a period of approximately 40 years, after which the site will be rehabilitated. Post-closure management of the landfills will be undertaken.

Are the impacts permanent and irreversible?

Yes. Landfill areas will be able to be rehabilitated and revegetated, however vegetation in these areas will be restricted to low-growing species such that landfill capping will not be infiltrated.

8.6 Haul Road Impacts

8.6.1 Overview

A concept design for the haul road to the quarry and landfills has been developed by Council. This was redesigned in April 2011 based upon a suggestion in the adequacy review by DECCW that the haul road be relocated to the north of vegetation type 7. The haul road now extends from the existing Stotts Creek RRC across the north of the site and rather than joining the existing unsealed road south of vegetation type 7, traverses a cleared area to the north of this. The current haul road concept and an indication of the previous concept alignment are shown on Figure 4.

The surface of the haul road is approximately 10 m wide, and the batters are of variable width up to approximately 13 m, meaning that the haul road footprint is up to 35 m width in some sections. The concept design for the road (within the site boundary) has a footprint of approximately 2.583 ha, of which 0.321 ha is currently vegetated (see Table 11).

Plate 10 Proposed haul road route looking east from near the north western boundary

8.6.2 Activity: Vegetation clearing

Description

As for clearing for the quarry footprints, ecological input into the concept design for the haul road has allowed for this to substantially avoid areas of higher conservation significance and as such the concept design haul road has been located as far as possible within existing cleared areas or along existing tracks such that a reduced amount of clearing is required (see Plate 10).

Based upon the current concept design, it is estimated that the haul road will result in removal of approximately 0.232 ha of camphor laurel dominated vegetation (vegetation types 1a and 1b), as well as relatively small areas of vegetation type 2a (0.066 ha) and 2b (0.006 ha) as well as vegetation type 3 (0.017 ha). The latter three vegetation types will likely be avoided through detailed design iterations. Council has indicated their commitment to avoidance of clearing native vegetation on site where possible.

Potential Impacts

Potential impacts associated with vegetation clearing are consistent with those described above, however have been further detailed with respect to the concept haul road design.

Potential Impact: Habitat Loss

The haul road has been designed such that minimal clearing will be required. No hollow-bearing trees will be cleared as a result of its development. Removal of vegetation for the

development of the haul road will not significantly reduce habitat resources available in the study area.

Potential Impact: Habitat Fragmentation

The haul road will principally be located along existing roads and cleared areas within the study area, and small areas of vegetation, such as the wet sclerophyll forest with lowland rainforest elements in the northwest of the site are currently not directly connected to other areas of vegetation in the site.

It is not anticipated that the level of fragmentation will be substantially increased as a result of construction and operation of the haul road.

Potential Impact: Loss of biodiversity

As indicated previously, impacts of historical clearing would have likely reduced biodiversity through modification of habitats. The haul road will result in loss of a relatively small area of vegetation and is not expected to impact upon the biodiversity of the study area.

Potential Impact: Fauna Mortality or Injury

Clearing of vegetation could result in the direct mortality of or injury to fauna that occur within the site.

Impact Evaluation for Vegetation Clearing

Will the activity affect areas of high conservation values?

The overlay of the current concept design of the haul road over the vegetation map (Figure 6), indicates that minor areas of wet sclerophyll forest (vegetation type 2a) and blackbutt wet and dry sclerophyll forest (vegetation type 2a and 2b) may be encroached upon (Table 10). It is anticipated that the detailed design of the haul road will result in avoidance of or a reduction in the requirement for clearing of areas of higher ecological value.

Will the activity affect individual animals and/or plants and/or subpopulations that play an important role in maintaining the long term viability of the species, population or ecological community?

As indicated above, minor encroachments currently mapped are likely to be able to be avoided or reduced, and it is not anticipated that individual species or populations would be affected by clearing for the haul road.

Will the activity affect habitat features that play an important role in maintaining the long-term viability of the species, population or ecological community?

The haul road will extend alongside habitats that support threatened species and endangered ecological communities, however is not expected to impact upon these such that their viability is compromised. No hollow-bearing trees will be removed for the alignment of the haul road.

Are the duration of the impacts long term?

The haul road will be in use for at least the duration of the landfill operations.

Are the impacts permanent and irreversible?

There is the possibility that the haul road could be reinstated to its prior condition over the cleared areas, however it is likely that this would be retained as an internal access road in the future.

8.6.3 Activity: Construction and Earthworks

Description

Construction and earthworks will be undertaken that will likely involve tasks such as excavation, importation of fill material (if required), ground compaction and road construction.

Potential Impacts

Potential Impact: Direct Mortality of Species

Construction of the haul road could result in direct mortality of fauna species.

Potential Impact: Habitat Degradation

- Altered Hydrology and Impacts to Aquatic Species - The haul road will extend across areas in which water would naturally flow, and changes to hydrology could result in impacts to aquatic species. The haul road design deliberately alters the local hydrology and has been designed to provide flood protection (Q100).
- Reduction in Air Quality - During construction there may be short term dust impacts associated with the haul road construction, however all practicable measures will be taken to reduce dust generation, such as use of water carts and avoiding dust generating activities.
- Reduction in Water Quality - The construction of the haul road will require disturbance to the natural ground surface from cut and fill and could result in localised decreases in water quality (e.g. increased turbidity) as a result of erosion and sedimentation.

Impact Evaluation for Earthworks

Will the activity affect areas of high conservation values?

Construction and earthworks will occur adjacent to areas of higher ecological significance, and as such there is the potential for these areas to be subject to indirect impacts. Careful management of construction activities will reduce the potential for indirect impacts to adjacent vegetation.

Will the activity affect individual animals and/or plants and/or subpopulations that play an important role in maintaining the long term viability of the species, population or ecological community?

Based upon the survey to date, no individual threatened flora species will be cleared as a result of the development of the haul road.

Construction and earthworks operations will be managed such that potential for mortality of individual fauna species is minimised.

Will it affect habitat features that play an important role in maintaining the long-term viability of the species, population or ecological community?

Construction of the haul road is unlikely to impact upon habitat features that maintain the long term viability of species, populations or ecological communities.

Are the duration of the impacts long term?

Yes.

Are the impacts permanent and irreversible?

Yes.

9. Management Measures

9.1 Overview

The mitigation of adverse effects arising from the project has been presented according to the hierarchy of avoidance, mitigation and offsetting of impacts. The Part 3A Assessment Guidelines indicate that 'where measures to avoid and mitigate are not possible, then offset strategies need to be considered. These may include offsite or local area proposals that contribute to the long term conservation of the threatened species'.

Although the potential impacts as a result of the proposed activity are considered to primarily be able to be avoided or mitigated, an offset for some aspects of the loss of biodiversity values is required. These values specifically relate to:

- Loss of some koala (and other fauna species) feed tree habitat – scattered eucalypts occur within the camphor dominated vegetation;
- Loss of shelter – camphor dominated vegetation provides shelter (e.g. thermal, cover), for a variety of fauna species;
- Narrowing of connectivity along the ridgeline; and
- Clearing of five white lace flower (*Archidendron hendersonii*) plants from within the camphor dominated vegetation and as such, loss of potential habitat for these and other rainforest species.

An overview of the key management measures for avoidance, mitigation of potential impacts are provided below and a summary how specific impacts identified in Section 8 will be addressed are provided in Table 12. Figure 8 shows the key management measures proposed to be implemented.

9.2 Impact Avoidance

The proposed infrastructure has been configured within the site such that areas of higher conservation significance and existing regimes are maintained. In particular, the West Valley Quarry footprint was constrained by the location of the blackbutt open forest habitat and provision of connectivity along the ridgeline. In addition, Council has committed to avoiding clearing of an area of vegetation that falls within the eastern section of the quarry footprint currently shown. The quarry footprint would be revised to reflect this during detailed design.

The footprint identified for the North Valley Quarry shown also avoids areas of higher ecological value, however will be subject to future concept design, which would take higher ecological value areas into consideration as constraints.

Development within Quirks Quarry will be limited to existing (approved) disturbed areas and as such avoids further clearing or disturbance to higher ecological value areas.

In order to reduce impacts upon areas that provide potential habitat for threatened rainforest species, the Haul Road concept plan was realigned to reduce the clearing requirement in the higher ecological value vegetation. The haul road concept was realigned in April 2011 to avoid

vegetation type 7, as suggested by DECCW. Figure 4 shows both the current and previous haul road alignments.

9.3 Impact Mitigation

9.3.1 Environmental Management

Environmental Management Plans

All landfill and quarry developments will be subject to compliance with guidelines and an approved environmental management plan (EMP). This will include management of the construction of the haul road.

The EMPs will include sub-plans detailing how a range of elements, including the following will be managed:

- Vegetation management including clear delineation of clearing footprints and identification of conservation significant trees (see below);
- Fauna management;
- Pest species management;
- Surface water management; and
- Soil management.

Each of the sub-plans would identify an objective, management actions, performance criteria, corrective actions as well as monitoring and reporting associated with each of the elements.

Landfill Environmental Management Plans

A draft LEMP (Appendix C of the Environmental Assessment) was developed for Quirks Landfill for the facilitation of safe and efficient operation of the proposed landfill and to safeguard the environment and surrounding community from pollution and off-site effects. This will form part of the application for an Environmental Protection Licence for the landfill operations. Future landfills at the site would also be subject to a site-specific LEMP.

The draft LEMP contains details of environmental goals and control measures with respect to:

- Water pollution, including landfill leachate;
- Air pollution, including gas emissions;
- Wastes, including quality and quantity;
- Noise pollution; and
- Remediation.

It also provides an outline of quarterly and annual monitoring of groundwater and surface water; leachate; and stormwater pond; as well as quarterly monitoring of landfill gas.

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6,870,000 6,869,500 6,869,000 6,868,500 6,868,000

Establish nest boxes for petaurid gliders

Haul road alignment selected to reduce clearing requirement - alignment chosen predominantly clear

Retain and manage native vegetation including potential koala feed trees

Retain and manage vegetation - Purchased land here to become operational land and subject to plan of management. Vegetation to be designated as 'natural area (bushland)' and registered with the S88B instrument

Low density planting of koala feed tree species on cleared floodplain

Proposed translocation recipient sites

Revegetate drainage line using locally sourced swamp sclerophyll/ koala feed tree species and provide alternative corridor for connectivity across cleared area

Retain vegetated corridor along ridgeline and connectivity to native vegetation

Clearly mark conservation significant plants that are in close proximity to development footprint

Implement translocation plan for White Lace Flower

Quarry developments subject to approved environmental management plans

Landfill subject to approved landfill environmental management plans

Revegetate along ridgeline using koala feed trees and other fauna resources to enhance connectivity along ridgeline

Vegetation Types

- Camphor Laurel Closed Forest (1a)
- Camphor Laurel Woodland (1b)
- Blackbutt Wet Sclerophyll Open Forest (2a)
- Blackbutt Dry Sclerophyll Open Forest (2b)
- Camphor Laurel - Pink Bloodwood Closed Forest (3)
- Grassland / Substantially Cleared Areas (4)
- Canefield (5)
- Broad-leaved Paperbark - Camphor Laurel Open Forest (6)
- Brush Box - Bennetts Ash Open Forest (7)
- Orchard (8)

1:10,000 (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

N

LEGEND

- Site Boundary
- Cadastre Boundary
- Management Areas
- Revegetation Areas
- Quirks Quarry
- North Valley Footprint
- West Valley Footprint
- Haul Road

Conservation Significant Plants

- Black Walnut
- Long-leaved Tuckeroo
- Smooth Scrub Turpentine
- White Lace Flower (vulnerable)

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Tweed Shire Council
Eviron Road Quarry and Landfill Environmental Assessment

Job Number 41-20806
Revision 1
Date 27 MAY 2011

Management Measures

Figure 8

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Data source: Tweed Shire Council - Aerial Photography (2008), Haul Road (2011), Cadastre boundary (2011). GHD - Site Boundary (2011), Vegetation Mapping (2010), Habitat Trees (2010), Management Areas (2010), Revegetation Areas (2010), Quirks Quarry (2010), West Valley (2010), North Valley (2011).

Quarry Plan of Management

A Quarry Plan of Management is required as part of the application for an Environmental Protection Licence for each of the proposed quarries. Works and activities for the quarries must be carried out in accordance with the site-specific Quarry Plan of Management.

Vegetation Management

In order to protect and maintain vegetation outside of the development footprints, the following would be included in the management plan for vegetation:

- Vegetation protection areas will be identified and established prior to construction.
- Vegetation (and, if necessary individual trees) identified to be retained in close proximity to development areas shall be clearly marked and a 'protection zone' established. This would be in the form of fencing (e.g. post and wire) placed around the base of these areas/trees. Fencing should not inhibit movement of fauna. The protection zone would extend to the drip line of the tree where space permits or as close as possible to the works if constrained. No construction activity (including vehicle movement and storage of materials) will occur within the protection zones. Protective measures shall remain in place until practical completion of works in the immediate area.
- All site personnel will be made aware of retained vegetation areas and requirements for the protection of these areas.
- If stockpiling of vegetative material is required, this is to be stored at least 50 m away from any watercourse and outside the drip zone of any retained trees.

Activities Prohibited within the Protection Area

Activities that would be prohibited in the protection areas include:

- Use of or parking of vehicles and equipment (unless associated with a permitted activity);
- Placement of construction materials, refuse, excavated spoils and stockpiling;
- Dumping of poisonous materials that may be harmful to plant health;
- Use of tree trunks as a winch support, anchorage, temporary power pole, signpost or other similar function.

Activities Permitted within the Protection Area

The following activities permitted in the protection areas include:

- Weed management;
- Activities as described in the Habitat Management Plan (to be developed); and
- Restoration and translocation activities.

9.3.2 Target Survey and Translocation of Threatened Plant Species

Target surveys for threatened plant species will be undertaken once the final development footprint has been confirmed.

A 'Preliminary Translocation Plan for Threatened Plants' has been prepared by Council in accordance with the *Guidelines for the Translocation of Threatened Plants in Australia* (Appendix F). The plan provides details of the proposed translocation of the white lace flower plants recorded in the study area via ameliorative enhancement, with the goal to establish a viable self-sustaining population at the site. Replacement ratios of 1:50 for tubestock (seed propagation), and 1:100 for cuttings have been included in the plan.

In the event that further threatened species are located in the development footprint, the Translocation Plan would be revised to incorporate additional individuals or species.

9.4 Offset of Residual Impacts

9.4.1 Restriction on Title

In 2010 Council negotiated the purchase of an area of about 6.5 ha of land which constitutes the north western portion of Lot 1 DP1159352 at Eviron to secure land for long term quarry and landfill operations. The purpose of the acquisition was for the creation of a corridor between the existing Stott's Creek RRC and Council's proposed Quarry and Landfill site at Eviron . A linking road would traverse this area thereby connecting the Eviron Road quarry and landfill proposal with existing infrastructure located at Stott's Creek RRC.

Part of this parcel of land in the north western portion will be classified as operational land. This area is also recognised as having a number of biodiversity values including threatened fauna and flora species habitat and corridor values associated with the vegetated areas on the upper slopes and ridgeline. In order to manage these habitat values in perpetuity, it is proposed that a positive covenant be registered on the title imposing a legal obligation in perpetuity to abide by the management actions of a Habitat Management Plan.

A plan showing the habitat areas would form part of the Habitat Management Plan. To create the legal obligations in perpetuity, a positive covenant is to be registered on the title where the Habitat Management Plan will be a memorandum attached to the positive covenant. The positive covenant will create the legal obligation to manage the land in accordance with the Habitat Management Plan

The Habitat Management Plan would describe:

- The habitat areas, being the blackbutt mapped forest upslope on the proposed haul road; and
- Management actions to maintain and improve this habitat in perpetuity.

The restriction on the title forms part of Council's statement of commitments.

9.4.2 Corridor Planting and Enhancement

Although it is recognised that planting and corridor enhancement measures may not be considered to be a direct 'offset', effective provision of these are predicted to provide longer term connectivity and habitat benefits to fauna species such as the koala that are thought to have a resident population in the study area.

Council have prepared a Preliminary Restoration Plan that outlines the intended works to establish the corridors described below. This is provided in Appendix G. The objectives of the plan include the:

- Reconstruction of bushland habitat to facilitate wildlife movement throughout the site and wider locality;
- Provision of a fauna refuge across the site to minimise the risk of fauna injuries and mortalities from quarry and landfill operations and natural disturbance events;
- Reconstruction of native vegetation communities consistent with that likely to have occurred prior to clearing, or, where the existing environment is highly modified, reconstruct a suitable alternative native vegetation community (Tweed Shire Council, 2011b).

The Preliminary Restoration Plan identifies that local provenance stock would be sourced where the vegetation community and constituent species are well represented in the local area (e.g. Blackbutt forest). Composite provenancing would be employed for species that are poorly represented in the locality, (such as Swamp Mahogany and associated species). In this case, the seed stock would be sourced from local, intermediate and long distances from the revegetation site i.e. ~60% sourced from local stock (on or adjoining the site), ~30% from an intermediate source and ~10% from a more removed site (Tweed Shire Council, 2011b).

The Preliminary Restoration Plan includes a five year schedule of works for maintenance and monitoring (including reporting). An evaluation report would be prepared at the end of the five year period, which would provide recommendations for the future management of the restoration areas (Tweed Shire Council, 2011b).

Corridor Planting adjacent to Perimeter Drain

To provide future potential habitat and an alternate route for connectivity across the site, planting of suitable riparian / floodplain vegetation will be undertaken adjacent to the watercourse in Lot 1 DP1159352. The Preliminary Restoration Plan identifies strategies for this area, referred to as the 'Northern Riparian Corridor', for planting and assisted natural regeneration. Species characteristic of Swamp Sclerophyll Forest would be planted along the alignment using techniques of cluster planting along with a revegetation screen. This will create a vegetated corridor that connects the lowland areas to the ridgeline and effectively connect vegetation adjacent to the eastern side of Quirks Quarry to retained eucalypt open forest in the central western area of the site and link to the ridgeline.

Corridor Planting along ridgeline at Eviron Road

The vegetation along the southern boundary of the site along Eviron Road (Lot 1 DP34555) in the immediate vicinity of the current haul road access is currently predominantly cleared of native vegetation. This location along the ridgeline provides an opportunity to enhance connectivity from the vegetation to the south of Quirks Quarry in the east, to adjacent habitats along the Condong Range west and southwest of the site. It is proposed that plantings in this area would reflect existing remnant vegetation along the ridgeline and focus on providing fauna habitat and feeding resources. Suggested planting in this area would include small-fruited grey-gum (*Eucalyptus propinqua*), tallowwood (*E. microcorys*) (for koalas and other arboreal mammals) and forest oak (*Allocasuarina torulosa*) (for glossy black-cockatoos). The Preliminary

Restoration Plan identifies a strategy for this 'Southern Ridgeline Corridor', which involved planting out with tubestock characteristic of Blackbutt wet sclerophyll forest.

9.4.3 Supplementary Nest Boxes

Although no hollow-bearing trees will be cleared, some mature eucalypts with the potential to provide for hollow recruitment will be lost. Consequently, in recognition of this, a nest box plan for petaurid gliders is proposed, with boxes to be established within the parcel of land set aside for habitat management in the north western portion of Lot 1 DP1159352.

9.5 Impact Management Summary

A summary of how it is proposed to avoid, mitigate or offset the potential impacts of the proposed activity is provided in Table 12.

Table 12 Impact Management Summary

Activity and Potential Impact	Avoid	Mitigate	Residual Impacts?	Offset
QUARRY DEVELOPMENT				
Vegetation Clearing				
Habitat Loss	◗ The quarry footprint has been configured such that it minimises clearing of native vegetation. ◗ The quarry footprint predominantly avoids areas of higher ecological value eucalyptus dominated vegetation.	◗ Clearly mark areas of higher ecological value to be retained. ◗ Fence with fauna permeable fencing to exclude vehicles, stockpiles and equipment from retained vegetation.	Yes: ◗ Shelter ◗ Connectivity ◗ Feed trees	◗ Management in perpetuity of part of land purchased that now forms the north western portion of Lot 1 DP1159352 through designation as Operational Land and subsequent requirement for a plan of management (including habitat management plan) for this land and registered with a s.88B instrument to identify the area burdened by the restriction. ◗ Plant preferred koala feed trees and other suitable species and enhance connectivity and available habitat along drainage line in Lot 1 DP1159352 and along ridgeline on Lot 1 DP34555. A Preliminary Restoration Plan detailing a five year strategy for these areas has been developed by Council (Appendix G).

Activity and Potential Impact	Avoid	Mitigate	Residual Impacts?	Offset
Habitat Fragmentation	◗ The quarry development does not fragment any habitats in the site and maintains habitat and connectivity for fauna species.	Not required.	Yes: ◗ Reduction in corridor width	◗ Restore a native vegetation corridor across the cleared floodplain area on Lot 1 DP1159352. ◗ Enhance connectivity along the southern boundary of the site in Lot 1 DP 34555 along ridgeline through planting. ◗ Provide nest boxes to offset for loss of recruitment of hollows.
Loss of biodiversity	◗ Development footprint avoids clearing of native vegetation and most conservation significant species.	◗ Undertake target surveys for conservation significant flora species within the development footprint during detailed design. ◗ Develop a translocation plan for threatened flora species within development footprint.	Yes. ◗ Loss of five white lace flower (*Archidendron hendersonii*)	◗ Vegetation on land acquired by Council (part Lot 1 DP1159352) will be subject to management and may enhance suitability for threatened rainforest plant species including white lace flower. A Preliminary Translocation Plan (Appendix F) has been prepared with the aim to maintain the genetic biodiversity of the white lace flowers in the locality.
Fauna Mortality or Injury	◗ Clearing will be managed to reduce potential direct impacts upon any individual animals. ◗ If possible, undertake clearing outside of koala breeding season (spring – summer) to reduce potential impacts.	◗ All clearing will be undertaken in the presence of an experienced fauna spotter-catcher. ◗ Operators are aware of potential presence of fauna species and due care is taken when clearing. Clearing is undertaken such that the fauna spotter-catcher can observe and check all cleared vegetation.	No.	Not required.

Activity and Potential Impact	Avoid	Mitigate	Residual Impacts?	Offset
Heavy Vehicle Movements				
Fauna Mortality or Injury	Heavy vehicle movements only occur during designated working hours which are outside of many species foraging hours.	◗ Site is signed to make drivers aware of presence of fauna species and take due care when travelling near bushland. ◗ Drivers observe lower speed limits in close proximity to bushland.	No.	Not required.
Drilling, blasting, and processing				
Habitat Degradation – air quality	◗ Avoid blasting during times of adverse wind conditions. ◗ Avoid blasting at times of temperature inversion.	◗ Operator to consider amount of blasting agent utilised, location and orientation of blast face. ◗ Processing of materials should only take place when conditions are favourable (i.e. not during high wind or inclement weather). ◗ A dedicated program of dust suppression should be implemented as per an approved management plan. ◗ Quarry design includes permanent devices to maintain water quality as required. ◗ Erosion and sediment control measures implemented as per the 'Blue Book'.	No.	Not required.
Stockpiling				
Adverse Impacts to Vegetation	◗ Stockpiles are located outside of vegetated areas and managed appropriately.	◗ Construction works to be undertaken in general accordance with AS 4970-2009.	No.	Not required.

Activity and Potential Impact	Avoid	Mitigate	Residual Impacts?	Offset
LANDFILL DEVELOPMENT				
Landfilling				
Habitat Degradation – Vermin and altered Species Dynamics	◗ Landfilling will be undertaken in previously cleared / disturbed areas (i.e. quarry footprints). No additional habitat will be removed for the purposes of landfilling operations.	◗ Implement measures detailed in an approved landfill EMP including: Regular compaction and covering of landfilled waste to reduce accessibility to fauna species. Minimise exposed area. Use of insecticides and pesticides if required in accordance with an approved LEMP. Selection of chemicals to take into account any potential ecological impacts to aquatic species. Use of scarecrows and bird scarers, as required.	No.	Not required.
Habitat degradation – Water Quality	◗ A leachate management system will collect landfill leachate as detailed in the LEMP including a fully engineered compacted clay and HDPE liner system.	Not required.	No.	Not required.
Habitat Degradation – Litter	◗ Orient landfill tipping cells in a direction that provides the greatest protection against the prevailing winds. ◗ Undertake landfilling within a bunded waste disposal area. ◗ All vehicle loads should be covered, even when transferring between landfills.	◗ Maintain a small active waste disposal area. ◗ Compact landfilled waste regularly throughout the day. ◗ Cover all landfilled waste at the end of each day. ◗ Use mobile litter fences if required around the active tipping area. ◗ Regular checks of the site for litter and collection and disposal.	No.	Not required.

Activity and Potential Impact	Avoid	Mitigate	Residual Impacts?	Offset
Habitat Degradation - Weeds	◗ The potential for spread of weeds will be limited through reduced movement of green waste through the site (green waste to be disposed of at Stotts Creek RRC). ◗ All vehicle loads should be covered, even when transferring between landfills.	◗ A weed management plan should be implemented for retained vegetation in the site.	No.	Not required.
Habitat Degradation - Noise		◗ Maintain all landfill plant and machinery in proper working order. ◗ Plant and equipment to only operate within approved hours of operation. ◗ Access to the site for heavy vehicles will be limited to the designated access.	No.	Not required.
Habitat Degradation – Air Quality		◗ Immediately cover or bury dusty waste loads. ◗ Earthworks should not be undertaken during high winds unless the soil to be excavated is moist. ◗ Dust suppression should be undertaken through use of a water cart as required.	No.	Not required.
Introduction of disease and pathogens		◗ Reduce potential for vector contact by compacting and covering waste regularly as per the LEMP and ensure minimal waste is exposed at any one time. ◗ Manage leachates and water flow from the site.	No.	Not required.

Activity and Potential Impact	Avoid	Mitigate	Residual Impacts?	Offset
HAUL ROAD				
Vegetation Clearing				
Habitat Loss	◗ Haul road and batters located as far as possible within existing cleared areas. ◗ Detailed design to reduce estimated clearing requirement.	◗ Clearly mark areas of higher ecological value to be retained. ◗ Fence with fauna permeable fencing to exclude vehicles, stockpiles and equipment from retained vegetation.	No.	Not required.
Habitat Fragmentation	◗ Haul road does not fragment habitats.	Not required.	No	Not required.
Loss of biodiversity	◗ Trim or lop branches in preference to clearing. ◗ Include design considerations to reduce footprint near areas of higher ecological value. ◗ Clear camphor laurels in preference to natives where necessary.	◗ Translocation of threatened plant species as per the Preliminary Translocation Plan for Threatened Plant Species (Appendix F).	◗ No	◗ Restoration in corridors as per the Preliminary Restoration Plan (Appendix G).
Fauna Mortality or Injury	◗ Clearing will be managed to reduce potential direct impacts upon any individual animals.	◗ All clearing will be undertaken in the presence of an experienced fauna spotter-catcher. ◗ Operators are aware of potential presence of fauna species and due care is taken when clearing.	No	Not required.

Activity and Potential Impact	Avoid	Mitigate	Residual Impacts?	Offset
Construction and Earthworks				
Habitat Degradation – altered hydrology	◗ Maintain existing flow pathways.	◗ The haul road design should include appropriately sized drainage structures where required along natural flow paths. ◗ The design of the haul road should maintain existing quality and quantity of runoff.	No	Not required.
Habitat Degradation – air quality	◗ Select a pavement surface that does not result in production of dust.	◗ Regularly maintain the road. ◗ Water the road for dust suppression as necessary.	No	Not required.
Habitat Degradation – Water Quality		◗ Implement erosion and sediment control measures as per the 'Blue Book' during construction.	No	Not required.

10. Threatened Species Assessment

10.1 Species Selection

A preliminary assessment was made of all threatened species, populations and ecological communities identified from the desktop assessment and/or from the field survey to determine whether a specific Part 3A Adverse Impact Assessment should be undertaken. This was based upon an evaluation of the significance of the impacts as per Step 3 of the Part 3A Threatened Species Guidelines.

The Part 3A Threatened Species Guidelines indicate that impacts are considered to be 'more significant' if the following apply:

- Areas of high conservation values are affected;
- Individual animals and/or plants and/or subpopulations that are likely to be affected by the proposal play an important role in maintaining the long term viability of the species, population or ecological community;
- Habitat features that are likely to be affected by the proposal play an important role in maintaining the long-term viability of the species, population or ecological community;
- The duration of the impacts are long-term; and
- The impacts are permanent and irreversible.

A summary of the proposed development with respect to the impact evaluation factors outlined above is provided in Table 13.

Table 13 Impact Evaluation Factors

Significance	Proposed Activity and Impact
Areas of high conservation values are affected.	Specific activities that have potential to impact upon areas of high conservation values areas are: - Clearing of vegetation for quarry establishment; - Clearing of vegetation for haul road establishment; and - Operational activities that may result in degradation of habitat. Areas considered to have higher ecological values in the study area include: - Eucalypt open forest including wet sclerophyll forest with lowland rainforest elements; and - Swamp sclerophyll forest. The proposed activity has been configured such that the maximum areas of these habitats are maintained in the study area, and where relevant, their existing connectivity to other areas of higher conservation value is retained.

Significance	Proposed Activity and Impact
Individual animals and/or plants and/or subpopulations that are likely to be affected by the proposal play an important role in maintaining the long term viability of the species, population or ecological community.	Although it is not expected that the proposed activity will affect the long term viability of any species, population or ecological community, specific activities that could have a direct impact upon individual flora and fauna species are: ◗ Clearing of vegetation for quarry establishment; ◗ Clearing of vegetation for haul road establishment; and ◗ Movement of heavy vehicles. Any threatened species identified in the study area are considered as likely to have an important role in maintaining the long term viability of the species population or ecological community. The proposed activity will have direct impacts upon a small stand of white lace flower (*Archidendron hendersonii*) which occur within the footprint of West Valley.
Habitat features that are likely to be affected by the proposal play an important role in maintaining the long-term viability of the species, population or ecological community;	Specific activities that may have impacts upon habitat features are: ◗ Clearing of vegetation for quarry establishment; and ◗ Clearing of vegetation for haul road establishment. No hollow-bearing trees will be cleared for the activity. Scattered eucalypts from within camphor laurel dominated vegetation will be removed where they occur within the development footprint. These would provide feeding resources for koalas and other fauna species.
The duration of the impacts are long-term.	Specific activities that will result in long term impacts: ◗ Removal of quarry materials; and ◗ Landfilling. It is anticipated that the proposed activity will take place over a period of 40 years. During this time some of the components of the activity will be rehabilitated for the purposes of the Tweed Regional Botanic Gardens.
The impacts are permanent and irreversible.	It is anticipated that the development footprints of all the quarry and landfill developments will be rehabilitated to become the future Tweed Shire botanic gardens. The final landform will depend upon the requirements for this. The impacts of clearing are not considered to be irreversible, however the footprint will not be returned to that existing. Future development of the botanic gardens has potential to provide beneficial impacts that will result in habitats in the study area that are improved for a variety of fauna species. In addition, due to the study area containing suitable conditions for a variety of rainforest species, areas outside of the footprints could be restored or rehabilitated to reflect the original communities that would have occurred on the site. Management and rehabilitation and of habitats in the study area is achievable and with respect to this the impacts are not considered to be permanent or irreversible.

Species for which a detailed assessment of impacts was undertaken against the Part 3A Guidelines and/or the EPBC Act Guidelines are listed in Table 14. Note that the following species were grouped for assessment given their similar habitat requirements:

- Rainforest flora species including the white lace flower (*Archidendron hendersonii*) – 'threatened rainforest plants';
- Rainforest doves; and
- Microchiropteran bat species.

Table 14 Threatened Species Assessed

Species Name	Common Name
FLORA SPECIES – (All assessed as 'threatened rainforest plants'	
Acacia bakeri	Marblewood
Archidendron hendersonii	White Lace Flower
Bosistoa transversa (Syn. Bosistoa selwynii)	Yellow Satinheart
Cassia brewsteri var. *marksiana*	Brush Cassia
Corokia whiteana	Corokia
Cryptocarya foetida	Stinking Cryptocarya
Davidsonia jerseyana	Davidson's Plum
Davidsonia johnsonii	Smooth Davidson's Plum
Dendrocnide moroides	Gympie Stinger
Desmodium acanthocladum	Thorny Pea
Diospyros mabacea	Red-fruited Ebony
Diospyros major var. *ebenus*	Shiny-leaved Ebony
Diploglottis campbellii	Small-leaved Tamarind
Drynaria rigidula	Basket Fern
Endiandra floydii	Floyd's Walnut
Endiandra muelleri subsp. *bracteata*	Green-leaved Rose Walnut
Gossia fragrantissima	Sweet Myrtle
Grevillea hilliana	White Silky Oak
Hicksbeachia pinnatifolia	Red Boppel Nut
Lepiderema pulchella	Fine-leaved Tuckeroo
Lindsaea brachypoda	Short-footed Screw Fern
Macadamia tetraphylla	Rough-shelled Bush Nut
Marsdenia longiloba	Clear Milkvine
Oberonia titania	Red-flowered King of the Fairies
Ochrosia moorei	Southern Ochrosia
Randia moorei	Spiny Gardenia

Species Name	Common Name
Symplocos baeuerlenii	Small-leaved Hazelwood
Syzygium hodgkinsoniae	Red Lilly Pilly
Syzygium moorei	Durobby
Taeniophyllum muelleri	Minute Orchid
FAUNA	
BIRDS	
Calyptorhynchus lathami	Glossy Black-cockatoo
Cyclopsitta diophthalma coxeni	Coxen's Fig-parrot
Glossopsitta pusilla	Little lorikeet
Ptilinopus magnificus	Wompoo Fruit-dove
Ptilinopus regina	Rose-crowned Fruit-dove
Todiramphus chloris	Collared kingfisher
Tyto capensis	Grass Owl
MAMMALS	
Dasyurus maculatus maculatus	Spotted-tailed Quoll
Falsistrellus tasmaniensis	Eastern False Pipistrelle
Miniopterus australis	Little Bentwing-bat
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat
Nyctophilus bifax	Eastern Long-eared Bat
Petaurus norfolcensis	Squirrel glider
Phascolarctos cinereus	Koala
Pteropus poliocephalus	Grey-headed Flying-fox
REPTILES	
Coeranoscincus reticulatus	Three-toed Snake-tooth Skink
INVERTEBRATES	
Mitchell's Rainforest Snail	*Thersites mitchellae*
ENDANGERED ECOLOGICAL COMMUNITIES	
Lowland rainforest on floodplain	

10.2 Part 3A Adverse Impact Assessment

Appendix H provides details of the Part 3A Adverse Impact Assessments in accordance with Appendix 3 of the Part 3A Assessment Guidelines.

The key findings of the Part 3A Adverse Impact Assessments were that the proposed activity was not likely to have an adverse impact on any species, populations or ecological communities or their habitats that occur or could occur in the study area such that they would be placed at risk of extinction.

10.3 Environment Protection and Biodiversity Conservation Act 1999

10.3.1 EPBC Act Assessments of Significance

Appendix H provides details of the EPBC Act Assessments of Significance that were undertaken. It was determined from these assessments that the proposed activity is not likely to have a significant impact upon any threatened species, populations or ecological communities, or migratory species.

11. Conclusion

11.1 Part 3A Assessment

Pursuant to the Part 3A Assessment Guidelines, development applications under Part 3A must contain a justification of the project based on the following key thresholds.

Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts will maintain or improve biodiversity values.

The application of the "improve or maintain" test to the project requires the consideration of positive and negative ecological impacts, proposed mitigation of negative impacts, and biodiversity offsets to compensate for residual negative impacts.

The proposed activity will result in the removal of approximately 10 ha of highly disturbed camphor laurel dominated vegetation primarily of relatively low ecological value. These areas are considered as such due to lack of denning or nesting habitat and low level of foraging resources for many native fauna species. The habitats in the study area will not be fragmented.

In order to maintain higher ecological value habitats, the proposed activity footprint has avoided areas of eucalypt open forest. Loss of biodiversity values however relate to loss of shelter, loss of foraging resources and a reduction in corridor width as well as removal of a small stand of white lace flower (*Archidendron hendersonii*) listed as vulnerable under the TSC Act. The genetic biodiversity of this species may be maintained through successful translocation.

An area of blackbutt open forest in the north west of the site on the southern portion of In the north western portion of Lot 1 DP1159352 that will be purchased by Council will become Operational Land, and as such will be subject to a specific Plan of Management including a Habitat Management Plan. This would effectively conserve this area in the site. The Plan of Management would include designation of the vegetated areas outside of the development footprint as a Natural Area, and identify management strategies including weed management and requirements for assisted natural restoration, which would potentially improve the habitat for fauna species including koala and also provide a suitable environment for recruitment of threatened rainforest plants.

It is intended that connectivity in some areas of the site be improved through planting of suitable resource species in targeted locations. Two locations have been identified, these being the area through In the eastern portion of Lot 1 DP1159352 along the drainage line between Quirks Quarry and the eucalypt open forest to the south of the North Valley footprint (see Figure 8); and the augmentation of vegetation along the northern side of Eviron Road that is currently cleared. This would benefit the populations of koala and other fauna species in the longer term through provision of alternate corridor as well as resources including koala feed trees, and winter flowering species such as *Eucalyptus robusta* in the lower lying areas. This could be considered to effectively meet the requirement to maintain biodiversity values in the medium to long term. A Preliminary Restoration Plan has been developed that identifies strategies for revegetation and assisted natural regeneration of these areas.

All aspects of the proposed activity will be subject to approved environmental management plans. As such, the activity will be subject to rigorous management throughout its lifespan.

Based upon the above considerations, it is expected that the proposed activity will maintain or improve the existing biodiversity values of the study area.

Whether or not the proposal is likely to reduce the long-term viability of a local population of any threatened species, population or ecological community.

The project is not likely to reduce the viability of any local populations of threatened biota.

Although a group of five individual white lace flower (*Archidendron hendersonii*) plants were identified within the development footprint and will be removed, this species was also recorded from the area that the Council intends to purchase and manage, and as such part of the population will be maintained and the vegetation in this area will be subject to management such that the potential for recruitment of this and other threatened rainforest species may be enhanced. A Preliminary Translocation Plan for Threatened Plants includes strategies towards maintaining this species in the study area. Should any other threatened plants be identified, the plan would be modified to incorporate these.

The proposed activity will not impact upon the lifecycles of any of the threatened species. There are no hollow-bearing trees within the development footprint, and as such breeding activity of hollow-dependant fauna species will not be directly impacted as a result of the activity. Sufficient vegetation and habitats will persist in the locality to maintain existing populations, and active management of areas of higher ecological value will enhance the habitats and maintain existing populations.

Whether or not the proposal is likely to accelerate the extinction of any species, population or ecological community or place it at risk of extinction.

Although the proposed activity will result in clearing of a small stand of white lace flower (*Archidendron hendersonii*) and a reduction in the area of lower ecological value habitats for both flora and fauna species on the site, the extent of the proposed activity is not considered to be such that any species are placed at risk of extinction. Adequate habitats will persist in the locality, including areas retained in the site that will be subject to active management to enhance their habitat values. As such is not expected that the proposed activity will place any species, populations or ecological communities at risk of extinction.

Whether or not the proposal will adversely affect critical habitat.

Stotts Island Nature Reserve has been declared as critical habitat for the Mitchell's rainforest snail. Council intends to utilise best practice techniques for their landfills and as such no adverse impacts to areas outside of the study area, including Stotts Island Nature Reserve are expected.

11.2 Matters of National Environmental Significance

The assessment has indicated that is not likely that development of the elements of the proposed Concept Plan would have a significant impact upon any matters of National Environmental Significance, and as such a referral to the Commonwealth would not be

necessary, although could be considered by Council. Subsequent project applications may require further ecological assessment and consideration of matters of National Environmental Significance would be required at that time.

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Appendix A

EPBC Protected Matters Report

Table B1 Threatened Flora Species Records

Species Name	Record Source		Status			Preferred Habitat	Distribution	Local Records	Likelihood of Occurrence
	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act	ROTAP				
APOCYNACEAE									
Marsdenia longiloba Clear Milkvine		✓	E	V	3RC-	Subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops	North from the Barrington Tops.	No records from within a 5 km radius. Recorded south of study area near Cudgera Creek.	*Possible Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.
Ochrosia moorei Southern Ochrosia		✓	E	E	2ECi	Riverine and lowland subtropical rainforest.	North from the Richmond River to Springbrook in Queensland.	No records from within a 5 km radius, however recorded just outside this along Tweed river at Condong to the west. Other district records include a number from the Burringbar Range in the south and Mount Warning National Park to the west.	*Likely Occurrence* Previously recorded in the district and potential habitat comprising wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.

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Allocasuarina defungens Dwarf Heath Casuarina		✓	E	E	2E	Coastal areas of wet to dry, dense, low, closed heath land growing on Pleistocene marine aeolian derived soils.	Confined to the north coast region of NSW from near Nabiac, north-west of Forster, to Byron Bay on the NSW north coast.	Not recorded in the Shire.	*Highly Unlikely Occurrence* Outside of species known distribution.
CUNONIACEAE									
Davidsonia jerseyana Davidson's Plum		✓	E	E	2ECi	Coastal subtropical rainforest.	Tweed and Brunswick Valleys.	Not recorded from within a 5 km radius. District records along the highway south of the site between Yelgun and Cudgera Creek as well as west of the site around Murwillumbah.	*Possible Occurrence* Suitable habitat occurs in the form of subtropical rainforest and wet sclerophyll forest. The species has been recorded previously in the district in similar habitat. Not recorded in survey.

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act	ROTAP				
Davidsonia johnsonii Smooth Davidson's Plum		✓	E	E	-	Lowland subtropical rainforest and low altitude wet sclerophyll forest. Has been recorded as isolated trees in paddocks and roadsides. Has been recorded from weed-threatened regrowth sub-tropical rainforest.	North from Tintenbar, Terania Creek and Mullumbimby area to upper Tallebudgera Creek in south east Queensland.	Not recorded from within a 5 km radius. Recorded to the southwest of the study area near Happy Valley, and to the north west across the Tweed River. Other district records occur along the Burringbar Range to the south.	*Possible Occurrence* Suitable habitat occurs in the form of wet sclerophyll forest with rainforest elements. The species has been recorded previously in the district in similar habitat. Not recorded in survey.
CYPERACEAE									
Eleocharis tetraquetra Square-stemmed Spike-rush	✓		E			Swampy areas.	Known from a number of locations in only three areas in New South Wales: Boambee, near Coffs Harbour and within Fortis Creek National Park and near Murwillumbah. Also found in Queensland and Asia.	One record from within a 5 km radius from 2006 to the north of the site near Duranbah.	*Possible Occurrence* The species could occur in lower lying areas of the study area. These areas will not be impacted as a result of the proposed activity. Not recorded in survey.

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EBENACEAE									
Diospyros mabacea Red-fruited Ebony	✓	✓	E	E	2ECi	Lowland subtropical rainforest, often near rivers.	Recorded from the Tweed Valley, Brunswick Valley and Oxley Valley in northern NSW.	Three records from within a 5 km radius. Recorded on Stotts Island as well as several district records along the Tweed River from Condong to Tyalgum.	*Likely Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.
Diospyros major var. ebenus Shiny-leaved Ebony	✓		E		-	Lowland or riverine subtropical rainforest.	Tweed Valley as well as Nambour and Gympie districts in Queensland.	Five records within a 5 km radius. Records north of the Tweed River near Tumbulgum to the north west of the site.	*Likely Occurrence* No district records of the species south of the Tweed River. Not recorded in survey.

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ESCALLONIACEAE									
Corokia whiteana Corokia	✓	✓	v	v	2VCi	Warm temperate rainforest and subtropical rainforest.	Restricted to north east NSW with three known populations, one in the Tweed Valley, one near Brunswick Heads and one in the Nightcap Range	Five records from within a 5 km radius (from 1897) near Tumbulgum. Other records north of the Tweed River near Upper Duroby.	*Possible Occurrence* Some potentially suitable habitat occurs in the study area. Not recorded in survey.
EUPHORBIACEAE									
Baloghia marmorata Jointed Baloghia		✓	v	v	3VC-	Subtropical rainforest on basaltic soils.	Confined to Lismore area and Tamborine Mountain, Queensland.	No records in the district. Recorded south of Alstonville.	*Possible Occurrence* Although the species has not been recorded in the local area previously, wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.

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FABACEAE – CAESALPINIOIDEAE									
Cassia brewsteri var. marksiana Brush Cassia	✓		E		2RCi	Littoral and riverine rainforest.	North from Brunswick Heads	11 records from within a 5 km radius. Closest records of the species from Stotts Island Nature Reserve and Clothiers Creek Road. Several other records throughout the district.	*Likely Occurrence* Has been recorded in the district previously. Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.
FABACEAE - FABOIDEAE									
Desmodium acanthocladum Thorny Pea		✓	v	v	2VC-	Dry rainforest and fringes of riverine subtropical rainforest on basalt-derived soils at low elevations.	Recorded only from northeast NSW in the Lismore area with other scattered records to the Tweed.	Not recorded from within a 5 km radius, however one record just outside this to the east of the study area just west of Casuarina. Many records from near Lismore.	*Possible Occurrence* Some marginal habitat occurs in the study area. Not recorded in survey.

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FABACEAE -MIMOSOIDEAE									
Acacia bakeri Marblewood			v		-	Wet sclerophyll eucalypt forest and rainforest	Mullumbimby north to coastal South East Queensland.	Not recorded from within a 5 km radius. Several records in Tweed Shire..	*Likely Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.
Archidendron hendersonii White Lace Flower	✓		v		-	Riverine and lowland subtropical rainforest.	North from Alstonville.	One record from within a 5 km radius (from 1931). Recorded to the south east of the study area near the coast at Bogangar.	*Known Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Recorded in study area in two locations by Council.

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FLACOURTIACEAE									
Xylosma terrae-reginae Queensland Xylosma	✓		E		-	Littoral rainforest.	North from Broken Head, NSW.	One record from within a 5 km radius. Records east of the Pacific Highway, one at Cudgen, and another south of Cudgera Lake Nature Reserve.	*Unlikely to occur* No suitable habitat occurs in the study area. Not recorded in survey.
LAURACEAE									
Cryptocarya foetida Stinking Cryptocarya	✓	✓	v	v	3VCi	Littoral rainforest.	North from Iluka.	Three records within a 5 km radius including a record southwest on the Condong Range along Clothiers Creek Road. A number of other records near Tweed Heads, Bogangar, and in the Mooball area.	*Likely Occurrence* Although 'littoral rainforest' does not occur in the study area, the species has been recorded to the southwest and thus it is presumed that suitable habitat would be present in the study area. Not recorded in survey.

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act	ROTAP				
Endiandra floydii Floyd's Walnut		✓	E	E	2VC-	Recorded from warm-temperate and subtropical rainforest, from sea level to 430 m. Warm temperate or subtropical rainforest with Brush Box overstorey, and in regrowth rainforest and Camphor Laurel forest.	Generally confined to Tweed and Brunswick Valleys and Byron Bay area, with occasional records in southeast Qld.	No records from within a 5 km radius. District records to the south of the site along the Burringbar Range. south of Palmvale and to the northwest of the site along the Macpherson Range. near Upper Crystal Creek.	*Possible Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.
Endiandra muelleri subsp. bracteata Green-leaved Rose Walnut	✓		E			Brush Box- and subtropical rainforest gently undulating to steep sub-coastal hills and floodplain margins, generally at low elevation (<200 metres).	North from Maclean. Occurs mainly in the Brunswick and Tweed. Valleys	One record from within a 5 km radius. 14 trees in total are reported from Koala Beach Estate to the south east of the study area.	*Likely Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.

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LINDSAEACEAE									
Lindsaea brachypoda Short-footed Screw Fern	✓		E		-	Very moist habitats, growing on banks and rocks, in subtropical or warm-temperate rainforest or palm forest.	North from Minyon Falls in Nightcap National Park.	Two records of the species from within a 5 km radius. One record of the species in the south of Cudgen Nature Reserve on the coast as well as records on the northern side of the Tweed River north of Tumbulgum.	*Possible Occurrence* Suitable very moist habitat does not occur in the study area. Not recorded in survey.
Lindsaea fraseri Fraser's Screw Fern	✓		E		-	Poorly drained, infertile soils in swamp forest or open eucalypt forest, usually as part of a ferny understorey.	In NSW only known from known only from two areas - near Hastings Point on the Tweed coast and in the Pillar Valley east of Grafton.	One record from within a 5 km radius. Two records near Cudgen Nature Reserve, Hastings point and a record from Cudgen.	*Possible Occurrence* Suitable habitat in the form of eucalypt forest occurs in the subject site. Not recorded in survey.

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MENISPERMACEAE									
Tinospora tinosporoides Arrow-head Vine		✓	v	v	3RC-	Wetter subtropical rainforest.	North from the Richmond River.	No records from within a 5 km radius. Recorded from near Cudgera Creek. Records predominantly from the Lismore area.	*Unlikely Occurrence* Unsuitable habitat occurs in the study area. Not recorded in survey.
MYRTACEAE									
Gossia fragrantissima Sweet Myrtle		✓	E	E	3EC-	Subtropical rainforest in coastal districts. Mostly found on basalt-derived soils.	North from the Richmond River.	No records from within a 5 km radius. Recorded to the north of study area near Bilambil. Records clustered around the Lismore and Mullumbimby areas.	*Possible Occurrence* Suitable subtropical rainforest habitat occurs adjacent to the subject site. Not recorded in survey.

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act	ROTAP				
Syzygium hodgkinsoniae Red Lilly Pilly	✓	✓	v	v	3VC-	Subtropical rainforest or gallery forest	North from the Richmond River to Gympie in Queensland.	One record from within a 5 km radius, a historical record from Condong (1913) is the closest to the site. Records also from Mooball National Park, north of the Tweed River at North Tumbulgum and along the Macpherson Range and Burringbar Range.	*Possible Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.
Syzygium moorei Durobby	✓	✓	v	v	2VCi	Lowland subtropical and riverine rainforest.	North from the Richmond River.	Six records from within a 5 km radius from Stotts Creek Nature Reserve to the north and along Clothiers Creek Road to the south west. Several other records scattered throughout the district.	*Likely Occurrence* Suitable habitat in the form of subtropical rainforest occurs in the subject site. Not recorded in survey.

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ORCHIDACEAE									
Geodorum densiflorum Pink Nodding Orchid	✓		E		-	Dry sclerophyll forest, often on coastal sand; at lower altitudes.	North of the Macleay River.	One record within a 5 km radius. All mapped records are near the coast. In the district the species has been recorded between Tweed Heads and Mooball Beach.	*Unlikely Occurrence* No suitable habitat on sand occurs in the subject site. Not recorded in survey.
Oberonia titania Red-flowered King of the Fairies	✓		v		-	Grows in a variety of habitats including in subtropical, littoral and dry rainforest, Melaleuca swamps, mangroves and gorges in sclerophyll forest.	North from Kendall.	One historical record (1897) in the district from north of the Tweed River near Tumbulgum.	*Possible Occurrence* Occurs in a variety of habitats. Not recorded in survey.

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Phaius australis Southern Swamp Orchid	✓		E	E	3VCa	Paperbark swamps and in sclerophyll forest, on the coast, at or near sea level.	Evans Head north. Historically North from Lake Cathie.	One record from within a 5 km radius just west of Cudgen Lake. Other records along Cudgen Creek.	*Possible Occurrence* Although a small patch of Broad-leaved Paperbark open forest occurs on the floodplain, the species is not expected to occur due to the narrow extent of this vegetation and lack of understorey. Not recorded in survey.
Taeniophyllum muelleri Minute Orchid		✓		v	-	Grows on outer branches and branchlets of rainforest tree on the coast and coastal ranges, from sea level to 250 m altitude.	North from the Bellinger River.	No records from within a 5 km radius. A record of the species south near Burringbar Gap.	*Possible Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.

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POLYPODIACEAE									
Drynaria rigidula Basket Fern	✓		E		-	Usually found in rainforest but also recorded from moist eucalypt and Swamp Oak forest.	North of the Clarence River, in a few locations at Maclean, Bogangar, Byron Bay, Mullumbimby, in the Tweed Valley and at Woodenbong.	One record from within a 5 km radius to the south east near Round Mountain. District records from edges of Mooball National Park, south of the study area.	*Likely Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.
PROTEACEAE									
Grevillea hilliana White Silky Oak	✓		E		-	Subtropical rainforest, often on basalt-derived soils.	North from Brunswick Heads. Known in NSW from near Brunswick Heads, on the slopes of Mt Chincogan in Byron Shire and in Tweed Shire in remnant patches of habitat, particularly around Terranora.	One record from within a 5 km radius from 1898 from north of the Tweed River near Tumbulgum. Other district records north of the Tweed River near Bilambil and at Banora Point.	*Possible Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.

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Hicksbeachia pinnatifolia Red Boppel Nut	✓	✓	v	v	3RC-	Subtropical rainforest, moist eucalypt forest and Brush Box forest.	North from the Nambucca Valley (chiefly north of Lismore).	Two records from within a 5 km radius from 1892. The location of the record is shown just to the west of Lot 1 DP1159352, however as the record is dated November 1892 the location may not be accurate.	*Possible Occurrence* Records indicate that this species was historically recorded in very close proximity to the subject site, although accuracy of record is unknown. Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.
Macadamia tetraphylla Rough-shelled Bush Nut	✓	✓	v	v	2VC-	Subtropical rainforest in coastal areas.	North of the Clarence River chiefly in the Tweed and Richmond Valleys.	One record from within a 5 km radius to the north of the study area just east of Stotts Island. Records along the Burringbar Range south of the site as well as scattered records throughout the district on the western side of the Pacific Highway.	*Likely Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.

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RUBIACEAE									
Randia moorei Spiny Gardenia	✓	✓	E	E	3ECi	Subtropical, riverine, littoral and dry rainforest. Hoop Pine and Brush Box are common canopy species.	North from Lismore in NSW to near Beenleigh.	Four records within a 5 km radius. Records from Stotts Island Nature Reserve and Condong as well as scattered records along Burringbar Creek and north of the Tweed River.	*Likely Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.
RUTACEAE									
Acronychia littoralis Scented Acronychia		✓	E	E	3ECi	Littoral rainforest on sand.	Port Macquarie, NSW to Fraser Island, Queensland.	No records from within a 5 km radius Records outside 5 km occur on the eastern side of Cudgen Lake and along the coast from Billinudgel Nature Reserve north to near Wommin Lake.	*Unlikely Occurrence* No suitable habitat occurs in the study area. Not recorded in survey.

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Bosistoa transversa (Syn. Bosistoa selwynii) Yellow Satinheart	✓	✓	v	v	-	Rainforest on volcanics.	Nightcap Range NSW north to Maryborough, Queensland.	One record from within a 5 km radius at Stotts Island NR. A number of district records north of the Tweed River and near Crystal Creek. Records also to the south along the Burringbar Range.	*Likely Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.
SAPINDACEAE									
Diploglottis campbellii Small-leaved Tamarind	✓	✓	E	E	2E	Riverine rainforest and eucalypt forest.	Richmond River NSW and Mudgeeraba Creek, Queensland.	18 records from within a 5 km radius. Number of records along the Condong Range to the southwest near Clothiers Creek as well as near Condong. Other district records from along the Oxley River west of Murwillumbah and near Mount Warning.	*Likely Occurrence* Some areas of potential habitat occur in the study area. Not recorded in survey.

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Species information sourced from PlantNET and NSW Threatened Species Website.

Species Name	Record Source		Status			Preferred Habitat	Distribution	Local Records	Likelihood of Occurrence
	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act	ROTAP				
Lepiderema pulchella Fine-leaved Tuckeroo	✓		v		2RC-	Lowland subtropical rainforest on infertile metasediments and on fertile basalts.	North of Brunswick Heads. Predominantly recorded from the Tweed Valley.	17 records from within a 5 km radius. Dated from 1897. Recorded from Stotts Island Nature Reserve and Tumbulgum. District records predominantly on the northern side of the Tweed River.	*Likely Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.
SYMPLOCACEAE									
Symplocos baeuerlenii Small-leaved Hazelwood	✓		v	v	2VC-	Subtropical and warm-temperate rainforest on less fertile soils derived from rhyolite.	North from the Nightcap Range.	Eight records from within a 5 km radius. Recorded from Condong and north of the Tweed River. A number of records from near Upper Crystal Creek.	*Likely Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act	ROTAP				
URTICACEAE									
Dendrocnide moroides Gympie Stinger	✓		E		-	Lowland rainforest, especially in gaps or other disturbed sites.	Clarence River north to North Queensland.	One record from within a 5 km radius from just north of Cudgen Lake. Records also from Mooball National Park.	*Likely Occurrence* Suitable habitat in the form of wet sclerophyll forest with rainforest elements occurs in the study area. Not recorded in survey.

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Table B2 Threatened Fauna Species Records

Species Name	Record Source		Threat Status		Preferred Habitat	Distribution	Local Records	Likely Occurrence
	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
AMPHIBIANS								
Crinia tinnula Wallum Froglet	✓		V	--	Generally restricted to acid paperbark swamps in wallum country of coastal south-east Qld and northern NSW. Most often found in fringing vegetation of wallum swamps.	Recorded along coastal NSW from Helensburgh south of Sydney to north of Bundaberg Queensland.	12 records from within a 5 km radius. A number of these occur east of the highway near Cudgen Lake.	*Possible Occurrence* An isolated patch of Melaleuca vegetation occurs along the watercourse which provides only marginal potential habitat for this species. Not recorded in survey

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Species Name	Record Source		Threat Status		Preferred Habitat	Distribution	Local Records	Likely Occurrence
	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Litoria olongburensis Wallum Sedge Frog	✓	✓	V	V	Sedgeland, Banksia and Melaleuca woodland in sandy coastal areas of south-east Qld and northern NSW. This species occurs along slow-flowing creeks and in acidic, marshy or swampy lowland habitats amongst emergent vegetation and reeds.	Yuragir National Park south of Grafton, north to Fraser Island, Queensland.	One record from within a 5 km radius. Records to the east of the study area near Cudgen Lake.	*Unlikely Occurrence* An isolated patch of Melaleuca vegetation occurs along the watercourse which provides only marginal potential habitat for this species. Not recorded in survey
Mixophyes iteratus Southern Barred Frog		✓	E	E	Found along shallow, rocky streams in upland and lowland rainforests, wet sclerophyll forests and farmland below 520 m altitude.	From Belli Creek near Eumundi, SEQ, to Warrimoo, mid-east NSW. Currently known from scattered locations in the catchments of the Mary, Upper Stanley, Caboolture and Coomera Rivers.	No records from within a 5 km radius. Recorded from near Reserve Creek south of the study area. Other records in the southwest towards Byrill Creek including within the Border Ranges NP.	*Unlikely Occurrence* Watercourse does not provide suitable habitat for species. Not recorded in survey

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
BIRDS								
Amaurornis olivaceus Bush hen	✓		V	--	Key elements of the species habitat are dense undergrowth 2-4 m tall and within 300 m of water. These include margins of freshwater streams and natural or artificial wetlands, usually within or bordering rainforest, rainforest remnants or forests. Also secondary forest growth, rank grass or reeds, thickets of weeds, crops or other farmland.	Coastal and subcoastal regions from the Top End of the Northern Territory and Cape York Peninsula south through eastern Queensland to north-eastern NSW.	Identified twice once at Sheens Creek and once at Sleepy Hollow Golf Course. Records from near Kingscliff and Cudgen Nature Reserve.	*Possible Occurrence* Species could utilise local drains as habitat. These areas occur in the lower-lying areas outside of the development footprint. Not recorded in survey.

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Anthochaera phrygia Regent Honeyeater		✓	E	E	Mainly inhabits temperate woodlands and open forests particularly Box-Ironbark woodland, and riparian forests of River Sheoak. Coastal lowland forests of swamp mahogany *E. robusta* and spotted gum *Corymbia citriodora* may also be important, during periods of drought in western regions.	Primary distribution is the inland slopes of south-east Australia. Previous distribution between northeast Victoria and southeast Queensland.	No records from within a 5 km radius. Previously recorded near Hastings Point on the coast to the south east of the study area.	*Unlikely occurrence.* Suitable habitat generally not available in the study area. Not recorded in survey.
Burhinus grallarius Bush Stone-curlew	✓		E	--	Open forest and woodland with a sparse grassy groundlayer and fallen timber.	Broad distribution throughout most of Australia apart from the central southern coast and inland, the far south-east corner and Tasmania.	One record from within a 5 km radius. Mainly coastal records from between Tweed Heads and Pottsville. A record also from north of Murwillumbah.	*Likely Occurrence* Small areas of open forest and woodland with suitable ground layer occur in the study area. Not recorded in survey

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Calyptorhynchus lathami Glossy Black-cockatoo	✓		V	--	Forest and woodland, particularly those with Allocasuarina sp. on which the species feed. Nests in hollow trees.	Central Queensland coast to East Gippsland in Victoria.	Six records from within a 5 km radius including records to the east of the highway near Cudgen Lake as well as one record west of the study area along the Tweed River near Condong.	*Likely Occurrence* Areas of blackbutt open forest complex occur within the study area so considered that the species could occur. Marginal foraging habitat only for this species with few Allocasuarinas recorded. A possible record of the species overflying the study area.
Cyclopsitta diophthalma coxeni Coxen's Fig-parrot		✓	E	E (Mig)	Upland and lowland rainforests, usually containing fig trees, including dry cool subtropical and littoral rainforests, tropical semi-deciduous vine forests and gallery forests.	Scattered populations occur east of the Great Dividing Range between Port Macquarie in NSW and near Gladstone in Queensland. Limited to about five populations.	No records from within a 5 km radius. Records of the species from Murwillumbah, Uki and Mt Warning NP.	*Unlikely Occurrence* Marginal suitable habitat occurs, although some fig trees recorded. Not recorded in survey

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Ephippiorhynchus asiaticus Black-necked Stork	✓		E	--	Permanent freshwater wetlands.	Coastal northern and eastern Australia.	20 records from within a 5 km radius. Recorded from Stotts Island NR as well as south near Clothiers Creek and east near Duranbah. Several records from the Terranora Broadwater and other scattered records throughout the Shire.	*Possible Occurrence* Could occasionally utilise lower lying areas of the study area. No suitable habitat occurs in the subject site. Not recorded in survey
Glossopsitta pusilla Little Lorikeet	✓		V	--	Open Eucalyptus forest and woodland., Riparian habitats are particularly favoured, Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species.	The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found as far west as Dubbo and Albury.	Mapped record of the species near Round Mountain.	*Known Occurrence* Suitable habitats are available for foraging for the species in the study area. Recorded during survey.

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Ixobrychus flavicollis Black Bittern	✓		V	--	Freshwater and estuarine wetlands generally in areas of permanent water and dense vegetation generally where permanent water is present. May occur in flooded grassland, forest, woodland, rainforest and mangroves.	Southern NSW north to Cape York and across the north Australian coast to the Kimberley. Also occurs in southwestern Western Australia.	Three records from within a 5 km radius. Recorded in or near Cudgen NR. Records also from Murwillumbah, as well as southwest near Mt Warning.	*Possible Occurrence* Could occasionally utilise lower lying areas of the study area. No suitable habitat occurs in the subject site. Not recorded in survey
Lathamus discolor Swift Parrot		✓	E	E	The species forages for lerps and nectar in flowering eucalypts during winter particularly in box ironbark forests and woodlands. In coastal areas the species may utilise swamp mahogany, spotted gum and red bloodwood. In north eastern NSW the species utilises, narrow-leaved red ironbark/ forest red gum forests and yellow box forest.	Breeds in Tasmania and migrates to mainland Australia, predominantly in Victoria and New South Wales, in Autumn.	No records from within a 5 km radius. Recorded from 1964 to the south of the study area near Happy Valley.	*Unlikely occurrence.* Eucalypt open forest occurs in the study area however not containing typical habitat. The species has not previously been recorded nearby. Not recorded in survey.

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Lophoictinia isura Square-tailed Kite	✓		V	--	Found in a range of habitats including dry woodlands and open forests. Preference for watercourses.	Coastal and subcoastal areas from south-western to northern Australia, Qld, NSW and Vic. Regular resident in the NSW northeast. Migrates to southeast to breed in summer.	Recorded from Jones Road and Yelgun. Mapped records from near Coolangatta and Mount Warning.	*Possible Occurrence* Foraging habitat for the species is available in the study area. Not recorded in survey.
Monarcha leucotis White-eared Monarch	✓		V	--	In NSW occurs primarily in coastal rainforest, swamp forest and moist eucalypt forest. Favours rainforest edges.	Iluka to Cape York, west to the Richmond Range. Occasional records south to Port Macquarie.	Several records from along the Tweed River valley as well as from Mooball National Park, south of Cudgen Lake and near Christies Creek.	*Likely Occurrence* Suitable habitats occur in the study area and several local records. Not recorded in survey.
Pachycephala olivacea Olive Whistler	✓		V	--	Wet forest above 500 m altitude, however may move to lower altitude forest during winter.	Disjunct distribution. Occurs in Beech forests at Barrington Tops and the McPherson Range in northern NSW. Also occurs from the Illawarra south to Victoria and inland to the Brindabella Range.	One record of the species from within a 5 km radius. Also near Happy Valley, south of the study area and along the McPherson Range.	*Unlikely Occurrence* Habitat in the study area is not suitable for the species. Not recorded in survey

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Pandion haliaetus (Pandion cristatus) Osprey	✓		V	-- (Mig, Listed Marine)	Coastal areas. Generally nest within 1 km of the coast in tall dead trees or dead crowns of trees.	Distributed around coastal Australia apart from Victoria and Tasmania.	Two records from within a 5 km radius. There are no osprey nests mapped within the study area. A nest is recorded from North Tumbulgum near the confluence of the Rous and Tweed Rivers, and another near Cudgen Creek south of Kingscliff. Several coastal records in the Tweed Heads region south to South Golden Beach. Additional records from near Murwillumbah.	*Possible Occurrence* Species may forage over the study area. The distance of the study area to water means that it is unlikely for the species to nest within the study area. Not recorded in survey

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Poephila cincta cincta Black-throated Finch (southern)		✓	E	E	Eucalypt woodland and riparian vegetation, including Melaleuca and Acacia shrubland.	Historically recorded from Inverell district to southern Cape York.	No records of this species occur within the Tweed Shire.	*Highly Unlikely Occurrence* Has not been previously recorded in the local area. Suitable habitat does not occur in the study area. Not recorded in survey.
Ptilinopus magnificus Wompoo Fruit-dove	✓		V	--	Coast and ranges. Has been recorded in or near low rainforest, low elevation wet sclerophyll forest (including brush box forest). Recorded mostly from mature forests, however has also been found in remnant and regenerating rainforest.	Hunter River, NSW north to Cape York Peninsula (considered rare south of Coffs Harbour).	One record from within a 5 km radius. Recorded in Stotts Island Nature Reserve as well as on the coast near Cudgen Lake. In the region, records occur in Mooball NP as well as several records from Nightcap and Border Ranges NP.	*Likely Occurrence* Suitable habitat in the form of wet sclerophyll forest with rainforest elements occurs on the study area. Not recorded in survey

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Ptilinopus regina Rose-crowned Fruit-dove	✓		V	--	Rainforest and closed forest as well as eucalypt or acacia woodland if foraging habitat is available.	Principally distributed from northeast NSW to northern Queensland. Extends south to Moruya. Additional vagrant records from eastern Victoria and Tasmania. The population is partly migratory.	One record from within a 5 km radius. Recorded at Cudgen Lake, Kingscliff, Terranora and Murwillumbah. Regional records within Mooball, Mt Warning and Border Ranges NP.	*Known Occurrence* Suitable habitat in the form of wet sclerophyll forest with rainforest elements occurs on the study area. Recorded on site by Council.
Rostratula australis (syn. Benghalensis s. lat.) Australian Painted Snipe		✓	E	V (Mig, Listed Marine)	Terrestrial, shallow freshwater species found in wetlands, lakes, swamps, inundated or waterlogged grasslands, dams and other freshwater to brackish habitats. Also use modified habitats such as grazing land, dams, sewage farms or irrigated crops.	Recorded from the Qld channel country and SE Qld as well as the river basins west of the Great Dividing Range in NSW, the Victorian Riverina and SE South Australia	No records from within a 5 km radius of the study area.	*Highly Unlikely Occurrence* Has not previously been recorded in the region. Not recorded in survey.

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Turnix melanogaster Black-breasted Button-quail		✓	E	V	Vine thicket rainforest with a closed canopy and deep litter layer. Thought to prefer dry low closed forests. Also recorded from Hoop Pine plantation, vine scrub regrowth and dry sclerophyll adjacent to rainforest.	Southeast Queensland to Bundaberg and northern NSW north of Bruxner Highway.	No records from within a 5 km radius of the study area. Recorded from reserved areas southwest of the study area.	*Unlikely Occurrence* Some areas of potential habitat occur in the study area. Not recorded in survey.
Tyto capensis Grass Owl	✓		V	--	Species inhabits areas of tall grass, including grass tussocks in swampy areas, grassy plains, swampy heath, and cane grass, or sedges on flood plains.	Occurs in two disjunct areas, these being the Manning River to Cape York and Barkly Tableland and Channel country of Western Australia	19 records from within a 5 km radius. Record of the species near Clothiers Creek Road, as well as a number of records east of the highway near Duranbah. Records also to the north near Chinderah.	*Likely Occurrence* Cane land occurs over part of the study area and the study area is likely to form part of the species foraging habitat. Not recorded in survey.

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Tyto novaehollandiae Masked Owl	✓		V	--	Dry eucalypt forests and woodlands from sea level to 1100 m.	Victoria around the eastern and northern coast to north western Western Australia. Distributed over most of NSW, with more records from coastal areas.	Species recorded at Jones Road, Yelgun and Taggets Hill.	*Possible Occurrence* No records from close proximity to the study area, foraging habitat available. Not recorded in survey.
MAMMALS								
Chalinolobus dwyeri Large-eared Pied bat		✓	V	V	Primarily recorded from higher altitude moist tall open forests adjacent to rainforests. It is usually found in well-timbered areas with gullies. Roosting has been recorded in disused mine shafts, caves, overhangs and disused Fairy Martin nests.	Recorded from Bungonia north to near Rockhampton, Queensland.	Not recorded within a 5 km radius. Shire records from reserves in the southwest including Mt Warning NP.	*Possible Occurrence* Foraging habitat in the form of open woodland occurs along the alignment. Limited roosting habitat available within hollows. Not recorded in survey.

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	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Dasyurus maculatus maculatus Spotted-tailed Quoll	✓	✓	V	E	Occurs in a wide range of habitats including densely vegetated areas from rainforest to woodland and also coastal heathland. Transient individuals have also been observed in open areas.	Eastern Victoria and Tasmania north to Southeast Queensland.	Four records from within a 5 km radius. Was recorded in close proximity to the study area in 2004. Other local records from south of Clothiers Creek Road, Cudgen Lake. Other scattered records of the species throughout the Shire.	*Likely Occurrence* Given the local record, there is potential for this species to forage in the study area at least on an occasional basis. Not recorded in survey.
Falsistrellus tasmaniensis Eastern False Pipistrelle			V	--	Moist habitats in tall open forest. Roosts in tree hollows, and on occasion under loose bark or in man-made structures.	South east coast and ranges from southen Queensland to Victoria and Tasmania.	No records from within a 5 km radius. The closest records to the study area are from Border Ranges and Nightcap National Parks.	*Likely occurrence* This species was recorded in the field survey as being 'almost certainly present' by Greg Ford (see Appendix E).

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Miniopterus australis Little Bentwing-bat	✓		V	--	Occurs in a variety of habitats including rainforest, wet sclerophyll forest or closed banksia scrub. Roost in caves, tunnels or tree hollows during the day. Maternity sites as large colonies in caves.	Coastal northeastern NSW and eastern Queensland.	Two records from within a 5 km radius. Records from near the Cobaki Broadwater, Cudgen NR and Cudgen Creek. Other records from reserves to the southwest.	*Known Occurrence* Foraging habitats available in the study area. Recorded from field survey (definite call identification).
Miniopterus schreibersii oceanensis Eastern Bentwing-bat	✓		V	--	Caves, mines, old mine tunnels, culverts and other man made structures. Forages in forested areas. Forms maternity colonies in caves.	East and north west Australian coast.	One record from within a 5 km radius. Recorded near Quirks Quarry. Other local records near both Cudgera and Cudgen Creeks as well as Mt Warning NP and Tyalgum.	*Known Occurrence* Recorded previously from near Quirks Quarry. Not recorded in survey.

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Species Name	Record Source		Threat Status		Preferred Habitat	Distribution	Local Records	Likely Occurrence
	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Mormopterus beccarii Beccari's Freetail-bat			V	--	A range of vegetation types from rainforests to open forests and woodlands. Often recorded along watercourses. Also occur in manmade environs. Mainly roost in tree hollows, although relatively large colonies have been in manmade structures.	Widely distributed across northern Australia from Western Australia to Queensland, extending south to the north-east corner of NSW.	No records from within a 5 km radius. A record from near Cobaki Broadwater, records from South Tweed and Banora Point. A record of this genus from Eviron Road.	*Possible Occurrence* Foraging habitats available in the study area. Not recorded in survey.
Mormopterus norfolkensis Eastern Freetail-bat	✓		V	--	Dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures.	Found along the east coast from south Queensland to southern NSW.	No records from within a 5 km radius. Recorded to the north of Bilambil. A record of this genus from Eviron Road.	*Possible Occurrence* Foraging habitats available in the study area. Not recorded in survey.

Key to Table:

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EP – Endangered Population
CE – Critically Endangered
Mig – Migratory

NP – National Park
NR – Nature Reserve
ROTAP Status – see Briggs and Leigh, 1995
EPBC – *Environment Protection and Biodiversity Conservation Act*

Local record locations obtained from Atlas of NSW Wildlife and Pacific Highway Upgrade Species Impact Statement (Woodward Clyde, & Landmark Ecological Services Pty Ltd, 1998).

Species information sourced from PlantNET and NSW Threatened Species Website.

Species Name	Record Source		Threat Status		Preferred Habitat	Distribution	Local Records	Likely Occurrence
	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Myotis macropus Large-footed Myotis			V	--	Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface.	Found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers.	No records from within a 5 km radius. Recorded in a number of locations including from Banora Point, Tweed Heads West, Hastings Point and Sleepy Hollow.	*Possible Occurrence* Foraging habitats available in the study area. Not recorded in survey.

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Species Name	Record Source		Threat Status		Preferred Habitat	Distribution	Local Records	Likely Occurrence
	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Nyctophilus bifax Eastern Long-eared Bat	✓		V	--	Lowland subtropical rainforest and wet and swamp eucalypt forest, extending into adjacent moist eucalypt forest. Roosts in tree hollows, on palm fronds, in dense foliage in rainforest as well as under bark.	Northeast NSW to Cape York. In NSW extends south to Coffs Harbour. In NSW confined to coastal plain and nearby ranges.	Two records from within a 5 km radius. Has been recorded near Eviron Road as well as north of the study area along the highway, near Cudgen Creek and south near Round Mountain. Other records in reserves to the southwest.	*Likely Occurrence* Has been recorded in close proximity to the study area previously, and a potential habitat occurs in the study area in the form of wet sclerophyll forest with rainforest elements. Possible record in survey (unreliable identification from poor quality sequence).
Phascolarctos cinereus Koala	✓		V	--	Suitable habitat depends on the availability of appropriate food trees. They generally occur in a variety of open forest and woodland habitats. Density of a population is relative to the amount of food trees available.	Fragmented distribution throughout eastern Australia, from north-east Qld to the Eyre Peninsula in SA. Also extend W of the Great Dividing Range predominantly along inland rivers.	112 records from within a 5 km radius, distributed throughout the local area. Species has previously been recorded near Quirks Quarry and along the southern ridge, as well as at the tip of the spur near Stotts Creek landfill.	*Known Occurrence* Eucalypt trees occur within the subject site and the species has previously been recorded on the study area. Recorded in survey.

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Species Name	Record Source		Threat Status		Preferred Habitat	Distribution	Local Records	Likely Occurrence
	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Potorous tridactylus tridactylus Long-nosed Potoroo	✓	✓	V / EP	V	Subtropical and warm temperate rainforest, tall open forest with dense understorey, wet and dry sclerophyll forests and coastal heaths. Requires thick ground cover for protection and nesting. Thought to prefer light soils for easy digging for food. The preferred habitat in north eastern NSW being dry and wet open shrubland.	South eastern coast from Queensland to eastern Victoria and Tasmania.	Two records from within a 5 km radius of the study area. Records from east of the Pacific Highway near Cudgen Lake. The Cobaki population occurs on the northern side of the Cobaki Broadwater.	*Unlikely Occurrence* Understorey for most of the study area was sparse and unlikely to contain preferred habitat of this species. Targeted in cage trapping survey. Not recorded in survey.
Pseudomys novaehollandiae New Holland Mouse		✓		V	Open heathlands, open woodlands with a heathland understorey and vegetated sand dunes.	Fragmented distribution across Tasmania, Victoria, New South Wales and Queensland.	No records from within a 5 km radius. Not recorded from Tweed Shire.	*Unlikely Occurrence* Habitat typical of this species does not occur in the study area. Not recorded in survey.

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Species information sourced from PlantNET and NSW Threatened Species Website.

Species Name	Record Source		Threat Status		Preferred Habitat	Distribution	Local Records	Likely Occurrence
	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Pteropus poliocephalus Grey-headed Flying-fox	✓	✓	V	V	Found in a range of habitats including rainforest, tall open forest and heath. Camps generally form in gullies, typically not far from water and usually in vegetation with a dense canopy.	Bundaberg to Melbourne, generally within 2 km of the coast.	Seven records from within a 5 km radius. Recorded from Cudgen Lake, Cudgen and within Stotts Creek Nature Reserve.	*Known Occurrence* No flying fox camp site within study area. Recorded on site by Council.
Xeromys myoides False Water Rat		✓		V	Saline grassland, mangroves, margins of freshwater swamps and lakes close to foredunes.	Largely unknown however recorded from disjunct areas from the Western Australia – Northern Territory Border to the Coomera River in Queensland.	No records from within a 5 km radius. Not recorded from Tweed Shire.	*Highly Unlikely Occurrence.* Species not previously recorded in Shire. Suitable habitats not available. Not recorded in survey.

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Species information sourced from PlantNET and NSW Threatened Species Website.

Species Name	Record Source		Threat Status		Preferred Habitat	Distribution	Local Records	Likely Occurrence
	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
REPTILES								
Coeranoscincus reticulatus Three-toed Snake-tooth Skink		✓	V	V	Inhabits rainforest, lowland closed forest and adjacent wet sclerophyll forests on loamy basaltic soils, where it is usually found in rotting logs or in loose soil and leaf litter under fallen trees.	Macleay Valley in NSW north to Southeast Queensland.	No records from within a 5 km radius. One record of the species adjacent the Tweed River near Condong to the west of the study area.	*Possible Occurrence* The species could utilise wet sclerophyll forest with rainforest elements near the haul road. Few reptiles were detected throughout the survey despite targeted surveys. Not recorded in survey.
INVERTEBRATES								
Phyllodes imperialis Pink Underwing Moth		✓	E	E	Lower montane rainforest. Breeding habitat in undisturbed old growth subtropical rainforest below 6 m altitude. Breeding habitat restricted to areas containing *Carronia multisepalea*, a rainforest vine, with a collapsed shrub-like habit.	Dorrigo north to Nambour, Queensland. Known only from few populations.	No records from within a 5 km radius. Recorded from far north eastern NSW, location unknown.	*Unlikely Occurrence* No suitable habitat occurs in the study area.

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Species information sourced from PlantNET and NSW Threatened Species Website.

Species Name	Record Source		Threat Status		Preferred Habitat	Distribution	Local Records	Likely Occurrence
	Atlas of NSW Wildlife	EPBC Protected Matters Report	TSC Act	EPBC Act				
Thersites mitchellae Mitchell's Rainforest Snail	✓	✓	E	CE	Occurs in remnant areas of lowland subtropical rainforest and swamp forest on alluvial soils. Preferred habitat includes elevated wetland areas supporting palm and fig trees.	Coastal plain between Ballina and Tweed Heads.	Three records within a 5 km radius. Recorded from Stotts Island NR (which is listed as critical habitat for the species). Also recorded from near Cudgen and Banora Point.	*Possible Occurrence* Wet sclerophyll forest with rainforest elements occurs in the study area, however remnants lack thick litter layers typical of known sites in the Tweed. Not recorded in survey.

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Species information sourced from PlantNET and NSW Threatened Species Website.

Table B3 Fisheries Management Act Listed Species (NSW Northern Rivers CMA)

Scientific Name	Common Name	Status	Likely Occurrence
Carcharius taurus	Grey nurse shark	Critically endangered	*Highly unlikely*
Maccullochella ikei	Eastern freshwater cod	Endangered	*Highly unlikely*
Nannoperca oxleyana	Oxleyan pygmy perch	Endangered	*Highly unlikely*
Pristis zijsron	Green sawfish	Presumed extinct	*Highly unlikely*
Nereia lophocladia	Marine brown alga	Critically endangered	*Highly unlikely*
Carcharadon carcharias	Great white shark	Vulnerable	*Highly unlikely*
Epinephelus daemelii	Black cod	Vulnerable	*Highly unlikely*

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EPBC – *Environment Protection and Biodiversity Conservation Act*

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Species information sourced from PlantNET and NSW Threatened Species Website.

Table B4 Endangered Ecological Communities – NSW Northern Rivers CMA – Murwillumbah (Qld – Southeast Hills and Range CMA sub-region)

Endangered Ecological Community	Threat Status	
	TSC Act	EPBC Act
Byron Bay Dwarf Graminoid Clay Heath Community	EEC	
Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions	EEC	
Coastal Cypress Pine Forest in the NSW North Coast Bioregion	EEC	
Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	EEC	
Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions	EEC	Nationally Threatened
Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion	EEC	
Sub-tropical Coastal Floodplain Forest of the NSW North Coast bioregion	EEC	
Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	EEC	
Themeda Grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner bioregions	EEC	

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Species information sourced from PlantNET and NSW Threatened Species Website.

Appendix C

Survey Effort

Table C1 – Flora Survey Effort

Table C2 – Fauna Survey Effort

Table C2 – Council Spotlighting Survey Effort

Table C1 Flora Survey Effort

Date	Location	Survey Effort
20/1/09	Transect and random meander from north valley to west valley.	1 botanist x 7 hours
21/1/09	Transect and meander through vegetation adjacent the haul road and in the south western portion of the subject site.	2 botanists x 7 hours
22/1/09	Investigations through vegetation along the drainage lines and to the east and southeast of Quirks Quarry.	1 botanist x 7 hours

Table C2 Fauna Survey Effort

Date	Elliot Traps	Cage Traps	Hair Traps	Bird Survey	Active Reptile Searches	Nocturnal Survey	Anabat
14/01/2009			30				
19/01/2009	100	24	80 + 30	1 person x 2 hours	opportunistic searches		
20/01/2009	100	24	80 + 30	1 person x 2 hours	2 persons x 20 minutes + opportunistic searches	2 persons x 2 hours	Overnight
21/01/2009	100	24	80 + 30	1 person x 2 hours	2 persons x 20 minutes + opportunistic searches	2 persons x 2 hours	Overnight
22/01/2009	100	24	80	1 person x 2 hours	2 persons x 20 minutes + opportunistic searches	2 persons x 2 hours	Overnight
23/01/2009				1 person x 2 hours	opportunistic searches		
Totals	400 trap nights	96 trap nights	590 trap nights	10 hours	4 hours	12 hours	3 nights

Table C3 Council Spotlighting Survey Effort

Date	Survey Effort	Location
6/07/2010	2 persons x 1 hour	Dwelling (previously the Hawkins residence) north along sealed access road to clearing adjacent Stott's Landfill (north western portion of Lot 1 DP1159352)
	2 persons x 1.5 hours	Dwelling south along western boundary to southern end of west valley area on ridgeline (Lot 1 DP1159352)
8/07/2010	3 persons x 1 hour	Dwelling north along sealed access road to clearing adjacent Stott's Landfill (north western portion of Lot 1 DP1159352)
	2 persons x 1 hour	Dwelling south along western boundary to southern end of west valley area on ridgeline (southern / south western portion of Lot 1 DP1159352)
Total	10 person hours	

Appendix D

Plant Species List

Table D1 Plant Species List

FAMILY	Scientific Name	Common Name
ACANTHACEAE	*Pseuderanthemum variabile*	Pastel Flower
ADIANTACEAE	*Adiantum hispidulum*	Rough Maidenhair Fern
ANACARDIACEAE	*Euroschinus falcatus*	Ribbonwood
	**Mangifera indica*	Mango
APIACEAE	*Centella asiatica*	Indian Pennywort
APOCYNACEAE	**Asclepias curassavica*	Redhead Cottonbush
	**Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush
	Parsonsia straminea	Monkey Rope
ARALIACEAE	*Polyscias sambucifolia*	Elderberry Panax
ARAUCARIACEAE	*Araucaria cunninghamii*	Hoop Pine
ARECACEAE	*Archontophoenix cunninghamiana*	Bangalow Palm
ASPLENIACEAE	*Asplenium australasicum*	Bird's Nest Fern
ASTELIACEAE	*Cordyline petiolaris*	Broad-leaved Palm Lily
ASTERACEAE	**Ageratina adenophora*	Crofton Weed
	**Ageratina riparia*	Mistflower
	**Ageratum houstonianum*	Blue Billygoat Weed
	**Baccharis halimifolia*	Groundsel Bush
	**Bidens pilosa*	Farmer's Friends
	**Cirsium vulgare*	Spear Thistle
	**Conyza bonariensis*	Flaxleaf Fleabane
	**Conyza sumatrensis*	Tall Fleabane
	**Hypochaeris radicata*	Flatweed
	Senecio bipinnatisectus	

Key to Table
Bold – Listed Species * prefix to scientific name – exotic species **R – ROTAP Species**

FAMILY	Scientific Name	Common Name
	**Sigesbeckia orientalis subsp. orientalis*	Indian Weed
BIGNONIACEAE	*Pandorea pandorana*	Wonga Wonga Vine
BLECHNACEAE	*Blechnum cartilagineum*	Gristle Fern
	Blechnum indicum	Swamp Water Fern
	Doodia aspera	Prickly Rasp Fern
CASUARINACEAE	*Allocasuarina torulosa*	Forest Oak
	Casuarina glauca	Swamp Oak
COMMELINACEAE	*Commelina cyanea*	Native Wandering Jew
CONVOLVULACEAE	**Ipomoea cairica*	Coast Morning Glory
CYATHEACEAE	*Cyathea australis*	Rough Tree-fern
CYPERACEAE	*Baumea articulata*	Jointed Twig-rush
	Carex appressa	
	Cyperus pilosus	
	Fimbristylis dichotoma	Common Fringe-sedge
	Gahnia clarkei	Tall Saw-sedge
DENNSTAEDTIACEAE	*Histiopteris incisa*	Bat's Wing Fern
	Pteridium esculentum	Bracken
DICKSONIACEAE	*Calochlaena dubia*	Rainbow Fern
DILLENIACEAE	*Hibbertia dentata*	Trailing Guinea Flower
DIOSCOREACEAE	*Dioscorea transversa*	Native Yam
DRYOPTERIDACEAE	*Arachniodes aristata*	Prickly Shield Fern
ELAEOCARPACEAE	*Elaeocarpus obovatus*	Hard Quandong
ERICACEAE - STYPHELIOIDEAE	*Trochocarpa laurina*	Tree Heath
EUPHORBIACEAE	*Alchornea ilicifolia*	Native Holly
	Homalanthus populifolius	Bleeding Heart
	Macaranga tanarius	Macaranga

Key to Table
Bold – Listed Species * prefix to scientific name – exotic species **[R] – ROTAP Species**

FAMILY	Scientific Name	Common Name
	Mallotus philippensis	Red Kamala
EUPOMATIACEAE	*Eupomatia laurina*	Bolwarra
FABACEAE - CAESALPINIOIDEAE	*Caesalpinia scortechinii*	Large Prickle-vine
	Caesalpinia subtropica	Corky Prickle-vine
	**Senna septemtrionalis*	Arsenic Bush
FABACEAE - FABOIDEAE	**Abrus precatorius subsp. precatorius*	Gidgee Gidgee
	Callerya megasperma	Native Wisteria
	Desmodium rhytidophyllum	
	Glycine tabacina	
	Hovea acutifolia	
	**Macroptilium atropurpureum*	Siratro
FABACEAE - MIMOSOIDEAE	*Acacia binervata*	
	Acacia melanoxylon	Blackwood
	Archidendron hendersonii	**White Lace Flower**
FLAGELLARIACEAE	*Flagellaria indica*	Whip Vine
GENTIANACEAE	**Centaurium tenuiflorum*	
GERANIACEAE	*Geranium homeanum*	
GLEICHENIACEAE	*Sticherus flabellatus*	Umbrella Fern
JUNCACEAE	*Juncus usitatus*	
LAURACEAE	**Cinnamomum camphora*	Camphor Laurel
	Cryptocarya bidwillii	Yellow Laurel
	Endiandra globosa[R]	Black Walnut
	Neolitsea dealbata	Hairy-leaved Bolly Gum
LILIACEAE	**Lilium formosanum*	Formosa Lily

Key to Table
Bold – Listed Species * prefix to scientific name – exotic species [R] **– ROTAP Species**

FAMILY	Scientific Name	Common Name
LOBELIACEAE	*Lobelia trigonocaulis*	Forest Lobelia
	Pratia purpurascens	Whiteroot
LOMANDRACEAE	*Lomandra longifolia*	Spiny-headed Mat-rush
	Lomandra multiflora subsp. multiflora	Many-flowered Mat-rush
LUZURIAGACEAE	*Eustrephus latifolius*	Wombat Berry
	Geitonoplesium cymosum	Scrambling Lily
LYTHRACEAE	**Cuphea carthagenensis*	
MALVACEAE	*Hibiscus splendens*	Pink Hibiscus
	**Sida rhombifolia*	Paddy's Lucerne
MELIACEAE	*Melia azedarach*	White Cedar
	Synoum glandulosum	Scentless Rosewood
MENISPERMACEAE	*Stephania japonica*	Snake Vine
MONIMIACEAE	*Wilkiea huegeliana*	Veiny Wilkiea
MORACEAE	*Ficus coronata*	Sandpaper Fig
	Ficus macrophylla	Moreton Bay Fig
	Ficus obliqua	Small-leaved Fig
	Ficus watkinsiana	Strangler Fig
	Maclura cochinchinensis	Cockspur Thorn
	Trophis scandens subsp. scandens	Burny Vine
MYRSINACEAE	**Ardisia crenata*	Coralberry
MYRSINACEAE	*Myrsine variabilis*	Muttonwood
MYRTACEAE	*Acmena smithii*	Lilly Pilly
	Angophora floribunda	Rough-barked Apple
	Archirhodomyrtus beckleri	Rose Myrtle
	Austromyrtus dulcis	Midgen Berry

Key to Table
Bold – Listed Species * prefix to scientific name – exotic species **[R] – ROTAP Species**

FAMILY	Scientific Name	Common Name
	Corymbia intermedia	Pink Bloodwood
	Eucalyptus acmenoides	White Mahogany
	Eucalyptus crebra	Narrow-leaved Ironbark
	Eucalyptus microcorys	Tallowwood
	Eucalyptus pilularis	Blackbutt
	Eucalyptus propinqua	Small-fruited Grey Gum
	Lophostemon confertus	Brush Box
	Melaleuca quinquenervia	Broad-leaved Paperbark
	**Psidium guajava*	Common Guava
	Rhodamnia maideniana[R]	Smooth Scrub Turpentine
	Rhodamnia rubescens	Scrub Turpentine
NYMPHAEACEAE	**Nymphaea caerulea*	Cape Waterlily
ONAGRACEAE	*Ludwigia peploides*	Water Primrose
ORCHIDACEAE	*Dipodium variegatum*	Blotched Hyacinth Orchid
PASSIFLORACEAE	**Passiflora edulis*	Common Passionfruit
	**Passiflora foetida*	Stinking Passionflower
	**Passiflora suberosa*	Corky Passionflower
	**Passiflora subpeltata*	White Passionflower
PHORMIACEAE	*Dianella caerulea*	Blue Flax Lily
PHYLLANTHACEAE	*Breynia oblongifolia*	Coffee Bush
	Glochidion ferdinandi	Cheese Tree
	Glochidion sumatranum	Umbrella Cheese Tree
	Phyllanthus virgatus	
PHYTOLACCACEAE	**Phytolacca octandra*	Inkweed
	**Rivina humilis*	Coral Berry
PINACEAE	**Pinus elliottii*	Slash Pine
PITTOSPORACEAE	*Bursaria spinosa*	Blackthorn

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FAMILY	Scientific Name	Common Name
	Pittosporum multiflorum	Orange Thorn
	Pittosporum revolutum	Wild Yellow Jasmine
POACEAE	**Andropogon virginicus*	Whisky Grass
	**Axonopus fissifolius*	Narrow-leafed Carpet Grass
	**Chloris gayana*	Rhodes Grass
	Cymbopogon refractus	Barbed Wire Grass
	Cynodon dactylon	Couch
	Entolasia marginata	Bordered Panic
	Entolasia stricta	Wiry Panic
	Imperata cylindrica	Blady Grass
	**Megathyrsus maximus*	Guinea Grass
	**Melinis minutiflora*	Molasses Grass
	**Melinis repens*	Red Natal Grass
	Microlaena stipoides	Weeping Grass
	Oplismenus aemulus	
	**Paspalum conjugatum*	Paspalum
	**Paspalum notatum*	Bahia Grass
	**Paspalum urvillei*	Vasey Grass
	**Saccharum officinarum*	Sugarcane
	**Setaria verticillata*	Whorled Pigeon Grass
	**Sporobolus fertilis*	Giant Parramatta Grass
	Themeda australis	Kangaroo Grass
POLYGONACEAE	*Persicaria attenuata*	A Smartweed
POLYPODIACEAE	*Platycerium bifurcatum*	Elkhorn
	Platycerium superbum	Staghorn
	Pyrrosia rupestris	Rock Felt Fern
PROTEACEAE	*Persoonia adenantha*	

Key to Table
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FAMILY	Scientific Name	Common Name
	Lomatia silaifolia	Crinklebush
	Stenocarpus sinuatus	Firewheel Tree
QUINTINIACEAE	*Quintinia verdonii*	Grey Possumwood
RHAMNACEAE	*Alphitonia excelsa*	Red Ash
	Pomaderris argyrophylla subsp. argyrophylla	
RIPOGONACEAE	*Ripogonum album*	White Supplejack
ROSACEAE	*Rubus moluccanus* var. *trilobus*	Molucca Bramble
	Rubus rosifolius	Native Raspberry
RUTACEAE	*Flindersia bennettiana*	Bennett's Ash
	Melicope elleryana	Pink-flowered Doughwood
	Zieria smithii	Sandfly Zieria
SAPINDACEAE	*Cupaniopsis anacardioides*	Tuckeroo
	Cupaniopsis newmanii[R]	
	Diploglottis cunninghamii	Native Tamarind
	Guioa semiglauca	Guioa
	Jagera pseudorhus var. *pseudorhus*	Foambark Tree
SAPOTACEAE	*Planchonella chartacea*	Thin-leaved Condoo
SMILACACEAE	*Smilax australis*	Lawyer Vine
SOLANACEAE	**Solanum chrysotrichum*	Devil's Fig
	**Solanum mauritianum*	Wild Tobacco Bush
	**Solanum nigrum*	Blackberry Nightshade
	**Solanum seaforthianum*	Climbing Nightshade
STERCULIACEAE	*Commersonia bartramia*	Brown Kurrajong
	Sterculia quadrifida	Red-fruited Kurrajong
THYMELAEACEAE	*Wikstroemia indica*	

Key to Table
Bold – Listed Species * prefix to scientific name – exotic species [R] **– ROTAP Species**

FAMILY	Scientific Name	Common Name
TILIACEAE	**Triumfetta rhomboidea*	Chinese Bur
TYPHACEAE	*Typha orientalis*	Broadleaf Cumbungi
ULMACEAE	*Aphananthe philippinensis*	Native Elm
	Trema tomentosa var. *viridis*	Poison Peach
UVULARIACEAE	*Tripladenia cunninghamii*	Ground Lily
VERBENACEAE	**Lantana camara*	Lantana
VITACEAE	*Cissus antarctica*	Kangaroo Vine
	Cissus hypoglauca	Water Vine
XANTHORRHOEACEAE	*Xanthorrhoea fulva*	
ZINGIBERACEAE	*Alpinia caerulea*	Native Ginger

Key to Table
Bold – Listed Species * prefix to scientific name – exotic species **[R] – ROTAP Species**

Appendix E

Fauna Survey Results

Fauna Species List

Anabat Analysis Summary

Table E1 – Fauna Species Recorded

Scientific Name	Common Name	Status			Survey Location						Detection Method							Council Record
		TSC Act	EPBC Act	EPBC Migr	NV1	NV2	WV	DL	G	HR	QQ	O	H	S	T	CP	W	An	
AMPHIBIANS																			
BUFONIDAE																			
*Chaunus (Bufo) marinus**	Cane Toad	U			✓	✓	✓	✓	✓	✓		✓	✓						
HYLIDAE																			
Litoria fallax	Eastern Dwarf Tree Frog	P						✓					✓						
Litoria gracilenta	Dainty Green Tree Frog	P			✓	✓	✓	✓					✓						
Litoria latopalmata	Broad-palmed Frog	P						✓					✓						
Litoria nasuta	Rocket Frog	P			✓			✓	✓	✓		✓	✓						
Litoria peronii	Peron's Tree Frog	P			✓								✓						
MYOBATRACHIDAE																			

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Anabat call confidence (see Greg Ford Report):
D - Definite
AC – Almost Certain
P - Possible

Scientific Name	Common Name	Status			Survey Location							Detection Method							Council Record
		TSC Act	EPBC Act	EPBC Migr	NV1	NV2	WV	DL	G	HR	QQ	O	H	S	T	CP	W	An	
Adelotus brevis	Tusked Frog	P						✓					✓						
Crinia signifera	Common Eastern Froglet	P			✓								✓						
Pseudophryne coriacea	Red-backed Toadlet	P								✓		✓	✓						✓
Uperoleia laevigata	Smooth Toadlet	P								✓			✓						
BIRDS																			
ACANTHIZIDAE																			
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	P			✓							✓							
Acanthiza lineata	Striated Thornbill	P								✓		✓	✓						
Acanthiza pusilla	Brown Thornbill	P			✓	✓	✓			✓		✓							
Gerygone olivacea	White-throated Gerygone	P				✓							✓						
Sericornis citreogularis	Yellow-throated Scrubwren	P			✓	✓						✓							
Sericornis frontalis	White-browed Scrubwren	P			✓					✓		✓	✓						

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		TSC Act	EPBC Act	EPBC Migr	NV1	NV2	WV	DL	G	HR	QQ	O	H	S	T	CP	W	An		
Sericornis magnirostris	Large-billed Scrubwren	P			✓							✓								
ACCIPITRIDAE																				
Aviceda subcristata	Pacific Baza	P				✓						✓	✓							
Haliastur sphenurus	Whistling Kite	P					✓					✓	✓							
ALCEDINIDAE																				
Dacelo novaeguineae	Laughing Kookaburra	P					✓						✓							
Todiramphus chloris	**Collared Kingfisher**	**V**			✓	✓						✓	✓							
ANATIDAE																				
Anas superciliosa	Pacific Black Duck	P						✓				✓								
Chenonetta jubata	Australian Wood Duck	P						✓				✓								
ARDEIDAE																				
Ardea alba (modesta)	Great Egret	P		✓				✓				✓								

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		TSC Act	EPBC Act	EPBC Migr	NV1	NV2	WV	DL	G	HR	QQ	O	H	S	T	CP	W	An	
Egretta novaehollandiae	White-faced Heron	P						✓				✓							
ARTAMIDAE																			
Cracticus nigrogularis	Pied Butcherbird	P			✓	✓						✓							
Cracticus torquatus	Grey Butcherbird	P					✓						✓						
Gymnorhina tibicen	Australian Magpie	P			✓	✓	✓			✓		✓							
Strepera graculina	Pied Currawong	P				✓				✓			✓						
CACATUIDAE																			
Calyptorhynchus lathami [++]	**Glossy Black-cockatoo**	**V**										✓							
CAMPEPHAGIDAE																			
Coracina novaehollandiae	Black-faced Cuckoo-shrike	P				✓						✓							
Coracina tenuirostris	Cicadabird	P			✓	✓				✓			✓						

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		TSC Act	EPBC Act	EPBC Migr	NV1	NV2	WV	DL	G	HR	QQ	O	H	S	T	CP	W	An		
Lalage leucomela	Varied Triller	P			✓	✓				✓			✓							
CAPRIMULGIDAE																				
Eurostopodus mystacalis	White-throated Nightjar	P				✓										✓				
CENTROPODIDAE																				
Centropus phasianinus	Pheasant Coucal	P					✓			✓			✓							
CHARADRIIDAE																				
Vanellus miles	Masked Lapwing	P						✓				✓								
CISTICOLIDAE																				
Cisticola exilis	Golden-headed Cisticola	P			✓	✓	✓		✓	✓		✓								
CLIMACTERIDAE																				
Cormobates leucophaea	White-throated Treecreeper	P			✓		✓					✓	✓							

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Scientific Name	Common Name	Status			Survey Location						Detection Method							Council Record
		TSC Act	EPBC Act	EPBC Migr	NV1	NV2	WV	DL	G	HR	QQ	O	H	S	T	CP	W	An	
COLUMBIDAE																			
Geopelia humeralis	Bar-shouldered Dove	P				✓	✓			✓		✓							
Leucosarcia melanoleuca	Wonga Pigeon	P				✓	✓			✓		✓	✓						
Macropygia amboinensis	Brown Cuckoo-Dove	P								✓		✓							
Ptilinopus regina	**Rose-crowned Fruit-dove**	**V**								✓									✓
CORACIIDAE																			
Eurystomus orientalis	Dollarbird	P				✓							✓						
CORVIDAE																			
Corvus orru	Torresian Crow	P			✓	✓	✓			✓		✓	✓						
CUCULIDAE																			
Cacomantis variolosus	Brush Cuckoo	P				✓							✓						

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		TSC Act	EPBC Act	EPBC Migr	NV1	NV2	WV	DL	G	HR	QQ	O	H	S	T	CP	W	An	
Eudynamys scolopacea	Common Koel				✓								✓						
DICAEIDAE																			
Dicaeum hirundinaceum	Mistletoebird	P					✓					✓							
DICRURIDAE																			
Dicrurus bracteatus	Spangled Drongo	P			✓	✓	✓			✓		✓	✓						
Grallina cyanoleuca	Magpie-lark	P						✓	✓			✓							
Monarcha (Symposiarchus) trivirgatus	Spectacled Monarch	P		✓						✓		✓							
Monarcha melanopsis	Black-faced Monarch	P		✓	✓					✓		✓							
Rhipidura leucophrys	Willie Wagtail	P				✓		✓				✓	✓						
ESTRILDIDAE																			
Neochmia temporalis	Red-browed Finch	P						✓	✓			✓							

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		TSC Act	EPBC Act	EPBC Migr	NV1	NV2	WV	DL	G	HR	QQ	O	H	S	T	CP	W	An	
Taeniopygia bichenovii	Double-barred Finch	P			✓	✓	✓			✓		✓							
EUPETIDAE																			
Psophodes olivaceus	Eastern Whipbird	P			✓	✓	✓			✓			✓						
MALURIDAE																			
Malurus lamberti	Variegated Fairy-wren	P					✓					✓							
Malurus melanocephalus	Red-backed Fairy-wren	P			✓							✓							
MEGAPODIIDAE																			
Alectura lathami	Australian Brush-turkey	P				✓						✓							
MELIPHAGIDAE																			
Entomyzon cyanotis	Blue-faced Honeyeater	P					✓						✓						
Lichenostomus chrysops	Yellow-faced Honeyeater	P				✓	✓			✓		✓	✓						

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		TSC Act	EPBC Act	EPBC Migr	NV1	NV2	WV	DL	G	HR	QQ	O	H	S	T	CP	W	An		
Lichmera indistincta	Brown Honeyeater	P					✓						✓							
Meliphaga lewinii	Lewin's Honeyeater	P			✓	✓				✓		✓	✓							
Melithreptus albogularis	White-throated Honeyeater	P				✓						✓	✓							
MOTACILLIDAE																				
Anthus novaeseelandiae	Richard's Pipit								✓			✓								
ORIOLIDAE																				
Oriolus sagittatus	Olive-backed Oriole	P			✓								✓							
Sphecotheres vieilloti	Australasian Figbird	P					✓			✓			✓							
PACHYCEPHALIDAE																				
Colluricincla harmonica	Grey Shrike-thrush	P					✓			✓			✓							
Colluricincla megarhyncha	Little Shrike-thrush	P								✓		✓	✓							

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Scientific Name	Common Name	Status					Survey Location					Detection Method								Council Record
		TSC Act	EPBC Act	EPBC Migr	NV1	NV2	WV	DL	G	HR	QQ	O	H	S	T	CP	W	An		
PARDALOTIDAE																				
Pardalotus striatus	Striated Pardalote	P				✓							✓							
PETROICIDAE																				
Eopsaltria australis	Eastern Yellow Robin	P								✓		✓								
Petroica rosea	Rose Robin	P			✓							✓								
PHASIANIDAE																				
Coturnix ypsilophora	Brown Quail	P							✓			✓								
PODARGIDAE																				
Podargus strigoides	Tawny Frogmouth	P				✓				✓		✓								✓
PSITTACIDAE																				
Glossopsitta pusilla	**Little Lorikeet**	**V**				✓						✓								
Platycercus adscitus	White Cheeked Rosella	P					✓					✓								

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Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet	P				✓						✓								
Trichoglossus haematodus	Rainbow Lorikeet	P			✓	✓						✓								
RALLIDAE																				
Porphyrio porphyrio	Purple Swamphen	P						✓				✓								
THRESKIORNITHIDAE																				
Platalea regia	Royal Spoonbill	P						✓				✓								
Threskiornis molucca	Australian White Ibis	P						✓				✓								
ZOSTEROPIDAE																				
Zosterops lateralis	Silvereye	P			✓	✓	✓			✓		✓	✓							
MAMMALS																				
CANIDAE																				

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		TSC Act	EPBC Act	EPBC Migr	NV1	NV2	WV	DL	G	HR	QQ	O	H	S	T	CP	W	An	
*Vulpes vulpes**	Fox	U					✓				✓						✓		
MACROPODIDAE																			
Wallabia bicolor	Swamp Wallaby	P					✓			✓		✓							
MURIDAE																			
Rattus lutreolus	Swamp Rat	P					✓								✓				
*Rattus rattus**	Black Rat	U			✓	✓	✓			✓					✓		✓		
PERAMELIDAE																			
Isoodon/Perameles sp.	unidentified Bandicoot	P			✓		✓							✓					
PETAURIDAE																			
Petaurus breviceps	Sugar Glider	P								✓		✓							✓
Petaurus sp.	Unidentified petaurid glider	P					✓			✓		✓							
PHALANGERIDAE																			

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		TSC Act	EPBC Act	EPBC Migr	NV1	NV2	WV	DL	G	HR	QQ	O	H	S	T	CP	W	An	
Trichosurus vulpecula	Common Brushtail Possum	P																	✓
Trichosurus sp.	brushtail possum	P												✓					
PHASCOLARCTIDAE																			
Phascolarctos cinereus	**Koala**	**V**			✓		✓					✓							✓
PTEROPODIDAE																			
Pteropus poliocephalus	Grey-headed Flying-fox	**V**	**V**																✓
VESPERTILIONIDAE																			
Falsistrellus tasmaniensis	**Eastern False Pipistrelle**	**V**																**AC**	
Miniopterus australis	**Little Bentwing-bat**	**V**																**D**	
Nyctophilus sp.[++]	Unidentified Long-eared Bat	P																P	

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		TSC Act	EPBC Act	EPBC Migr	NV1	NV2	WV	DL	G	HR	QQ	O	H	S	T	CP	W	An	
Scotorepens orion[++]	Eastern Broad-nosed Bat	P																P	
Scotorepens sp.[++]	Unidentified Broad-nosed Bat	P																P	
Vespadelus pumilus	Eastern Forest Bat	P																D	
REPTILES																			
AGAMIDAE																			
Pogona barbata	Bearded Dragon	P				✓						✓							
BOIDAE																			
Morelia spilota	Carpet Python	P					✓					✓							
SCINCIDAE																			
Eulamprus tenuis	Barred-sided Skink	P								✓		✓							
Lampropholis delicata	Dark-flecked Garden Sunskink	P			✓	✓	✓			✓		✓							

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Data received for analysis

Approximately 665 Anabat sequence files recorded at a quarry site near Tweed Heads over three nights – 20/1/2009 (63 files), 21/1/2009 (539 files) and 22/1/209 (43 files).

Data quality was good for most files recorded on 20th January and most files recorded on 21st January; however, about one-third of the files from 21/1/09 and ALL files recorded on 22/1/09 contained only background noise/interference.

Call identification standard

Call identification was based on keys and call descriptions published for New South Wales (Pennay *et al*. 2004) and southern Queensland (Reinhold *et al*. 2001).

Analysis results

Two species were positively identified from this data set:

***Miniopterus australis* – little bent-winged bat**

Definitely present on 21st January and probably also on 20th (but calls on 20th not reliably attributed)

***Vespadelus pumilus* – eastern forest bat**

Definitely present on both 20th and 21st and responsible for more than half of the calls recorded

At least one other species was also present but calls could not be reliably identified. The species most likely responsible for these calls was:

***Falsistrellus tasmaniensis* – eastern false pipistrelle**

This species was almost certainly present, with numerous calls from 21st January very similar to those described for the species

However, at least two other species – eastern broad-nosed bat (*Scotorepens orion*) and central-eastern broad-nosed bat (*Scotorepens* species) - sometimes produce calls that cannot be differentiated from *F. tasmaniensis*. All three species are likely to be present in the survey area (Churchill 1998; van Dyck and Strahan 2008)

Several poor quality call sequences may have been from a fourth species, but reliable identification was impossible. These calls were possibly from one of the long-eared bats (*Nyctophilus* species), but could equally have been from *F. tasmaniensis* or *Scotorepens* spp.

References

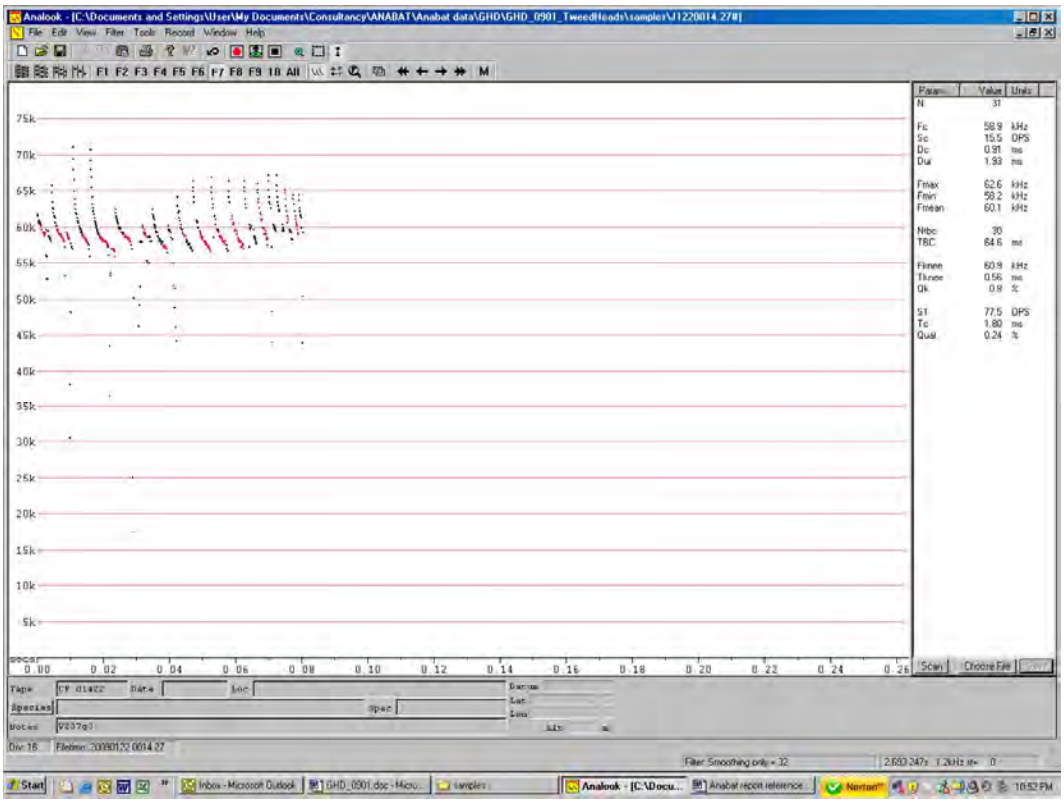
Churchill, S. (1998). *Australian Bats*. New Holland; Sydney.

Pennay, M., Law, B. and Reinhold, L. (2004). *Bat Calls of New South Wales*. Department of Environment and Conservation, Hurstville.

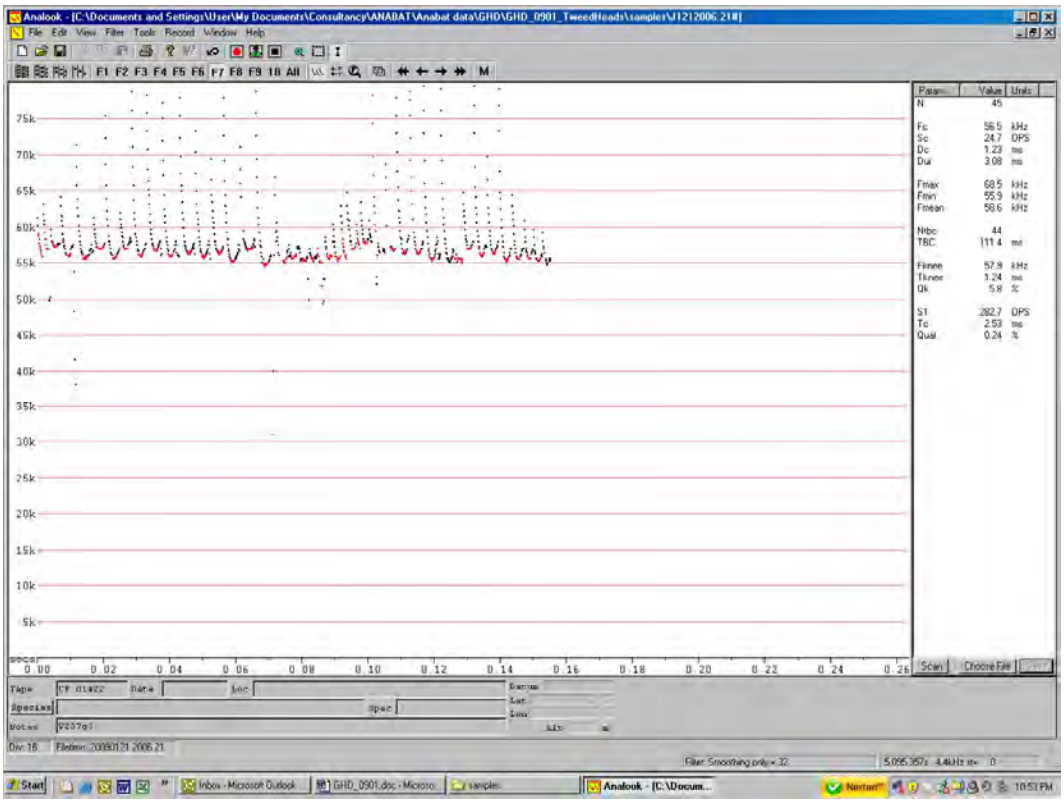
Reinhold, L., Law, B., Ford, G. and Pennay, M. (2001). *Key to the bat calls of south-east Queensland and north-east New South Wales*. Department of Natural Resources and Mines, Brisbane.

van Dyck, S. and Strahan, R. (ed.) (2008). *The Mammals of Australia*. New Holland, Sydney.

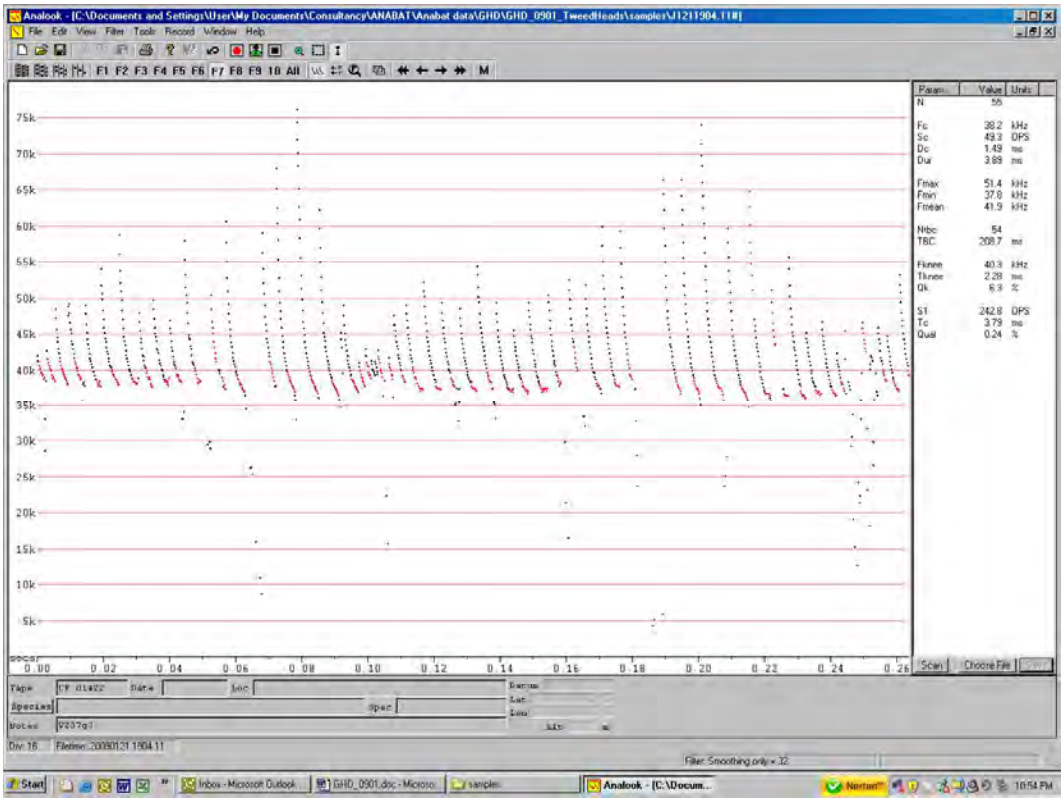
Appendix Sample call traces recorded during the Tweed Heads survey.



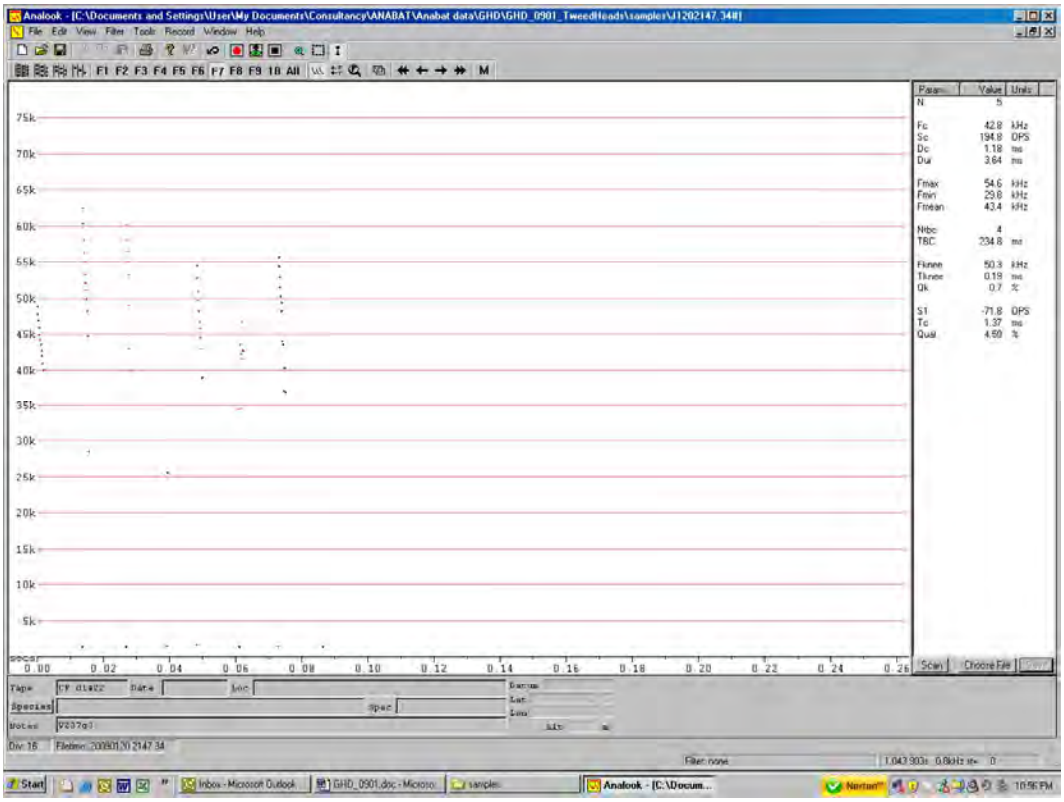
Miniopterus australis



Vespadelus pumilus



Probably *Falsistrellus tasmaniensis*



Possibly *Nyctophilus* species – but could also be weak recording of *F. tasmaniensis* or *Scotorepens* spp.

Appendix F

Preliminary Translocation Plan for Threatened Plants

TWEED SHIRE COUNCIL

Preliminary Translocation Plan for Threatened Plants

Eviron Road Quarry and Landfill

May 2011

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1 Introduction

Tweed Shire Council (TSC) proposes to translocate threatened flora species identified within the development footprint of the proposed Eviron Road Quarry and Landfill (Eviron Rd Q&L), Eviron, Tweed Shire Local Government Area.

1.1 Background information

The proposed Eviron Rd Q&L is designated a Part 3A Major Project under the *Environmental Planning and Assessment Act 1979* (EP&A Act), with TSC as the proponent. A concept plan (Application #: 08_0067) and stage 1 (08_0068) project application was lodged with NSW Department of Planning (DoP) on the 31 March 2008. An environmental assessment which addressed both the concept and stage 1 project application was lodged with DoP on 9 December 2010.

The DoP, in consultation with other state departments, assessed the adequacy of the environmental assessment accompanying the application. In assessing the adequacy of the assessment in relation to biodiversity, the Department of Environment, Climate Change and Water (DECCW), identified (among other things) the need for a translocation plan for threatened flora species requiring removal (DOC11/4925). The environmental assessment had identified one threatened plant species within the development footprint: White Lace Flower (*Archidendron hendersonii*). White lace Flower is listed as Vulnerable under the NSW *Threatened Species Conservation Act 1995*.

This Preliminary Translocation Plan for Threatened Plants (Preliminary Translocation Plan) is intended to meet the DECCW requirement for a translocation plan and in doing so provide an ecological sound, practical plan for the translocation of threatened plants subject to removal. The plan is 'preliminary' because aspects of the plan are likely to change as the project develops (eg. the extent and configuration of the development footprint will be determined once the design plans are finalised and the targeted threatened flora surveys, proposed during the detailed design phase, will potentially identify additional threatened species or individuals of White Lace Flower). It is intended that this document be updated to incorporate new information relevant to the translocation plan as it becomes available, including additional species and confirmation of numbers for translocation.

The translocation plan is one element of the management measures proposed by TSC as part of the proposed Eviron Rd Q&L to achieve a 'maintain or improve' outcome for biodiversity values. It is noted that in developing the management measures for the Eviron Rd Q&L proposal, the hierarchy of: avoidance, mitigation and offsetting has been followed. The proposed development footprint was designed to avoid areas of higher conservation significance. Construction and operational impact mitigation measures were developed to minimise direct and indirect impacts within the development footprint and receiving environment; these will be incorporated into an approved Environmental Management Plan (EMP) for the site. A strategy for offsetting residual impacts has also been prepared including the retention and on-going management of bushland which is to be set aside as conservation areas. The larger of the two conservation areas is to be registered with a s88B instrument which would restrict use and require management in accordance with a Habitat

Management Plan. The translocation of threatened plants is proposed as the West Valley Quarry footprint would directly impact individuals.

This Preliminary Translocation Plan has been developed in accordance with *Guidelines for the Translocation of Threatened Plants in Australia* (Vallee *et al*, 2004).

1.2 Objectives

The objectives of the translocation program are as follows:

- To directly support the conservation of the target species, and to maintain self-sustaining populations capable of surviving in both the short and long term.
- To preserve individuals of threatened species in situ wherever possible and limit transplanting to those species within the quarry and landfill footprint.
- To maintain the local genetic stock of individuals of threatened species which are proposed to be removed as part of the Eviron Rd Q&L, within the site.
- To re-establish the affected individuals in analogous habitat in close proximity to the source site, with long-term security of tenure.
- To manage the key threatening processes of the target species at the recipient site, particularly during the establishment phase.
- To produce additional propagated stock from the source plants as a contingency for potential losses of transplanted individuals.
- To provide an ecologically sound, practical plan that will maximise the chance for successful translocation.

2 Pre-translocation assessment

2.1 Ecological considerations of target species

A sound understanding of the target species ecological and biological attributes is required to maximise the chance of translocation success.

2.1.1 White Lace Flower (*Archidendron hendersonii*)

White Lace Flower has been recorded in two locations of the Eviron Rd Q&L site. One cluster of five stems was recorded within the understorey of Camphor Laurel Closed Forest on the north-east facing slopes of the western ridgeline (record 1). The average height of individuals within cluster 1 was 6m. Given that these stems are clustered in such close proximity, it is considered likely that they are closely related if not ramets (genetically identical individuals reproduced vegetatively). Accordingly, all stems within this cluster are considered the ‘source plant’.

The second record of White Lace Flower on site was in the understorey of Blackbutt Wet Sclerophyll Open Forest on the lower section of the north-east facing slopes of the western ridgeline in the far northwest of the site. The proposed development is to retain and manage this community as a conservation area. One juvenile plant was recorded in this location (record 2).

The on-site records of White Lace Flower and potential recipient sites for translocation are depicted in Figure 1.

Conservation status

White Lace Flower is designated Vulnerable under the TSC Act. There is currently no recovery plan available for this species. Four priority action strategies have been identified for this species (discussed below).

Description

White Lace Flower is a tree to 18 m in height and a stem diameter of 60 cm (NPWS, 2002; Floyd, 2008). The leaves are alternate and bipinnate with each primary leaf stalk bearing one pair of secondary leaf stalks which each typically bear six leaflets (Floyd, 2008). The leaflets are usually opposite and the terminal leaflets are often larger than the lower leaflets (Floyd, 2008). The leaflets are distinctly asymmetrical. There is a raised gland approximately half way along the primary stalk (Harden, 2006). The creamy-white flowers are fluffy and fragrant with up to ten grouped within a bunch (NPWS, 2002). The fruit is a woody curved orange pod, 7-10 cm and 12 mm wide, constricted between seeds (Floyd, 2008). The pod splits open to reveal glossy black seeds and a red or yellow pod interior (NPWS, 2002).

Distribution

White Lace Flower is endemic to Australia occurring from North-East Queensland south to the Richmond River in North-East NSW (CSIRO, 2010). The Tweed Shire is, therefore, approaching the southern extent of this species range. Records within Tweed Shire are all from the coastal hills and plains within the east of the Shire (GIS Enlighten, 2010).

Habitat

White Lace Flower is known to occur in riverine, littoral and lowland subtropical rainforest on a variety of soils including coastal sands and those derived from basalt and metasediments (NPWS, 2002). In the Tweed Shire and on the site, is has been found in the understorey of Camphor Laurel dominant forest and Wet Sclerophyll forest (pers. obs).

Figure 1

Legend

- White Lace Flower Record 1
- White Lace Flower Record 2
- Recipient_site_1
- Recipient_site_2
- Site_boundary
- Parcel Boundary

0 40 80 160M

1:6,573

N

Cadastre: 09 May, 2011
© Land and Property Management Authority (LPMA) and Tweed Shire Council.

Boundaries shown should be considered approximate only.

DO NOT SCALE
COPY ONLY - NOT CERTIFIED

GDA
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

Date Printed: 4 May 2011
Author: Sally Cooper, Design Unit

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Reproductive ecology

White Lace Flower flowers between September and December (NSW Scientific Committee, 2010) with fruit ripe between June to January. This species has 'mimetic fruit', which is brightly coloured fruit or seed with no associated pulp or aril. It mimics fleshy fruit thereby facilitating consumption and dispersal of the seed without providing any nutritional benefit to the seed disperser (usually a bird) (Galetti in Levey *et al*, 2002). White Lace Flower, like most mimetic fruit species, has a long fruiting period meaning fruit is available to seed dispersers for a long period of time (Galetti in Levey *et al*, 2002). Mimetic fruit species are often high in secondary compounds that are thought to deter seed predators; the secondary compound in *Archidendron* spp. are saponins (Galetti in Levey *et al*, 2002). Galetti notes, in Levey *et al* (2002), that there is little evidence in the published literature of avian frugivores eating mimetic seeds in the wild.

White Lace Flower is known to flower and fruit well; however, it is often represented by only single trees per stand and seedlings are rare (NSW Scientific Committee, 2010). This suggests that germination or seedling survival, rather than fecundity or pollination, is the limiting factor for this species to increase its population size. However, Floyd (2008) reports excellent germination results with fresh seed of 33-100% after 7-19 days. Some growers claim better results with filing of seed (scarification) (Floyd, 2008). Tweed Shire Council Nursery Manager Greg Newland reports high germination rates for this species followed by slow seedling growth (pers. coms., 23/3/11). Slow establishment by seedlings is likely to increase the risk of seedling mortality and may be a contributing factor to the threatened nature of this species, particularly where it establishes in sub-optimal habitat and where threatening process are present. This highlights the importance of post-planting care and maintenance during the establishment phase of the translocated individuals.

Another possible explanation for the low level of natural recruitment is that the mimetic fruit of White Lace Flower may not be attractive to bird dispersers and as a result seed dispersal rates may be low. If seed is not being readily dispersed it is likely falling close by and competing with the parent plant.

Population genetics

The two clusters identified on site are located approximately 700 m apart and associated with the same ridgeline (Condong Range). This distance is within the home range of pollinators and dispersers of this species. Accordingly, it is considered likely that they are from the same breeding population and there is unlikely to be significant genetic variation between them. In discussions with the Curator of the Australian Plant DNA Bank, Dr Martin Elphinstone, it was noted that the site is at the southern extreme of this species range which extends to far north Queensland. Dr Elphinstone suggests there is likely to be minimal genetic divergence between two local groups of individuals separated by 700 m, relative to the amount of genetic diversity distributed throughout the species as a whole (pers coms., M. Elphinstone, 1/4/11). Accordingly, the risk of inbreeding or outbreeding depression is considered minor. Further, given that there has been little genetic research done on any members of the genus and virtually none on the species *Archidendron hendersonii*, it would be difficult and expensive to get any data quickly on the conservation genetics consequences of translocating individuals (pers coms., M. Elphinstone, 1/4/11). Sampling throughout the species range would be required to give the genetic population on site some context. Consequently, population genetic testing is not considered warranted in this case.

Threatening processes and recovery strategies

Threats identified for the conservation of White Lace Flower include:

- Loss of habitat through clearing and fragmentation.
- Habitat degradation through weed invasion and disturbance.
- Illegal collection of seeds for horticulture (DEC, 2005).

In making the final determination for listing White Lace Flower as Vulnerable, the NSW Scientific Committees (2010) note the small size of the known populations, and the small size of the stands of rainforest in which they are found, put the species at risk from further fragmentation of rainforest and from degradation of stands from weed invasion and disturbance.

Four recovery strategies, and associated priority actions, have been identified for White Lace Flower (DEC, 2005). These are detailed in Table 2.1 below.

Table 2.1: Recovery strategies and priority actions for White Lace Flower

Recovery strategy	Priority action	Priority
Habitat management: Fire	Ensure regional fire plans, hazard reduction burn guidelines include protocols for protecting rainforest habitats.	High
Habitat management: Other	Ensure that managers are aware of populations and habitat and that PoMs, fire plans, pest management plans take account of requirements for the recovery of White Lace Flower. Survey before road and track maintenance in the habitat of the species, protect road and trackside plants.	Medium
Habitat management: Weed Control	Assess weed threats to populations, manage as necessary. Implement Bitou bush control as described in the approved TAP.	Medium
Community and land-holder liaison/ awareness and/or education	Encourage the community to participate in the detection of White Lace Flower at new locations, and encourage their participation in habitat rehabilitation projects.	Low

The highest priority recovery strategy is the management of fire regimes to protect the rainforest habitat of this species. This highlights the significance of inappropriate fire regimes as a threat to the conservation of this species and the success of translocating this species.

Transplanting potential

No information could be found relating to past translocation attempts of this species or genus.

Recommended method of propagation

Germination from seed is known to be successful if sown fresh, as seed is reputedly short-lived (Floyd, 2002; Ralph, 2003). Preferably seed should be collected before it falls from the pod and sown immediately after collection (Nicholson, 2007). Ralph (2003) recommends soaking seed overnight in water to drown any insect larvae.

The Australian Native Plant Society (ANPS) note that the closely related *Archidendron grandiflorum* is relatively easily propagated from seed and that is responds to the same methods as used for the related Acacia sp. (ie. pre-treatment by soaking in boiling water or by scarification). ANPS (2010) also suggest cuttings should be successful for the closely related *A. grandiflorum*.

The available data suggests propagation by freshly sown seed is the best method for this species. It is recommended that the collected seed be equally split into four treatment groups for experimental purposes:

1 A control group that is sown fresh without any treatment.

2 A group that is soaked in room-temperature water overnight prior to sowing.

3 A group that is briefly soaked in boiling water prior to sowing.

4 A group that is scarified prior to sowing (either nicked with knife or abraded with sandpaper).

Experimenting with different pre-sowing treatments will provide useful information for future propagation of this species and can be shared with other environmental managers, land care groups and nurseries.

2.2 Assessment of recipient sites

Two potential recipient sites have been identified and considered. The proposed recipient sites are:

- Recipient site 1: within the patch of retained Blackbutt Forest on Lot 1 DP1159352 in the sites far north-west.
- Recipient site 2: within the patch of retained Blackbutt Forest also on Lot 1 DP1159352 in the central west of the site (refer to Figure 1).

An assessment of the suitability of the two potential recipient sites is provided in Table 2.2 below.

Table 2.2: Suitability assessment of the two potential recipient sites.

Assessment criteria	Recipient site 1	Recipient site 2
Current or past presence of species within site	Yes – one juvenile species recorded in understorey of Blackbutt forest community.	None known.
Suitable habitat	Yes Historically, it is expected that the site would have been vegetated with sclerophyll forest on the hill slopes and ridgelines, with drier sclerophyll dominating the ridgelines and more exposed slopes and wet sclerophyll on the lower hills slopes. The wet sclerophyll forest on the lower, more protected slopes would have likely intergraded into lowland rainforest on the floodplain, which has since been converted to sugar cane crop fields. Recipient Site 1 encompasses wet sclerophyll forest on hill slopes, with rainforest elements in the understorey. The community is not expected to regenerate completely into a rainforest community; however, the wet sclerophyll forest of the lower slopes is considered suitable habitat. The metasediment soils are suitable.	Uncertain This is a drier community than that occurring at Recipient Site 1. The canopy may be too open and subsequently the understorey may be too exposed for translocated plants. The drier nature of this community is likely a result of the increased exposure of this site due to its topographic position on an easterly spur which projects from the main ridgeline. This site would have likely intergraded into lowland rainforest or possibly swamp sclerophyll forest in the low-lying areas. The lower south-facing slopes are likely to be most protected and subsequently most suitable for translocation of rainforest species. The metasediment soils are suitable.
Appropriateness of successional stage of community.	Vegetation descriptions of this community identify characteristic early successional rainforest species within the mid stratum. However, it is not expected to succession completely to a rainforest community. Rather, the understorey of the wet sclerophyll community will continue to harbour rainforest plants in the understorey, so long as disturbance by fire and weed invasion are managed. Given that this species grows to 18 m, it is capable of living out its lifecycle in the lower tree stratum, beneath the eucalypt canopy.	Fewer rainforest trees and shrubs have been recorded in the mid stratum of this community. It is not expected to succession into a rainforest community. Rather, the understorey of the dry sclerophyll community on the more protected lower south-facing slopes may be suitable to harbour rainforest plants in the understorey, so long as disturbance by fire and weed invasion are managed. Given that this species grows to 18 m, it is capable of living out its lifecycle in the lower tree stratum, beneath the eucalypt canopy.
Adequacy of habitat area to support self-sustaining population.	Approximately 3 ha. In modern times, White Lace Flower is characteristically found in small populations within small patches of rainforest. Accordingly, this site is expected to be sufficient to support a small population.	Approximately 1.2 ha; however, the suitable areas within this patch are restricted to a smaller area. This site is expected to be of sufficient size to support a small population.
Disturbances/threatening processes present at the site.	Weed invasion is moderate within this community, with Camphor Laurel scattered throughout the canopy. Weed management will be incorporated into a Habitat Management Plan which would be required for this site under a s88B covenant.	Due to the proximity of this area to disturbed and proposed operational areas, it is likely to be susceptible to weed invasion. Management of this site is incorporated into the Preliminary Restoration Plan (TSC, 2010). The Translocation Plan and Restoration Plan actions will be incorporated into a site-wide

	Grazing by exotic and native herbivores is a potential threat to the success of the translocation. There is currently a horse that freely grazes throughout the site. In addition, there is the potential for grazing by rabbits and macropods. Tree guards may be required for out-planted individuals until they establish themselves, if grazing becomes a problem. There is low potential for a wild fire or escaped fuel reduction fire to burn this community and destroy the translocated and naturally occurring plants and/or alter the community's structure and floristics. Fire management will be incorporated into the site-wide EMP for this site and is discussed further in Section 3.3.1.	EMP to provide for more wholistic environmental management of the site. Grazing by exotic and native herbivores is a potential threat to the success of the translocation. As stated, there is currently a horse that freely grazes throughout the site. In addition, there is the potential for grazing by rabbits and macropods. Tree guards may be required for out-planted individuals until they establish themselves, if grazing becomes a problem. This community is expected to be more susceptible to fire than recipient site 1 because it is a drier community. Fire management will be incorporated into a site-wide EMP and is discussed further in Section 3.3.1.
Additional threatening processes that the site is susceptible to.	Future quarrying at North and West Valley has the potential to increase dust pollution in the sites vicinity. Smothering of vegetation by dust can be detrimental to growth and vigour of plants. Dust deposition on the leaves of plants can impede plant growth by inhibiting photosynthesis and evapo-transpiration. Dust management and monitoring will be incorporated into all Q&L operations at the site. Leachate pollution could potentially impact upon vegetation if not adequately contained. The EMP addresses leachate management.	Future quarrying at North and West Valley has the potential to increase dust pollution in the sites vicinity. Smothering of vegetation by dust can be detrimental to growth and vigour of plants by inhibiting photosynthesis and evapo-transpiration. Dust management and monitoring will be incorporated into all Q&L operations at the site. Leachate will be managed according to the EMP.
Security of land tenure	As previously stated, Recipient Site 1 would be part of the conservation area. The restriction of use upon the land would be secured by a s88B instrument, which would also require on-going management in accordance with an approved Habitat Management Plan.	The tenure of this site is not secured. The concept plan for the Eviron Rd Q&L proposes management of this site as a conservation area. Furthermore, the future land use of the site, beyond the quarry and landfill, is a regional botanical garden. The regional botanic garden masterplan incorporates native vegetation communities into the design and provides the opportunity for continued management of the bushland at Recipient Site 2. However, the long-term security of the site as bushland is not legally protected.
Compatibility of current and future land tenure at site with translocated population.	The proposed Eviron Rd Q&L has an expected lifespan of 40 years. However, as previously discussed the bushland within which Recipient Site 1 occurs will be managed as a conservation area throughout the life of the Q&L. Accordingly, the land use is considered compatible with the translocation program. Beyond the life of the Q&L, it is intended that the site be	During the 40 year lifespan of the Eviron Rd Q&L, the site will be retained as bushland. The close proximity to quarry and landfill operational land makes this site susceptible to disturbances such as weed invasion and dust pollution; however, these disturbances will be managed in accordance with the site-wide EMP.

	developed into a regional botanic garden. The approach to the planned Tweed Regional Botanic Gardens is one that promotes and conserves regional native flora. Accordingly, the botanic gardens land use is viewed as supportive of the translocation program.	The regional botanic garden planned, post-Q&L, is viewed as compatible with the translocation program.
Access for out-planting and maintenance.	The exact location of the out-planting is yet to be determined. However, the site is in the vicinity of the proposed Haul Rd where there is expected to be good access.	The exact location of the out-planting is yet to be determined. However, the site is in the vicinity of the proposed Haul Rd where there is expected to be good access.
Potential conflict with cultural values at the site.	The Cultural Heritage Assessment for the Proposed Eviron Rd Q&L (Converge, 2009) did not locate any areas or objects of Indigenous cultural heritage significance. However, the assessment noted that this may be attributed to the low ground integrity (GI) and poor ground surface visibility (GSV) levels that predominated over the majority of the project area and the recent ground disturbance of ridgelines, locations where there would have been a higher possibility of identifying Indigenous cultural heritage. The translocation works require minimal ground disturbance, being restricted to small holes to be excavated for the out-planting of propagated stock. Any unexpected finds of potential cultural heritage significance are to follow the procedures outlined in the Converge Cultural Heritage Assessment (2009).	As previously stated, the Cultural Heritage Assessment for the Proposed Eviron Rd Q&L (Converge, 2009) did not locate any areas or objects of Indigenous cultural heritage significance. Any unexpected finds of potential cultural heritage significance are to follow the procedures outlined in the Converge Cultural Heritage Assessment (2009).
Potential for ecological values of the site to be impacted upon by translocation works.	Recipient Site 1 occurs within Blackbutt Wet Sclerophyll Open Forest which is not considered an Endangered Ecological Community. The bushland associated with the site is, however, considered ecologically significant for its habitat values. Translocation works have the potential to impact upon the ecological values of the community if inappropriate genetic stock or diseased stock is introduced to the site or if site preparation, out-planting and maintenance activities disturb the existing vegetation and/or habitat. The translocation plan addresses these risks and provides measures to minimise them.	Recipient Site 2 occurs within Blackbutt Dry Sclerophyll Open Forest which is not considered an Endangered Ecological Community. It is; however, considered to have habitat values including for fauna movement (eg. koala). The translocation plan addresses the potential ecological impacts associated with translocation works and provides measures to minimise them.
Determination of suitability as recipient site	**Yes – it is recommended to proceed.**	**No – not recommended to proceed. Suitability of habitat is sub-optimal and translocation risk is considered too high.**

2.3 Number of plants required

The goal of the translocation plan is to establish a viable self-sustaining population at the recipient site. Plant attrition is commonly very high in translocated populations. The general rule of thumb provided by Vallee *et al* (2004) is to propagate enough plants as resources allow to compensate for expected high attrition rates.

Little is known about the size of naturally occurring White Lace Flower populations, except that the known populations are small, generally occurring within small stands of remnant rainforest (NSW Scientific Committee, 2010). It is inferred that this species would naturally occur as isolated individuals or small clusters scattered throughout suitable habitat. Accordingly, the aim of the translocation is not to establish a large population of White Lace Flower at the site, rather it is to retain the existing genetic stock on site by transplanting stock from those individuals subject to clearing to protected bushland habitat and provide a minor enhancement of the existing population size so that it is better equipped to cope with natural stochastic events.

To account for expected high mortality rates, it is recommended that enough reproductive material is collected to produce tubestock at a ratio of 1:50 (eg. 50 seeds per source plant). As discussed in Section 2.1.1, the cluster of stems is considered one source plant. Accordingly a minimum of 50 seeds are required from the source plant. Depending on seasonal seed production this seed may need to be collected over successive seasons. A ratio of 1:100 is recommended for cuttings, to allow for an expected higher attrition rate. This would equate to 100 cuttings from the source plant.

2.4 Threats to translocation success and management measures

Potential threats to the success of the translocation plan and the measures proposed to manage these threats are discussed in Table 2.3.

Table 2.3: Threats to translocation success and mitigation measures

Threats	Threat rating	Management measures
Insuffcient seed produced prior to clearing.	Low	If seed production is insufficient, it will be substituted with cuttings for propagation.
Source stock becomes diseased or dies prior to completion of seed collection.	Low	No propagation material to be collected from diseased stock. Source stock to be treated with appropriate insecticide/fungicide prior to collection, if necessary.
Poor germination rate	Moderate	Seed to be sown fresh and treated according to treatment group (eg. soaked overnight, soaked in boiling water or scarified). Review and modify germination conditions as required (eg watering rate, sunlight exposure, growing medium).
High tubestock mortality post-out-planting	High	Careful selection of out-planting sites based on micro-climatic conditions. Out-plant in clusters separated from each other to reduce chance of mass mortality from isolated events (eg tree fall). Manage threatening processes such as weed invasion and fire. Provide adequate maintenance and monitoring (eg. regular watering during establishment and ongoing weed management).
Accidental clearing or disturbance during construction of haul road and/or operation of quarry and landfill.	Low	The recipient site is within an area proposed for retention and management as bushland, protected under a s88B instrument. Identification of this area as a conservation area and no-go zone for construction and operational personnel will be clearly stated within the site induction program, EMP and construction design plans. Measures will be in place to protect the conservation area during construction and operation, including clear identification of no-go zone.
Natural disaster (eg bushfire)	Low	Incorporate fire management measures into habitat management plan and EMP and ensure fire trails and water supplies are maintained sufficiently.

2.5 Licensing requirements

A licence is required under section 132C of the *National Parks and Wildlife Act* to pick a threatened plant for scientific, educational or conservation purposes. All personnel involved in the collection of propagation material, propagation and out-planting require a s132C licence.

3 Translocation proposal

3.2 Translocation team

The proposed translocation team and key responsibilities are detailed in Table 3.1.

Table 3.1: Proposed translocation team and key responsibilities

Team member	Organisation	Key responsibilities
Eviron Rd Q&L project manager	TSC	Ensure translocation plan is implemented and adequately funded.
Environmental Scientist/Ecologist/Botanist	TSC/consultant	Provide technical advice and supervision during translocation.
Nursery staff	TSC	Propagate and raise seedlings.
Conservation genetics expert	Universities	Provide expert advice on specialised field of conservation genetics, as required.

3.3 Proposed methodology

3.3.1 Pre-translocation tasks and considerations

Pre-clearing targeted threatened plant survey

It is important to have a good understanding of all threatened species on site and the population characteristics of each threatened species such as: number of populations, size of each population and location in relation to other populations. It is also important to accurately determine the number of individuals subject to removal as a result of the proposed development. To acquire this information, targeted threatened plant surveys are required. These will be undertaken as early as possible to allow for incorporation of additional information into the translocation plan.

The need for targeted threatened plant species surveys was identified in the environmental assessment report for the Eviron Rd Q&L (GHD, 2010). This report suggested targeted surveys be undertaken once the final development footprint is determined.

Once finalised, the development footprint would be surveyed and marked in the field to clearly demarcate the vegetation subject to disturbance and allow environmental scientists/botanists to accurately target their surveys. All threatened plant species identified during targeted surveys will be flagged and relevant information including species name, number of stems, height of each stem, condition and general observations recorded.

It can be difficult to discern whether clusters of stems are ramets (individuals which are physically distinct but genetically the same – formed by asexual reproductive means such as coppicing) or genets (genetically distinct individuals). Each stem will be given a plant identification number. Clusters of stems seemingly from the same rootball will be considered ramets. The plant code will identify both the plant and stem number (eg. 'AH_1_1', which represents *Archidendron hendersonii*, plant 1, stem 1).

Record keeping

Records will be kept for each sample of propagation material and maintained from the time of collection, to the raising of seed/cuttings, planting out of tubestock and maintenance and monitoring period. The following information will be collected for each sample:

- Sample id code (unique code to be created for each sample – eg. 'AH_1_1_1', which represents *Archidendron hendersonii*, plant 1, stem 1, seed 1);
- Source plant location (GPS coordinates and description);
- Date of collection;
- Type of material collected (eg. seed, cutting);
- Amount of material collected;
- Seed treatment technique;
- Date of sowing;
- Date of germination;
- Date of out-planting;
- Location of out-planting (GPS coordinates and description);
- Monitoring results (refer to Section 3.3.3 for proposed monitoring method).

Each sample will be tagged with its Sample id code for the duration of its life cycle.

Baseline data

Once out-planting sites have been finalised, but prior to out-planting, baseline data is to be collected from each of the sites. This will provide data on habitat traits at a micro level that can be compared between sites and over time to provide a better understanding on the species most preferable micro-habitat traits. Data to be collected includes:

- GPS location;
- Altitude;
- Slope;
- Aspect;
- Canopy coverage;
- Vegetation community association;
- Soil type;
- Landform morphology;

- Disturbances and overall ecological condition.

Recipient site preparation

The recipient site needs to be prepared for out-planting. In particular, the threatening processes (as outlined in Section 2.1.1) need to be removed or controlled.

Following project approval, a s88B instrument will be applied for to ensure security of tenure over the site.

Weed control works within the recipient site will be undertaken as early as possible in the translocation program, preferably well ahead of out-planting. This is to minimise the risk of habitat modification and competition by exotic species.

The habitat management plan for the conservation area is to incorporate fire management measures to protect the wet sclerophyll habitat of the recipient site. The fire regime for the wet sclerophyll forest will depend upon the conservation objectives. There is evidence to suggest that a wet sclerophyll forest can maintain itself with a healthy mature canopy without necessarily requiring fire to inhibit rainforest incursion (Watson, 2001). It has been suggested that logging, rather than fire, is more responsible for facilitating rainforest incursion in wet sclerophyll forest (Watson, 2001). Blackbutt regenerates with epicormic buds rather than lignotubers and is subsequently more sensitive to intense fires. A carbon-dating study from northern NSW suggests wet sclerophyll forests are adapted to very long interfire intervals, at least in terms of intense stand replacing fires (Turner, 1984 in Watson, 2001). The study found twelve layers of charcoal within the soil of wet sclerophyll Blackbutt forest and an average interfire interval of 280 years; however, it is possible that low intensity fires occurred within these intervals but did not show up in the charcoal record (Turner, 1984 in Watson, 2001). Fire, even low intensity burns, would jeopardise the success of the translocation program, at least until individuals are well established and have reached reproductive maturity. Accordingly, the translocation program relies on exclusion of bushfire in this area. This information will be incorporated into the conservation area habitat management plan and site EMP.

Staff training

The staff involved in the translocation program will be provided with an induction into the translocation program and a copy of the translocation plan. This includes seed collectors, nursery staff propagating stock, bush regeneration contractors undertaking weed control and out-planting and relevant site managers including the quarry and landfill supervisors and waste management coordinator. The program will be coordinated by TSC Environmental Scientists.

The translocation plan will be integrated with the habitat management plan and restoration plan as well as the site EMP. This is to ensure that site personnel are familiar with the translocation program and its management requirements are incorporated into daily site management practices.

3.3.2 Translocation tasks and considerations

Type of translocation proposed

The type of translocation proposed is 'ameliorative enhancement'. This describes an attempt to increase population size by adding individuals to an existing population to ameliorate the loss of part or all of that population as a result of development (Vallee *et al*, 2004).

The loss of a cluster of White Lace Flower from the development footprint will be compensated for by increasing the population size within the area of retained bushland where a juvenile White Lace Flower has been recorded.

Collection of propagules

Seed is to be collected from the source plant during the fruiting period between June and January.

In accordance with the florabank Model Code of Practice, it is recommended that no more than 20% of fruit is removed from any one plant (in any one season), unless clearing is imminent. If no fruit is borne prior to clearing, cuttings are to be taken from young growing tips.

Collected seed is to be stored in accordance with the florabank *Guidelines for Native Seed Storage for Revegetation*.

Collected seed is to be delivered to TSC Nursery or contracted private nursery for propagation. Sample id codes are to be kept with the sample at all times on a label that is not going to deteriorate with water and sun exposure.

Propagation

The seed is to be categorised, in equal numbers, into one of four treatment groups:

1. Group 1: control group that is sown fresh without any treatment.
2. Group 2: group that is soaked in room-temperature water overnight prior to sowing.
3. Group 3: group that is briefly soaked in boiling water prior to sowing.
4. Group 4: group that is scarified prior to sowing (either nicked with knife or abraded with sandpaper).

Group 1 seed is to be sown directly into the growing medium as soon as possible after collection, preferably on the same day.

Group 2 is to be soaked in room temperature water overnight and sown into the growing medium on the following day.

Group 3 is to be soaked in boiling water. Some seeds do not tolerate excessive time in boiling water (ANPSA, 2009) and given that White Lace Flower is a rainforest plant it is not considered a fire adapted species and is potentially intolerant of long periods of soaking in boiling water. Accordingly, it is recommended that the boiling water treatment be restricted to a brief (one minute) immersion/s in boiling water then allowed to cool. Seeds that soften and swell to 1.5-2 times their original size can be sown; those that don't swell are to be retreated, up to three times. Any seeds which float are usually infertile and can be discarded (ANPSA, 2009).

Group 4 seed is to be pre-treated with scarification. This can be achieved by abrading the seed with fine sandpaper; either manually or by gluing sandpaper to the inside surfaces of a small plastic container, placing the seeds in and then shaking the container vigorously (ANPSA, 2009). Alternatively, the seed coat can be nicked with a sharp knife taking care to restrict the cut to the seed coat and avoid damage to the inner portion of the seed. The method of scarification used should be recorded for each sample.

The different treatment groups provide an opportunity to experiment with seed treatment methods and ultimately determine the most successful method for this species. This information can guide future propagation and translocation programs for White Lace Flower.

In the event that seed production is insufficient, propagation would be undertaken using cuttings. In accordance with the Australian Native Plant Society (Australia) (ANPSA) recommendations, cuttings should be taken from firm, current season's growth; both hard woody material and soft 'floppy' growth are likely to be unsuccessful. A test of suitability is to bend the stem through 60 - 90 degrees, if it springs back to its original position it's suitable but if it breaks or remains limp its best avoided. However, where clearing is imminent and propagation material is scarce, it is better to collect sub-optimal material rather than none at all. It is noted that cuttings can be taken at any time of year but root formation is very slow in the colder months (ANPSA, 2009). Potted cuttings would be approximately 75 mm long with leaves trimmed to reduce leaf surface area and treated with a root-promoting hormone.

The recommended growing medium is a standard commercial seed raising mix or if made in-house: a mix of 80-85% washed river sand and 15 - 20% peat moss (ANPSA, 2009). Artificial peat moss made from waste products such as coconut fibre is a more sustainable option and is readily available.

Seed should be sown to a depth approximately twice the seed diameter and spaced to allow easy ‘potting-on’ post-germination.

A fungicide treatment is recommended to prevent 'damping-off' (rotting of the seedling stem at soil level). The use of sterilized seed-raising mixes and sowing so that seedlings are not crowded are effective ways of preventing infection (ANPSA, 2009).

To minimise risk of introducing diseased stock to the site, the following practices are to be adhered to:

- Only clean, healthy and disease free material is to be collected.
- When collecting propagation material, new, clean, tagged and separate bags/containers are to be used for each source plant (if more than one is located within the development footprint).
- Any cuttings are to be taken using clean secateurs which are to be disinfected between plants (eg. sprayed with a 70% methylated spirits solution).
- Propagation and growing benches are to be kept clean and sterilised.
- Fungicide treatment to be used on seed, as required.
- Growing medium is to be fresh and prepared and stored hygienically, such as from an accredited growing media supplier.
- Trays/pots or tubes are to be new or if re-used, sterilised.
- Over-wetting propagating material is to be avoided and air-circulatation is to be maintained around the pots/trays/tubes.
- The propagation and hardening off areas are to be kept free from weeds, liverwort and moss (NGIA, 2004).

Tweed Shire Council Nursery staff has indicated that approximately 24 months is required to propagate and raise the stock to a stage when it is ready for out-planting (pers. com. Greg Newland, 23/3/11).

Out-planting

Tubestock is to be 'hardened off' prior to out-planting to assist in their adaptation to natural conditions.

Out-planting should preferably be undertaken during spring to take advantage of good growing conditions (warming temperatures, more sunlight hours). This will ensure the most intensive period of maintenance (watering and weeding) occurs during the first spring and summer when hot and sometimes dry conditions may otherwise cause heat stress and rapid weed growth.

The recommended planting arrangement is clusters of tubestock throughout the recipient site. This mimics the natural occurrence of this species in low density isolated clusters. Successfully propagated stock would be arranged in 5-10 clusters, with the number of individuals within each cluster dependent upon propagation success. Indicative locations of out-planting clusters are depicted in Figure 2. During out-planting each plant will remain tagged with its plant id code. A GPS coordinate will be taken for each plant planted into the ground and a mud map of the location of each plant, labelled with its plant id code, will be prepared.

Each transplant is to be planted in a hole approximately 1.5 – 2 times the width and depth of the existing rootball. Care is to be taken when digging holes to avoid damage to the root

system of existing vegetation. Planting in close proximity to the existing White Lace Flower is to be avoided. The stock is to be watered in; fertilizer is optional. Weed-free mulch is to be placed around the base of the stock but kept clear of the stem.

If the existing horse continues to have unrestricted grazing access throughout the site, the planted stock will require fencing protection during the establishment period.

A minimum of 10 healthy tubestock is to be retained at the nursery as insurance in the event of mass losses of the planted stock. The insurance stock could be out-planted as replacement stock but only after the initial five year monitoring period to allow adequate time to assess the suitability of the recipient site and gain a better understanding of the micro-habitat preferences.

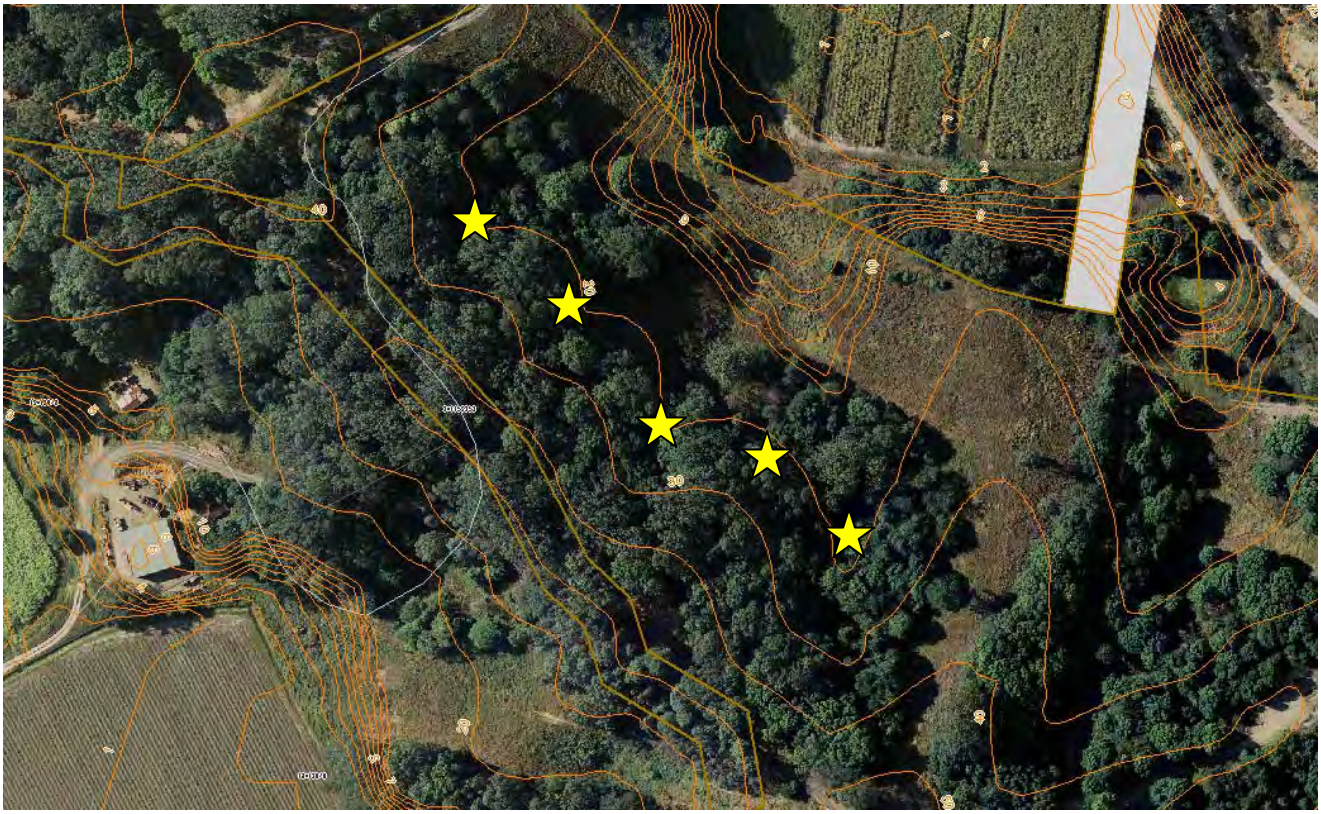

Figure 2: Indicative locations of out-planting clusters.

3.3.3 Post-translocation tasks and considerations

Maintenance

As previously stated, translocated populations are renowned for having high attrition rates. To minimise plant losses a good maintenance program is required. The proposed maintenance program is provided in Table 3.2.

Table 3.2: Proposed maintenance program

Task	Frequency and method
Watering	The plants would initially be watered in during out-planting. For the first month post-planting, watering would be undertaken weekly. For the subsequent five months of the first year, watering would be undertaken fortnightly. For the remaining five months of the first year, watering would be undertaken once a month. Watering events may be skipped in the event of adequate rainfall.
Weed control	Primary weed control would be undertaken prior to out-planting as part of site preparations. For the six months post-planting, weed control would be undertaken once a month. All weeding within 10 m of the transplanted stock would be hand-weeded to minimise risk of spray drift damage. For the remaining five months of the first year, weed control would be undertaken every second month. For the subsequent four years, weed control events would be undertaken quarterly (four times a year). Beyond the five year period, weed control would be addressed in the overall weed management of the conservation area as directed by the habitat management plan.

Monitoring

The proposed monitoring program is to run over a five year period. The proposed monitoring schedule is:

- Within the first six months post-planting, monitoring would be undertaken every second month post-planting.
- For the remaining five months of the first year, monitoring would be undertaken once at the end of the year.
- For the subsequent four years of the monitoring program, monitoring would be undertaken annually.

The following key performance indicators would be assessed during each monitoring event:

- Translocated stock survival – proportion of tubestock planted survived;
- Likely cause of any translocated stock mortalities;
- Height of translocated stock;
- Dust deposition on leaves of translocated stock (qualitative visual observation);
- Qualitative assessment of translocated stock health (eg. visual observations on the presence of fungi or insect infestations and dieback or discolouration of foliage);
- Evidence of any damage to surrounding native vegetation (eg. dieback from possible root damage, trampling, spray drift damage);
- The presence of flowers or fruit on translocated stock;
- The presence of any natural recruitment (seedlings);

- Presence of threatening processes (eg. weed encroachment, fire, evidence of herbivore grazing).

The key performance indicators have been selected to allow the translocation objectives to be measured.

Adaptive management

The data collected during monitoring will be analysed to attempt to recognise any patterns or potential causal relationships between transplant success and micro-habitat traits and environmental management practices (eg. weed management, dust suppression).

This information will guide maintenance practices and frequency, inform which sites are most suitable for replacement plantings (if required) and guide site management practices. The findings can be disseminated to assist future conservation of this species.

Reporting

Progress reports will be produced annually during the five year monitoring program. The annual progress report will be a brief document (1-2 pages) including the following:

- a brief discussion of works completed since commencement/last progress report
- a description of outstanding works planned for the subsequent year, highlighting priority tasks
- presentation of monitoring results
- any recommendations for adapting works to suit changing conditions, shifting priorities (eg. new threatening processes).

In addition to progress reports, an evaluation report is to be prepared at the end of the five year program. The evaluation report will summarise the monitoring data over the five year period, discuss findings and provide recommendations for future translocation plans.

The reports will be submitted to the TSC Waste Management Coordinator.

4 Schedule of works

The proposed works have been incorporated into a schedule provide in Table 4.1. Note that the schedule is subject to change with adaptive management guiding maintenance frequency and development and seasonal timeframes (eg. construction schedule and fruiting period) all influencing the works schedule.

Table 4.1: Proposed schedule of works

Task	Prior to clearing	Year 1												Year 2												Year 3												Year 4												Year 5											
		A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
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Baseline data collection																																																													
Site preparation																																																													
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Weed control																																																													
Monitoring																																																													
Reporting																																																													

Note: A coloured box indicates one event for the month; if more than one event is proposed, the number within the box indicates the total events proposed for the month.

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5 Conclusion

To maximise the success of the program, the translocation plan must be considered and incorporated into the other management plans; namely, the conservation area habitat management plan and site-wide EMP.

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Appendix G

Preliminary Restoration Plan

TWEED SHIRE COUNCIL

Preliminary Restoration Plan

Eviron Road Quarry and Landfill

May 2011

Version 2

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1 Introduction

Tweed Shire Council (TSC) is proposing to establish two new quarries and three landfills and a haul road in Eviron, in the far North Coast of NSW (Eviron Rd Q&L/the proposal).

The proposed Eviron Rd Q&L is designated a Part 3A Major Project under the *Environmental Planning and Assessment Act 1979* (EP&A Act), with TSC as the proponent. An environmental assessment prepared by GHD (2010) for the Eviron Rd Q&L Major Project Concept Plan application (08_0067) and Stage 1 project application (08_0068) was lodged with NSW Department of Planning (now Department of Planning and Infrastructure - DPI) on the 31 March 2008.

The DPI, in consultation with other state departments, assessed the adequacy of the environmental assessment accompanying the application. In assessing the adequacy of the assessment in relation to biodiversity, the Department of Environment, Climate Change and Water (now the Office of Environment and Heritage - OEH), identified the need for a preliminary restoration plan that provides sufficient information to assess the likely success of the corridor planting and enhancement proposed in the environmental assessment report.

The proposed restoration program is over a five year period. Beyond the five year period management of these restoration areas will be incorporated into general site management in accordance with a site-wide Environmental Management Plan (EMP).

The subject Preliminary Restoration Plan is intended to fulfil OEH's further information request and provide an ecologically sound, practical plan, to guide restoration works.

2 Project location

2.1 Site location

The Eviron Rd Q&L site is located at Eviron, within the Tweed Local Government Area, and comprises Lot 1 DP1159352, Lot 602 DP1001049 and Lot 1 DP34555 (Figure 1).

The site occurs on the northern and easterly slopes of the Condong Range and the adjoining floodplain. The site is bound by Eviron Road in the south, the Pacific Highway to the east and sugar cane fields to the north and west. Stott's Creek Resource Recovery Centre adjoins the site to the northwest and Quirk's Quarry occurs in the eastern portion of the site.

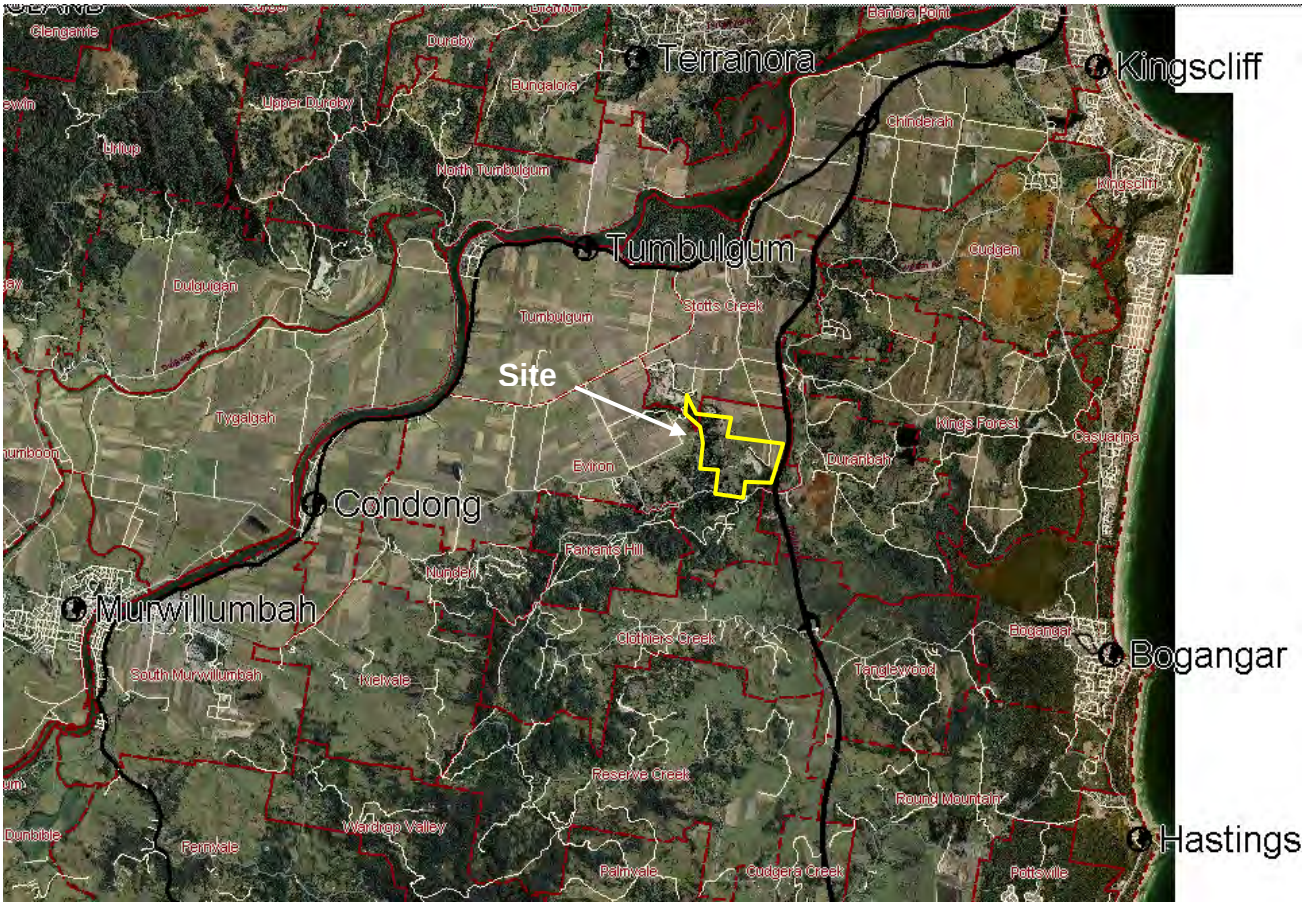

Figure 1: Site locality

2.2 Nominated restoration work areas

The ecological assessment prepared by GHD (2010) has proposed corridor planting and enhancement to provide wildlife corridors and facilitate wildlife movements across the site. Two suitable corridor alignments were nominated: Northern Riparian Corridor and Southern Ridgeline Corridor (refer to Figures 2-4).

2.2.1 Northern Riparian Corridor

The Northern Riparian Corridor is aligned along a heavily modified and degraded drainage line which flows in a north-westerly direction across the northern portion of the site. This drainage line discharges into Ledday's Creek approximately 1 km to the north-west of the site; Ledday's Creek discharges into the Tweed River at Stott's Island. The intent of the Northern Riparian Corridor is to reconstruct habitat and provide a lowland route across the site for native wildlife. This corridor will connect lowland areas to the Condong Range ridgeline and connect the patch of retained sclerophyll forest/camphor laurel forest east and south of Quirk's Quarry with the patch of retained sclerophyll forest in the central west of the site.

A small narrow strip of Broad-leaved Paperbark – Camphor Laurel Open Forest was recorded along this drainage line (GHD, 2010). This community was determined to be analogous with Endangered Ecological Community (EEC): Swamp Sclerophyll Forest on Coastal Floodplains (SSF) (GHD, 2010). The remainder of the drain is cleared and dominated by exotic groundcovers.

It is proposed that this corridor be planted out with swamp sclerophyll forest species, including koala feed tree species (eg. Swamp Mahogany – *Eucalyptus robusta*). The goal is to achieve a corridor width in the order of 20m. The length of the drainage line is approximately 956m, amounting to a total restoration area of approximately 1.9 ha.

Given the extent of the area requiring reconstruction, the restoration method proposed for this area comprises a combination of revegetation and assisted regeneration. Assisted regeneration is focussed around areas of existing native vegetation, where possible, and otherwise inter-dispersed amongst proposed revegetation clusters. In addition to numerous revegetation clusters a single row revegetation screen is proposed along the entire length of the corridor. This serves to introduce a seed source along the entire length of the corridor to promote natural regeneration, as well as providing visual screening of the site.

An existing access road occurs parallel to the drainage line. This road has been built up with fill which is not a suitable growing medium for bush restoration. Rather than remove the road fill, it is proposed that the vegetated corridor be established around the existing access track. The access track will provide good access for planting, maintenance and monitoring during the establishment phase of works. Given the close proximity of the track to the drainage line, the restoration area will be wider on one side of the bank than the other (generally wider on the southern and western side of the bank) in order to achieve the 20 m wide corridor.

An existing revegetation screen occurs on the north-eastern side of the access road. These plantings were previously established for the purpose of a visual screen and are currently 1-1.5m in height. These plantings will continue to serve the function of screening the site, both visually and from weed seed; however, will remain separate from the SSF plantings by the access road. The species selection used for the existing visual screen is characteristic of riparian rainforest rather than SSF.

An aerial photograph of the Northern Riparian Corridor is provided in Figure 2 and the nominated revegetation and assisted regeneration areas are depicted in Figure 3.

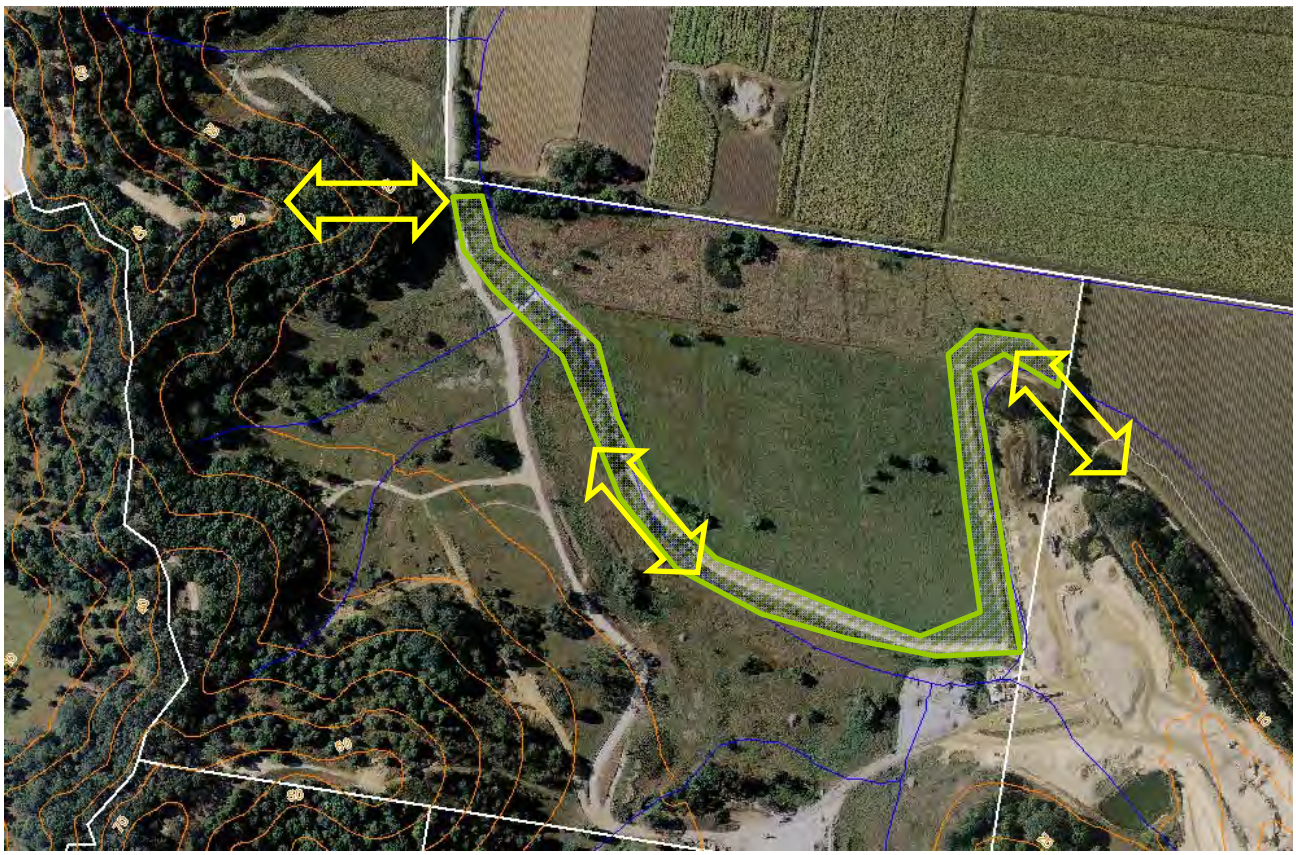

Figure 2: Northern Riparian Corridor restoration work area

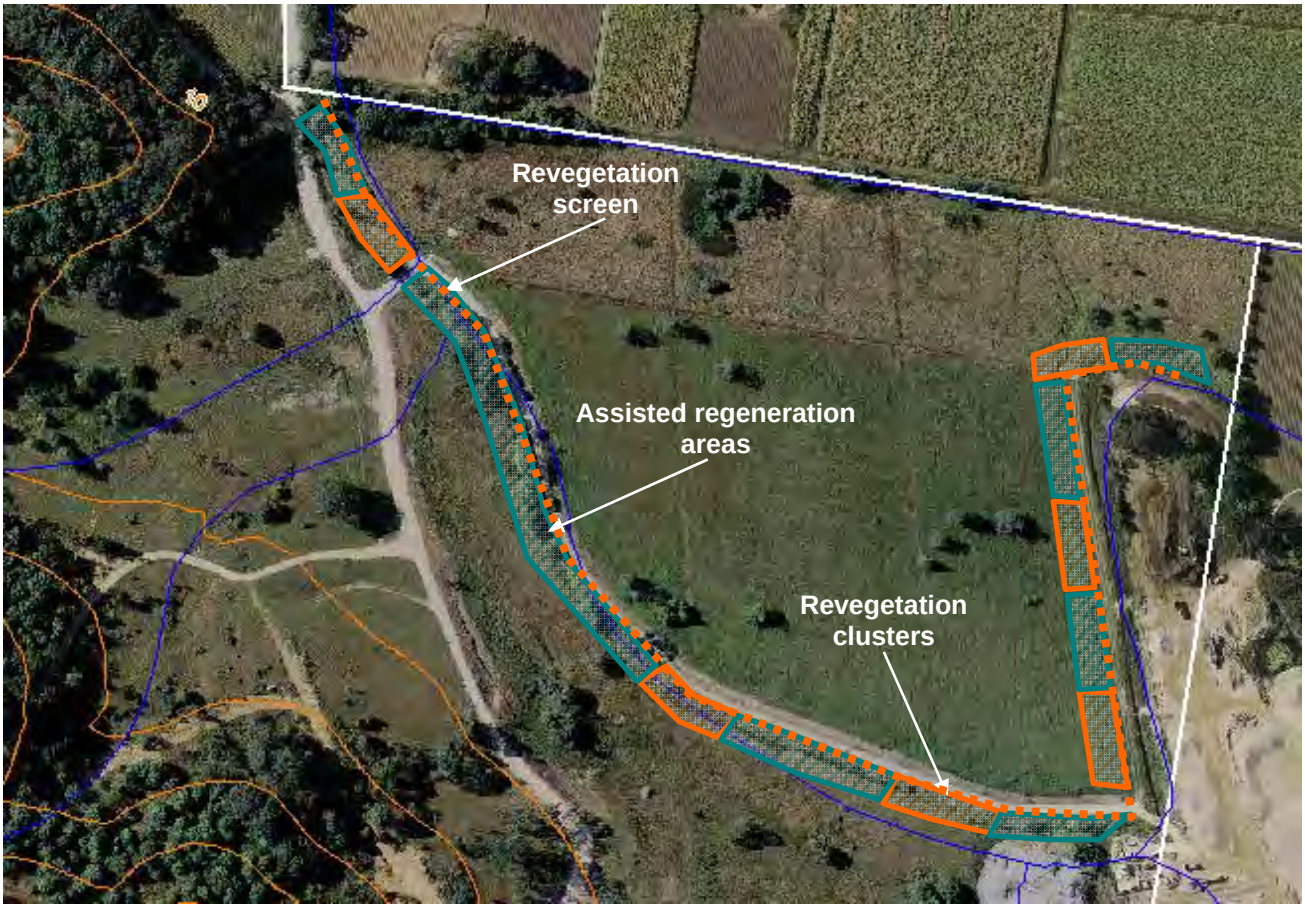

Figure 3: Northern Riparian Corridor nominated revegetation and assisted regeneration work areas

2.2.2 Southern Ridgeline Corridor

The Southern Ridgeline Corridor occurs along the ridge of the Condong Range in the southern portion of the site. It provides for upland east-west movement of native fauna and connects the patch of retained sclerophyll forest/camphor laurel forest east and south of Quirk's Quarry with the retained sclerophyll forest in the western portion of the site. The western portion of this corridor is vegetated with Blackbutt Wet Sclerophyll Open Forest and the eastern portion is vegetated with camphor laurel forest and, further east, sclerophyll forest. The central portion of this corridor, in the vicinity of the existing haul road and the residence of Lot 1 DP 34555, is largely cleared of native vegetation and represents a break in the linkage across the site. It is proposed that this area be planted to reconstruct wet sclerophyll habitat and inturn improve the connectivity of this east-west corridor. The revegetation area will be down slope of the existing residence of Lot 1 DP 34555, generally between the 60 and 70m contour for a length of approximately 220m. The proposed width of the Southern Ridgeline Corridor revegetation area is approximately 20m amounting to a restoration area of approximately 0.44ha.

An aerial photograph of the Southern Ridgeline Corridor is provided in Figure 4.

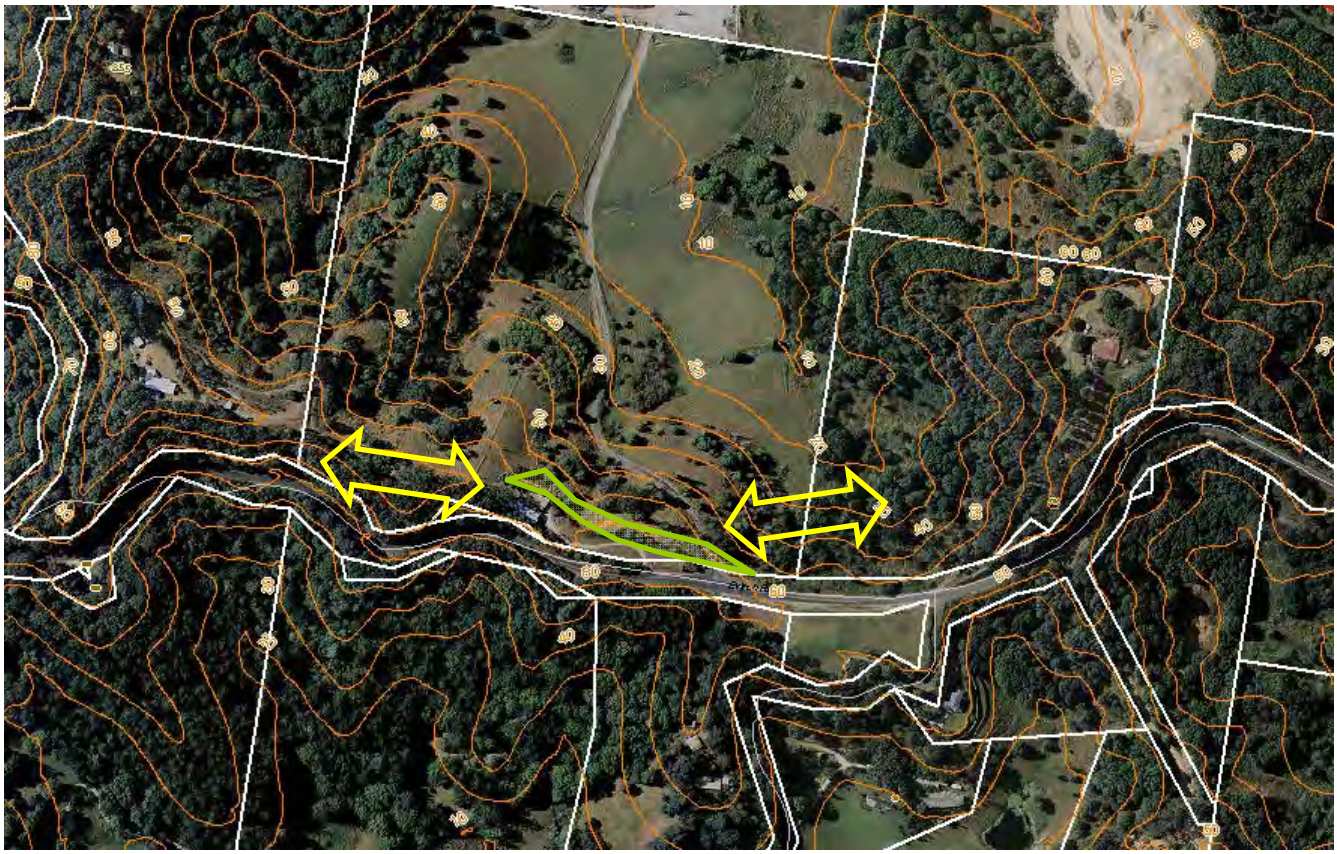

Figure 4: Southern Ridgeline Corridor restoration work area

Refer to section 5 for more information on proposed works.

3 Restoration objectives

The restoration objectives are as follows:

- To contribute to 'maintaining or improving biodiversity values' at the site and its locality.
- To reconstruct bushland habitat that connects areas of retained bushland on the site (and adjoining the site) to facilitate wildlife movement (and genetic transfer) throughout the site and wider locality.
- To provide a fauna refuge across the site to minimise the risk of fauna injuries and mortalities from quarry and landfill operations and natural disturbance events (eg. fire or storms).
- To reconstruct native vegetation communities consistent with that likely to have occurred prior to clearing, or where the existing environment is highly modified, reconstruct a suitable alternative native vegetation community.
- Along the Northern Riparian Corridor, the objective is to reconstruct a swamp sclerophyll forest that is commensurate with SSF EEC.
- Along the Southern Ridgeline Corridor, the objective is to reconstruct Blackbutt wet sclerophyll forest.
- To revegetate with species that provides significant habitat values as much as possible (eg. Koala and Glossy Black-cockatoo feed trees).
- To restore and improve the ecological integrity of degraded areas of existing vegetation along the corridors through assisted regeneration.
- It is not expected that mature swamp sclerophyll forest or Blackbutt wet sclerophyll forest communities will be achieved within the period of the five year program. However, at the completion of the five year period, it is expected that the revegetation areas will represent healthy self-sustaining regrowth communities with a floristic and structural diversity comparable to benchmark swamp sclerophyll/Blackbutt wet sclerophyll forest communities. The assisted regeneration areas are expected to have a significant cover of native vegetation.
- At the end of the five-year program it is expected that the presence of exotic species be significantly reduced.

Refer to Section 5.6 and Appendix C for detailed Key Performance Indicators (KPIs).

4 Biological and ecological considerations of target vegetation communities

4.1 Swamp sclerophyll forest EEC

The suitability of the proposed Northern Riparian Corridor restoration area, in terms of landform, elevation, inundation and soil type, for establishing SSF is discussed below.

4.1.1 Landform, elevation and inundation

Swamp sclerophyll forest generally occurs on alluvial flats and drainage lines associated with coastal floodplains on soils that are either waterlogged or subject to periodic flooding or inundation (DECC, 2007; Scientific Committee, 2004). This community is generally found below 20 m elevation (DECC, 2007).

Floodplains are level landform patterns on which there may be active erosion and deposition of sediment by flooding, where the average interval is 100 years or less (DECC, 2007). The Northern Riparian Corridor restoration area is flat (<8 degrees) and subject to flooding. Incorporating the BMT WBM Pty Ltd (2009) updated climate change predictions; the flood design level for the site is 4.0 m, which is 2-4 m above existing levels. As no filling is proposed within this area, the site will continue to be subject to flooding.

The landform, elevation and periodic flooding at the Northern Riparian Corridor restoration area are suitable for the re-establishment of SSF.

4.1.2 Soil type

Swamp sclerophyll forest is associated with humic clay loams and sandy loams (Scientific Committee, 2004). Soil investigations undertaken by Gilbert+Sutherland (2007) included three boreholes along the drainage line associated with the Northern Riparian Corridor restoration area and an additional two boreholes in close proximity (on the north-eastern side of the drainage line). The boreholes revealed the soil profile in the area consists of medium clay to a depth of 40 cm overlying heavy clay along the drainage line and clayey sand to loam (10 and 20 cm, respectively) overlying heavy clay on the north-eastern side of the drainage line. The borehole soil profile results are consistent with the 1:100,000 soil landscape mapping of the area which maps the entire site as occurring within the Tweed (tw) alluvial landscape (Morand, 1996). The Tweed soil landscape consists of deep Quaternary alluvium and estuarine sediments; the soils are described as deep (>200 cm), poorly drained Brown Alluvial Clays on levees and Humic Gleys on backplains (Morand, 1996).

The soils within the Northern Riparian Corridor restoration area are potentially a little heavier (higher in clay content) than what is typical host to SSF; however, the clayey sand and loam detected on the north-east side of the drainage line are more suitable soil types and restoration area is likely to harbour soils with varying clay:sand ratios. Given the occurrence of a small patch of regrowth SSF already exists within this area, it is considered suitable for this community type. It is expected that the heavier soils would allow for the incorporation of some rainforest species within the community structure.

4.2 Blackbutt wet sclerophyll forest

The suitability of the proposed Southern Ridgeline Corridor restoration area, in terms of landform, elevation, inundation and soil type, for establishing Blackbutt wet sclerophyll forest is discussed below.

Blackbutt wet sclerophyll forest was recorded along the ridgeline that occurs around the western and southern boundaries of the site, with another patch occurring on a spur east of Quirks Quarry. This community was found to be analogous with TVMS community 201: Blackbutt Open Forest Complex and Biometric vegetation type 24: Blackbutt - Tallowwood tall moist forest of the far north east of the North Coast.

4.2.1 Landform, elevation and inundation

The landscape position for Biometric vegetation type 24: Blackbutt - Tallowwood tall moist forest of the far north east of the North Coast is described as the eastern Mount Warning Shield. The TVMS community Blackbutt Open Forest Complex is described as occurring on ridges and hillslopes, with floristic composition varying with soil fertility and aspect (Kingston *et al*, 2004). The existing occurrence of this community on site is along the ridgeline and hillslopes associated with Condong Range, with elevation varying between approximately 10 – 60 AHD. This community occurs on elevated coastal hills and ridges where the soils are moderately well draining.

4.2.2 Soil type

This community is associated with the Burringbar (bu) soil landscape (Morand, 1996). Soil investigations undertaken by Gilbert+Sutherland (2007) included nine boreholes along the ridgeline. The results from the boreholes found the soil profile to comprise silty/sandy/gravelly clay, loam and clayey gravelly sand (to a depth of 90cm) overlying siltstone, silty sand, sandy gravel, silty medium clay and gravelly sandy light clay (Gilbert+Sutherland, 2007). The borehole investigations are generally consistent with Morand (1996) description which describes a typical profile of a shallow layer of crumbly clay loam overlying silty clay loam overlying quartite phyllite on the ridge top; a shallow layer of crumbly clay loam overlying silty clay loam overlying red plastic clay overlying siltstone/mudstone/shale on the upper slopes; and a shallow layer of crumbly clay loam overlying stony silty clay/yellow mottled clay and red crumbly clay overlying quartzite/phyllite on the lower slopes.

Blackbutt forest is known to occur on all of these variations of the Burringbar soil landscape. Accordingly, the soil within the southern ridgeline restoration area is considered suitable for this community.

5 Scope of works

The proposed scope of works is detailed in the following sections.

5.1 Seed collection and propagation

Seed is to be collected from native species within and adjoining the existing Swamp Sclerophyll Forest and Blackbutt wet sclerophyll forest communities of the Northern Riparian Corridor and southern ridgeline, respectively. Seed is to be collected from species listed in the revegetation species lists for each restoration area (Appendix A).

In accordance with the florabank Model Code of Practice, it is recommended that no more than 20% of fruit is removed from any one plant (in any one season).

Records will be kept for each sample of propagation material and maintained from the time of collection, to the raising of seed/cuttings, planting out of tubestock and maintenance and monitoring period. The following information will be collected for each sample:

- Sample id code (unique code to be created for each sample – eg. 'EP_1', which represents *Eucalyptus pilularis*, plant 1);
- Source plant location (GPS coordinates and description);
- Date of collection;
- Type of material collected (eg. seed, cutting);
- Amount of material collected;
- Seed treatment technique;
- Date of sowing;
- Date of germination;
- Date of out-planting;
- Location of out-planting (GPS coordinates and description);
- Monitoring results (refer to Section 5.6.2 for proposed monitoring method).

Each sample will be tagged with its Sample id code for the duration of its life cycle.

Collected seed is to be stored in accordance with the florabank *Guidelines for Native Seed Storage for Revegetation*.

Collected seed is to be delivered to TSC Nursery or contracted private nursery for propagation. Sample id codes are to be kept with the sample at all times on a label that is not going to deteriorate with water and sun exposure.

5.1.1 Seed provenance

Local seed is typically endorsed as the preferred source of stock for revegetation plantings, primarily because local seed is considered best adapted to local conditions and it is in the interest of conserving local variation in genetic material. However, it is noted that problems can arise from limiting revegetation stock to that which is locally sourced. Namely, by encouraging the establishment of populations that do not harbour sufficient evolutionary potential for future environmental change (Moritz, 1999). Or through the selection of inbred or genetically inferior stock (Lowe, 2009), particularly in highly degraded landscapes which are likely to have inherently high levels of inbreeding due to fragmentation and genetic isolation of populations. To simulate gene flow in highly fragmented landscapes, revegetation programs may employ 'composite provenancing' which involves sourcing a mixture of seed stock from varying distances from the nominated revegetation site (Lowe, 2009). This method utilises predominantly local seed but also incorporates proximate and eco-geographically matched sources, with a small proportion (~10-30%) being sourced from much further afield (Lowe, 2009) (refer to Figure 5). Composite provenancing theory is based on providing a variety of genes to an area to allow for the redistribution of preadapted genes and the evolution of new adaptive gene combinations. This creates an environment where natural selection can take place.

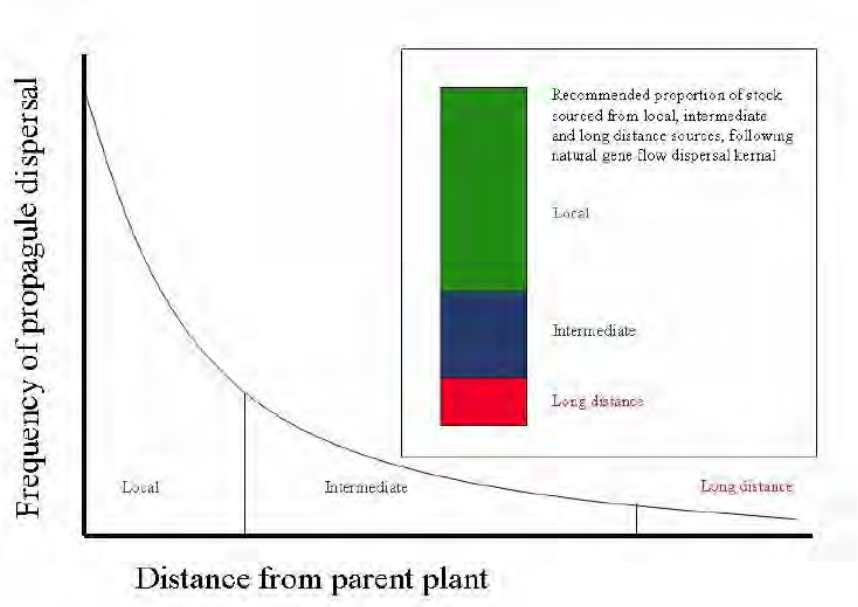

Figure 5: Recommended proportion of seed stock from varying distances from the subject site, based on composite provenancing theory (Source: Lowe, 2009).

The level of genetic diversity in the local seed stock is expected to be highly variable depending on the individual species, the abundance of that species in the locality and the connectivity between patches of similar vegetation types within the locality. Blackbutt forest is well represented and relatively well connected in the locality, so the genetic diversity of Blackbutt is expected to be considerably diverse. However, there is very little Swamp Mahogany dominated communities in the locality and as a result, obtaining local provenance Swamp Mahogany stock with high genetic diversity is likely to be difficult. Accordingly, sourcing the stock for this species will require an element of composite provenancing, where a variety of sources, likely from further afield, will be utilised.

For species that are poorly represented in the locality, the seed stock will be sourced from local, intermediate and long distances from the revegetation site in general accordance with Lowe (2009) recommendations, ie. ~60% sourced from local stock (on or adjoining the site), ~30% from an intermediate source and ~10% from a more removed site. For species well represented in the locality, all seed will be of local provenance.

5.2 Site preparation

5.2.1 Control of grazing

A cow was seen grazing throughout the Northern Riparian Corridor. Further, patches of flattened grasses/herbs we observed characteristic of a resting place of a cow within this area. The presence of cattle has the potential to significantly reduce restoration success through trampling and grazing of planted tubestock and natural regeneration. Access by cattle to the restoration area will need to be controlled, either through destocking or fencing. Temporary fencing, such as electric tape, could be employed around revegetation clusters; however, would require maintenance to remain effective.

There was no evidence of cattle grazing within the Southern Ridgeline Corridor; however, macropod scats were observed. The potential for macropod grazing on planted tubestock and natural regeneration exists. However, fencing is not considered necessary, at least initially. If herbivore grazing becomes a significant problem in this area, tree guards may be required.

5.2.2 Primary weed control

Refer to Section 5.4 for proposed primary weed control works.

5.3 Revegetation

5.3.1 Nominated revegetation areas

The areas to be revegetated include:

- Northern Riparian Corridor: a single row of trees along the entire length of the corridor (approximately 956m) with six additional revegetation clusters of approximately 50 x 20 m, focussed on open areas with minimal to no native canopy cover. This amounts to a total revegetation area of approximately 0.7ha of the total 1.9ha restoration area (the remainder will be treated with assisted regeneration).
- Southern Ridgeline Corridor: focussed on gap in existing ridgeline vegetation centred around the existing residence on Lot 1 on DP34555. A 220m x 20m strip (an estimated 0.44ha will be revegetated) (refer to Figure 4).

5.3.2 Revegetation species selection

The Northern Riparian Corridor is to be revegetated with species characteristic of SSF. The Southern Ridgeline Corridor is to be revegetated with species characteristic of Blackbutt wet sclerophyll forest. A species list for revegetation works is provided in Appendix A, it has been developed with consideration for the list of flora species recorded at site, characteristic species for each community, site conditions and suitable pioneer species. No threatened species are to be included in the plantings.

The species list included in Appendix A provides an indication of species abundance recorded at the site. This, along with the Key Performance Indicators (KPIs) relating to floristic and structural diversity (Appendix B), will be used to guide the planting composition. It is noted that the revegetation species composition will differ from a mature community composition in that there will be a higher proportion of pioneer species during the establishment phase of the community.

In the Northern Riparian Corridor, Swamp Oak (*Casuarina glauca*) saplings are prevalent, particularly near the existing patch of SSF. This species is successfully regenerating itself in this area and in the absence of establishing other SSF species, there is risk that Swamp Oak forest will dominate the area. Accordingly, plantings of Swamp Oak are not proposed; however, their establishment will be promoted through assisted regeneration.

5.3.3 Revegetation planting density and tubestock quantity

Within the Northern Riparian Corridor, the revegetation screen will be planted out with a single row of trees, spaced approximately 1m apart. The revegetation cluster areas will be planted out with tubestock at a density of 1 plant per $1m^2$ with a ratio of 3 trees/shrubs to 1 groundcover.

The Southern Ridgeline Corridor will be planted out with tubestock at a density of 1 plant per $1m^2$ with a ratio 4 trees/shrubs to 1 groundcover.

The tubestock quantities required, based on the above density and ratio, are presented in Table 5.1.

Table 5.1: Tubestock quantities required for revegetation.

	Ground covers	Trees / shrubs	Total
Northern Riparian Corridor			
Revegetation screen (956m @ 1 plant per linear m)	-	956	956
Revegetation clusters (6 clusters of 50 x 20m)	1 500	4 500	6 000
Southern Ridgeline Corridor	880	3 520	4 400
Total	2 380	8 976	11 356

At least a 90% survival rate of planted stock is expected throughout the duration of the program. Any plant losses experienced above this will be replaced through supplementary planting events.

Refer to Section 5.6 for maintenance and monitoring requirements.

5.3.4 Mulching

At the out-planting stage, revegetation areas are to be mulched to a depth of 75 - 100 mm. Mulch is beneficial for weed suppression, water retention and reducing soil erosion. It is recommended that either wood chip or cane mulch is used. Soybean mulch is not recommended as it generally contains viable soy seed which is likely to be introduced to the area. Care is to be taken in sourcing mulch to guard against introducing weed propagules to the area. Where possible mulch from native vegetation cleared on site will be used to maximise potential germination of local seed within the restoration areas. Use of Camphor Laurel mulch is acceptable as long as no foliage is mulched with the timber, as this is likely to contain camphor seed. Mulch is to be kept clear of the tubestock stems to minimise the risk of stem rot.

5.4 Weed control

5.4.1 Weed control target areas

Weed control is to take place throughout the restoration areas, in both the revegetation and assisted regeneration areas.

5.4.2 Primary and follow-up control events

A primary weed control event is required as part of site preparations for revegetation works. This is to remove any existing weeds to allow for out-planting and mulching.

Follow-up weed control works are to be undertaken as required to achieve the Key Performance Indicators (refer to Appendix C). Follow-up weed control would be undertaken as revegetation maintenance works (Section 5.6) and assisted regeneration works (Section 5.5).

5.4.3 Priority weed species

Weed species recorded within the restoration areas are listed in Appendix B, Table B.1.

The priority weed species to be targeted in control works are:

- Weeds of National Significance (WoNS)
- noxious weeds listed under the *Noxious Weeds Act 1993*
- weeds associated with a Key Threatening Process listed under the TSC Act
- environmental weeds which have been identified by NSW *North Coast Weed Advisory Committee* (NCWAC) as one of 187 species considered to have the greatest potential impact on native vegetation.

Refer to Appendix B, Table B.1 for designations of weeds recorded on site. A brief discussion on each of these categories is provided below.

WoNS

The Australian Weeds Committee (2009) has identified 20 WoNS. WoNS are species that have degraded large portions of Australia's natural and productive landscape and require action at a national level to reduce their impacts (AWC, 2009). There is a national strategy for each WoNS specifying actions to better manage the weed (AWC, 2009). One WoNS was recorded on site: Lantana (*Lantana camara*).

Noxious weeds

Within the site, six noxious weeds were recorded:

- Groundsel Bush (*Baccharis halimifoila*) - class 3
- Camphor Laurel (*Cinnamomum camphora*) - Class 4
- Lantana - Class 4.

Class 3 noxious weeds are plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies, are not widely distributed in the area and are likely to spread in the area or to another area. The legal requirement for class 3 weeds is: 'the plant must be fully and continuously suppressed and destroyed'. Groundsel Bush is a class 3 weed known to occur on site., within the Northern Riparian Corridor.

Class 4 noxious weeds are plants that pose a threat to primary production, the environment or human health, are widely distributed in the area to which the order applies and are likely to spread in the area or to another area. The control objective for weed control class 4 is to minimise the negative impact of those plants on the economy, community or environment of NSW. The legal requirement for class 4 weeds is: 'the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority'. Class 4 weeds recorded on site include Camphor Laurel and Lantana. Management of the sites class 4 noxious weeds is to be in accordance with the NSW North Coast Weed Advisory Committee (NCWAC) Regional Management Plans for these species.

Weeds associated with a TSC Act Key Threatening Process listed under TSC Act

Key Threatening Processes (KTPs) listed under Schedule 3 of the TSC Act of relevance to the weeds species recorded on the site and the rehabilitation works on site include:

- Invasion and establishment of exotic vines and scramblers (ie. *Ipomoea cairica*).
- Invasion, establishment and spread of *Lantana camara*
- Invasion of native plant communities by exotic perennial grasses (ie. *Paspalum urvillei* and *Setaria sphacelata*).

Environmental weeds

The NSW NCWAC's Environmental Weed Taskforce, in consultation with organisations and individuals involved in weed control, identified 187 weeds as having, or with potential to have, a significant impact on native vegetation on the NSW North Coast (NCWAC, 2000). These weeds were weighted for their current major or minor impact and their potential for major or minor impact on North Coast native vegetation communities (NCWAC, 2000). They are ranked in order of potential impact, with 1 being the species with the greatest potential impact.

Of the NCWAC 187 environmental weed species (with greatest potential impact on native vegetation), nine were recorded on site (refer to Appendix B, Table B.1).

5.4.4 Best practice

Weed removal techniques and herbicide application is to be conducted according to current best practice methods in bushland restoration. Specifically, works are to be undertaken in accordance with the following guidelines:

- The Department of Industry and Investment (I&I) (2009) *Noxious and environmental weed control handbook a guide to weed control in non-crop, aquatic and bushland situations* and
- The Department of Environment and Conservation's *Guidelines for bush regeneration in threatened species habitat and endangered ecological communities*.

Best practice guidelines recommend an integrated approach to weed control spanning several years, with the final combination of control treatments being site-specific. Integrated weed management is the coordinated use of a range of suitable chemical and non-chemical control methods and reduces reliance upon herbicides (I&I, 2009).

Throughout herbicide application, weather conditions are to be assessed and monitored to reduce the risk of drift and subsequent off-target damage (I&I, 2009) as heavy rains following herbicide application can reduce the effectiveness of a treatment and may cause contamination through run-off (I&I, 2009).

5.4.5 Legislative considerations

All herbicide applications are to be undertaken in accordance with the requirements of the *Pesticides Act 1999*. Under this Act all pesticide users must:

- use only pesticides registered by the Australian Pesticides & Veterinary Medicines Authority (APVMA) that are approved for the intended situation of use
- read the registered label on the pesticide container (or have them read to the user) and strictly follow the label directions
- not risk injury to persons, property and non-target plants and animals through the use of the pesticide
- obtain an AVPMA permit if the user wishes to vary the label directions or use pattern
- make a record of pesticide applications
- be trained (WorkCover, 2006).

Under the *National Parks and Wildlife Act* 1974, bush regeneration contractors must hold a current S132C licence to undertake bush regeneration works in the vicinity of threatened species and within EECs in the Tweed LGA.

5.4.6 Pesticide use reporting and notification

The *Pesticides Regulation 2009* requires persons using pesticides, and acting for or on behalf of a public authority, takes a record of each use. For treatments undertaken by hand or by hand-held applicators, the supervisor of the herbicide application works is the person responsible for the record keeping.

It is also a requirement of the *Pesticides Regulation 2009* that any pesticide use in public places includes public notification in accordance with the *Tweed Shire Council Pesticide Use Notification Plan* (TSC, 2007).

Under the TSC Pesticide Use Notification Plan, publicly accessible landfill sites are considered low to moderate use areas. For control of weeds and grasses, both spot and directed applications of a non selective herbicide may be used. For this type of weed treatment, the TSC Pesticide Use Notification Plan requires a permanent sign at the entrance to the site. Stott's Creek Resource Recovery Centre fulfils this requirement; however, the restorations areas occur in areas of the proposed landfill site that won't be publicly accessible. The other pesticide requirements for landfill sites relate to insecticide (flies) and rodenticide applications which are not relevant to restoration works.

5.4.7 Fauna considerations

The habitat requirements of fauna species known, or likely, to occur on site are to be considered when controlling weeds. Herbicides without surfactants are to be used (i.e. Roundup Biactive® or Weedmaster® Duo) to minimise impacts to aquatic fauna.

5.5 Assisted regeneration

Assisted regeneration is to occur within nominated areas of the Northern Riparian Corridor as depicted in Figure 3. These areas are focussed around areas of existing native vegetation where native soil and canopy seed banks exist or are otherwise inter-dispersed between revegetation clusters and adjacent to the revegetation screen. The idea is to expand on areas of existing native vegetation and establish seed sources along the corridor (through revegetation works) which will promote natural regeneration.

The assisted regeneration is to primarily involve targeted weed control. The nominated areas are weed infested which is characteristic of cleared, highly disturbed, areas. The regeneration potential of these areas is considered high in the area surrounding the existing SSF because of the in-situ soil and canopy seed bank. The potential for assisted regeneration success in areas away from existing native vegetation is reduced due to a limited seed source. However, once the revegetation screen and clusters reach reproductive maturity, they are expected to contribute to the seed bank within the regeneration areas and improve regeneration success.

Weed control works within these areas is to employ targeted spot applications around regenerating natives growing amongst the weeds to reduce competition from weeds and promote the establishment of native recruits.

5.6 Maintenance, monitoring and adaptive management

The works are to be maintained and monitored over a five year period. To measure progress of the works programs, KPI's have been developed (Appendix C). The KPIs would be applied to each restoration area separately. The bush regeneration contractor will be required to undertake the level of maintenance and monitoring necessary to achieve the KPIs; however, the minimum requirements are described below.

5.6.1 Maintenance

The proposed maintenance program is outlined in Table 5.2.

Table 5.2: Proposed maintenance program

Task	Frequency and method
Watering	The plants would initially be watered in during out-planting. For the first three months post-planting, watering would be undertaken weekly. For the subsequent three months of the first year, watering would be undertaken monthly. Watering events may be skipped in the event of adequate rainfall.
Weed control	Primary weed control would be undertaken prior to out-planting as part of site preparations. For the duration of the five-year program, weed control would be undertaken once every second month. Regular weed control is considered important due to the significant assisted regeneration component of the program, which relies on targeted weed control.

5.6.2 Monitoring

The proposed monitoring schedule is bi-annual monitoring events for the duration of the five-year program.

5.6.3 Adaptive management

In line with the principles of adaptive management, the frequency of maintenance and monitoring is subject to change with achievement of the project objectives the primary requirement.

The KPIs are provided in Appendix C is in the form of an assessment checklist which is intended to be used and submitted by the bush regeneration contractor as part of the annual self-assessment and reporting requirement. The methodology for measuring the KPIs would be negotiated between TSC and the bush regeneration contractor.

An annual on-site meeting would be held with attendance of TSC Environmental Scientists and the bush regeneration contractor.

5.7 Hygiene and safety requirements

5.7.1 Handling and application of herbicides

Herbicides have potentially harmful effects on human health. By following label instructions and applying herbicides in the correct manner, using best practices and trained staff, adverse effects can be avoided (I&I, 2009).

Bush regenerators handling pesticides are to do so in accordance with the WorkCover NSW *Code of practice for the safe use of pesticides in non-agricultural workplaces* (2006). This code of practice provides guidance on the safe use of pesticides, to protect the health and safety of workers using pesticides and is intended to assist with achieving compliance with the *Occupational Health and Safety Act 2000* and *Occupational Health and Safety Regulation 2001*.

All personnel handling pesticides are to be familiar with the most current Material Safety Data Sheet (MSDS) available for the product.

5.7.2 Managing against the introduction of harmful pathogens

The bush regenerator should take precautions to avoid the introduction of pathogens into the site. In particular, the bush regeneration contractor should ensure no infected nursery stock is planted at the site.

5.8 Reporting

The bush regeneration contractor commissioned for the subject works will be required to provide annual progress reporting at the completion of each year of the five year program. The annual report will be a brief document (1-2 pages) including the following:

- a brief discussion of works completed to date, including an update on revegetation, weed control and assisted regeneration works. Indicative photos may be included were deemed appropriate
- a description of outstanding works planned for the subsequent year, highlighting priority tasks
- a self-assessment against the KPIs (provided in Appendix C)
- any recommendations for adapting works to suit changing conditions, shifting priorities (eg. new listing of noxious weed species, or outbreak of particular weed species at site)
- copies of Daily Work Sheets.

In addition to progress reports, an evaluation report is to be prepared at the end of the five year program. The evaluation report will summarise the monitoring data over the five year period, discuss findings and provide recommendations for future management of the restoration areas.

The reports will be submitted to the TSC Waste Management Coordinator.

6 Schedule of works

The schedule of works, based on the minimum requirements for maintenance and monitoring, is presented in Table 6.1. Additional maintenance and monitoring events may be required to achieve the annual KPIs and the overall project objectives by the end of the program. Adaptive management will be employed to adjust the maintenance and monitoring frequency, and KPI's if required, to best achieve the project objectives.

Table 6.1: Schedule of works based on minimum maintenance and monitoring requirements

Task	Prior to clearing	Year 1												Year 2												Year 3												Year 4												Year 5											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Seed collection & propagation																																																													
Site preparation																																																														
Out-planting																																																														
Watering				4	4	4																																																								
Weed control																																																														
Monitoring																																																														
Reporting																																																														

Note: A coloured box indicates one event for the month; if more than one event is proposed, the number within the box indicates the total events proposed for the month.

7 Breakdown of tasks and delegation of responsibilities

The breakdown of tasks and delegation of responsibilities is presented in Table 7.1.

Table 7.1: Breakdown of tasks and delegation of responsibilities

Task	Responsible authority
Seed collection	TSC – environmental scientists/bush regeneration contractor
Propagation of seed and raising of seedlings	TSC – nursery staff/private nursery staff
Sourcing of tubestock	Bush regeneration contractor in consultation with TSC environmental scientists
Site preparation – control of grazing	TSC – Waste Coordinator in consultation with adjoining landholders (cattle/horse); bush regeneration contractor in consultation with TSC environmental scientists (tree guards)
Site preparation – primary weed control	Bush regeneration contractor
Revegetation – initial out-planting and supplementary planting as required	Bush regeneration contractor
Weed control – follow-up maintenance	Bush regeneration contractor
Contractor OHS	Bush regeneration contractor
Monitoring – self assessment	Bush regeneration contractor
Monitoring – on site meeting	Bush regeneration contractor and TSC environmental scientist
Annual reporting – submission	Bush regeneration contractor
Annual reporting – review	TSC environmental scientist
Adaptive management	Collaboration between bush regeneration contractor and TSC environmental scientists

8 References

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Appendix A: Revegetation species list

Table A.1: Revegetation species list for Northern Riparian Corridor

Family	Botanical name	Common name	Abundance recorded within vegetation community on site
Trees canopy species			
Myrtaceae	*Eucalyptus resinifera*	Red Mahogany	Not recorded
Myrtaceae	*Eucalyptus robusta*	Swamp Mahogany	Occasional
Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum	Not recorded
Myrtaceae	*Lophostemon suaveolens*	Swamp Box	Not recorded
Myrtaceae	*Melaleuca linariifolia*	Flax-leaved Paperbark	Not recorded
Myrtaceae	*Melaleuca quinquenervia*	Broad-leaved Paperbark	Common
Rhamnaceae	*Alphitonia excelsa*	Red Ash	Not recorded
Rhamnaceae	*Alphitonia petriei*	White Ash	Not recorded
Small trees / shrubs			
Araliaceae	*Polyscias sambucifolia*	Elderberry Ash	Not recorded
Elaeocarpaceae	*Elaeocarpus obovatus*	Hard Quandong	Not recorded
Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry Ash	Not recorded
Euphorbiaceae	*Homalanthus populifolius*	Bleeding Heart	Not recorded
Euphorbiaceae	*Macaranga tanarius*	Macaranga	Uncommon
Euphorbiaceae	*Mallotus philippensis*	Red Kamala	Not recorded
Fabaceae - Mimosoideae	*Acacia melanoxylon*	Blackwood	Common
Malvaceae	*Hibiscus diversifolius*	Swamp Hibiscus	Common
Moraceae	*Ficus coronata*	Sandpaper Fig	Not recorded
Myrsinaceae	*Myrsine variabilis*	Muttonwood	Not recorded
Myrtaceae	*Acmena smithii*	Creek Lilly Pilly	Uncommon (planted)
Myrtaceae	*Callistemon salignus*	Willow Bottlebrush	Not recorded
Myrtaceae	*Melaleuca alternifolia*	Tea Tree	Not recorded
Phyllanthaceae	*Glochidion ferdinandi*	Cheese Tree	Not recorded
Phyllanthaceae	*Glochidion sumatranum*	Umbrella Cheese Tree	Not recorded
Sapindaceae	*Cupaniopsis anacardioides*	Tuckeroo	Uncommon (planted)
Sapindaceae	*Jagera pseudorhus*	Foam Bark Tree	Not recorded
Groundcovers			
Cyperaceae	*Gahnia clarkei*	Tall Saw-sedge	Not recorded
Cyperaceae	*Gahnia sieberiana*	Red-fruit Saw-sedge	Not recorded
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	Not recorded
Phormiaceae	*Dianella caerulea*	Blue Flax Lily	Not recorded

Table A.2: Revegetation species list for Southern Ridgeline Corridor

Family	Botanical name	Common name	Abundance recorded within vegetation community on site
Trees canopy species			
Myrtaceae	*Corymbia intermedia*	Pink Bloodwood	Occasional
Myrtaceae	*Eucalyptus crebra*	Narrow-leaf Ironbark	Occasional
Myrtaceae	*Eucalyptus pilularis*	Blackbutt	Dominant
Myrtaceae	*Eucalyptus propinqua*	Small-fruited Grey Gum	Occasional
Myrtaceae	*Eucalyptus siderophloia*	Grey Ironbark	Common
Myrtaceae	*Lophostemon confertus*	Brush Box	Common
Rhamnaceae	*Alphitonia excelsa*	Red Ash	Not recorded
Small trees / shrubs			
Casuarinaceae	*Allocasuarina littoralis*	Black She-oak	Not recorded
Casuarinaceae	*Allocasuarina torulosa*	Forest Oak	Not recorded
Euphorbiaceae	*Homalanthus populifolius*	Bleeding Heart	Not recorded
Euphorbiaceae	*Macaranga tanarius*	Macaranga	Occasional
Euphorbiaceae	*Mallotus philippensis*	Red Kamala	Common
Lauraceae	*Neolitsea dealbata*	Hairy-leaved Bolly Gum	Common
Meliaceae	*Synoum glandulosum*	Scentless Rosewood	Common
Sapindaceae	*Jagera pseudorhus*	Foam Bark Tree	Not recorded
Sterculiaceae	*Commersonia bartramia*	Brown Kurrajong	Not recorded
Ulmaceae	*Trema tomentosa var. aspera*	Poison Peach	Not recorded
Groundcovers			
Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	Not recorded
Lomandraceae	*Lomandra multiflora*	Many-flowered Mat-rush	Common
Phormiaceae	*Dianella caerulea*	Blue Flax Lily	Not recorded

Appendix B: Weed species recorded at the site

Table B.1: Weed species recorded at the site

Family	Botanical name	Common Name	Status*	Restoration area recorded and abundance#
Apocynaceae	*Gomphocarpus fruticosus*	Balloon Cotton Bush	Environmental weed	NRC – common; SRC – common
Asteraceae	*Ageratum houstonianum*	Blue Billygoat Weed	Environmental weed – ranked 56	NRC – uncommon
Asteraceae	*Aster subulatus*	Wild Aster	Environmental weed	NRC – occasional
Asteraceae	*Baccharis halimifoila*	Groundsel Bush	Class 3 noxious weed; environmental weed – ranked 26	NRC – uncommon
Asteraceae	*Bidens pilosa*	Farmers Friends	Environmental weed – ranked 131	NRC – occasional
Asteraceae	*Senecio madagascariensis*	Fireweed	Environmental weed	NRC – uncommon
Convulvulaceae	*Ipomoea cairica*	Five-leaved Morning Glory	Environmental weed – ranked 23; KTP	NRC – common
Fabaceae - Faboideae	*Desmodium uncinatum*	Silver-leaved Desmodium	Environmental weed – ranked 83	NRC – common
Fabaceae - Faboideae	*Neonotonia wightii*	Perennial Soybean	Environmental weed	NRC – common
Haloragaceae	*Myriophyllum aquaticum*	Parrots Feather	Environmental weed	NRC – common
Lauraceae	*Cinnamomum camphora*	Camphor Laurel	Class 4 noxious weed	NRC – common; SRC – common
Poaceae	*Paspalum mandiocanum*	Broad-leaved Paspalum	Environmental weed	NRC – dominant; SRC – common
Poaceae	*Paspalum urvillei*	Vasey Grass	Environmental weed – ranked 104; KTP	NRC – dominant

Poaceae	*Setaria sphacelata*	Setaria	Environmental weed – ranked 68; KTP	NRC – dominant; SRC – dominant
Rosaceae	*Rubus bellobatus*	Kittatinny Blackberry	Environmental weed	NRC - Common
Solanaceae	*Solanum capsicoides*	Devil's Apple	Environmental weed	NRC – uncommon
Solanaceae	*Solanum chrysotrichum*	Devil's Fig	Environmental weed	NRC – common; SRC – dominant
Solanaceae	*Solanum mauritianum*	Tobacco Bush	Environmental weed	NRC – common; SRC – common
Solanaceae	*Solanum nigrum*	Blackberry Nightshade	Environmental weed	NRC – occasional
Verbenaceae	*Lantana camara*	Lantana	WoNS; Class 4 noxious weed; environmental weed – ranked 10; KTP	NRC – occasional; SRC – common
Verbenaceae	*Verbena bonariensis*	Purpletop	Environmental weed – ranked 178	NRC – common

* WoNS are Weeds of National Significance.

Noxious weeds are those listed under the NSW *Noxious Weeds Act 1993*.

Key Threatening Process (KTP) listed under the NSW *Threatened Species Conservation Act* 1995 (TSC Act).

Environmental weeds are exotic invasive species, those with a ranking have been identified by NSW North Coast Weed Advisory Committee as one of 187 species considered to have the greatest potential impact on native vegetation.

NRC – Northern Riparian Corridor

SRC – Southern Ridgeline Corridor

Appendix C: Key Performance Indicators Assessment Proforma

Table C.1: Key Performance Indicators Assessment Proforma

KPI	Description	Target	Annual performance achieved
Revegetation			
Tubestock survival	Proportion of planted tubestock survived	90%	
Floristic diversity and species composition	Number of surviving future tree canopy species	>5	
	Number of surviving future small trees/shrubs species	>5	
	Number of surviving future groundcover species	>2	
Structural diversity	Proportion of surviving species which are future tree species (emergent and canopy species)	=/>50%	
	Proportion of surviving species which are future shrub species	=/>30%	
	Proportion of surviving species which are future ground cover species (concentrated along verge of drainage line)	=/>10%	
Weed control			
Representation of WoNS/Noxious weeds	% cover of WoNS/Noxious weeds in tree stratum	<1%	
	% cover of WoNS/Noxious weeds in shrub stratum	<5%	
	% cover of WoNS/Noxious weeds in ground stratum	<5%	
Representation of environmental weeds	% cover of environmental weeds in tree stratum	<1%	
	% cover of environmental weeds in shrub stratum	<5%	
	% cover of environmental weeds in ground stratum	<10%	
Assisted regeneration			
Recruitment of native species	Number of stems of native species within nominated assisted regeneration areas	Greater than previous year	

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Appendix H

Threatened Species Assessments

Part 3A Adverse Impact Assessment

EPBC Act Assessments of Significance

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1 Introduction

1.1 Approach

This Appendix includes assessments of the potential impacts associated with the proposed activity upon threatened species and endangered ecological communities. A preliminary analysis of all species and ecological communities identified from the desktop assessment or that were identified from the field surveys was undertaken to develop a list of species and ecological communities that require a formal assessment against the Part 3A Threatened Species Assessment Guidelines and/or the EPBC Act significant impact criteria. This analysis was based upon the likelihood of occurrence and the potential direct or indirect impacts (as detailed in Section 8 of the Ecological Assessment report). The outcome of this analysis is provided in Table F1. (Note that only species with a 'possible' likelihood of occurrence or greater are included in the table).

Section 2 of this Appendix contains 'Adverse Impact Assessments' in accordance with the Part 3A Threatened Species Assessment Guidelines, while Section 3 contains assessments in accordance with the EPBC Significant Impact Guidelines (*EPBC Act Policy Statement 1.1, Significant Impact Guidelines – Matters of National Environmental Significance,* DEWHA 2009).

Note that the questions for Factors 4, 5 and 6 in the Adverse Impact Assessments relate to disturbance regimes, habitat connectivity and critical habitat. As these are generally consistent for each species in relation to the activity they have been addressed in the first Adverse Impact Assessment and have not been replicated for each species. Where clarification was considered warranted it was included for a particular species.

1.2 Clearing Summary

The development footprints of the proposed activity and the approximate areas of clearing by vegetation type are provided in Table F2 (replicated from Table 11 in the Ecological Assessment report).

As noted in the body of the report, the estimated areas of clearing have been generated based upon calculations from overlaying the elements of the Concept Plan (Figure 3) over the Vegetation Map (Figure 6). As such, they do not necessarily present an exact figure in relation to clearing, and in many cases the figures will over represent the area to be cleared. In addition, the eastern portion of the West Valley footprint currently covers an area of Vegetation Type 7 located to the north and east of the proposed haul road in the central southern portion of Lot 1 DP1159352 (see Figure 6).

It is anticipated that where low areas of clearing are indicated, (e.g. the 60 m^2 of vegetation type 2b and 170 m^2 of vegetation type 3), that these would be able to be avoided or minimised during detailed design. In addition, the 3680 m^2 of vegetation type 7 that currently falls within the concept footprint for West Valley quarry is not likely to require clearing. The concept design assumed a minimum pit level of RL 4 AHD, however as this eastern section would provide little gain with regard to quarry resource and would intercept elements of Council's botanic gardens concept, Council has committed to avoiding clearing of vegetation type 7 and to minimise clearing of native vegetation in general.

Table F1 Species Selection for Assessment

Species Name	Status		Recorded	Assessment Required?	Justification
	TSC Act	EPBC Act			
FLORA SPECIES					
Acacia bakeri Marblewood	V		×	✓	Likely occurrence. Although not recorded from within a 5 km radius of study area. Has previously been recorded in subtropical rainforest in the region. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Archidendron hendersonii White Lace Flower	V		✓	✓	Known occurrence. Recorded in the footprint of West Valley and also within vegetation adjacent to the southern side of the proposed haul road. Historical record within 5 km radius, although a number of more recent records in the Tweed Shire. A stand of five individuals will be removed as a result of the activity.
Bosistoa transversa (Syn. Bosistoa selwynii) Yellow Satinheart	V	V	×	✓	Likely occurrence – species previously recorded at Stotts Island Nature Reserve. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.

Species Name	Status		Recorded	Assessment Required?	Justification
	TSC Act	EPBC Act			
Cassia brewsteri var. marksiana Brush Cassia	E		×	✓	Likely occurrence – species previously recorded at Stotts Island Nature Reserve and along Clothiers Creek Road. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Corokia whiteana Corokia	V	V	×	✓	Possible occurrence, (historical records from Tumbulgum only). Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Cryptocarya foetida Stinking Cryptocarya	V	V	×	✓	Likely occurrence. Although preferred habitat of littoral rainforest does not occur, species has been recorded to the southwest of the study area. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Davidsonia jerseyana Davidson's Plum	E	E	×	✓	Possible occurrence although not recorded from within a 5 km radius of study area. Has previously been recorded in subtropical rainforest in the region. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.

Species Name	Status		Recorded	Assessment Required?	Justification
	TSC Act	EPBC Act			
Davidsonia johnsonii Smooth Davidson's Plum	E	E	×	✓	Possible occurrence although not recorded from within a 5 km radius of study area. Has previously been recorded in subtropical rainforest in the region. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Dendrocnide moroides Gympie Stinger	E		×	✓	Likely occurrence. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Desmodium acanthocladum Thorny Pea	V	V	×	✓	Possible occurrence as not recorded from within a 5 km radius of study area. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Diospyros mabacea Red-fruited Ebony	E	E	×	✓	Likely occurrence – species previously recorded at Stotts Island Nature Reserve. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.

Species Name	Status		Recorded	Assessment Required?	Justification
	TSC Act	EPBC Act			
Diospyros major var. ebenus Shiny-leaved Ebony	E		×	✓	Likely occurrence although species only recorded on the northern side of the Tweed River in the district. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Diploglottis campbellii Small-leaved Tamarind	E	E	×	✓	Likely occurrence – species previously recorded at Stotts Island Nature Reserve and along Clothiers Creek Road. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Drynaria rigidula Basket Fern	E		×	✓	Likely occurrence – species previously recorded at Round Mountain. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Eleocharis tetraquetra Square-stemmed Spike-rush	E		×	×	Possible occurrence - Marginal potential habitat only within the study area. The watercourses will not be disturbed as a result of the proposed activity.
Endiandra floydii Floyd's Walnut	E	E	×	✓	Possible occurrence only as no records from within a 5 km radius of study area. Development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.

Species Name	Status		Recorded	Assessment Required?	Justification
	TSC Act	EPBC Act			
Endiandra muelleri subsp. bracteata Green-leaved Rose Walnut	E		×	✓	Likely occurrence. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Gossia fragrantissima Sweet Myrtle	E	E	×	✓	Possible occurrence. Not previously recorded in proximity to the study area. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Grevillea hilliana White Silky Oak	E		×	✓	Possible occurrence however historical record only within a 5 km radius of study area. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Hicksbeachia pinnatifolia Red Boppel Nut	V	V	×	✓	Possible occurrence. Mapped record adjacent to study area, although historical record from 1892. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Lepiderema pulchella Fine-leaved Tuckeroo	V		×	✓	Likely occurrence. Historical records only. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.

Species Name	Status		Recorded	Assessment Required?	Justification
	TSC Act	EPBC Act			
Lindsaea brachypoda Short-footed Screw Fern	E		×	×	Possible occurrence. No preferred habitats of the species will be impacted as a result of the proposed activity.
Lindsaea fraseri Fraser's Screw Fern	E		×	×	Possible occurrence. No preferred habitats of the species will be impacted as a result of the proposed activity.
Macadamia tetraphylla Rough-shelled Bush Nut	V	V	×	✓	Likely occurrence. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Marsdenia longiloba Clear Milkvine	E	V	×	✓	Possible occurrence only. No records from within a 5 km radius. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Oberonia titania Red-flowered King of the Fairies	V		×	✓	Possible occurrence. Historical record only in proximity to the study area. Grows in a variety of habitats. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Ochrosia moorei Southern Ochrosia	E	E	×	✓	Likely occurrence. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.

Species Name	Status		Recorded	Assessment Required?	Justification
	TSC Act	EPBC Act			
Phaius australis Southern Swamp Orchid	E	E	×	×	Possible occurrence. The swamp sclerophyll forest in the study area will not be cleared as a result of the proposed activity and provides marginal habitat only for this species.
Randia moorei Spiny Gardenia	E	E	×	✓	Likely occurrence. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Symplocos baeuerlenii Small-leaved Hazelwood	V	V	×	✓	Likely occurrence. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Syzygium hodgkinsoniae Red Lilly Pilly	V	V	×	✓	Likely occurrence (although historical records only in proximity to the study area). Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Syzygium moorei Durobby	V	V	×	✓	Likely occurrence. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Taeniophyllum muelleri Minute Orchid		V	×	✓	Possible occurrence. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.

Species Name	Status		Recorded	Assessment Required?	Justification
	TSC Act	EPBC Act			
FAUNA					
AMPHIBIANS					
Crinia tinnula Wallum Froglet	V		×	×	Possible occurrence. Marginal habitat only occurs in the study area and this will not be removed as a result of the activity. The species has not previously been recorded in close proximity to the study area.
BIRDS					
Burhinus grallarius Bush Stone-curlew	E		×	×	Likely occurrence. The species has been predominantly recorded from near coastal areas and is not expected to occur in the study area. Areas of potential habitat will be retained in the study area.
Calyptorhynchus lathami Glossy Black-cockatoo	V		A possible record overflying the study area.	✓	Possible occurrence. A black cockatoo species was observed overflying the study area. Only marginal habitat for this species is available in the study area comprised of sparsely distributed forest oak (*Allocasuarina torulosa*) within blackbutt open forest, all of which will be retained. No trees with hollows will be removed as a result of the proposed activity.

Species Name	Status		Recorded	Assessment Required?	Justification
	TSC Act	EPBC Act			
Ephippiorhynchus asiaticus Black-necked Stork	E		×	×	Possible occurrence. The lower lying areas in which this species may occasionally forage will not be impacted as a result of the proposed activity.
Glossopsitta pusilla Little Lorikeet	V		✓	✓	Known occurrence. Species identified in the study area. No trees with hollows will be removed as a result of the proposed activity.
Ixobrychus flavicollis Black Bittern	V		×	×	Possible occurrence. The lower lying areas in which this species may occasionally forage will not be impacted as a result of the proposed activity.
Pandion haliaetus (Pandion cristatus) Osprey	V		×	×	Possible occurrence. No nests occur in the study area, thus no breeding habitat will be impacted. A small area of marginal foraging habitat will be removed, however this is unlikely to impact this species given the area of foraging habitat available in the local area.
Ptilinopus magnificus Wompoo Fruit-dove	V		×	✓	Likely occurrence. The species has previously been recorded in relatively close proximity to the study area. The proposed activity will result in the removal of 10.5 ha of camphor laurel dominated vegetation in which this species could forage. In addition, the Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.

Species Name	Status		Recorded	Assessment Required?	Justification
	TSC Act	EPBC Act			
Ptilinopus regina Rose-crowned Fruit-dove	V		×	✓	Known occurrence. The proposed activity will result in the removal of 10.5 ha of camphor laurel dominated vegetation in which this species could forage. In addition, the Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
Todiramphus chloris Collared kingfisher	V		✓	✓	Known occurrence. Preferred habitat unlikely to be impacted as a result of the activity.
Tyto capensis Grass Owl	V		×	✓	Likely occurrence. The proposed activity will result in the removal of vegetated areas on the slopes. Potential habitat for this species occurs in the lower lying areas of the study area and as such a small area of foraging habitat may be affected by the activity.
MAMMALS					
Chalinolobus dwyeri Large-eared Pied bat	V	V	×	×	Possible occurrence. No breeding habitat for this species will be removed. Foraging habitat will be removed from within the development footprint, however a large proportion of existing foraging habitat will be retained in the site and the surrounding area. The species could occasionally forage in the study area.

Species Name	Status		Recorded	Assessment Required?	Justification
	TSC Act	EPBC Act			
Dasyurus maculatus maculatus Spotted-tailed Quoll	V	E	×	✓	Likely occurrence. The proposed activity will result in the removal of 10.5 ha of camphor laurel dominated vegetation. Much of this vegetation does not provide adequate protection for the species in terms of dense understorey, however the species may occasionally forage in these areas as part of a home range. A large proportion of existing foraging habitat will be retained in the site and the surrounding area.
Falsistrellus tasmaniensis Eastern False Pipistrelle	V		✓	✓	Likely occurrence ('almost certainly present'). The proposed activity will result in the removal of 10.5 ha of camphor laurel dominated vegetation. No hollow trees will be removed as a result of the activity. No maternity sites will be removed.
Miniopterus australis Little Bentwing-bat	V		✓	✓	Known occurrence. The proposed activity will result in the removal of 10.5 ha of camphor laurel dominated vegetation. No hollow trees will be removed as a result of the activity. No maternity sites will be removed.
Miniopterus schreibersii oceanensis Eastern Bentwing-bat	V		×	✓	Known occurrence. The proposed activity will result in the removal of 10.5 ha of camphor laurel dominated vegetation. No trees with hollows will be removed as a result of the activity. No maternity sites will be removed.

Species Name	Status		Recorded	Assessment Required?	Justification
	TSC Act	EPBC Act			
Mormopterus beccarii Beccari's Freetail-bat	V		×	×	Possible occurrence. The proposed activity will result in the removal of 10.5 ha of camphor laurel dominated vegetation. No trees with hollows will be removed as a result of the activity. No maternity sites will be removed.
Mormopterus norfolkensis Eastern Freetail-bat	V		×	×	Possible occurrence. The proposed activity will result in the removal of 10.5 ha of camphor laurel dominated vegetation. No trees with hollows will be removed as a result of the activity. No maternity sites will be removed.
Myotis macropus Large-footed Myotis	V		×	×	Possible occurrence. The proposed activity will result in the removal of 10.5 ha of camphor laurel dominated vegetation. No trees with hollows will be removed as a result of the activity. No maternity sites will be removed.
Nyctophilus bifax Eastern Long-eared Bat	V		Possible record from survey	✓	Likely occurrence. The proposed activity will result in the removal of 10.5 ha of camphor laurel dominated vegetation. No trees with hollows will be removed as a result of the activity. No maternity sites will be removed.

Species Name	Status		Recorded	Assessment Required?	Justification
	TSC Act	EPBC Act			
Petaurus norfolcensis Squirrel Glider	V		✓	✓	Possible occurrence. Petaurid glider observed in study area. Species potential habitats will be predominantly retained. No trees with hollows will be removed as a result of the proposed activity.
Phascolarctos cinereus Koala	V		✓	✓	Known occurrence. The koala was recorded in the study area on the western side within blackbutt open forest. The development footprint has been configured such that areas of higher density eucalypts in the study area will be retained, however a number of eucalypts will be removed from within the development footprints.
Pteropus poliocephalus Grey-headed Flying-fox	V	V	×	✓	Likely occurrence. The proposed activity will result in the removal of foraging habitat for this species only. No camp site occurs in the study area.
REPTILES					
Coeranoscincus reticulatus Three-toed Snake-tooth Skink	V	V	×	✓	Possible occurrence. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.

Species Name	Status		Recorded	Assessment Required?	Justification
	TSC Act	EPBC Act			
INVERTEBRATES					
Thersites mitchellae Mitchell's Rainforest Snail	E	E	×	✓	Likely occurrence. Although development footprint avoids most higher ecological value habitats there is some potential for the species to occur within camphor laurel dominated vegetation.
ENDANGERED ECOLOGICAL COMMUNITIES					
Swamp sclerophyll forest on coastal floodplains	EEC		✓	×	Known occurrence. The proposed activity will not result in clearing of this EEC.
Lowland rainforest	EEC		✓	✓	Known occurrence. Vegetation adjacent to the northern side of the haul road contains elements of this endangered ecological community.

Table F2 Estimated Clearing Areas

		Clearing Area (ha)				
		Existing Approval	Stage 1		Future Stage	
#	Vegetation Type	Quirks Quarry	West Valley	Haul Road	North Valley	Total
1a	Camphor laurel (**Cinnamomum camphora*) closed forest	(1.006)	1.689	0.217	3.170	5.076
1b	Camphor laurel (**Cinnamomum camphora*) open forest to open woodland	(0.255)	3.084	0.015	0.068	3.167
2a	Blackbutt (*Eucalyptus pilularis*) wet sclerophyll forest	(0.367)	0.000	0.066	0.000	0.066
2b	Blackbutt (*Eucalyptus pilularis*) dry sclerophyll forest	(0.000)	0.000	0.006	0.000	0.006
3	Camphor laurel – pink bloodwood (**Cinnamomum camphora* – *Corymbia intermedia*) closed forest	(0.000)	0.000	0.017	0.000	0.017
4	Grassland / cleared areas	(4.770)	5.831	2.269	0.313	8.413
5	Canefield	(0.000)	0.000	0.000	0.000	0.000
6	Broad-leaved paperbark – camphor laurel (*Melaleuca quinquenervia* – **Cinnamomum camphora*) open forest	(0.000)	0.000	0.000	0.000	0.000
7	Brush Box – Bennett's ash (*Lophostemon confertus* – *Flindersia bennettiana*) open forest	(0.000)	0.368	0.000	0.000	0.368
8	Orchard	(0.000)	0.000	0.000	0.000	0.000

2 Part 3A Adverse Impact Assessments

Part 3A AIA1 Threatened Rainforest Plants including white lace flower (*Archidendron hendersonii*)

Overview

Several threatened rainforest species have previously been recorded within a 5 km radius of the Eviron Road study area. They include the white lace flower (*Archidendron hendersonii*) which was identified from within the understorey of camphor laurel dominated vegetation in the south western portion of Lot 1 DP1159352 as well as within wet sclerophyll open forest in the north western portion of the lot (see Figure 6 in the Ecological Assessment for locations).

The study area and surrounding lands are likely to have previously supported lowland rainforest on sheltered lower slopes and floodplain areas, and wet and dry sclerophyll forest on the slopes. These areas would have provided potential habitat for a number of threatened rainforest plants. However, the vegetation in the study area has historically been subject to clearing, and a large proportion of the vegetated areas, particularly along the western side of the study area are heavily infested with camphor laurels in areas of dense canopy, or are comprised of camphor laurels and weed species such as lantana and exotic grasses in the more open disturbed areas.

Some areas containing native vegetation occur in the study area. These include the vegetated areas on Lot 1 DP1159352, that comprise Vegetation Type 2a, a blackbutt wet sclerophyll open forest in the very north west of the study area, and the two small patches of pink bloodwood – camphor laurel closed forest (Vegetation Type 3), which are recognised as having elements floristically and structurally similar to a lowland rainforest community. Patches of blackbutt wet sclerophyll open forest also occur along the ridgelines including the eastern and southern sides of Quirks Quarry, and along the western ridgeline and southern boundary of the site.

The proposed development has been configured to locate most areas of clearing in previously disturbed camphor laurel dominated areas of the site, such that the more natural areas can be retained and managed or persist in the study area. The areas of vegetation to be cleared within the development footprints (based upon the concept plan) are provided in Table F2.

Despite previous disturbances within the native vegetation communities, a number of rainforest plants previously recorded in the region have potential to occur due to either persistence in a disturbed area (e.g. in the seedbank), or potentially as a result of the spread of propagules by rainforest birds or flying-foxes throughout the Shire. As a result of this threatened rainforest species may occur within rainforest areas, wet sclerophyll forest as well as the understorey of camphor laurel dominated bushland. In addition they can also be found as isolated paddock trees in cleared areas.

Survey in the study area to date has involved random meander surveys. Although it is expected that an inventory of the majority of species occurring in the study area has been obtained, target surveys for threatened plant species will be undertaken once the final development footprint has been confirmed.

This adverse impact assessment assumes that because the development footprint is located in an area that has been subject to a high level of historical disturbance, that it is unlikely to support a viable population of a species without a high intensity level of management (although noted that they could persist). As the translocation potential of many species is reasonably well known (e.g. Nicholson and Nicholson, 1995; Floyd, 2008), a Preliminary Translocation Plan for Threatened Plants (Appendix F) for any species identified in the development footprint has been developed. This describes steps for the translocation of the white laceflower. The document would be revised to include any additional threatened species should they be identified in the footprint when the detailed design is developed.

The following 'threatened rainforest plants' were considered for this assessment of significance. Although their patterns of germination may vary, the habitat types in which they occur are relatively consistent. It is noted that most of these species have scattered records in the Shire, including within reserved areas, while some of the species have been recorded from historical records only (for example the only record for *Oberonia titania* in proximity to the site is from 1897).

- Marblewood – *Acacia bakeri.*
- Yellow Satinheart - *Bosistoa transversa (*Syn*. Bosistoa selwynii*).
- Brush cassia – *Cassia brewsteri* var*. marksiana.*
- Corokia – *Corokia whiteana.*
- Stinking cryptocarya – *Cryptocarya foetida*.
- Davidson's plum – *Davidsonia jerseyana*.
- Smooth Davidson's plum – *Davidsonia johnsonii*.
- Gympie stinger – *Dendrocnide moroides.*
- Thorny pea – *Desmodium acanthocladum.*
- Red-fruited ebony – *Diospyros mabacea.*
- Shiny-leaved ebony – *Diospyros major* var*. ebenus.*
- Small-leaved tamarind – *Diploglottis campbellii.*
- Basket fern – *Drynaria rigidula.*
- Floyd's walnut – *Endiandra floydii.*
- Green-leaved rose walnut – *Endiandra muelleri* subsp*. bracteata.*
- Sweet myrtle – *Gossia fragrantissima*.
- White silky oak – *Grevillea hilliana.*
- Red boppel nut – *Hicksbeachia pinnatifolia.*
- Fine-leaved tuckeroo – *Lepiderema pulchella.*
- Rough-shelled bush nut – *Macadamia tetraphylla.*
- Clear milkvine – *Marsdenia longiloba.*

- Red-flowered king of the fairies – *Oberonia titania.*
- Southern ochrosia – *Ochrosia moorei.*
- Spiny gardenia – *Randia moorei.*
- Small-leaved hazelwood – *Symplocos baeuerlenii.*
- Red lilly pilly – *Syzygium hodgkinsoniae.*
- Durobby – *Syzygium moorei.*

Adverse Impact Assessment for Threatened Rainforest Plants

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

a) displaces or disturbs threatened species and/or populations

The proposed activity will result in the removal of a stand of five white lace flower (*Archidendron hendersonii*) from within the footprint of West Valley. These plants occur within the centre of the quarry resource and will not be able to be avoided. Translocation and propagation (seeds of the species which are reported to germinate rapidly (Nicholson and Nicholson, 2000) has been investigated and a Preliminary Translocation Plan has been developed (Appendix F). A juvenile of the species was recorded from within the vegetation to be retained in the north western portion of Lot 1 DP1159352, which could suggest that additional individuals of this (and other) species may occur in the locality.

Survey to date did not identify any further threatened rainforest plants within the development footprint, however as indicated above, should any be identified, options for translocation would be investigated and the Preliminary Translocation Plan would be revised accordingly.

b) disrupts the breeding cycle

Removal of the stand of white lace flowers will effectively disrupt their breeding cycle within the development footprint. The proposed activity will not result in any impacts upon the breeding cycle of any of the threatened rainforest species outside of the development footprint.

c) disturbs the dormancy period

This factor is not applicable to the threatened plant species. The seedbank within the development footprint could potentially contain some propagules of threatened rainforest plant species as described in (h) below.

d) disrupts roosting behaviour

This factor is not applicable to threatened plant species.

e) changes foraging behaviour

This factor is not applicable to threatened plant species.

f) affects migration and dispersal ability

The proposed activity will not affect the dispersal ability of any of the threatened rainforest species. Movement of plant species locally could be attributed to rainforest bird species or flying-foxes distributing propagules. Retention of vegetation in the study area and persistence of vegetation in the locality, will retain the existing 'dispersal ability' of the threatened plant species

that could occur in the study area.

g) disrupts pollination cycle

The proposed activity will not affect the pollination cycle of any of the threatened rainforest plants. Pollinators are not expected to be impacted as a result of the proposed activity.

h) disturbs seedbanks

As indicated above, the proposed activity will disturb the seedbank in the development footprint. There is some potential for propagules of threatened rainforest species to occur in vegetation across the study area (for example as a result of dispersal by birds and flying foxes). It is not known whether any rainforest propagules occur within the subject site. Based upon the species identified within the predominant vegetation on the study area, the seedbank likely comprises a variety of weed species, including camphor laurel (**Cinnamomum camphora*) and lantana (**Lantana camara*).

i) disrupts recruitment

The proposed activity will result in the clearing of a development footprint predominantly within camphor laurel dominated vegetation. Notwithstanding this, propagules of threatened rainforest species may, at least on occasion, geminate and grow in this vegetation type. This may be the reason as to why the white lace flower was recorded from within the camphor laurel dominated vegetation.

There was apparent recruitment of a number of common rainforest plants (e.g. rose myrtle *Archirhodomyrtus beckleri*) within the camphor vegetation, and thus there is potential for the proposed activity to disrupt recruitment of threatened rainforest species should propagules of the species occur within this area. Notwithstanding this, suitable areas for potential recruitment occur within areas to be retained in the study area, such as the vegetation adjacent to the southern side of the haul road in the north western portion of Lot 1 DP1159352, and as such recruitment of threatened plant species will be disrupted within the immediate development footprint only.

j) affects the interaction between threatened species and other species in the community (e.g. pollinators, host species, mycorrhizal associations).

The proposed activity is not expected to have any impacts upon pollination, host species or mycorrhizal associations that are important to any of the threatened rainforest species.

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?

a) disturbs any permanent, semi-permanent or ephemeral water bodies;

The footprint of the proposed activity will disturb ephemeral watercourses that are derived from the slopes of the Condong Range. Disturbance of these relates to drainage lines from the range to the lowland area in the immediate vicinity of the development footprints and will not have any specific impacts upon the threatened rainforest plants as they do not occur in the immediate downslope of the ephemeral watercourses to be disturbed. Stormwater that presently flows in the ephemeral drainage lines will be redirected around the development footprint, such that clean stormwater runoff will continue to discharge to the drainage lines. This will be documented within a Stormwater Management Plan prior to seeking an Environmental Protection Licence.

b) degrades soil quality;

Landfills associated with the proposed activity will be managed under strict guidelines such that soil quality in the study area is not degraded as a result of the activity.

c) clears or modifies native vegetation;

The proposed activity will result in removal of vegetation that is dominated by exotic species and principally avoids areas containing native vegetation. Despite this, these areas may provide potential habitat for the threatened rainforest species.

The proposed development footprint has been configured to principally avoid clearing of areas of native vegetation. Areas of native vegetation will be retained and managed on Lot 1 DP1159352, while other areas will persist in the study area (as well in the wider area).

d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread

Potential sources of weeds typically associated with landfills will be minimised at Eviron Road through the continuation of the practice of segregated green organic waste being processed at Stotts Creek RRC and not disposed of within the landfills at Eviron Road. Council is committed to minimising the presence of vermin species through best practice landfilling techniques including minimising the amount of waste exposed at any given time and where necessary through pest control programs.

The vegetation on the site is presently subject to high levels of weed infestation as a result of previous land management as well as the highly invasive nature of camphor laurels. Those more native areas of the site will be subject to maintenance such that existing weed species are managed and new species do not become established.

e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat

The key habitat of the threatened rainforest plants in the form of wet sclerophyll forest with elements of lowland rainforest will be retained.

f) affects natural revegetation and recolonisation of existing species following disturbance

The proposed activity will not impact upon natural revegetation and recolonisation of existing species outside of the development footprint after disturbance (although it is noted that recolonisation with the existing vegetation dominated by camphor laurel is undesirable). Assisted natural regeneration will be undertaken in native areas proposed to be retained and managed in the study area. As previously indicated, landfills are not typically rehabilitated with vegetation with significant root systems that would penetrate the capping, and as such rehabilitation in the development footprints would comprise only shallow-rooted species.

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

A number of the threatened rainforest species have a relatively limited distribution in the Far North Coast region of NSW or are at or near their limit of known distribution in the Tweed Shire. The white lace flower identified in the study area has a distribution between Coffs Harbour and Cape Melville in Cape York (Nicholson and Nicholson, 2000).

4. How is the proposal likely to affect current disturbance regimes?

a) modifies the intensity and frequency of fires

The proposed activity will not alter any fire regimes.

b) modifies flooding flows

The haul road has been designed such that it provides flood immunity for the Q100 event and thus modifies the flood flows, by providing a bund to prevent flood water impacting on the quarrying and landfilling activities. This modification result in negligible impact to flooding flows.

5. How is the proposal likely to affect habitat connectivity?

a) creates a barrier to fauna movement

The quarry footprints are designed to retain a vegetated corridor along the ridgeline and as a result the proposed activity does not create a barrier to fauna movement.

b) removes remnant vegetation or wildlife corridors

As discussed previously, the proposed activity has been configured with the aim to avoid areas containing native vegetation. Of these, some areas will be retained and managed, while others will persist in the study area.

c) modifies remnant vegetation or wildlife corridors

The clearing of existing camphor laurel dominated vegetation on the eastern side of the ridge will reduce the width of the existing wildlife corridor along the ridgeline from the current width of between approximately 140 m to >200 m, to approximately 100 m wide beside the quarry development footprint.

6. How is the proposal likely to affect critical habitat?

a) removes or modifies key habitat features

No critical habitat is listed for any of the rainforest plants with the potential to occur within the study area.

b) affects natural revegetation or recolonisation of existing species following disturbance

The proposed activity will not affect any revegetation or recolonisation of any critical habitat.

c) introduces weeds, vermin or feral species

Survey results indicate that the study area currently contains a range of weeds, vermin and feral species, potentially due to its location adjacent to the existing Stotts Creek RRC and historical clearing and disturbance. The proposed activity will not result in the introduction of weeds, vermin or feral species that will impact upon the critical habitat in Stotts Island Nature Reserve.

Stotts Island Nature Reserve is currently within 2.5 km of the existing Stotts Creek RRC. The new landfill and quarry developments in the study area will be subject to stringent management practices, and as such are not expected to introduce weeds, vermin or feral species to Stotts Island Nature Reserve.

d) generates or disposes of solid, liquid or gaseous waste

The proposed activity includes three landfill sites which will involve the disposal of solid wastes.

The landfill has been designed such that emissions are contained or managed. The operations associated with the proposed activity will be subject to strict management and are unlikely to impact upon critical habitat at Stott's Island Nature Reserve.

e) uses pesticides, herbicides or other chemicals

Use of pesticides or herbicides would be utilised in the study area in accordance with a pest species management plan. It is anticipated that these would be utilised to control minor weed infestations or similar, and as such are not expected to result in any impacts upon the critical habitat at Stotts Island Nature Reserve.

Conclusion

The proposed activity is not expected to impact upon the viability of any of the threatened rainforest plants such that they are placed at risk of extinction.

Part 3A AIA2 Glossy Black-cockatoo - *Calyptorhynchus lathami*

Overview

The glossy black-cockatoo is listed as a vulnerable species in NSW. It feeds almost exclusively on seeds of *Allocasuarina* species, which generally occur in open eucalypt forest and woodland. and nests in large hollow-bearing trees. The species is distributed from southeastern Queensland and extends inland to as far west as the Riverina district of NSW (Robinson, 2004).

Areas of eucalypt open forest are mapped within the study area. Forest oak (*Allocasuarina torulosa*) were very sparsely distributed in these areas and no evidence of feeding of the species (i.e. chewed cones) was found. The entire area of eucalypt open forest (wet and dry sclerophyll) will persist.

No hollow-bearing trees or foraging habitat of the glossy black-cockatoo will be removed as a result of the proposed activity, however the species is being assessed due to the likely observation of the species overflying the study area during the survey.

Adverse Impact Assessment for the Glossy Black-cockatoo

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

a) displaces or disturbs threatened species and/or populations

The proposed activity is not expected to displace or disturb any individual glossy black-cockatoos. The possible record of the species was overflying the study area and as such the study area may not be utilised by the species.

Operational impacts associated with the proposed activity that could disturb the species such as blasting and drilling are presently in operation in the region

b) disrupts the breeding cycle

The glossy black-cockatoo is not known to breed in the study area. The species nests in hollow-bearing trees. Few hollow-bearing trees were recorded in proximity to the development footprint during the survey and none will be removed as a result of the proposed activity. There was only

a low density of *Allocasuarina* trees in the study area, none of which occur within the development footprint, and as such there is a reasonably low likelihood that the species would nest in the study area given the limited feeding resources available. As such, the breeding cycle of the species is not expected to be disrupted as a result of the proposed activity.
c) disturbs the dormancy period
The glossy black-cockatoo is not reported to have a dormancy period.
d) disrupts roosting behaviour
The species was not observed roosting in the study area. It is not expected that the proposed activity will disrupt the roosting behaviour of the species.
e) changes foraging behaviour
Marginal foraging habitat for the species occurs within the study area, none of which will be cleared as a result of the activity. Areas that the species is more likely to utilise such as the eucalypt open forest containing low density *Allocasuarina torulosa* will not be cleared as a result of the proposed activity.
f) affects migration and dispersal ability
The proposed activity will not affect the migration or dispersal ability of the glossy black-cockatoo.
g) disrupts pollination cycle
The proposed activity will not affect pollination cycles in the region.
h) disturbs seedbanks
The proposed activity will disturb the seedbank in the development footprint only. This is unlikely to result in any impacts to the species.
i) disrupts recruitment
The proposed activity will not disturb recruitment of the glossy black-cockatoo or their feed species.
j) affects the interaction between threatened species and other species in the community (e.g. pollinators, host species, mychorrizal associations).
The proposed activity is not expected to have any impacts upon pollination, host species or mycorrhizal associations that are important to habitat tree species.
2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
a) disturbs any permanent, semi-permanent or ephemeral water bodies;
The footprint of the proposed activity will disturb ephemeral watercourses that are derived from the slopes of the Condong Range. Disturbance of these relates to drainage lines from the range to the lowland area in the immediate vicinity of the development footprints and will not have any specific impacts upon the species habitat. Stormwater that presently flows in the ephemeral drainage lines will be redirected around the development footprint

b) degrades soil quality;
See equivalent factor in Part 3A AIA1
c) clears or modifies native vegetation;
The proposed development footprint has been configured to principally avoid clearing of areas of native vegetation. Areas of native vegetation will be retained and managed on Lot 1 DP1159352, while other areas will persist in the study area (as well in the wider area).
d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread
See equivalent factor in Part 3A AIA1
e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat
There were only three trees with hollows identified in the study area. None of these will be impacted as a result of the proposed activity. As such, no key habitat features will be removed or disturbed as a result of the proposed activity. Low density of *Allocasuarina torulosa* was recorded in native vegetation areas, and these will not be removed or disturbed as a result of the proposed activity.
f) affects natural revegetation and recolonisation of existing species following disturbance
The proposed activity will not impact upon natural revegetation and recolonisation of existing species outside of the development footprint after disturbance (although it is noted that recolonisation with the existing vegetation dominated by camphor laurel is undesirable). Assisted natural revegetation will occur in native areas proposed to be retained and managed in the study area. As previously indicated, landfills are not typically rehabilitated with vegetation with significant root systems that would penetrate the capping, and as such rehabilitation in the development footprints would comprise only shallow-rooted species.
3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
The glossy black-cockatoo is not at the limit of its distribution in the Tweed Shire.
Conclusion
The proposed activity is unlikely to have impacts upon the foraging or nesting habitat of the glossy black-cockatoo. Areas that contain low density of feed trees will be retained in the study area. As such the proposed activity is not expected to have adverse impacts upon the species that they are placed at increased risk of extinction.

Part 3A AIA3 Coxen's Fig-parrot - *Cyclopsitta diophthalma coxeni*

Overview

The Coxen's fig-parrot is a cryptic species that occurs within lowland and upland vegetation containing fig trees but also feeds on other fruiting rainforest species. The species is thought to have declined partly as a result of clearing of lowland subtropical rainforest. There have only been around 30 confirmed records of the species in north eastern NSW since 1970.

The species is reported to be superficially similar in appearance to several species of lorikeet, particularly the little lorikeet *Glossopsitta pusilla*, which was identified in the study area during the surveys (Coxen's Fig-Parrot Recovery Team. 2001). Although it is unlikely that the species occupies habitats in the study area, the species has been selected for assessment as a precautionary approach due to the record of the little lorikeet in the study area.

Adverse impact assessment for the Coxen's Fig Parrot

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

a) displaces or disturbs threatened species and/or populations

The species was not recorded from surveys, however small fragments of wet sclerophyll vegetation containing rainforest elements (including figs) are present in the north west of the study area (north western portion of Lot 1 DP1159352). The proposed activity has been configured to avoid clearing of this habitat.

Operational impacts associated with the proposed activity that could disturb the species such as blasting and drilling are presently in operation in the region, and the activity is thus not expected to disturb the species.

b) disrupts the breeding cycle

It is not known whether the Coxen's fig parrot breeds in the study area, although considered to be unlikely given the paucity of records of the species. No hollow-bearing trees (in which the species could nest) will be removed as a result of the proposed activity.

c) disturbs the dormancy period

The Coxen's fig parrot is not reported to have a dormancy period.

d) disrupts roosting behaviour

It is not expected that the proposed activity will disrupt the roosting behaviour of the species.

e) changes foraging behaviour

The proposed activity retains foraging habitat for the species, and is not expected to result in changes to the species foraging behaviour.

f) affects migration and dispersal ability

The proposed activity will not affect the migration or dispersal ability of the Coxen's fig parrot.

g) disrupts pollination cycle
The proposed activity will not affect pollination cycles of plant species in the study area.
h) disturbs seedbanks
See equivalent factor in Part 3A AIA2.
i) disrupts recruitment
The proposed activity will not disturb recruitment of the Coxen's fig-parrot or their feed species.
j) affects the interaction between threatened species and other species in the community (e.g. pollinators, host species, mychorrizal associations).
See equivalent factor in Part 3A AIA2.
2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
a) disturbs any permanent, semi-permanent or ephemeral water bodies;
See equivalent factor in Part 3A AIA2.
b) degrades soil quality;
See equivalent factor in Part 3A AIA1.
c) clears or modifies native vegetation;
See equivalent factor in Part 3A AIA2..
d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread
See equivalent factor in Part 3A AIA1.
e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat
No trees with hollows occur within the development footprint. The potential (albeit marginal) foraging habitat of this species in the form of wet sclerophyll vegetation with lowland rainforest elements will not be cleared as a result of the proposed activity.
f) affects natural revegetation and recolonisation of existing species following disturbance
See equivalent factor in Part 3A AIA2..
3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
The core range of the Coxen's fig parrot is from Gympie in south-east Queensland to the Richmond River in north-east New South Wales (Coxen's Fig-Parrot Recovery Team, 2001). As such it could be considered to be near to its southern distribution in the Tweed Shire.

4. How is the proposal likely to affect current disturbance regimes?
a) modifies the intensity and frequency of fires
See equivalent factor in Part 3A AIA1
b) modifies flooding flows
See equivalent factor in Part 3A AIA1
Conclusion
The Coxen's fig parrot was not identified from within the study area, however potential habitat exists that could provide foraging habitat for the species. The proposed activity does not impact directly upon any of the species preferred habitat, and as such is not expected to have adverse impacts upon the species such that they are placed at risk of extinction.

Part 3A AIA4 Little Lorikeet – Glossopsitta pusilla

Overview

The little lorikeet was listed as a vulnerable species in 2009. The known distribution of the species is from Cairns to Adelaide, and in NSW it has been recorded from the coast to the western slopes.

The species generally forages in dry open eucalypt open forest and woodland on nectar and pollen of profusely flowering eucalypts, however is known also to feed on melaleucas and mistletoes. The species nests in hollows with very small openings (ca. 3 cm), only occasionally in dead trees, and is thought to be nomadic.

As indicated previously, no hollow-bearing trees will be removed as a result of the proposed activity. Their preferred foraging habitat comprising dry eucalypt open forest vegetation will be retained and managed in the study area and will persist in the locality.

Adverse Impact Assessment for the Little Lorikeet

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?
a) displaces or disturbs threatened species and/or populations
The little lorikeet was recorded from surveys at NV2 adjacent to the eucalypt open forest. Foraging habitats in the immediate area will persist and as such the species is not expected to be displaced as a result of the proposed activity. Operational impacts associated with the proposed activity that could disturb the species such as blasting and drilling are presently in operation in the region, and the activity is thus not expected to disturb the species.
b) disrupts the breeding cycle
It is not known whether the little lorikeet breeds in the study area. No hollow-bearing trees will be removed as a result of the proposed activity.

c) disturbs the dormancy period
The little lorikeet is not reported to have a dormancy period.
d) disrupts roosting behaviour
The species was not observed roosting in the study area. It is not expected that the proposed activity will disrupt the roosting behaviour of the species.
e) changes foraging behaviour
The proposed activity retains foraging habitat for the species, and is not expected to result in changes to the species foraging behaviour.
f) affects migration and dispersal ability
The proposed activity will not affect the migration or dispersal ability of the little lorikeet.
g) disrupts pollination cycle
The proposed activity will not affect pollination cycles of plant species in the study area.
h) disturbs seedbanks
See equivalent factor in Part 3A AIA1.
i) disrupts recruitment
The proposed activity will not disturb recruitment of the little lorikeet or their feed species.
j) affects the interaction between threatened species and other species in the community (e.g. pollinators, host species, mychorrizal associations).
The proposed activity is not expected to have any impacts upon pollination, host species or mycorrhizal associations that are important for plant species on which the little lorikeet feeds.
2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
a) disturbs any permanent, semi-permanent or ephemeral water bodies;
See equivalent factor in Part 3A AIA2.
b) degrades soil quality;
See equivalent factor in Part 3A AIA2.
c) clears or modifies native vegetation;
The proposed activity will result in removal of vegetation that is dominated by exotic species. Areas of native vegetation will persist in the study area. These areas may be subject to bush regeneration to enhance their value for fauna species.
d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread
See equivalent factor in Part 3A AIA2

e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat

No hollow-bearing trees occur within the development footprint. As indicated above, the species preferred habitat of dry eucalypt open forest vegetation will be retained and managed in the study area and will persist in the locality.

f) affects natural revegetation and recolonisation of existing species following disturbance

The proposed activity will not impact upon natural revegetation and recolonisation of existing species outside of the development footprint after disturbance (although it is noted that recolonisation with the existing vegetation dominated by camphor laurel is undesirable). Assisted natural revegetation will occur in native areas proposed to be retained and managed in the study area. As previously indicated, landfills are not typically rehabilitated with vegetation with significant root systems that would penetrate the capping, and as such rehabilitation in the development footprints would comprise only shallow-rooted species.

3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The little lorikeet is not at the limit of its known distribution, which extends from Cairns to Adelaide.

4. How is the proposal likely to affect current disturbance regimes?

See Part 3A AIA1.

5. How is the proposal likely to affect habitat connectivity?

See Part 3A AIA1.

6. How is the proposal likely to affect critical habitat?

See Part 3A AIA1.

Conclusion

The little lorikeet was observed foraging in the study area The proposed activity will retain a large proportion of the vegetated areas in the study area, in particular those areas containing eucalypts will be retained. As no trees with hollows occur within the development footprint, nest sites are unlikely to be impacted upon. It is expected that the local population of little lorikeets would be able to persist in the study area and will not be placed at risk of extinction as a result of the proposed activity.

Part 3A AIA5 Rainforest Doves

Overview

The rose-crowned fruit-dove (*Ptilinopus regina*) was recorded from within Vegetation Type 3. This species and the wompoo fruit-dove (*Ptilinopus magnificus*) ('rainforest fruit-doves') have previously been recorded in close proximity to the study area. Both are expected to forage in the study area at least on an occasional basis.

Both rainforest fruit-dove species have a similar distribution on the coast and ranges from the Hunter River in NSW north to Cape York Peninsula. Both species inhabit similar habitat types, the rose-crowned fruit dove inhabits sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest and the wompoo fruit-doves inhabit rainforest, low elevation moist eucalypt forest and brush box forests. Both species feed on a range of fruits and are thought to be locally nomadic such that they can follow ripening fruit. The species form nests on tree branches or palms.

All vegetation within the study area could provide potential foraging habitat for both of the doves, as they also feed upon camphor laurel fruits.

Adverse Impact Assessment for the rainforest doves

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

a) displaces or disturbs threatened species and/or populations

Although neither species was recorded from within the study area, it expected that they would forage in the study area at least on occasion. Foraging habitat similar to that found in the study area is available throughout the region, although camphor laurels are being removed in a number of areas locally. Adequate foraging resources will persist in the study area for the species.

Operational impacts associated with the proposed activity that could disturb the species such as blasting and drilling are presently in operation in areas adjacent to the study area, and these are not expected to detrimentally impact upon the rainforest doves.

b) disrupts the breeding cycle

The proposed activity is not expected to disrupt the breeding cycle of the rainforest doves. The species utilises nests for breeding purposes, and as such could nest within any vegetated areas in the study area.

c) disturbs the dormancy period

The rainforest doves are not reported to have a dormancy period.

d) disrupts roosting behaviour

The rainforest doves are do not have fidelity to specific roosting sites. The proposed activity will remove vegetation from the development footprint. Vegetated areas outside this will be available for the species to roost and forage.

e) changes foraging behaviour
As indicated previously, the footprint will predominantly result in the removal of camphor laurel dominated vegetation on which the rainforest doves could forage. Similar vegetation including wet sclerophyll forest containing lowland rainforest elements including fig species (as well as camphor laurels) will be retained in the study area and will persist in the locality, and as such the species will be able to continue to utilise resources within the study area as necessary.
f) affects migration and dispersal ability
The proposed activity will not affect the dispersal ability of the threatened rainforest doves. Connectivity of vegetation in the study area will be maintained.
g) disrupts pollination cycle
The proposed activity will not affect pollination cycles of plant species in the study area.
h) disturbs seedbanks
See equivalent factor in Part 3A AIA1.
i) disrupts recruitment
The proposed activity will not disturb recruitment of the rainforest doves or their feed species outside of the development footprint.
j) affects the interaction between threatened species and other species in the community (e.g. pollinators, host species, mychorrizal associations).
See equivalent factor in Part 3A AIA1
2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
a) disturbs any permanent, semi-permanent or ephemeral water bodies;
See equivalent factor in Part 3A AIA1
b) degrades soil quality;
See equivalent factor in Part 3A AIA1
c) clears or modifies native vegetation;
See equivalent factor in Part 3A AIA1
d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread
See equivalent factor in Part 3A AIA1
e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat
An area of foraging habitat of the rainforest doves will be removed as a result of the proposed activity. Adequate foraging resources will persist in the study area and adjacent land such that the species is able to continue foraging in the local area.

f) affects natural revegetation and recolonisation of existing species following disturbance
See equivalent factor in Part 3A AIA1.
3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
The study area is not located near the limit of the distribution either of the rainforest doves.
4. How is the proposal likely to affect current disturbance regimes?
See Part 3A AIA1.
5. How is the proposal likely to affect habitat connectivity?
See Part 3A AIA1.
6. How is the proposal likely to affect critical habitat?
See Part 3A AIA1.
Conclusion
Although the proposed activity will result in the removal of an area potential foraging habitat for the threatened rainforest doves, adequate resources will be retained in the study area and persist in the locality in which the species will be able to forage. The proposed activity will not impact upon either species lifecycle, and as such is not expected to have adverse impacts upon the species such that they are placed at risk of extinction.

Part 3A AIA6 Collared Kingfisher – *Todiramphus chloris*

Overview

The collared kingfisher is distributed around northern Australia, from Shark Bay in Western Australia, to the mouth of the Clarence River in NSW. The species is predominantly recorded from the mouths of large coastal rivers and usually nests in or in close proximity to mangroves.

This species was observed near to drainage lines in the lower lying areas of the site during the surveys, and may occasionally forage in close proximity to these areas. Mangrove ecosystems which are the typical habitat of the species do not occur in the study area, and it is likely that the record may be of a transient individual rather than a permanent resident of the site. No areas of habitat typically utilised by this species will be removed as a result of the proposed activity, however an assessment has been undertaken due to the record of the species during the survey.

Adverse Impact Assessment for the Collared Kingfisher

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

a) displaces or disturbs threatened species and/or populations

No known habitat of the collared kingfisher occurs in the study area, however mangroves sporadically occur in the drains throughout the canefields. These habitats occur in the lower lying areas of the study area (although no mangroves were recorded). Lower lying areas will not be impacted as a result of the proposed activity.

Operational impacts associated with the proposed activity that could disturb the species such as blasting and drilling are presently in operation in or adjacent to the study area.

b) disrupts the breeding cycle

The proposed activity is unlikely to disturb any nest sites for the collared kingfisher.

c) disturbs the dormancy period

The collared kingfisher is not reported to have a dormancy period.

d) disrupts roosting behaviour

It is not expected that the collared kingfisher would select roosting sites within the camphor laurel dominated vegetation. Removal of this vegetation from within the development footprints is not expected to disrupt the roosting behaviour of the species.

e) changes foraging behaviour

The preferred food of the collared kingfisher is crabs, however the species will also take snails, shrimp, frogs and lizards. The proposed activity is not expected to result in any changes to the foraging behaviour of the collared kingfisher.

f) affects migration and dispersal ability

The proposed activity will not affect the migration or dispersal ability of the collared kingfisher.

g) disrupts pollination cycle

The proposed activity will not affect pollination cycles of plant species in the study area.

h) disturbs seedbanks

See equivalent factor in Part 3A AIA1.

i) disrupts recruitment

See equivalent factor in Part 3A AIA1.

j) affects the interaction between threatened species and other species in the community (e.g. pollinators, host species, mychorrizal associations).

See equivalent factor in Part 3A AIA1.

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
a) disturbs any permanent, semi-permanent or ephemeral water bodies;
The collared kingfisher may utilise ephemeral or semi-permanent watercourses in the lower lying areas of the site. These will not be disturbed as a result of the proposed activity.
b) degrades soil quality;
See equivalent factor in Part 3A AIA1.
c) clears or modifies native vegetation;
See equivalent factor in Part 3A AIA1.
d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread
See equivalent factor in Part 3A AIA1.
e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat
There were only two trees with hollows identified in the study area, none of which falls within the development footprint. Key foraging habitats typical of the species such as mangrove habitats do not occur within the study area.
f) affects natural revegetation and recolonisation of existing species following disturbance
See equivalent factor in Part 3A AIA1.
3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
The known distribution of the collared kingfisher extends around the northern coastline of Australia to the Clarence River mouth in NSW. As such the study area is reasonably close (within 200 km) to the limit of its distribution.
4. How is the proposal likely to affect current disturbance regimes?
See Part 3A AIA1.
5. How is the proposal likely to affect habitat connectivity?
See Part 3A AIA1.
6. How is the proposal likely to affect critical habitat?
See Part 3A AIA1.
Conclusion
Habitats in which the collared kingfisher typically forages do not occur within the study area. No potential nesting or breeding sites will be subject to impacts as a result of the proposed activity. As such the species is likely to persist in the study area. The proposed activity is not expected to have adverse impacts upon the species such that they are placed at risk of extinction.

Part 3A AIA7 Grass owl – *Typo capensis*

2.7.1 Overview

Grass owls occupy areas of long grass in grassy plains, swampy heath and sugar cane. Unlike many owl species, the grass owl rests by day on a trampled platform in a large tussock or other heavy vegetative growth known as a 'form'. The species also breeds on the ground in nests which are found in trodden grass. These are often accessed by tunnels through vegetation.

The grass owl was not detected during the field survey, however has been recorded locally and habitat in the lower lying areas of the site is likely to provide both foraging and breeding habitat for the species.

2.7.2 Adverse Impact Assessment for the Grass Owl

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

a) displaces or disturbs threatened species and/or populations

Potential grass owl nesting and foraging habitats occur in the lower lying areas of the study area. These areas predominantly occur outside of the development area and will not be directly impacted as a result of the proposed activity.

Operational impacts associated with the proposed activity that could disturb the species such as blasting and drilling are presently in operation in or adjacent to the study area. Lower lying areas of the site are currently maintained by slashing (or contain canefields), which may have previously displaced species from potential breeding sites.

b) disrupts the breeding cycle

The proposed activity is unlikely to disturb any nest sites of the grass owl.

c) disturbs the dormancy period

The grass owl is not reported to have a dormancy period.

d) disrupts roosting behaviour

The grass owl roosts in a 'form' on the ground and as such the proposed activity is unlikely to impact upon the species roosting behaviour.

e) changes foraging behaviour

The grass owl will be able to maintain current foraging behaviours. This will not be impacted by the proposed activity as all works will be undertaken during the day, outside of the species foraging time.

f) affects migration and dispersal ability

The proposed activity will not affect the migration or dispersal ability of the grass owl.

g) disrupts pollination cycle

The proposed activity will not affect pollination cycles of plant species in the study area.

h) disturbs seedbanks
See equivalent factor in Part 3A AIA1.
i) disrupts recruitment
See equivalent factor in Part 3A AIA1.
j) affects the interaction between threatened species and other species in the community (e.g. pollinators, host species, mychorrizal associations).
See equivalent factor in Part 3A AIA1.
2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
a) disturbs any permanent, semi-permanent or ephemeral water bodies;
See equivalent factor in Part 3A AIA1..
b) degrades soil quality;
See equivalent factor in Part 3A AIA1.
c) clears or modifies native vegetation;
See equivalent factor in Part 3A AIA1.
d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread
See equivalent factor in Part 3A AIA1.
e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat
As indicated above, key foraging habitat of the grass owl will not be impacted by the proposed activity.
f) affects natural revegetation and recolonisation of existing species following disturbance
See equivalent factor in Part 3A AIA1.
3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
The grass owl is known from all Australian states, and the study area is not at the limit of its known distribution.
4. How is the proposal likely to affect current disturbance regimes?
See Part 3A AIA1.
5. How is the proposal likely to affect habitat connectivity?
See Part 3A AIA1.

6. How is the proposal likely to affect critical habitat?

See Part 3A AIA1.

Conclusion

The grass owl potentially forages over the more open lower lying areas of the study area and could roost and nest in canefields or grass land in the lower lying areas of the study area. These areas predominantly occur outside of the development footprint and are currently subject to management measures including slashing and harvest of sugar cane. The proposed activity is not expected to impact upon the foraging behaviour or prey species of the grass owl, and as such is not considered likely to have an adverse impact upon the species such that they are placed at risk of extinction.

Part 3A AIA8 Spotted-tailed Quoll – *Dasyurus maculatus*

Overview

The spotted-tailed quoll is a carnivore that feeds upon a range of species including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits and insects. The species also feeds on carrion as well as domestic chickens.

The species is known from a variety of habitat types and utilise hollow-bearing trees, fallen logs and other similar sites as den sites. Females occupy a home range of up to 750 ha, while males can range up to 3500 ha. Individuals require an abundance of food and large areas of relatively intact vegetation through which to forage.

The species was not recorded during the field survey, however they are known to be relatively cryptic and trap shy, and the study area could form part of a home range of a species. A record from 2006 is located to the south west of the study area. Low numbers of hollow-bearing trees or fallen hollow logs were found within the development footprint, and as such potential den sites for the species (and a number of prey species) will not be impacted as a result of the proposed activity.

Adverse Impact Assessment for the Spotted-tailed Quoll

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

a) displaces or disturbs threatened species and/or populations

The spotted tailed quoll was not recorded from the study area during surveys however has previously been recorded in reasonably close proximity to the study area, and as such the study area is considered likely to be part of a home range of one or more individuals. The species may occasionally forage over the study area, however the proposed activity is not expected to result in any individuals being displaced.

Operational impacts associated with the proposed activity that could disturb the species such as blasting and drilling are presently in operation in or adjacent to the study area.

b) disrupts the breeding cycle
It is considered unlikely due to the lack of den sites that the species would utilise the study area as a breeding site. As such the proposed activity is not expected to disrupt the breeding cycle of the spotted-tailed quoll.
c) disturbs the dormancy period
The spotted-tailed quoll is not reported to have a dormancy period.
d) disrupts roosting behaviour
This factor is not relevant to the spotted-tailed quoll.
e) changes foraging behaviour
The proposed activity will result in the clearing of an area that may form part of a species home range. The removal of these areas is not expected to result in changes to the species foraging behaviour.
f) affects migration and dispersal ability
The proposed activity will not result in restrictions to movement of the species. Existing routes of migration and dispersal will be maintained.
g) disrupts pollination cycle
The proposed activity will not affect pollination cycles of plant species in the study area.
h) disturbs seedbanks
See equivalent factor in Part 3A AIA1.
i) disrupts recruitment
See equivalent factor in Part 3A AIA1.
j) affects the interaction between threatened species and other species in the community (e.g. pollinators, host species, mychorrizal associations).
See equivalent factor in Part 3A AIA1.
2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
a) disturbs any permanent, semi-permanent or ephemeral water bodies;
See equivalent factor in Part 3A AIA1.
b) degrades soil quality;
See equivalent factor in Part 3A AIA1.
c) clears or modifies native vegetation;
See equivalent factor in Part 3A AIA1.

d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread
See equivalent factor in Part 3A AIA1.
e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat
No hollow-bearing trees occur within the development footprint of the proposed activity and the vegetation to be removed provides only marginal habitat with low ground cover and limited denning sites. A relatively small area of marginal foraging habitat will be removed for the purposes of the proposed activity.
f) affects natural revegetation and recolonisation of existing species following disturbance
See equivalent factor in Part 3A AIA1.
3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
The spotted-tailed quoll (subsp. *maculatus*) is distributed from south east Queensland to Tasmania. Populations have declined and may comprise a series of disjunct populations. The study area is not near the limit of distribution of the species.
4. How is the proposal likely to affect current disturbance regimes?
See equivalent factor in Part 3A AIA1.
5. How is the proposal likely to affect habitat connectivity?
See equivalent factor in Part 3A AIA1.
6. How is the proposal likely to affect critical habitat?
See equivalent factor in Part 3A AIA1.
Conclusion
The study area may form a small part of the home range of a spotted-tailed quoll. The proposed activity will not remove any potential denning sites of the species or breeding locations of its prey species. In addition, connectivity will be retained along the western ridgeline. The proposed activity is not expected to result in adverse impacts to the spotted-tailed quoll such that the location population is placed at risk of extinction.

Part 3A AIA9 Microchiropteran Bats

2.9.1 Overview

Species considered within this Adverse Impact Assessment are:

- Little bentwing-bat – *Miniopterus australis*
- Eastern bentwing-bat – *Miniopterus schreibersii oceanensis*
- Eastern long-eared bat – *Nyctophilus bifax*
- Eastern false pipistrelle – *Falsistrellus tasmaniensis*

Although it is recognised that each of these species has individual breeding and foraging habitat requirements, the habitats within the areas of potential impact all comprise foraging habitat, and limited or no roosting and breeding habitat is available.

Little Bentwing-bat

The Little Bentwing-bat is found in coastal northeastern NSW and is distributed from Cape York in Queensland to Wollongong in NSW in moist eucalypt forest, rainforest or dense coastal banksia scrub. The little bentwing-bats roost by day in caves, tunnels and other man-made structures and sometimes tree hollows. The species forages at night beneath the canopy of densely vegetated habitats. The species breeds in maternity colonies within a specific nursery cave. The species goes into shallow hibernation in winter in the southern part of its range, but arouses frequently to hunt for food.

Eastern bentwing-bat

The eastern bentwing-bat has a coastal distribution from Cape York to near Adelaide. It roosts by day in caves, mines, stormwater channels or similar structures. The species forages over the tree canopy on small insects. In south eastern Australia the species hibernates throughout the winter months, but remain active through winter in the northern part of its range. The species breeds in maternity colonies within a specific nursery cave.

Eastern long-eared bat

Eastern long-eared bats are distributed across northern Australia extending north from south to the Clarence River area to Cape York and can be locally common in a range of habitats. The species has been found to roost in a range of situations and utilise a range of roost sites including communal roosts in tree hollows, dense foliage in rainforest, under bark or in shallow depressions on trees, amongst leaves of epiphytes and less often in man-made structures. Seasonal changes in roost selection have been recorded for the species.

Eastern false pipistrelle

The eastern false pipistrelle inhabits moist habitats, foraging within or above the tree canopy and is distributed from Tasmania north to southern Queensland in relatively low numbers. The species generally roosts in eucalypt hollows or under loose bark, however is also known to

inhabit man-made structures. Breeding of the species occurs from spring to early summer after hibernation in the winter months.

Adverse Impact Assessment for the Microchiropteran Bats

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

a) displaces or disturbs threatened species and/or populations

It is expected that microchiropteran bat species forage over the study area and may roost within suitable areas such as hollows or under loose bark of trees. The camphor laurel dominated vegetation that will principally be removed as a result of the proposed activity contains limited roosting habitat for the microchiropteran bat species. Foraging habitat will be retained in the site and persist in the local area, and as such the species are not expected to be displaced or disturbed as a result of the proposed activity.

Operational impacts associated with the proposed activity that could disturb the species such as blasting and drilling are presently in operation in or adjacent to the study area.

b) disrupts the breeding cycle

The two bent-wing bat species breed in maternity caves, none of which occur within the study area and as such will not be disrupted.

The eastern long-eared bat and the eastern false pipistrelle roost in a range of situations including tree hollows. No hollow-bearing trees will be removed as a result of the proposed activity, and as such the breeding cycle of these species is not expected to be disrupted.

c) disturbs the dormancy period

The bentwing-bats both have a dormancy period and seek cold roosts during winter in south eastern Australia, however in the Tweed region this may not be required by the species. This would not be disturbed as result of the proposed activity.

The eastern long-eared bat is not reported to have a dormancy period.

The eastern false pipistrelle is reported to hibernate during the winter months. No hollows in which this species would hibernate will be disturbed as a result of the proposed activity.

d) disrupts roosting behaviour

The roosting behaviour of the microchiropteran bat species is unlikely to be disrupted as a result of the proposed activity.

e) changes foraging behaviour

The proposed activity will result in the clearing of an area that could form part of the foraging habitat of the microchiropteran bat species. The removal of these areas will result in a reduction in the available vegetation within the site, however is not expected to result in changes to the species foraging behaviour. Adequate areas of foraging habitat will be retained in the site and persist in the locality.

f) affects migration and dispersal ability

The proposed activity will not result in restrictions to movement of the microchiropteran bat species.

g) disrupts pollination cycle
The proposed activity will not affect pollination cycles of plant species in the study area.
h) disturbs seedbanks
See equivalent factor in Part 3A AIA1.
i) disrupts recruitment
See equivalent factor in Part 3A AIA1.
j) affects the interaction between threatened species and other species in the community (e.g. pollinators, host species, mychorrizal associations).
See equivalent factor in Part 3A AIA1.
2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
a) disturbs any permanent, semi-permanent or ephemeral water bodies;
See equivalent factor in Part 3A AIA1.
b) degrades soil quality;
See equivalent factor in Part 3A AIA1.
c) clears or modifies native vegetation;
See equivalent factor in Part 3A AIA1.
d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread
See equivalent factor in Part 3A AIA1.
e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat
All of the microchiropteran bat species use a range of hollows in which to roost. No maternity caves or culverts will be impacted as a result of the development and a relatively small area of foraging habitat will be removed for the purposes of the proposed activity.
f) affects natural revegetation and recolonisation of existing species following disturbance
See equivalent factor in Part 3A AIA1.
3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
The distribution of the eastern long-eared bat extends south to Coffs Harbour, the little bent-wing bat extends along the coast south to Wollongong, and the eastern bentwing-bat has a coastal distribution throughout NSW and Queensland. The study area is not near the limit of the known distribution for any of these species.

4. How is the proposal likely to affect current disturbance regimes?
See equivalent factor in Part 3A AIA1.
5. How is the proposal likely to affect habitat connectivity?
See equivalent factor in Part 3A AIA1.
6. How is the proposal likely to affect critical habitat?
See equivalent factor in Part 3A AIA1.
Conclusion
As the proposed activity will not impact upon any breeding habitat of the bentwing-bats, and is unlikely to impact of breeding habitat of the eastern long-eared bat, and foraging habitat will be retained in the study area, it is not expected that any of the species would be adversely affected such that they are placed at risk of extinction.

Part 3A AIA10 Squirrel Glider – *Petaurus norfolcensis*

Overview

The squirrel glider is sparsely distributed in coastal and near coastal areas from western Victoria to North Queensland. The species is reported to prefer dry eucalypt forests, and is usually absent from closed forests The species requires abundant hollow-bearing tree resources in which to shelter and breed.

A number of petaurid gliders were observed during spotlighting in the study area (see Section 7.2.2 of report). All records of petaurid gliders were from within blackbutt open forest in the north west of the study area in the north western portion of Lot 1 DP1159352 and the ridgeline along the western boundary (Figure 7).

Squirrel gliders have not previously been recorded within a 5 km radius of the site. The closest Atlas of NSW Wildlife record is from 1992 near Mooball National Park just over 10 km south of the study area. The habitats in the study area are connected along the ridgelines to Mooball National Park.

Habitat for petaurid glider species will be retained in the study area. No hollow-bearing trees will be removed as a result of the proposed activity.

Adverse Impact Assessment for the Squirrel Glider

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

a) displaces or disturbs threatened species and/or populations

The preferred habitat of the squirrel glider in the study area would be within the eucalypt open forest patches (see Figure 6). These areas will be principally be retained and the proposed activity is not likely to displace the species from these habitats.

Operational impacts associated with the proposed activity that could disturb the species such as blasting and drilling are presently in operation in or adjacent to the study area, although these impacts will occur in closer proximity to the species habitats. Operations will only take place during the day and will not disturb foraging habit of the species.

b) disrupts the breeding cycle

The species breeds throughout the year. No hollow-bearing trees in which the species typically breeds will be cleared as a result of the proposed activity and as such the proposed activity is not expected to disrupt the breeding cycle of the species.

c) disturbs the dormancy period

The squirrel glider is not reported to have a dormancy period.

d) disrupts roosting behaviour

The squirrel glider shelters in tree hollows, with family groups utilising a number of hollows within their home range. As indicated above, no hollow-bearing trees will be removed as a result of the proposed activity.

e) changes foraging behaviour

The proposed activity is not expected to result in any changes to the foraging behaviour of the squirrel glider. Areas of potential foraging habitat will be retained in the site and persist in the locality.

f) affects migration and dispersal ability

The proposed activity will not affect the migration or dispersal ability of the squirrel glider. The vegetated ridgeline will be retained with a buffer of at least 30 m on the study area side of the ridgeline to maintain connectivity to other vegetated areas along the Condong Range. The haul road will be up to 30 m in width (although generally narrower than this), which is within the known gliding ability of the squirrel glider.

g) disrupts pollination cycle

The proposed activity will not affect pollination cycles of plant species in the study area.

h) disturbs seedbanks

See equivalent factor in Part 3A AIA1.

i) disrupts recruitment

See equivalent factor in Part 3A AIA1.

j) affects the interaction between threatened species and other species in the community (e.g. pollinators, host species, mychorrizal associations).
See equivalent factor in Part 3A AIA1.
2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
a) disturbs any permanent, semi-permanent or ephemeral water bodies;
See equivalent factor in Part 3A AIA1.
b) degrades soil quality;
See equivalent factor in Part 3A AIA1.
c) clears or modifies native vegetation;
See equivalent factor in Part 3A AIA1.
d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread
See equivalent factor in Part 3A AIA1.
e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat
There were only two trees with hollows identified in the study area. No hollow-bearing trees occur within the development footprint. Key foraging habitat will not be impacted by the proposed activity.
f) affects natural revegetation and recolonisation of existing species following disturbance
See equivalent factor in Part 3A AIA1.
3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
The squirrel glider is not at the limit of its known distribution, although according to the Atlas of NSW Wildlife, the species has only been recorded three times in the Tweed Shire.
4. How is the proposal likely to affect current disturbance regimes?
See equivalent factor in Part 3A AIA1.
5. How is the proposal likely to affect habitat connectivity?
See equivalent factor in Part 3A AIA1.
6. How is the proposal likely to affect critical habitat?
See equivalent factor in Part 3A AIA1.
Conclusion
Although very few records of this species exist in the Tweed Shire, the study area is within the

species known distribution and contains some habitats that could be utilised by the squirrel glider. The proposed activity does not result in the clearing of the species denning or breeding habitats in the form of hollow-bearing trees, and maintains connectivity to the eucalypt open forest along the ridgeline that will be retained in the study area. In addition, the proposed activity will not remove foraging habitat of the species, and as such is not considered likely to have adverse impacts upon the local population of the squirrel glider such that they are placed at risk of extinction.

Part 3A AIA11 Koala – *Phascolarctos cinereus*

Overview

Koalas are highly specialised and feed on eucalypt species. In the Tweed Shire, they are recognised as having a preference for the following eucalypt species:

- Tallowwood (*Eucalyptus microcorys*);
- Swamp mahogany (*E. robusta*);
- Forest red gum (*E. tereticornis*); and
- Small-fruited grey gum (*E. propinqua*).

Of these, only tallowwood and small-fruited grey gums were recorded from the study area. These species were reasonably sparsely distributed within the eucalypt open forest areas (see Figure 6).

It is reported that koalas will occupy a home range for the term of their life, and those individuals identified in the study area during surveys are likely to be part of a low density resident population in the Eviron area.

In order to retain this species habitat, the eucalypt open forest areas were considered to be a constraint to development, and as such the development footprint avoids areas of preferred habitat, although occasional eucalypts occur within the development footprint.

Adverse Impact Assessment for the Koala

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

a) displaces or disturbs threatened species and/or populations

The preferred habitat of the koala in the study area is likely to be within the eucalypt open forest patches (see Figure 6). These areas will primarily persist. The proposed activity is not likely to displace the species from these habitats. The species is considered likely to utilise camphor laurel habitat for thermal shelter. The proposed development will reduce the availability of these areas in the study area, however similar habitats remain available both within the study area and along the Condong Range.

Operational impacts associated with the proposed activity that could disturb the species such as blasting and drilling are presently in operation in or adjacent to the study area.

b) disrupts the breeding cycle

The proposed activity is not expected to disrupt the species breeding cycle.
c) disturbs the dormancy period
The koala is not reported to have a dormancy period.
d) disrupts roosting behaviour
The koala's preferred habitat of eucalypt open forests will predominantly persist in the study area.
e) changes foraging behaviour
The proposed activity is not expected to result in any changes to the foraging behaviour of the koala. Areas of potential foraging habitat will persist in the study area, although some eucalypts will be removed from the development footprint.
f) affects migration and dispersal ability
The proposed activity will not affect the migration or dispersal ability of the koala. The vegetated ridgeline will persist with a buffer of at least 30 m on the study area side of the ridgeline to maintain connectivity to other vegetated areas along the Condong Range.
g) disrupts pollination cycle
The proposed activity will not affect pollination cycles of plant species in the study area.
h) disturbs seedbanks
See equivalent factor in Part 3A AIA1.
i) disrupts recruitment
See equivalent factor in Part 3A AIA1.
j) affects the interaction between threatened species and other species in the community (e.g. pollinators, host species, mychorrizal associations).
See equivalent factor in Part 3A AIA1.
2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
a) disturbs any permanent, semi-permanent or ephemeral water bodies;
See equivalent factor in Part 3A AIA1.
b) degrades soil quality;
See equivalent factor in Part 3A AIA1.
c) clears or modifies native vegetation;
See equivalent factor in Part 3A AIA1.
d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread
See equivalent factor in Part 3A AIA1.

e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat
Key foraging habitat will not be impacted by the proposed activity.
f) affects natural revegetation and recolonisation of existing species following disturbance
See equivalent factor in Part 3A AIA1.
3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
The koala is not at the limit of its known distribution.
4. How is the proposal likely to affect current disturbance regimes?
See equivalent factor in Part 3A AIA1.
5. How is the proposal likely to affect habitat connectivity?
See equivalent factor in Part 3A AIA1.
6. How is the proposal likely to affect critical habitat?
See equivalent factor in Part 3A AIA1.
Conclusion
The footprints of the proposed activity have been configured to avoid areas of higher density koala foraging habitat and will not result in fragmentation of habitats. The proposed activity will result in removal of areas of camphor laurel dominated vegetation that may provide thermal shelter for the species, however large areas of similar habitats will persist in the locality. As such it is not expected that the proposed activity will result in adverse impacts to the local koala population such that they are placed at risk of extinction.

Part 3A AIA12 Grey-headed Flying-fox – *Pteropus poliocephalus*

Overview

The grey-headed flying-fox is found in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Three of these habitats exist in the study area, and the species was recorded during surveys in July foraging on flowering blackbutts in the study area. Flying-fox roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water and in vegetation with a dense canopy. No roosting sites were identified in the study area.

This species will travel up to 50 km to forage on the nectar and pollen of native trees, in particular species of *Eucalyptus*, *Melaleuca* and *Banksia*, and fruits of rainforest trees and vines. Some of these native plants occur in the study area and numerous grey-headed flying-foxes were recorded feeding on the nectar of eucalypts and banksias. This species is sensitive to the loss of key roosting and foraging resources, particularly winter and summer flowering species.

Adverse Impact Assessment for the Grey-headed Flying-fox

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

a) displaces or disturbs threatened species and/or populations

The grey-headed flying fox was recorded foraging within the study area. Foraging habitat similar to that found in the study area is available throughout the region, although camphor laurels are being removed in a number of areas locally. Foraging resources of the species will be retained and managed and will also persist in the study area and locality.

Operational impacts associated with the proposed activity that could disturb the species such as blasting and drilling are presently in operation in areas adjacent to the study area, however these only occur during the day time and no camp site occurs in the study area, and as such the species is unlikely to be impacted as a result of operational impacts.

b) disrupts the breeding cycle

No specific roosting or camp site was identified in the study area. The proposed activity is not expected to disrupt the breeding cycle of the grey-headed flying-fox.

c) disturbs the dormancy period

The grey-headed flying fox is not reported to have a dormancy period.

d) disrupts roosting behaviour

No specific roosting or camp site was identified in the study area.

e) changes foraging behaviour

As indicated previously, the footprint will predominantly result in the removal of camphor laurel dominated vegetation on which the grey-headed flying-fox may forage. Similar vegetation including wet sclerophyll vegetation with lowland rainforest elements including fig species (as well as camphor laurels) will largely persist in the study area, and as such the species will be able to continue to utilise resources within the study area as necessary.

f) affects migration and dispersal ability

The proposed activity will not affect the dispersal ability of the grey-headed flying-fox. The species is highly mobile.

g) disrupts pollination cycle

The proposed activity will not affect pollination cycles of plant species in the study area.

h) disturbs seedbanks

See equivalent factor in Part 3A AIA1.

i) disrupts recruitment

The proposed activity will not disturb recruitment of feed species of the grey-headed flying-fox.

j) affects the interaction between threatened species and other species in the community (e.g. pollinators, host species, mychorrizal associations).

See equivalent factor in Part 3A AIA1

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
a) disturbs any permanent, semi-permanent or ephemeral water bodies;
See equivalent factor in Part 3A AIA1
b) degrades soil quality;
See equivalent factor in Part 3A AIA1
c) clears or modifies native vegetation;
See equivalent factor in Part 3A AIA1
d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread
See equivalent factor in Part 3A AIA1
e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat
An area of potential foraging habitat of the grey-headed flying-fox will be removed as a result of the proposed activity. Adequate foraging resources will persist in the study area and adjacent land such that the species is able to continue foraging in the local area.
f) affects natural revegetation and recolonisation of existing species following disturbance
See equivalent factor in Part 3A AIA1.
3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
The study area is not located near the limit of distribution of the grey-headed flying-fox.
4. How is the proposal likely to affect current disturbance regimes?
See equivalent factor in Part 3A AIA1.
5. How is the proposal likely to affect habitat connectivity?
See equivalent factor in Part 3A AIA1
6. How is the proposal likely to affect critical habitat?
See equivalent factor in Part 3A AIA1
Conclusion
The proposed activity will not impact upon a maternity site of the grey-headed flying fox, and a small area of marginal foraging habitat will be removed as a result of the proposed activity. As such, it is not considered likely that the proposed activity would have an adverse impact upon the species such that they would be placed at risk of extinction in the local area.

Part 3A AIA13 Three-toed snake-tooth skink – *Coeranoscincus reticulatus*

Overview

The three-toed snake-tooth skink is found in rainforest and occasionally moist eucalypt forest. The species lives in loose soil, leaf litter and rotting logs, and feeds on earthworms and beetle grubs.

Potential habitat of the species occurs predominantly in the north west of the study area (north western portion of Lot 1 DP1159352) and the species has previously been recorded in fauna surveys farther to the west of the study area. Potential habitat of the species will predominantly persist in the study area.

Adverse Impact Assessment for the Three-toed Snake-tooth Skink

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

a) displaces or disturbs threatened species and/or populations

Although the three-toed snake-tooth skink was not recorded in the study area, potential foraging habitat occurs in the north west of the study area in the north western portion of Lot 1 DP1159352, adjacent to the location of the haul road. The footprint of this has been designed such that it avoids most of this species habitat. The activity however is not expected to displace the three-toed snake-tooth skink if it occurs in the study area.

Operational impacts associated with the proposed activity that could disturb the species such as blasting and drilling are presently in operation in areas adjacent to the study area and are not expected to disturb the species.

b) disrupts the breeding cycle

The proposed activity is not expected to disrupt the breeding cycle of the three-toed snake-tooth skink as the proposed activity principally avoids this species habitat.

c) disturbs the dormancy period

It is not known whether the three-toed snake-tooth skink has a dormancy period, however as the proposed activity avoids this species habitat, it is not expected to result in disturbances to the species.

d) disrupts roosting behaviour

The species does not utilise roosting habitat.

e) changes foraging behaviour

The proposed activity is not expected to change the foraging behaviour of the three-toed snake-tooth skink.

f) affects migration and dispersal ability

Haul road will be constructed in the cleared area between the two patches of wet sclerophyll forest in the north western portion of Lot 1 DP1159352.

g) disrupts pollination cycle
This factor is not relevant for this species.
h) disturbs seedbanks
See equivalent factor in Part 3A AIA1.
i) disrupts recruitment
This factor is not relevant for this species.
j) affects the interaction between threatened species and other species in the community (e.g. pollinators, host species, mychorrizal associations).
See equivalent factor in Part 3A AIA1
2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
a) disturbs any permanent, semi-permanent or ephemeral water bodies;
See equivalent factor in Part 3A AIA1
b) degrades soil quality;
See equivalent factor in Part 3A AIA1
c) clears or modifies native vegetation;
See equivalent factor in Part 3A AIA1
d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread
See equivalent factor in Part 3A AIA1
e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat
As indicated the proposed activity principally avoids key foraging habitat of the species.
f) affects natural revegetation and recolonisation of existing species following disturbance
See equivalent factor in Part 3A AIA1.
3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
The three-toed snake-tooth skink occurs in the coast and ranges from the Macleay valley in NSW to south-eastern Queensland. The study area is not at the limit of this species distribution.
4. How is the proposal likely to affect current disturbance regimes?
See equivalent factor in Part 3A AIA1

5. How is the proposal likely to affect habitat connectivity?
a) creates a barrier to fauna movement
The three-toed snake-toothed skink is a relatively immobile species, and existing cleared areas may presently represent barriers to movement. As such the placement of the haul road along the existing cleared area between the patches of wet sclerophyll forest (in the north western portion of Lot 1 DP1159352) will be situating this over what could be an existing barrier for movement of this species. The proposed activity will not create any additional barriers to movement for this species.
b) removes remnant vegetation or wildlife corridors
See equivalent factor in Part 3A AIA1
c) modifies remnant vegetation or wildlife corridors
The proposed activity principally avoids clearing of wet sclerophyll or rainforest habitats that would provide potential habitat for this species.
6. How is the proposal likely to affect critical habitat?
See equivalent factor in Part 3A AIA1
Conclusion
The proposed activity may result in minor potential clearing of area of wet sclerophyll open forest which could provide potential habitat for the species if it were to occur in the study area. Other potential habitat for the species will be retained in the site or persist in the locality. As such the proposed activity is not likely to have an adverse impact on a population of the three-toed snake-toothed skink such that it would be placed at risk of extinction.

Part 3A AIA14 Mitchell's rainforest snail – *Thersites mitchellae*

Overview

The preferred habitats of the Mitchell's rainforest snail are remnant areas of lowland subtropical rainforest and swamp forest on alluvial soils. In addition, slightly higher ground around the edges of wetlands with palms and fig trees are particularly favoured habitat. The species requires a well-developed leaf litter layer for food, shelter and breeding, and an intact canopy.

Suitable habitat occurs in the study area adjacent to the northwestern boundary of the site in the areas of wet sclerophyll containing elements of lowland rainforest. The species was not recorded here during surveys, however it is expected that these areas could provide the habitat requirements of the species.

Critical habitat of the species has been declared at Stotts Island Nature Reserve, which is located approximately 2.5 ha to the north of the study area. The recovery plan for the species (NPWS, 2001) indicates that a population of several hundred snails occupies the 120 ha of lowland subtropical rainforest. Populations of the species are known to persist in narrow strips of remnant rainforest.

Adverse Impact Assessment for the Mitchell's Rainforest Snail

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?

a) displaces or disturbs threatened species and/or populations

Although the Mitchell's rainforest snail was not recorded in the study area, potential habitat occurs in the north west of the study area, adjacent to the location of the haul road. The footprint of this has been designed such that it avoids most of this species habitat. The activity however is not expected to displace the Mitchell's rainforest snail if it occurs in the study area.

Operational impacts associated with the proposed activity are not expected to disturb the species.

b) disrupts the breeding cycle

The proposed activity is not expected to disrupt the breeding cycle of the Mitchell's rainforest snail as the proposed activity principally avoids this species habitat.

c) disturbs the dormancy period

It is not known whether the Mitchell's rainforest snail has a dormancy period, however as the proposed activity principally avoids this species habitat, it is not expected to result in disturbances to the species.

d) disrupts roosting behaviour

The species does not utilise roosting habitat.

e) changes foraging behaviour

The proposed activity is not expected to change the foraging behaviour of the Mitchell's rainforest snail.

f) affects migration and dispersal ability

The species is only expected to utilise the wet sclerophyll vegetation with lowland rainforest elements and is not expected to migrate or disperse to other areas in the study area.

g) disrupts pollination cycle

Not relevant to this threatened species.

h) disturbs seedbanks

Not relevant to this threatened species.

i) disrupts recruitment

Not relevant to this threatened species.

j) affects the interaction between threatened species and other species in the community (e.g. pollinators, host species, mychorrizal associations).

Not relevant to this threatened species.

2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
a) disturbs any permanent, semi-permanent or ephemeral water bodies;
See equivalent factor in Part 3A AIA1
b) degrades soil quality;
See equivalent factor in Part 3A AIA1
c) clears or modifies native vegetation;
See equivalent factor in Part 3A AIA1
d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread
See equivalent factor in Part 3A AIA1
e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat
As indicated the proposed activity principally avoids key foraging habitat of the species.
f) affects natural revegetation and recolonisation of existing species following disturbance
See equivalent factor in Part 3A AIA1.
3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
The study area is not at the limit of this species distribution.
4. How is the proposal likely to affect current disturbance regimes?
See equivalent factor in Part 3A AIA1
5. How is the proposal likely to affect habitat connectivity?
See equivalent factor in Part 3A AIA1
6. How is the proposal likely to affect critical habitat?
See equivalent factor in Part 3A AIA1
Conclusion
Due to the proximity of the site to Stotts Island Nature Reserve and the presence of wet sclerophyll vegetation containing lowland rainforest species, there is a possibility that the species could occur in the study area. The proposed development footprints predominantly avoid any areas in which this species is likely to occur. In addition, the activity will not impact upon the critical habitat of the species. As such, it is not likely that the proposed activity would have an adverse impact upon the Mitchell's rainforest snail such that the species is placed at risk of extinction.

Part 3A AIA15 Lowland Rainforest

Overview

Two small patches of wet sclerophyll vegetation mapped as Vegetation Type 3 (Figure 6) to the north of the proposed haul road contain a variety of rainforest species consistent with the Scientific Determination for lowland rainforest. A precautionary approach has been taken to these patches, and as such, an assessment of adverse impacts for the endangered ecological community lowland rainforest has been undertaken. As indicated previously, the proposed haul road has been aligned to avoid clearing of these vegetation patches.

Note that another small patch of vegetation containing brush box and Bennetts ash mapped as Vegetation Type 7 was not considered to meet the Scientific Committee determination for the lowland rainforest EEC due to the high level of disturbance, lack of structural attributes, and the relatively low number of characteristic lowland rainforest species. Notwithstanding this, Vegetation Type 7 is unlikely to be required for the quarry footprint as it is to the north and east of the proposed haul road, and as such is likely to persist in the study area.

Adverse Impact Assessment for Lowland Rainforest

1. How is the proposal likely to affect the lifecycle of a threatened species and/or population?
Not relevant to the ecological community.
2. How is the proposal likely to affect the habitat of a threatened species, population or ecological community?
a) disturbs any permanent, semi-permanent or ephemeral water bodies;
See equivalent factor in Part 3A AIA1
b) degrades soil quality;
See equivalent factor in Part 3A AIA1
c) clears or modifies native vegetation;
The proposed activity has been designed to avoid areas of Vegetation Type 3. These small patches are presently fragmented from other areas and have a high edge to area ratio. As such, it is not expected that the proposed activity would result in additional edge effects such that the vegetation structure is modified.
d) introduces weeds, vermin or feral species or provides conditions for them to increase and/or spread
The vegetation community presently contains a variety of weeds both within, and in adjacent areas, and as such is unlikely to be further impacted as a result of the proposed activity.
e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat
See equivalent factor in Part 3A AIA1

f) affects natural revegetation and recolonisation of existing species following disturbance
See equivalent factor in Part 3A AIA1.
3. Does the proposal affect any threatened species or populations that are at the limit of its known distribution?
Not relevant to the ecological community.
4. How is the proposal likely to affect current disturbance regimes?
See equivalent factor in Part 3A AIA1
5. How is the proposal likely to affect habitat connectivity?
See equivalent factor in Part 3A AIA1
6. How is the proposal likely to affect critical habitat?
See equivalent factor in Part 3A AIA1
Conclusion
The proposed activity avoids clearing of Vegetation Type 3 which contains elements of lowland rainforest. Development of the haul road is not expected to compromise those areas, and as such is not expected to have adverse impacts on the endangered ecological community.

3 EPBC Act Assessments of Significance

Significant Impact Criteria

The EPBC Significant Impact Guidelines provide details with respect to Assessment of Significance for all matters of National Environmental Significance. Assessment criteria guidelines are slightly different for endangered or critically endangered species and vulnerable species. The key difference relates to the vulnerable species criteria considering 'important populations' of a species, whereas the endangered or critically endangered species criteria considers all populations of the species. In addition the vulnerable species criteria include consideration of whether an activity will *substantially* interfere with the recovery of the species, while the endangered or critically endangered species criteria considers any interference with the recovery of the species. Note that impacts have been assessed in relation to the Significant Impact Guidelines (DEWHA, 2009).

Definitions

Key definitions for the significant impact assessments from the Significant Impact Guidelines (DEWHA, 2009) are provided below.

Population of a species

An occurrence of the species in a particular area.
In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

- a geographically distinct regional population, or collection of local populations, or
- a population, or collection of local populations, that occurs within a particular bioregion.

Habitat critical to the survival of a species or ecological community

Areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal;
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- to maintain genetic diversity and long term evolutionary development; or
- for the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/ or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.

Important Population

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal;

- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

Vulnerable Species Assessments

EPBC AOS1 Vulnerable Rainforest Plants

Overview

Several vulnerable rainforest species have previously been recorded within a 5 km radius of the Eviron Road study area. Species listed as vulnerable under the EPBC Act for which habitats are available in the study area are listed in Table F1 and have been assessed below in one assessment of significance for 'vulnerable rainforest plants'. Although the patterns of germination of the rainforest plants may vary, their preferred habitat types are reasonably similar. None of the species were identified within the subject site (development footprint) of the study area.

The preferred habitat in the study area of the vulnerable rainforest plants would comprise the wet sclerophyll vegetation (type 3 and type 2a), although areas of camphor laurel dominated vegetation may also provide habitat that is suitable for recruitment of the species. The haul road concept design currently avoids clearing of Vegetation Type 3 and predominantly avoids clearing of Vegetation Type 2a. The quarry footprints will result in clearing of approximately 5.0 ha of camphor laurel closed forest, and 4.3 ha of camphor laurel open forest to open woodland.

- Yellow Satinheart - *Bosistoa transversa (*Syn*. Bosistoa selwynii*).
- Corokia – *Corokia whiteana.*
- Stinking cryptocarya – *Cryptocarya foetida*.
- Thorny pea – *Desmodium acanthocladum.*
- Red boppel nut – *Hicksbeachia pinnatifolia.*
- Rough-shelled bush nut – *Macadamia tetraphylla.*
- Clear milkvine – *Marsdenia longiloba.*
- Small-leaved hazelwood – *Symplocos baeuerlenii.*
- Red lilly pilly – *Syzygium hodgkinsoniae.*
- Durobby – *Syzygium moorei.*
- Minute Orchid - *Taeniophyllum muelleri.*

EPBC Act Assessment of Significance for Vulnerable Rainforest Plants

a) Will the activity lead to a long term decrease in the size of an important population of a species

Although none of the vulnerable rainforest plants were identified during the survey, areas of potential habitat occur in the study area in the wet sclerophyll open forest in the north west of the study area. In addition, other vegetated areas including areas of camphor laurel dominated vegetation could provide habitat for vulnerable rainforest plants.

None of the listed vulnerable rainforest species were identified during the survey from within the footprint of the proposed activity. Targeted threatened flora surveys will be undertaken in association with detailed development of the quarry footprints and adjacent areas to be retained. Should any individuals be identified investigations would be undertaken into potential for translocation into areas to be retained and managed. Although unlikely, should any of the vulnerable species occur within the development footprint it is not expected to lead to a long term decrease in the size of an important population of a species.

b) Will the activity reduce the area of occupancy of an important population

The concept design principally avoids clearing of areas of wet sclerophyll open forest containing rainforest species, although as indicated will result in a reduction in the area covered by camphor laurel, that could provide potential habitat for recruitment of threatened rainforest species.

c) Will the activity fragment an existing important population into two or more populations

The proposed activity does not result in fragmentation of any vegetation communities. Fragmentation has occurred in the study area historically, with a clearing of approximately 30 m width extending between the two types of wet sclerophyll vegetation on in the north western portion of Lot 1 DP1159352 (see Figure 6). The proposed activity will not fragment any population into two or more populations.

d) Will the activity adversely affect habitat critical to the survival of a species

No critical habitat is listed for any of the vulnerable rainforest plants.

The camphor laurel dominated vegetation within the development footprints is not recognised as being 'habitat critical to the survival of a species'. Although it is recognised that camphor laurel may provide habitat in which vulnerable rainforest species could be recruited, .

e) Will the activity disrupt the breeding cycle of an important population

As indicated, none of the listed vulnerable rainforest species were identified during the survey from within the footprint of the proposed activity. Targeted threatened flora surveys will be undertaken in association with detailed development of the quarry footprints and adjacent areas to be retained. Should any individuals be identified investigations would be undertaken into potential for translocation into areas to be retained and managed. Breeding cycles of a particular species would be addressed in the event that a population is identified and disruption to this avoided.

f) Will the activity modify destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The activity will remove vegetation from the development footprint. Much of this area has been previously cleared or is dominated by camphor laurels.

The proposed activity will not result in changes to the environment such that vegetation communities that will persist in the study area are impacted such that there is a decline in any vulnerable rainforest plants that may be present in the locality.

g) Will the activity result in invasive species that are harmful to a threatened species becoming established in a threatened species habitat

Several invasive weed species currently dominate vegetation in the study area, including within those areas of preferred habitat of the vulnerable rainforest plants. The proposed activity is not expected to result in any additional invasive species becoming established in the study area.

Segregated green organic waste will continue to be processed at Stotts Creek and will not be disposed of within the landfills at Eviron Road. As such the risk of introduction of invasive species to the study area will not be increased. Vegetation and weeds in the study area are likely to be more actively managed on the site as part of an overall management plan for the activity.

h) Will the activity introduce disease that may cause the species to decline

It is considered that there is a low risk of introduction of disease as a result of the activity. The landfills will only accept solid waste class one and will be fully contained and managed as per an approved landfill environmental management plan. As such, wastes will be managed such that any potential for the introduction of disease will be minimised. It is unlikely therefore that the activity could result in a decline in the vulnerable rainforest plants as a result of disease.

i) Will the activity interfere substantially with the recovery of a species

Impacts associated with the proposed activity are unlikely to interfere with the recovery of any of the vulnerable rainforest plants.

Conclusion

Based upon the above assessment, it is not expected that the proposed activity would have a significant impact upon any of the vulnerable rainforest plants. Recommendations provided in the ecological assessment to reduce potential impacts of the proposed activity should be observed. These include:

- Targeted threatened flora surveys in association with detailed development of the quarry footprints and adjacent areas to be retained.
- Development of management strategies including investigation into potential for translocation into areas to be retained and managed.
- Management of wet sclerophyll vegetation in the north western portion of Lot 1 DP1159352.

EPBC AOS2 Grey-headed Flying-fox – *Pteropus poliocephalus*

Overview

An overview of the Grey-headed flying fox is provided in Section 2 Part 3A 13.

Assessment of Significance for the Grey-headed Flying-fox (Vulnerable)

a) Will the activity lead to a long term decrease in the size of an important population of a species

The proposed activity will result in the removal of vegetation from the development footprint. These areas are principally comprised of camphor laurel dominated vegetation on which the grey-headed flying-fox forages at least on occasion. These habitats are common within the region, including within reserved areas, and it is not expected that the removal of vegetation from the development footprint will result in a long term decrease in the size of the population of the grey-headed flying-fox in the local area.

b) Will the activity reduce the area of occupancy of an important population

The proposed activity will result in a reduction in the foraging area available for this species. Large areas of similar habitat exist throughout the locality. The area of occupancy of the local population will not be reduced.

c) Will the activity fragment an existing important population into two or more populations

The proposed activity will not fragment the population of this highly mobile species.

d) Will the activity adversely affect habitat critical to the survival of a species

No critical habitat is listed for the grey-headed flying-fox.

Roosting sites and associated foraging habitat are critical to the survival of this species. Although an area of foraging habitat will be removed as a result of the proposed activity, large areas of similar habitats will persist in the region, including within conservation reserves. No breeding habitat occurs in the study area.

The proposed activity will not adversely impact upon habitat critical to the survival of the grey-headed flying-fox.

e) Will the activity disrupt the breeding cycle of an important population

The study area is not a grey-headed flying-fox maternity roost site, and the activity will therefore not affect the breeding cycle of the grey-headed flying-fox.

f) Will the activity modify destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The activity will remove vegetation from the development footprint only. Much of this area has been previously cleared or is dominated by camphor laurels. The proposed activity will not result in changes to the environment such that vegetation communities that persist in the study area will be modified or isolated.

In the context of the large areas of similar habitat that will persist in the study area and areas reserved within surrounding areas, the proposed activity is unlikely to result in a decline in the grey-headed flying-fox.

g) Will the activity result in invasive species that are harmful to a threatened species becoming established in a threatened species habitat

Several invasive weed species currently dominate vegetation in the study area. The proposed development is not expected to result in any further invasive species becoming established in the study area. In addition, segregated green organic waste will continue to be processed at Stotts Creek and not disposed of within the landfills at Eviron Road. As such the risk of introduction of invasive species will be reduced. Vegetation and weeds in the study area are likely to be more actively managed on the site as part of an overall management plan for the activity.

h) Will the activity introduce disease that may cause the species to decline

The proposed activity will not result in the introduction of diseases that would cause a decline in the grey-headed flying-fox.

i) Will the activity interfere substantially with the recovery of a species

As the proposed activity will not impact upon the species maternity sites and will result in the removal of only a small area of the species foraging habitat, the activity is not expected to substantially interfere with the recovery of the grey-headed flying-fox.

Conclusion

Based upon the above assessment, it is not expected that the proposed activity will have a significant impact upon any of the grey-headed flying-fox. Recommendations provided in the ecological assessment to reduce potential impacts of the proposed activity should be observed.

EPBC AOS3 Three-toed snake-tooth skink – *Coeranoscincus reticulatus*

Overview

An overview of the three-toed snake-toothed skink is provided in Section 2 Part 3A AIA14.

Assessment of Significance for the Three-toed Snake-tooth Skink

a) Will the activity lead to a long term decrease in the size of an important population of a species

The three-toed snake-tooth skink was not recorded during the survey, however potential habitat (wet sclerophyll vegetation) occurs in the study area mapped as Vegetation Type 3. The potential habitat of the species will persist in the study area, and as such it is not expected that the proposed activity will result in a decrease in the size of a population of this species.

b) Will the activity reduce the area of occupancy of an important population

The development footprint has been configured such that it avoids the preferred habitats in which this species could occur, and as such is not expected to reduce the area that could be occupied by a population of this species.

c) Will the activity fragment an existing important population into two or more populations

Habitats in which this species could occur are presently fragmented and the proposed activity will not result in further fragmentation of these habitats.

d) Will the activity adversely affect habitat critical to the survival of a species

No critical habitat is listed for the three-toed snake-tooth skink.

As indicated in (b) habitats likely to be important for this species have been principally avoided and as such will not adversely affect any habitat critical to this species survival.

e) Will the activity disrupt the breeding cycle of an important population

As indicated, the proposed activity avoids areas of this species preferred habitat, and as such the breeding cycle of the three-toed snake-tooth skink is not expected to be disrupted.

f) Will the activity modify destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The activity will remove vegetation from the development footprint only. This will not decrease the availability of the species preferred habitat. In addition, the proposed activity will not isolate or decrease the quality of the habitat that will persist in the study area. The species is not expected to decline as a result of the proposed activity.

g) Will the activity result in invasive species that are harmful to a threatened species becoming established in a threatened species habitat

Several invasive weed species currently dominate vegetation in the study area. The proposed development is not expected to result in any further invasive species becoming established in the study area. In addition, segregated green organic waste will continue to be processed at Stotts Creek and not disposed of within the landfills at Eviron Road. As such the risk of introduction of invasive species will be reduced. Vegetation and weeds in the study area are likely to be more actively managed on the site as part of an overall management plan for the activity.

h) Will the activity introduce disease that may cause the species to decline

The risk of introduction of disease as a result of the activity that could result in a decline in the three-toed snake-tooth skink is considered low.

The landfills will operate as per an approved landfill environmental management plan, and wastes will be managed such that any potential for disease will be minimised.

i) Will the activity interfere substantially with the recovery of a species

As the proposed activity principally avoids this species habitat, it is not expected to impact upon a population and therefore would not interfere substantially with the recovery of the three-toed snake-toothed skink.

Conclusion

Based upon the above assessment, it is not expected that the proposed activity will have a significant impact upon any of the three-toed snake-toothed skink. Recommendations provided in the ecological assessment to reduce potential impacts of the proposed activity should be observed.

Endangered Species Assessments

EPBC AOS4 Endangered Rainforest Plants

As for the vulnerable rainforest plants, endangered rainforest plants identified in Table F1 have been assessed in one Assessment of Significance. None of the species were identified within the subject site (development footprint) of the study area, however as indicated, this would be subject to target surveys during detailed design.

Species considered in this assessment are:

- *Davidsonia jerseyana* - Davidson's Plum
- *Davidsonia johnsonii* - Smooth Davidson's Plum
- *Diospyros mabacea* - Red-fruited Ebony
- *Diploglottis campbellii* - Small-leaved Tamarind
- *Endiandra floydii* - Floyd's Walnut
- *Gossia fragrantissima* -Sweet Myrtle
- *Ochrosia moorei* - Southern Ochrosia
- *Randia moorei* - Spiny Gardenia

The endangered rainforest plants have habitat requirements consistent with those described for the vulnerable rainforest plants in Section 2.1.1.

3.1.1 EPBC Act Assessment of Significance for Endangered Rainforest Plants

1. Will the activity lead to a long term decrease in the size of a population of a species

Although none of the endangered rainforest plants were identified during the survey, areas of potential habitat occur in wet sclerophyll open forest, in the north west of the study area. In addition, other vegetated areas including areas of camphor laurel dominated vegetation could provide habitat for endangered rainforest plants.

As indicated previously, no listed endangered plants were identified during the survey from within the footprint of the proposed activity. Targeted threatened flora surveys will be undertaken in association with detailed development of the quarry footprints and adjacent areas to be retained. Should any individuals be identified investigations would be undertaken into potential for translocation into areas to be retained and managed. Although unlikely, should any of the vulnerable species occur within the development footprint it is not expected to lead to a long term decrease in the size of an important population of a species.

As no threatened species were identified from within the footprint of the proposed activity, it is not expected to lead to a long term decrease in the size of a population of a species.

2. Will the activity reduce the area of occupancy of the species

The potential habitat areas for endangered rainforest plants are indicated above. The footprint of the proposed activity will principally reduce the area of camphor laurel dominated vegetation in which the endangered rainforest plants could occur. As none of the species were recorded, it is not expected that the activity will result in a reduction in the area of occupancy of a population.

3. Will the activity fragment an existing population into two or more populations

The proposed activity does not result in fragmentation of any vegetation communities. Fragmentation has occurred in the study area historically, with an existing clearing of approximately 30 m width extending between the two types of wet sclerophyll vegetation in the north western portion of Lot 1 DP1159352 (see Figure 6). The proposed activity will not fragment any population into two or more populations.

4. Will the activity adversely affect habitat critical to the survival of a species

No critical habitat is listed for any of the endangered rainforest species.

The species are known to prefer a range of habitats including lowland subtropical rainforest and moist sclerophyll forest such as are mapped in the north west of the study area. The expected impacts upon this habitat associated with the activity are not expected to adversely impact on habitat that is critical to the endangered rainforest plants.

5. Will the activity disrupt the breeding cycle of a population

The activity will not result in disruption to the breeding cycles of any of the endangered rainforest plants.

6. Will the activity modify destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The activity will remove vegetation from the development footprint. Much of this area has been previously cleared or is dominated by camphor laurels.The proposed activity will not result in changes to the environment such that vegetation communities are modified or isolated however will slightly decrease the availability of habitat.

7. Will the activity result in invasive species that are harmful to a critically endangered or endangered species becoming established in a critically endangered or endangered species' habitat

Several invasive weed species currently dominate vegetation in the study area. The proposed development is not expected to result in any further invasive species becoming established in the study area, in particular within the lowland rainforest or the wet sclerophyll habitats.

Segregated green organic waste will continue to be processed at Stotts Creek and not disposed of within the landfills at Eviron Road. As such the risk of introduction of invasive species to the study area will not be increased. Vegetation and weeds in the study area are likely to be more actively managed on the site as part of an overall management plan for the activity.

8. Will the activity introduce disease that may cause the species to decline
The risk of introduction of disease as a result of the activity that could result in a decline in any species of endangered rainforest plant is considered low. The landfills will only accept solid waste class one and will be fully contained and managed as per an approved landfill environmental management plan. As such, wastes will be managed such that any potential for the introduction of disease will be minimised.
9. Will the activity interfere with the recovery of a species
The proposed activity will not interfere with the recovery of any of the endangered rainforest plants.
Conclusion
Based upon the above assessment, it is not expected that the proposed activity will have a significant impact upon any of the endangered rainforest plants Recommendations provided in the ecological assessment to reduce potential impacts of the proposed activity should be observed.

EPBC AOS5 Coxen's Fig-parrot - Cyclopsitta diophthalma coxeni

Overview

An overview of the Coxen's fig-parrot is provided in Part 3A AIA4 in Section 2.

EPBC Act Assessment of Significance for the Coxen's Fig Parrot

a) Will the activity lead to a long term decrease in the size of a population of a species

Although the Coxen's fig parrot was not identified during surveys, potential habitat for the species (the wet sclerophyll vegetation types that contain elements of lowland rainforest) is present in the northwest of the study area. The areas of camphor laurel dominated vegetation could also provide habitat for the species.

Clearing and operational aspects of the activity are not expected to directly impact upon the species, no hollow-bearing trees will be removed as a result of the proposed activity. The activity is not expected to lead to a long term decrease in a population of the species should it inhabit the study area.

b) Will the activity reduce the area of occupancy of the species

The footprint of the proposed activity will principally reduce the area of camphor laurel dominated vegetation. The proposed activity may result in a relatively small reduction in the potential foraging area for this species in the study area, although large areas of similar habitats will persist in the local area.

c) Will the activity fragment an existing population into two or more populations

The proposed activity does not result in fragmentation of any vegetation communities. Fragmentation has occurred in the study area historically, with an existing clearing of approximately 30 m width extending between the two types of wet sclerophyll vegetation in the north western portion of Lot 1 DP1159352 (see Figure 6). The proposed activity will not fragment any population into two or more populations.

d) Will the activity adversely affect habitat critical to the survival of a species

No critical habitat is listed for the Coxen's fig parrot.

The species is reported to prefer habitats containing fig trees. In the study area, this habitat is present in the wet sclerophyll forest containing lowland rainforest elements in the north west of the study area (north western portion of Lot 1 DP1159352). Clearing for the haul road will avoid clearing of fig trees.

The species is thought to thought to nest in high trees within or near the edge of rainforest, in a nest chamber excavated on the underside of a dead or decaying limb or trunk in a living or dead tree (Coxen's Fig-Parrot Recovery Team, 2001). No hollow-bearing trees will be removed as a result of the proposed activity.

The impacts upon habitats associated with the activity are not expected to adversely impact on habitat that is critical to the Coxen's fig parrot.

e) Will the activity disrupt the breeding cycle of a population

The activity will not result in disruption to the breeding cycle of the Coxen's fig parrot.

f) Will the activity modify destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The activity will remove vegetation from the development footprint. Much of this area has been previously cleared or is dominated by camphor laurels. The proposed activity avoids clearing of this species potential habitat.

The proposed activity will not result in changes to the environment such that vegetation communities are modified or isolated.

g) Will the activity result in invasive species that are harmful to a critically endangered or endangered species becoming established in a critically endangered or endangered species' habitat

Several invasive weed species currently dominate vegetation in the study area. The proposed development is not expected to result in any further invasive species becoming established in the study area, in particular within the lowland rainforest habitats.

Segregated green organic waste will continue to be processed at Stotts Creek and not disposed of within the landfills at Eviron Road. As such the risk of introduction of invasive species to the study area will not be increased. Vegetation and weeds in the study area are likely to be more actively managed on the site as part of an overall management plan for the activity.

It is expected that species such as foxes, feral cats and known that black rats and cane toads occupy or forage within vegetation in the study area, and as such the activity is not expected to introduce any other species that may impact upon species habitats.

h) Will the activity introduce disease that may cause the species to decline

The risk of introduction of disease as a result of the activity that could result in a decline in any species of endangered rainforest plant is considered low.

The landfills will only accept solid waste class one and will be fully contained and managed as per an approved landfill environmental management plan. As such, wastes will be managed such that any potential for the introduction of disease will be minimised.

i) Will the activity interfere with the recovery of a species

The proposed activity will not interfere with the recovery of the Coxen's fig parrot.

Conclusion

Based upon the above assessment, it is not expected that the proposed activity will have a significant impact upon the Coxen's fig parrot should it utilise the site. Recommendations provided in the ecological assessment to reduce potential impacts of the proposed activity should be observed.

EPBC AOS6 Spotted-tailed Quoll – Dasyurus maculatus

Overview

An overview of the spotted-tailed quoll is provided in Section 2 Part 3A AIA9.

EPBC Act Assessment of Significance for the Spotted-tailed Quoll

a) Will the activity lead to a long term decrease in the size of a population of a species

Although the Spotted-tailed Quoll was not recorded during the surveys, it has recently been recorded just to the south of Eviron Road to the southwest of the study area, and as such the study area is considered likely to be part of a home range of one or more individuals.

Clearing and operational aspects of the activity are not expected to directly impact upon the species. No hollow-bearing trees will be removed as a result of the proposed activity. The activity is not expected to lead to a long term decrease in a population of the species should it inhabit the study area.

b) Will the activity reduce the area of occupancy of the species

The footprint of the proposed activity will principally reduce the area of camphor laurel dominated vegetation. The proposed activity may result in a relatively small reduction to the potential foraging area for this species in the study area, although large areas of similar habitats will persist in the local area and the study area would only form a minor part of a much larger home range.

c) Will the activity fragment an existing population into two or more populations

The proposed activity will not result in the fragmentation of an existing population.

d) Will the activity adversely affect habitat critical to the survival of a species

No critical habitat is listed for the spotted-tailed quoll.

The species is reported from a wide range of habitats and regularly moves between multiple den sites, and thus use of the study area by the spotted-tailed quoll is likely to be infrequent and opportunistic as part of its much larger home range. Given that there is minimal potential shelter in the form of tree hollows or hollow logs large enough for this species within the study area it is considered unlikely that it is critical habitat for the spotted-tailed quoll.

The expected impacts upon this habitat associated with the activity are not expected to adversely impact on habitat that is critical to the spotted-tailed quoll.

e) Will the activity disrupt the breeding cycle of a population

The activity will not result in disruption to the breeding cycle of the spotted-tailed quoll.

As indicated, the spotted-tailed quoll forages opportunistically over a large home range. The proposed activity will not provide barriers to this movement and existing potential shelter and foraging resources will persist in the study area and surrounding lands. As indicated there are minimal denning habitats available in the study area for the spotted-tailed quoll and thus the activity is unlikely to disrupt the breeding cycle of a local population of the species.

f) Will the activity modify destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The activity will remove vegetation from the development footprint. Much of this area has been previously cleared or is dominated by camphor laurels. Areas currently mapped within the haul road concept design constitute a very minor component of a species home range, and as such will not decrease the quality of the habitat such that there is a decline in the species.

The activity will not result in impacts upon habitats outside of the development footprint such that the species would be likely to decline.

g) Will the activity result in invasive species that are harmful to a critically endangered or endangered species becoming established in a critically endangered or endangered species' habitat

Several invasive weed species currently dominate vegetation in the study area. The proposed development is not expected to result in any further invasive species becoming established in the study area.

Segregated green organic waste will continue to be processed at Stotts Creek and not disposed of within the landfills at Eviron Road. As such the risk of introduction of invasive species to the study area will not be increased. Vegetation and weeds in the study area are likely to be more actively managed on the site as part of an overall management plan for the activity.

As indicated previously it is likely that feral species such as foxes and feral cats are present in the study area.

h) Will the activity introduce disease that may cause the species to decline

The risk of introduction of disease as a result of the activity that could result in a decline in the spotted tailed quoll is considered low.

The landfills will only accept solid waste class one and will be fully contained and managed as per an approved landfill environmental management plan. As such, wastes will be managed such that any potential for the introduction of disease will be minimised.

i) Will the activity interfere with the recovery of a species

The clearing associated with the proposed activity and operational activities are not expected to interfere with the recovery of the spotted-tailed quoll.

Conclusion

Based upon consideration of the above factors it is concluded that the proposed activity is not likely to have a significant impact upon the endangered species the spotted-tailed quoll. Recommendations provided in the ecological assessment to reduce the potential impacts of the proposed activity should be observed.

EPBC AOS7 Mitchell's rainforest snail – *Thersites mitchellae*

Overview

An overview of the Mitchell's rainforest snail is provided in Section 2 Part 3A AIA15.

EPBC Act Assessment of Significance for the Mitchell's Rainforest Snail

a) Will the activity lead to a long term decrease in the size of a population of a species

Although the Mitchell's rainforest snail was not recorded during the surveys, potential habitat occurs in the north west of the study area, adjacent to the location of the haul road. The footprint of this has been designed such that it avoids most of this species habitat. The activity however is not expected to lead to a long term decrease in a size of population of the Mitchell's rainforest snail if it occurs in the study area.

b) Will the activity reduce the area of occupancy of the species

The footprint of the proposed activity will principally reduce the area of camphor laurel dominated vegetation. The proposed activity may result in a relatively small reduction in the potential foraging area for this species in the study area, although large areas of similar habitats will persist in the local area.

c) Will the activity fragment an existing population into two or more populations

The proposed activity does not result in fragmentation of any vegetation communities. Fragmentation has occurred in the study area historically, with a clearing of approximately 30 m extending through the two types of wet sclerophyll vegetation on in the north western portion of Lot 1 DP1159352 (see Figure 6). The proposed activity will not fragment any population into two or more populations.

d) Will the activity adversely affect habitat critical to the survival of a species

Stotts Island Nature Reserve, located approximately 2.5 km to the north of the study area is listed as critical habitat for the Mitchell's rainforest snail. Within the study area, the lowland areas of wet sclerophyll vegetation may provide suitable habitats. These areas will not be impacted as a result of the proposed activity, and as such, no habitat critical to the survival of the Mitchell's rainforest snail will adversely affected.

e) Will the activity disrupt the breeding cycle of a population

It is known that the Mitchell's rainforest snail lays eggs and the juveniles are thought to be arboreal. Provided that the activity does not clear preferred habitat of the species, then it is not expected that it would disrupt the species breeding cycle..

f) Will the activity modify destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The activity will remove vegetation from the development footprint. Much of this area has been previously cleared or is dominated by camphor laurels. The proposed activity avoids clearing of this species potential habitat.

The activity will not result in impacts upon habitats outside of the development footprint such that the species would be likely to decline.

g) Will the activity result in invasive species that are harmful to a critically endangered or endangered species becoming established in a critically endangered or endangered species' habitat

Several invasive weed species currently dominate vegetation in the study area. The proposed development is not expected to result in any further invasive species becoming established in the study area.

Segregated green organic waste will continue to be processed at Stotts Creek and not disposed of within the landfills at Eviron Road. As such the risk of introduction of invasive species to the study area will not be increased. Vegetation and weeds in the study area are likely to be more actively managed on the site as part of an overall management plan for the activity.

h) Will the activity introduce disease that may cause the species to decline

The risk of introduction of disease as a result of the activity that could result in a decline in the Mitchell's rainforest snail is considered low.

The landfills will only accept solid waste class one and will be fully contained and managed as per an approved landfill environmental management plan. As such, wastes will be managed such that any potential for the introduction of disease will be minimised.

i) Will the activity interfere with the recovery of a species

The following recovery actions are outlined in the recovery plan for the Mitchell's rainforest snail (NPWS, 2001):

- Survey and research
- Protection of extant populations and habitat
- Commonwealth listing
- Community awareness and involvement

The clearing associated with the proposed activity and operational activities are not expected to interfere with the recovery of the Mitchell's rainforest snail.

Conclusion

Based upon consideration of the above factors it is concluded that the proposed activity is not likely to have a significant impact upon the endangered species the spotted-tailed quoll. Recommendations provided in the ecological assessment to reduce the potential impacts of the proposed activity should be observed.

EPBC AOS8 Migratory Species

Three Commonwealth listed migratory bird species were recorded in the study area during the survey:

- Great Egret - *Ardea alba (modesta)*
- Spectacled Monarch - *Monarcha (Symposiarchus) trivirgatus*
- Black-faced Monarch - *Monarcha melanopsis*

As indicated by the EPBC Act Protected Matters Report (Appendix A), it is likely that several other migratory species have been recorded in the locality and some may occur on the site as vagrants.

3.1.2 Migratory Species Assessment

The EPBC Assessment guidelines define an action as likely to have a significant impact on a migratory species, if it will:

a) Substantially modify (including fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species.

An important habitat is considered:

- Habitat used by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species. Or:
- Habitat that is of critical importance to the species at particular life-cycle stages. Or:
- Habitat utilised by a migratory species which is at the limit of the species range. Or:
- Habitat within an area where the species is declining.

The site is not considered likely to constitute an *important area of habitat* on the basis of the following:

The site is not known breeding habitat for any of the above mentioned species and constitutes only a very small area of more extensive areas of similar habitat on adjoining lands and in the wider locality. The site is not considered capable of supporting an ecologically significant proportion of any of these species (at most, only a small group or transient individuals).

While some migratory species occurring in the locality may be at the limits of their range, no such species were recorded in the study area. Additionally, similar habitat is known to occur both north and south of the locality.

b) Will the activity result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or

An invasive species is one that may become established in the habitat, and harm the migratory species by direct competition, modification of habitat, or predation. The proposed activities will not result in an invasive species that is harmful to a migratory species becoming established in an area of important habitat.

c) Will the activity seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species

No ecologically significant proportion of the population of a migratory species occurs in the study area. No disruption on the lifecycle of any migratory bird is likely, as the site did not contain suitable potential breeding habitat for any of the migratory species. The loss of potential foraging habitat is considered unlikely to significantly affect the foraging success of these migratory species.

Conclusion

Based on consideration of the above factors it is concluded that the proposed activity is unlikely to have a significant impact on migratory species.

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Appendix M

Traffic Impact Assessment

CLIENTS | PEOPLE | PERFORMANCE

Tweed Shire Council

Report for Eviron Road Quarry and Landfill Proposal

Traffic Impact Assessment

November 2010

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

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A Traffic Counts
B SIDRA Output

1. Introduction

Tweed Shire Council's 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. This outlines a proposed staged project 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, a dedicated acid sulfate soils treatment area, 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. Material won from quarrying is used for road building and other Council civil projects, and overburden stockpiled for road construction, clay liners (where appropriate) and site rehabilitation purposes.

The following report assesses the traffic impacts of the expansion of the development on the surrounding network for the operational phase of the facility only.

The site is located within the Tweed Shire Council in Northern New South Wales. The general location of the site is shown in Figure 1 below.

1.1 Objectives

This TIA is required by Council in order to assess the impact on the surrounding road network. This report will include:

- Review of background traffic;
- Review the trip generation of the facility;
- Analyse the access intersection operation and any impacted intersection; and
- Provide recommendations on improvement works required to minimise anticipated development impacts.

1.2 Methodology

The Methodology for conducting this TIA for the Quarry involves the following main tasks:

The assessment of traffic impacts involved the following main tasks:

- Assessment of Road Network Traffic Conditions;

  A site visit have been undertaken to review the proposed routing and access arrangements to/from the site. The characteristics of the route are considered in light of the type of vehicles using the route; tonnage; average trips per week; timing; and hours of operation. The road layout has been reviewed to ensure the accessibility for all vehicles are adequately catered for and in compliance with Austroads Guidelines.

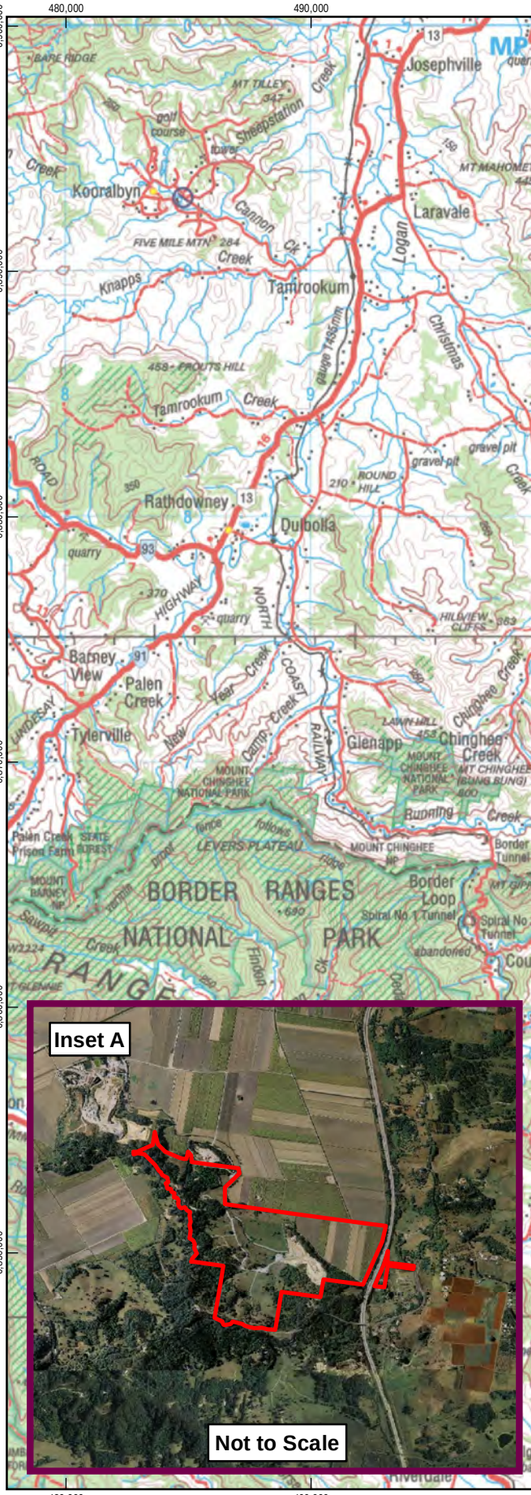
- Review of background traffic data (tube counts) provided by Council.
- Review trip generation of the proposed activities;
- Intersection Analysis;

  Analysis of intersections to access site and other impacted intersections using the intersection modelling software Sidra Intersection 4.0 (SIDRA);

  The analysis was undertaken for the AM, and PM peak hours, for the following scenarios:

  – Existing (2009);
  – Day of opening (2012); and
  – 10 year design horizon after opening (2022).
- Performance of Road Network;

  Following estimation of traffic generation, the performance of the road network was assessed to determine the construction and operational impact of the proposed Quarry and Landfill facility. The assessment is for existing conditions, day of opening and a 10 year design period. Suitable background traffic growth rates to be calculated for opening and 10 year design period.
- Access - the site access was assessed to review operation and sight distance issues.



Refer Inset A

1:250,000 (at A3)

0 2 4 6 8 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

Site Boundary

Tweed Shire Council
Eviron Road Quarry and Landfill Environmental Assessment

Job Number 41-20806
Revision 1
Date 27 MAY 2011

Locality Plan

Figure 1

N:\AU\Toowoomba\Projects\41\20806\GIS\Maps\4120806_31.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

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© 2006. The Commonwealth give no warranty regarding the Data's accuracy, completeness, currency or suitability for any particular purpose.

Data source: Tweed Shire Council - Aerial Photography (2008). Geoscience Australia - NATMAP Raster Premium 250k (2005). GHD - Site Boundary (2011).

2. Existing Traffic Conditions

The following discuss the possible intersection that the project site will most likely use to gain access to and from the site.

2.1 Existing Road Network

The existing road network is shown in Figure 2 below. The site has access currently has access onto Eviron Road. However for the proposed activities all vehicles will access the site via the existing access to Stotts Creek RRC from Leddays Creek Road. Therefore site access to and from Eviron Road was not assessed as this access will be removed as part of the Concept Plan and the key intersections assessed were:

- Tweed Valley Way and Leddays Creek Road; and
- Facility access / Leddays Creek Road and Bartletts Road.

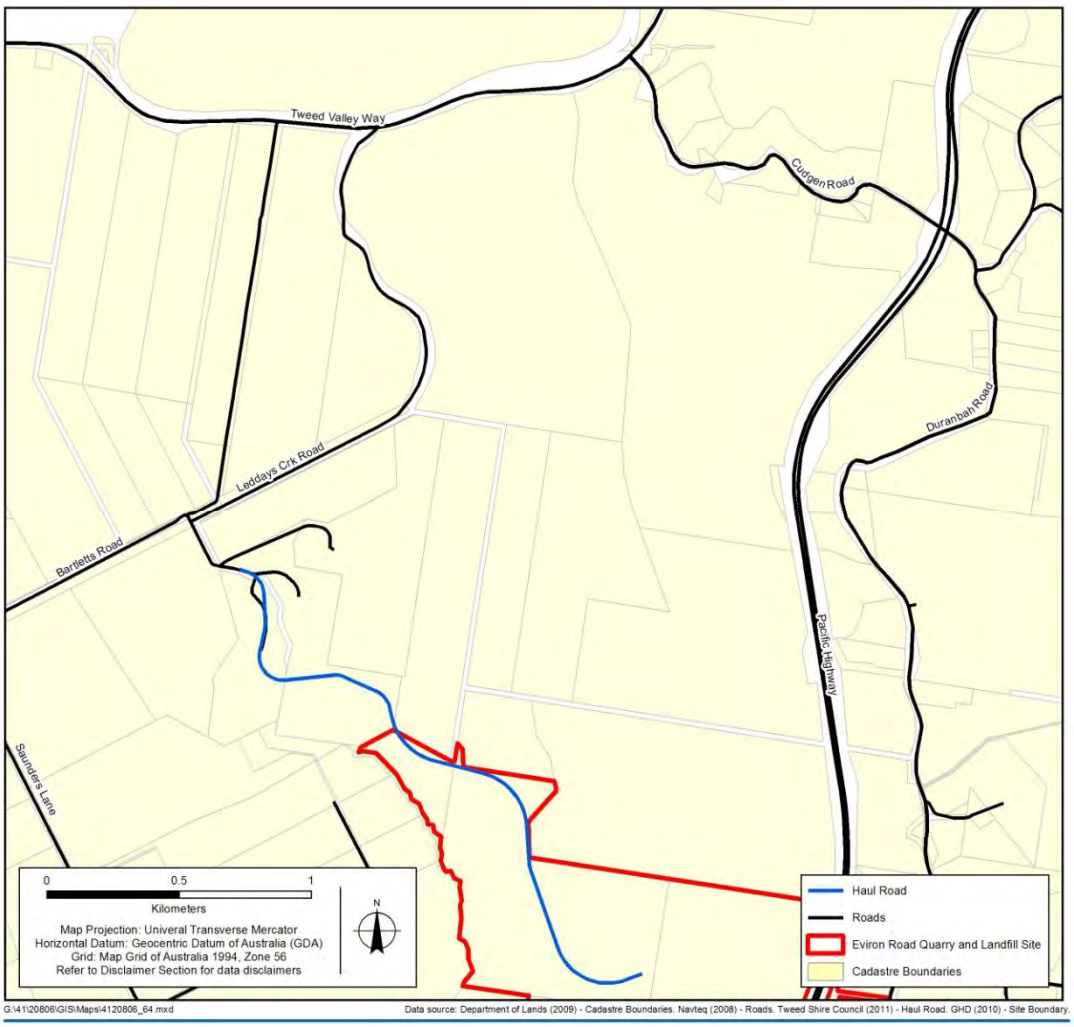


Figure 2 Surrounding Road Network

2.2 Road Network Details

Figure 3 shows the condition of Leddays Creek Road from the intersection of Bartletts Road looking north. It is a sealed two lane rural road (one lane each direction) that starts at the Quarry Access and joints on to Tweed Valley Way to the north.

Figure 3 Leddays Creek Road Looking North from Bartletts Road Intersection

Figure 4 shows the intersection of Tweed Valley Way (eastbound) and Leddays Creek Road. Tweed Valley Way is a two lane (one lane each direction) 100km/hr arterial road which follows the Tweed River and eventually loops back on to the Pacific Highway which is directly to the east of Quirks Quarry.

Figure 4 Tweed Valley Way from Leddays Creek Road Intersection

2.3 Surrounding Land Uses

The surrounding land use is predominantly rural with the majority of land sugar cane fields with some rural residential housing. Council's existing waste disposal facility Stotts Creek Resource Recovery Centre is located north west of the site aand a disused private quarry (O'Keeffe's Quarry) is located directly north of the site.

2.4 Background Traffic

With only a few residential houses within the Leddays Creek road catchment area background traffic is limited with the majority of traffic being from the quarry. Peak traffic along Tweed Valley Way occurs at 8:00-9:00 AM and 3:00-4:00 PM.

Traffic data was provided by Council for the following locations:

- Entrance to Stotts Creek RRC (Leddays Creek Road)
- Eviron Road (off Duranbah Road); and
- Tweed Valley Way (north of the southern entrance to Tumbulgum).

Key statistics for these three locations including the average daily traffic (ADT), morning and afternoon peak hour traffic volumes and the percentage of heavy vehicles[1] is provided in the following table.

Table 2-1 Traffic Count Key Statistics

	Entrance to Stotts Creek RRC (Leddays Creek Road)	Eviron Road	Tweed Valley Way
ADT – Weekday	625	345	10698
ADT – Weekend	425	390	10449
ADT – 7 days	568	358	10321
% heavy vehicles (Class 3 and above)	31%	12%	6%
AM Peak	75	38	893
PM Peak	79	43	1001

Note: all data provided by Tweed Shire Council

[1] Defined as Class 3 and above in accordance with Austroads Vehicle Classification System

3. Proposed Development

3.1 Development Profile

The development of the quarry and landfill project will be undertaken in stages over the course of 30 – 40 years. The current Concept Plan outlines the intention for progressive development of landfills within quarry voids across the site:

- Stage 1 (Project Application):
  - Construction of a haul road from Stott's Creek RRC to the site;
  - Landfill within the Quirks Quarry site; and
  - Quarrying at the West Valley site.
- Future Stages:
  - Landfill within the void formed by West Valley quarry;
  - Quarrying at North Valley; and
  - Landfill within the void formed by North Valley.

Based on the Quirks Quarry Landfill concept design, including forecast resource recovery and waste generation, it is anticipated that there will be an operational period of approximately 10 years. Similarly, based on projected extraction rates of 200,000 tonnes per annum for West Valley Quarry an approximate operational period of 10.5 years has been assumed. Taking into account the potential void created by the West Valley Quarry, approximately 12 years of landfilling may be achieved.

The quarry and landfill developments associated with the future stages are expected to be of a similar scale and nature to those investigated in Stage 1. As noted elsewhere in the Environmental Assessment, the scope of future staged application/s would be reviewed at a later stage prior to the submission of an application, and take into consideration emerging technologies in resource recovery, alternatives to landfilling and increase regulation of waste minimisation and landfill diversion targets.

As the facility is essentially a continuation of existing quarry operations and relocation of existing landfilling operations from the Stotts Creek site, there is not considered to be an official construction phase. Heavy vehicles, soil and building relocations already existing on site will not use the surrounding road network.

3.2 Site Access and Operating Hours

The existing access point for Quirks Quarry onto Eviron Road will be discontinued and access will no longer be permitted. For this reason the access on to Eviron Road has not been included in this assessment. The access point for all activities associated with the Concept Plan (including the Stage 1 Project Application) will be the existing access onto Leddays Creek Road from the Stotts Creek RRC as shown in Figure 46 below.

Waste collection vehicles will proceed through the Stotts Creek facility and along the proposed haul road to Quirks Quarry Landfill. Whilst small vehicular traffic (ie domestic and small commercial customers) will not enter the Eviron Road site and will continue to utilised the transfer station facility at the Stotts Creek RRC. Therefore this traffic is not considered further in the assessment as it is considered to be a continuation of the existing operations and not part of the Concept Plan.

As described in Section 7.2, the expected hours of operation of Quirks Quarry landfill are 7am to 4pm Monday to Friday and 9am to 4pm Saturday and Sunday, whilst quarrying activities will operate between 7am and 5pm Monday to Friday and 7am to 12pm Saturday.

Figure 5 Site Access from Leddays Creek Road

4. Traffic Generation

On the basis of the traffic data provided by Council for the existing quarry and landfill operations and the traffic counts for the identified intersection, a number of assumptions regarding the traffic generation, distribution and directional splits were made as part of this assessment to derive the turning movement traffic volumes. Overall it is noted that the traffic generation has been assumed based on information on expected maximum outputs from the Quarry and expected maximum intake at the landfill. Both facilities will use the same access and route to Tweed Valley Way.

It is recommended that during detail design, classified traffic counts should be undertaken at the Bartletts Road / Leddays Creek Rd intersection and Tweed Valley Way / Leddays Creek Rd intersection to confirm that assumptions summarised below:

- 5% traffic growth rate applied to tube counts provided by Council (refer Appendix A);
- Assumed directional split for counts on Tweed Valley Way in the AM 60% heading east, 40% heading west and reverse in the PM;
- Generated traffic in peak hours coming to / from the quarry/landfill. AM - 40% out, 60% in and reverse in PM;
- Turning movements from Leddays Creek Road for both traffic counts and generated traffic, 50% east (right), 50% west(left).
- There will be no net increase in traffic from the site during the establishment of the Quirks Quarry landfill.
- It is assumed that traffic growth is at 5% in accordance with other recent traffic data counts in the area.
- As the activities for the Stage 1 Project Application are in essence a continuation of existing Council activities in this area, from a traffic impact point of view it is considered that there is no construction phase as such with all heavy vehicles, soil and building relocations already either existing on site or utilising the site and will not add additional traffic to the surrounding road network. Staff/employee movements to site will still remain as per existing activities.

4.1 Quirks Quarry Landfill

To provide for the worst case scenario/maximum traffic generation, a waste acceptance rate of 70,000 tonnes per annum has been adopted, but it is acknowledged that this will gradually increase from 48,000 tonnes per annum from the start of operations. Heavy vehicles (ie kerbside waste collection vehicles) constitute 13% of the vehicles entering the Stotts Creek RRC (as is currently the case).

Based on the expected waste tonnages and traffic counts from Stotts Creek, in the order of 550 vehicles per day would be expected at the site initially, with approximately 10% of these vehicles being present at the peak time, equating to the following:

- 7 heavy vehicles; and
- 48 light vehicles.

Traffic associated with site employees would contribute six vehicles in peak hour.

This traffic would travel onto Leddays Creek Road and it is assumed that at the intersection with Tweed Valley Way, a 50/50 split of vehicles would occur for a left and right turn.

Since the traffic levels associated with the landfill component are currently already accounted for within the existing road network (ie due to the presence and use of the existing Stotts Creek RRC) there is no net impact (other than the anticipated growth in vehicular traffic that would have been experienced in any case) on traffic volumes on Leddays Creek Road and Tweed Valley Way associated with this activity. Traffic associated with waste disposal facilities both at Stotts Creek and Quirks Quarry Landfill will remain the dominant source of traffic on Leddays Creek Road.

4.2 West Valley Quarry

It is expected that 200,000 tonnes will be extracted and removed from the site each year. It has been assumed that haulage vehicles are truck and dog trailers with an average 25 tonnes per load capacity.

Whilst the quarry haulage regime will be highly variable and dependent of the availability and demand for quarry resource an average traffic generation of 26 vehicles a day has been adopted. This has been derived from the expected tonnages and average capacity of a truck and dog trailer. Based on the traffic count provided by Council for Eviron road, the number of Class 4 heavy vehicles generated by the proposed quarry is consistent with the existing traffic counts. During peak periods this would equate to three vehicles per hour. Traffic associated with site employees would contribute ten vehicles in peak hour

The proposed haulage route from the quarry will be through the internal haul road to Stotts Creek RRC, then right onto Leddays Creek Road and on to Tweed Valley Way.

Product haulage from the quarry will be by heavy vehicles on an as required basis. The level of activity at the quarry will be variable depending on local construction and maintenance requirements. The haulage route will also vary depend on the location of construction activity. However it is anticipated

All haulage will occur during daylight hours between the hours of 7:00am - 5:00pm Monday to Friday. Combinations of trucks will be used but it is expected that truck and dog trailers setups will mainly be used. These trucks have a payload of between 20 – 30 tonnes per load and will reduce the number of truck trips and resulting potential impacts.

Heavy vehicle traffic on Eviron Road associated with quarrying activities will be eliminated upon establishment of the proposed haul road and closure of the current Quirks Quarry site access. However this traffic will be diverted to Leddays Creek Road and the intersection with Tweed Valley Way. The split of traffic travelling east or west on Tweed Valley Way will be dependent on the required destination of quarry materials, however it is assumed that this is a 50/50 split. The addition of on average 26 heavy vehicles a day associated with the quarry, will impact upon Leddays Creek Road increasing heavy vehicles by approximately 13%, indicating that the landfill activities will still largely be responsible for the bulk of the traffic generation. In terms of the impact on overall traffic volumes on Tweed Valley Way the impact is minimal.

5. Intersection Analysis

The intersection analysis reviewed two locations, these being the site access on to Leddays Creek Road and the intersections of Leddays Creek Road with Tweed Valley Way.

5.1 Tweed Valley Way / Leddays Creek Road

Figure 6 shows the layout of the intersection of Tweed Valley Way and Leddays Creek Road. Traffic can access the site by a right or left turn lanes from the Tweed Valley Way and can also turn either way when exiting from Leddays Creek Road. An added lane is present for vehicles performing a left turn out of Leddays Creek Road onto Tweed Valley Way, however for the right turn, only a painted island refuge is provided. During detail design it is recommended that a safety audit be conducted on this intersection to ensure that the additional heavy vehicle traffic associated with the quarry does not present a safety hazard and that there are adequate sight distances both for traffic travelling on and accessing Tweed Valley Way.

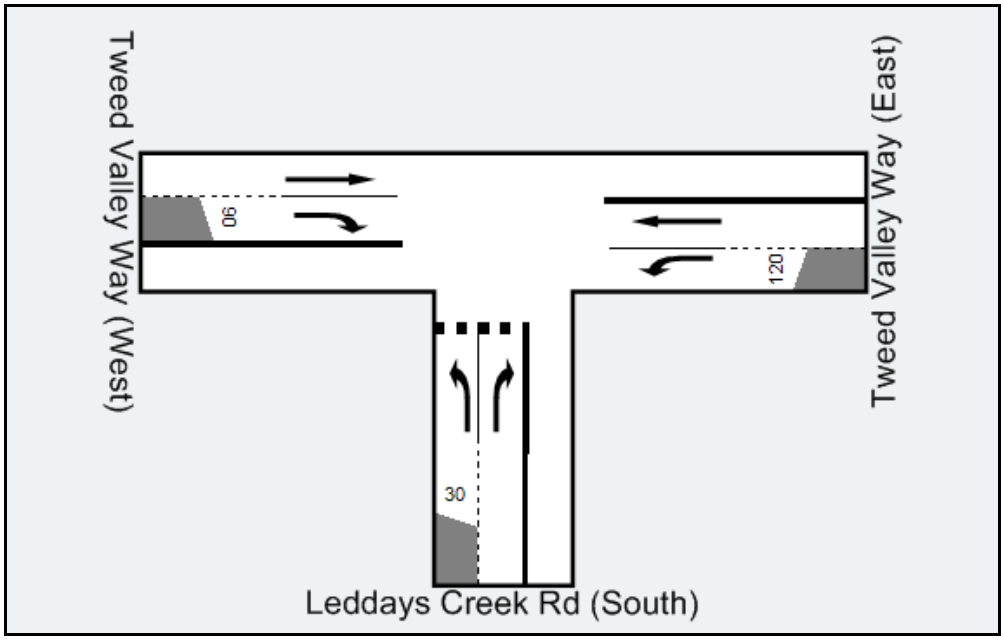


Figure 6 Intersection Layout

5.2 Site Access / Leddays Creek Road

Figure 7 below shows the intersection layout for the Bartletts Road and Leddays Creek Road (ie the site access road). Bartletts Rd is a minor unsealed (dirt) road that does appear to experience much traffic. For the traffic generation estimates it was assumed that all traffic associated with the proposed activities travels via Leddays Creek Road. As shown in Figure 8 below, there is no signage leading up to the intersection from either approach on Leddays Creek Road (ie from the north and from the site access).

Traffic on Bartletts Road is signed to give way to traffic on Leddays Creek Road, include the access road to the landfill such that traffic to and from the site access flows freely through this intersection. However with the following will require further consideration in the detail design:

- Safe access for local traffic from Bartletts Road
- Potential for increased maintenance of the pavement due to impact from heavy vehicles.

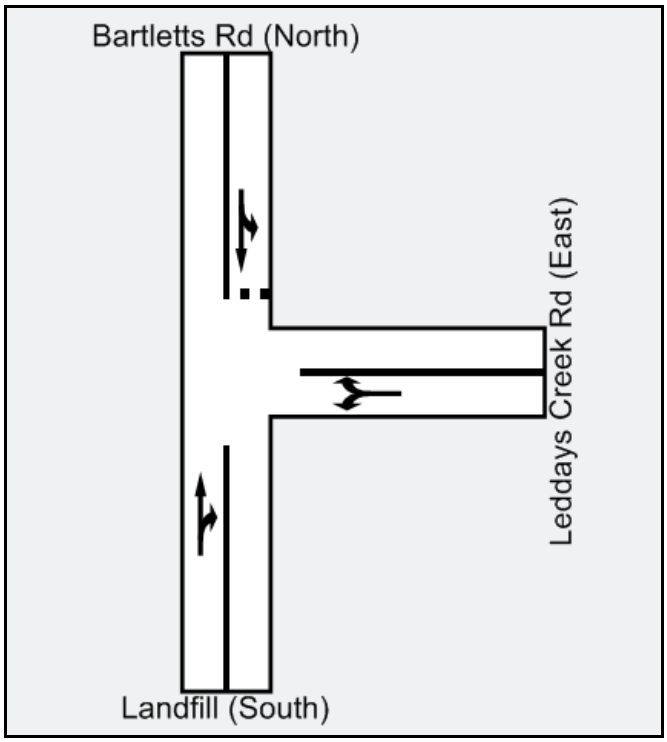


Figure 7 Intersection Layout

Figure 8 Intersection Leddays Creek Road (Site Access Road) and Bartletts Road

6. Access to Transport Routes

Part of the criteria in selecting Eviron Road for long term extractive and waste disposal activities was the proximity of the site to existing transportation routes.

The access to the Tweed Valley Way (major arterial) is approximately two kilometres from the site entrance, with access to the Pacific Highway (north and south bound) a further four kilometres north east. Currently quarry access via Eviron Road results in heavy vehicles travelling approximately 5km north along Duranbah Road which is a two lane rural road (one lane each direction) with a 60-80km/hour speed limit, passing through rural residential areas and tourist attractions (Tropical Fruit World). The closure of this access will remove this traffic from Duranbah Road and provide improved access to the Tweed Valley Way and Pacific Highway for quarry traffic.

For traffic accessing the waste disposal facilities proposed, access to major transport routes will remain unchanged.

7. Recommendations and Conclusion

During detail design a road safety audit will be undertaken to identify whether additional measures are required for the safe access/egress of heavy vehicles onto Tweed Valley Way is required. Further, a review of safe access for the low volume of local traffic entering Leddays Creek Road from Bartletts Road should also be undertaken.

The planned maintenance program for Leddays Creek Road shall be reviewed during the detail design to ascertain whether the addition of heavy vehicles associated with the quarrying activities will necessitate maintenance being brought forward.

Detail design of the proposed haul road will be in accordance with good practice for heavy vehicles 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). 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.
- *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 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: *Manual of uniform traffic control devices;* and
- *Surface material* – the haul road 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.

A traffic management plan will be prepared for the operation of the site that covers procedures and controls for traffic using both the Stotts Creek RRC and the facilities associated with the Stage 1 Project Application and Concept Plan.

Appendix A

Traffic Counts

MetroCount Traffic Executive
Weekly Vehicle Counts (Virtual Week)

VirtWeeklyVehicle-314 -- English (ENA)

Datasets:

Site:	**[99999] Eviron Road off Duranbah Road.**
Direction:	7 - North bound A>B, South bound B>A., **Lane:** 0
Survey Duration:	14:00 Wednesday, 30 April 2008 => 13:43 Wednesday, 7 May 2008
File:	C:\Program Files\Metro1174Count v316\User\Data\9999907May2008.EC0 (Plus)
Identifier:	E4071FHH MC56-6 [MC55] (c)Microcom 02/03/01
Algorithm:	Factory default
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**14:00 Wednesday, 30 April 2008 => 13:43 Wednesday, 7 May 2008**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Factory default profile
)heme:	Vehicle classification (AustRoads94)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 2507 / 2508 (99.96%)

Weekly Vehicle Counts (Virtual Week)

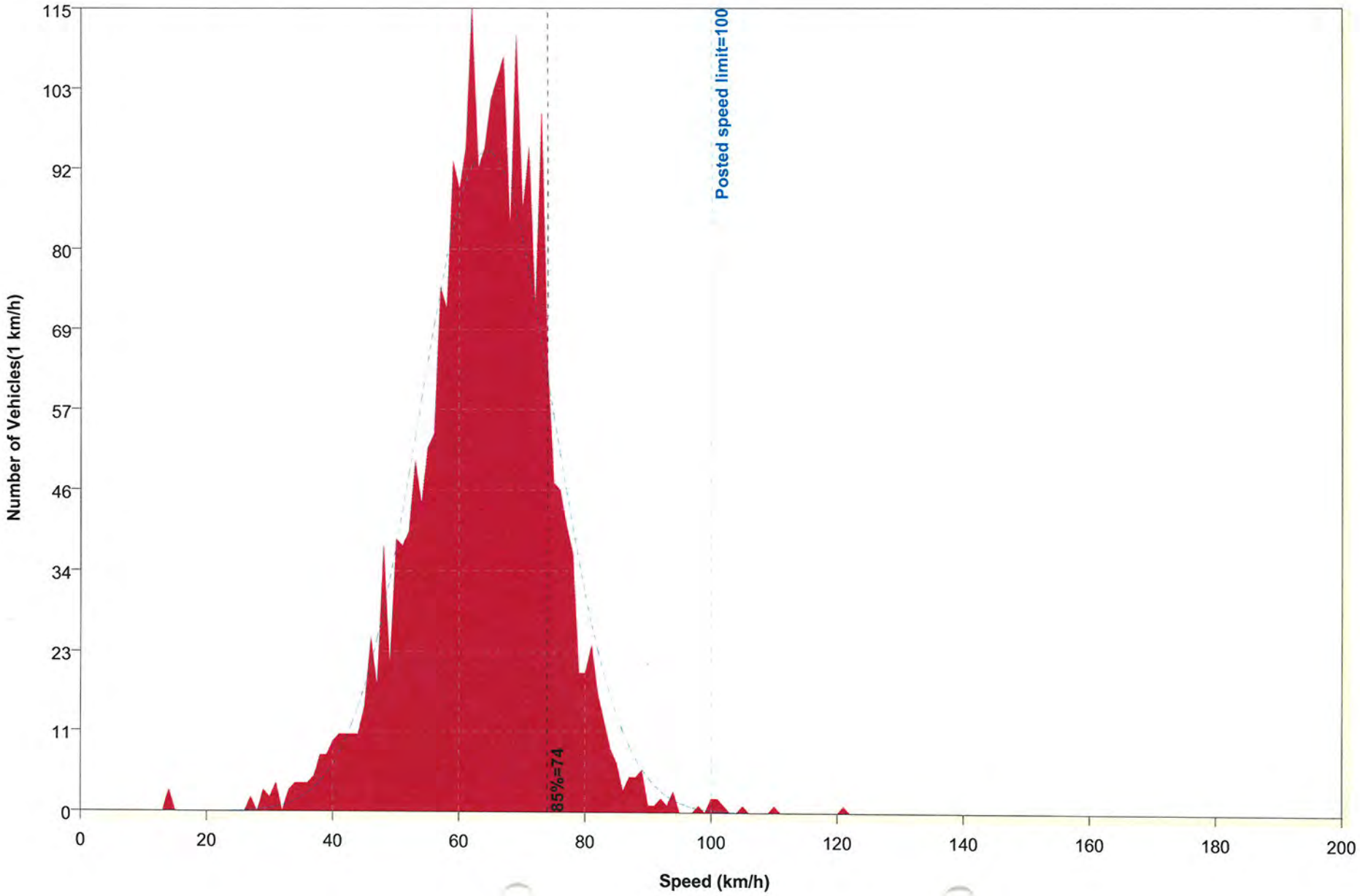
VirtWeeklyVehicle-314
Site: 99999.0SN
Description: **Eviron Road off Duranbah Road.**
Filter time: **14:00 Wednesday, 30 April 2008 => 13:43 Wednesday, 7 May 2008**
Scheme: Vehicle classification (AustRoads94)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Averages 1 - 5	Averages 1 - 7
Hour									
0000-0100	0.0	2.0	0.0	0.0	0.0	4.0	2.0	0.4	1.1
0100-0200	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3
0200-0300	0.0	0.0	0.0	0.0	1.0	1.0	1.0	0.2	0.4
0300-0400	3.0	0.0	1.0	0.0	0.0	1.0	3.0	0.8	1.1
0400-0500	1.0	1.0	1.0	0.0	2.0	1.0	1.0	1.0	1.0
0500-0600	6.0	13.0	6.0	0.0	9.0	3.0	0.0	6.8	5.3
0600-0700	17.0	22.0	24.0	0.0	19.0	6.0	2.0	16.4	12.9
0700-0800	32.0	31.0	28.0	0.0	18.0	21.0	15.0	21.8	20.7
0800-0900	38.0	**36.0<**	**31.0<**	0.0	**42.0<**	18.0	14.0	29.4	25.6
0900-1000	25.0	24.0	27.0	0.0	36.0	24.0	32.0	22.4	24.0
1000-1100	**42.0<**	34.0	26.0	**39.0<**	32.0	21.0	**38.0<**	**34.6<**	**33.1<**
1100-1200	39.0	26.0	0.0	26.0	28.0	**41.0<**	24.0	23.8	26.3
1200-1300	39.0	11.0	0.0	32.0	21.0	38.0	34.0	20.6	25.0
1300-1400	44.0	29.0	0.0	24.0	30.0	28.0	29.0	25.4	26.3
1400-1500	**46.0<**	**40.0<**	0.0	32.0	31.0	22.0	**44.0<**	29.8	30.7
1500-1600	37.0	37.0	0.0	32.0	**46.0<**	**90.0<**	39.0	**30.4<**	**40.1<**
1600-1700	33.0	39.0	0.0	**32.0<**	32.0	27.0	36.0	27.2	28.4
1700-1800	36.0	30.0	0.0	27.0	31.0	21.0	18.0	24.8	23.3
1800-1900	11.0	21.0	0.0	13.0	17.0	16.0	11.0	12.4	12.7
1900-2000	11.0	10.0	0.0	8.0	6.0	11.0	4.0	7.0	7.1
2000-2100	3.0	6.0	0.0	7.0	4.0	3.0	5.0	4.0	4.0
2100-2200	6.0	2.0	0.0	5.0	6.0	7.0	5.0	3.8	4.4
2200-2300	1.0	1.0	0.0	1.0	2.0	9.0	4.0	1.0	2.6
2300-2400	1.0	2.0	**0.0<**	0.0	2.0	5.0	1.0	1.0	1.6
Totals									
0700-1900	422.0	358.0	112.0	257.0	364.0	367.0	334.0	302.6	316.3
0600-2200	459.0	398.0	136.0	277.0	399.0	394.0	350.0	333.8	344.7
0600-0000	461.0	401.0	136.0	278.0	403.0	408.0	355.0	335.8	348.9
0000-0000	472.0	418.0	144.0	278.0	415.0	418.0	362.0	345.4	358.1
AM Peak	1000	0800	0800	1000	0800	1100	1000		
	42.0	36.0	31.0	39.0	42.0	41.0	38.0		
PM Peak	1400	1400	2300	1600	1500	1500	1400		
	46.0	40.0	0.0	32.0	46.0	90.0	44.0		

* - No data.

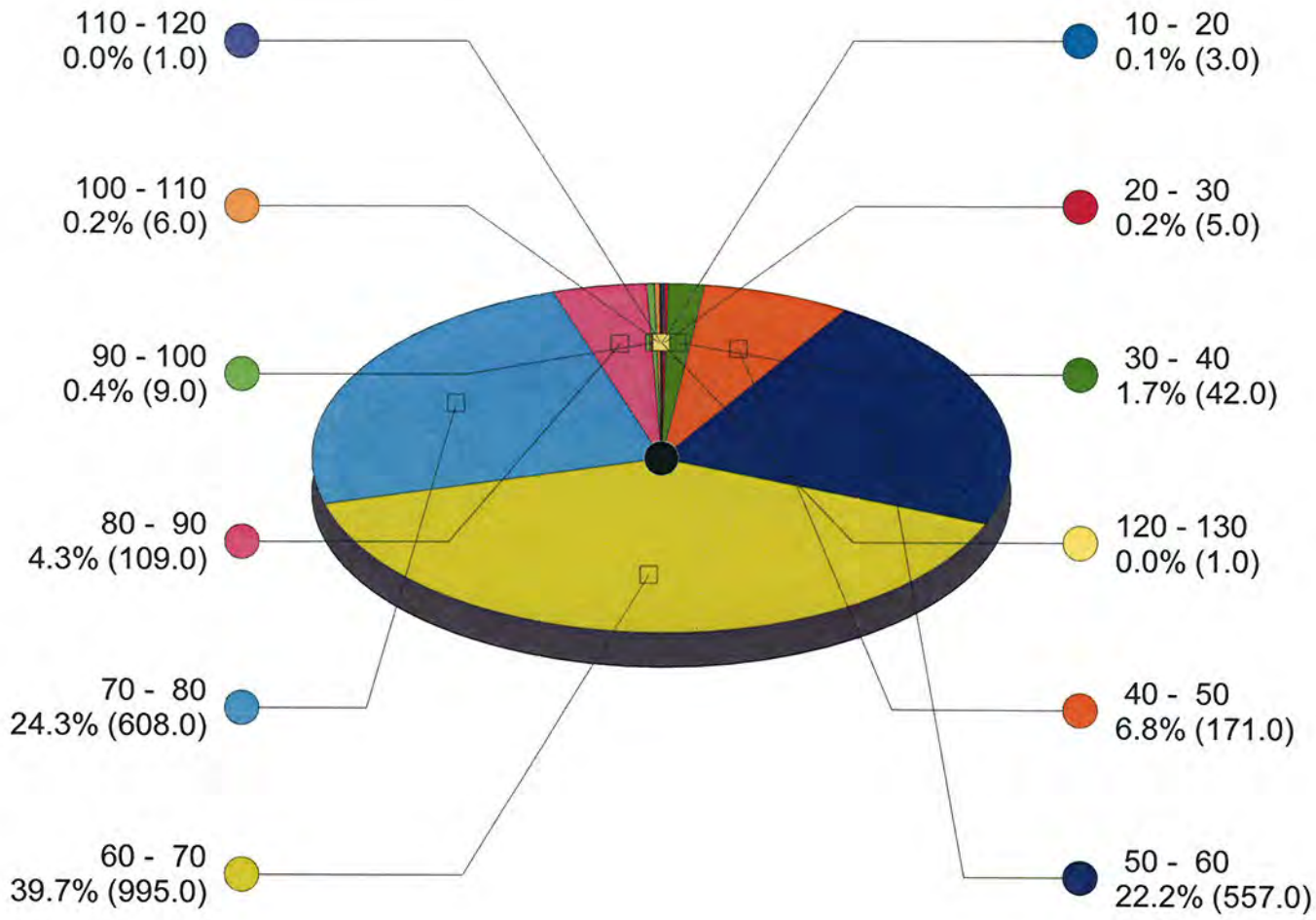
Speed Histogram

SpeedHist-316(Metric) **Site:** 99999.0SN
Description: Eviron Road off Duranbah Road.
Filter time:14:00 Wednesday, 30 April 2008 => 13:43 Wednesday, 7 May 2008
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (AustRoads94)



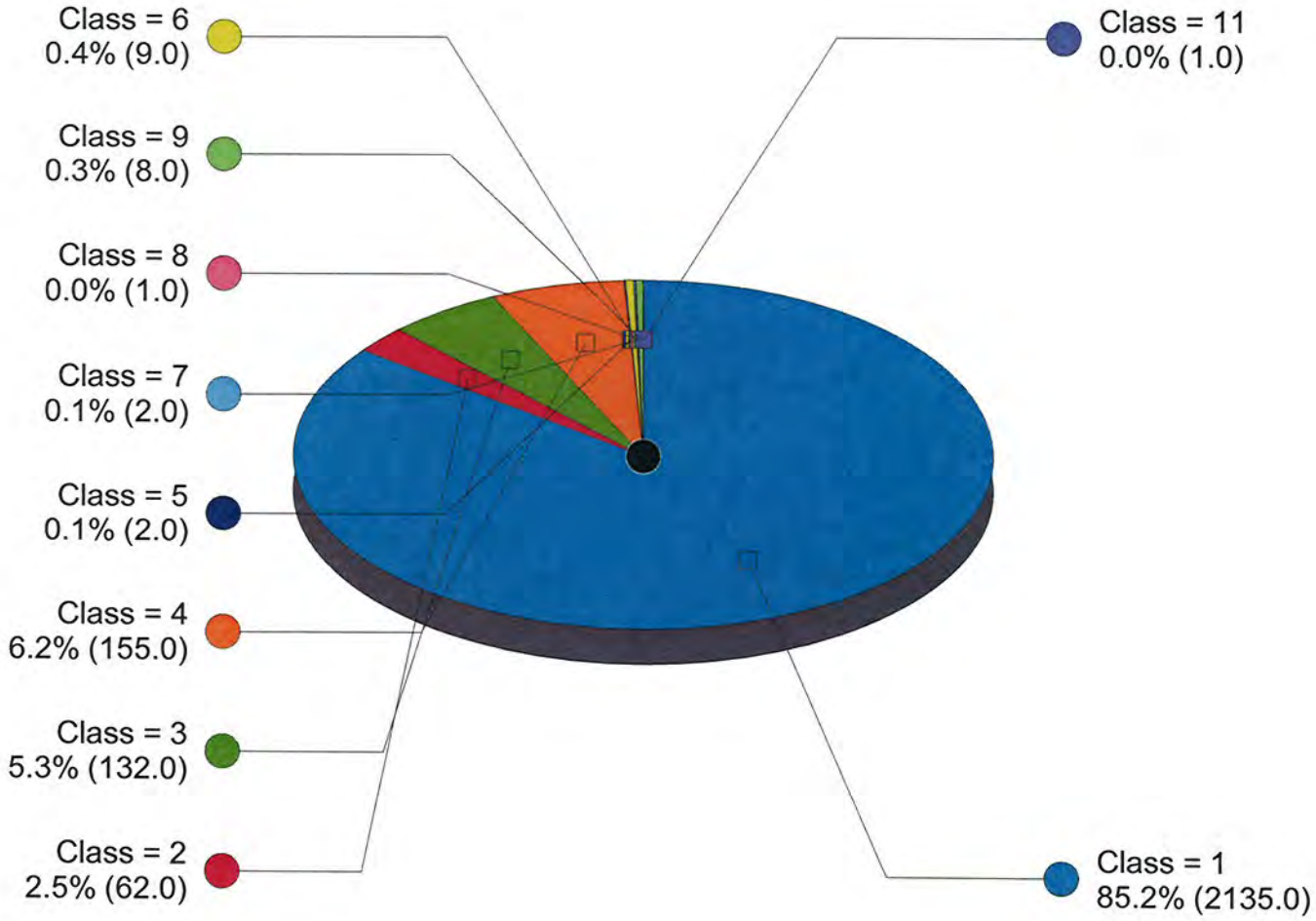
Speed Bin Chart

SpeedBin-315(Metric) **Site:** 99999.0SN
Description: Eviron Road off Duranbah Road.
Filter time: 14:00 Wednesday, 30 April 2008 => 13:43 Wednesday, 7 May 2008
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (AustRoads94)
Total=2507



Class Bin Chart

ClassBin-317(Metric) **Site:** 99999.0SN
Description: Eviron Road off Duranbah Road.
Filter time: 14:00 Wednesday, 30 April 2008 => 13:43 Wednesday, 7 May 2008
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (AustRoads94)
Total=2507



TWEED SHIRE COUNCIL

FACSIMILE TRANSMISSION

TO	:	Alison Marszalek - GHD
FAX NO	:	0755571099
FROM	:	Adam Faulkner
FAX NO	:	(02) 6670 2557
TELEPHONE	:	(02) 6670 2659
SUBJECT	:	**Tweed Shire Council Traffic Count**
FILE REFERENCE		
DATE	:	Tuesday, 23 December 2008 9:35 AM
NO OF PAGES	:	7 (inclusive)

[L22dr03

Alison,

Please find attached Tweed Shire Council Traffic Count. Apologies for it not being in spreadsheet format.

Regards
Adam

THIS MESSAGE IS INTENDED FOR THE ADDRESSEE NAMED AND MAY CONTAIN CONFIDENTIAL INFORMATION. IF YOU ARE NOT THE INTENDED RECIPIENT, PLEASE DESTROY IT AND NOTIFY THE SENDER. VIEWS EXPRESSED IN THIS MESSAGE ARE THOSE OF THE INDIVIDUAL SENDER, AND ARE NOT NECESSARILY THE VIEW OF TWEED SHIRE COUNCIL UNLESS OTHERWISE STATED.

Civic & Cultural Centre, Tumbulgum Road (PO Box 816) Murwillumbah NSW 2484
Phone: (02) 6670 2400 Fax: (02) 6670 2429
ABN: 90 178 732 496 web: www.tweed.nsw.gov.au

TWEED SHIRE COUNCIL

TRAFFIC COUNT

LOCATION: Leddays Creek Road

outsid Solo Waste

DATE INSTALLED 10-12-08 TIME 1-30

DATE REMOVED 17-12-08 TIME 11.00

X Y

SITE NO 548191 6876547 MACHINE NO. 1315.

RECORDING INTERVAL Hourly

TUBE SPACING 1metre

TOP OF BIN SEVEN SPEED 85% = 51kph

SPEED BIN SIZE —

SITE CONFIGURATION —

A.D.T. 568.

MetroCount Traffic Executive
Weekly Vehicle Counts (Virtual Week)

VirtWeeklyVehicle-363 -- English (ENA)

Datasets:

Site:	**[99999] Outside Stotts Island Tip.**
Direction:	8 - East bound A>B, West bound B>A., **Lane:** 0
Survey Duration:	11:59 Wednesday, 10 December 2008 => 10:07 Wednesday, 17 December 2008
File:	C:\Program Files\Metro1315Count v316\User\Data\9999917Dec2008.EC0 (Plus)
Identifier:	T0341FSM MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**11:59 Wednesday, 10 December 2008 => 10:07 Wednesday, 17 December 2008**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Factory default profile
Scheme:	Vehicle classification (AustRoads94)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 3976 / 3982 (99.85%)

Weekly Vehicle Counts (Virtual Week)

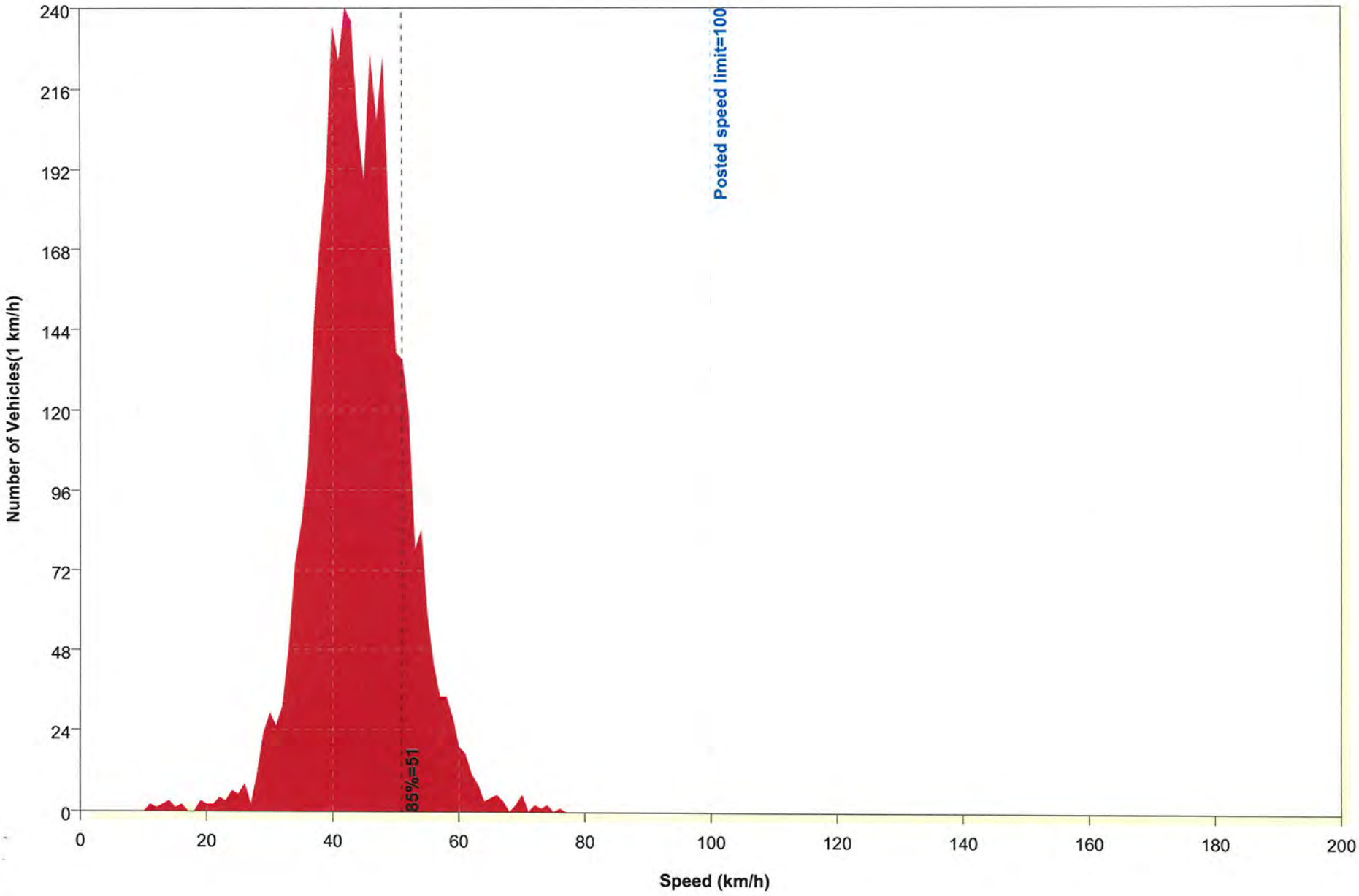
VirtWeeklyVehicle-363
Site: 99999.0WE
Description: **Outside Stotts Island Tip.**
Filter time: **11:59 Wednesday, 10 December 2008 => 10:07 Wednesday, 17 December 2008**
Scheme: Vehicle classification (AustRoads94)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Averages 1 - 5	Averages 1 - 7
Hour									
0000-0100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0100-0200	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.4	0.3
0200-0300	2.0	2.0	0.0	2.0	2.0	0.0	0.0	1.6	1.1
0300-0400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0400-0500	1.0	3.0	1.0	3.0	1.0	0.0	0.0	1.8	1.3
0500-0600	13.0	11.0	9.0	13.0	11.0	2.0	2.0	11.4	8.7
0600-0700	28.0	34.0	28.0	22.0	25.0	6.0	1.0	27.4	20.6
0700-0800	42.0	56.0	32.0	48.0	26.0	9.0	2.0	40.8	30.7
0800-0900	88.0	63.0	**51.0<**	62.0	61.0	22.0	7.0	**65.0<**	50.6
0900-1000	74.0	**87.0<**	35.0	55.0	60.0	39.0	13.0	62.2	51.9
1000-1100	88.0	83.0	0.0	71.0	59.0	**61.0<**	69.0	60.2	61.6
1100-1200	**92.0<**	67.0	0.0	**76.0<**	**77.0<**	55.0	**84.0<**	62.4	**64.4<**
1200-1300	94.0	69.0	0.0	57.0	53.0	**60.0<**	**84.0<**	54.6	59.6
1300-1400	82.0	**85.0<**	0.0	**79.0<**	58.0	40.0	57.0	60.8	57.3
1400-1500	**103.0<**	84.0	30.0	69.0	**75.0<**	47.0	73.0	**72.2<**	**68.7<**
1500-1600	79.0	49.0	**67.0<**	67.0	55.0	38.0	51.0	63.4	58.0
1600-1700	34.0	30.0	25.0	35.0	26.0	12.0	9.0	30.0	24.4
1700-1800	12.0	10.0	12.0	8.0	1.0	0.0	2.0	8.6	6.4
1800-1900	1.0	3.0	3.0	0.0	2.0	1.0	0.0	1.8	1.4
1900-2000	0.0	0.0	1.0	0.0	0.0	1.0	0.0	0.2	0.3
2000-2100	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.1
2100-2200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2200-2300	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.3
2300-2400	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.4	0.3
Totals									
0700-1900	789.0	686.0	255.0	627.0	553.0	384.0	451.0	582.0	535.0
0600-2200	817.0	720.0	284.0	649.0	578.0	392.0	452.0	609.6	556.0
0600-0000	817.0	720.0	286.0	649.0	578.0	392.0	454.0	610.0	556.6
0000-0000	833.0	736.0	298.0	667.0	592.0	394.0	456.0	625.2	568.0
AM Peak	1100	0900	0800	1100	1100	1000	1100		
	92.0	87.0	51.0	76.0	77.0	61.0	84.0		
PM Peak	1400	1300	1500	1300	1400	1200	1200		
	103.0	85.0	67.0	79.0	75.0	60.0	84.0		

* - No data.

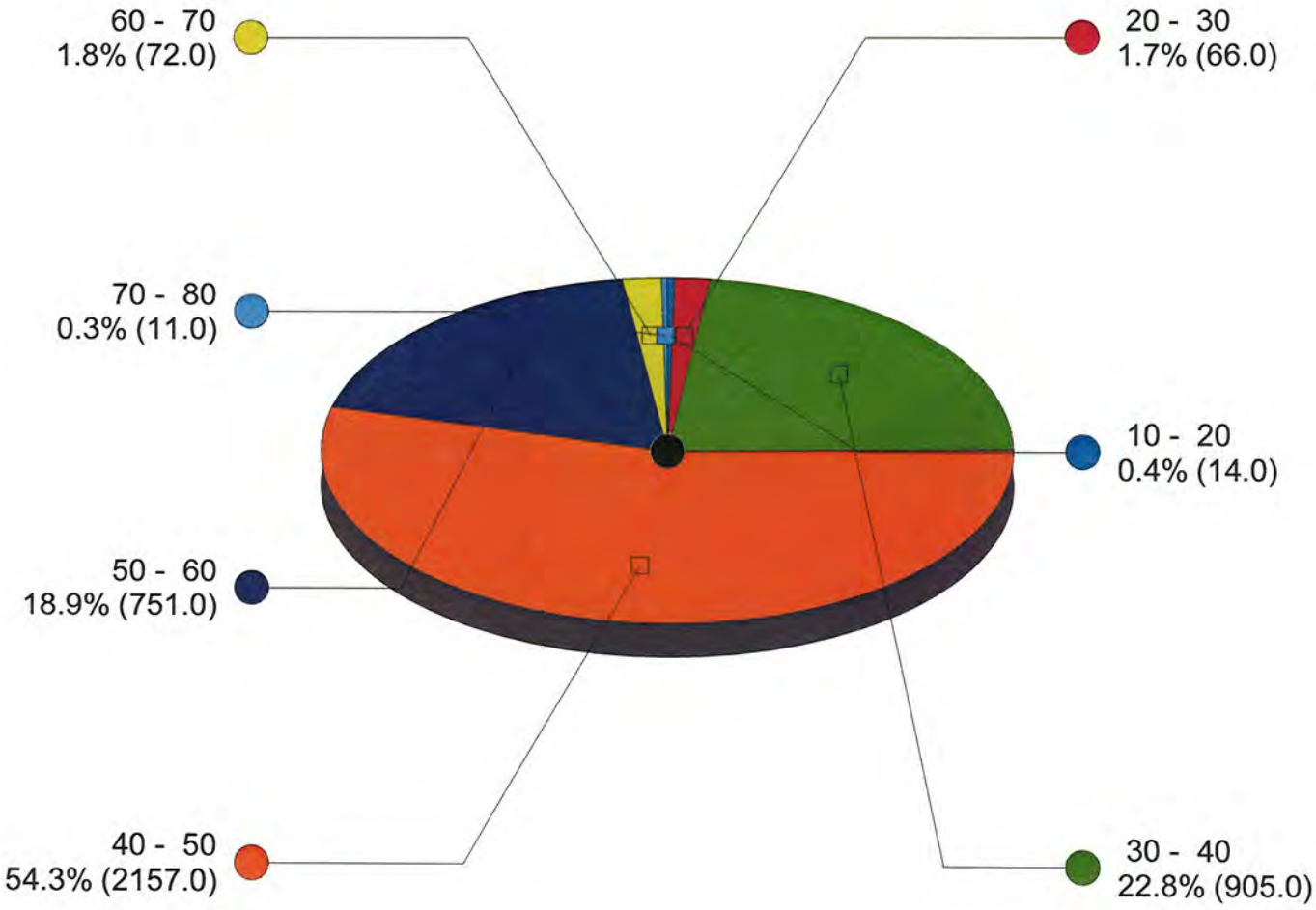
Speed Histogram

SpeedHist-348(Metric) **Site:** 99999.0WE
Description: Outside Stotts Island Tip.
Filter time:11:59 Wednesday, 10 December 2008 => 10:07 Wednesday, 17 December 2008
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (AustRoads94)



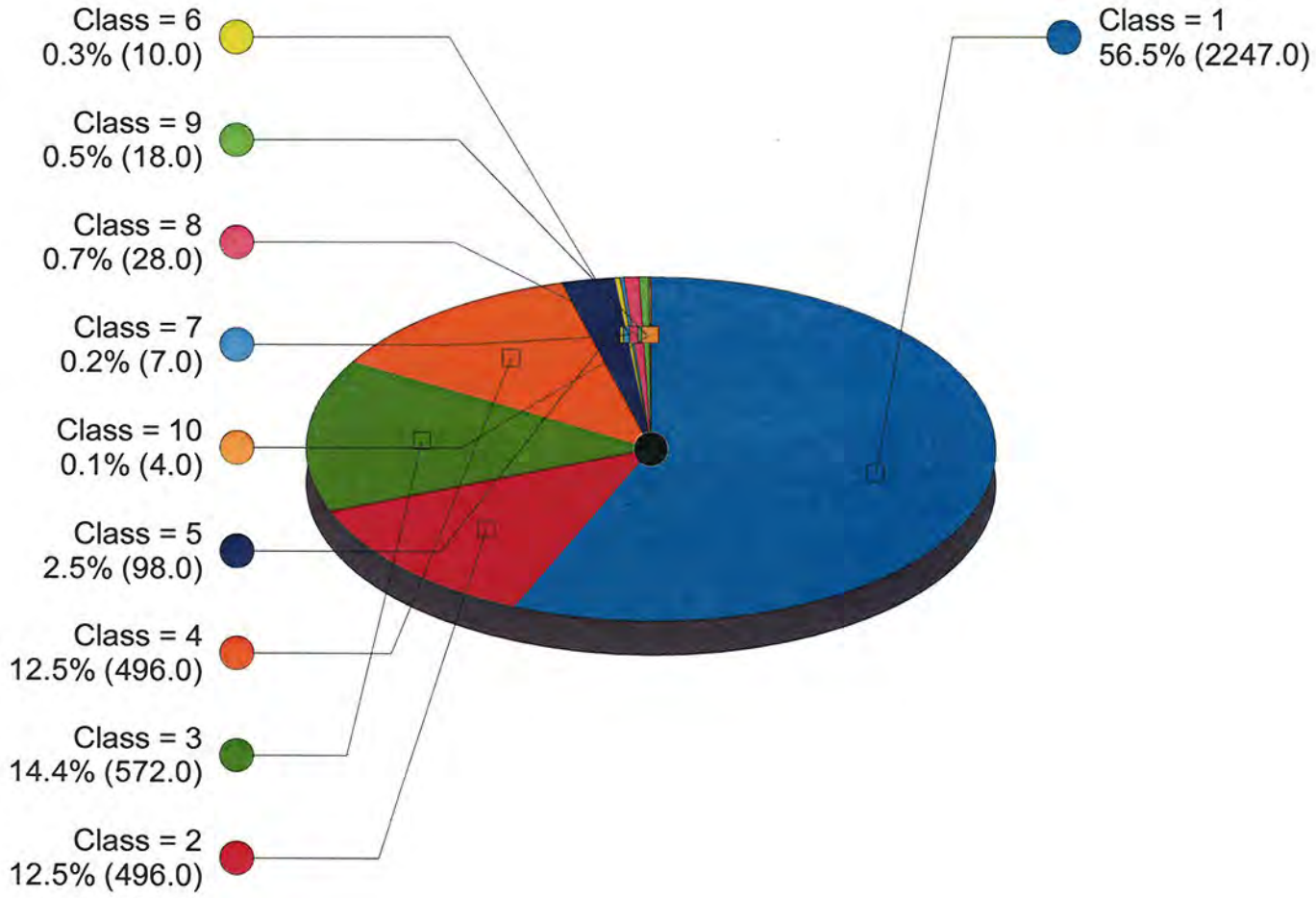
Speed Bin Chart

SpeedBin-349(Metric) **Site:** 99999.0WE
Description: Outside Stotts Island Tip.
Filter time: 11:59 Wednesday, 10 December 2008 => 10:07 Wednesday, 17 December 2008
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (AustRoads94)
Total=3976



Class Bin Chart

ClassBin-350(Metric) **Site:** 99999.0WE
Description: Outside Stotts Island Tip.
Filter time: 11:59 Wednesday, 10 December 2008 => 10:07 Wednesday, 17 December 2008
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (AustRoads94)
Total=3976



MetroCount Traffic Executive
Weekly Vehicle Counts (Virtual Week)

VirtWeeklyVehicle-27 -- English (ENA)

Datasets:

Site:	**[99999] Tweed Valley Way north of the southern entrance to Tumbulgum.**
Direction:	7 - North bound A>B, South bound B>A., **Lane:** 0
Survey Duration:	7:58 Wednesday, 2 May 2007 => 13:31 Wednesday, 9 May 2007
File:	C:\Program Files\Metro1021Count v316\User\Data\9999909May2007.EC0 (Plus)
Identifier:	L759VJMS MC56-6 [MC55] (c)Microcom 02/03/01
Algorithm:	Factory default
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**7:58 Wednesday, 2 May 2007 => 13:31 Wednesday, 9 May 2007**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range:	10 - 160 km/h.
Direction:	North, East, South, West (bound)
Separation:	All - (Headway)
Name:	Factory default profile
Scheme:	Vehicle classification (AustRoads94)
Units:	Metric (meter, kilometer, m/s, km/h, kg, tonne)
In profile:	Vehicles = 76803 / 76847 (99.94%)

Weekly Vehicle Counts (Virtual Week)

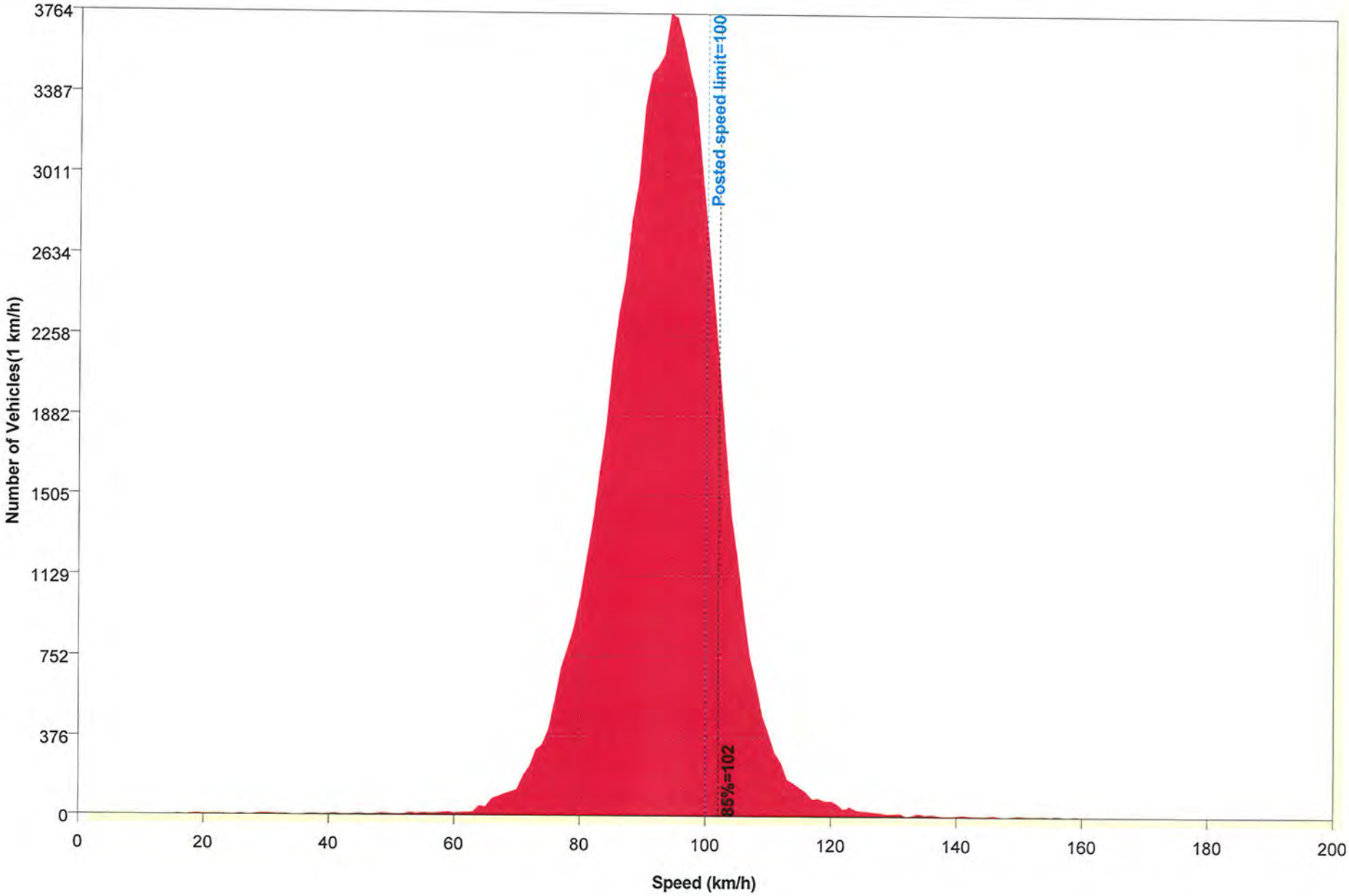
VirtWeeklyVehicle-27
Site: 99999.0SN
Description: **Tweed Valley Way north of the southern entrance to Tumbulgum.**
Filter time: **7:58 Wednesday, 2 May 2007 => 13:31 Wednesday, 9 May 2007**
Scheme: Vehicle classification (AustRoads94)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Hour	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Averages 1 - 5	Averages 1 - 7
0000-0100	23.0	23.0	22.0	18.0	35.0	70.0	73.0	24.2	37.7
0100-0200	13.0	12.0	17.0	14.0	18.0	35.0	69.0	14.8	25.4
0200-0300	14.0	23.0	16.0	17.0	24.0	32.0	60.0	18.8	26.6
0300-0400	21.0	40.0	32.0	37.0	42.0	41.0	35.0	34.4	35.4
0400-0500	56.0	75.0	73.0	81.0	68.0	43.0	40.0	70.6	62.3
0500-0600	180.0	263.0	250.0	239.0	228.0	167.0	104.0	232.0	204.4
0600-0700	533.0	667.0	**706.0<**	695.0	658.0	336.0	186.0	651.8	540.1
0700-0800	740.0	844.0	446.0	852.0	789.0	446.0	341.0	686.2	613.0
0800-0900	**945.0<**	**949.0<**	465.0	**927.0<**	**940.0<**	703.0	439.0	**781.8<**	**729.1<**
0900-1000	719.0	686.0	332.5	712.0	690.0	781.0	599.0	578.7	606.5
1000-1100	777.0	636.0	321.0	671.0	675.0	989.0	815.0	566.8	650.6
1100-1200	812.0	652.0	320.0	646.0	721.0	**992.0<**	**891.0<**	578.5	669.3
1200-1300	775.0	625.0	330.0	662.0	685.0	**941.0<**	843.0	567.8	648.9
1300-1400	840.0	659.0	202.5	734.0	755.0	907.0	812.0	565.5	639.0
1400-1500	779.0	639.0	747.0	741.0	874.0	850.0	**876.0<**	756.0	786.6
1500-1600	1016.0	919.0	**997.0<**	**1024.0<**	**972.0<**	878.0	750.0	**985.6<**	**936.6<**
1600-1700	**1043.0<**	**967.0<**	996.0	996.0	876.0	748.0	794.0	975.6	917.1
1700-1800	859.0	934.0	954.0	931.0	912.0	765.0	640.0	918.0	856.4
1800-1900	408.0	436.0	456.0	522.0	591.0	542.0	357.0	482.6	473.1
1900-2000	219.0	211.0	212.0	262.0	409.0	290.0	246.0	262.6	264.1
2000-2100	143.0	165.0	184.0	233.0	302.0	264.0	174.0	205.4	209.3
2100-2200	165.0	177.0	163.0	198.0	244.0	260.0	133.0	189.4	191.4
2200-2300	106.0	69.0	97.0	112.0	183.0	261.0	84.0	113.4	130.3
2300-2400	34.0	44.0	57.0	54.0	89.0	151.0	44.0	55.6	67.6
Totals									
0700-1900	9713.0	8946.0	6567.0	9418.0	9480.0	9542.0	8157.0	8443.1	8526.2
0600-2200	10773.0	10166.0	7832.0	10806.0	11093.0	10692.0	8896.0	9752.3	9731.2
0600-0000	10913.0	10279.0	7986.0	10972.0	11365.0	11104.0	9024.0	9921.3	9929.1
0000-0000	11220.0	10715.0	8396.0	11378.0	11780.0	11492.0	9405.0	10316.1	10320.9
AM Peak	0800	0800	0600	0800	0800	1100	1100		
	945.0	949.0	706.0	927.0	940.0	992.0	891.0		
PM Peak	1600	1600	1500	1500	1500	1200	1400		
	1043.0	967.0	997.0	1024.0	972.0	941.0	876.0		

* - No data.

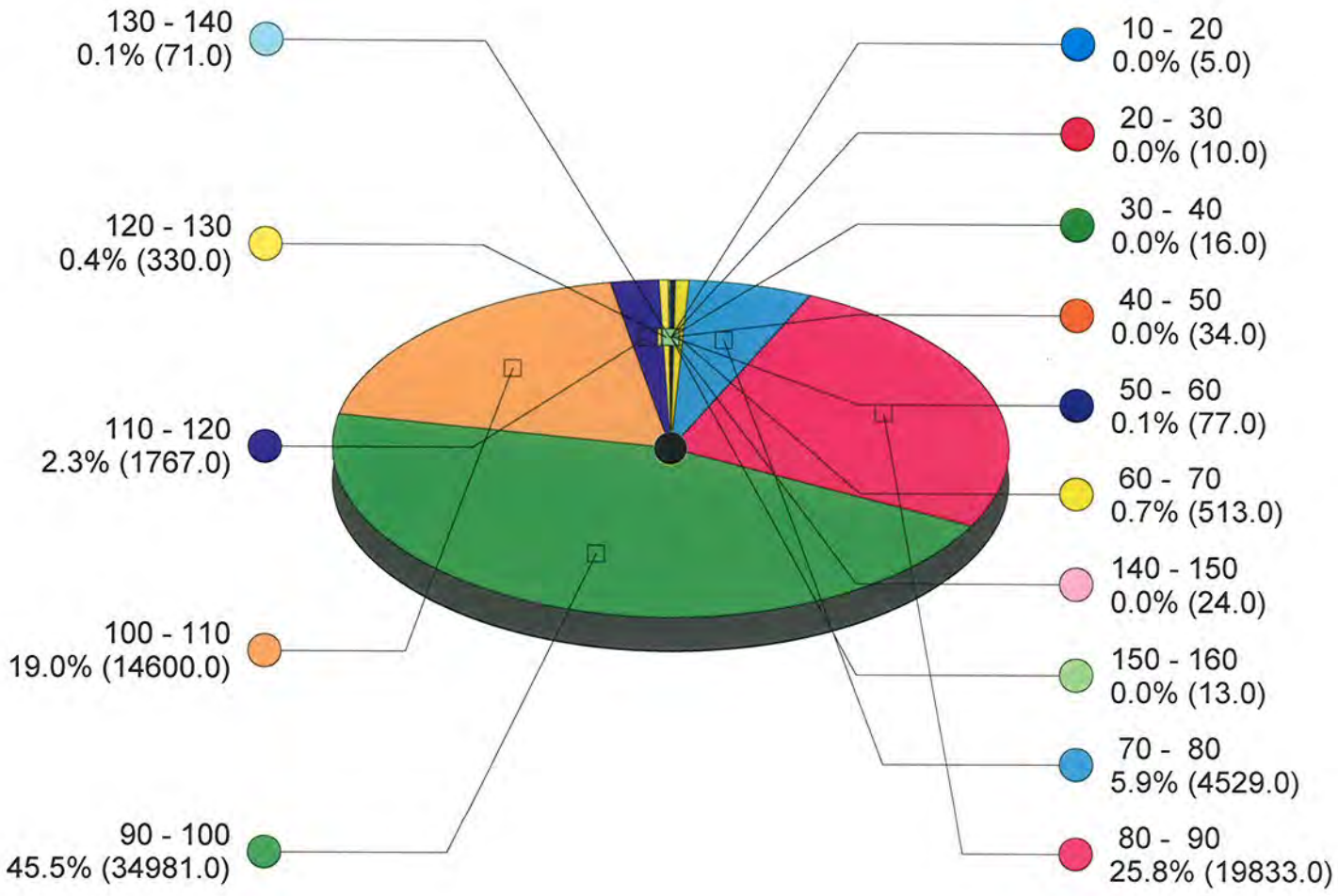
Speed Histogram

SpeedHist-26 (Metric) **Site:** 99999.0SN
Description: Tweed Valley Way north of the southern entrance to Tumbulgum.
Filter time: 7:58 Wednesday, 2 May 2007 => 13:31 Wednesday, 9 May 2007
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (AustRoads94)



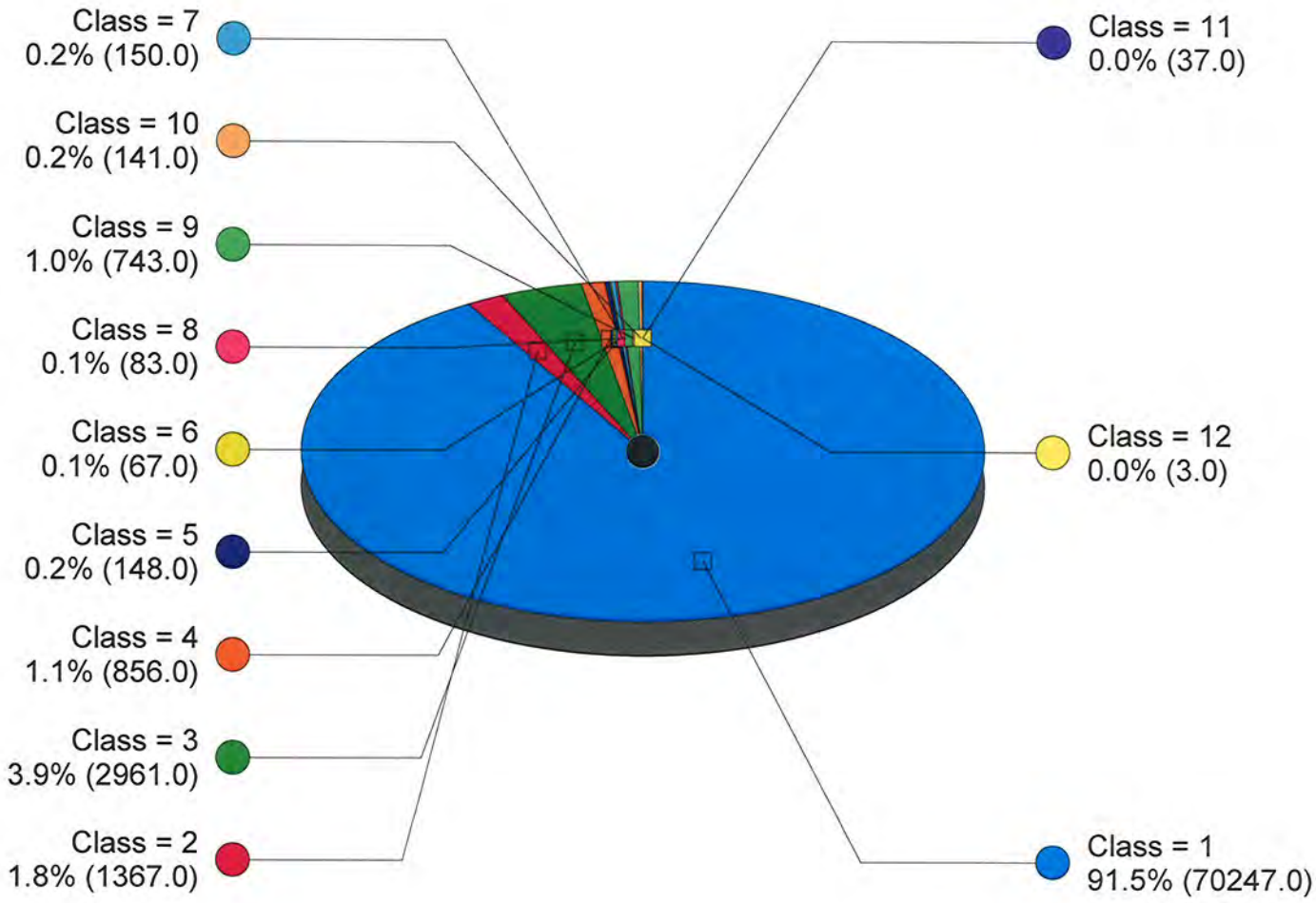
Speed Bin Chart

SpeedBin-24 (Metric) **Site:** 99999.0SN
Description: Tweed Valley Way north of the southern entrance to Tumbulgum.
Filter time: 7:58 Wednesday, 2 May 2007 => 13:31 Wednesday, 9 May 2007
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (AustRoads94)
Total=76803



Class Bin Chart

ClassBin-25 (Metric) **Site:** 99999.0SN
Description: Tweed Valley Way north of the southern entrance to Tumbulgum.
Filter time: 7:58 Wednesday, 2 May 2007 => 13:31 Wednesday, 9 May 2007
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)
Scheme: Vehicle classification (AustRoads94)
Total=76803



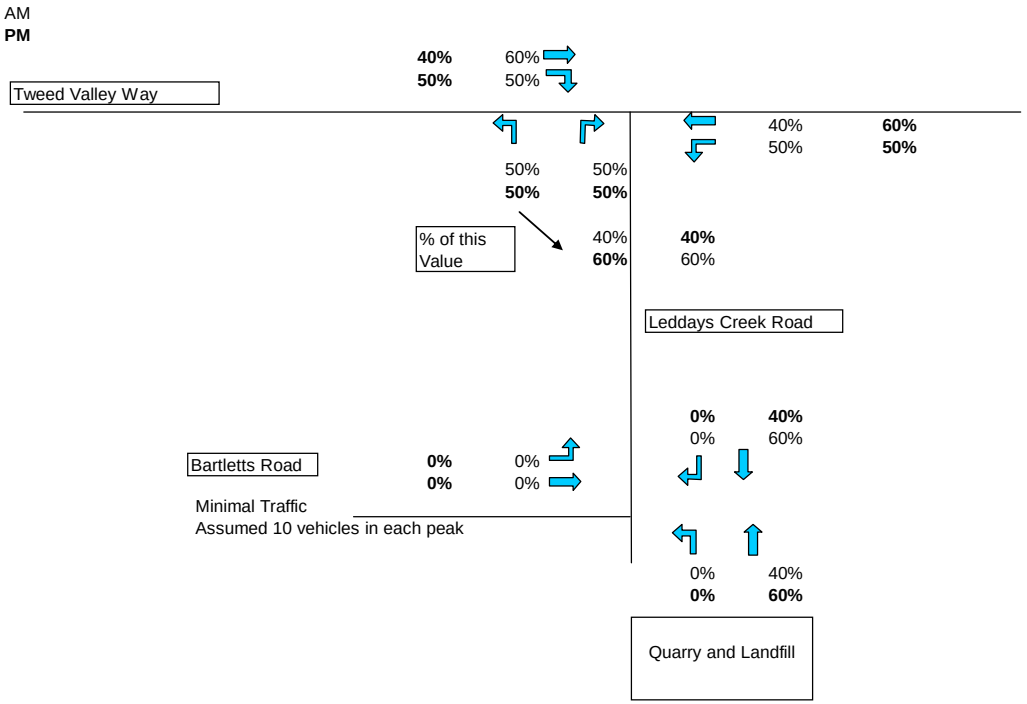
Class Speed Matrix

ClassMatrix-23
Site: 99999.0SN
Description: **Tweed Valley Way north of the southern entrance to Tumbulgum.**
Filter time: **7:58 Wednesday, 2 May 2007 => 13:31 Wednesday, 9 May 2007**
Scheme: Vehicle classification (AustRoads94)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12) Dir(NESW) Sp(10,160) Headway(>0)

Speed (km/h)	Class 1	2	3	4	5	6	7	8	9	10	11	12	Speed Totals	
10 - 20	4	.	.	1	.	.	.	.	.	.	.	.	5	0.0%
20 - 30	10	.	.	.	.	.	.	.	.	.	.	.	10	0.0%
30 - 40	15	.	.	1	.	.	.	.	.	.	.	.	16	0.0%
40 - 50	27	1	1	1	1	.	.	.	2	1	.	.	34	0.0%
50 - 60	68	4	2	1	.	1	.	.	1	.	.	.	77	0.1%
60 - 70	447	14	28	8	5	1	1	.	7	1	1	.	513	0.7%
70 - 80	4061	141	191	54	8	8	18	3	32	11	2	.	4529	5.9%
80 - 90	17811	503	913	260	37	25	54	30	160	30	8	2	19833	25.8%
90 - 100	32097	562	1282	411	57	24	59	41	368	60	19	1	34981	45.5%
100 - 110	13609	131	480	103	34	6	16	9	168	38	6	.	14600	19.0%
110 - 120	1686	8	52	13	3	1	.	.	4	.	.	.	1767	2.3%
120 - 130	307	3	10	3	3	1	1	.	1	.	1	.	330	0.4%
130 - 140	70	.	.	.	.	.	1	.	.	.	.	.	71	0.1%
140 - 150	22	.	2	.	.	.	.	.	.	.	.	.	24	0.0%
150 - 160	13	.	.	.	.	.	.	.	.	.	.	.	13	0.0%
	70247	1367	2961	856	148	67	150	83	743	141	37	3	76803	
	91.5%	1.8%	3.9%	1.1%	0.2%	0.1%	0.2%	0.1%	1.0%	0.2%	0.0%	0.0%		
	Class Totals													

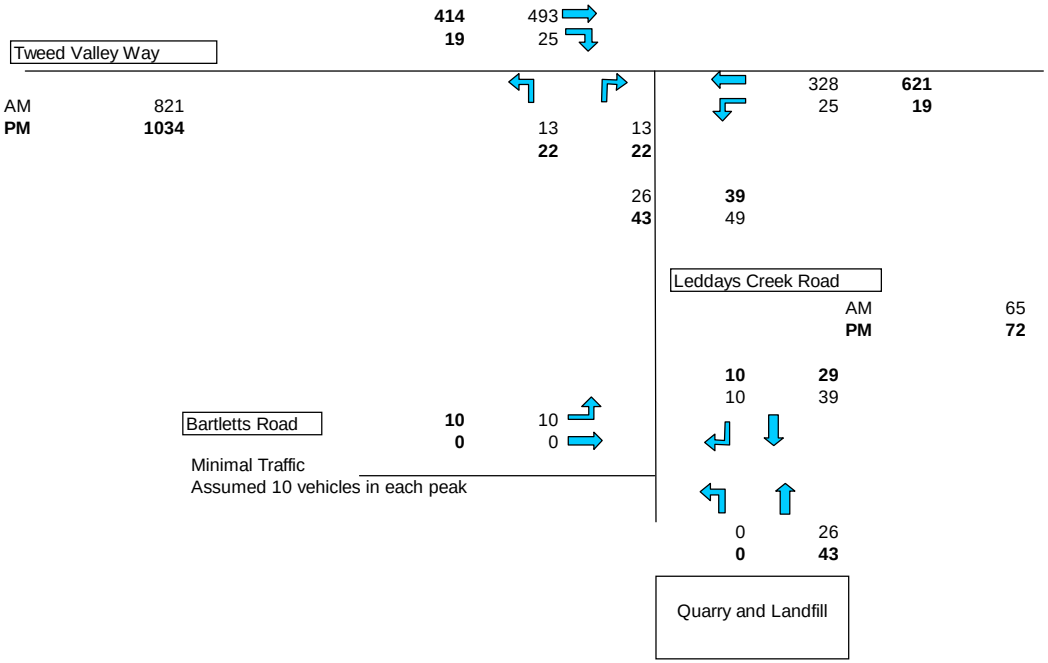
Appendix B

SIDRA Output

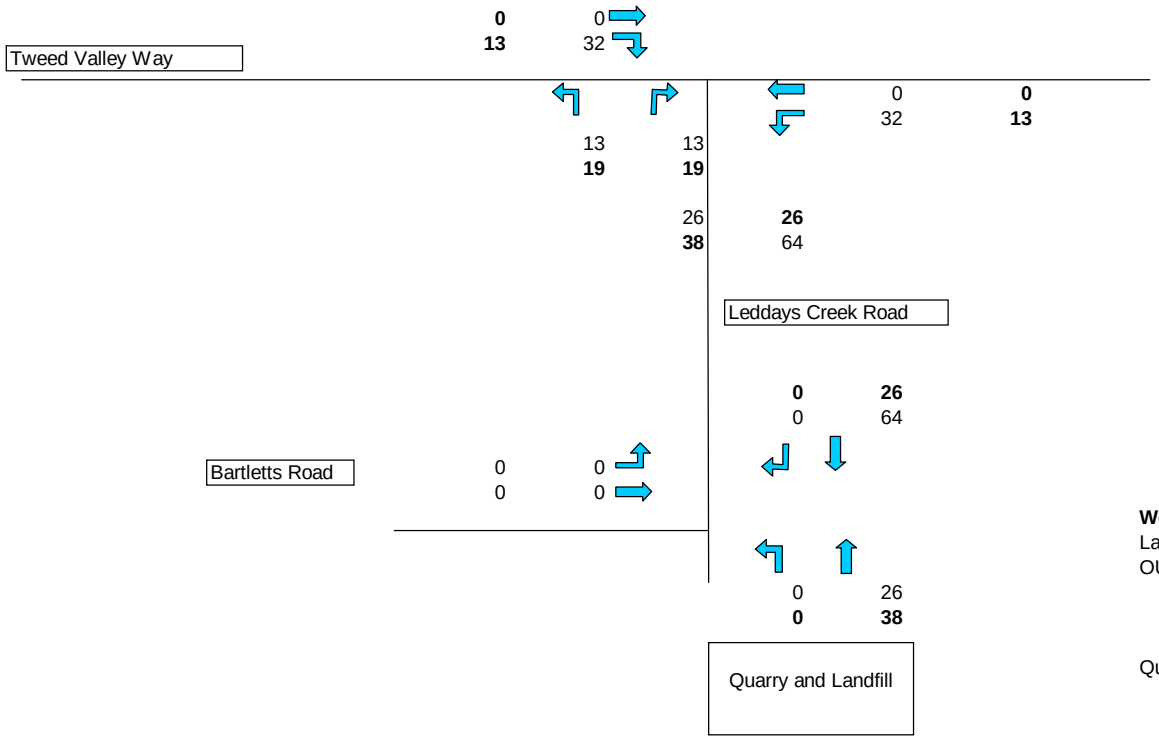


Percentage Splits

Physical Traffic Counts
Assumptions
Traffic counts have been combinded together
5% per year Traffic Growth on Counts
Assumed all traffic on Ledday Creek Road is using Quarry so no growth applied



Base AM and PM



Worst Case

Landfill

OUT	IN	
45	45	HV Vehicles peak
6	6	Staff

Quarry

3	3	HV Vehicles peak
10	10	Staff

Total	64	64

AM

Landfill

OUT	IN	
45	45	private
0	6	Staff

Quarry

3	0	HV Vehicles peak
0	10	Staff

PM

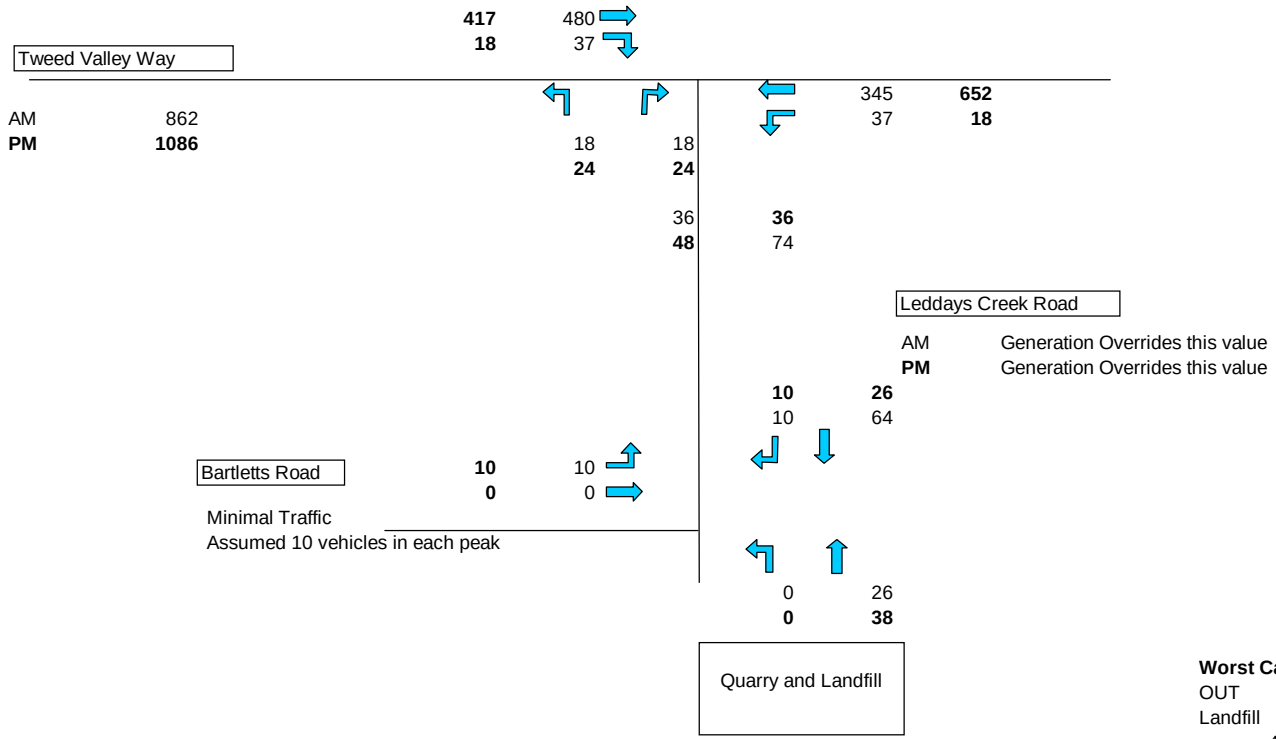
Landfill

OUT	IN	
45	45	private
6	0	Staff

Quarry

0	3	HV Vehicles peak
10	0	Staff

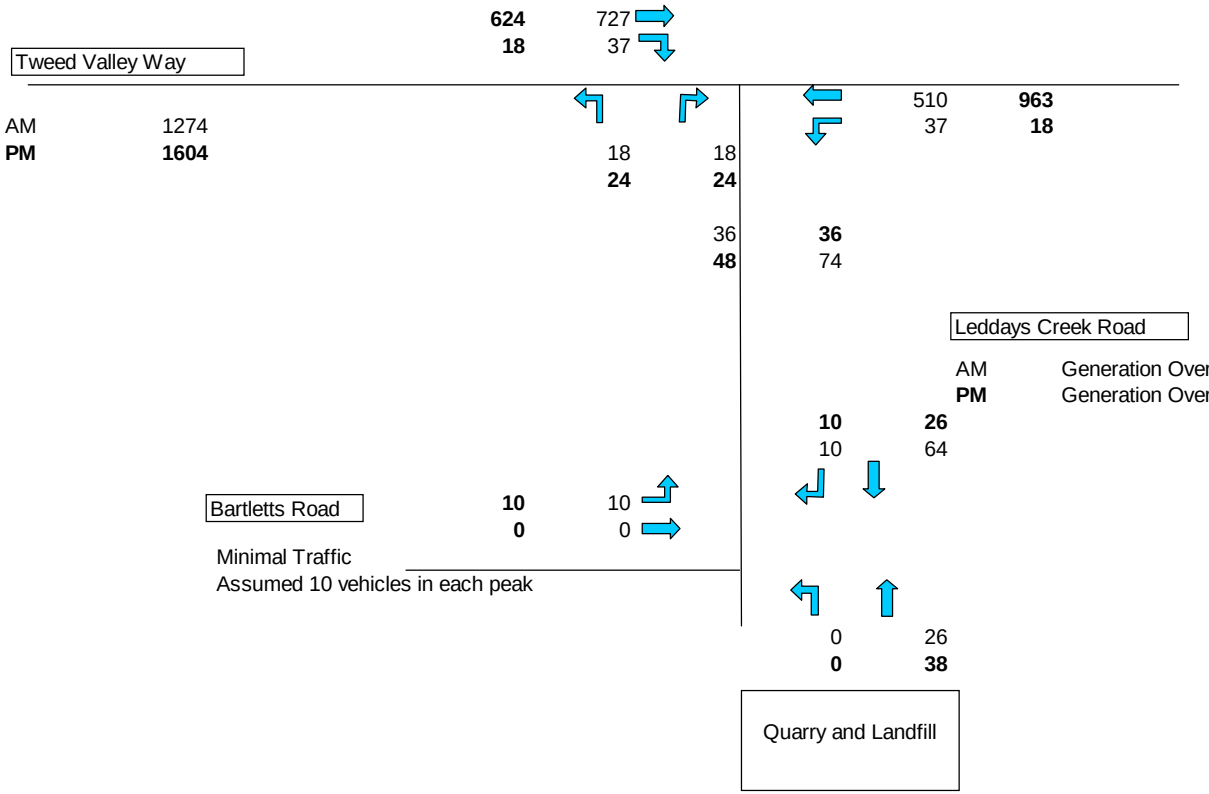
2012
Opening Year
Assumptions
5% per year Traffic Growth
Assumed all traffic on Ledday Creek Road is using Quarry/landfill
Assummed 50/50 Split for all movements
traffic on Ledday Creek Road is private vehicles using landfill so no growth applied



Worst Case

	OUT	IN		
Landfill				
	45	45	Private	
	6	6	Staff	
Quarry				
	3	3	HV Vehicles peak	Class 4
	10	10	Staff	
Total	64	64		

2012 Opening Year
Assumptions
5% per year Traffic Growth
Assumed all traffic on Ledday Creek Road is using Quarry/landfill
Assummed 50/50 Split for all movements
traffic on Ledday Creek Road is private vehicles using landfill so no growth applied



Worst Case

	OUT	IN		
Landfill				
	45	45	Private	
	6	6	Staff	
Quarry				
	3	3	HV Vehicles peak	Class 4
	10	10	Staff	
Total	64	64		

10 Year Combine AM and PM

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	R. Ward/M Fletcher	G. Nicholls		B. Van Heerden		

Appendix N

Cultural Heritage Assessment

Cultural Heritage Assessment for the Proposed Eviron Road Quarry and Landfill Site - Tweed Shire.

09117C/2009

converge
heritage + community

Converge Heritage + Community undertook this cultural heritage assessment and prepared this report.

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Eviron Road Quarry and Landfill Proposal

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09117C

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Client:
Tweed Shire Council

Revision	Date	Nature of revision	Prepared by	Authorised by
0	15/06/09	Initial Draft Report	PH, IF, SB	PH
1	19/06/09	Peer Review		GK
2	09/07/09	Final Draft	PH, IF	PH
3	31/07/09	Final Report	PH, IF	PH

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converge heritage + community

Executive Summary

This technical report details the results of a cultural heritage assessment of the Indigenous and non-Indigenous cultural heritage aspects of a site comprising four lots of approximately 158 hectares and a proposed haul road (link road) from the existing Stott's Creek Landfill Facility to the proposed Eviron Road Quarry and Landfill site as part of the Eviron Road Quarry and Landfill Proposal, Tweed Shire. Specifically, the requirements for the cultural heritage assessment and for this technical report were that:

- The presence of Aboriginal and Historic (non-Aboriginal) objects and sites should be identified and mapped;
- The significance of the area to Aboriginal people should be determined;
- That a search of the relevant registers and databases be undertaken;
- The local Aboriginal community should be consulted;
- An impact assessment of the development on any identified sites should be undertaken;
- Mitigation and/or amelioration measures will be identified;
- That procedures for unexpected finds should be prepared.

The scope did not include the drafting of a chapter for the Environmental Assessment (EA) associated with the Eviron Road Quarry and Landfill Proposal.

No areas or objects of Indigenous Cultural heritage significance were identified within the project area. This may have been contributed to by the low GI and poor GSV levels that predominated over the majority of the project area and the recent ground disturbance of ridgelines, locations where there would have been a higher possibility of identifying Indigenous Cultural heritage. Neither were any non-Indigenous areas or objects of Cultural heritage significance identified within the project area, most probably due to activities from the recent historic past including grazing, dairying and other more general farming activity, until more recent quarrying. There were five springboard trees (see section 3.2.5) identified during the field survey, which have historic interest, as they may be illustrative of the past activities of loggers and timber getters.

These survey results and the register searches indicate that there is only a low probability that further, undetected cultural heritage material may remain in the study area, either within areas of low visibility or as subsurface remains. The following recommendations were made to assist in protecting and managing the cultural heritage values of the project area.

Recommendation 1 - On-going consultation with the local Aboriginal community

On-going consultation between TSC and the local Aboriginal community is recommended, to ensure cultural considerations are incorporated into future development activities at the site. Consultation about activities that involve disturbance or modification of the land surface in the project area will be important in order to allow appropriate mitigation programs to be implemented. This on-going consultation should result in the formulation of a Management Plan (MP) for the site.

It is further recommended that TSC negotiate a Council-wide Memorandum of Understanding (MoU) with the local Aboriginal community for the management and conservation of cultural heritage. The MoU should include acknowledgement by TSC that cultural heritage assessments should take place before any land surface disturbance, including predevelopment vehicle access and placement of fill, for those areas identified as potentially containing cultural heritage.

Recommendation 2 - Program of site monitoring

A program of site monitoring by representatives of the Aboriginal Party during activities causing ground disturbance should be developed as a management option for recognised areas with a higher potential for the presence of unidentified cultural heritage. Within the project area this would be the ridgelines bounding the site and especially the north-south running ridgelines in the southeast quadrant of the project area.

Recommendation 3 - Procedures for unexpected finds

Much of the project area had poor GSV which limited the possible identification of cultural objects and raises the possibility that further, undetected cultural heritage still exists within the study area. Procedures should therefore be developed through consultation and agreement with the local Aboriginal community for unexpected finds. These procedures could be incorporated into the MoU recommended above. An agreed "Procedures for Unexpected Finds" would limit the need for monitoring of ground disturbance activities by Traditional Owner representatives as they (the procedures) provide an effective way of minimising project impacts on unrecorded Aboriginal cultural heritage. An example of "Procedures for Unexpected Finds" is provided in Attachment C for TSC and local Aboriginal community consideration and negotiation.

Recommendation 4 - Cultural heritage inductions

Due to the potential for cultural heritage to remain within the project area, it is recommended that work crews be specifically instructed of their obligations to look for cultural heritage material, including attendance at a cultural heritage awareness induction along with the distribution of educational leaflets at Workplace Health and Safety meetings. Inductions and provision of leaflets is best co-ordinated through the local Aboriginal community and should inform the workers what archaeological material may look like, and give them clear instructions on procedures for inadvertent discoveries.

Recommendation 5 - Springboard trees

Whilst no areas or objects of non-Indigenous Cultural heritage significance were identified during the field survey, there were five sites (springboard trees) of historic interest that may be illustrative of the past activities of loggers and timber getters. Wherever possible these springboard trees should be retained *in situ*. Where leaving the springboard trees *in situ* on site is not a practicable option, and specifically for EQ5, which has already been cut down, TSC should consider relocation to an appropriate location, a park for example, where they can be preserved and displayed along with appropriate interpretation.

1.0 Introduction

Converge Heritage + Community (Converge) was commissioned by the Tweed Shire Council (TSC) to undertake an assessment of the Indigenous and non-Indigenous cultural heritage aspects of the Eviron Road Quarry and Landfill Proposal at Eviron, in the Tweed Shire (the project area – Figure 1).

Figure 1: *The Eviron Road Quarry and Landfill Proposal project area (map courtesy of TSC).*

1.1 Project Background

To meet quarry and landfill requirements into the future, TSC is proposing to establish new quarry and landfill facilities at Eviron Road, Eviron, within Council owned land zoned 5(a) Special Purpose (Garbage Depot) under the Tweed Local Environment Plan 2000 (TLEP). The concept plan application involves land filling at an existing quarry (known as Quirks Quarry) once quarry materials have been exhausted, then establishing two new quarry sites (known as West Valley and North Valley) followed consecutively by landfill. The project has evolved out of the need to establish a new primary regional putrescibles landfill site as the existing Stott's Creek Landfill will reach capacity in the next few years. The proposal will be split into stages. The first stage is the subject of a separate project application to be submitted concurrently with the concept plan. The Stage 1 project application includes a landfill at Quirks Quarry, quarrying at West Valley, and associated infrastructure including a linking road from the existing Stott's Creek Landfill. The site comprises approximately 158 hectares on Lot 1 DP 34555, Lot 26 DP 615931 and Lot 602 DP

1001049 (Figure 2) and a proposed haul road (link road) from the existing Stott's Creek Landfill Facility to the proposed Eviron Road Quarry and Landfill site (Figure 3).

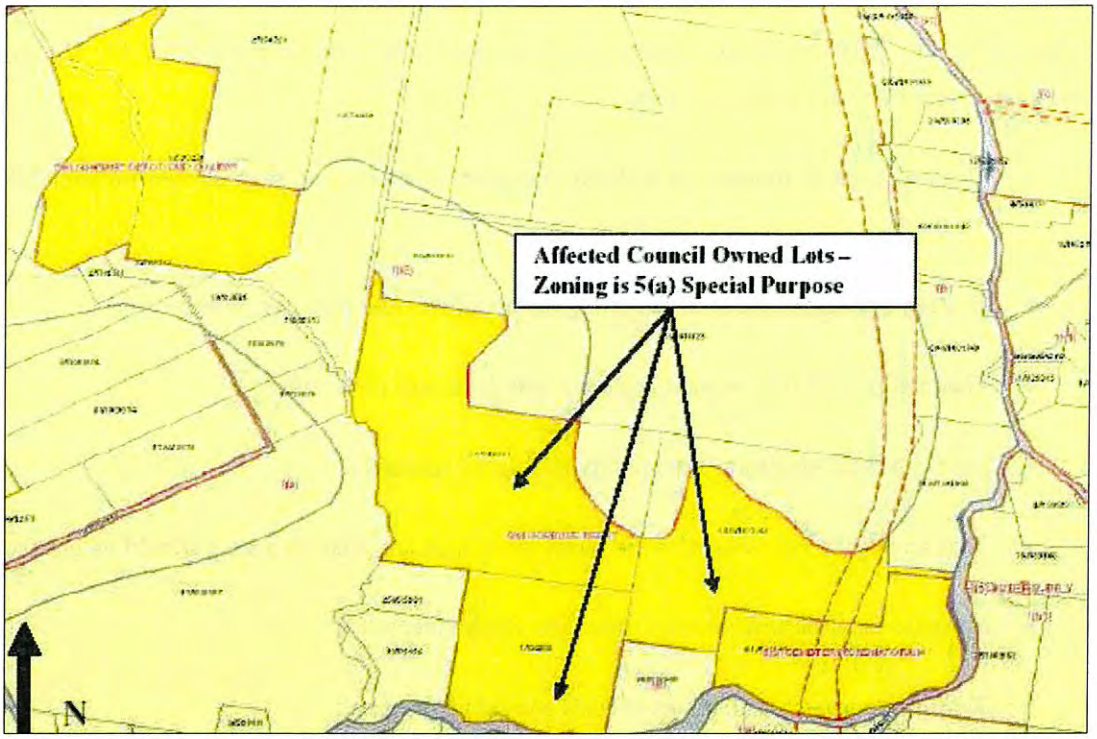
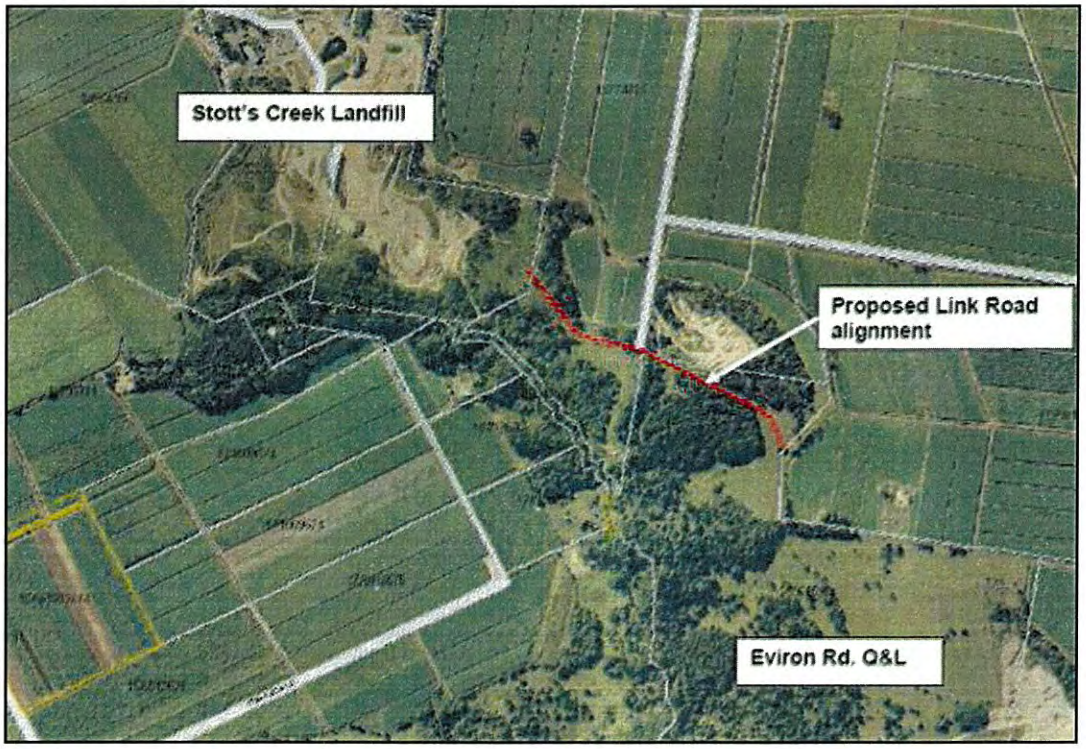


Figure 2: *Zoning and site boundaries (map courtesy of TSC).*

Figure 3: *Proposed haul road (link road) from the existing Stott's Creek Landfill Facility to the proposed Eviron Road Quarry and Landfill site (image courtesy of TSC).*



To meet the requirements of the Director General, NSW Department of Planning and the Environmental Assessment (EA) for the Eviron Road Quarry and Landfill proposal, TSC require a cultural heritage assessment (Indigenous and non-Indigenous), a technical report and a subsequent chapter for the Environmental Assessment (EA). Specifically, the requirements for the cultural heritage assessment and report are that:

- The presence of Indigenous and non-Indigenous objects and sites should be identified and mapped;
- The significance of the area to Aboriginal people should be determined;
- That a search of the relevant registers and databases undertaken;
- That the local Aboriginal community should be consulted;
- That an impact assessment of the development on any identified sites should be undertaken;
- Mitigation and/or amelioration measures will be identified;
- That procedures for unexpected finds should be prepared.

It is understood the project area comprises approximately 158 hectares of Tweed Shire Council owned land and also includes a proposed haul road alignment connecting the proposed quarry and landfill site to Stott's Creek, an existing landfill to the north west of the site (outside study area).

1.2 Consultation

Consultation for this cultural heritage assessment has been in accordance with both the DECC January 2005 Protecting Aboriginal Objects and Places - Interim Guidelines for Community Consultation and the May 2009 Draft Community Consultation Requirements for Proponents. Within Tweed Shire there are three Aboriginal community groups who have previously expressed an interest in directly participating in cultural heritage assessment. Each of the three groups were notified and invited to register an interest for consultation and assessment of the project area. The notification, registration, information exchange, and review process was as follows:

- On 1 May 2009, a representative of Converge Heritage + Community, Ian Fox, met with the Tweed Shire Council Aboriginal Advisory Committee (AAC) and confirmed the groups interest and registration for the project area. Advice about the project proposal was provided and the AAC nominated a community member

and Traditional Owner descendant, Mark Cora, to participate in field assessment and liaise on the AAC's behalf. The AAC includes representatives of a number of Tweed Aboriginal community groups including the Tweed/Byron Local Aboriginal Land Council (TBLALC) and Minjungbal Museum and Resource Study Centre (MMRSC). Both these organisations have previously participated in cultural heritage assessment and nominated George Scott (TBLALC) and Garth Lena (MMRSC) to participate in field work and liaise on the respective group's behalf.

- In order to ensure that Aboriginal community members who are not members of representative groups would have the opportunity to register their interest in the project area a public notice was placed in the Tweed Daily News on 18 May, 2009. Three persons responded to the public notice but each was previously aware of the project through the meeting held with the AAC on 1 May, 2009. The registered respondents were; Jackie McDonald on behalf of her family; Lesley Mye on behalf of her family; and Aunty Joyce Summers on behalf of her family. Each respondent was contacted by telephone and provided information in relation to the project and assessment process. Each respondent nominated Mark Cora (previously nominated by the AAC) to represent their interests during field assessment.

- Participants in the field assessment (see section 3.2 Field Survey Outcomes) provided information exchange which is included in this report (see section 4.0 Site Evaluation and Impact Assessment). A copy of this Draft Cultural Heritage Assessment Report will be provided to each of the three community groups and individual respondents to public notification. Following a period of 21 days to review the draft and respond all comments will be collated for inclusion in the final report.

- Copies of the final report will be provided to registered Aboriginal parties (AAC, TBLALC, MMRSC, and three respondents to Public Notice) as well as DECC. Notification of acceptance of the Final Report by Aboriginal parties will be forwarded to DECC for consideration, however, at this stage it is not intended to make application for an Aboriginal Heritage Impact Permit (AHIP) (see section 3.3 Conclusion).

1.3 Scope of Study

Converge was commissioned by the TSC to undertake a cultural heritage assessment of the Indigenous and non-Indigenous cultural heritage aspects of a site comprising four lots of approximately 158 hectares and a proposed haul road (link road) from the existing Stott's Creek Landfill Facility to the proposed Eviron Road Quarry and Landfill site as part of the Eviron Road Quarry and Landfill Proposal. The requirements for the cultural heritage assessment and technical report are detailed in Section 1.1 Project Background. The scope did not include the drafting of a chapter for the Environmental Assessment (EA) associated with the Eviron Road Quarry and Landfill Proposal.

2.0 Contextual Research

2.1 Bio-geographical Context

The physical landscape is important in identifying the interface between humans and their environment, and this is particularly true of Aboriginal Australia where a close relationship has always existed between people and their surroundings. Environmental factors can also have considerable influence upon the distribution of people (and thus the archaeological remains of their sites) across the landscape. Hence consideration of vegetation, geomorphology and geology is important in establishing an interpretative framework for the archaeological record.

Similarly, estimation of the availability of potential food and fibre resources available to Aboriginal groups offers another valuable clue in evaluating the most likely ways they would have utilised areas. Extant vegetation, its structure and condition also provide indicators of the integrity of the ground surface. By looking at aspects like species structure, integrity of the bush land and presence/absence of certain plant and grass species susceptible to ploughing disturbance, it can be determined whether an environment has been modified and by what degree. This is important for developing an objective idea of what the environment and ecosystem could have been like before the impacts of European settlement.

2.1.1 Vegetation

The site has undergone extensive clearing in the past as a result of timber getting, pastoralism and agriculture and more recently quarrying activities. The existing vegetation consists of mixed grasses, weeds, ferns, small stands of mango and other fruit trees, and regrowth vegetation. On the steeper slopes the regrowth vegetation is dominated by introduced noxious species such as Camphor Laurel (*Cinnamomum camphora*), with some Lantana (*Lantana camara*). The presence of these species confirms to a degree that extensive land clearing has occurred at the site at some time in the recent past. There are isolated remnant Eucalypt trees including Ironbark (*Eucalyptus crebra*), Tallowwood (*Eucalyptus microcorys*), Flooded Gum (*Eucalyptus grandis*), Sydney Blue Gum (*Eucalyptus saligna*), and some remnant dry forest species such as Hoop Pines (*Araucaria*

Figure 4: *Regrouth vegetation*

cunninghamii). Some of the lower lying areas between the ridgelines with higher soil moisture still contain swamp vegetation dominated by Broad-leaved Paperbark (*Melaleuca quinquenervia*). The site is also bounded in the north by sugar cane fields.

2.1.2 Geomorphology and Geology

The study area is dominated by the Palaeozoic Neranleigh-Fernvale group comprising shales, siltstones and sandstones, and massive cobble conglomerates. The low lying portions of the site are underlain by deep Quaternary alluvium and estuarine sediments, with marine clays present. The site contains eroded drainage lines that flow to man-made agricultural drains which discharge from the site.

2.2 Aboriginal Cultural Background

Scientific assessment of cultural evidence from selected sites supports the fact that Aboriginal people were living in the Tweed from 10,000 years ago, and at least 20,000 years ago regionally (Neal & Stock, 1986). Aboriginal oral tradition tells a story of 'Three Brothers' who first came to this land in the 'Dreamtime' and formed the nucleus of tribes with whom today's Traditional Owner descendants identify (Vesper, undated). A common feature of their identity is language, acknowledged as the Bundjalung / Yugumbeh language chain. The language dialect for the Tweed is known as Ngandowal, a name referring to the people who say 'Ngando' for the word 'who' or 'somebody' (Livingstone, 1892).

There are more than 50 names used to describe the Tweed areas traditional Aboriginal people in the written record of the early European settlers (Fox, 2003). However, there is general acceptance for the presence of three main groups in the Tweed River Valley. These were the Cooginburra people for the Tweed Coastal area, the Tul-gi-gin people for the North Arm, and the Moorang-Moobar people for the Southern and Central Arms around Wollumbin (Mt Warning) (Harper, 1894; Keats, 1988). Population numbers of these three groups are known to have fallen dramatically, before and after the permanent European presence, mainly through the unchecked spread of European sourced illness and disease. Research suggests that prior to any European contact each of the three groups may have contained from 500 to 700 members distributed across their area of 'country' (Fox, in prep, 2009).

The project area would likely have been within the 'country' of the Cooginburra people as it is known that a favored winter camp for this group, at the time of European settlement, was on

the eastern bank of the Tweed River, approximately 4kms to the north-west (see section 2.5 Register Searches). The last 'traditional member' of the Cooginburra people (also known as the Bogangar tribe) was Biddy Richmond, whose obituary is recorded in the Tweed Daily, August 21, 1933.

2.3 Historical Background

This section presents a brief contextual history of the Tweed River Valley area and is largely summarised from the book, 'Regional Histories of New South Wales', prepared by the Heritage Office and Department of Urban Affairs and Planning (1996). It is not intended to be an exhaustive historical treatment of the project area.

Permanent European settlement of the Tweed began around 1844. These settlers were generally loggers and timber getters with Terranora emerging as the centre for cedar getters in the 1860s. The timber getters were joined by pastoralists around 1860 with a boom in the 1870s. Land was rapidly taken up by small farms with farmers experimenting with an array of crops including opium poppies, arrowroot, mulberry trees for silkworm and tobacco however eventually falling back on maize and sugar (Heritage Office and Department of Urban Affairs and Planning 1996:68). By 1880, the sugar industry had boomed with several mills in operation at Cudgen, Abbotsford and the CSR mill at Condong. Towns began to prosper in the region, the most popular being Murwillumbah which was gazetted as a town in 1879 (Heritage Office and Department of Urban Affairs and Planning 1996:68). By 1894, the railway had connected Lismore to Murwillumbah via Byron Bay and later connected to the State rail network through Casino to Grafton.

Land records data available from the Tweed Heads and District Historical Society identify the survey of a road along the ridgeline (Condong Range) at the southern boundary of the project area that connected Condong, on the Tweed River, to Duranbah in the east. The road was surveyed on 24 March, 1896, and shows the location of the CSR mill at Condong and farms serviced by the road along the route. The first recorded land owner for the area of the subject properties identified in Figure 2 was Arthur Loder, who selected a large portion (No. 247) in 1889 that included some of the area of the present Quirks Quarry and much of the lower floodplain, which was progressively cleared and drained to plant sugar cane. In 1899 Heindrick Appo is the first selector of 50 acres (No. 82) along the ridgeline and valley which contains the current access road, off Eviron Road, to Quirks Quarry. Subdivision of Lot 247 took place in

1908 and John Bird selected the balance of remaining Crown Land and a portion of No. 247 which became two titles of No. 260 and No. 261. Bird's property totaled 220 acres and along with Appo's 50 acres, effectively included all of the project area which is now the subject of the quarry and landfill proposal.

From an historical perspective maps of the Land Records Data provide annotations of original vegetation cover, prior to land clearance, and locations for existing structures and access tracks. In this case an access track is marked on maps which lead down the watershed ridgeline of Condong Range to the North West of the project area, in the direction of the current Stotts Island Landfill facility. Distribution of the original vegetation is mapped and marked as: *Brush in gullies and on lower slopes, box gum, bloodwood, blackbutt, ironbark and tallowwood on ridges, mahogany tea tree and oak in swamp.*

A gumming disease crisis infiltrated the sugar cane industry in the 1890s and dairy farming began to take over with the peak of the industry transpiring in the early 1940s. Commercial banana farming emerged from 1910 and it was at this time that Indians and Chinese also entered the industry. Despite the 'bunchy top' disease proving to be a small set back in the industry in the 1920s, the banana trade remained an important industry. Vegetables such as peas, beans and potatoes eventually replaced maize which is now primarily grown as a fodder crop (Heritage Office and Department of Urban Planning 1996:68). Sugar cane cultivation continues in the vicinity of the project area.

Figure5: *Quirks Quarry and sugar cane cultivation.*

Murwillumbah became the primary supportive town to all these industries, however it now displays little evidence of its history due to the great fire of 1907 having destroyed its main street. Tweed Heads has successfully turned to tourism with some of its most popular tourist destinations being Mount Warning, Springbrook and Lamington National Parks and the Border Ranges.

2.4 Previous Studies

Aside from traditional knowledge, that is knowledge passed down through the generations by word of mouth, there is some literature available concerning Aboriginal culture in the Tweed area (for example see Harper 1894; Curr 1887; Crowley 1978; Keats 1988; Neal and Stock 1986). The following section provides a brief outline of relevant archaeological and cultural heritage findings from research projects and previous consultancy works carried out in proximity to the present project area.

2.4.1 Academic Research

The Bundjalung Mapping Project (BMP) is a pilot project designed to assist Indigenous Australian communities to record, store and manage information about their cultural places and landscapes. The Project, based on the north coast of New South Wales, is the result of a unique partnership between Southern Cross University, Bundjalung people, the Northern Rivers Catchment Management Authority, and the Department of Environment & Climate Change (National Parks and Wildlife Service Division). A Memorandum of Understanding sets out guidelines and the conditions of information access and exchange.

An electronic database has been designed and successfully trialled with the Tweed Aboriginal community which stores community knowledge in a culturally appropriate way. The database is cross referenced to a documentary library or 'Keeping Place' containing in excess of 1250 separate entries collected from private resources and the public domain. Access to the database and library is controlled by the community and in the case of the current trial, by the Tweed/Byron Local Aboriginal Land Council. The TBLALC are participants in this Preliminary Archaeological Assessment and have provided approval for access to the BMP database and documentary records.

2.4.2 Consultancies

Recent work undertaken in the general area includes a Preliminary Archaeological Overview of the proposed Byrrill Creek Dam (Converge 2009a) located approximately three kilometres north west of Kunghur and 30 kilometres south west of the present project area. The study included consultation with the Aboriginal community, a preliminary field survey to assess impacts to Aboriginal cultural heritage values and a literature review. Four sites of Aboriginal cultural heritage significance were located during the survey. This, coupled with the numerous Aboriginal sites and areas previously recorded within the area, indicated that there was a reasonable possibility that further, undetected cultural heritage material and associated elements would remain within the

proposed dam area. Aboriginal sites within the proposed dam area included isolates, artefact scatters, scarred trees and grinding areas.

Converge (2009b) also undertook an archaeological excavation of a small shell midden identified during the construction of a road deviation in West Tweed Heads (approximately 13 kilometres north-west of the current project area). Investigations also included further survey of the remainder of the deviation footprint. Excavations revealed that the shell midden was of a relatively small size with material ranging in size from complete shells to small fragments. The majority of shell was recovered from the top 10cms of the deposit. The shell material consisted of oyster with some remains of large and small varieties of whelks; all estuarine shell fish species. One stone artefact was recovered: a bifacial retouched silcrete flake. The survey revealed two previously unidentified sites, a stone artefact scatter and a shell scatter. These sites were however beyond the road corridor and would not have been impacted as a result of any remaining construction activity. A cultural significance story, based on consultation with the local Aboriginal community, was also composed to provide a strengthened emphasis for determining cultural significance and heritage assessment, which was more inclusive of the Aboriginal community's perspective.

Recent consultancy work in the general area also includes the Aboriginal Cultural Heritage Assessment and Management Plan (Mary Dallas Consulting Archaeologists 2009) for the proposed Nightcap Village rural settlement area, located approximately 28 kilometres south west of the current project area. The survey and assessment resulted in the location of five surface stone artefact scatters (identified as open campsites), two isolated stone artefacts and areas of relatively undisturbed deposits with the potential to contain sub-surface remains. Three of the open campsites had been previously recorded by McIntyre (AHIMS #04-1-0018) and Tweed Byron LALC (NV1 and NV2). Common stone artefact types included flakes, retouched flakes and cores of predominantly silcrete and quartzite. It was recommended that project impact should avoid two of the five campsite locations. Recommendations also included test excavations of three locations including one of the open campsites, one area where an isolated artefact was located in association with an area of Potential Aboriginal Deposit (PAD) and a subsequent PAD area.

Everick Heritage Consultants Pty Ltd (2007) undertook a cultural heritage assessment of a proposed sand quarry at South Ballina in north-eastern NSW (approximately 60 kilometres south of the current project area). There were no recorded sites on the DECC Aboriginal Heritage Information Management System (AHIMS) register and database within the vicinity of the subject lands and there was no evidence of Aboriginal sites or relics identified during the field survey of areas to be impacted by proposed quarry activities. The Jali Local Aboriginal Land Council also did

not identify any areas of cultural significance within the subject lands. The author states that the literature and site data indicated that it was unlikely that Aboriginal sites would be found in this environment and even if sites did exist, they are unlikely to be *in situ* due to the large proportion of disturbed surface sand.

Everick Heritage Consultants Pty Ltd (2008) undertook a cultural heritage assessment of the Kings Forest Estate, between Duranbah and the Tweed Coast and approximately 3km to the east of the project area. Kings Forest has been the subject of at least five archaeological surveys over the past 30 years, primarily because the area has been identified for potential urban development. Much of the area has been disturbed with land clearance, sand mining, agriculture, and establishment of timber plantations which have been subsequently cleared. A total of 17 recorded sites were assessed and resulted in a recommendation that six sites be left *in situ* within areas not subject to past disturbance or future development. Of the remainder, two sites had been destroyed, two potential sites were not recognised by Traditional Owner descendents, and due to significant disturbance seven sites were recommended for professional excavation and recovery of artefacts.

Mary Dallas Consulting Archaeologists (2008) undertook an Aboriginal and European cultural heritage assessment of the Casuarina Town Centre, Kingscliff South, on the Tweed Coast and approximately 6km east of the project area. No sites or items of European heritage significance or areas of historical archaeological potential were identified within the study area during the site inspection. No Aboriginal sites or individual items of Aboriginal cultural history were identified on the land subject to the proposed development. It was noted that the subject land was severely impacted by a sustained period of sand mining between the 1950's and 1970's and any evidence of cultural remains was likely to have been destroyed at that time. It was recommended that suitable signage be erected to recognise Aboriginal occupation of the land and further signage provide sand mining history of the area. Any further investigation for cultural evidence was considered un-warranted.

2.5 Register Searches

Desktop searches of the following register and databases were undertaken for the project area: Aboriginal Heritage Information Management System (AHIMS) Aboriginal sites register; the Bundjalung Mapping Project (BMP) Aboriginal sites database; the (former) Register of the National Estate; World Heritage List; National Heritage List; and the Commonwealth Heritage List.

There were no Aboriginal sites listed on the World Heritage List, National Heritage List, the Commonwealth Heritage List or the (former) Register of the National Estate within the project area.

There were no sites listed on the AHIMS Aboriginal sites register (provided as a printout list from DECC). However, there are five sites recorded on the BMP database on the Tweed River floodplain and within 4kms of the project area (see Table 1). A further six sites are recorded to the east, beyond Duranbah Ridge, and approximately 3kms from the project area. (This area is known as Kings Forest and each site is the location for an isolated find, such as a stone axe). Note: At the request of the TBLALC grid references are not provided. Should further information be necessary, other than that provided, enquiries should be directed to the Sites Officer TBLALC.

Table 1: BMP Sites

Site	Location	Type	Comment
Ev 1	Dinseys Rock	Bora Ring	Photograph and information provided by Dinsey family. Also stated an Aboriginal burial area is nearby to the rock (Mary Keeshan – granddaughter of George Dinsey).
Ev 2	"Camden Haven"	Open campsite	Property of Quirk family on eastern bank of Tweed River. Recorded as the winter campsite for Aboriginal people at the time of early European settlement.
Ev 3	"Camden Haven"	Burial area	Property of Quirk family on eastern bank of Tweed River. Aboriginal burial area in clump of trees along eastern property boundary. Note: May be the same location as stated by Mary Keeshan (Ev 1)
Ev 4	Leddays Creek	Midden	Shell midden beside creek bank to the south of Stotts Island (now cane field) information provided by Jenny Wein – exact location not provided.
Ev 5	Stotts Creek	Midden	Shell midden at the base of ridgeline adjacent to McLeods Creek.

3.0 Fieldwork

3.1 Methodology

Archaeologists use various forms of assessment to carry out cultural heritage surveys and these surveys occur in a series of clearly defined steps including sampling, surveying, site evaluation, recording, impact assessment, and management recommendations. This project is a cultural heritage assessment in relation to Indigenous and non-Indigenous cultural heritage sites and places within the project area. Briefly, the methodology applied to the cultural heritage assessment was as follows:

- The field survey was to assess the presence of, and/or the potential for Indigenous and non-Indigenous cultural heritage within the project area;

- The field survey was carried out on foot and, due to the entire project area not being surveyed, used a *probabilistic* sampling strategy (i.e. where decisions are made to survey without reference to any prior knowledge or predictive model of what heritage resources might exist in the landscape);

- Traditional Owner representatives participated in the field survey and consultation was in accordance with DECC Aboriginal Cultural Heritage Draft Community Consultation Requirements for Proponents, May 2009, provided under Part 6 of the *National Parks and Wildlife Act, 1974*. Traditional Owner representatives were encouraged to provide oral information about any culturally sensitive areas and voice any concerns they may have felt during the fieldwork;

- For the purposes of this report the following definitions apply:

  ⇒ **Site** refers to *all* physical traces of Aboriginal occupation, including isolated artefacts, or traces of non-Indigenous cultural heritage.

  ⇒ **Isolate** refers to a find-spot of a single artefact separated by more than 30 metres from other artefacts and/or associated archaeological features.

  ⇒ **Artefact scatter** refers to a group of 2 or more artefacts located on the ground surface, with a distance of no greater than 30m between each and occurring within an arbitrary linear distance nominated by the archaeologist subject to factors such as artefact

type, environment, visibility, integrity and previously recorded site characteristics occurring within the larger project area.

- Culturally modified trees, commonly called **scarred** or **carved** trees, were assessed according to a detailed list of selection criteria developed by Converge that allow for some degree of scientific rigour to be applied to the identification process.

- Where relevant the archaeologist made reference to the principles of the Burra Charter (see Appendix B) as a basis for attributing levels of scientific significance to areas or objects noted during the survey. However with respect to Indigenous cultural heritage, the attribution of significance on the basis of cultural grounds was left entirely to the Traditional Owner representatives on the survey team;

- Areas of interest were photographed using a digital camera with 12.1 effective mega-pixels, and locations were recorded using a hand-held global positioning system (GPS) accurate to approximately 4 metres (WGS 84 geodetic format), and all field data was recorded in a field notebook. Upon completion of the report these photographs are stored on disk (CD) in the Converge office;

- There are a variety of issues that can, in a variety of ways, constrain cultural heritage survey and assessment. Two constraints, however, remain constant across all landscapes; ground surface visibility and ground surface integrity. **Ground Surface Integrity (GI)** and **Ground Surface Visibility (GSV)** were both recorded across the project area in order to provide insight into the levels to which the landscape had been modified, and how much of the ground surface could actually be seen during the survey. GI and GSV levels were both determined using a percentage range between 0-100% i.e. **Zero - 0%; Poor - 1-25%; Moderate- 26-50%; Fair - 51-75%; Good - 76-85%; Excellent 86-100%**.

3.2 Field Survey Outcomes

The field component of this cultural heritage assessment was conducted over three days on 18th - 19th March 2009 and 30 July 2009. The study area was traversed via the use of both established vehicle tracks and walking paths, as well as exploration of more vegetated areas (regrowth forest and grassed area). A particular focus of the survey was the ridgelines bounding the project area.

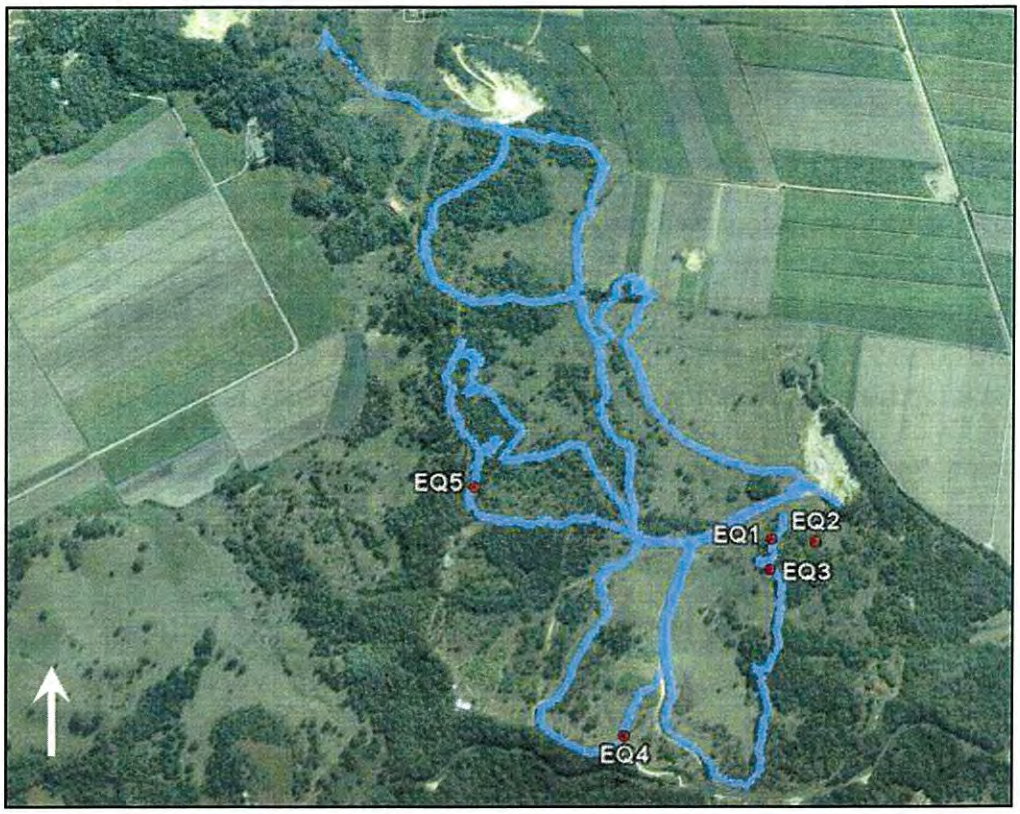


Figure 6: *Survey routes and sites of Historic Interest (Image adapted from Google Earth Pro 2008).*

3.2.1 GI and GSV within the Project Area

The majority of the project area demonstrated poor GI exhibiting clear evidence of being subject to long-term disturbance in historic times. The disturbance has consisted of a variety of activities including vegetation clearance, livestock grazing, agricultural cultivation, the creation and use of vehicular access tracks and more recently quarrying activities. This disturbance has led to a reduction in vegetation maturity and diversity and the introduction of exotic vegetation, especially lantana and camphor laurel trees.

Although GSV levels fluctuated between poor to good, the majority of the project area exhibited poor GSV generally caused by regrowth or heavy leaf litter and grass cover, with higher levels primarily restricted to vehicular tracks (see Figures 4-9). The fact that the majority of the study area exhibited poor GSV raises the possibility that further, undetected cultural heritage may remain within the study area.

Figure 7: *Low GI and GSV*

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3.2.2 Indigenous Cultural Heritage

Traditional Owner representatives participated in the field survey. In accordance with the agreement reached with the interested parties, the Aboriginal participants were as follows:

- George Scott represented the TBLALC;
- Garth Lena represented the Minjungbal Resource Museum and Study Centre;
- Lewis Williams attended as a volunteer on the first day of the survey and represented the AAC and Traditional Owner descendants on the second day of the survey;
- Mark Rotumah attended as a volunteer on the first day of the survey in company with Garth Lena;
- Mark Cora represented the AAC and Ngandowal Traditional Owner descendants on the first day of the survey;

The Traditional Owner representatives were accompanied by Converge Heritage + Community representatives Dr Phil Habgood, and Ian Fox. This survey was conducted to determine the degree to which the proposed project will impact any Aboriginal cultural heritage areas and objects. The results of this inspection are outlined in the following sections.

Figures 8-9: *The Team undertaking the survey*

3.2.3 Areas and objects of Aboriginal cultural heritage significance

No areas or objects of Aboriginal cultural heritage significance were identified during the field survey. This may be a result of the low GI and GSV evident throughout the project area. Another contributing factor could have been the recent ground disturbance caused by the re-grading of existing access tracks and firebreaks for geological drilling and other activities (Figures 10-11). These tracks followed ridgelines which were the areas most likely to have cultural material present.

The Traditional Owner representatives did indicate that the project area held cultural heritage significance for them as it would have been crossed by a traditional Aboriginal pathway that followed the ridgelines from the coast to more inland areas. Along the boundary of the project area the ridgelines are particularly well defined and represent a direct east-west route between the coast and the middle reaches of the Tweed River.

***Figures 10-11**: Recent ground disturbance caused by the re-grading of tracks and firebreaks*

3.2.5 Areas and objects of non-Indigenous cultural heritage significance

No areas or objects of non-Indigenous cultural heritage significance were identified during the field survey. However, there were five sites of historic interest - all are springboard trees (see Figure 6). Springboard trees are tree stumps with springboard notches. Springboards were slabs of wood that were inserted into notches cut into the tree to allow the upper tree to be cut. The identified springboard trees may be illustrative of the past activities of loggers and timber getters. One of the examples (EQ5) is already cut down and had recently been damaged by heavy machinery (Figure 16). There were a number of examples of other logged trees that lacked the springboard cuts (Figure 17). The springboard trees could be relics as defined by the NSW *Heritage Act 1977* as they relate to the settlement of the area and may be 50 or more years old. However, they have not been assessed as having any local or State significance and so a section 139 permit under the Act is not required.

Figures 12-16: *Clockwise from top left, Springboard Trees – EQ1 EQ2, EQ3, EQ4 and EQ5.*

Figure 17: *Logged tree.*

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3.3 Conclusion

No areas or objects of Indigenous cultural heritage significance were identified within the project area. This may have been contributed to by the low GI and poor GSV levels that predominated over the majority of the project area and the recent ground disturbance of ridgelines, locations where there would have been a higher possibility of identifying Indigenous cultural heritage. No non-Indigenous areas or objects of cultural heritage significance were identified within the project area, most probably due to historic activities on the project area that have been agriculturally–based until more recent quarrying. These survey results and the register searches indicate that there is only a low probability that further, undetected cultural heritage material may remain in the study area, either within areas of low visibility or as subsurface remains.

4.1 Aboriginal Cultural Significance

Archaeologists place a high priority on levels of existing site preservation as a means of determining scientific integrity and therefore, the value of the contextual data found within a site, or surrounding a particular object. Any loss of scientific integrity does not, however, reduce the cultural significance of a place and/or item. Equally, the presence of bush food species, trees of great age, or a particular bluff in a mountain range, for example, may provide indicators of cultural importance not borne out in the archaeological record. An assessment of cultural significance was attained through consultation with the relevant local Aboriginal community organisations that have traditional knowledge and interests in the area. There remains the potential for artefacts within areas of low visibility or as subsurface remains.

4.2 Archaeological (Scientific) Significance

To assess archaeological (scientific) significance, the requirements of the NSW *Heritage Act 1977* considered and the best practice guidelines of the Burra Charter (Marquis-Kyle and Walker 1999) were applied where relevant. The following table lists each of the sites identified during the course of the survey with reference to their attributed levels of scientific significance.

Table 2 Significance assessment

Site ID[1]	GPS Co-ordinates[2]		Description	Scientific Significance
	Easting	Northing		
EQ1	0549830	0549830	springboard tree	**Nil - Historic interest only**
EQ2	0549919	0549919	springboard tree	**Nil - Historic interest only**
EQ3	0549826	0549826	springboard tree	**Nil - Historic interest only**
EQ4	0549526	0549526	springboard tree	**Nil - Historic interest only**
EQ5	0549227	6868943	springboard tree	**Nil - Historic interest only** Recently damaged by heavy machinery

[1] EQ = Eviron Quarry
[2] Datum = WGS 84

4.3 Impact Assessment

It is important to note that the fragile nature of cultural heritage and its associated environment, especially in relation to any as yet unidentified cultural heritage that may exist in areas of low GSV and/or within subsurface deposits (e.g. stone artefacts), would be both easily and irrevocably impacted on by ground disturbance and/or quarrying activities that will occur within the study area. Where areas or objects of Indigenous and/or non-Indigenous cultural heritage are uncovered cultural heritage mitigation measures will need to be established. With respect to Indigenous cultural heritage this should be facilitated through the formulation of a Management Plan (MP) for the site with the local Aboriginal community.

4.4 Aboriginal Community Expectations and Issues

Field survey participants expressed surprise that no cultural evidence was located during the walkover. Both Garth Lena and George Scott felt that the ridgeline (Condong Range) provided an important through route for traditional Aboriginal people and therefore would likely provide campsite evidence. It was considered possible that artefacts may have been collected by early European settlers and it was noted that the ridgeline was first an access track and later a formed road as European land selection took place.

All field survey participants discussed the fact that the recent re-grading of existing access tracks and firebreaks for geotechnical surveys had further disturbed the land surface in those areas considered most likely to contain cultural evidence. A statement was made by Garth Lena that the cultural field survey should have been undertaken before the re-grading of the existing access tracks and firebreaks and the geotechnical survey. Participants requested that this be raised as an issue of concern and that, where possible, cultural heritage surveys should be undertaken before any construction activity or land surface disturbance.

5.0 Management and Recommendations

5.1 Cultural Heritage Management

When protecting cultural heritage values, a number of management options are available. These include:

1. **Avoidance**.

   This option is favoured by the Traditional Owners as it allows for their cultural heritage to remain on 'country'. Sites remaining on 'country' may require the development of site specific management protocols including the establishment of activity exclusion zones.

2. **Mitigation**

   In areas where impact cannot be avoided an appropriate mitigation program utilising recognised archaeological methods will need to be developed. Mitigation processes may varying according to site or feature types and may include but not be restricted to processes such as detailed site recording and mapping, manual and machine excavation and/or controlled collection of artefacts and features.

3. **Monitoring**

   A program of site monitoring by representatives of the Aboriginal Party during activities causing ground disturbance (i.e. earthworks) can be developed as a management option for recognised areas of medium to high potential for the presence of unidentified cultural heritage. Such a program should be developed at the planning stages of the project and be based on areas noted within the survey results as having such potential.

Ultimately, the most important factor within the successful management of the cultural heritage process remains ongoing consultation between the proponent and the local Aboriginal community. This consultation process should be formalised with the development of an agreement that creates a clear framework for both process and protocols. Formalising an agreement is also the best step toward the effective management of cultural resources that are currently 'invisible' (for example as a result of low GSV) but that may be exposed during future development.

5.2 Recommendations

5.2.1 On-going consultation with the local Aboriginal community

On-going consultation between TSC and the local Aboriginal community is recommended to ensure cultural considerations are incorporated into future development activities at the site. Consultation about activities that involve disturbance or modification of the land surface in the project area will be important in order to allow appropriate mitigation programs to be implemented. This on-going consultation should result in the formulation of a Management Plan (MP) for the site.

It is further recommended that TSC negotiate a Council-wide Memorandum of Understanding (MoU) with the local Aboriginal community for the management and conservation of cultural heritage. The MoU should include acknowledgement by TSC that cultural heritage assessments should take place before any land surface disturbance, including predevelopment vehicle access and placement of fill, for those areas identified as potentially containing cultural heritage.

5.2.2 Program of site monitoring

A program of site monitoring by representatives of the Aboriginal Party during activities causing ground disturbance should be developed as a management option for recognised areas with a higher potential for the presence of unidentified cultural heritage. Within the project area this would be the ridgelines bounding the site and especially the north-south running ridgelines in the southeast quadrant of the project area, also the location of EQ 1-3 (Figure 18).

Figure 18: *Areas with higher potential for the presence of unidentified cultural heritage (Image adapted from Google Earth Pro 2008).*

5.2.3 Procedures for unexpected finds

Much of the project area had poor GSV which limited the possible identification of cultural objects and raises the possibility that further, undetected cultural heritage still exists within the study area. Procedures should therefore be developed through consultation and agreement with the local Aboriginal community for unexpected finds. These procedures could be incorporated into the MoU recommended above. An agreed "Procedures for Unexpected Finds" would limit the need for monitoring of ground disturbance activities by Traditional Owner representatives as they (the procedures) provide an effective way of minimising project impacts on unrecorded Aboriginal cultural heritage. An example of "Procedures for Unexpected Finds" is provided in Attachment C for TSC and local Aboriginal community consideration and negotiation.

5.2.4 Cultural heritage inductions

Due to the potential for archaeological sites to remain within the project area, it is recommended that work crews be specifically instructed of their obligations to look for cultural heritage material, including attendance at a cultural heritage awareness induction along with the distribution of educational leaflets at Workplace Health and Safety meetings. Inductions and provision of leaflets is best co-ordinated through the local Aboriginal community and should inform the workers what archaeological material may look like, and give them clear instructions on procedures for inadvertent discoveries.

5.2.5 Springboard Trees

Whilst no areas or objects of non-Indigenous cultural heritage significance were identified during the field survey, there were five sites (springboard trees) of historic interest that may be illustrative of the past activities of loggers and timber getters. Wherever possible these springboard trees should be retained *in situ*. Where leaving the springboard trees *in situ* on site is not a practicable option, and specifically for EQ5, which has already been cut down, TSC should consider relocation to an appropriate location, a park for example, where they can be preserved and displayed along with appropriate interpretation.

6.0 References

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Appendix A – Relevant Legislation

In New South Wales, three pieces of legislation provide the primary context for Aboriginal heritage management: the *National Parks and Wildlife Act 1974* (NPW Act); the *Heritage Act 1977*; and the *Environmental Planning and Assessment Act 1979* (EP&A Act). Other relevant legislation includes the *Aboriginal Land Rights Act 1983*, the Commonwealth *Native Title Act 1993* and the *NSW Native Title Act 1994*.

The National Parks and Wildlife Act 1974

The NPW Act is administered by the Department of Environment and Climate Change (DECC) and is the primary legislation for the protection of Aboriginal cultural heritage in New South Wales. One of the objectives of the NPW Act is:

> *'the conservation of objects, places or features (including biological diversity) of cultural value within the landscape, including but not limited to: (i) places, objects and features of significance to Aboriginal people …'* (s.2A[1][b])

Part 6 of the Act provides specific protection for Aboriginal objects and places by making it an offence if impacts are not authorised. If impacts on Aboriginal objects and places are anticipated, an Aboriginal Heritage Impact Permit (AHIP) should be obtained. AHIPs can be issued under S.87 and S.90 of the NPW Act.

An *Aboriginal object* is any deposit, object or material evidence (that is not a handicraft made for sale) relating to Aboriginal habitation of New South Wales, before or during the occupation of that area by persons of non-Aboriginal extraction (and includes Aboriginal remains).

An *Aboriginal place* is a place declared so by the Minister administering the NPW Act because the place is, or was, of special significance to Aboriginal culture. It may or may not contain Aboriginal objects.

The NPW Act does not provide protection for spiritual areas or natural resource areas that have no physical evidence of Aboriginal occupation or use, unless they have been declared an Aboriginal place.

The Heritage Act 1977

The Heritage Act protects the State's natural and cultural heritage. Aboriginal places or objects that are recognised as having high cultural value are listed on the State Heritage Register. The State Heritage Register protects particular places and items that the Aboriginal community has formally recognized as being of high cultural value. The State Heritage Register provides an extra level of protection beyond that provided by the Department of Environment and Conservation's register (the AHIMS register and database) as it protects against any damage or destruction to these special places. The Aboriginal heritage of NSW is irreplaceable and as such there are heavy penalties for offences under the Heritage Act.

The Environmental Planning and Assessment Act 1979

The EP&A Act is administered by Local Government and the NSW Department of Planning and provides planning controls and requirements for environmental assessment in the development approval process. It also establishes the framework for Aboriginal heritage values to be formally assessed in land-use planning and development consent processes.

Aboriginal Land Rights Act 1983

The NSW *Aboriginal Land Rights Act 1983* establishes the NSW Aboriginal Land Council (NSWALC) and Local Aboriginal Land Councils (LALCs). The Act requires these bodies to:

(a) take action to protect the culture and heritage of Aboriginal persons in the Council's area, subject to any other law; and
(b) promote awareness in the community of the culture and heritage of Aboriginal persons in the Council's area.

DECC recognises and acknowledges the statutory role and responsibilities of NSWALC and LALCs.

Native Title Legislation

The Commonwealth *Native Title Act 1993* and *NSW Native Title Act 1994* provide the legislative framework to:

(a) recognise and protect native title;
(b) establish ways in which future dealings affecting native title may proceed, and to set standards for those dealings;
(c) establish a mechanism for determining claims to native title; and

(d) provide for, or permit, the validation of past acts invalidated because of the existence of native title.

DECC acknowledges that native title legislation provides native title holders and registered native title claimants with certain procedural rights in relation to Acts which affect native title.

Appendix B – The Burra Charter

Although not codified in law, the Burra Charter (Marquis-Kyle and Walker 1999) is the foundational document upon which cultural heritage management practice is based, and this document continues to guide cultural heritage management in Australia. It was first adopted in 1979 by Australia ICOMOS (International Council on Monuments and Sites) and was initially designed for the conservation of and management of historical heritage. However, after the addition of further guidelines that defined cultural significance and conservation policy, use of the charter was extended to Indigenous studies.

The Burra Charter defines conservation as 'the processes of looking after a place so as to retain its cultural significance' (Article 1.4). A place is considered significant if it possesses aesthetic, historic, scientific or social value for past, present or future generations (Article 1.2). The definition given for each of these values is as follows (Articles 2.2 to 2.5).

Aesthetic value includes aspects of sensory perception for which criteria can and should be stated. Such criteria may include consideration of the form, scale, colour, texture and material of the fabric; the smells and sounds associated with the place and its use.

Historic value encompasses the history of aesthetics, science and society, and therefore to a large extent underlies all of the terms set out in this section. A place may have historic value because it has influenced, or has been influenced by, an historic figure, event, phase or activity. It may also have historic value as the site of an important event. For any given place the significance will be greater where evidence of the association or event survives *in situ*, or where the settings are substantially intact, than where it has been changed or evidence does not survive. However, some events or associations may be so important that the place retains significance regardless of subsequent treatment.

Scientific (archaeological) research value of a place will depend upon the importance of the data involved, on its rarity, quality or 'representativeness', and on the degree to which the place may contribute further substantial information.

Social value embraces the qualities for which a place has become a focus of spiritual, political, national or other cultural sentiment to a majority or minority group.

Article 2.6 of the Guidelines notes that other categories of cultural significance may become apparent during the course of assessment of particular sites, places or precincts. A range of cultural significance values may apply. Article 5 of the Burra Charter states that:

Conservation of a place should identify and take into consideration all aspects of its cultural significance without unwarranted emphasis on any one aspect at the expense of others (Marquis-Kyle and Walker 1999).

Draft Procedures for Unexpected Finds

- During project activities involving ground breaking activities outside nominated monitoring areas, TSC will encourage its employees or sub-consultants to be vigilant for cultural heritage. A Cultural Heritage Awareness Induction program would support this process.

- In the event that suspected cultural heritage is found, then the TSC Liaison Officer will inform the Tweed/Byron Local Aboriginal Land Council's (TBLALC) nominated Liaison Officer or other nominated representative of the Local Aboriginal community as soon as possible but no later than two business days following the discovery of suspected cultural heritage.

- TSC will ensure that a 30m buffer zone surrounding the outer extent of the find is flagged, and that all project activities cease within this buffer zone until such time as clearance to continue Project Activities is provided in writing by the TBLALC nominated Liaison Officer or other nominated representative of the Local Aboriginal community and/or their representative/s.

- The TBLALC nominated Liaison Officer or other nominated representative of the Local Aboriginal community and/or their representative/s will undertake an assessment of the suspected cultural heritage and a survey of the flagged buffer zone area to determine the presence and extent of any cultural heritage.

- If it is found that further management actions such as monitoring are required in order to mitigate the impact of project activities on cultural heritage then the TBLALC nominated Liaison Officer or other nominated representative of the Local Aboriginal community and/or their representative/s will produce a brief post assessment report that identifies the nature and location of the identified or potential cultural heritage and incorporates appropriate management options, including the location of any monitoring areas, for consideration by TSC.

- Unless otherwise negotiated between the Parties' Liaison Officers, relocation of the cultural heritage should be undertaken by the TBLALC nominated Liaison Officer or other nominated representative of the Local Aboriginal community and/or their representative/s within four business days of its discovery. Identified cultural heritage will be relocated to an agreed location within the project area not subject to ground breaking activities or, where

this is not practicable, to an area outside the project area agreed to by the Local Aboriginal community.

- After relocation of all cultural heritage, the TBLALC nominated Liaison Officer or other nominated representative of the Local Aboriginal community and/or their representative/s will provide TSC with a written statement that gives clearance to the flagged area. This written statement will be provided to TSC on the same business day that recovery of any cultural heritage occurs unless another business day is agreed to by both Parties. Once a written statement providing clearance for the flagged area is received then flagging will be removed and project activities may continue in that area.

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8th July 2009

Cultural Heritage Assessment for the Proposed Eviron Road Quarry and Landfill Site - Tweed Shire.

This letter is to confirm that with respect to the project above, I and/or my organisation have been consulted throughout the project, were invited to participate in the fieldwork component of the project and have been provided with the opportunity to comment on a draft of the Report.

Having reviewed the draft report I am in agreement with the outcomes of the study and the recommendations made in the report.

Signed

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8th July 2009

Cultural Heritage Assessment for the Proposed Eviron Road Quarry and Landfill Site - Tweed Shire.

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Having reviewed the draft report I am in agreement with the outcomes of the study and the recommendations made in the report.

Signed Lewis D. Wellard

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Signed

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Having reviewed the draft report I am in agreement with the outcomes of the study and the recommendations made in the report.

Signed

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ABORIGINAL CULTURAL HERITAGE
~ Stotts Creek Eviron ~

Members of the Aboriginal Community are invited to register their interest for a Cultural Heritage Study of the Eviron Rd Quarry and Landfill Proposal.

Please contact : Ian Fox of **CONVERGE HERITAGE & COMMUNITY** PO Box 87 Burringbar NSW 2483 or Tel. (02) 6677 0260 within 14 days of the date of this notice.

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21 March 2011

David Hannah
Senior Environmental Scientist
Engineering and Operations
Tweed Shire Council
P.O. Box 816
Murwillumbah NSW 2483

Dear David

Additional Aboriginal Community Consultation for the Proposed Eviron Road Quarry and Landfill Site – Tweed Shire – 09117C

I respond to your request for clarification of the extent of Aboriginal community consultation undertaken by Converge for the above identified project. A Cultural Heritage Assessment for the project was undertaken in accordance with the then DECC *Interim Guidelines for Community Consultation* and the then newly released *May 2009, Draft Community Consultation Requirement for Proponents.*

Consultation with the Aboriginal community commenced on 1 May 2009 at a Tweed Shire Council (TSC) Aboriginal Advisory Committee (AAC) meeting and was followed up with a Public Notice, registration of individuals and groups, and a field assessment over three days with nominated community representatives. I understand that a recent review of Converge's Assessment by DECCW has identified some issues and inadequacies with the Aboriginal community consultation process and additional evidence is required from the local Aboriginal community stakeholders regarding their views on the Aboriginal cultural heritage assessment process.

I note that the points for consideration raised by DECCW are effectively a retrospective application of the current guidelines *Aboriginal cultural heritage consultation requirements for Proponents, 2010.* Converge acknowledges that a more comprehensive record of consultation is required under the current guidelines, but these were not in place at the time of the original assessment. I sought clarification from DECCW and spoke by telephone with the officer responsible, Nick Pulver, on 18 February, 2011. He advised that further correspondence from the Aboriginal stakeholders would be necessary to satisfy concerns that the consultation undertaken included endorsement of the process and support for the Cultural Heritage Assessment's outcomes and recommendations.

Accordingly, I met with the TSC AAC on 4 March, 2011, to explain DECCW concerns and seek further input from the Aboriginal stakeholders. As you are aware formal minutes of the AAC meetings are taken by Council staff, but in essence, the AAC confirmed that appropriate consultation had taken place for the original assessment and committee members supported the original findings and recommendations. Stakeholders agreed to provide further documentary evidence of support and copies of their correspondence is attached. That is; a letter from the TBLALC, and e-mails from the Tweed Aboriginal Co-operative Society Limited, and registered individual Jackie McDonald (on behalf of herself

and Aunty Joyce Summers). Please note, however, that Garth Lena (representing the Minjungbal Museum) gave verbal endorsement at the meeting and Lesley Mye (registered individual) has declined to be further involved in TSC AAC consultation processes.

It is my understanding that submission of the attached correspondence from Aboriginal stakeholders would be sufficient evidence of community endorsement for the proposed project and the level of consultation undertaken. Further concerns raised by DECCW relating to preparation of a Cultural Heritage Management Plan (CHMP) are considered by Converge to be a matter for Council as this is a recommendation and action from the original Cultural Heritage Assessment.

Please don't hesitate to contact me if I can be of further assistance in relation to our assessment and project recommendations.

Yours sincerely

Ian Fox
Project Manager
Northern NSW.

TWEED BYRON LOCAL ABORIGINAL LAND COUNCIL

P.O. Box 1410
Kingscliff, NSW 2487
Telephone: (07) 5536 1763
Fax: (07) 5536 9832
E-mail: finance@tblalc.com.au
21/25 Ourimbah Road
Tweed Heads NSW 2485

ABN: 44 992 419 248

Dear Ian

RE: Eviron Road Quarry

The Tweed Byron Local Aboriginal Land Council has been consulted throughout the course of the Aboriginal Heritage Assessment of the Eviron Road Quarry undertaken by your office. We have reviewed a copy of the report and the Tweed Byron local Aboriginal Land Council are satisfied with the outcome.
Ian Fox, Phil Habgood and myself with other community members inspected the property at the above address.
No artifacts were found on the walk over, visibility was in some areas were up 90%.
The property had been disturbed by Shire Council earth works.

Based on the impact of its past and current land use, chances of finding Aboriginal sites
Or relics within this area are Medium to low.

Recommendation.

1. Tweed Byron LALC agrees with the recommendations that were put forward in your report on pages 28-30.

2.Monitoring of all clearing and ongoing excavated works on the proposed site.

3. If Aboriginal cultural material is uncovered during or after the development then work must stop in this area and the lalc be contacted.

Any questions please don't hesitate to contact us on the above number.

Thank you

Cyril Scott
Cultural Sites Officer
Tweed Byron Local Aboriginal Land Council

Ian Fox

From: mctogo [mctogo@austarnet.com.au]
Sent: Tuesday, 8 March 2011 4:09 PM
To: ifox@archaeo.com.au
Cc: 'Aunty Joyce Summers'
Subject: Proposed Eviron Road Quarry and Landfill Project

Dear Ian,
I write in response to your request for further comments from the Aboriginal stakeholders in relation to the proposed Eviron Road Quarry and Landfill project site. Aunty Joyce Summers has also asked me to respond on her behalf.

I confirm that Mark Cora represented us during the survey. Thank you for providing us with a copy of the Aboriginal Cultural Heritage Assessment for the site. We have read the report and are satisfied that the document accurately reflects the Cultural Heritage values, the recommendations as requested by our community and the level of community consultation.

Yours sincerely
Jackie McDonald, also for and behalf of Aunty Joyce Summers

Ian Fox

From: Tweed Aboriginal Co-operative [tweedco-op@shopsafe.com.au]
Sent: Wednesday, 9 March 2011 6:10 AM
To: Ian Fox
Subject: Environ Quarry

TWEED ABORIGINAL CO-OPERATIVE SOCIETY LIMITED
P.O. BOX 6218 TWEED HEADS SOUTH. NSW 2486 PHONE /FAX NO: 0755242275
Email:tweedco-op@shopsafe.com.au

4th March 2011

Dear Ian

Re: Environ Quarry Proposed Development Report

This letter is to let you know that Tweed Aboriginal Co-operative Society Limited are fully satisfied with the consultation you did back in 2009 and support the recommendations of the final report

Garth Lena was our representative on site

Should you need anything further please do not hesitate to call or email

Yours faithfully
Tweed aboriginal co-operative Society Limited

Per Desrae Rotumah

GHD

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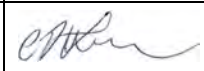
Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	A Marszalek	M Svikis		C Salmon		
1	A Marszalek E Cornelius	M Svikis		C Salmon		
2	A Marszalek E Cornelius	M Svikis		C Salmon		2/11/11