

MAJOR PROJECT APPLICATION No. MP08-0234 RISE CONCEPT PLAN

ENGINEERING REPORTS



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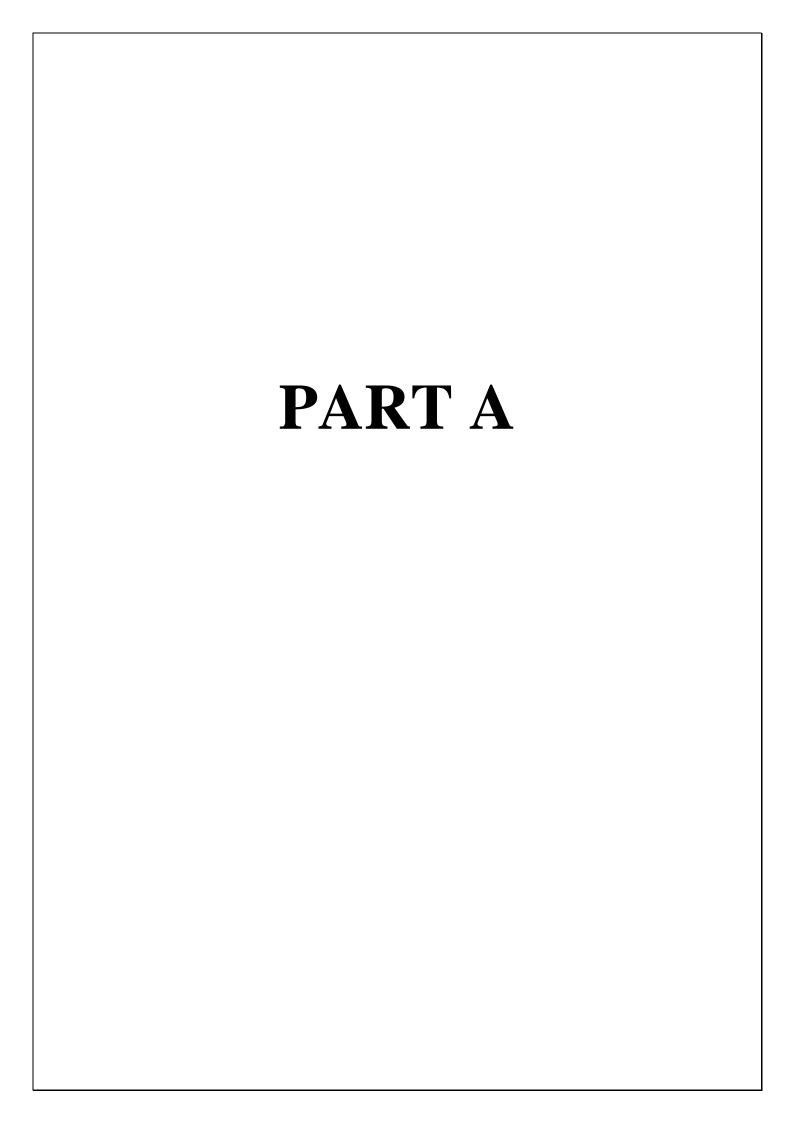
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RISE CONCEPT PLAN

RESPONSE TO DIRECTOR GENERALS ENVIRONMENTAL ASSESSMENT REQUIREMENTS

KEY ASSESSMENT REQUIREMENT No. 5

UTILITIES & INFRASTRUCTURE REPORT



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Utilities & Infrastructure Report

1. INTRODUCTION

This Utilities & Infrastructure Report has been prepared in response to the DGEAR's Key Assessment Requirement No. 5 for Rise Concept Plan application MP08-0234.

2. EXISTING UTILITIES & INFRASTRUCTURE

2.1 General

The proposed Rise development is located within the boundaries of the Bilambil Heights Urban Release Area in Tweed Shire.

Portions of the site are currently connected to existing utilities and infrastructure. Existing utilities and infrastructure will require upgrading and new infrastructure constructed to meet the ultimate requirements of the overall development in accordance with the overall Tweed Shire Council (TSC) Infrastructure Planning and Section 64 Developer Services Plan (DSP) prepared for the Bilambil Heights Urban Release Area.

2.2 Specific Utilities

2.2.1 Potable Water

The Rise development site is located in the North West Precinct of the DSP for Tweed Shire.

Potable water is derived from the Bray Park Water Treatment Plant in Murwillumbah and pumped to a low level water zone reservoir located at Snowgum Crescent Bilambil Heights and services development within Bilambil Heights by gravity up to approximately RL 85.

A booster pump station is located adjacent to the Snowgum Crescent Reservoir which pumps potable water from the Snowgum Crescent reservoir to an existing 1.1 ML reservoir located within Rise Development on a parcel of land owned by TSC in fee simple.

The 1.1 ML reservoir has a base level of RL 207 and services an intermediate water catchment zone between RL 120 and RL 85, generally external to the Rise Development site.

The rising main linking the booster pump station at the Snowgum Crescent reservoir to the existing 1.1 ML reservoir at a high point within Rise is currently inadequate to service the numbers of houses connected to the intermediate zone and requires upgrade to DN250 or greater, subject to detailed design by TSC.

TSC have placed development conditions on an existing Deferred Commencement Development Consent for a 76 Lot subdivision over the proposed Precinct B of the Rise Concept Plan area which

will require the Developer of Rise to contribute to the upsizing of the rising main between Snowgum Crescent reservoir and the existing 1.1 ML reservoir servicing the existing Bilambil Heights residential area. Further it requires the Developer to provide TSC a site for the future augmentation of the Snowgum Crescent low level reservoir to be dedicated to TSC for the purposes of constructing a future low level reservoir adjacent to McAlisters Road to augment the existing storage capacity of the Snowgum Crescent reservoir and provide access easements. TSC is to purchase the future low level reservoir site from the Developer and the developer is to create the required access and service line easements.

TSC has an existing easement for access to the existing 1.1 ML reservoir and the existing rising main is located within that easement.

The location of the existing easement to the existing 1.1 ML reservoir does not suit the ultimate layout of Rise Development and negotiations have occurred between the Developer and TSC to agree on a proposed Water Strategy which will result in TSC constructing the new increased capacity rising main to the 1.1 ML reservoir in Rise along the existing easement and Rise fully funding the relocation of the rising main to another vertical / horizontal alignment that suits the Rise development on a progressive basis as subdivision works proceed.

Refer to Appendix A and VKL Consulting Pty Ltd Drawing No. 1355-09-SK200.

The cost of infrastructure to deliver from the Tweed River to Rise development via the Bray Park Water Treatment Plant, a series of pumping stations and reservoirs and rising mains are part of the Section 64 Developer Services Plan (DSP) for the NW area of Tweed Shire.

The current DSP for the Bilambil Heights Urban Release Area makes provision for upgrades in capacity to service the area and a major upgrade of the Bray Park Water Treatment Plant is expected to be completed by December 2009 by TSC.

The existing 1.1 ML reservoir surrounded by the Rise development will be replaced by a new reservoir with sufficient capacity to service Rise development, at the cost of the Developer with TSC contributing to the pro rata cost of capacity to service areas of the Bilambil Urban Release Area beyond Rise development, the details of which will be resolved with TSC during the processing by TSC of the first Rise Precinct Development Consent.

2.2.2 <u>Sewerage</u>

The Rise development is located within the Banora Point DSP area.

Limited external reticulated sewerage sewer main capacity exists for the servicing of new development comprising the Rise development and future development within the Cobaki and Bilambil Heights precinct. Adequate capacity or planned augmentation of the Banora Point Waste Water Treatment Plant exists to service these areas.

Utilities & Infrastructure Report

There is a Deferred Commencement Development Approval for a 76 Lot subdivision over Precinct B of the Rise development. This area of the site gravitates to an existing public sewerage system in McAllisters Road. Refer VKL Consulting Pty Ltd Drawing No. 1355-09-SK201 in Appendix A.

Subject to available capacity of this system at the time of Construction Certificate, augmentation of the pumps in the existing pump station and flat grade sections of the existing gravity sewer in Peninsular Drive will be determined. The extent of augmentation required will be dependent upon whether other approved developments within the catchment have proceeded at the time that the Rise development approvals are granted over that particular precinct.

There is an existing licensed sewerage treatment plant "Pasveer 1000" on the Rise site which serviced the Terranora Country Club however it is not intended to operate this plant to service the overall Rise development but it may be utilized in the initial stages of Rise as a storage tank prior to pumping off peak to the existing Peninsular Drive gravity sewer system.

Approval exists under the current Resort Consent for a sewerage treatment plant to be located to the north of the subject site near Cobaki Road but within the land owned by the Rise applicant. The approval for this site sewerage treatment plant is part of an existing approval for a Golf Course Resort Development. This approval is still valid as substantial commencement on the Golf Course Resort Development Consent has been acknowledged by TSC. The approval provides for site disposal of treated effluent with precautionary discharge approval to Cobaki Creek.

The Rise Concept envisages that this approved Sewerage Treatment Plant will not be constructed and that sewage will be pumped to the Banora Point Waste Water Treatment Plant for treatment and effluent disposal via existing discharge licenses that TSC has for Banora Point Waste Water Treatment Plant.

3. <u>UTILITIES & INFRASTRUCTURE REQUIREMENTS FOR THE RISE</u> DEVELOPMENT

3.1 General

The Rise Concept proposal is for a major Community Title Scheme (CTS) development comprising mixed land uses with some public and mostly private roads for access to and within the various precincts as shown on the Rise Concept Plan.

As a consequence of the proposed size of Rise it is proposed that potable water storage and potable water reticulation be owned, operated and maintained by TSC.

Similarly it is proposed that sewerage reticulation mains, pump stations and rising mains are also owned, operated and maintained by TSC, as is the case with freehold lot subdivisions within TSC area, except for the sewerage system from Precinct I – private school which will discharge into the public sewer via private pump station and private rising main.

The Rise Concept proposes that potable water usage be reduced by the construction of an Integrated Water Management System which will collect stormwater runoff from roofs, public and private roads and open space areas of the community lands within the Community Title area and direct this stormwater to community storage tanks and surface storage areas located on community land. This collected stormwater would be treated and piped back to individual premises and open space areas for use in toilet flushing, car washing and irrigation of landscape areas and active recreation areas via a dual reticulation system.

The stormwater recycling system will be privately owned, operated and maintained by the Rise CTS Body Corporate.

The overall utilities and infrastructure required for the Rise development will include the construction of infrastructure external to the site and within the Rise development footprint.

Determination of utility services demands and infrastructure sizing for the Rise development have been calculated on the proposed densities and standard TSC Design Guidelines as set out in TSC DCP D10 Water and D11 Sewer unless otherwise noted.

3.2 <u>Projected Water & Sewerage Infrastructure Demands Based On Integrated Water Management</u>

3.2.1 General

The proposed integrated water management system will mean that a dual water reticulation system will be provided in accordance with the principals set forth in relevant Water Services Association of Australia (WSAA) Water Code of Australia and in accordance with the DCP design requirements of TSC. Installation will also comply with the NSW Plumbing Code and AS3500.

Potable water will be plumbed into dwellings in the development for use in kitchens, hot water systems, showers, baths and bathroom basins.

In commercial buildings potable water will be plumbed to food preparation areas, sinks, basins, showers and baths.

All other uses will be plumbed for recycled stormwater in accordance with the NSW Plumbing Code.

Water balance studies carried out by Gilbert & Sutherland as part of the MP08-0234 application indicate that there will be times during certain climatic occurrences where insufficient stormwater can be captured and stored to ensure 100% reliability of the recycled supply. Therefore potable water storage and system delivery will need to be sized to ensure adequacy of supply during periods where recycled stormwater is not available.

3.2.2 <u>Demands – Potable Water</u>

Table 3.1 sets forth the projected potable water demands for the development on a development precinct basis without dual use and with dual use and projected sewage discharge from each precinct and the Rise development in total.

Table 3.1 - Projected Potable Water Demand - Without & With Dual Use

Table 5	1 - Projected Potable	e water t	<u> Jemana – </u>	without & v	vim Duai	Use
Precinct	Product	Number	Equivalent	Sewerage	Max. Day	Max. Day Potable
		of	Persons	Discharge	Water	Water Demand
		Units	EP	180/EP/d with	Demand	With Dual Water
		or		application of	Without	System 405
		Агеа		Basix Litres	Dual System	t/EP/d
		11100		Danie Division	850 L/d/EP	Litres
					Litres	Littes
A-1	Community hall	500 m2	50	9000	42500	20,250
A-2	Village supermarket	1200 m2	20	3600	17000	8,100
A-3	Village shopping centre	600 m2	5	900	4250	2,025
A-4	Boutique hotel apartments		384	69120	326400	
A-4 A-5	Tavern	160 Apts 600 m2	40	7200	34000	155,520
						16,200
A-6	Hospitality Training school	700 m2	21	3780	17850	8,505
A-7	Local business suites &	3700 m2	32	5760	27200	12,960
	Retail					
A-8	Medium Rise apartments	38	121.6	21888	103360	49,248
A-9	Medium Rise apartments	23	55.2	9936	46920	22,356
A-10	Medium Rise apartments	36	86.4	15552	73440	34,992
A-11	Child care	400 m2	16	2880	13600	6,480
A-12	Community Club	350 m2	25	4500	21250	10,125
A-13	Community lap pool	25 m long	25	6000	21250	NIL
A-14	Community tennis courts +	1	5	900	4250	2,025
	Pavillon					
B-1	Retirement living	15	48	8640	40800	19,440
B-2	Retirement living	180	432	77760	367200	174,960
B-3	Retirement living club	800 m2	58	10440	49300	23,490
D-1	Low density house & land	80	256	46080	217600	103,680
D-2	2 storey townhouse	40	128	23040	108800	51,840
E-1	Res A housing lots	24	76.8	13824	65280	31,104
E-2	3 storey Boulevard villas	45	144	25920	122400	58,320
E-3	3 storey townhouses	6	19.2	3456	16320	7,776
F	Nursing home land	200 beds	680	122400	578000	275,400
G-1	Retirement living	25	60	10800	51000	
		162	388.8	69984		24,300
G-2	Retirement living	102			330480	157,464
G-3	Retirement living		28.8	5184	24480	11,664
G-4	Retirement living club bld	800 m2	58	10440	49300	23,490
H-1	Res A housing lots	34	108.8	19584	92480	44,064
H-2	Housing lots	2	6.4	1152	5440	2,592
I	Private School	2.76 Ha	100	18000	85000	40,500
J	2 & 3 Storey Townhouses	36	115.2	20736	97920	46,656
	Hilltop Plaza penthouses	5	16	2880	13600	6,480
L-2	Hilltop Plaza sub penthouses	31	99.2	17856	84320	40,176
L-3	Hilltop Plaza apartments	12	28.8	5184	24480	11,664
L-4	Hilltop Plaza apartments	1 (780m2)	40	7200	34000	16,200
1.7-4	facilities	I (TOVILL)	40	/200	34000	10,200
L-5	Hilltop Plaza retail /	1472 m2	63.2	11376	53720	25,596
	restaurants / studios / art		55.2			
	school					
L-6	Retail art shop houses (Soho	8	19.2	3456	16320	7,776
1.70	units)	U	17.2	37.50	10320	',,',0
17	Art studios & shops	8	10.2	3456	16220	7 776
L-7	erit studios or shops	0	19.2	3456	16320	7,776

Table 3.1 continued.

Precinct	Product	Number	Equivalent	Sewerage	_	Max. Day Potable
		of	Persons	Discharge	Demand	Water Demand
		Units	EP	180/EP/d with	Without Dual	With Dual Water
		or		application of	System 850	System 405
		Area		Basix Litres	1/d/EP	ℓ/EP/d
					Litres	Litres
L-8	Art house apartments	16	38.4	6912	32640	15,552
L-9	Art facility/café building	200 m2	5.3	954	4505	2,147
L-10	Hilltop apartments (Nth	137	328.8	59184	279480	133,164
L-11	Hilltop apartments (Nth	28	67.2	12096	57120	27,216
L-12	Health Spa	600 m2	26.4	4752	22440	10,692
L-13	2 storey Hillside Pole homes	30	96	17280	81600	38,880
L-14	Custom house lots	15	48	8640	40800	19,440
L-15	3 storey Boulevard villas	17	54.4	9792	46240	22,032
M-1	Retirement village	60	144	25920	122400	58,320
M-2	Retirement village	144	345.6	62208	293760	139,968
M-3	Retirement club	800 m2	57.2	10296	48620	23,166
N-1	Res A housing lots	28	89.6	16128	76160	36,288
N-2	Villas	32	102.4	18432	87040	41,472
N-3	Retail shops	375 m2	5.3	954	4505	2,147
N-4	Hillside housing	11	35.2	6336	29920	14,256
N-5	Apartments on 'bluff'	70	168	30240	142800	68,040
N-6	Apartments on 'bluff'	7	16.8	3024	14280	6,804
N-7	Private Community club	350 m2	25	4500	21250	10,125
N-7	Private community lap pool	25m long	25	6000	21250	NIL
N-7	Private Community tennis	1	5	900	4250	2,025
	court + Pavillon					1
0-1	Hillside housing	27	86.4	15552	73440	34,992
U	Sports Fields & Amenities	1	10	1800	8500	4,050
	RISE TOTALS		5,649.8	1,019,964	4,802,330	2,267,919
			EP	Litres	Litres	Litres

Table 3.2 - Possible Additional Demand if Other Areas of Terranora Group Management land is developed in the Future

Precinct	Product	Number of Units or Area	Equivalent Persons EP	Sewerage Discharge 180/EP/d with application of Basix Litres	Max. Day Water Demand Without Dual System 850 L/d/EP Litres	Max. Day Potable Water Demand With Dual Water System 405 L/EP/d Litres
N-8	Res A lots	12	38.4	6912	32640	15,552
O-2	Hillside housing	11	35.2	6336	29920	14,256
P-1	Hillside housing	34	108.8	19584	92480	44,064
P-2	Res A lots	10	32	5760	27200	12,960
Q	Eco village Rural Res	8	25.6	4608	21760	10,368
R-1	Village centre general store	200 m2	5	900	4250	2,025 *
R-2	Village centre servicestation	200 m2	5	900	4250	2,025 *
S	Nursing home land	200 beds	680	122400	578000	275,400 *
T	2 Storey villas	16	51.2	9216	43520	20,736 *
	RISE TOTALS		942.8	169,704	801,380	381,834
			EP	Litres	Litres	Litres

Table 3.3 sets forth the projected demand for recycled water for use within houses and commercial buildings. The projected demands shown exclude demand for irrigation purposes. This can be used to assess the extra demand on potable water network should no stored stormwater be available during periods when little or no rain falls to replenish stored stormwater.

Table 3.3 - Projected Recycled Water Demand

Precinct	- Projected Recycled Water De Product	Number of	Equivalent	Max. Day Recycled
		Units or	Persons	Water Demand With
		Area	EP	Dual System 445 1/EP/d
A-1	Community hall	500 m2	50	22,250
A-2	Village supermarket	1200 m2	20	8,900
A-3	Village shopping centre	600 m2	5	2,225
A-4	Boutique hotel apartments	160 Apts	384	170,880
A -5	Tavern	600 m2	40	17,800
A-6	Hospitality Training school	700 m2	21	9,345
A-7	Local business suites & Retail	3700 m2	32	14,240
A-8	Medium Rise apartments	38	121.6	54,112
A-9	Medium Rise apartments	23	55.2	24,564
A-10	Medium Rise apartments	36	86.4	38,448
A-11	Child care	400 m2	16	7,120
A-12	Community Club	350 m2	25	11,125
A-13	Community lap pool	25 m long	25	11,125
A-14	Community tennis courts + pavillon	1	5	2,225
B-1	Retirement living	15	48	21,360
B-2	Retirement living	180	432	192,240
B-3	Retirement living club	800 m2	58	25,810
D-1	Low density house & land	80	256	113,920
D-2	2 storey townhouse	40	128	56,960
E-1	Res A housing lots	24	76.8	34,176
E-2	3 storey Boulevard villas	45	144	64,080
E-3	3 storey townhouses	6	19.2	8,544
F	Nursing home land	200 beds	680	302,600
G-1	Retirement living	25	60	26,700
G-2	Retirement living	162	388.8	173,016
G-3	Retirement living	12	28.8	12,816
G-4	Retirement living club building	800 m2	58	25,810
H-1	Res A housing lots	34	108.8	48,416
H-2	Housing lots	2	6.4	2,848
I	Private School	2.76 Ha	100	44,500
J	2 & 3 Storey Townhouses	36	115.2	51,264
L-1	Hilltop Plaza penthouses	5	16	7,120
L-2	Hilltop Plaza sub penthouses	31	99.2	44,144
L-3	Hilltop Plaza apartments	12	28.8	12,816
L-4	Hilltop Plaza apartments facilities	1 (780m2)	40	17,800
L-5	Hilltop Plaza retail / restaurants /	1472 m2	63.2	28,124
L-6	Retail art shop houses (Soho units)	8	19.2	8,544
L-7	Art studios & shops	8	19.2	8,544
L-8	Art house apartments	16	38.4	17,088
L-9	Art facility/café building	200 m2	5.3	2,359
L-10	Hillton apartments (Nth Ridge)	137	328.8	146,316
L-11	Hilltop apartments (Nth Ridge)	28	67.2	29,904
L-12	Health Spa	600 m2	26.4	11,748
L-13	2 storey Hillside Pole homes	30	96	42,720

Table 3.3 continued.

Precinct	Product	Number of	Equivalent	Max. Day Recycled
		Units or	Persons	Water Demand With
		Area	EP	Dual System 445 1/EP/d
L-14	Custome house lots	15	48	21,360
L-15	3 storey Boulevard villas	17	54.4	24,208
M-1	Retirement village	60	144	64,080
M-2	Retirement village	144	345.6	153,792
M-3	Retirement club	800 m2	57.2	25,454
N-1	Res A housing lots	28	89.6	39,872
N-2	Villas	32	102.4	45,568
N-3	Retail shops	375 m2	5.3	2,359
N-4	Hillside housing	11	35.2	15,664
N-5	Apartments on 'bluff'	70	168	74,760
N-6	Apartments on 'bluff'	7	16.8	7,476
N-7	Private Community club	350 m2	25	11,125
N-7	Private Community lap pool	1	-	-
N-7	Private Community Tennis court +	1	5	2,225
	Pavillon			
0-1	Hillside housing	27	86.4	38,448
U	Sports Fields & Amenities	1	10	4,450
	TOTALS		5634.8	2,507,486
			EP	Litres

Table 3.4 - Possible Additional Demand if Other Areas of Terranora Group Management land is developed in the Future

Precinct	Product	Number of	Equivalent	Max. Day Recycled
		Units or	Persons	Water Demand With
O-2	Hillside housing	11	35.2	15,664 *
P-1	Hillside housing	34	108.8	48,416 *
P-2	Res A lots	10	32	14,240 *
Q	Eco village Rural Res	8	25.6	11,392 *
R-1	Village centre general store	200 m2	5	2,225 *
R-2	Village centre service station	200 m2	5	2,225 *
S	Nursing home land	200 beds	680	302,600 *
T	2 Storey villas	16	51.2	22,784 *
	TOTALS		942.8	419,546
			EP	Litres

Utilities & Infrastructure Report

Based on the projected difference in potable water demand without Integrated Water Management and with Integrated Water Management as shown in Table 8.1 it can be seen that projected reduction in potable water demand using an Integrated Water Management system is projected to be of the order of 52.35%.

With integrated water management principles being applied to a major project, as proposed over the subject land, major reduction in potable water usage can be achieved during climatic periods when sufficient stormwater can be captured, stored and treated. Ownership of other land within the Bilambil Heights Urban Release Area is far more fragmented and the ability to achieve significant reductions in potable water demand over the whole of the release area is less certain.

As the proposed 7 ML reservoir (subject to detailed design) to be constructed in Precinct K on the subject land will service areas in the proposed development and other areas within the Bilambil Heights Urban Release Area, TSC will need to determine what reduction, if any, in reservoir capacity and trunk potable water supply delivery is appropriate, given the reduction that can be achieved by the proponent using Integrated Water Management system within the proposed RISE development. These matters will be determined at the time of detailed design and Development Applications to TSC.

4. INFRASTRUCTURE COMPONENTS - INTERNAL

4.1 Potable Water System

The Rise development land ranges in elevation from RL 5 AHD to RL 216 AHD.

The Rise development will have three (3) potable water supply zones.

Refer to VKL Consulting Pty Ltd Drawing Nos. 1355-07-SK11 & 1355-07-SK200 in Appendix A.

4.1.1 Low Level Potable Water

This zone applies to future Precincts located on the northern extremity of the development site outside the Rise MP08-0234 Concept Plan area where possible future development may occur subject to future rezoning and Development Applications to TSC.

Precinct U (Sports Park) is included in the low level potable water zone.

As this zone will ultimately be serviced from the east, initially it will be serviced from the proposed 7 ML high level zone reservoir located within the subject site with a pressure reduction valve in the trunk main located at approximately RL 85 AHD.

Ultimately the low level zone will service development between RL 85 to RL 5.

On the south eastern section of Rise no development exists in the range of RL 120 to RL 85 and therefore the Snowgum Crescent Reservoir does not service any of Rise by gravity feed.

4.1.2 High Level Zone

VKL Consulting Pty Ltd Drawing No. 1355-07-SK11 shows the extent of development which is serviced by the high level zone located in Precinct K. Refer Appendix A.

This water zone will be serviced by a proposed 7 ML reservoir to be constructed in the region of the existing 1.1 ML reservoir. It is proposed that the reservoir be constructed in two (2) sections which will facilitate future TSC reservoir maintenance and allow the existing 1.1 ML reservoir to remain in service until the first half of the new reservoir is constructed and commissioned then it will be decommissioned / demolished and the second half of the new reservoir constructed.

The 7 ML reservoir will be filled via a new pumping main to be constructed from the existing Snowgum Low Level Reservoir to the new reservoir. An upgrade of the existing pump station and pumps at Snowgum Reservoir will be required because of the greater delivery flow required. Refer to External Components.

The high level zone will service development between RL 180 and RL 120 within the Rise development and within other existing areas and future Bilambil Heights Urban Release areas.

4.1.3 Boostered Level Zone

An area of the proposed development, contained in Precinct L, is at an elevation above the high level zone serviced by the proposed new 7 ML reservoir and will service development above RL 180.

This boostered level water zone will be serviced by the high level reservoir supplying a pressure booster pump station. This booster pump station will be supported with backup diesel powered pump or generator, subject to detailed design, to ensure continuity of supply water to the boostered level zone if a electricity outage occurs.

Pumps will have a duty point which will service the highest properties in the development and provide adequate fire flows for the commercial development proposed in precincts of the boostered level water zone.

4.2 Sewerage System

4.2.1 General

The proposed development is part of the contributing area serviced by the Section 64 DSP covering Banora Point Sewerage Treatment Plant. Current capacity or planned expansion of capacity of the plant exists to handle sewage from the RISE development and Bilambil Heights Urban Release Area in general.

4.2.2 Initial Stage – Interim Servicing

The subject site has a number of sub catchments – Refer VKL Consulting Pty Ltd Drawing No. 1355-07-SK10 in Appendix A.

Subject to approval and phasing of actual development it is probable that initial development will commence from Marana Street in Precinct B. This area is proposed to be sewered via the existing Peninsular Drive system to Banora Point STP.

Sections of this existing Council system will require augmentation to have adequate capacity. Subject to final design considerations the existing licensed Pasveer sewerage treatment plant (P1000) located on the southern part of the proposed development land may be ultilised to provide limited storage capacity for the sewage from initial areas of development. This sewage will then be pumped into the existing Peninsular Drive sewerage system at off peak times thereby making more efficient use of existing sewerage infrastructure.

4.2.3 Internal Works

The various sewerage sub catchments within Rise will be sewered by gravity sewer combined with pump stations and rising mains to convey the sewage to a major pump station near Cobaki Road on the applicants land. These sewers and pump stations are proposed to be transferred to TSC ownership for operation and maintenance except for a small privately owned system which will service the proposed private school in Precinct I in the southern section of the subject development.

Sewage from this privately owned and operated system will be conveyed by rising main to the proposed public sewers.

It is proposed that pump stations will have eight (8) hours storage at average dry weather flow (ADWF) to provide adequate storage in the event of an electrical outage or mechanical failure.

Refer VKL Consulting Pty Ltd Drawing No. 1355-07-SK09 in Appendix A for layout.

5. <u>INFRASTRUCTURE COMPONENTS - EXTERNAL</u>

5.1 Potable Water

The supply of potable water to Rise Development comes from the Tweed River and is treated at the Bray Park Water Treatment Plant which is currently undergoing a major augmentation to increase capacity to 100 ML per day. This augmentation by TSC is expected to be completed by December 2009.

The Bilambil Urban Release Area is part of the TSC North West DSP. Provision has been made in the DSP to upgrade the potable water delivery and storage system that will service the Rise development.

Components of these upgrades of the delivery and storage system are planned to be constructed in the near future by TSC in their planned works programme.

The timing of the Rise development is not expected to require TSC to bring forward any of the planned DSP works.

5.2 Sewer

Ultimately sewage from the majority of the development will gravitate and be pumped to the north of the site, consistent with the current Resort Development Approval, and conveyed along Cobaki Road / Pigabeen Road by rising main to the existing TSC trunk sewerage system which delivers sewage to Banora Point STP.

The extent of external work required to service the subject land will be dependent upon timing of the development and whether construction of Cobaki Lakes Development has proceeded to the extent of construction of the proposed regional sewerage pump station near the intersection of the proposed Cobaki Parkway and Piggabeen Road.

If this proposed regional pump station has not been constructed for Cobaki Lakes by the time the proposed Rise development proceeds then the external works required to service the subject land will need to be extended to the Council existing trunk sewerage infrastructure at the Gollin Drive pump station.

External sewerage infrastructure from the regional pump station to be constructed near the intersection of Cobaki Parkway to Banora Point Waste Water Treatment Plant form part of the DSP charges for Banora Point.

Provision exists under this DSP for Developers to fund the construction of works included in the DSP and receive credits against future DSP charges applicable.

Conveyance of sewage from Rise to the regional pump station is a cost to be borne by the Developer of Rise.

6. <u>STORMWATER RECYCLING SYSTEM – INTEGRATED WATER MANAGEMENT SYSTEM</u>

6.1 General

As a Community Title Scheme development, the Rise development proposes a privately owned, operated and managed stormwater recycling system to reduce potable water demand at times when captured and treated stormwater is available.

Gilbert & Sutherland have undertaken a Water Balance Assessment as part of the MP08-0234 application and it is likely during extended periods where no or limited rainfall occurs that no captured stormwater will be available for recycling. In these times it is proposed that the recycled water mains will be filled via metered flow from the publically owned potable water mains.

6.2 Components of Private Stormwater Recycling System

6.2.1 <u>Collection & Site Storage</u>

It is intended, as outlined in the Gilbert & Sutherland Report, that stormwater runoff from roofs, hard surfaces, public and private roads and community lands be directed to community owned storage tanks and storage ponds.

This captured stormwater, will undergo treatment processes, including an on-site filtration / disinfectant process to satisfy appropriate water quality / health standards to enable the stormwater to be recycled back into each house / community areas for use in toilet flushing, car washing, landscape watering and irrigation of community land and public open spaces.

It is estimated that up to 3 ML of potable water per day can be saved when the project is fully developed and recycled stormwater is available.

The community storage tanks and water bodies will be connected to the treatment plant via private pumps and private rising mains owned by the Rise Community Association.

Treated stormwater will be conveyed to a reuse water storage reservoir and used to supply the development.

6.2.2 <u>Recycled Stormwater Reticulation System</u>

As with the potable water reticulation system there will be three (3) zones, being low level, high level and boostered level however there will only be one (1) recycled stormwater reservoir.

The differentiation between low level and high level zone will be controlled by pressure reduction valves.

The recycled stormwater reticulation system will also have designed controls to ensure that pressures in the recycled water system are a minimum of five (5) metres of head lower than the potable water network as a safeguard against possible cross connection to the potable water network.

The recycled stormwater mains and connections will be constructed using lilac coloured pipes in accordance with Water Code of Australia and the NSW Plumbing Code. Refer to VKL Consulting Pty Ltd Drawing No. 1355-09-SK14 in Appendix A.

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Each property will have a private metered connection for recycled stormwater.

At suitable location(s) potable water connection(s) will be provided to allow filling of the recycled watermain in the event of recycled stormwater not being available.

The connection(s) will have appropriate valve and backflow prevention devices to prevent possible contamination of the potable water supply.

7. <u>ROADS</u>

7.1 General

As the Rise development will be a Community Title Scheme development the roads will be a combination of public and privately owned and maintained roads.

VKL Consulting Pty Ltd Drawing No. 1355-07-SK03 in Appendix A sets out the proposed road hierarchy for the development.

7.2 Public Road - Internal

The proposed public roads in the development form part of the proposed local area road network as reviewed with TSC.

Preliminary negotiations with TSC has determined that a maximum centreline grading of 12% will be supported on these roads.

Long sections and cross sections of these proposed public road are attached to this submission.

7.3 Private Roads

The private roads proposed for the development will have various profiles and surface treatments.

Long sections and cross sections of the proposed private roads are attached to this submission.

7.4 Internal Private Cycleways & Pathways

The locations of proposed internal private cycleways and pathways are shown on VKL Consulting Pty Ltd Drawing No. 1355-07-SK03 in Appendix A.

7.5 External Road Works

The Traffic Report by CRG which forms part of this Application is the reference document on external road works required to accommodate traffic volumes generated by this development.

Utilities & Infrastructure Report

Upgrade works will be required along Cobaki Road and Piggabeen Road to the north and Marana Street to the east with various other intersection upgrade works. Some of these external works are included in the Tweed Shire Section 94 plans.

In respect of the Section 94 listed works the proponent shall seek offsets for any works constructed by the proponent.

8. STORMWATER DRAINAGE

The Stormwater Management Plan prepared by Gilbert & Sutherland which forms part of the MP08-0234 application is the reference document in regard to stormwater.

As outlined in the Integrated Water Management section of this report it is proposed to collect stormwater runoff, from roofs, roads and open space areas for reuse in houses, landscape and open space areas.

Peak stormwater discharges from the site will not exceed predevelopment peak discharges.

It is proposed that the network of collection pits, pipes and open swales that are used to capture and convey stormwater to community owned facilities, open water bodies and legal points of discharge from the site will conform with TSC Standard DCP requirements for subdivisions. The collected stormwater will either be treated for recycling within houses or for use in irrigation of landscape and open space areas.

It is proposed that all public road drainage to a point of legal discharge will be an asset of TSC. Where appropriate, easements through the Community land to a legal point of discharge will be provided in favour of TSC via Statutory Easements.

If the legal point of discharge is a Community owned tank or open storage the Community Association will become the owner of the water from the point of entry into the tank or open storage of water from public roads in the development.

Overflows from these storages will be directed to natural depressions in a manner which does not cause concentration and potential scouring of the natural depression(s).

9. <u>SUMMARY OF EXISTING INFRASTRUCTURE CAPACITY TIMING & MANAGEMENT OF STAGED CONSTRUCTION OF INFRASTRUCTURE</u>

A. Potable Water Supply

Refer to VKL Consulting Pty Ltd Drawing No. 1355-07-SK200 in Appendix A for proposed staging.

C	Capacity of Existing Infrastructure	Future Infrastructure	Timing of Construction of Infrastructure	Management of Staged Infrastructure
1. (i)	External Sufficient capacity at low level Snowgum Reservoir for Stage 1	(i)Water treatment plant at Bray Park upgrade to 100ML/day now under construction by TSC via DSP charges.	(i) Completed by Dec 2009	(i) No impact on management
(ii)	Rising main/pumps to 1.1ML reservoir. Sufficient capacity of Reservoir to service Precinct B. Rising main to 1.1ML Reservoir currently under sized for existing connections.	(ii) TSC to build new rising main to 1.1ML Reservoir. (iii) Rise to construct new 7ML Reservoir in two halves. Decommission 1.1ML Reservoir when one half of 7ML Reservoir built. (iv) TSC to upgrade Snowgum Pump Station to match design flow requirements. (v) Capacity upgrade will provide for other Bilambil Heights Urban Release area. (vi) TSC to upgrade water conveyance from Bray Park to Snowgum Reservoir. TSC to construct additional low level Reservoir on site purchased from Rise in Precinct C.	 (ii) TSC planning immediate upgrade of rising main to 1.1ML Reservoir. Easement already exists for this main. (iii) Commission 1st half of 7ML Reservoir by commencement of demand from Precincts A, D or F of Rise (Actual Precincts may change depending on market demand). (iv) Immediate upgrade planned by TSC with rising main upgrade. (v) As required by DSP & demand. 	(ii) Construction in accordance with DSP & TSC Infrastructure Planning. (iii) Progressively build infrastructure ahead of demand.
2. (i)	Internal No existing reticulation	(i) Construction of reticulation mains(ii) Construction of booster pump station	 (i) Progressively on a stage by stage basis by Rise. (ii) To be available by demand by Precincts H or L (Actual Precincts may change depending on market demand). 	 (i) Design overall system to ensure that reticulation main will have capacity for stages to be serviced. (ii) Design overall system to ensure that reticulation is sized to have capacity on a staged basis.

B. Sewerage

Refer to VKL Consulting Pty Ltd Drawing No. 1355-07-SK201 & SK202 in Appendix A.

	apacity of Existing Infrastructure	Future Infrastructure	(Timing of Construction of Infrastructure		Management of Staged Infrastructure
1. (i)	External Limited external sewer reticulation capacity exists for Rise early Precincts to Peninsular Drive pump station	(i) Upgrade existing pump station in McAllisters Rd & augment flat sections of Peninsular Drive gravity sewer	(i)	With development of Precinct B (or the first Precinct to be developed).	(i)	All work required with construction of Precinct B(or the first Precinct to be developed).
(ii)	Banora Point Waste Water Treatment Plant	(i) Designed for staged upgrade to services DSP for Bilambil Heights Urban Release Area	(i)	As set out in DSP	(i)	Management of upgrades by TSC
(iii)	Gollin Drive PS to Banora Point WWTP. Existing capacity as part of Bilambil Heights / Cobaki Lakes DSP	(i) Upgrade PS at Gollin Drive as required by DSP	(i)	As set out in DSP	(i)	Management of upgrades by TSC
(iv)	Conveyance from Rise to Gollin Drive, no existing infrastructure	(i)Regional pump station & rising main to Gollin Drive	(i)	First developer in Cobaki Lakes / Bilambil Heights Urban Release Area to build off- sets against Sec 64 charges.	(i)	Management by TSC as DSP infrastructure
		(ii) Rising main from Rise to regional pump station	(ii)	By Rise developer after Precinct B. (or the first Precinct to be developed).	(ii)	Managed by Rise developer. Top up water required to minimise sepcicity.
2. (i)	Internal No existing infrastructure	(i) Pump stations, rising mains & gravity sewers	(i)	As required to meet development	(i)	Early stages water injection will be required & temporary rising mains of smaller diameter required to minimize sepcicity. Design overall system to ensure adequate capacity for development.

C. Recycled Stormwater System

Capacity of Existing Infrastructure	Future Infrastructure	Timing of Construction of Infrastructure	Management of Staged Infrastructure
No capacity exists	 (i) Storage tanks & storage ponds (ii) Stormwater treatment plant (iii) Recycled stormwater reservoir (iv)Recycled stormwater booster pump station (v) Community tanks, pond storage, pumps & rising mains to treatment plant. (vi)Reticulation mains 	(i) In accordance with staging (ii) With first development stage after Precinct B. (or the first Precinct to be developed). (iii) With first development stage after Precinct B. (or the first Precinct to be developed). (iv) With first development stage after Precinct B. (or the first Precinct B. (or the first Precinct to be developed). (v) With first development stage after Precinct to be developed). (v) With first development stage after Precinct B. (or the first Precinct to be developed).	 (i) Sized for ultimate design capacity. (ii) Construct for ultimate capacity. (iii) Construct ultimate capacity. (iv) Construct ultimate capacity. (v) Construct ultimate capacity. (vi) Design mains for ultimate capacity.
		(vi) Stage by stage.	

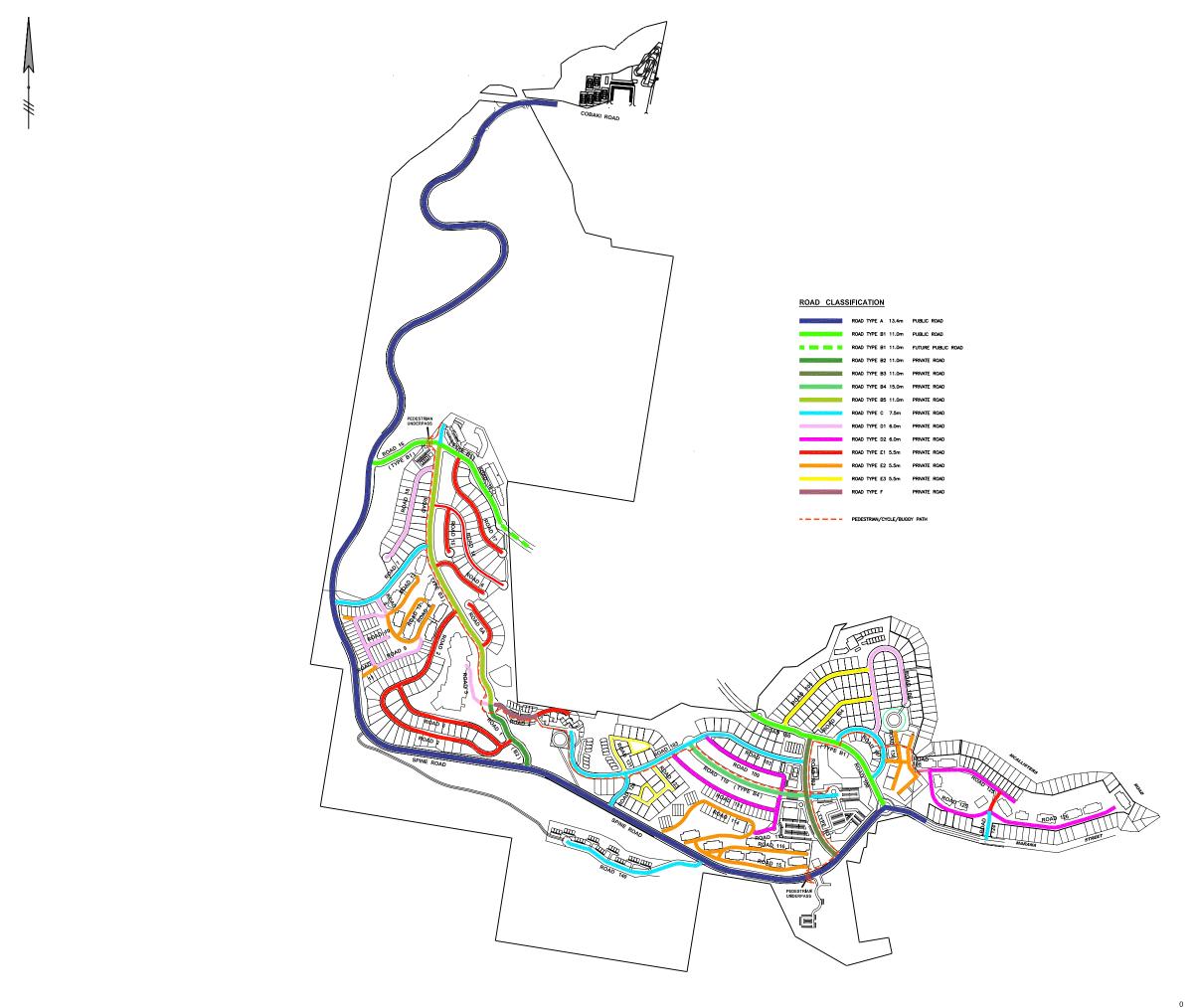
D. Roads

(Capacity of Existing Infrastructure	Future Infrastructure	Timing of Construction of Infrastructure	Management of Staged Infrastructure
1. (i)	External Capacity exists for 2660 traffic movements per day on Kennedy Drive	(i) Cobaki Parkway (ii) Connection from Rise to Cobaki Parkway upgrade to Cobaki Rd.	(i) After existing capacity used in Kennedy Drive (ii) After existing capacity used in Kennedy Drive	(i) TSC D/A control (ii) TSC D/A control
2. (i)	Internal No existing infrastructure	(i) Spine Road (ii) Internal roads	(i) After existing capacity used in Kennedy Drive (ii) Stage by stage	(i) Not staged TSC D/A control

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APPENDIX A

VKL Consulting Pty Ltd Drawing Nos. 1355-07-SK03, SK09, SK10, SK11, SK14, SK200, SK201 & SK202

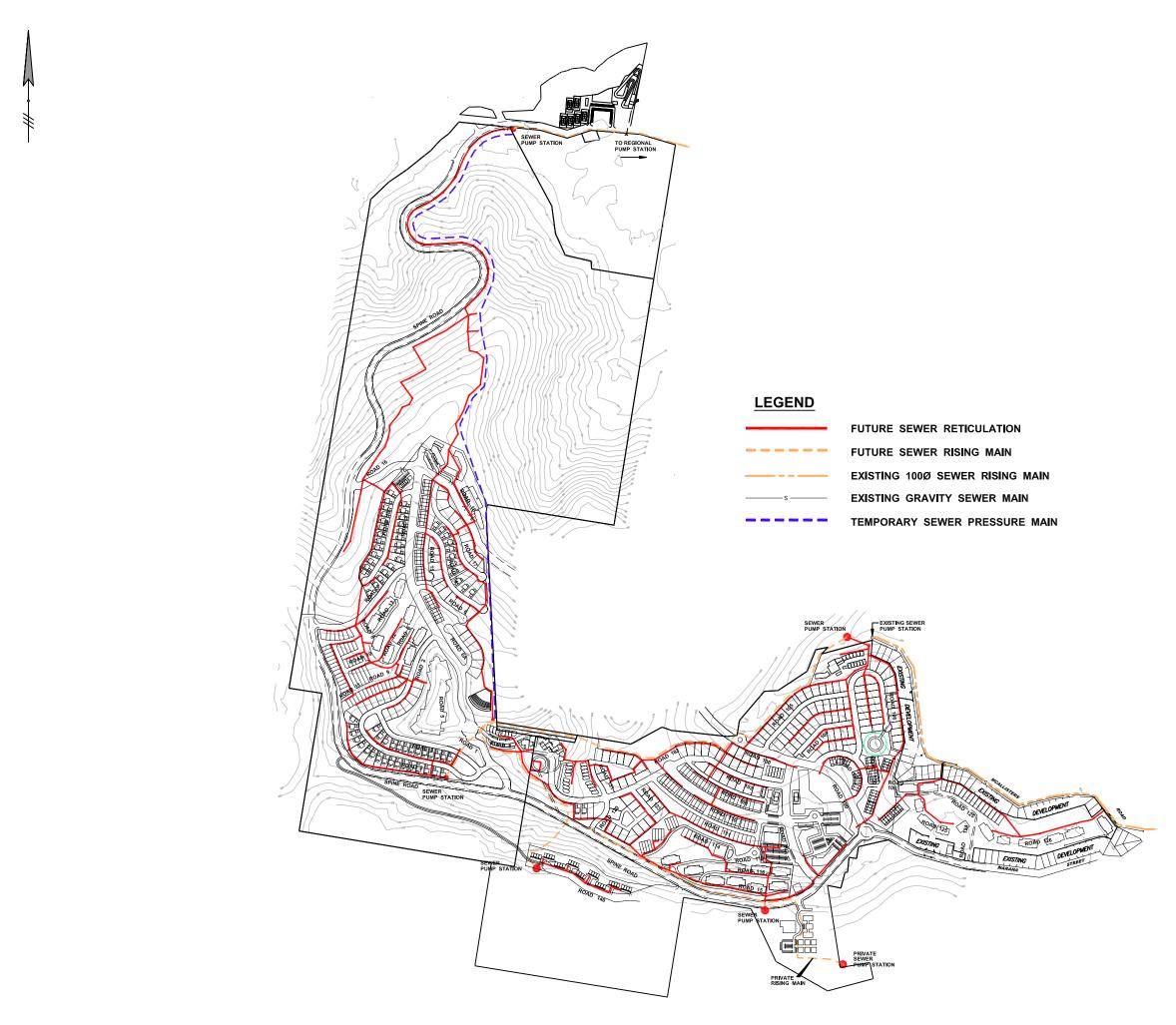






ROAD CLASSIFICATIONS



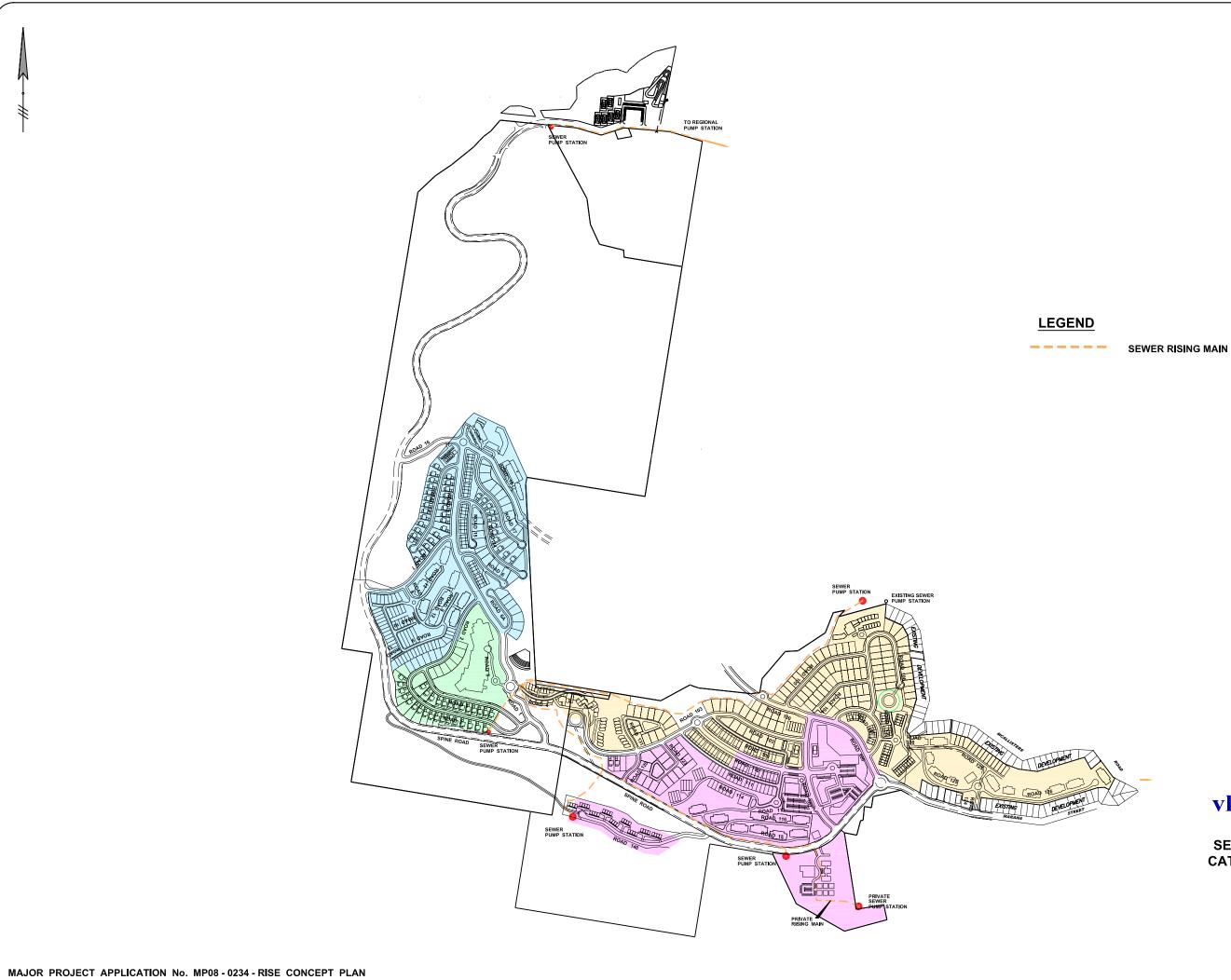




SEWER RETICULATION

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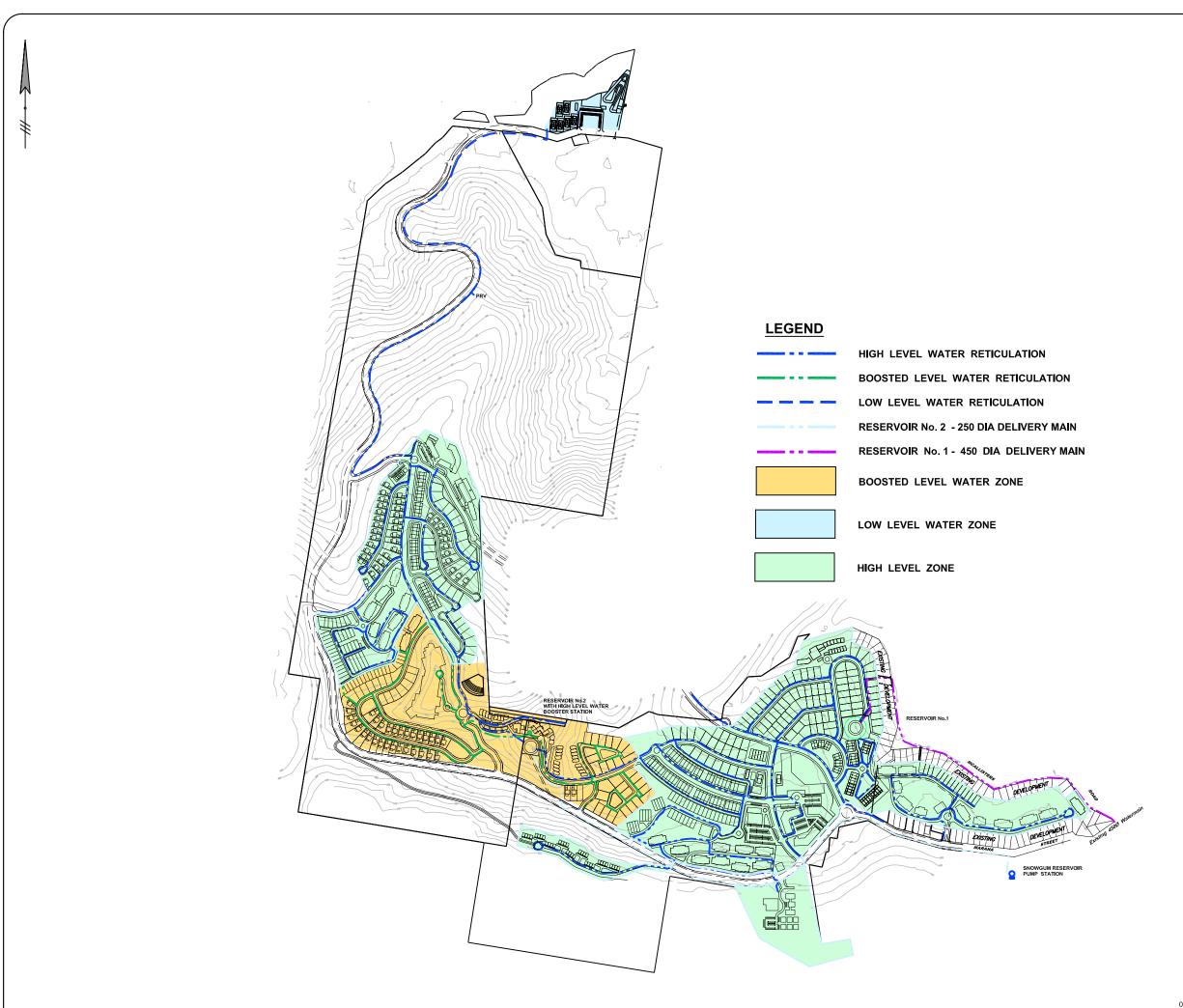




SEWER RETICULATION CATCHMENT ZONE PLAN

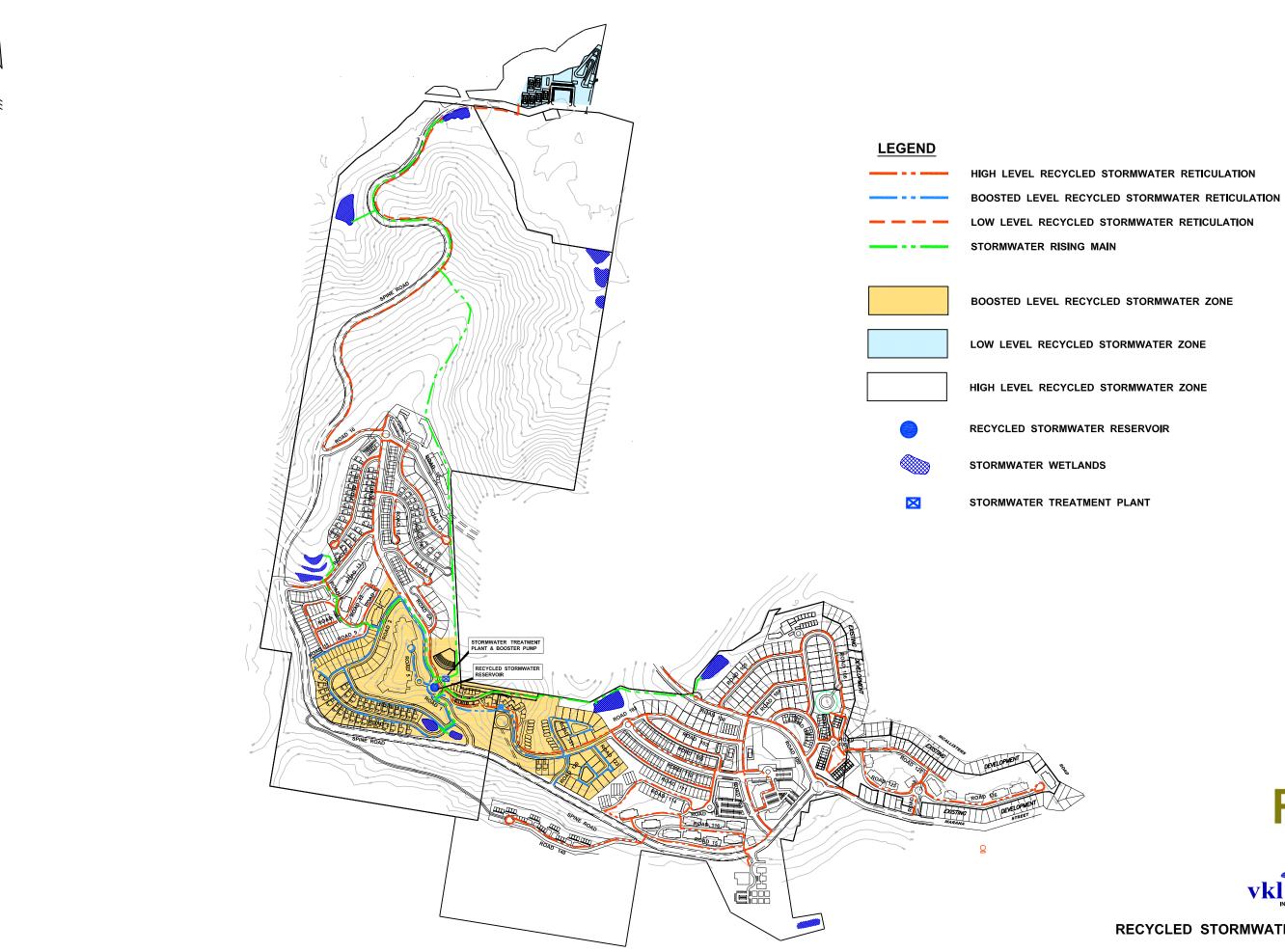
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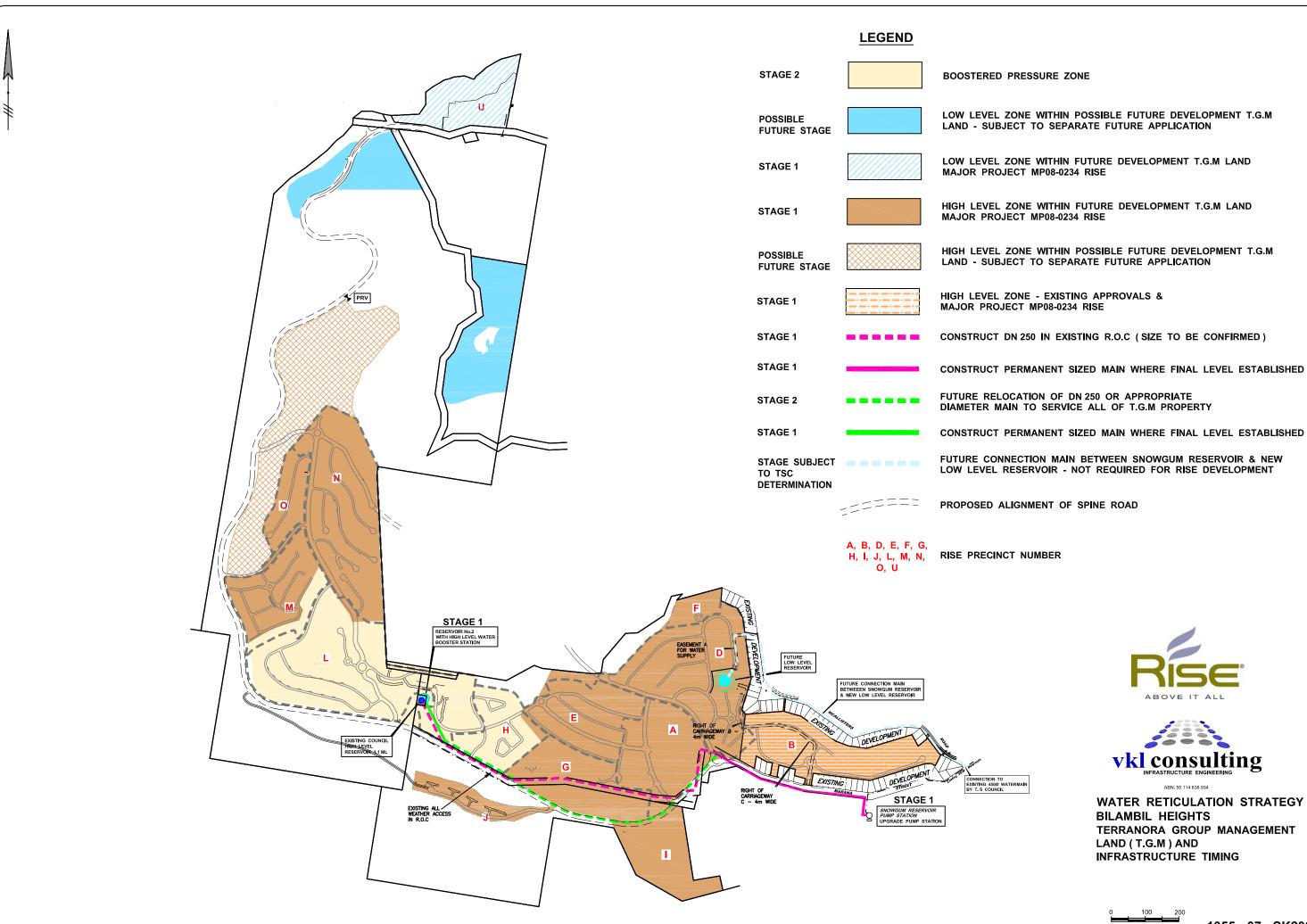


POTABLE WATER RETICULATION

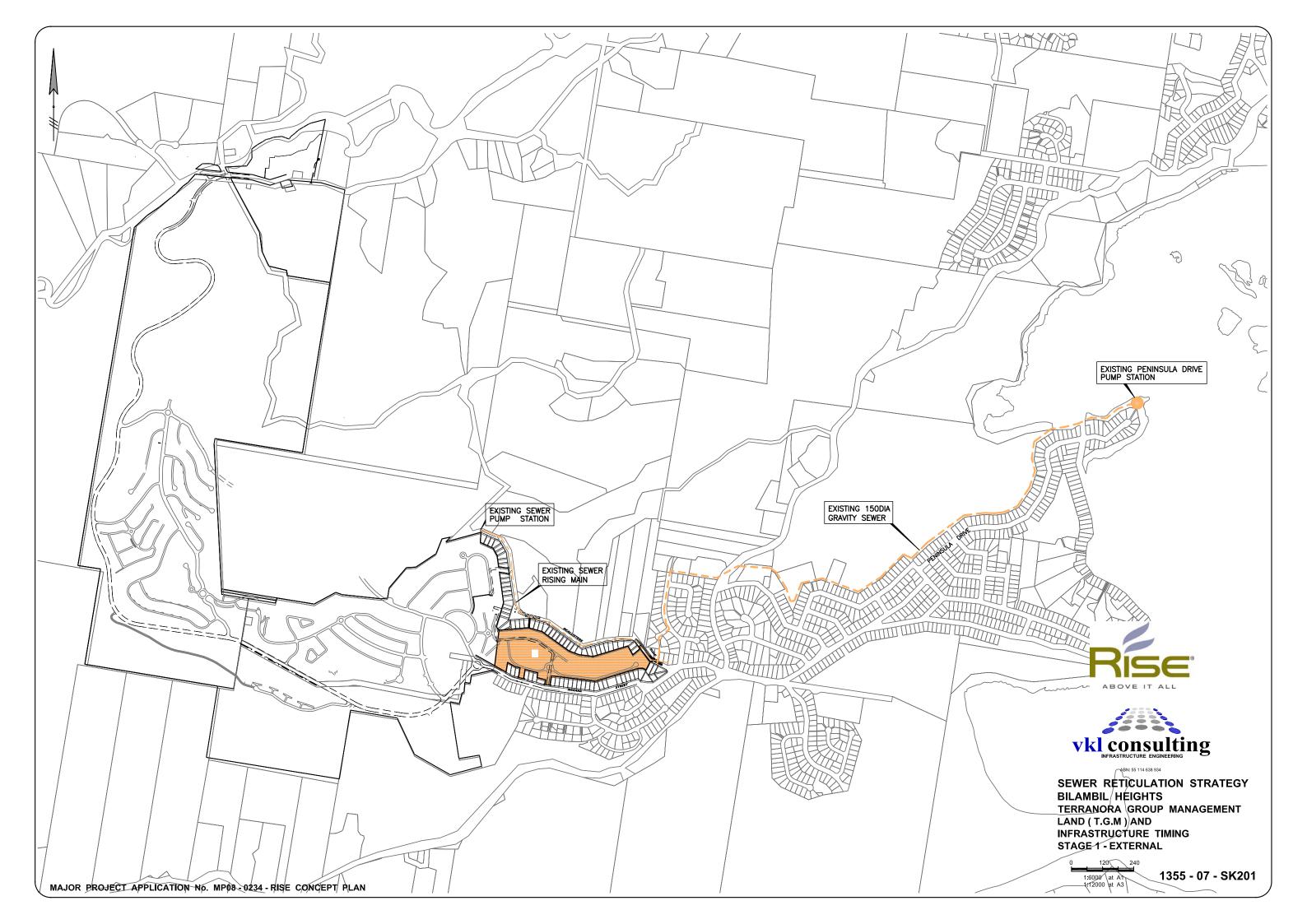


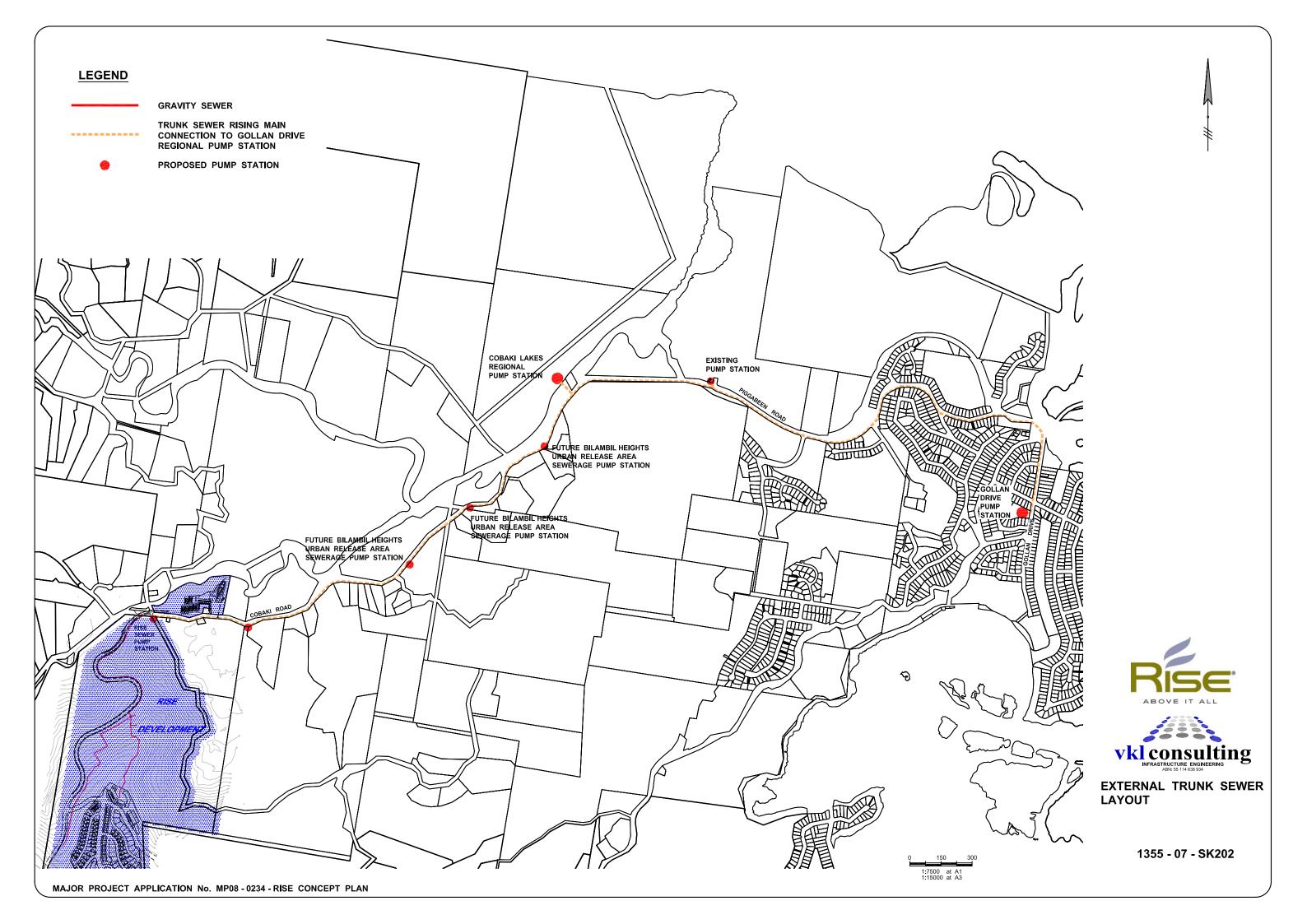


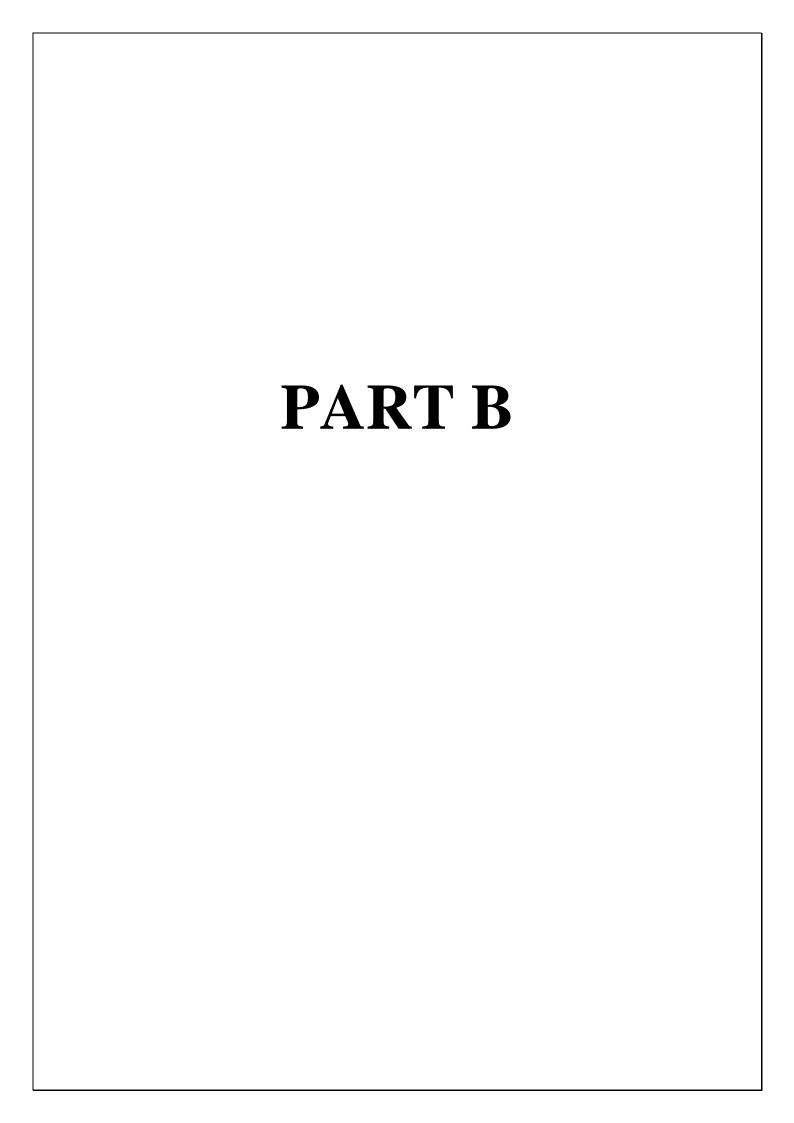
RECYCLED STORMWATER RETICULATION



MAJOR PROJECT APPLICATION No. MP08 - 0234 - RISE CONCEPT PLAN









MAJOR PROJECT APPLICATION No. MP08-0234

RISE CONCEPT PLAN

SUBDIVISION DCP CONFLICTS

RESPONSE TO DGEARS GENERAL REQUIREMENTS No. 3B



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March 2009

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1. <u>INTRODUCTION</u>

This Report sets out items in Tweed Shire Council DCP – Section A5 Subdivision Manual where variation is sought to enable the proposed Rise Concept Plan to succeed.

Some variations are sought as a consequence of Rise being a large scale Community Title Scheme but with significant elements which will appear and function as a standard subdivision.

2. <u>IDENTIFICATION OF CLAUSES & PROPOSED VARIATIONS</u>

A5 – Subdivision Manual

Item No.	DCP A5 Clause No.	Subject Matter	Proposed Variation	Justification	Overall Project Compliance
1.	A5.2.1 (a) Dot point 3 sub Dot 4	"Provide public transport & local community facilities operating from initial stage of development"	Delete requirement	Initial development likely to be Retirement living precinct which will have private transport facilities. Decision on when public transport is provided is decision taken by Government & private bus owner who has licence for that area.	Transport & facilities will be provided in initial phase but it will be private. The intent of the requirement will be met. Overall on Rise Development private facilities will be provided to residents as it is a Community Title development.
2.	A5.2.1 (a) Dot points 7 & 8	"Ridgelines are preserved without visual intrusion and excessive benching" "housing & other forms of urban development to integrate natural features not dominate or remove"	Delete requirement	Integrated concept plan which provides features of hillside village. Concept destroyed if compliance required.	Extent of visual intrusion onto ridgeline is minimal. This has been documented in ML Design Report.
3.	Table A5-3 Note 1	Site Grading Acceptance Criteria	Amend 1.2m to 3.0m	Built form solution to be applied to site. Concept plan shows Architectural concept details.	As a consequence of topography & minimization of cut / fill at subdivision stage a built form solution is proposed in some areas which requires some flexibility on retaining wall height as the retaining walls may be incorporated in buildings. The maximum

Item No.	DCP A5 Clause No.	Subject Matter	Proposed Variation	Justification	Overall Project Compliance
					height of 1.2m is too restrictive in some locations. The majority of the site is capable of achieving the current DCP D6 Guidelines. The suggested amendments will allow site specific solutions without need to amend DCP at a later date. The suggested 3.0m was chosen as it is approximately equivalent to a floor level.
4.	Table A5-3 E2	Criteria for maximum permissible combined height of retaining walls or batters	Amend heights at boundaries of lots created within subdivision. Residential insert 3.0m for above & below street level. No limit on Spine Road	Topographic reasons. Built form solution to be applied to site. Concept plan shows Architectural concept details. Not practical along Spine Road as road level is controlled by grade agreed with TSC.	Comments as for Item 3 above. This will only apply where there is multi unit development not where detached housing is to be provided. The Spine Road is access denied except at public and private road intersections. The levels of the Spine Road are based on 12% grade which dictate batter / retaining wall heights.
5.	A5.4.10	Movement Network	Criteria to apply only to public roads	Large integrated Community Title development with many private roads, bikeways & pathways.	The DCP Movement Network Criteria is essentially applicable to freehold subdivisions. Rise generally conforms to the majority of the requirements however flexibility is required to deal with topography & built form solutions, private road sections & logical sizing of multi unit developments.
6.	A5.4.11	Open Space Network	Delete specific requirements	Open Space provided within large integrated Community Title development	The Open Space Criteria in the DCP have been based on freehold subdivision open space uses. Provision is made on the community land for residents. The overall Rise Development will provide more open space than a freehold subdivision of equal size.
7.	A5.4.12	Lot Layout	Delete specific requirements	Concept Plan provides details of large integrated Community Title development lot layout.	The Lot Layout requirements do not envisage a Community Title development of the size of Rise. Whilst Rise Development does not comply with the prescriptive requirements of A5.4.12 it does achieve a suitable outcome given site topography.

Item No.	DCP A5 Clause No.	Subject Matter	Proposed Variation	Justification	Overall Project Compliance
8.	A5.5 in its Entirety	Rural Subdivision Guidelines & Development Standards	Delete	No applicable to large integrated Community Title development.	No Rural Residential lots proposed in concept therefore these requirements are not appropriate for inclusion.
9.	A5.6.1 Subdivision under the Community Titles Act General	Description of Works	After "will include community owned" insert "and public"	As a consequence of the large scale of the Community Titled development water reticulation & sewerage infrastructure to be publically owned to avoid differential treatment for rating purposes.	Tweed Shire Council DCP has been prepared on the basis that Community Title developments are relatively small in size & have private services. Rise Development is a large integrated development & proposes that public water supply & sewerage infrastructure be provided on the basis of equality to all ratepayers. The Community Titles Act provides for Statutory Easements to permit utility services providers to access the infrastructure for operational & maintenance purposes.
10.	A5.6.1 Subdivision under the	(i) Landforming	Amend as proposed in Items 3 & 4	Large integrated Community Title development with Architectural solution	Refer to appropriate submissions Items 1 to 9 above.
	Community Titles Act Design	(ii) Movement network	Amend as proposed in Item 5	Large integrated Community Title development with Architectural solution	Refer to appropriate submissions Items 1 to 9 above.
	Guidelines & Development Standards	(iii)Lot layout	Amend as proposed in Item 7	Large integrated Community Title development with Architectural solution	Refer to appropriate submissions Items 1 to 9 above.
		(iv) Open space network	Amend as proposed in Item 6	Large integrated Community Title development with Architectural solution	Refer to appropriate submissions Items 1 to 9 above.
		(v) Infrastructure (a) Water, Sewer	Delete references to community responsibility. All reticulation to be publically owned & maintained in a similar manner to freehold title subdivision.	Large scale Community Title development. Council policy not developed for this size development. To avoid adverse differential rating between TSC rate payers.	Refer to appropriate submissions Items 1 to 9 above.

Item No.	DCP A5 Clause No.	Subject Matter	Proposed Variation	Justification	Overall Project Compliance
11.	Appendix E	Buffers	Delete	Subject to Major Project determination	It is acknowledged that Appendix E is advisory & these matters are to be addressed by DGEARS specific requirements. The outcomes of those considerations will determine any specific buffer requirements.

D1 -Development Design Specification Road Design

Item	DCP	Subject Matter	Proposed	Justification	Overall Project Compliance
No.	D1 Clause No.		Variation		
1.	D1.10 Table D1.6	Maximum Grades on Roads	1. Insert additional road type for "private road" Desirable max. grade – 16% Absolute max. grade – 25%	Large integrated Community Title development with low speed environment. Variable topography to avoid significant cut & batter heights	Overall the majority of the road gradings comply with the DCP however in a number of minor areas the private road gradings will need to be 25% grades. This 25% grade is consistent with private access requirements & relevant Codes. All public roads comply with the DCP.
2.	D1.10.2	Longitudinal grade through intersection	Delete clause for private roads	Impractical in community titled areas of site. Low speed traffic environment.	Public roads comply. The majority of the private roads throughout Rise comply with the requirement however where the maximum 25% grades apply to private roads it is not possible to achieve the requirements without extensive earthworks.
3.	D1.11.2(c) D1.11.3(b) & (c)	Minimum length vertical curves for visual appearance	Delete for private roads	Variable topography to avoid significant cut & batter heights	Public roads comply. The majority of private roads throughout Rise comply however where maximum grades are required the use of public road minimum vertical curve standards would result in significant earthworks. As internal private road the traffic speeds will be low. Lengths of vertical curves can be lowered with safety.
4.	D1.14	Urban cross section elements	Delete entire clause for private roads. Adopt cross sections shown in Rise Major Project Application No. MP08-0234	Large integrated Community Title development. To minimize cut / fill on site & integrate with Architectural built form concepts	Public road cross sections will conform, some of the private road cross sections conform, however some have been modified to suit build form access solutions as a consequence of topography & requirement to conform where possible with D6 of the TSC DCP – Landforming.
5.	D1.15 Table D1.8 & Notes	Footpath & utility services allocation	Delete for private roads. Insert publically owned infrastructure within Statutory Easements in Rise development	Existing requirements do not fit with Rise concept private road cross section configuration	Public road sections will conform. Private road verge widths vary to suit topography and built form access solutions. All private road reserves are community land & will have Statutory Easements where public utilities are layed.

Item No.	DCP D1 Clause No.	Subject Matter	Proposed Variation	Justification	Overall Project Compliance
6.	D1.16	Urban footways & cycleways	Delete for private roads & infrastructure Austroads grades & signage to apply	Large integrated Community Title development. Australian road rules do not apply	Public roads will comply. Proposed cycleways / footways within Rise will be community owned & maintained. Generally these will conform with public road standards however as a consequence of topography some small lengths may not comply. These will be constructed on community land & may have variable alignment to achieve satisfactory grade.
7.	D1.17	Urban intersection	Delete sections for private roads that are not applicable to low speed environment	Low speed environment on private roads	Public roads comply. Some private intersections will conform however in certain circumstances the topography / road sections & low speed environment dictates that public road intersection configurations are not warranted.
8.	D1.18 D1.19	Roundabout & traffic calming	Delete requirement for private roads in low speed environment	Large scale Community Title development	Public roads will comply. Public road configurations are not necessary for low speed environment of private roads. Traffic calming will be achieved on private roads by the topography, gradings & where required, other traffic calming features.
9.	D1.20.1 D1.20.2	Parking	Delete for private roads. Insert "as proposed in Architects submission"	Large scale Community Title development. Private parking.	Generally adequate parking will be provided within private property, private roads & in buildings.
10.	D1.21	Bus routes	Applicable only to public roads	Community Title development with private roads	Public roads will be suitable for public bus transport. Public bus operators in general will not travel on private roads. Shape of development land and Spine Road will mean that distance to public transport DCP requirements can be complied with.
11.	D1.22	Urban driveways & access	Delete requirement for access to every lot at time of land subdivision	Large Community Title development which includes Architectural built form solutions in some areas to avoid excessive cut / fill batters. Access gained at building stage.	Access to each lot will be provided to most lots at time of subdivision. There are some locations where the built form solution will provide the formal access to the lot. Rather than undertake excessive earthworks at subdivision stage it is appropriate to permit steep embankments at subdivision stage. Flexibility is required so that unnecessary earthworks is eliminated.

Item No.	DCP D1 Clause No.	Subject Matter	Proposed Variation	Justification	Overall Project Compliance
12.	D1.24 to D1.34	Rural development standards	Delete	Not applicable to Community Title development	No Rural Residential lots proposed in Rise Development.

D6 – Site Regrading

Item No.	DCP D6 Clause No.	Subject Matter	Proposed Variation	Justification	Overall Project Compliance
1.	D6.05.2(i) Dot point 1	General criteria Regrading not to take place on significant topographical natural features	Delete this requirement	Rise concept provides or hillside development Art village on highest land which will require reprofiling	Regrading is proposed in the area of the Arts Village as this is central to Rise concept of "hillside villages". Other areas generally comply.
2.	D6.05.4(i) Dot points 2 & 3	Shape surface criteria	Delete this requirement	Architectural solution for built form to take up changes in level to avoid significant cut / fill batters in Community Title development	It is not intended that major terracing of land occur at subdivision stage so that earthworks are minimized. Some reprofiling will occur at building stage as buildings take account of landform.
3.	D6.05.4 Note 1	Combined height of retaining wall	Delete 1.2m Insert 3.0m	Architectural solution for built form to take up changes in level to avoid significant cut / fill batters in Community Title development	As a consequence of topography & minimization of cut / fill at subdivision stage a built form solution is proposed which requires some flexibility. The maximum height of 1.2m is too restrictive in some locations. The majority of the site is capable of achieving the current DCP D6 Guidelines. The suggested amendments will allow site specific solutions without need to amend DCP at a later date. The suggested 3.0m was chosen as it is approximately equivalent to a floor level.
4.	D6.05.6(b)(c) Table D6.1	Maximum permissible combined height of retaining walls	Amend Table D6.1 Boundaries of lots created in subdivision Side & rear boundaries – 3.0m all types of subdivision Street boundaries above & below roads – 3.0m	Large integrated Community Title development with built form Architectural solutions to avoid significant cuts & fills.	Comments as for Item 3 above. This will only apply where there is multi unit development not where detached housing is to be provided. The Spine Road is accessed denied except at public and private road intersections. The levels of the Spine Road are based on 12% grade which dictate batter / retaining wall heights.
5.	D6.07.2	Removal of cleared material from site	Amend to allow vegetation chipping & use as mulch	Recycling of material. Helps stabilized disturbed areas.	More appropriate that vegetation that is removed is recycled on site & used in landscape works.

Item No.	DCP D6 Clause No.	Subject Matter	Proposed Variation	Justification	Overall Project Compliance
6.	D6.15	Staging	Delete this clause	Large Community Title scheme. This clause will not function where Architectural solutions used to reduce significant cut / fill batter heights. Not practical in Rise circumstances.	In most project stages compliance can be achieved however flexibility is required where topography dictates built form solutions, particularly as Rise is a major integrated Community Title with many stages.

D9 - Cycleway & Pedestrian Pathway Design Specification

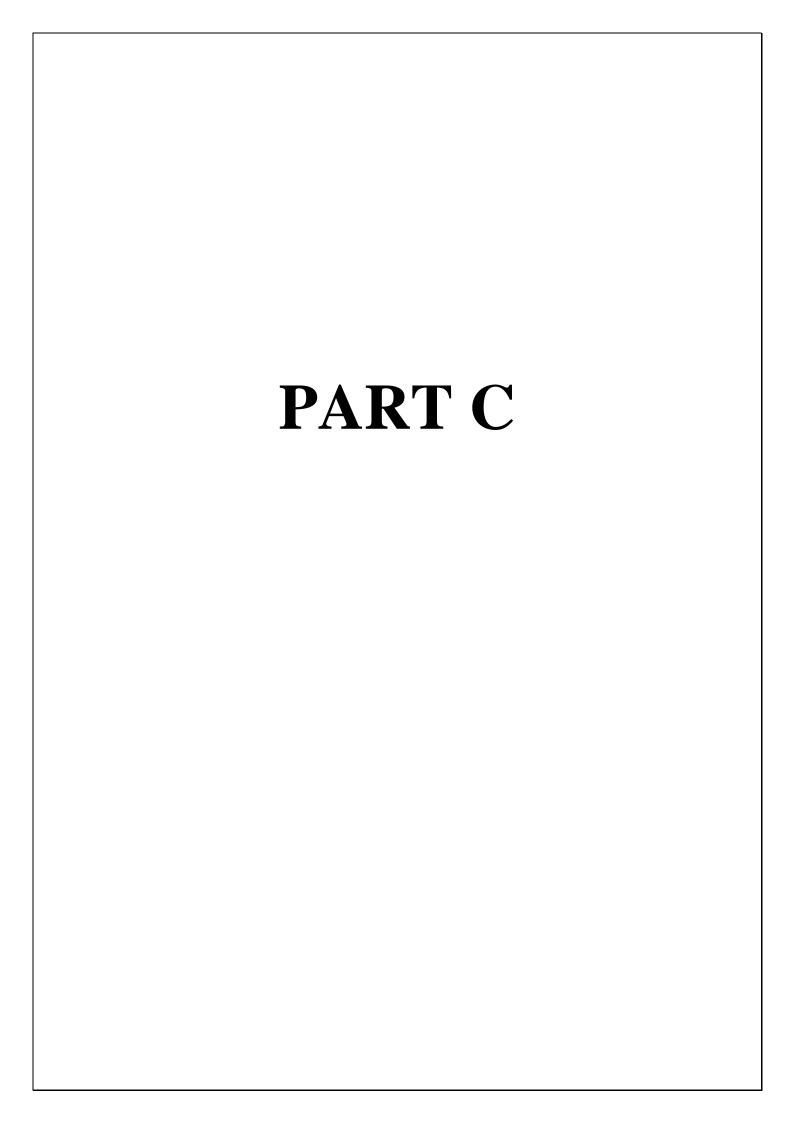
Item No.	DCP D9 Clause No.	Subject Matter	Proposed Variation	Justification	Overall Project Compliance
1.	D9.10.1 Table D9.1	Minimum design standards	Delete minimum path & formation width. Delete maximum grades on private community land & roads	Community Title development. Adopt as shown on Rise concept plans to avoid significant cuts & fills.	Comply on public roads & most private roads & community owned pathways & cycleways. Flexibility needed to reduce major earthworks where steeper grades occur on Rise project.
2.	D9.12	Special requirements footpaving	Delete for private community land & roads	Not public footpaving	Comply for public roads. Privately owned & maintained surfaces may have special treatments.

D11 - Water Supply Development Design Specification

Item	DCP D11 Cl N	Subject Matter	Proposed	Justification	Overall Project Compliance
No.	D11 Clause No.		Variation		
1.	D11.06.1	Water peak daily demands	Amend to designate potable / reuse water	Concept provides for dual use water reticulation with toilets & yard watering supplied from community owned & treated captured stormwater. Publically owned potable water reticulation with the community titled development.	Total water demands to be provided & met. Variation required to use recycled treated stormwater to reduce potable water demand as an Integrated Water Management Scheme. Recycled stormwater privately owned & operated. Potable water Council owned & operated within community land – access by Statutory Easement.
2.	D11.07(a)	Mains alignment	Delete where water mains layed within community lands & private roads	Large scale Community Title development with public watermains in Statutory Easements with varied private road cross sections	Will comply in public roads. In private roads an allocation of alignment will be provided & covered by Statutory Easement.
3.	D11.07.2	Private land easements	Amend to Statutory Easement	Community Title Act has provision for Statutory Easement over publically owned infrastructure	Provisions for Statutory Easement exists in Community Titles Act for public owned infrastructure to be accessed & maintained.

D12 - Sewerage System Design Specification

Item No.	DCP D12 Clause No.	Subject Matter	Proposed Variation	Justification	Overall Project Compliance
1.	D12.06.2	Design loading	Amend ADWF to 180 ℓ / EP / day	Large scale Community Title development will be subject to Basix provisions which result in lower volume of sewage per EP	TSC DCP D12 requirements do not take into account projects subject to Basix & resulting reduction in sewage generation through low use shower heads, taps, dishwashers, washing machines & dual flush toilets. Accepted criteria is 180 \(\ell \)/EP/day compared to 240 \(\ell \)/EP/day in D12 of DCP.
2.	D12.07.1(a) & (b)	Sewer alignment	Delete requirements	Concept is for public sewers in large scale Community Title development with Concept Architectural solutions to minimize significant cut & fill batters. Existing requirements will be impractical. In some areas public sewers will be located within private roads because of topography.	Comply with alignment on public roads where applicable. Built form access solutions & topography require flexibility be available for alternate alignments where public sewers are layed through community lands within Statutory Easement.
3.	D12.07.1(c) & D12.07.4	Sewer alignment & easements	Insert Statutory Easement where public sewers are layed in community land	Community Title Act provides for Statutory Easements over publically owned utilities.	Public sewers to be layed on appropriate alignments with Statutory Easements for maintenance access.
4.	D12.10.9	Property connection	Delete requirement	May not be practical because of topographical constraints.	Comply in most instances however flexibility required because of topography in community lands.
5.	D12.12.30	Trunk sewer design	Delete requirement	May not be practical because of topography & public sewers in large Community Title development.	Generally will comply however flexibility required in community lands because of topography. Public trunk sewers layed in Statutory Easements.





MAJOR PROJECT APPLICATION No. MP08-0234 RISE CONCEPT PLAN

RESPONSE TO DIRECTOR GENERAL'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS

KEY ASSESSMENT REQUIREMENT No. 12 SITE PREPARATION WORKS



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GEOTECHNICAL REPORT & SLOPE ANALYSIS DGEARS ITEM 12 SITE PREPARATION (2)

1. <u>INTRODUCTION</u>

Geotechnical investigations have previously been undertaken by Border-Tech Geotechnical Engineering Services in November 1996 and by Gilbert & Sutherland in December 1997.

These Geotechnical investigations were undertaken as part of the Statement of Environmental Effects (SEE) in support of a Resort Development Application which was approved over the subject site and remains as an active Development Approval.

Investigation test locations of the two Geotechnical investigations have been compiled and overlayed with the Rise concept so that the relativity of the Geotechnical testing can be related to the current application concept. Refer Appendix A of this Report – VKL Consulting Pty Ltd Drawing No. 1355-07-SK150.

This Report has been prepared on the basis of the conclusions of the Border-Tech Geotechnical Engineering Services Report dated November 1996 and extracts from the Gilbert & Sutherland Report dated December 1997 which are included in Appendices B & C respectively as the Geotechnical conditions applicable to the site have not changed, notwithstanding that the project concept has changed.

2. <u>INTERPRETATION</u>

The Border-Tech Geotechnical Engineering Services Report dated November 1996 makes references to various components of the Golf Course Resort and proprietary names. These are not referred to elsewhere in the Rise Major Project Application documentation.

For the purpose of interpretation we identify the subject area in the Rise concept plan.

Table 1

Item No.	Reference Clause Border-Tech Report dated Nov 1996	Ref Page No. Border-Tech Report dated Nov 1996	Area Referred to in Border-Tech Report dated Nov 1996	Equivalent Location in Rise Concept Plan
1.	2.1	3	"Landscaped Golf Course Area"	Precincts A, B, C, D, E, F, G & H
2.	2.1	3	"Clubhouse & Hotel" Precinct	Precincts A, D, E & G
3.	2.1	3	"Norville Property"	Part Precinct L, Precincts M, N, O & land to the north of Precinct N through to Cobaki Creek Road
4.	2.1	3	"Holmview"	West of the Spine Road Chainages 2700 to 3400 Refer VKL Consulting P/L Dwg No. 1355-07-SK07C for Spine Road chainages. This area is outside of Rise concept application area.

3. EXTENT OF TESTING

During the Border-Tech Geotechnical investigation of the site a total of 30 No. boreholes and 17 No. test pits were bored / excavated to establish underlying Geotechnical conditions. Undisturbed and disturbed samples were collected and tested and reported on.

A further 5 No. boreholes were drilled by Gilbert & Sutherland during their investigation to establish soil classifications over the site.

Refer to VKL Consulting Pty Ltd Plan No. 1355-07-SK150 for locations of boreholes and test pits in Appendix A.

4. GEOLOGY OF SITE

Extracts & Ref. Border-Tech Report dated November 1996 – Section 2 & Gilbert & Sutherland Report dated December 1996 – Section 3.4/3.5

The site consists of various geological formations with the oldest rocks being metasediments of the Neranleigh - Fernvale Group. These occur in the northern region of the site in the valley floor near Cobaki Creek Road and form the foot slopes rising to the south from Cobaki Creek Road.

Metasediments are typically sandstone and siltstone however beds of greywake can occur near the basalt – metasediment contact.

Above these Neranleigh – Fernvale Group are Tertiary age basalt lava flows (Lamington Volcanic Group) with younger volcanic rhyolitic lava (Lamington Volcanic Group) overlaying the basalt and forms the higher areas of the subject site.

The rhyolitic can be dissected into two types, being upper tuffaceous rhyolite and lower penlitic, vitreous (glassy) brittle rhyolite.

The contacts between the base of the basalt and underlying Neranleigh – Fernvale beds and the top of the basalt and overlaying rhyolitic have their own weathering characteristics and locally control topography and soil type.

Recent alluvials of Cobaki Creek form low lying land at Cobaki Creek level.

Gilbert & Sutherland's investigation of soil types found that the site soils consisted of Ferrosols, Dermosols and Kurosols.

The Ferrosols being associated with the Tertiary Age basalt lava flows and the Demosols / Kurosols associated with the younger volcanic rhyolitic lava and older metasediments of the Neranleigh – Fernvale Group.

5. SUBSURFACE PROFILE

Extracts & Ref. Border-Tech Report dated November 1996 – Section 3

The Geotechnical investigation identified boundaries between different soil and rock types. Each type has different influences and effect on development.

The Border-Tech Report dated November 1996 breaks the site up into different Geotechnical assessment units (GAU's). Descriptions of each unit is contained in the Border-Tech Report.

6. <u>GEOTECHNICAL CONCLUSIONS – Including Conclusions from Border-Tech</u> Report Dated November 1996

The subject site has some complex geological structures and whilst geological / Geotechnical properties are expected to be typically gradational they could exhibit rapid lateral variations.

In a broad scale Geotechnical investigations such as the Border-Tech and Gilbert & Sutherland investigations it cannot be expected that lateral variations can be identified.

Specific detailed Geotechnical investigations will be required for each component or Precinct of the development at the time Development Consent application or construction approval stage.

The investigations found that there are no geological conditions evident on the site which would indicate that the proposed development cannot be satisfactorily achieved.

There are no known geological conditions at the site which could adversely affect the adjoining land and a consequence of the proposed development.

Rhyolitic deeper than 5-7 metres and basalt shelf rock may not be rippable.

Specifically designed subsurface drainage will be required in the contact zones between the various geological formations throughout the subject site.

Subject to detailed design of earthworks at Development Application stage per Precinct a range in size of basalt boulders may be encountered. In those areas where basalt boulders are encountered, foundation design for structures will need to account for the possibility of variable degrees of bearing capacity.

If areas of basalt boulders are encountered during DA and construction design specific attention to construction safety methods will be required to prevent boulders from rolling beyond the specific construction sites. One method of achieving this is to locate stripped topsoil windrows down slope of the construction site.

No evidence of active land slippage was identified on the subject site during investigations.

As a consequence of slopes in steeper areas of the site construction design documentation should take into account the potential for stability failure to occur and provide suitable batter / fill slopes, benching of fill areas, subsurface and cut off drainage together with vegetation restoration of disturbed areas.

7. SUMMARY OF GEOTECHNICAL INVESTIGATIONS

Ref. Border-Tech Report dated November 1996 & Gilbert & Sutherland Report dated December 1997

There are no apparent Geotechnical reasons evident that would prevent the proposed development being completed.

Detail Geotechnical investigations will be required at the time of construction of the various components of the proposed development.

Unrippable rhyolite and basalt may be encountered in various areas of the proposed development together with varying sizes of basalt boulders.

Subsurface drainage will be required at the interface zone of various geological formations and cut off drains will be required where cut batters are to be located.

Disturbed areas are to be reinstated with appropriate vegetation.

8. SLOPE ANALYSIS

Slope analysis mapping has been prepared which reflects the existing profiles of the site. Refer Michel Services Group Drawing No. 8715-8 - Refer Appendix D of this Report.

The concept plan for Rise has taken into account the existing slopes during the preliminary design of the concept.

The built form of the proposed Rise development will modify the existing slopes in some areas.

SITE PREPARATION WORKS DETAILED SURVEY PLAN SHOWING EXISTING & PROPOSED LEVELS & CUT & FILL QUANTITIES DGEARS ITEM 12

1. EXISTING & PROPOSED LEVELS

Preliminary road and adjacent land proposed to be reprofiled as shown in VKL Consulting Pty Ltd Drawing Nos. 1355-07-SK06C and 07C appended in the project concept drawing documentation and specifically in Appendix A of this Report.

Existing contours are shown in light grey at 5m contour interval and preliminary final contour levels shown in red at 1m contour interval.

These plans show, in plan view, the areas of proposed disturbance at the subdivision stage.

Additional reprofiling of the site will occur at the building stage however the architectural design seeks to accommodate changes in level across the various sites by incorporating level differences within the built form to minimise the extent of earthworks required.

Differences in level are also accommodated by single sided access from internal roads where appropriate – See typical sections on VKL Consulting Pty Ltd Drawing No. 1355-07-SK13A.

Preliminary road gradings and cross sections are shown on VKL Consulting Pty Ltd Drawing Nos. 1355-07-SK20 to SK142. Refer to Major Project Application MP08-0234 VKL Consulting Pty Ltd drawing set.

2. <u>CUT & FILL QUANTITIES</u>

Based on the preliminary road gradings and lot reprofiling included with this application have been calculated and are recorded on VKL Consulting Pty Ltd Drawing No. 1355-07-SK12C in Appendix A. These volumes of cut and fill are not solid volumes and make no provision for any detailed earthworks that may be required during building operations.

Subject to detailed design there will be an excess of material to site requirements of approximately 237,000 cubic metres.

This volume of earthworks will be hauled from the site and will comprise a mixture of the various material types identified in the Geotechnical investigations by Border-Tech and Gilbert & Sutherland.

No specific area of disposal of this material has been identified at this early phase however preliminary discussions have occurred with Tweed Shire Council on the need for fill to complete the formation of future arterial roads servicing Bilambil Heights Release Area.

Potential sites are shown on VKL Consulting Pty Ltd Drawing No. 1355-07-150. Refer Appendix A of this Report.

Subject to final design, approval and construction timing it is anticipated that the haul route of excess earthworks from the site will be along Cobaki Road to the proposed Scenic Drive deviation.

No earthworks materials will be required to be imported to the site.

Soil and fill materials will be moved from one section of the site to other areas of the site, subject to design requirements and construction of the various precincts of the development.

3. ASSESSMENT OF EXTENT OF CUT/FILL DEPTHS & AREA OF SITE DISTURBANCE

An assessment of the extent of depths of cut/fill over the proposed development area at bulk earthworks stage is required.

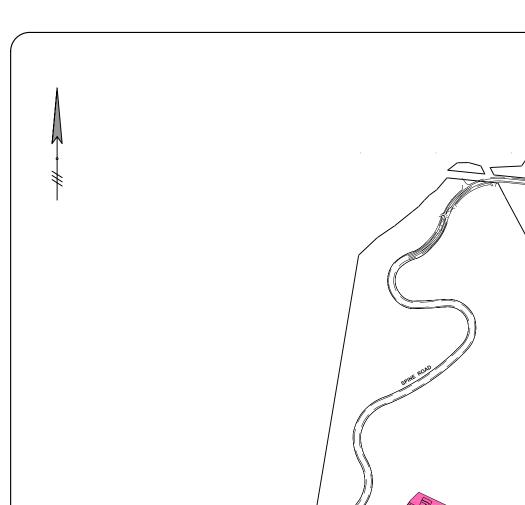
This assessment is shown on VKL Consulting Pty Ltd Drawing No. 1355-07-301 in Appendix A in the form of coloured areas showing ranges of depths of cut/fill.

This assessment has then been used to assess the percentage of areas of the development footprint where cut/fill depths exceed five (5) metres as set out in TSC DCP - D6 which provides for a maximum percentage of 10%.

The outcome of this assessment indicates that the proposed Rise Development complies with the DCP – D6 with a percentage of 6.27% taking into account of public and private roads.

APPENDIX A

VKL Consulting Pty Ltd Drawing Nos. 1355-07-SK06, SK07, SK12, SK13, SK150 & SK301



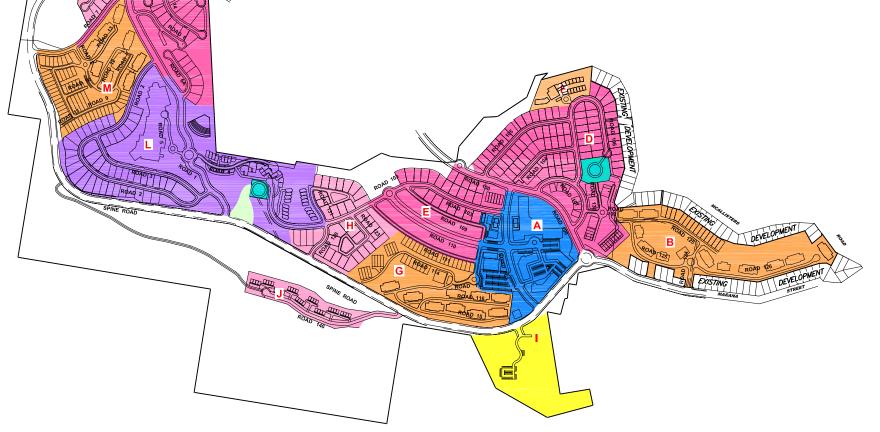
BULK EARTHWORKS VOLUME

PrecInct	Cut	FIII	Disturbed Area
m3	m3*	m3*	m2
A	53030	2830	46260
B	8050	3410	28390
D E F	33460 8100	15330 4540	106042 92290 6000
G	11610	5460	59380
H	5700	1000	35000
l	1500	8000	12000
J	4710	5630	21700
L	156440	59250	108620
M	22570	1550	50990
N	21900	14220	115465
O	3030	3760	23465
U	3190	4310	39380
SPINE ROAD	179820	146440	128413
Exported	off site	237000	
TOTAL	513000	513000	

* NETT SOLID VOLUMES

NOTES:

THE EARTHWORKS FIGURES SHOWN ARE PRELIMINARY ONLY.

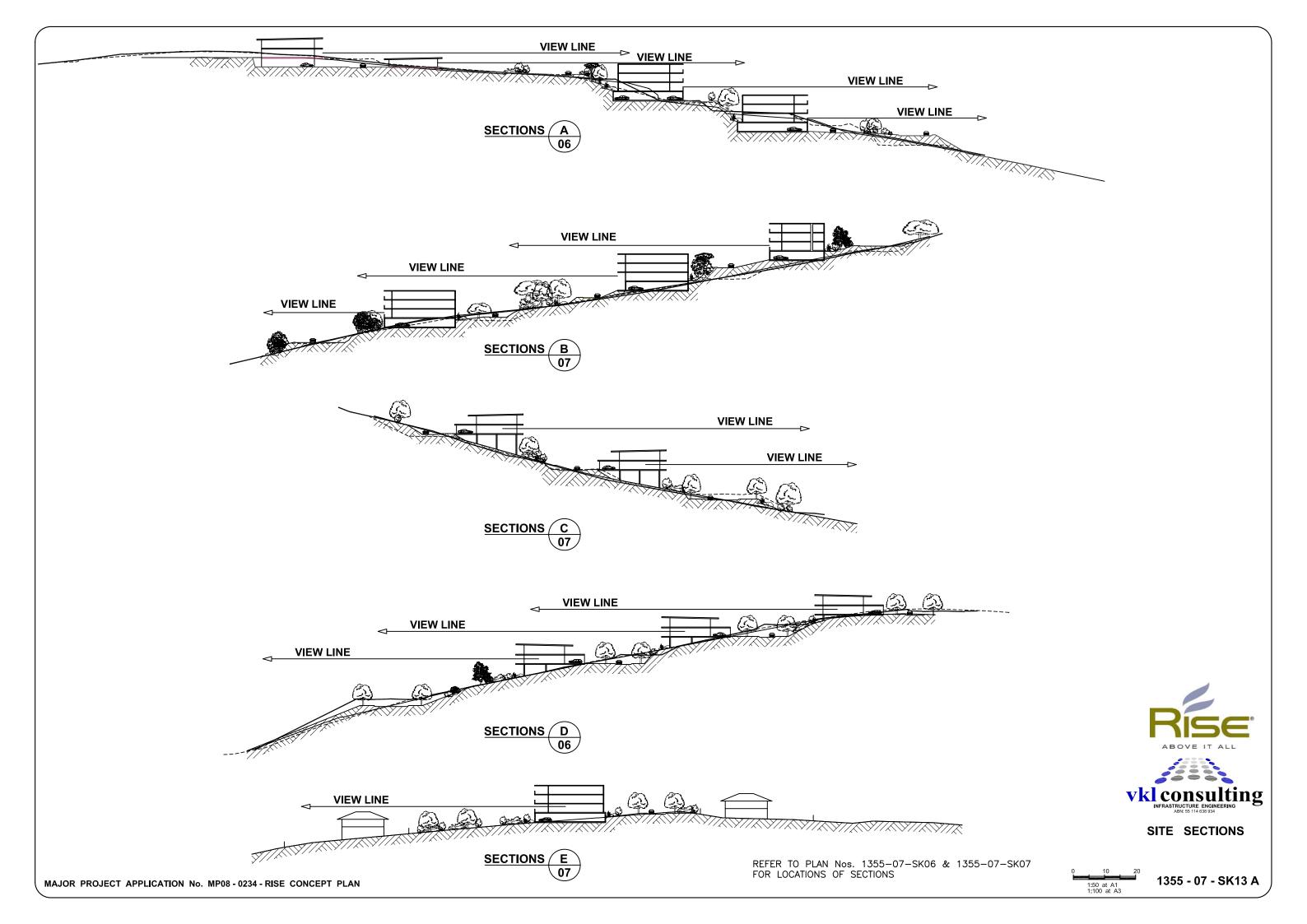


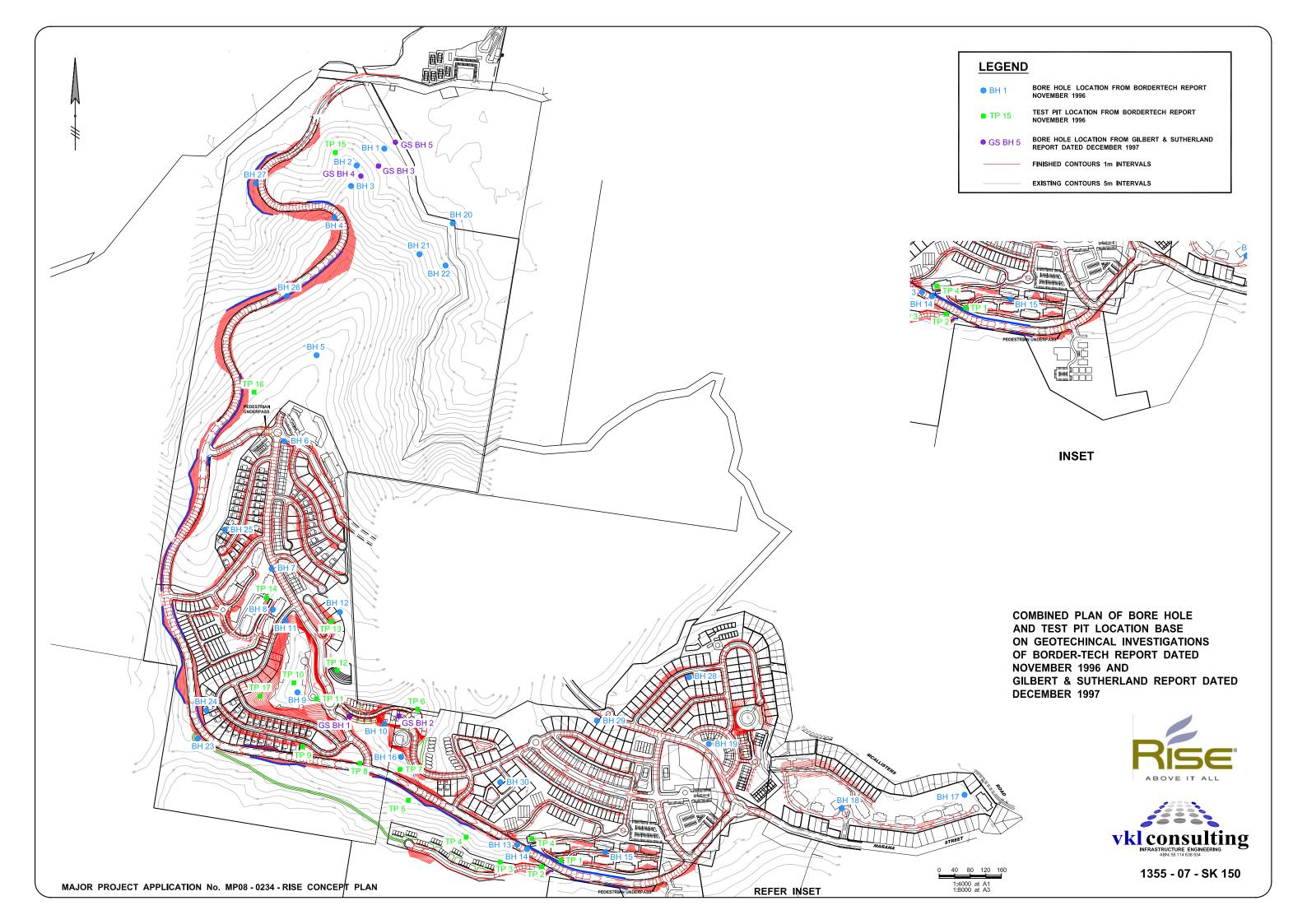


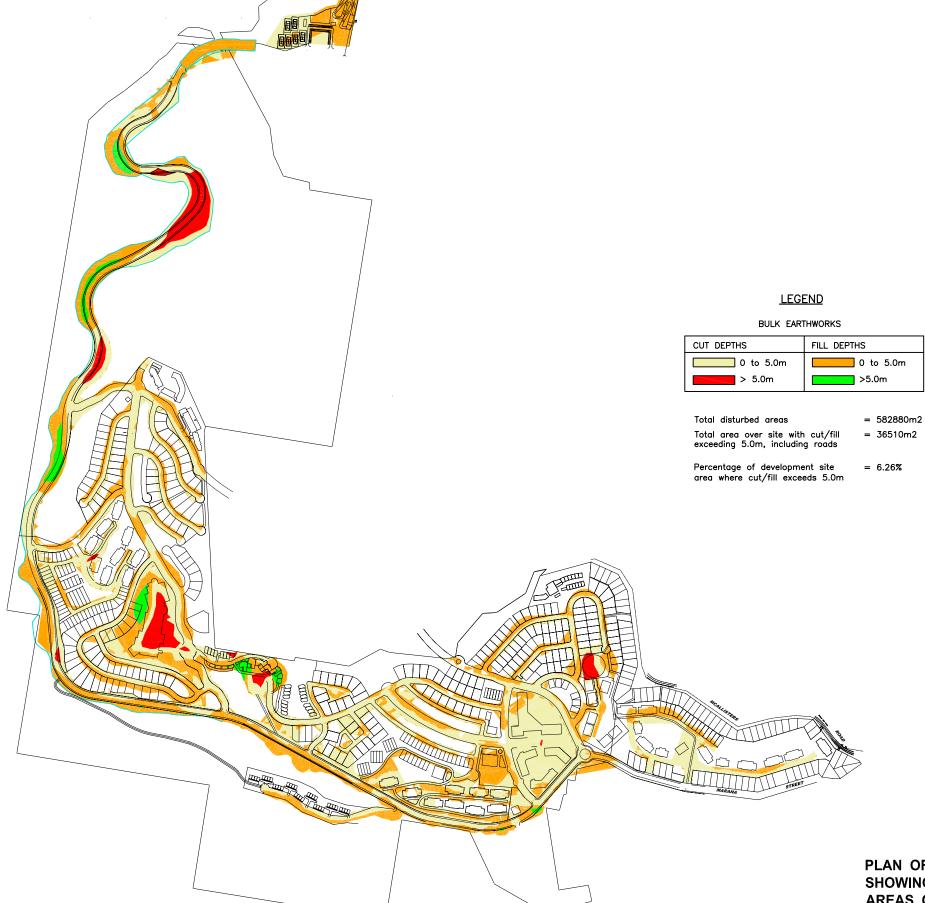
BULK EARTHWORKS VOLUMES

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1355 - 07 - SK12 B

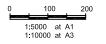


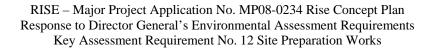






PLAN OF BULK EARTHWORKS SHOWING DEPTHS OF CUT/FILL AND AREAS OF DISTURBANCE INCLUDING PUBLIC AND PRIVATE ROADS





APPENDIX B

Border-Tech Geotechnical Services Report dated November 1996

Site Investigation Report

for

The Proposed Terranora Resort Project

for

Terranora Group Management

Report Number: BT 4466 Date Issued: 1 Nov 96

BORDER-TECH

Geotechnical Engineering Services Unit 6/12 Greenway Drive Tweed Heads South 2486 Telephone: (07) 5524 6199 Facsimile: (07) 5524 6533

P.O. Box 6340

Tweed Heads South 2486

MB:db:BT 4466

27 August 1996

Terranora Group Management c/- Weathered Howe Pty Ltd Consulting Engineers P.O. Box 1653 SOUTHPORT OLD 4215

Dear Sir

Re: Terranora Golf Project

- 1. As requested we have carried out the preliminary site investigation and geological assessment of the above property. The aim of the investigation was to establish the soil and geological conditions pertaining to the site to confirm it's suitability for the proposed development.
- 2. This report presents the results of the investigation. Should you have any queries please do not hesitate to contact this office.

Yours faithfully **BORDER-TECH**

Thomas J Dick

B.E., M.I.E., C.P.Eng., L.G.E. (Q & NSW),

R.P.E.O. (4105)

John C Beal

M.Sc.(Geol), M.A.G.S, M.A.L.M.M,

1 teal

M.I.A.E.G, M.A.N.C.O.L.D.

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1.0 INTRODUCTION

This preliminary geotechnical study has been carried out at the request of Mr N Grummet of Weathered Howe Pty Ltd on behalf of Terranora Group Management (17 July 1996) for the purpose of assessing the overall suitability of the site for the proposed development and to identify any potential problem areas.

The scope of the report is to identify soil and rock types and any unstable slopes via aerial photos, geological mapping, auger drilling, test pitting and materials testing. Comment is also sought on the hydrogeology of the site with particular reference to water storage areas.

The geotechnical site investigation consisted of drilling a total of thirty boreholes using either a Jacro 200 or a GCH 200 truck mounted drilling rig employing spiral flight augering techniques. Seventeen backhoe test pits were also excavated across the site to allow bulk sampling and visual inspection of insitu sub surface profiles. Undisturbed samples were obtained in the boreholes to allow strength properties to be established in the field. Both undisturbed and disturbed samples were returned to the laboratory for analysis. The locations of the boreholes and test pits are shown on the drawings included in Appendix C to this report.

2.0 SITE DESCRIPTION

2.1 Topography

The undulating landscaped golf course area is bounded by basalt scarps facing east, south and southwest. There are topographic - highs (volcanic rhyolite) in the area of the proposed Clubhouse and Hotel precinct.

The Norville property has centrally located undulating ground with gradients mainly 10° - 25° bounded by basalt scarps (25° - 35°) facing south, east and west and with slopes (20° - 30°) steepening northwards as the land drops down to merge with flatter ground (Storage site area) and alluvial flats areas of Cobaki Creek. (Farmhouse area)

The site is free of obvious landslip topography (slip scarps, hummocky ground, tilted trees) apart from possible minor shallow slumping marked by reedy patches. Ancient landslips along the steep basalt scarp areas are indicated by anomalous contour patterns but these areas are well treed and cannot be identified with any certainty. There is no evidence of active large scale landslips.

Active erosion gullying is limited to cuts in the steep sections of the existing access track between "Holmview" and the two water tanks, and in the area of the spillway for the main Norville property dam adjacent to Cobaki Creek Road.

2.2 Vegetation

It is understood that details of vegetation will be covered in an environmental report.

Generally vegetation is either golf course, grass in cleared areas, or pockets of a dense shrub and tree growth. Grassing has been achieved by the past clearing of basalt boulders now left

as windrows, the latter commonly defining the edge of treed areas. Treed areas also occur along the steep basalt scarps and restrict detailed mapping and drilling access.

2.3 <u>Drainage</u>

Drainage of the Norville property is by numerous small natural watercourses, towards Cobaki Creek with the exception of east and southeast aspects where minor courses drain hillslopes towards Bilambil Creek.

Drainage of the existing golf course is into a series of small dams placed along the watercourse bounding its north / northwestern extent. Comments on the availability of groundwater is discussed in section 6.0 below.

Along the western proposed boundary of the Norville property and in the north east corner at the footslopes of steep basalt hillside, springs and boggy areas occur where bedrock lies at a shallow depth.

Two dams occur at the contact between the volcanic rhyolite and the basalt and tracks traversing this contact were observed to be boggy; drilling returns from this contact showed higher than normal soil moisture content.

2.4 Geology

The oldest rocks, metasediments of the Neranleigh-Fernvale Group, occur in the valley floor along Cobaki Road formation and form the foot slopes of the Norville Property and the steep

ascent area between the proposed storage site and the existing two small water tanks located upslope of the basalt / metasediment contact. The metasediments are typically sandstone and siltstone, although beds of greywacke occur at two known locations near to the basalt - metasediment contact.

These are followed by Tertiary age basalt lava flows (Lamington Volcanic Group) which overlie the Neranleigh-Fernvale Group and form all the remaining Norville property and the golf course with the exception of the topographic high country.

The younger volcanic rhyolitic lava (Lamington Volcanic Group) overlies the basalt and forms the high points, that is, the distinctive hill at the southern end of the Norville property (Hotel precinct area) and the hill on the golf course near to the reservoir tank. (Clubhouse area) The rhyolite can be subdivided into two types; an upper tuffaceous rhyolite and a lower perlitic, vitreous (glassy) brittle rhyolite.

The contacts between the base of the basalt and underlying Neranleigh-Fernvale Beds and the top of the basalt and overlying rhyolite have their own weathering characteristics and locally control topography and soil type.

Recent alluvials of the Cobaki Creek form the low lying land at the Cobaki Road level.

(Commencement of access road area)

3.0 SUBSURFACE PROFILE

Geological mapping (Figure 1), auger drilling (Appendix A), test pitting (Appendix A) and sample collection have been carried out across the proposed development site. Physical

properties of materials tested are discussed in section 4.0 below and summarised in Appendix C. The definition of selected geotechnical terms also appears in this appendix.

The geotechnical investigation identified boundaries between the different soil and rock types. Each type is associated with a typical profile (depth, weathering grade and material strength) with its own influence on site development. The site has therefore been subdivided into the various profiles which are referred to as geotechnical assessment units. (GAU's). Their relevance to geotechnical work is listed in Table 1 which can also be referred to in Figure 1 which locates the GAU's and the approximate location of contact boundaries between the main rock types.

A brief description of the profiles is given below and Table 2 summarises the main findings of the drilling and pit testing programme.

3.1 Rhyolite

The two types of rhyolite give different profiles. The tuffaceous rhyolite appears to have a gradational profile showing a gradual decrease in weathering and increase in rock strength with depth. Typically an intermediate to low plasticity soil (clay-silty clay) passes into a highly weathered, weak bedrock at about 2.0 metres below ground surface, becoming strong to very strong at about 5.0 - 7.0 metres below ground surface. (Depth estimated from exposure in the cut for the existing reservoir tank.) This depth is variable particularly if the land surface has been modified by removal of soil or placement of fill. Table 1 and Figure 1 shows this profile as [2A].

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The perlitic and rhyolite appears not to have the gradational profile of the tuffaceous variety. Fresh to near fresh perlite is glassy, brittle and strong but with weathering can rapidly break down into a silt clay of low to high plasticity clay. Up to 4.0 metres or so of residual soil in this material has been recorded. Table I and Figure 1 shows this profile as [2B].

3.2 The Rhvolite / Basalt Contact.

In areas where there is a rhyolite / basalt contact, the development of 8 metres or more of highly weathered, very weak siltstones - claystones with near soil type properties can occur. This has been observed at the borrow pit area downslope of the existing reservoir tank.

These materials may not be limited to the present day weathered profile, but may continue, near horizontal, between the base of the Rhyolite and upper surface of the basalt. That is, drilling through the rhyolite may intersect soil to weak rock at depth, interbedded between strong rhyolite and basalt. Where erosion has exposed these ancient conditions in association with weathered basalt a complex weathered soil profile has resulted. Table 1 and Figure 1 shows this contact profile as 2A / 3B or 2B / 3B and may be present at 2A / 3C; 2B / 3C contacts.

3.3 Basalt

Because of an unstable silica contact volcanic rocks commonly weather rapidly and the typical gradation of rock to a residual soil can be absent; strong near fresh corestones rapidly pass into an adjacent weak highly weathered basalt. This makes assessment of soil profile difficult - drilling refusal may indicate a corestone and not necessarily the depth at which weak, highly weathered basalt is absent.

Soil thickness includes colluvial and residual soils and in most places differentiation between the two is uncertain particularly over the basalt areas where loose rock boulders may either have originated from short distances upslope (ie: colluvial 'floaters') or be in-situ corestones, (the residual product of weathered basalt.) Figure 4 illustrates the relationship between colluvium, residual soil and weathered rock.

Soil thickness can also vary depending on its topographic position. Down the centre of the Norville property 4.0 metres or more of plastic clay and clay with corestones occur and are assumed to overly massive, strong basalt although this has yet to be proved by drilling. This contrasts to steep hillside - scarp areas where perhaps up to twice this thickness may occur in areas where both colluvial and residual soils have accumulated and where strong massive layers of basalt may be completely absent.

Figure 4 shows now a profile of soil upon rock can pass into an underlying soil. A reverse weathered profile is not uncommon in areas of numerous thin basalt flows and care must be taken that investigation identifies the presence of a reverse profile and that any bedrock used as a foundation horizon is not underlain by a soil.

Table 1 and Figure 1 show basalt scarp profile as unit [3B] and the more typical basalt profile away from steep areas as unit [3A]. Ground with a topography between 3A and 3B type profiles is described as GAU 3C and is assumed to have a profile somewhere between the two.

3.4 Metasediments

These beds weather to give an intermediate to high plasticity clay. Depth of weathering is variable due to the different rock types found in the Neranleigh-Fernvale Beds. These are typically sandstones, siltstones and greywackes and shown as unit 4A in Table 1 and Figure 1. Depth to bedrock is typically 1.0 to 2.0 metres. However, in the steep hillside above the major dam on the Norville property, up to 4.3 metres of colluvium and residual soil is present.

3.5 Alluviais

Local knowledge of the area opposite to Norville's "Holmeview" indicate up to 6.0 metres of alluvial sands and gravels occur. Historically these alluvials have been used for aggregate and localised earthworks. It is understood that the proposed development will not utilise these materials. Table 1 and Figure 1 show these river alluvials as UNIT [1A].

TABLE 2: Summary of soil types from Borehole and Test Pit Programme

Neranleigh-Fernvale	Typically a 2.0 metre residual soil (CL-CH) overlying 0.5 to
Beds	2.0 metres of highly weathered very weak bedrock. Depth to
[GAU: 4]	the weak bedrock may be greater than 4.0 metres in places, as
	shown by TP 15 and BH 27 where both show sandy clay
_	(approximately 1.0 metre thick) overlying at least 2.0 metres of
	extremely weathered low strength metasediment. These
	locations may be a source of earthworks construction material.

Typically cobbles and boulders in colluvium within a residual Basalt (Spurs and undulatory CL-CH profile (mainly CH) known to be 4.7 metres thick in topography.) places. (TP 9) The residual clay is typically very stiff below 2.5 metres but can soften with depth. It is worth noting that [GAU: 3A] massive fresh or near fresh basalt bedrock has not been intercepted. Excavation into 0.5 metres of extremely weathered basalt underlying 3.8 metres residual CH was achieved in TP 16. (3.8 to 4.3 metres). Highly variable thicknesses of MH-CH clay with moderately Basalt (Scarp and steep strong (in-situ) corestones of highly weathered basalt passing hillside areas) into an underlying CL-CH clay soil. This repeated soil profile [GAU: 3B / 3C] is greater than 8.8 metres thick in places. (BH 15) **Rhyolite** Typically 1.5 to 2.0 metres ML-CI clay overlying extremely [GAU: 2A / 2B] weathered very weak bedrock (eg: BH 9) Residual soil thickness greater towards base of the rhyolite (typically a perlitic variety of the rhyolite) where up to 4.0 metres has been recorded. (TP 12) and in the cut face adjacent to BH 16. In BH 16 the residual soil of the weathered rhyolite sits upon at least 2.0 metres of completely to extremely weathered bedrock (leached basalt profile?)

Based on preliminary field mapping, bedrock excavation in access road cuts is expected to be achieved without the need to blast

- * At chainage CH: 660 metres a 6 10 metre cut may intersect a greywacke bed of the Neranleigh- Fernvale Group. The greywacke when fresh is typically very strong and may present slow excavation conditions.
- * At chainage CH: 900 1000 metres a 6 10 metre cut through steep basalt scarps may go below the weathered profile into fresh extremely strong basalt which if massive with tight discontinuity's will present slow excavation conditions with the possibility of either a rock breaker or blasting being required. Site investigations to date indicate that the basalt is not likely to be massive, but made up of discrete corestones and weathered material, and will therefore be rippable.
- * At chainage CH: 2000 2100 metres a 5 10m cut for the access road into rhyolite may intersect tight strong bedrock and present slow excavation conditions.

It is advised that drilling at these chainages (see Table 4) to a depth equal to the proposed design cuts be carried out to ascertain rock quality. Similarly, drilling at the site of the cut or cut and fill for the proposed Golf cart Storage area should be undertaken.

8.0 GEOTECHNICAL SUMMARY

Excavation across the site will be in several materials types with their own distinctive geotechnical properties. Geological mapping and subsurface investigations have identified the

locations of the various soil and rocks of the area. It is emphasised that geological and geotechnical properties are typically gradational yet can exhibit rapid lateral variations. Detailed geological assessment for specific site work during the construction period is strongly advised.

8.1 Statement of Foundation Conditions.

Generally, acceptable foundation conditions exist across the site. Areas where prediction is uncertain are:

- (1). Along steep basalt scarps [GAU 3B and 3C in part] where reverse weathering profiles occur and sound bedrock may be 8.0 metres or more below ground surface. Acceptable bedrock for unit foundations may occur at shallower depths where the profile includes an horizon of strong weathered basalt corestones. Drilling through this horizon to ascertain its thickness will be necessary before relying upon it as a foundation base.
- (2) In areas described in (1) above but overlain by weathered rhyolite [contact of GAU 3B with 2A & 2B]. Drilling plus Standard Penetration Testing will need to be carried out if units are to be located on this material. High material moisture contents can be expected.
- (3) Along the rhyolite / basalt contact generally (contact of GAU 3A with 2A and 2B) where depth of weathering is likely to be highly variable and where seepages from the contact can be expected. It is not yet known whether weak material at this contact is limited to depth of weathering below the present day ground surface or whether these conditions persist along the contact to pass beneath the hotel precinct and areas proposed for some of the units. The

intermittent presence of perlitic rhyolite at or adjacent to the rhyolite / basalt contact increases the uncertainty of the state of weathering and strength of material in the contact areas.

8.2. Statement on Site Slope Stability

There is no evidence of active landsliding on the site or degrading by collapse / slumping of the golf course. Instability may occur as a result of excavating the deep cuts for the proposed access road.

Slope failure modes include:

- basalt boulders and corestones rolling or toppling out of the cut
- rock blocks in the metasediments sliding or toppling from the cut / batters.
- slumping or circular soil-slip failure of the residual and colluvial soil.
- deterioration of cut batters by extensive gully erosion or rilling in the mildly dispersive soils of the Neranleigh-Fernvale metasediments.

The construction of cut-off drains and bench drains and their rehabilitation by vegetation of the slopes is expected to stabilise the cuts. In areas of deep cuts into basalt boulders and corestones, barriers placed at the foot of the cuts will be sufficient to keep the road clear of falls.

Limit equilibrium analyses of slopes using peak effective strength parameters for the Neranleigh Fernvale soils show that for soil covers of 1.5 to 2.5 metres thickness:

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- * Slopes of 12° to 20° have calculated factors of safety against mass movements of between 1.8 and 2.9; and
- Slopes of 20° to 27° have factors of safety of between 1.5 and 1.8.

Hence one and two storey development on existing slopes of up to 20° does not represent a hazardous situation provided that siteworks do not increase the overall slope. However the marginal nature of the estimated factors of safety for slopes in excess of 20° will necessitate geotechnical review of individual building proposals at the planning stage.

Also arising from the stability analyses are the flowing conclusions :-

* For cut slopes in the residual soils and extremely weathered Neranleigh
Fernvale bedrock, a long term factor of safety of 1.5 will limit heights and batter
slopes to:-

Height of Cut (m)	Maximum Overall Batter Slope (H to V)
2.0	0.75 to 1
3:0	1 to 1
4.0	1.25 to 1
5.0	1.5 to 1

* Cut slopes in excess of 5.0 metres will require field assessment during excavation.

- * The stability of the cut sloes in highly to slightly weathered bedrock will be controlled by defects in the rock mass rather than rock mass strength. However it is anticipated that cut slopes of 0.66 to 1 will be stable.
- * Natural slopes of 7 to 1 (8°) require benching prior to placing and compacting fill.

8.3 Road Construction

Following bulk excavations, the subgrade along the road will vary from residual soils through weathered rock to moderately strong to strong bedrock. CBR tests indicate results of 9 to 15 with basaltic soils being the lowest grade material. We would recommend that these values be used for design purposes until more detailed information is available regarding the location and level of the road. Design CBR values should be confirmed once the subgrade is during exposed during construction.

The installation of sub soil drains will be required in areas where ground seepage is encountered. The areas of likely groundwater have been dealt with in this report.

With respect to subgrade preparation, should bedrock be exposed at subgrade level, the rock should be ripped to a depth of 0.3 metres and compacted to a density ratio of 90 per cent modified. For soil subgrades or select fills, recommended density ratios are:-

* Within 1 metre of final level

100 % Standard Compaction

* 1 metre or more below final level

95% Standard Compaction

Soil fill should be placed and compacted in layers not exceeding 200 mm loose thickness and at a moisture content in range of Optimum minus 1 per cent to Optimum plus 2 per cent.

8.4 Unit Development

This section report is intended to deal with the proposed unit construction. This assumes that the proposed units will fall within the scope of AS 2870 - 1996 'Residential Slabs and Footings'. Development outside the scope of this standard will require detailed analysis once final location and type of construction if available. Earthworks will also play a large part in the design of the footing systems for the proposed units and we would therefore recommend that each construction site be addressed individually once location and level are finalised.

Residual soils occurring in the study area are relatively strong and generally shallow strip / pad footings may be designed for an allowable bearing pressure of 150 kPa. However the clay soils are moderately reactive to moisture variations and the site conditions would be classified as Class M in accordance with AS 2870 - 1996 'Residential Slabs and Footings' where final soil depths exceed 1 metre. For soil depths of 0.4 to 1.0 metres, a classification of Class S could be adopted and Class A for depths of less than 0.4 metres.

Thus the design of foundations for individual structures will generally be governed by shrink / swell considerations as well as differential settlements due to varying fill depths.

Alternate footing systems that may be adapted to the site conditions include:-

- Strip / Pad footings
- Deep Beam' strip footings
- * Raft Slabs; and
- * Pier and beam foundations

Due to the potentially expansive nature of the clay soils, it is recommended that gardens and large trees are not located in close proximity to dwellings as these can induce significant moisture changes beneath footings.

In areas where fill is to placed, slopes in excess of 8° will require terracing to key the fill onto the slope. Fill should be placed in layers of 200 millimetres loose thickness and each layer compacted to at least 95 per cent of the Maximum Dry Density for Standard Compaction at a moisture content in range of Optimum minus 1 per cent to Optimum plus 2 per cent.

Fill slopes supporting buildings should be battered to maximum gradients of 1.5 (H) to 1 (V) and limited in height to 2.5 metres. Structures should be set back at least 2.0 metres from the crest of fill slopes. Where fills do not support dwellings, the maximum height may be increased to 4 metres for a slope of 1.5 (H) to 1 (V) and 5.5 metres for a slope of 2 (H) to 1 (V). Placement of fill on slopes in excess of 20° is not recommended.

8.5 Retaining Walls

Where an excavated slope is to be cut to a slope of less than 1.25 (H) to 1 (V), some form of retaining structure will be necessary.

For large or important retaining structures, detailed analysis and design on an individual basis is recommended. For minor structures or preliminary purposes, the following design parameters may be adopted:

*	Bulk Density	1.8 t/m ³
*	Lateral Earth Pressure Coefficients	
	'At Rest' conditions	0.5
	'Active' conditions	0.4
*	Minimum lateral earth pressure	5.0 kPa

These parameters assume that adequate sub soil drainage is provided behind the walls to prevent any build up in hydro static pressure and that a free draining material is used as backfill. A minimum lateral earth pressure of 5 kPa has been recommended to allow for local surcharge and pressures developed during compaction of the backfill. This precaution may not be necessary for all applications.

8.6 Erosion & Siltation

The clay soils are generally not dispersive in nature and thus run off should not be turbid. However, the strong aggregation and bonding of soil particles could lead to erosion where high water velocities are allowed to develop on unprotected or unvegetated slopes.

The faces of cut or fill slopes should be protected from erosion by vegetation and / or artificial coverings. In addition, sheet run off should be intercepted by catch drains or diversion bunds above the cuts major slopes. It is likely that construction activities will result in some erosion and necessitate siltation control measures. Appropriate measures are detailed in the Soil Conversation Service of New South Wales publication 'Urban Erosion and Sediment Control'.

8.7 Further Site Investigation

Prior to finalisation of building design foundation and road alignment or dam site location it is considered the following site investigations should be carried out. A summary is given in Table 1.

Hotel Precinct: A minimum of two cored boreholes to be drilled through

varied rock types into basalt bedrock.

Clubhouse: A minimum of two cored boreholes to be drilled two to

three metres beyond golf cart storage foundations.

Access Road: Drilling of deep cut areas into underlying bedrock.

Residential units located Either dozer excavation of scarp or core drilling to

on basalt scarps: establish soil / rock profile.

Residential units located Occasional core drilling to confirm soil / rock profile.

on undulating basalt country:

Small dam sites on

One or two test pits to bedrock and testing of soils for

minor watercourse:

embankment usage.

Extension of existing

Numerous test pits to bedrock in both dam floor and

dam site (s):

abutments; assess suitability of available soils for

embankment usage. Field permeability testing of

reservoir floor

Groundwater:

Assess local knowledge of possibility of fractured rock

aquifer at depth. Check yield and water quality.

TABLE 4: ACCESS ROAD INVESTIGATION - DRILL HOLE LOCATIONS

Chainage		
250 -270 *	Metasediment	[GAU 4A]
440 - 450 *	Metasediments	[GAU 4A]
550 - 600 *	Metasediments	[GAU 4A]
Note 660 *	Metasediment / I	Basalt contact ?
830 -840 *	Basalt	[GAU 3B/3C] ··
900 - 910 *	Basalt	[GAU 3B/3C]
950 - 1000	[East side of cents	re line] [3C/3A]
1650 - 1700 *	Basalt	[GAU 3B/3C]
Note 1900 *	Perlite / Basalt c	ontact?
2050 - 2100 *	Rhyolite	[GAU 2B]

Note 2700	Tuff / Perlite contact? [GAU 2A / 2B] [West side of centre line]	

* Unless indicated otherwise holes are to be located upslope of proposed road centre line.

9.0 OVERALL ASSESSMENT

- There are no geological conditions at the site which would indicate that the proposed development cannot be satisfactorily realised.
- There are no geological conditions at the site which because of the proposed development would adversely affect neighbouring properties.
- Further foundation investigation drilling in the location of the proposed hotel precinct
 and Clubhouse / golf cart storage area need to be carried out.
- Rock rippability of rhyolite below 5.0 to 7.0 metres may not be possible.
- Availability of underground water remains to be investigated.
- Consideration should be given to the enlargement of existing dams for reservoir storage.
- The rippability of deep cuts in basalt areas cannot be predicted. Further investigation of these deep cuts along the access road alignment is advised prior to commencement of excavation.
- In general the proposed location of all the residential units requires only confirmation
 foundation drilling with the exception of any units located on steep basalt scarp or on the
 contact of geological rock types where further foundation investigation to bedrock is
 advised.

 On-site geotechnical supervision for specific site works during the construction period is advised.

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R.P.E.Q. (4105)

John C Beal

M.Sc. (Geol), M.A.G.S, M.A.LM.M,

fc Bad

M.I.A.E.G, M.A.N.C.O.L.D.

Test Pit Results



Appendix A

Field Results

Borehole Logs BH 1 to BH 30

Test Pit Logs TP 1 to TP 17

GEOTECHNICAL ENGINEERING SERVICES

6/12 Greenway Drive. Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANORA GROUP MANAGEMENT BOREHOLE						BH 1
PROJECT:	TERRANOR	A RE	SORT P	ROJECT	JOB N	o:	BT 4466
EQUIPMENT	TYPE: JA		200		HOLE DIAMETER: 100mm		
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type. Structure		Consistency/ Rel. Density
TOPSOIL			0.2		TOPSOIL		
RESIDUAL	-		1.3		Sandy CLAY: Medium plasticity. Fine to medium grained sand. Trace of fine to medium irregular gravel (Surface cobbles & befrequent in places). Moist (w <wp). (cl-ch)<="" brown="" payellow="" td=""><td>n oulders</td><td>STIFF VERY STIFF</td></wp).>	n oulders	STIFF VERY STIFF
·NERAN LEIGH FERNVALE GROUP		•	2.0		Extremely Weathered ROCK: Remoulds to S Sandy CLAY: Dry to moist. Pale yel brown (XW)	low/	ENTREMELY LOW STRENGTH
					BH 1 TERMINATED AT 2.0m TUNGSTEN CARBIDE REFUSAL ON DISTINCTLY WEATHERED ROCK		
					· · · · · · · · · · · · · · · · · · ·		
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ogged By	ÆD		Date	22/7/	96 Checked By 365 I	Date 14.8.	a.c

GEOTECHNICAL ENGINEERING SERVICES
6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GR	OUP M	ANAGEM	ENT	BOREHOLE N	lo: BH 2
PROJECT:	TERRANOR	A RE	SORT P	ROJECT		JOB No:	BT ++66
EQUIPMENT	TTYPE: JA	ACRO	200		HOLE DIAMETER:	100mm	
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Stru	cture	Consistency/ Rel. Density
TOPSOIL			0.2		TOPSOIL		
RESIDUAL			1.3		Sandy CLAY: Medium plasticity. F grained sand. Trace of fine irregular gravel Moist (wyellow/brown (CL-CH)	to medium	STIFF VERY STIFF
NERAN LEIGH FERNVALE GROUP			2.0		Extremely Weathered ROCK: Remo Sandy CLAY: Dry to mois brown (XW)	oulds to Silty t, Pale yellow/	ENTREMELY LOW STRENGTH
					BH 2 TERMINATED AT 2.0m TUNGSTEN CARBIDE REFUSAL DISTINCTLY WEATHERED ROO		
,							
·							
					·		
Logged By	ÆD		Date	22/7/	96 Checked By JG	Date 14.	3.96

GEOTECHNICAL ENGINEERING SERVICES6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GROUP M	ANAGEM	ENT	BOREHOLE N	o: BH 3
PROJECT:	TERRANOR	A RESORT F	ROJECT		JOB No:	BT 4466
EQUIPMENT	TYPE: JA	ACRO 200		HOLE DIAMETER: 1	00mm	
Geological Profile	Samples	W A T Depth E in m	Graphic Log	Soil or Rock Type, Struct	ure	Consistency/ Rel. Density
TOPSOIL		0.2		TOPSOIL		
RESIDUAL		1.4		Sandy CLAY: Medium plasticity, Firgrained sand, Trace of fine to irregular gravel, Moist (w <w (cl-ch)<="" brown="" td="" yellow=""><td>medium</td><td>STIFF VERY STIFF</td></w>	medium	STIFF VERY STIFF
NERAN LEIGH FERNVALE GROUP		2.0		Extremely Weathered ROCK: Remove Sandy CLAY: Dry to moist, brown (XW)		ENTREMELY LOW STRENGTH
				BH 3 TERMINATED AT 2.0m TUNGSTEN CARBIDE REFUSAL O DISTINCTLY WEATHERED ROC		
				· · · .		
					·	
		:			·	
Logged By	JED	Date	22/7/	/96 Checked By JG	Date 14.8	Form R18 Issue

GEOTECHNICAL ENGINEERING SERVICES

6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GROUP M	IANAGEM	ENT BORE	EHOLE No: BH 4
PROJECT:	TERRANOR	A RESORT	PROJECT	JOB N	No: BT 4466
EQUIPMENT	TYPE: JA	ACRO 200		HOLE DIAMETER: 100mm	
Geological Profile	Samples	T Depth	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
TOPSOIL		0.2		TOPSOIL	
RESIDUAL		0.8		Silty CLAY: High plasticity, Trace of fine to grained sand. Occasional cobbles, Mo (w <w<sub>p), Red/brown (CH)</w<sub>	
RESIDUAL		1.3		Sandy CLAY: Medium plasticity. Fine to megrained sand, Trace of fine to mediur irregular gravel Moist (w <w<sub>p). Pale yellow/brown (CL-CH)</w<sub>	
NERAN LEIGH FERNVALE GROUP				Extremely Weathered ROCK: Remoulds to S Sandy CLAY: Dry to moist, Pale ye brown (XW)	
· 		2.9			
				BH 4 TERMINATED AT 2.9m ON EXTREMELY WEATHERED ROCK	
Logged By	JED	Date	22/7/	796 Checked By JG	Date 14. 8.96 Form R18 Issue

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6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	TERRANORA GROUP MANAGEMENT BOREHOLE					
PROJECT:	TERRANOR	A RE	SORT P	ROJECT		JOB No:	BT 4466
EQUIPMENT	TTYPE: JA	CRO	200		HOLE DIAMETE	R: 100mm	
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Typ	e. Structure	Consistency/ Rel. Density
TOPSOIL			0.2		TOPSOIL		
RESIDUAL	Disturbed =12503 FMC=34.8 0.5m Disturbed =12504 FMC=34.8		1.0		CLAY: High plasticity, With grained sand and silt, Red/brown (CH)		STIFF
	1.0m Disturbed =12505 FMC=37.2		1.6		Silty CLAY: High plasticity, Moist (w≥w _p), Orang		STIFF
·	1.6m				BH 5 TERMINATED AT 1.6 TUNGSTEN CARBIDE REF ON FLOATER OR BEDROO	USAL	·
	-			,	. : . :		
Logged By	JED		Date	22/7	/96 Checked By JOS	Date 14	8 31

GEOTECHNICAL ENGINEERING SERVICES

6/12 Greenway Drive. Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GROUP N	1ANAGEN	ENT	BOREHOLE N	lo: BH 6
PROJECT:	TERRANOR	A RESORT	PROJECT		JOB No:	BT 4466
EQUIPMENT	TYPE: JA	ACRO 200		HOLE DIAMET	ER: 100mm	
Geological Profile	Samples	W A Depth	Graphic Log	Soil or Rock T	ype, Structure	Consistency/ Rel. Density
TOPSOIL	0.2m	0.2		TOPSOIL		
	Disturbed =12506 NMC=38.7 0.5m Disturbed =12507 NMC=39.3	1.0		CLAY: High plasticity, Wisand and silt, Mois (CH)	th a trace of fine grained it (w≤w _p), Red/brown	STIFF
RESIDUAL	1.0m	2.0		Clayey S ILT: High plastici sand, Moist (w≤w		VERY STIFF
		2.5		BH 6 TERMINATED AT 2	2.0m	
					· ·	
	<u> </u>					
	<u>-</u> .					
Logged By	JED	Date	22/7	196 Checked By JG	Date 14.	9 D C

GEOTECHNICAL ENGINEERING SERVICES 6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	BOREHOLE No	: BH 7			
PROJECT:	TERRANOR	A RESORT F	ROJECT	J	OB No:	BT 4466
EQUIPMENT	TYPE: JA	ACRO 200		HOLE DIAMETER: 100	mm	
Geological Profile	Samples	T Depth	Graphic Log	Soil or Rock Type, Structur	e	Consistency/ Rel. Density
TOPSOIL		0.2		TOPSOIL		
RESIDUAL		2.3		Silty CLAY: High plasticity. Trace of fi sand. Occasional cobbles & floa (w <w<sub>p). Red/brown (CH)</w<sub>	ne grained iters, Moist	STIFF VERY STIFF
		{ }	1	BH 7 TERMINATED AT 2.3m		
					v.	·
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Logged By	ÆD	Date	22/7/9	6 Checked By JEO	Date (4.	Form R18 Issue 1

GEOTECHNICAL ENGINEERING SERVICES

6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANORA GROUP MANAGEMENT BOREHOLE					
PROJECT:	TERRANOR	JOB No:	BT 4466			
EQUIPMENT	r Type: JA	ACRO 200		HOLE DIAMETE	R: 100mm	
Geological Profile	Samples	W A T Depth E in m	Graphic Log	Soil or Rock Type	e. Structure	Consistency/ Rel. Density
TOPSOIL		0.2		TOPSOIL		
RESIDUAL	0.5m - Disturbed =12508 NMC=34.7	0.8		Silty CLAY: High plasticity, Moist (w≤w _p), Red/b	-	STIFF
	1.0m	1.5		Silty CLAY: High plasticity. Moist (w <w<sub>p). Red/b</w<sub>		VERY STIFF
				BH 8 TERMINATED AT 1.5 TUNGSTEN CARBIDE REF		
					·	
	-					
Logged By	JED	Date	23/7/	/96 Checked By Joo	Date 14.	8.46

GEOTECHNICAL ENGINEERING SERVICES

6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANORA GROUP MANAGEMENT BOREHOLE N					
PROJECT:	TERRANOR	BT 4466				
EQUIPMENT	TYPE: JA	CRO 200		HOLE DIAMETER: 100mm		
Geological Profile	Samples	W A Depth	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density	
TOPSOIL	0.2m	0.2		TOPSOIL		
·	Disturbed =12484 NMC=24.2			Clayey Sandy SILT: Medium plasticity, Sand fine to		
	0.5m			medium grained. Moist (w≈w _p). Grey/brown (ML-MH)		
RESIDUAL	=12485 NMC=32.8	1.0		<u> </u>		
	1.0m Disturbed =12486 NMC=30.5			Sandy CLAY: Low to medium plasticity. With fine to medium grained sand, Moist (w≤w _p). Pale grey/brown (Rock structure evident) (CL/CL-CH)	STIFF	
LAMINGTON	1.5m	1.6		Extremely Weathered ROCK: Remoulds to Sandy	EXTREMELY	
VOLCANICS	Disturbed =12487 NMC=18.7	1.9		CLAY: Low to medium plasticity, Fine to medium grained sand, Dry to moist (w <w<sub>p). Pale grey/white (XW)</w<sub>	LOW	
-	1.9m			BH 9 TERMINATED AT 1.9m TUNGSTEN CARBIDE REFUSAL		
·						
			1			
ogged By	ÆD	Date	22/7/9	6 Checked By FW Date 11	48-96	

GEOTECHNICAL ENGINEERING SERVICES 6/12 Greenway Drive. Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANORA GROUP MANAGEMENT BOREHOLE							
PROJECT:	TERRANOR	ERRANORA RESORT PROJECT JOB No:						
EQUIPMENT	TYPE: JA	HOLE DIAMETER:	100mm					
Geological Profile	Samples	W A T Depth	Graphic Log	Soil or Rock Type, St	nucture	Consistency/ Rel. Density		
TOPSOIL		0.1		TOPSOIL				
·		0.8		Sandy CLAY: Medium plasticity. medium grained sand. Dr grey (CL-CH)	With silt. Fine to y to moist, Pale	VERY STIFF		
RESIDUAL		1.4		Sandy CLAY: Medium plasticity, medium grained sand. Dr Pale grey/brown (CL-C	y to moist (w≥w _p).	STIFF		
		1.6		Silty CLAY: Medium plasticity. V medium grained sand. Dr Pale yellow/brown (CL		VERY STIFF		
LAMINGTON VOLCANICS		2.5		Extremely Weathered ROCK: Re CLAY: Dry. Pale grey/w		ENTREMELY LOW STRENGTH		
		2.5		BH 10 TERMINATED AT 2.5m				
				••••••••••••••••••••••••••••••••••••••				
	·							
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GEOTECHNICAL ENGINEERING SERVICES
6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANORA GROUP MANAGEMENT BOREHOLE							No: BH II
PROJECT:	TERRANOR	A RES	SORT P	ROJECT			JOB No:	BT 4466
EQUIPMENT	TYPE: JA	CRO	200			HOLE DIAMETER:	100mm	
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log		Soil or Rock Type. Str	ucture	Consistency/ Rel. Density
TOPSOIL			0.1		TOPSO	IL		
	0.5m Disturbed =12509 FMC=25.5		0.9		CLAY:	Medium plasticity. With figrained sand, Moist (w <wb></wb> brown (CL-CH)		STIFF
RESIDUAL	1.0m Disturbed = 12510 FMC=37.0				CLAY:	Medium plasticity, With s grained sand, Moist (w>w brown (CL-CH)		FIRM/ STIFF
	2.0m		2.0		Silty CL	AY: Medium plasticity. W medium grained sand. Mo		STIFF
			2.5		BH 11 7	Pale brown (CL-CH) ERMINATED AT 2.5m	·	-
	 	}			'			
			- -		·			
				·	·			
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GEOTECHNICAL ENGINEERING SERVICES6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GF	ROUP M	ANAGEM	ENT BO	OREHOLE No:	BH 12
PROJECT:	TERRANOR	DB No:	BT 4466				
EQUIPMENT	TYPE: JA	CRC	200		HOLE DIAMETER: 100m	nm	
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure		Consistency/ Rel. Density
TOPSOIL			0.1		TOPSOIL		,
RESIDUAL	 - 		1.0		Clayey SILT: High plasticity. With fine g Moist (w <w<sub>p). Red/brown (M</w<sub>	grained sand. H)	STIFF VERY STIFF
					BH 12 TERMINATED AT 1.0m IN VERY STIFF CLAYEY SILT		-
					·		
·							
							<i>,</i>
Logovi De	TED.		<u> </u>		Okalai Da	Dea: 11/10	f-/
Logged By	ED		Date	23/7/	Checked By J CO	Date 14. 8	<u>- 46</u>

GEOTECHNICAL ENGINEERING SERVICES

6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GROUP N	ANAGEM	ENT	BOREHOLE NO	BH 13		
PROJECT:	TERRANOR	A RESORT	PROJECT		JOB No:			
EQUIPMEN'	TTYPE: G	CH 200		HOLE DIAMETER:	110mm			
Geological Profile	Samples	T Depth	Graphic Log	Soil or Rock Type, Stra	acture	Consistency/ Rel. Density		
TOPSOIL		0.2		TOPSOIL		STIFF		
FILL		0.6		Gravelly Clayey SILT: High plastic medium grained sand, Fine gravel, Moist (w <w<sub>p), Red</w<sub>	to coarse irregular	VERY STIFF		
				BH 13 TERMINATED AT 0.6m TUNGSTEN CARBIDE REFUSAI ON BEDROCK OR FLOATER				
			. }					
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ogged By	.JED	Date	24/7	/96 Checked By FCD	Date 14.	8.96		

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6/12 Greenway Drive. Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANORA GROUP MANAGEMENT BOREHOLE No:					
PROJECT:	TERRANOR	A RESORT I	ROJECT	JOB No:	BT 4466	
EQUIPMENT	TYPE: JA	ACRO 200		HOLE DIAMETER: 100mm		
Geological Profile	Samples	T Depth	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density	
TOPSOIL		0.3		TOPSOIL		
RESIDUAL	0.4 U=50 PP=300	0.7		Clayey SILT: High plasticity. With fine to medium grained sand, Moist (w <w<sub>p), Red/brown (MH)</w<sub>	STIFF	
		0.9		Cobbles & Clayey SILT: High plasticity, With fine to medium grained sand & medium to coarse friable gravel, Moist (w <wp), (mh)<="" brown="" red="" th=""><th>DENSE/ STIFF</th></wp),>	DENSE/ STIFF	
				BH 14 TERMINATED AT 0.9m		
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CLIENT:	TERRANOR	A GROUP M	ANAGEMENT	BOREHOLE N	lo: BH 15/1
PROJECT:	TERRANOR	A RESORT I	ROJECT	JOB No:	BT 4466
EQUIPMENT	TYPE: JA	CRO 200	HOLE DIAMETE	ER: 100mm	
Geological Profile	Samples	W A Depth E in m	Graphic Soil or Rock Typ	pe. Structure	Consistency/ Rel. Density
TOPSOIL		0.1	TOPSOIL		
; FILL	Disturbed =12511 NMC=29.5		Gravelly Silty CLAY: High to medium grained s Occasional cobbles	sand. Moist (w <w<sub>p).</w<sub>	STIFF
•				` '	}
	0.8m	0.8			1
	Disturbed		Silty SAND: Fine to medium	n grained. Dry to moist	
	≈12512 NMC=16.8	0.9	Pale grey (SM)		DENSE
	0.9m]]			
COLLUVIUM	1.0m]	Sandy CLAY: High plasticit		1
	Disturbed]]		d, Predominantly fine	STIFF
	≈12513 NMC=24.8]]	MC(())	st (w <w<sub>p), Red/brown</w<sub>	1
	1.5m		(ĆH)		}
	, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	1.8)
		1.0			1
	2.0m	i i			ļ
		}			ľ
	Disturbed	} {			
	=12514 NMC=36.5	}			STIFF
1	N.11C -30.3	•			
	2.5m	}			1
) }		•	
]			}
					ļ
DECIDALA	1	[[Silty CLAY: High plasticity		
RESIDUAL	1]	sand Moist (w <w<sub>p)</w<sub>	Red/brown (CH)	VERY
•	-			· · · · · · · · · · · · · · · · · · ·	STIFF
		}			
		}			
		} }			
		}			
		}			
	4.2m]			
	U50				VERY
	PP ~400	[[STIFF
	4.55m	4.5	Continued on BH 15/2		-
			Continued on Bri 13/2		
Logged By	JED	Date	24/7/96 Checked By JC	Date 14	0 0/

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CLIENT:	TERRANOR	A GROUP M	ANAGEM	TENT BOREHOLE	No: BH 15/2
PROJECT:	TERRANOR	A RESORT F	ROJECT	JOB No:	BT 4466
EQUIPMENT	TTYPE: JA	ACRO 200		HOLE DIAMETER: 100mm	
Geological Profile	Samples	W T Depth E in m	Graphic Log	Soil or Rock Type. Structure	Consistency/ Rel. Density
	4.7m Disturbed	4.5		Continued from BH 15/1 Gravelly CLAY: High plasticity. With sand fine to medium grained. Fine to coarse irregular gravel. Some friable particles. Dry to moist (w <w_p). (ch)<="" brown="" red="" td=""><td>STIFF</td></w_p).>	STIFF
	=12515 NMC=45.0 4.9m	5.9		Silty SAND: Fine grained. Moist to wet, Grey (SN	f) DENSE
RESIDUAL	6.0m Disturbed =12516 NMC=43.0 6.5m			Completely Weathered ROCK: Remoulds to Silty CLAY: Fine to coarse grained sand. Intrusions (Quartz) Moisture ingress (w≥w _p Pale grey blotched and streaked pale orange brown (RS)	
·	7.5m	7.0		Clayey SILT: Medium plasticity, With clay and fine grained sand, Moist (w>w _p). Grey (ML-MH)	STIFF
	Disturbed =12517 NMC=43.4	7.5		Sandy Clavey SILT: High plasticity. Fine to medium grained sand, Moist (w>w _p). Pale grey streaked grey and red (MH)	STIFF
	8.0m Disturbed =12518 NMC=46.4	8.5		Sandy Clayey SILT: Medium to high plasticity. Fine to medium grained sand. Moist (w>w _p). Grand blotched orange/brown (ML-MH)	
	8.5m	6.3		BH 15 TERMINATED AT 8.5m	
Logged By	ÆD	Date	24/7	/96 Checked By TOD Date 71	4-8-96 Form R18 Issue

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6/12 Greenway Drive. Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GROUP M	ANAGEM	ENT BOREHOLE	No: BH 16/1
PROJECT:	TERRANOR	A RESORT I	ROJECT	JOB No:	BT 4466
EQUIPMENT	TYPE: G	CH 200		HOLE DIAMETER: 110mm	
Geological Profile	Samples	W A Depth E in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
TOPSOIL	-	0.2		TOPSOIL	
RESIDUAL	L O G			Sandy CLAY: Medium plasticity. Fine to medium grained sand. Trace of fine to medium friable gravel. Moist (w <w<sub>p). Pale yellow/brown (CL-CH)</w<sub>	STIFF
LAMINGTON VOLCANICS	T T	2.3		Extremely Weathered ROCK: Remoulds to Silty CLAY: Medium plasticity, With fine to medium friable gravel, Moist (w <w<sub>p). Pale yellow flecked white (XW)</w<sub>	ENTREMELY LOW STRENGTH
RESIDUAL		4.0		CLAY: High plasticity. With silt and fine grained sand. Dry to moist (w <wp). (ch)="" 16="" 2<="" bh="" brown="" continued="" dark="" on="" red="" th=""><th>VERY STIFF</th></wp).>	VERY STIFF
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GEOTECHNICAL ENGINEERING SERVICES
6/12 Greenway Drive. Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GROUP M	ANAGEM	ENT		В	OREHOLE!	io: BH 16/2
PROJECT:	TERRANOR	A RESORT P	ROJECT			JC	DB No:	BT 4466
EQUIPMENT	TYPE: G	CH 200	_	но	LE DIAMET	E R: 110m	ım	
Geological Profile	Samples	W A T Depth E in m	Graphic Log	S	oil or Rock Ty	pe. Structure		Consistency/ Rel. Density
		4.0		Continued fro	m BH16/1			
RESIDUAL	4.2m U50 PP>400 - 4.55m	5.0		medi: blotcl	eathered ROC Y: Medium p um grained san hed orange/brok k structure evic	lasticity, With nd. Moist (w: wn (RS)	h fine to	STIFF
LAMINGTON VOLCANICS					athered ROCK D: Fine to m streaked orang	edium graine	d, Moist	ENTREMELY LOW STRENGTH
		6.0		BH 16 TERM TUNGSTEN (IN DISTINCT	CARBIDE RE	FUSAL	К .	
Logged By	JED_	Date	26/7	96 Chec	ked By JE	<u> </u>	Date (4.	8 . 96 Form R18 Issue 1

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CLIENT:	TERRANOR	A GROUP M	IANAGEM	ENT	BOREHOLE N	o: BH 17
PROJECT:	TERRANOR	A RESORT I	PROJECT		JOB No:	BT 4466
EQUIPMENT	TYPE: JA	ACRO 200		HOLE DIAMETER:	100mm	· — — —
Geological Profile	Samples	T Depth	Graphic Log	Soil or Rock Type, Str	ructure	Consistency/ Rel. Density
TOPSOIL		0.2		TOPSOIL		
RESIDUAL (BASALT)		1.6		Silty CLAY: High plasticity. Trac grained sand. Moist (w≈v (CH)		STIFF VERY STIFF
			} } }	BH 17 TERMINATED AT 1.6m TUNGSTEN CARBIDE REFUSA ON FLOATER	ıL.	
						}
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				. •		
Logged By	ÆD	Date	9/8/	96 Checked By JGD	Date 14.	7 96

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CLIENT:	TERRANOR	A GROUP M	ANAGEM	ENT	BOREHOLE No	b: BH 18
PROJECT:	TERRANOR	A RESORT I	ROJECT		JOB No:	BT 4466
EQUIPMEN'	T TYPE: JA	ACRO 200		HOLE DIAMETER: 10	00mm	
Geological Profile	Samples	T Depth	Graphic Log	Soil or Rock Type, Struct	ure	Consistency/ Rel. Density
TOPSOIL		0.2		TOPSOIL		
RESIDUAL (BASALT)		0.9		Silty CLAY: High plasticity, Trace of grained sand, Moist (w≈w _p). (CH)		STIFF VERY STIFF
				BH 18 TERMINATED AT 0.9m TUNGSTEN CARBIDE REFUSAL ON FLOATER		
			,			
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CLIENT:	TERRANOR	LA GROUP M	LANAGEM	ENT	BOREHOLE N	lo: BH 19
PROJECT:	TERRANOR	A RESORT I	PROJECT		JOB No:	BT 4466
EQUIPMENT	TYPE: JA	ACRO 200		HOLE DIAME	TER: 100mm	· -
Geological Profile	Samples	A T Depth E in m	Graphic Log	Soil or Rock	Type. Structure	Consistency Rel. Density
TOPSOIL		0.2		TOPSOIL		
RESIDUAL (BASALT)		1.4			city. Trace of fine to medium ist (w≈w _p). Red/brown	STIFF VERY STIFF
				BH 19 TERMINATED A TUNGSTEN CARBIDE I ON FLOATER		
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CLIENT:	TERRANOR	A GROUP M	ANAGEM	ŒNT			BOREHOLE No: BH 20		
PROJECT:	TERRANOR	A RESORT P	ROJECT				JOB No:	BT 4466	
EQUIPMEN'	TTYPE: JA	ACRO 200			HOLE DIA	METER:	100mm		
Geological Profile	Samples	W A T Depth	Graphic Log		Soil or Ro	ock Type, Str	ructure	Consistency/ Rel. Density	
TOPSOIL	0.0m Disturbed	0.2		TOPSO	IL				
RESIDUAL	=12545 FMC=18.2 0.5m U50 =12546 PP=>400 FMC=16.6	0.2		Sandy C		ned sand, Dr	With silt. Fine to to moist (w <w<sub>p)CH)</w<sub>	VERY STIFF	
	0.65m 1.0m Disturbed =12547	1.3		Silty Sar		ained sand, l	m plasticity. Fine Moist (w <w<sub>p). /CL-CH)</w<sub>	VERY STIFF/ HARD	
NERAN LEIGH FERNVALE GROUP	FMC=4.7	2.1		Extreme	ly Weathered I SAND: Wit yellow/white	h clay, Dry to	noulds to Silty o moist, Pale	ENTREMELY LOW STRENGTH	
				V BIT	ERMINATE REFUSAL ON IERED ROC	EXTREM	ELY		
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6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GROUP M	ANAGEM	ENT	BOREHOLE N	o: BH 21
PROJECT:	TERRANOR	A RESORT F	ROJECT		JOB No:	BT 4466
EQUIPMENT	TYPE: H	AND AUGER	.	HOLE DIAMETER	: 65mm	
Geological Profile	Samples	M A T Depth E in m	Graphic Log	Soil or Rock Type,	Structure	Consistency/ Rel. Density
TOPSOIL		0.2		TOPSOIL		
RESIDUAL	0.5m Disturbed =12548	0.7		Sandy CLAY: Medium plastic grained sand. With silt gravel, Dry (w <w<sub>p). P (CL-CH)</w<sub>	Trace of fine angular	VERY STIFF
NERAN LEIGH FERNVALE	FMC=1.5			Extremely Weathered ROCK: Clayey SAND: Fine t Dry to moist. Pale yelle	o medium grained.	ENTREMELY LOW
GROUP		1.2		white (XW)		STRENGTH
				BH 21 TERMINATED AT 1.2 HAND AUGER REFUSAL ON EXTREMELY WEATHERED	V	
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				: :		
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			(,	
				BH 22 TERMINATED AT 1.0m HAND AUGER REFUSAL ON FLOATER	
		1.0			STIFF
				(CH)	VERY
RESIDUAL				Silty CLAY: High plasticity. Trace of fine to medium grained sand, Moist (w≈wp), Red/brown	STIFF
TOPSOIL	-	0.2	nuarra manana	TOPSOIL	
Geological Profile	Samples	T Depth	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
EQUIPMEN	T TYPE: H	AND AUGER	\	HOLE DIAMETER: 65mm	
PROJECT:	TERRANOR	A RESORT F	ROJECT	JOB No:	BT 4466
CLIENT:	IERRANOR	LA GROUP M	ANAGEM	ENT BOREHOLE	No: BH 22

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6/12 Greenway Drive. Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GR	OUP M	ANAGEM	ENT	BOREHOLE	No: BH 23
PROJECT:	TERRANOR	A RE	SORT P	ROJECT		JOB No:	BT +466
EQUIPMENT	FTYPE: JA	ACRO	200		HOLE DIAME	TER: 100mm	
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock	Type, Structure	Consistency/ Rel. Density
TOPSOIL			0.1		TOPSOIL		·
RESIDUAL					Clayey SILT: High plastic Moist (w <w<sub>p). R</w<sub>	city. With fine grained sanded/brown (MH)	VERY
			1.0				STIFF
					BH 23 TERMINATED A IN VERY STIFF CLAYE		
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6/12 Greenway Drive. Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GROUP M	ANAGEM	ENT	BOREHOLE NO	o: BH 24
PROJECT:	TERRANOR	A RESORT F	ROJECT		JOB No:	BT 4466
EQUIPMEN'	T TYPE: JA	ACRO 200		HOLE DIAMETER:	100mm	
Geological Profile	Samples	T Depth	Graphic Log	Soil or Rock Type, Stru	cture	Consistency/ Rel. Density
TOPSOIL		0.3		TOPSOIL		
FILL		0.7		Clayey SILT: High plasticity. With grained sand. Moist (w <wp (mh)<="" td=""><td></td><td>STIFF</td></wp>		STIFF
		0.9		Cobbles & Clayey SILT: High plast medium grained sand & me friable gravel, Moist (w <wp) (mh)<="" td=""><td>dium to coarse</td><td>DENSE/ STIFF</td></wp)>	dium to coarse	DENSE/ STIFF
٠.				BH 24 TERMINATED AT 0.9m TUNGSTEN CARBIDE REFUSAL	ON COBBLES	
				·		
				·		
	<u>.</u> .]		er.	
Logged By	JED	Date	24/7.	96 Checked By JGO	Date (4.	8. 9.6 Form R18 Issue

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6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	a GROU	P MANAGEM	ENT BOREHOLE I	No: BH 25
PROJECT:	TERRANOR	A RESOI	RT PROJECT	JOB No:	BT 4466
EQUIPMENT	TYPE: JA	CRO 200	0	HOLE DIAMETER: 100mm	
Geological Profile	Samples		epth Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
TOPSOIL		0	.3	TOPSOIL	•
FILL	•	. 0	.7	Clayey SILT: High plasticity. With fine to medium grained sand, Moist (w <w<sub>p), Red/brown (MH) Cobbles & Clayey SILT: High plasticity. With fine to</w<sub>	STIFF
		0	.9	medium grained sand & medium to coarse friable gravel. Moist (w <w<sub>p), Red/brown (MH)</w<sub>	DENSE/ STIFF
				BH 25 TERMINATED AT 0.9m TUNGSTEN CARBIDE REFUSAL ON COBBLES	
^					
		}			
Logged By	JED	Dat	e 24/7.	796 Checked By Jab Date 14	8 . 96 Form R18 Issue 1

GEOTECHNICAL ENGINEERING SERVICES
6/12 Greenway Drive. Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GROUP M	ANAGEM	ENT BOREHOLE N	o: BH 26
PROJECT:	TERRANOR	A RESORT I	PROJECT	JOB No:	BT 4466
EQUIPMENT	TYPE: JA	ACRO 200		HOLE DIAMETER: 100mm	
Geological Profile	Samples	W A T Depth E in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
TOPSOIL		0.1		TOPSOIL	
RESIDUAL				Clayey SILT: High plasticity. With fine grained sand. Moist (w <wp), (mh)<="" brown="" red="" td=""><td>STIFF</td></wp),>	STIFF
_	-	1.0			VERY STIFF
				BH 26 TERMINATED AT 1.0m ON FLOATER	
				•	
	-				
Logged By	ÆD	Date	23/7/	96 Checked By Jes Date 14	8.96

GEOTECHNICAL ENGINEERING SERVICES 6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	LA GROUP M	IANAGEM	ENT BOREHOLE N	No: BH 27
PROJECT:	TERRANOR	A RESORT F	ROJECT	JOB No:	BT 4466
EQUIPMENT	TYPE: J	ACKRO 200		HOLE DIAMETER: 110mm	<u> </u>
Geological Profile	Samples	A T Depth E in m	Graphic Log	Soil or Rock Type. Structure	Consistency/ Rel. Density
TOPSOIL		0.1		TOPSOIL	
:	0.4m U50 =12570 PP=250 NMC=13.9	1.2		Sandy CLAY: Medium plasticity, With fine to medium grained sand. With a trace of silt, Moist (w≈wp). Pale yellow/brown (CL-CH)	STIFF VERY STIFF
RESIDUAL		2.1		Clayey Silty SAND: Fine to medium grained, Fines of low to medium plasticity, Moist. Pale yellow streaked white (SC)	VERY DENSE
NERAN- LEIGH FERNVALE GROUP		4.0		Extremely Weathered ROCK: Remoulds to Clayey Silty SAND: Fine to medium grained. Dry to moist. Pale orange blotched pale yellow/ brown (XW) BH 27 TERMINATED AT 4.0m	EXTREMELY LOW STRENGTH
				BH 2/ JERMINATED AT 4.UM	
Logged By	JED	Date	31/7/	796 Checked By JGO Date 1 4	8.96

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Logged By	JED	Date	9/8/9	Checked By	TGO Date 14.	8.96
•					·	
				:		
				BH 28 TERMINATED A ON FLOATER	T 1.3m	
RESIDUAL		1.3	Here were the second se		ace of fine to medium occassional cobbles).	VERY STIFF
RESIDUAL		0.8		(w <w<sub>p), Red/brow</w<sub>	in (CH)	51117
RESIDUAL		0.2		Silty CLAY: High plastic	city. Trace of fine to medium casional cobbles. Moist	STIFF
Geological Profile TOPSOIL	Samples	T Depth	Graphic Log	Soil or Rock TOPSOIL	Type, Structure	Consistency/ Rel. Density
EQUIPMEN'	T TYPE: JA	ACRO 200		HOLE DIAME	CTER: 100mm	<u></u>
PROJECT:	TERRANOR	A RESORT F	PROJECT		JOB No:	BT 4466

GEOTECHNICAL ENGINEERING SERVICES
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CLIENT:	TERRANOR	RA GROUP M	ANAGEM	ENT	BOREHOLE N	o: BH 29
PROJECT:	TERRANOR	A RESORT P	ROJECT		JOB No:	BT 4466
EQUIPMENT	TYPE: JA	ACRO 200		HOLE DIAMETER:	100mm	
Geological Profile	Samples	T Depth	Graphic Log	Soil or Rock Type. St	ructure	Consistency/ Rel. Density
TOPSOIL		0.2		TOPSOIL		
RESIDUAL		1.0		CLAY: High plasticity. With fine grained sand and silt. Mo Red/brown (CH)	to medium ist (w <w<sub>p).</w<sub>	STIFF
		1.6		Silty CLAY: High plasticity, With Moist (w≥w _p), Orange/br		STIFF -
				BH 29 TERMINATED AT 1.6m TUNGSTEN CARBIDE REFUSA ON FLOATER OR BEDROCK	L	
					·	
·						
Logged By	ÆD	Date	9/8/9	Of Checked By	Date 14	<u> </u>

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CLIENT:	TERRANOR	o: BH 30				
PROJECT:	TERRANOR	A RESORT P	ROJECT		JOB No:	BT 4466
EQUIPMEN	T TYPE: JA	ACRO 200		HOLE DIAMETER:	100mm	
Geological Profile	Samples	T Depth	Graphic Log	Soil or Rock Type, Stru	acture	Consistency Rel. Density
TOPSOIL		0.2		TOPSOIL	,	
		0.8		Silty CLAY: High plasticity, With Moist (w≤w _p). Red/brown		STIFF
RESIDUAL		1.5		Silty CLAY: High plasticity, With a Moist (w <w<sub>p). Red/brown</w<sub>		VERY STIFF
			711111111111111111111111111111111111111	BH 30 TERMINATED AT 1.5m TUNGSTEN CARBIDE REFUSAI	ON FLOATER	
·		-		•		
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Togged By	,TED	Date	9/8/9	Of Checked By Jes	Date 14.8	

EOTECHNICAL ENGINEERING SERVICES /12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GROUP M	ANAGEM	ŒNT	TEST PIT No:	TP 1
PROJECT:	TERRANOR	A RESORT I	PROJECT		JOB No:	BT 4466
EQUIPMEN'	TTYPE: C.	ASE 550		HOLE DIAMETER: 45	0mm	
Geological Profile	Samples	W A T Depth E in m	Graphic Log	Soil or Rock Type, Structi	ure	Consistency/ Rel. Density
TOPSOIL		0.3	***************************************	TOPSOIL	····	<u>.</u>
RESIDUAL	0.4m	1.1		Clayey SILT: High plasticity, Trace of sand, Moist (w <w<sub>p), Red/brow</w<sub>		VERY STIFF
	PP>400	1.8		Silty CLAY: High plasticity, Trace of sand, Occasional cobbles, Moi Red/brown (CH)		VERY STIFF
LAMINGTON VOLCANICS		.2.4		Extremely Weathered ROCK: Remou of frequent cobbles & Sandy S Medium plasticity. Fine to coasand. Moist (w <wp). (xw)<="" ora:="" pale="" td=""><td>ilty CLAY: erse grained</td><td>ENTREMELY LOW STRENGTH</td></wp).>	ilty CLAY: erse grained	ENTREMELY LOW STRENGTH
				TP 1 TERMINATED AT 2.4m BUCKET REFUSAL ON FLOATER OR BEDROCK		
	~	·				
Logged By	JED	Date	31/7	/96 Checked By Jeo	Date 14	8-96 Form R18 Issue 1

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CLIENT:	TERRANOR	RA GROUP M	IANAGEM	ENT TEST PIT No	TP 2
PROJECT:	TERRANOR	A RESORT I	PROJECT	JOB No:	BT 4466
EQUIPMENT	TYPE: C	ASE 550		HOLE DIAMETER: 450mm	
Geological Profile	Samples	W A T Depth	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
TOPSOIL		0.2		TOPSOIL	
		14		Clayey SILT: High plasticity, Trace of fine grained sand, Moist (w≤w _p), Red/brown (MH)	STIFF
RESIDUAL		2.4		Silty CLAY: High plasticity. Trace of fine grained sand, Occasional cobbles, Moist (w <w<sub>p). Red/brown (CH)</w<sub>	VERY STIFF
				Silty CLAY: Medium plasticity. With fine grained sand. Moist (w≤w _p). Orange/brown (CL-CH)	VERY
LAMINGTON VOLCANICS		4.0		Extremely Weathered ROCK: Remoulds to Silty CLAY: Medium plasticity, With fine to medium grained sand, Moist (w <w<sub>p), Red/brown blotched grey (XW)</w<sub>	EXTREMEI.N LOW STRENGTH
				TP 2 TERMINATED AT 4.7m LIMIT OF MACHINE	
Logged By	JED	Date	31/7/		4.8.96

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CLIENT:	TERRANOR	A GROUP M	ANAGEM	ENT	TEST PIT No:	TP 3
PROJECT:	TERRANOR	A RESORT P	ROJECT		JOB No:	BT 4466
EQUIPMENT	TYPE: C.	ASE 550		HOLE DIAMETER:	450mm	
Geological Profile	Samples	T Depth	Graphic Log	Soil or Rock Type, Struc	cture	Consistency/ Rel. Density
TOPSOIL ·		0.4		TOPSOIL & COBBLES	•	
	PP=200 0.6m	0.8		Clayey SILT: High plasticity, Trace sand. Moist (w≥w _p). Red/br	-	STIFF
		1.6		Clayev SILT: High plasticity, Trace medium grained sand, Occa Moist (w <w<sub>p). Red/brown</w<sub>		VERY STIFF
RESIDUAL	PP>400 1.8m			Silty CLAY: Medium to high plastic to medium grained sand, Oc Moist (w <w<sub>p). Orange/bro</w<sub>	ccasional cobbles.	VERY STIFF
		3.2		Silty CLAY: Medium to high plastic cobbles, Moist (w <w<sub>p). Or (CL-CH/CH)</w<sub>	city. Frequent ange/brown	STIFF/ DENSE
		3.8		TP 3 TERMINATED AT 3.8m BUCKET REFUSAL ON MATRIX FREQUENT COBBLES & SILTY		
Logged By	ÆD	Date	31/7/	96 Checked By Jes	Date 4.	8.96

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CLIENT:	TERRANOR	A GRO	OUP M.	ANAGEM	ENT	TEST PIT No:	TP 4
PROJECT:	TERRANOR	A RES	ORT P	ROJECT		JOB No:	BT 4466
EQUIPMENT	TTYPE: C.	ASE 5	50		HOLE DIAMETER:	450mm	
Geological Profile	Samples	1 5 1	Depth in m	Graphic Log	Soil or Rock Type. St	ructure	Consistency/ Rel. Density
TOPSOIL			0.2		TOPSOIL		
FILL			1.2		Clayey SILT: High plasticity. Tra sand. Occasional cobbles Red/brown (MH)		STIFF
RESIDUAL			1.9		Silty CLAY: High plasticity, Trac cobbles and boulders. Mo brown (CH)	ce of silt, Frequent oist (w <w<sub>p). Red/</w<sub>	VERY STIFF
					TP 4 TERMINATED AT 1.9m BUCKET REFUSAL ON FREQ COBBLES & BOULDERS	UENT	
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Logged By	JED	r	Date	31/7/	96 Checked By Jao	Date j 4. 8	7 - 96 Form R18 Issue

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CLIENT:	TERRANOR.	A GROU	MANAGEM	TEST PIT No:	TP 5
PROJECT:	TERRANOR	A RESOF	T PROJECT	JOB No:	BT 4466
EQUIPMENT	TTYPE: CA	ASE 550		HOLE DIAMETER: 450mm	
Geological Profile	Samples	A T De E in		Soil or Rock Type, Structure	Consistency/ Rel. Density
FILL		0.	9	Clayey SILT: High plasticity. With rubbble (Bricks & Timber) & occasional cobbles. Moist (w≤w _p). Red/brown (MH)	STIFF
				Clavey SILT: High plasticity, Trace of fine grained sand, Occasional cobbles. Moist (w <w<sub>p), Red/brown (MH)</w<sub>	STIFF
RESIDUAL				Silty CLAY: Medium to high plasticity. Trace of fine to medium grained sand. Moist (w\le w_p). Orange/red/brown (CL-CH/CH)	STIFF
RESIDUAL SOIL/ROCK STRUCTURE		2.	8	Sandy CLAY: Medium plasticity, With silt. Fine to medium grained sand. Moist (w≤w _p). Pale Orange blotched grey (CL-CH) (Some rock structure evident)	VERY STIFF/ HARD
LAMINGTON VOLCANICS			2	Extremely Weathered ROCK: Remoulds to Sandy Clayey GRAVEL: Fine to coarse rounded & irregular gravel. Some friable particles & cobbles. Dry to moist. Grey blotched pale Red/brown (XW)	EXTREMELY LOW STRENGTH
				TP 5 TERMINATED AT 4.2m BUCKET REFUSAL ON COBBLES	
Logged By	ÆD	Date	31/7/	196 Checked By Jeo Date 14.8	7 · 96 Form R18 Issue

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CLIENT:	TERRANOR	A GROUP M	IANAGEM	ENT	TEST PIT No:	TP 6
PROJECT:	TERRANOR	A RESORT	PROJECT		JOB No:	BT +466
EQUIPMENT	TYPE: C	ASE 550		HOLE DIAMETER:	450mm	
Geological Profile	Samples	W A T Depth E in m	Graphic Log	Soil or Rock Type. Str	nucture	Consistency/ Rel. Density
TOPSOIL		0.2		TOPSOIL		
RESIDUAL	_	0.4		Gravelly CLAY: Medium plasticit coarse grained sand. Fine gravel, Some friable partic Pale grey streaked pale or	to coarse angular cles, Moist (w≤w _p).	STIFF
LAMINGTON VOLCANICS		1.0		Extremely Weathered ROCK: Res GRAVEL: Fine to coarse Some friable particles (angular gravel.	ENTREMELY LOW STRENGTH
		1.4		Distinctly Weathered ROCK: Fine particle size, Pale grey. Dr		LOW STRENGTH
				TP 6 TERMINATED AT 1.4m TUNGSTEN CARBIDE REFUSA ON BEDROCK	L	
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					e.	
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6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GF	ROUP M	ANAGEM	ENT TEST PIT N	o: TP 7
PROJECT:	TERRANOR	A RE	SORT P	ROJECT	JOB No:	BT 4466
EQUIPMENT	TYPE: C.	ASE	550		HOLE DIAMETER: 450mm	
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type. Structure	Consistency, Rel. Density
TOPSOIL		1	0.2		TOPSOIL	
•		2			Silty CLAY: High plasticity, Trace of fine grained sand, Moist (w≤w _p), Red/ brown (CH)	STIFF
RESIDUAL		5	0.7		Gravelly CLAY/Clayey GRAVEL: Fine to coarse angular rounded gravel in matrix, With highly plastic silty clay. Moist (w <w<sub>p), Red/brown (CH/GC)</w<sub>	VERY STIFF/ VERY DENSE
	1	6		KULKULUNIKATUK	icasionii (Cib CO)	
LAMINGTON VOLCANICS (BASALTIC)		8	<u>.</u>		Extremely Weathered ROCK: Remoulds to Clayey GRAVEL: Fine to coarse angular gravel. Exfoliated basalt particles in silty clay of his plasticity. Frequent cobles & boulders (XX)	
		9	1.9		plasticity. 1 requests cooles ac counters (22 v	Jinakon
		0	1.9		TP 7 TERMINATED AT 1.9m BUCKET REFUSAL ON BOULDERS OR BEDROCK	
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GEOTECHNICAL ENGINEERING SERVICES
6/12 Greenway Drive, Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GROUP	MANAGEN	ENT	TEST PIT No:	TP 8
PROJECT:	TERRANOR	A RESORT	PROJECT		JOB No:	BT 4466
EQUIPMENT	TTYPE: CA	ASE 550		HOLE DIAMETER:	450mm	
Geological Profile	Samples	W A T Depr E in n		Soil or Rock Type, S	tructure	Consistency Rel. Density
TOPSOIL		0.3		TOPSOIL & COBBLES		
RESIDUAL		1.3		Silty CLAY: High plasticity, Tra sand, Frequent cobbles, I Red/brown (CH)		STIFF
				TP 8 TERMINATED AT 1.3m BUCKET REFUSAL ON BOULDERS OR BEDROCK		
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CLIENT:	TERRANOR	TERRANORA GROUP MANAGEMENT TEST PIT No					
PROJECT:	TERRANOR	A RESORT P	ROJECT	JOB No:	BT 4466		
EQUIPMENT	TYPE: C	ASE 550	HOLE DIAME	TER: 450mm	50mm		
Geological Profile	Samples	A Depth	Graphic Soil or Rock 7	Type. Structure	Consistency/ Rel. Density		
TOPSOIL		0.3	TOPSOIL: With occasio				
COLLUVIUM].	0.6	CLAY: Medium to high p medium grained s Grey (CL-CH/	and Moist (w≤w _p).	STIFF		
RESIDUAL		2.6	Silty CLAY: High plastic sand, Moist (w <v< td=""><td>ity. Trace of fine grained v_p). Red/brown (CH)</td><td>VERY STIFF</td></v<>	ity. Trace of fine grained v _p). Red/brown (CH)	VERY STIFF		
		-		sticity. Trace of fine grained wp). Pale orange streaked ey (CL-CH)	STIFF		
	3.6m Disturbed PP=200 4.0m	3.6	medium friable gr grey mottled red/t	nigh plasticity. With fine d sand, Trace of fine to ravel, Moist (w≤wp), Pale prown and orange/brown vident) (CL-CH/CH)	STIFF		
			TP 9 TERMINATED AT	4.7m			
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CLIENT:	TERRANOR	A GROUP M	IANAGEME	ENT	TEST PIT No:	TP 10	
PROJECT:	TERRANOR	JOB No:	BT 4466				
EQUIPMENT	TTYPE: C	ASE 550		HOLE DIAMETER:	450mm		
Geological Profile	Samples	T Depth	Graphic Log	Soil or Rock Type. Stru	cture	Consistency Rel. Density	
TOPSOIL		0.2		TOPSOIL			
.		0.6		Clayey Sandy SILT: Medium plastic medium grained sand, Mois Pale grey (ML-MH)		STIFF	
RESIDUAL				Sandy CLAY: Medium plasticity, With silt and fine to medium grained sand, Dry to moist (w <w<sub>p). Pale grey/white (CL-CH) (Some rock structure evident)</w<sub>		VERY STIFF/ HARD	
LAMINGTON VOLCANICS (RHYOLITE)		1.4		Extremely Weathered ROCK: Remo CLAY: Medium plasticity (w <w<sub>p). Pale grey white</w<sub>		EXTREMELY LOW STRENGTH	
			1	TP 10 TERMINATED AT 1.8m BUCKET REFUSAL			
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EOTECHNICAL ENGINEERING SERVICES

12 Greenway Drive. Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GI	ROUP M	ANAGEM	ENT		TEST PIT No:	TP 11
ROJECT:	TERRANOR	A RE	SORT P	ROJECT			JOB No:	BT 4466
QUIPMENT	TTYPE: CA	ASE	550			HOLE DIAMETER	R: 450mm	
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log		Soil or Rock Type	:, Structure	Consistency/ Rel. Density
TOPSOIL			0.2		TOPSOI	TL		·
RESIDUAL	PP = >400		0.9		CLAY:	Medium plasticity, Tr grained sand, Moist ((CL-CH)		VERY STIFF
LAMINGTON VOLCANICS (RHYOLITE)			1.4		Extremel	y Weathered ROCK: SAND: Fine to medi- grey/white (XW)	Remoulds to Clayey um grained, Dry, Pale	EXTREMELY LOW STRENGTH
					BUCKE	ERMINATED AT 1.4 T REFUSAL ON DIS IERED ROCK		
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CLIENT:	TERRANOR	A GROU	P MANAGEM	ŒNT		TEST PIT No:	TP 12
PROJECT:	TERRANOR	A RESOI	RT PROJECT			JOB No:	BT 4466
EQUIPMENT	TYPE: C.	ASE 550			HOLE DIAMETER: 4	50mm	
Geological Profile	Samples	1 2 1	pth Graphic m Log		Soil or Rock Type, Struc	ture	Consistency/ Rel. Density
TOPSOIL		0	.3	торѕо	TL		•
COLLUVIUM			.6	CLAY:	Medium plasticity. With fine grained sand, Moist (w <w<sub>p). (CL-CH)</w<sub>		STIFF
	PP = 200 0.7m			CLAY:	Medium plasticity. With silt medium grained sand, Moist grey/brown (CL-CH)		STIFF
		1	.6				
RESIDUAL	PP=150 1.9m			Clayey S	ILT: Medium plasticity, Tra grained sand, Moist (w≥w _p). (ML-MH)		FIRM / STIFF
	PP=>400 3.0m	2	.8	Sandy S	ilty CLAY: Medium plasticit medium grained sand. Moist	(n. <n.<sup>b).</n.<sup>	VERY
			.6		Pale orange brown blotched (CL-CH) (Rock structure		STIFF
LAMINGTON VOLCANICS (TUFF)			.0	Entreme	ly Weathered ROCK: Remo Silty CLAY: Medium plasti to coarse friable gravel, Dry grey/white (XW)	icity. With fine	ENTREMELY LOW STRENGTH
					ERMINATED AT 4.0m OF MACHINE		
Fogsed Bi	JED	Date	a 31/7/	/96	Checked By FO	Date 14. 8	8-96

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CLIENT:	TERRANOR	A GF	OUP M	ANAGEM	ŒNT		TEST PIT No:	TP 13
PROJECT:	TERRANOR	A RE	SORT P	ROJECT			JOB No:	BT 11 66
EQUIPMENT	TYPE: C	ASE	550			HOLE DIAMETER:	50mm	
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log		Soil or Rock Type, Struc	ture	Consistency/ Rel. Density
TOPSOIL			0.3		торѕо			•
COLLUVIUM	PP = 180 0.6m		0.6		CLAY:	Medium to high plasticity. T fine grained sand, Moist (ws (CL-CH)		STIFF
RESIDUAL	Disturbed Bulk Sample = 12565 0.9m		2.0		CLAY:	High plasticity. Trace of silt sand. Moist (w <w<sub>p). Red bro</w<sub>		VERY STIFF
					TP 13 T	ERMINATED AT 2.0m		
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Logged By	JED		Date	31/7/	/96	Checked By FC3	Date 14.8	Form R18 Issue

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CLIENT:	TERRANOR	A GROUP M	ANAGEMEN	π	TEST PIT No:	TP 1+
PROJECT:	TERRANORA RESORT PROJECT JOB No:					BT 4466
QUIPMEN	TTYPE: C.	ASE 550		HOLE DIAMETER	: 450mm	
Geological Profile	Samples	W A T Depth E in m	Graphic Log	Soil or Rock Type	Structure	Consistency Rel. Density
TOPSOIL		0.2	Т	OPSOIL		•
•	0.4m U50 =12564 PP=150 FMC=33.4	0.2				STIFF
RESIDUAL	PP = >400 2.3m			LAY: High plasticity, Trace Occasional cobbles an (w <w<sub>p). Red/brown</w<sub>	d boulders. Moist	VERY STIFF
	3.8m					VERY STIFF
	= 12568	4.2				
	4.2m		Т	P 14 TERMINATED AT 4.2	m	
ogged By	ÆD.	Date	31/7/96	Checked By FLD	Date (4.	L 8.96

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CLIENT:	TERRANOR	A GROUP M	ANAGEM	ENT	TEST PIT No:	TP 15
PROJECT:	TERRANOR	A RESORT P	ROJECT		JOB No:	BT 4466
EQUIPMEN'	TTYPE: C	ASE 550		HOLE DIAMETER:	450mm	
Geological Profile	Samples	W A T Depth E in m	Graphic Log	Soil or Rock Type, Stru	acture	Consistency/ Rel. Density
TOPSOIL	_	0.1		TOPSOIL		•
	0.4m Disturbed =12566 NMC=14.4			Sandy CLAY: Medium plasticity. V medium grained sand. With Moist (w≈w _p). Pale yellow/	a trace of silt.	STIFF
RESIDUAL		2.1		Clayey Silty SAND: Fine to medium of low to medium plasticity yellow streaked white (S	, Moist, Pale	VERY DENSE
NERAN- LEIGH FERNVALE GROUP				Extremely Weathered ROCK: Rem Silty SAND: Fine to medi to moist. Pale orange blotch brown (XW)	um grained. Dry	ENTREMELY LOW STRENGTH
	3.8m Disturbed = 12567 4.0m	4.0		TP 15 TERMINATED AT 4.0m		
Logged By	ÆD	Date	31/7/	96 Checked By Jes	Date (4.8	3-96

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CLIENT:	TERRANOR	A GROUP M.	TEST PIT No:	TP 16		
PROJECT:	TERRANOR	A RESORT P	ROJECT		JOB No:	BT 4466
EQUIPMEN'	T TYPE: C	ASE 550		HOLE DIAMETER:	450mm	
Geological Profile	Samples	A T Depth E in m	Graphic Log	Soil or Rock Type, Str	ucture	Consistency/ Rel. Density
TOPSOIL		0.3	7	OPSOIL		
RESIDUAL	-	2.6		ilty CLAY: High plasticity, Trace sand, Moist (w≈w _p), Red		STIFF
		3.8	S	andy Silty CLAY: High plasticity grained sand. Trace of fine gravel, Moist (w <w<sub>p). Rec (Some rock structure evide</w<sub>	to medium friable d/brown (CH)	VERY STIFF
LAMINGTON VOLCANICS (BASALTIC)		4.3	1	xtremely Weathered ROCK: Rer CLAY: Medium plasticit (w <wp). blotch<="" brown="" red="" td=""><td>y. With silt. Moist</td><td>ENTREMELY LOW STRENGTH</td></wp).>	y. With silt. Moist	ENTREMELY LOW STRENGTH
			1	P 16 TERMINATED AT 4.3m		
ogged By	JED	Date	31/7/96	Checked By Jes	Date 14-	1

EOTECHNICAL ENGINEERING SERVICES

12 Greenway Drive. Tweed Heads South Ph (07) 55 246 199

CLIENT:	TERRANOR	A GROUP M	IANAGEM	ENT	TEST PIT No:	TP 17
ROJECT:	TERRANOR	ANORA RESORT PROJECT JOB No:				
QUIPMENT	TYPE: CA	ASE 550		HOLE DIAMETER:	450mm	
Geological Profile	Samples	A T Depth E in m	Graphic Log	Soil or Rock Type, Strue	cture	Consistency/ Rel. Density
TOPSOIL		0.2		Clayey Sandy SILT: Medium plastic medium grained sand, Mois Pale grey (ML-MH)		STIFF
RESIDUAL				Sandy CLAY: Medium plasticity, W to medium grained sand. Dr (w <w<sub>p), Pale grey/white ((Some rock structure eviden</w<sub>	y to moist (CL-CH)	VERY STIFF/ HARD
LAMINGTON VOLCANICS		1.2		Extremely Weathered ROCK: Remo CLAY: Medium plasticity, (w <w<sub>p). Pale grey white</w<sub>	oulds to Silty With silt, Dry (XW)	. EXTREMELY LOW STRENGTH
				TP 17 TERMINATED AT 1.4m BUCKET REFUSAL		
			1.4			
					•	
ogged By	JED	Date	31/7/	96 Checked By Fo	Date (4	8 96 Form R18 Issue



Appendix B

Laboratory Sample Test Results

Tabulation of Results
Report No. 2510 - Triaxial Test Results
Certificate No. 8448 - Soaked CBR Test Results
Certificate No. 8449 - Material Classification Test Results
Certificate No. 8459 - Material Classification Test Results



ŧ
Resu
of Test
nary
Summa
<u>۔</u>
Table D
<u>स</u>

					I								<u></u>		% Passing	% Passing Sieve Size	
Sample Location	Sample	Geological	NMC	TI	J.d.	PI	rs	S/S	<u>ن</u>	0	ОМС	ддм	CBR	9.5 mm	2.36 mm	300 µm	75 µm
ВН9	12485	Rhyolitic															
0,5 to				.00	27	=	5.0			******	•••••			001	86	96	79
1.0 m.								*****		-++					••••		
BH 9	12486	Rhyolitic				***************************************			†••••• 								
1.5 to	******	bedud -	•••••	35	22	Ξ	0'9					*****			100	96	82
1.9 m.		*****					*****					+					
BH8	12508	Basaltic			-	-		-									
0.5 to				7	44	27	16.0			*****					90 .	66	85
1.0 m.	*****						*****					•					
BH 15	12517	Basaític					<u></u>				******						
7.5 to				52	39	2	8.0					*****	••••		100	94	74
7.7 m.							•••••					+ -				,	
TP 13	12565	Basaltic					****										
0.6 to	*****		28.5								37.5	1.29	6			,,,,,	
0.9 m.	TE***					•	•••••	· • • • • • • • • • • • • • • • • • • •								•••••	
TP 14	12569	Basaltic		****	****												***************************************
0.4 to			33.4	,				4									
0.9 m.	=***									•••••		*****					
BH 15	7171	Basaltic						-							***		
4.2 to				****			,	•••••	9	<u>∞</u>	,	•••••	••••				
4.55 m.				•	-			••••		******	*,						
BH 15	7172	Başaltic		****													
5.7 to		****		*****			*****		2	24							
5.92 m.				4			. ,,,,	*****	*****			••••					
				1													



Table D2 - Summary of test Results

				ļ											% Passing	% Passing Sieve Size	
Sample	Sample		NMC	3	7	Z	ST	S/S	ت	Φ	Φ OMC MDD CBR	MDD	CBR	9.5 mm	2.36 mm	2.36 pm 300 pm	75 um
Location				-		•••••											
BH 20	12547	Meta -			L.,			 									
1.0 to		Sedimentary		39	23	9	8,0		******	*****					60	\$	<u>~</u>
1.5 m.											*****	****				****	
BH 2!	12548	Meta -												***************************************			**************************************
0.5 to		Sedimentary		42	25	11	8.0				*****		•••••	001	86	06	79
1.0 m.									.,,								1
TP 15	12566	Meta -															
0.4 to		Sedimentary	14.5				*****				16,5 1,76	1.76	15				
0.8 m.							*****			.****	*****	****			******		
BH 27	12570	Meta -						<u></u>									
0.4 to		Sedimentary	13.9			******	*****	6:0				•••••			•	*****	
0.8 m.							*****					····-		•••••			
				*****	*****									••••			
						ĺ									•	-	

Legend:

NMC = Natural Moisture Content (%) LL = Liquid Limit (%)

PL = Plastic Limit (%) PI = Plasticity Index (%)

LS = Linear Shrinkage (%)

S/S = Shrink / Swell Index (%) c = Cohesion (kPa)

φ = Internal Angle of Friction (°)
 OMC = Optimum Moisture Content (%)
 MDD = Maximum Dry Density - Standard Compaction (t/m³)

CBR = Soaked Californian Bearing Ratio (%)



Unit 2 / 37 Queens Rd, Everton Hills Q. 4053

P.O. Box 387, FERNY HILLS Q. 4055

PHONE: (07) 3353 4266 MOBILE: 018 733 795 FAX: (07) 3353 4409

REPORT NO: 2510 SHEET: 1 of 2

TRIAXIAL TEST RESULTS TESTED IN ACCORDANCE WITH BISHOP & HENKEL & GEOTEST INTERNAL METHOD

CLIENT :

BORDER - TECH

JOB NO : G066/3

PROJECT :

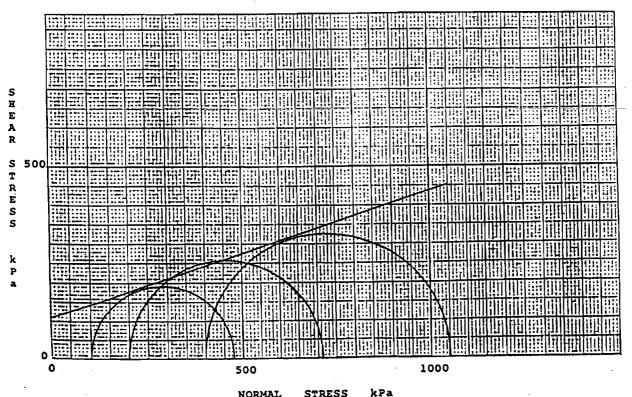
TERRANORA LAKES DEVELOPMENT

DATE

: 29.07.96

RESULTS

SAMPLE NUMBER	7171	HOLE NUMBER	:	15
TEST TYPE/SAMPLE TYPE	Quick Undrained, Staged 50mm Undisturbed	DEPTH (m)	4.20	to 4.55
EFFECTIVE CONFINING STRESS	100	200	400	kPa
INITIAL MOISTURE CONTENT	46.6	_	-	8
WET DENSITY	1.76	_	-	t/cu.m
DRY DENSITY	1.20	_	-	t/cu.m
MAXIMUM DEVIATOR STRESS	380	512	643	kPa
AXIAL STRAIN AT FAILURE	5.5	12.5	18.5	-
VISUAL CLASSIFICATION	SILTY CLAY : r	medium plast and light bro		d brown
CORESION (c) 110 kPa	INTERNAL FRIC	TION ANGLE	(¢)	18



STRESS NORMAL

This laboratory is registerd by the National Association of Testing Authorities, Australia. The tests reported herein have been performed in accordance with its terms of registration. This report may not be reproduced, except in full.

Authorised Signature

J. Glek

 Unit 2 / 57 Queens Rd, Evertón Hills Q. 4053 P.O. Box 387, FERNY HILLS Q. 4055

PHONE: (07) 3353 4266

MOBILE: 018 733 795

FAX: (07) 3353 4409

REPORT NO : 2510 SHEET: 2 of 2

TRIAXIAL TEST TESTED IN ACCORDANCE WITH BISHOP & HENKEL & GEOTEST INTERNAL METHOD

CLIENT :

BORDER - TECH

JOB NO : G066/3

PROJECT :

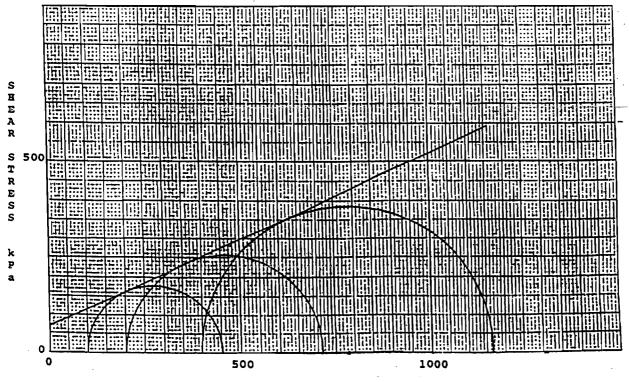
TERRANORA LAKES DEVELOPMENT

DATE

: 29.07.96

RESULTS

WEGORIO				
SAMPLE NUMBER	7172	HOLE NUMBER		15
. TEST TYPE/SAMPLE TYPE	Quick Undrained, Staged 50mm Undisturbed	DEPTH (m)	5.7	5.92
EFFECTIVE CONFINING STRESS	100	200	400	kPa
INITIAL MOISTURE CONTENT	39.3	_	· <u>-</u>	8
WET DENSITY	1.83	-	_	t/cu.m
DRY DENSITY	1.31	_		t/cu.m
MAXIMUM DEVIATOR STRESS	338	511	764	kPa
AXIAL STRAIN AT FAILURE	5.0	9.0	14.5	95
VISUAL CLASSIFICATION	SILTY CLAY : 1	ow plasticity	y, brown	and grey.
COHESION (c) 70 kPa	INTERNAL FRIC	TION ANGLE	- (φ)	24



NORMAL STRESS kPa

s laboratory is registerd by the National ociation of Testing Authorities, Australia, tests reported acrein have been performed scoordance with its terms of registration. This art may not be reproduced, except in full.

Authorised Signature

2/9 JUL 1996

echnical Engineering Services 3/12 Greenway Drive d Heads South 2486 Telephone:

(07) 5524 6199

Facsimile:

(07) 5524 6533

P.O. Box 6340

Tweed Heads South 2486

'ALIFORNIA BEARING RATIO REPORT

		REPORT NUMBER:	8448
JENT:	TERRANORA GROUP MANAGEMENT	JOB NUMBER:	BT 4466
₹ <u>OJEC</u> T :	TERRANORA RESORT PROJECT	DATE OF ISSUE:	13/8/96

est Methods:

AS 1289 F1.1, 2.1.1 - 1977, 5.1.1 - 1993

EST DATA

imple Number
ate Sampled
ate Tested
est Location and Level

12565	12566		
31/7/96	<u>3</u> 1/7/96	Ĺ	
6/8/96	6/8/96		
TEST PIT TP13	TEST PIT TP15		
0.6 - 0.9	0.4 - 0.8		
Below Natural	Below Natural		
Surface Level	Surface Level		

ESULTS

.B.R. (%)
metration (mm)
oak Period
laterial Description

9	15		
5.0	5.0		
4 Days	4 Days		
Red Brown Silty CLAY	Pale Yellow Brown Sandy CLAY		

ABORATORY DATA

of rock retained on 19mm sieve lass of Rammer (kg)
rop of Hammer (mm)
ayers/Blows per Layer
laximum Dry Density (t/m³)
ry Density Before Soaking (t/m³)
ry Density After Soaking (t/m³)
lass of Surcharge (kg)
well (%)

nil	nil	
2.7	2.7	
300	300	
3/53	3/53	
1.29	1.76	
1.28	1.76	
1.28	1.76	
6.75	6.75	
0.0	0.5	

IOISTURE CONTENTS

fatural (%)

Pptimum Moisture (%)

Is Compacted (%)

Aoisture after soak (%)

Op 30 mm Layer (%)

Intire depth of Sample (%)

28.5	14.4			
37.3	16.7	_		
38.0	17.0			
39.6	18.2	. 		
43.6	19.7		` <u> </u>	
42.3	18,2	<u> </u>		





intechnical Engineering Services 6/12 Greenway Drive ed Heads South 2486

Telephone: (07) 5524 6199 Facsimile: (07) 5524 6533

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Tweed Heads South 2486

1ATERIAL CLASSIFICATION

REPORT NUMBER: 8449

LIENT:	TERRANORA GROUP MANAGEMENT	JOB NUMBER:	BT 4466
ROJECT:	TERRANORA RESORT PROJECT	DATE OF ISSUE:	13/8/96

est Methods: AS1289 3.1.1, 3.2.1, 3.3.1, 3.4.1 & 3.6.1 - 1995

est Data imple Number ate Sampled

ate Tested est Location and Level

12485	12487	12508	12517
24/7/96	24/7/96	24/7/96	24/7/96
30/7/96	30/7/96	30/7/96	30/7/96
Borehole BH 9	Borehole BH 9	Borehole BH 8	Borehole BH15
0.5 - 1.0 m.	1.5 - 1.9 m.	0.5 - 1.0 m.	7.5 - 7.7 m.

LASTICITY INDEX RESULTS

inear Shrinkage (%) iquid Limit (%) astic Limit (%) asticity Index (%) fould Length (mm) rumbling / Curling rying Procedures reparation

5.0	6.0	16.0	8.0
38	35	71	52
27	22	44	39
11	13	27	13
250	250	250	150
nil	nil	nil	nil
<u>a</u> ir	air air	_ air	air
dry	dry	dгу	dгу

ARTICLE SIZE DISTRIBUTION RESULTS

ieve Size -

	% Passing	% Passing	% Passing	% Passing
19.0 mm				
9.5 mm			·	
. 4,75 mm [100			. _
2.36 mm	98			
I.18 mm	96	100	_	100
600	94	95		97
micron				
300	90	90		94 .
micron	,			
150 micron	84	85		86
75 micron	79	82		74





:echnical Engineering Services 6/12 Greenway Drive d Heads South 2486

Telephone: (07) 5524 6199

Facsimile:

(07) 5524 6533

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Tweed Heads South 2486

IATERIAL CLASSIFICATION

REPORT NUMBER: 8459

JENT:	TERRANORA GROUP MANAGEMENT	JOB NUMBER:	BT 4466
OJECT:	TERRANORA RESORT PROJECT	DATE OF ISSUE:	- 13/8/96

st Methods: AS1289 3.1.1, 3.2.1, 3.3.1, 3.4.1 & 3.6.1 - 1995

st Data mple Number ite Sampled ite Tested st Location and Level

12547	12548	
26/7/96	26/7/96	
30/7/96	30/7/96	
Borehole BH 20	Borehole BH 21]
1.0 - 1.5 m.	0.5 - 1.0 m.	

ASTICITY INDEX RESULTS

near Shrinkage (%) quid Limit (%) astic Limit (%) asticity Index (%) ould Length (mm) rumbling / Curling ying Procedures eparation

8.0	8.0	
39	42	
23	25	
16	17	
250	250	
nil	nil	
air	air	
dry	dry	

ARTICLE SIZE DISTRIBUTION RESULTS

ieve Size -

% Passing_	% Passing_	% Passing	% Passing
		10	
	100		
	99		
100	_ 98		
99	_ 97		
98	95		
94	90		
85	82		
81	79		
	100 99 98 94 85	100 99 100 98 99 97 98 95 94 90 85 82	100 99 100 98 99 97 98 95 94 90 85 82







Appendix C

Site Plans

Key to Site Plans - Dwg. No. 1

Borehole Location Plan (South East Section) - Dwg. No. 2

Borehole Location Plan (South West Section) - Dwg. No. 3

Borehole Location Plan (North West Section) - Dwg. No. 4

Borehole Location Plan (Gun Club Area) - Dwg. No. 5

Key to Geotechnical Assessment Unit Maps - Dwg. No. 6

Geotechnical Assessment Unit Legend

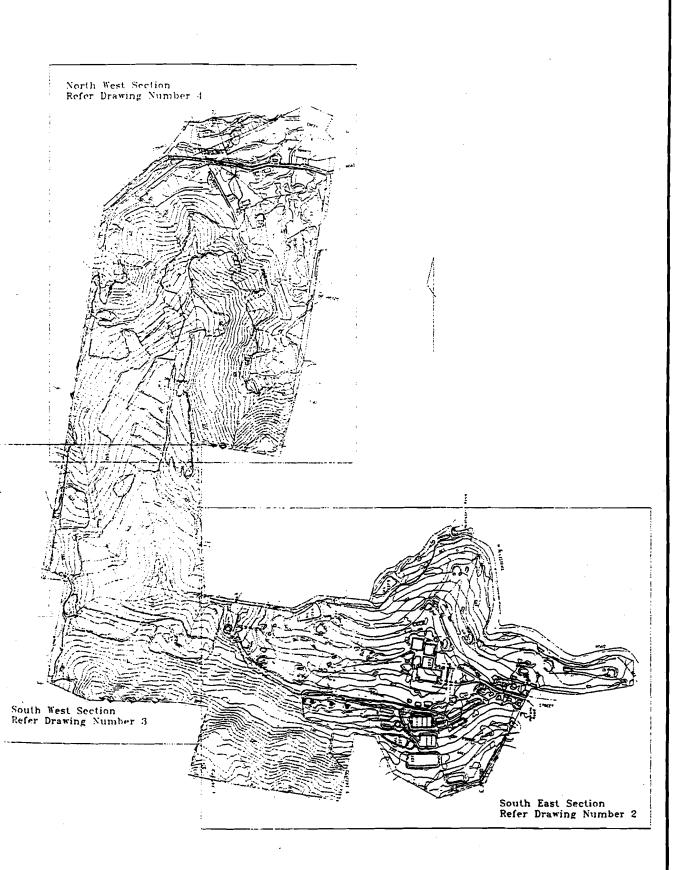
Geotechnical Assessment Unit Map (North West Section) - Dwg. No. 7

Geotechnical Assessment Unit Map (South West Section) - Dwg. No. 8

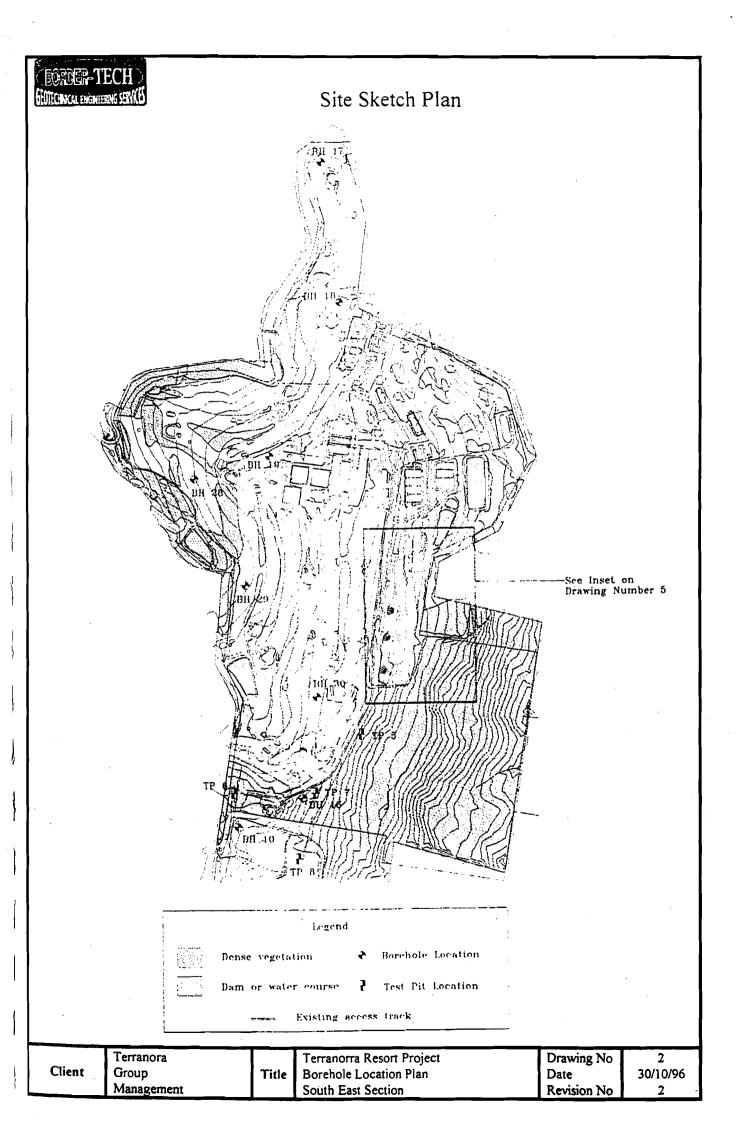
Geotechnical Assessment Unit Map (South East Section) - Dwg. No. 9

Geological Explanation Sheet - Dwg. No. 10

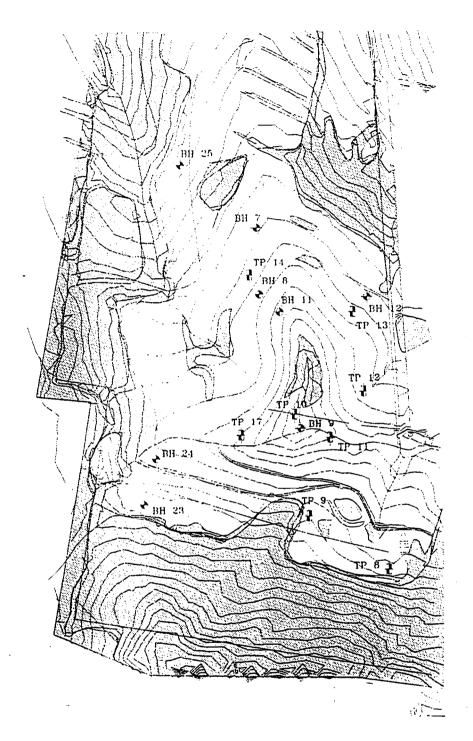




	Тегтапога		Terranorra Resort Project	Drawing No	1
Client	Group	Title	Overall Plan	Date	30/10/96
	Management		Key to Site Plans	Revision No	2





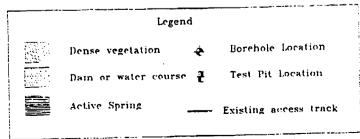


	Legend		
:	Dense vegetation	٠	Borchole Location
	Dam or water course	ģ	Test Pit Location
- "2	Active Spring		Existing access track

	Terranora		Terranorra Resort Project	Drawing No	3
Client	Group	Title	Borehole Location Plan	Date	30/10/96
	Management		South West Section	Revision No	2

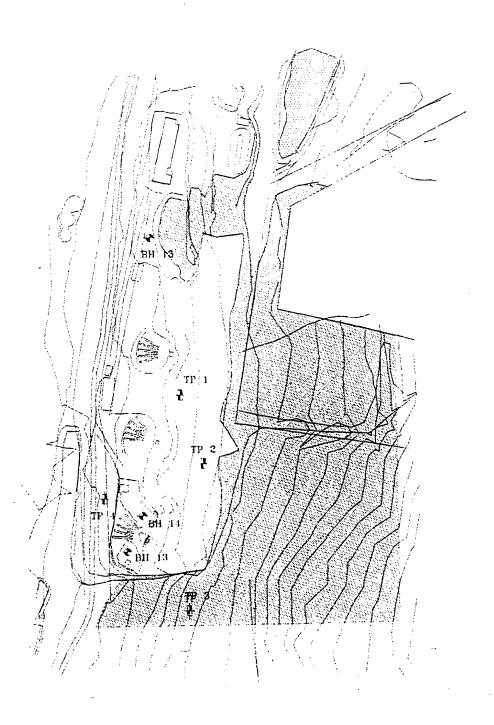






	1 CH ANOL
Client	Group
	Managen

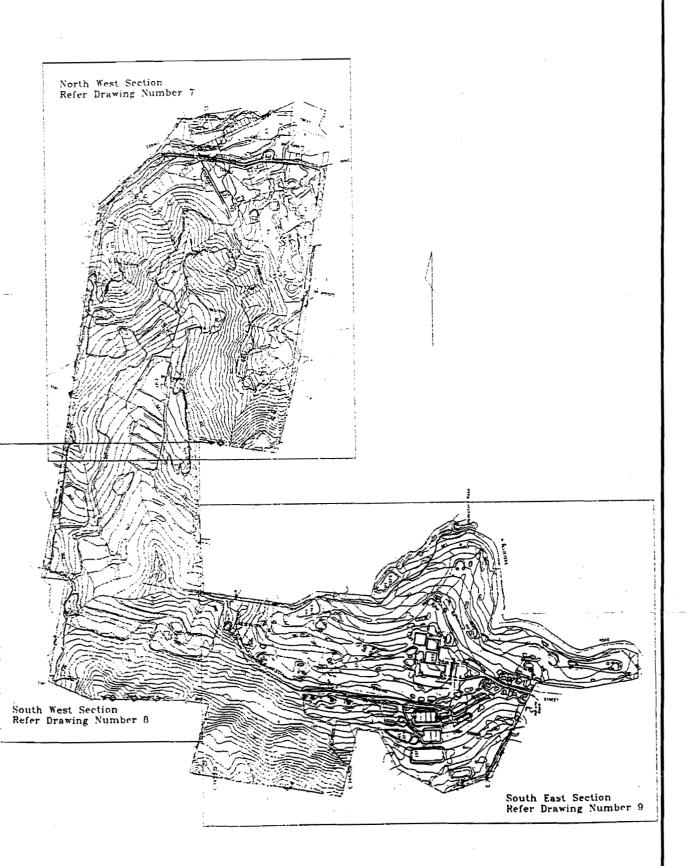




Legend	
Dense vegetation & Borehole Loca	tion
Dam or water course ? Test Pit Locat	ion
Existing access track	

	Terranora		Terranorra Resort Project	Drawing No	5
Client	Group	Title	Borehole Location Plan	Date	30/10/96
	Management		Inet From Drawing 2 - Gun Club Area	Revision No	2_





	Terranora		Terranorra Resort Project	Drawing No	6
Client	Group	Title	Overall Plan	Date	30/10/96
	Management		Key to G.A.U. Maps	Revision No	2



GEOTECHNICAL ASSESSMENT UNITS.

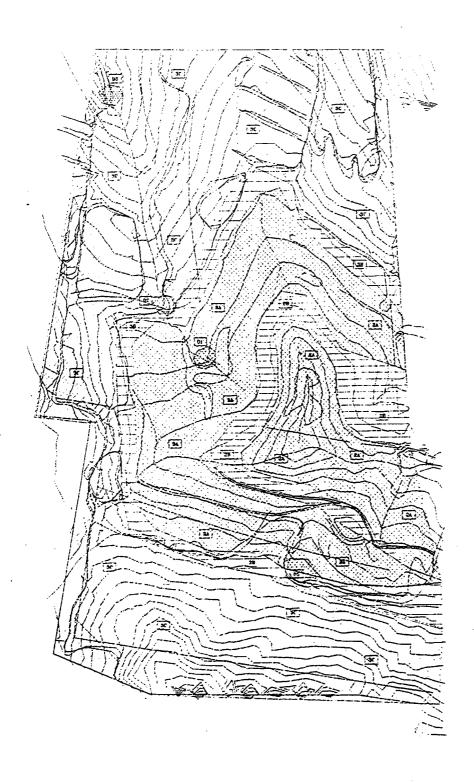
WATERCOURSE DAM SITE [D, to D,] ACCESS ROAD WITH PROPOSED DEEP CUT INVESTIGATION SITE
POSSIBLE MINOR
RESERVOIR SITE
METASEDIMENTS 2.0->4.0m CL-CH overlying strong bedrock
hillslopes) Assume profile as for 3A to 3B
weathered corestones, very weak to very strong in places
BASALT (Steep Scarps) 1.0->8.5m MH-CH with bands of
2.0->4.0 m CH grading to strong corestones bedrock.
BASALT (Undulating topography)
PERLITIC RHYOLITE 2.5-4.0+m CL-CH strong bedrock
rock at 4.0 to 7.0 m
TUFFACEOUS RHYOLITE
clay
RECENT ALLUVIUM
GEOTECHNICAL ASSESSMENT UNIT





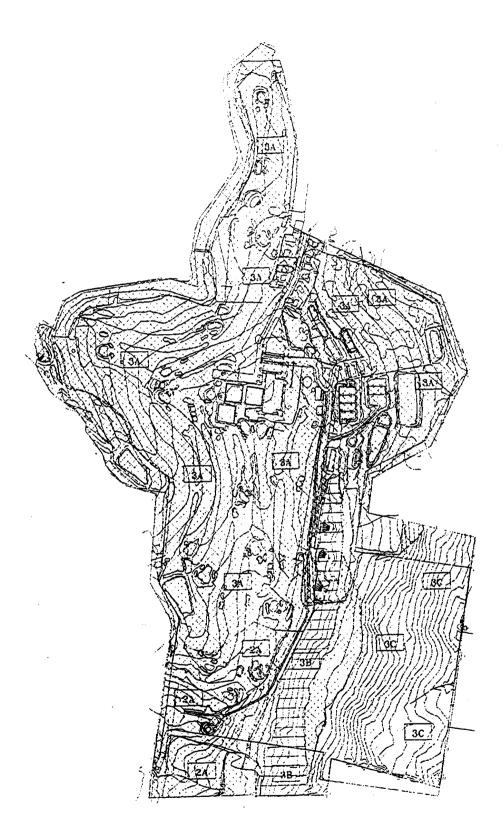
	Теттапога		Terranorra Resort Project	Drawing No	7
Client	Group	Title	Geotechnical Assesment Unit Map	Date	30/10/96
	Management		North West Section	Revision No	2





	Теггалога		Terranorra Resort Project	Drawing No	8
Client	Group	Title	Geotechnical Assesment Unit Map	Date	30/10/96
	Management		South West Section	Revision No	2

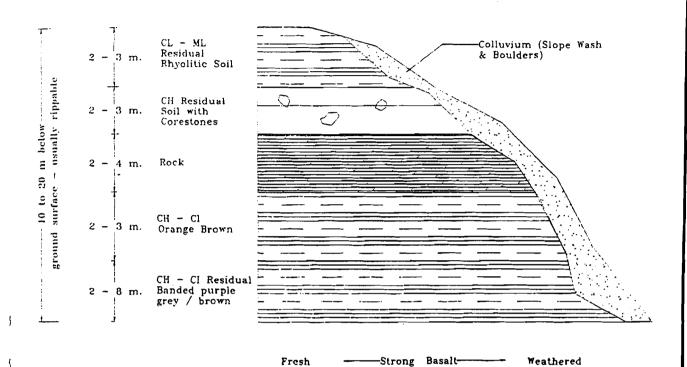




	Тегтапога
Client	Group
	Management

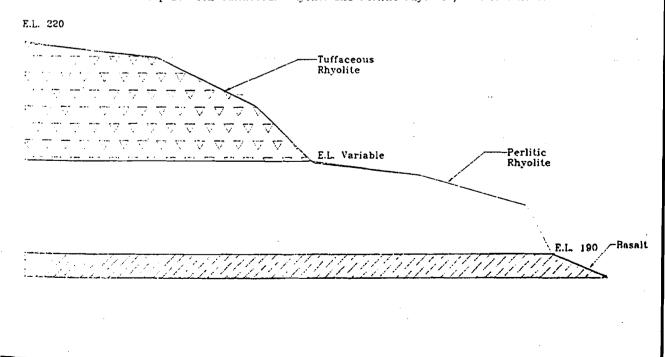


Reverse Weathering Profile in Basalt Scarps Figure 4



Note This is a typical figure only intended to show typical profile

Relationship Between Tuffaceous Rhyolite and Perlitic Rhyolite / Basalt Contact



Client	Terranora Group Management	Title	Terranorra Resort Project Geological Explanation Sheet	D	rawing No ate evision No	10 30/10/96 2
					011 1 10	



Appendix D

Photographic Plates

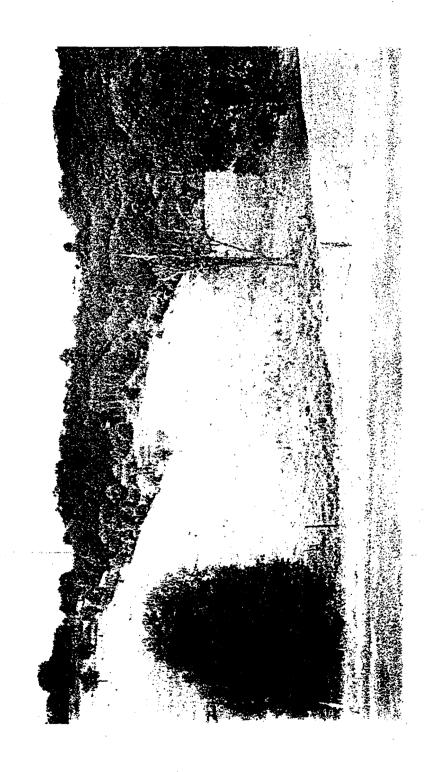


Plate Number 1 - Borrow Pit Area



This photograph shows the contact—between the base of the highly weathered rhyolite overlying the highly weathered—leached surface of the basalt flow. (GAU 2A (2B) / 3B).



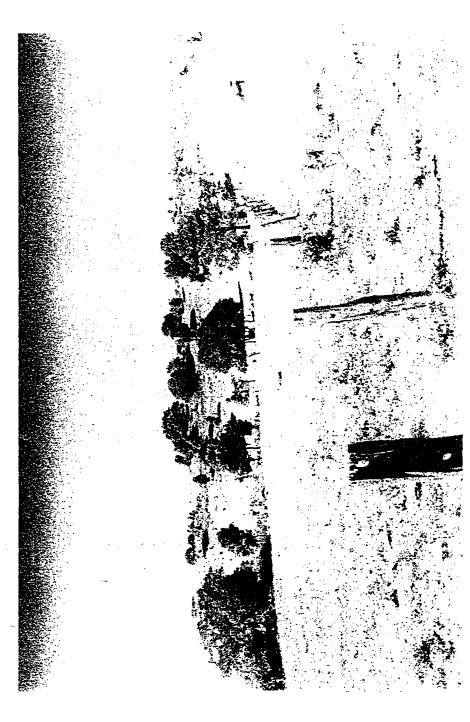


Erosion in the centre mid ground at the spillway of the large dam neat to Cobaki Road. Treed background is typical of Geotechnical Assessment Unit 3B / 3C



Looking towards the proposed clubhouse area from the proposed Hotel precincts. The proposed access road is to transverse the rhyolitic country (near parallel to the most distant fence line). A deep cut is required in the saddle at approximately mid view.





Looking Eastwards towards the proposed Hotel precinct area from gently sloping basaltic area (Geotechnical Assessment Unit 3A). The contact between the rhyolite and basalt is situated at approximately the change in slope angle of the fence line.





Typical steep topography in Geotechnical Assessment Units 3B / 3C. This area has been cleared. This is typical of areas where deep road cuts will be required.

Acid Sulphate Soils Sampling and Test Results

technical Engineering Services 6/12 Greenway Drive ad Heads South 2486 Telephone: (07) 5524 6199 Facsimile: (07) 5524 6533

P.O. Box 6340

Tweed Heads South 2486

JED:mh:TG-2:BT 4466

29 September, 1996

Terranora Group Management C- Weathered Howe Pty Ltd P O Box 1653 SOUTHPORT QLD 4215

Attention: Mr G Dick / Mr B Johnson

Dear Sir

Re: Terranora Resort Project

- 1. As requested we have visited the above site with the objective of carrying out a limited investigation for the purpose of identifying any acid generated soils on the site. The investigation was based on a random check basis below RL 5.0 (AHD) and involved identifying areas on the site where acid sulphate soils may be present The investigation was not intended as a full acid sulphate soils investigation and is intended to be only indicative of the results presented. The results of the investigation are presented below.
- 2. The site consists of two properties which are located adjacent to each other in the Terranora / Cobaki area of the Tweed Valley. For the purpose of the investigation the sites are described as the Norville property and the Golf Course Property.
- 3. The Golf course property has an undulating landscape bounded by basalt scarps facing east, south and southwest. A topographic high is located on the western end of the site where the two sites adjoin. The Norville property has centrally located undulating ground bounded by basalt scarps facing east west and south. The undulating ground

steepens northwards as the land drops down to merge with flatter ground and the flat areas of Cobaki Creek.

- 4. The site investigation involved auguring six (6) boreholes to 1.5 meters at random locations in the lower lying areas adjacent to Cobaki creek. Samples were taken at 0.5 meter intervals through the soil profile. At some locations tungsten carbide refusal was encountered on cobbles or boulders, where this occurred the borehole was relocated. Samples were taken and stored on ice in an esky to minimise sweating and returned to our Tweed Heads laboratory.
- 5. The samples were processed at our Tweed Heads Laboratory and analysed for acid generating soils in the form of Total Sulfidic Acidity TSA (Dent and Bowman, 1996) as described in the interim manual for acid sulphate soils. The results of the testing are presented in tabulated report form attached to this report.
- 6. Should you have any further enquires or require further testing or sampling please do not hesitate to contact this office.

Yours Faithfully

BORDER-TECH

Mark Bolton Manager

echnical Engineering Services 3/12 Greenway Drive d Heads South 2486 Telephone: (07) 5524 6199 Facsimile: (07) 5524 6533

P.O. Box 6340

Tweed Heads South 2486

ACID SULPHATE TEST

Terranora Group Management

ct: Terranora Resort Project

lo.: BT 4466

t:

Method: (Dent and Bowman, 1996)

Issued: 28/9/96

	Sample Identification	Date Sampled Date Tested	Initial pH	Total Actual Acidity (mol/m ³ soil)	Total Potentia I Acidity (mol/m ³ soil)	Total Sulphidic Acidity (mol H+/m ³ soll)	Material Description	Reaction to Hydrogen Peroxide
	Borehole 1 0.0 - 0.4	25/9/96					Sandy CLAY, moist,	
	below natural surface level	26/9/96	3.8	105	106	1	pale yellow brown	nil
	Borehole 2 0.5 - 0.7	25/9/96				_	Sandy CLAY, moist,	
4	below natural surface level	26/9/96	3.8	85	93	8	pale yellow brown	nil
	Borehole 2 1.0 - 1.4 below natural surface level	25/9/96 26/9/96	4.8	44	76	32	Sandy CLAY / clayey SAND, wet, pale yellow brown	nil
	Borehole 3 0.2 - 0.5 below natural surface level	25/9/96 26/9/96	3.8	86	97	11	Sandy CLAY, moist, pale yellow brown	nil
	Borehole 3 1.3 - 1.5 below natural surface level	25/9/96 26/9/96	3.8	35	30	5	Sandy CLAY, moist/wet, pale yellow brown	nil
	Borehole 4 0.3 - 0.8 below natural surface level	25/9/96 26/9/96	3.8	30	63	33	Sandy CLAY, moist, pale yellow brown	slight
	Borehole 1 0.9 - 1.4 below natural surface level	25/9/96 26/9/96	3.8	78	84	6	clayey SAND,wet,	nil
							٠	
						_		
-								

Acid Sulphate Soils Investigation

NOTE: NOT TO SCALE

BORDER - TECH 6/12 Greenway Drive, South Tweed Heads 2486

Client: Terranora Group Management

Project: Terranora Resort Project

BT 4466

96/01

Residual Pesticides Soil Sampling and Test Results

echnical Engineering Services 3/12 Greenway Drive d Heads South 2486

Telephone: (07) 5524 6199 Facsimile: (07) 5524 6533

P.O. Box 6340

Tweed Heads South 2486

JED:mh:TG-2:BT 4466

15 October, 1996

Terranora Group Management C- Weathered Howe Pty Ltd P O Box 1653 SOUTHPORT QLD 4215

Attention: Mr G Dick / Mr B Johnson

Dear Sir

Re: Terranora Resort Project

- 1. As requested we have visited the above site with the objective of carrying out a limited investigation for the purpose of identifying pesticide residuals. The investigation involved identifying areas on the site where pesticides were used, griding the areas and auguring boreholes for the purpose of obtaining soil samples for testing. The results of the investigation are presented below.
- 2. The site consists of two properties which are located adjacent to each other in the Terranora / Cobaki area of the Tweed Valley. For the purpose of the investigation the sites are described as the Norville property and the Golf Course Property.
- 3. The Golf course property has an undulating landscape bounded by basalt scarps facing east, south and southwest. A topographic high is located on the western end of the site where the two sites adjoin. The Norville property has centrally located undulating ground bounded by basalt scarps facing east west and south. The undulating ground steepens northwards as the land drops down to merge with flatter ground and the flat areas of Cobaki Creek.

- 4. Information obtained from officials of the past golf club and locals indicate the Golf course property was used as grazing land for dairy cattle prior to 1964. The property was previously named "Highfields" before being purchased in 1964 for the purpose off establishing a country club. A nine hole golf course was established at this stage which was expanded to Eighteen holes in 1974. The course has been operating at this level to the present date. From our inquiries there has been no known use of pesticides on this property.
- 5. Discussions with the Norville family reveal the Norville property has been owned by the family since 1908. The property was used generally for cattle grazing although discussions reveal in 1970 the undulating ground north of the topographic high was terraced using surface boulders and residual soils. Once the ground was rendered relatively level a small cropping operation was carried out. Irrigation was pumped from the existing spring fed dam at the southern end of the Norville property. The small crops grown in this area included corn, sweet potatoes, potatoes, tomatoes, and limited growth of sugar cane for wind breaks. Pesticides were used in this operation although it is unclear as to the exact type of pesticides used. Both sprays and powders were employed and it was indicated these were only used seasonally. The small cropping operation was ceased in 1978.
- 6. The site investigation involved griding the four terraced areas, each on a 20 meter grid. One randomly selected sector was drilled to a depth of 1.5 meters and samples were taken at 0.5 meter intervals through the soil profile. At some locations tungsten carbide refusal was encountered on basalt cobbles or boulders, where this occurred the borehole was relocated. Samples were taken and stored on ice in an esky to minimise sweating and returned to our Tweed Heads laboratory.

- 7. The samples were forwarded by courier to Australian Laboratory Services, Brisbane Laboratory for analysis for residual organophosphate and organochloride pesticides. The results of the testing are presented in tabulated report form attached to this report.
- 8. Should you have any further enquires or require further testing or sampling please do not hesitate to contact this office.

Yours Faithfully

BORDER-TECH

Mark Bolton Manager





ORGANICS QUALITY CONTROL REPORT

:H No.: EB6250

DATE BATCH RECEIVED: 07/10/96

VT : Border-Tech

DATE BATCH COMPLETED: 14/10/96

∍thod :	Test	Matrix	Method	Reference	QC Lot	Date	Date
ode					Number	Samples	Samples
	-		Extraction	Analysis		Extracted	Analysed
·-068	Pesticides	Soil	Tumbler	USEPA 8270B	OCOPS440	08/10/96	10/10/96



AUSTRALIAN LABORATORY SERVICES P/L

A.C.N. 009 936 029



ANALYTICAL REPORT

2 1 PAGE

CONTACT: MR J DICK SORDER-TECH

CLIENT: ADDRESS:

P 0 80% 6340

TWEED HEADS SOUTH

2486

LABORATORY: BATCH NUMBER:

SUB BATCH:

No. OF SAMPLES:

DATE RECEIVED:

04/10/95 14/10/96

EB6250

0

ENV BRISBANE

DATE COMPLETED:

BT 4466

SAMPLE TYPE: SOIL

PROJECT:

·····	SAMPLE TYPE	•	PROJECT:				
nalysis_description	Units	LOR	12992	12993	12994	12995	
·							
cisture Content (dried @ 103°C) RGANDCHLDRINE PESTICIDES	\	0.1	25.5	22.6	24.9	23.8	
#3HC	æg/kg	0.05	K0.05	<0.05	<0.05	<0.05	
é s	mg/kg	0.05	<0.05	<0.05	<0.05	<0.05	
- & g-8HC	æ g/kg	0.1	<0.1	<0.1	<0.1	<0.1	
-380	ag/kg	0.05	<0.03	(0.05	<0.05	<0.05	
eptachlor	∄g/kg	0.05	<0.03	<0.05	<0.05	<0.05	
ldrin	ag/kg	0,05	<0.05	<0.05	<0.05	<0.05	
eptachlor epoxide	ag/kg	0.05	KOLO 5	<0.05	<0.05	<0.05	
hlordane - trans	æg/kg	0.05	<0.0B	<0.05	<0.05	<0.05	
ndosulfan 1	ag/kg	0.05	<0.05	<0.05	<0.05	<0.05	
hlordane - cis	ag/kg	0.05	<0.03	<0.05	<9.95	<0.05	
ieldrin	æg/kg	0.05	CO. .05	<0.05	<0.05	<0. 95	
98	ag/kg	0.05	<0.03	k 0.05	<0.05	<0.05	
ndrin .	ag/kg	0.05	<0.0€	<0.05	<0.05	<0.05	
ndosulfan 2	mg/kg	0.05	€C.IE	<0.05	<0.05	<0.0 5	
99	≡ g/kg	0.05	<0.0E	<0.05	<0.05	<0.05	
ndrīn aldehyde	#g/kg	0.05	<0.0E	<0.05	<0.05	<0.85	
ndosulfan sulfate	#g/kg	0.05	<0.05	<0.05	<0.95	<0.05	
91	ag/kg	0.2	<0.2	<0.2	<0.2	<0.2	
ndrin ketone	⊒ g/kg	0.05	<0.05	<0.05	<0.05	<0.05	
ethoxychlor	∎g/kg	0.2	CQ.2	<0.2	<0.2	©.2 _	
RGANOPHOSPHORUS PESTICIDES	· .					_	
ichlorvos	ag/kg	0.05	<0.05	<0.05	<0.95	<0.05	
emeton-S-methyl	ag/kg	0.05	₹ 9.33	<0.05	<0.05	<0.85	
lenocreptophes	⊉ g/kg	0.2	<2.3	<0.2	<0.2	₹0.2	
imethoate	≊g/kg	8.05	C.E	<0.05	<0.05	<0.05	
iazinon	ag/kg	0.05	<0.0E	<0.05	<0.05	₹8.05	
hlorpyrifos-methyl	⊒g/kg	0.05	<€.33	<0.05	<0.05	€ 2.05	
arathion-methyl	ag/kg	0.2	C0.2	(0.2	<0.2	¢.2	

3:

atoles analysed on an as redeliked basis. Results reported or eight basis.

Final Report which supersedes any preliminary reports with this batch number.

Results apply to sample(s) as submitted by client:







CONTACT: MR J DICK

BORDER-TECH

P 0 30% 6340

TWEED HEADS SOUTH

AUSTRALIAN LABORATORY SERVICES P/L



ANALYTICAL REPORT

PAGE

LABORATORY:

BATCH NUMBER:

EB6250 -

SUB BATCH:

0

No. OF SAMPLES:

04/10/96

DATE RECEIVED:

ENV BRISBANE

DATE COMPLETED:

14/10/96

12995

BT 4466

CLIENT:

ADDRESS:

SAMPLE TYPE:

SDIL

2485

PROJECT:

12992 12993 12994 Units alvsis description LOR

lathicn	 æg/kg	0.05	<0.05	<0.05	<0.05	<0.05
ithion	ang/kg	0.05	<0.05	<0.05	<0.05	<0.05
lorpyrifos	mg/kg	0.05	<0.05	<0.05	<0.05	<0.05
rathion	a g/kg	0.2	<0.2	<0.2	<0.2	<0.2
rimohos-ethyl	ng/kg	0.05	KOLO 5	<0.05	<0.05	<0.05
lorfenvinonos E	mg/kg	0.05	<0.05	<0.05	<0.05	<0.05
lorfenvingnos Z	a g/kg	0.05	<0.05	<0.05	<0.05	<0.05
amophos-ethyl	m g/kg	0105	<0.05	<0.05	<0.05	<0.05
naaiphos	ang/kg	0.05	ko.os	<0.95	<0.05	<0.05
othiofos	æg/kg	0.05	<0.05	<0.05	<0.05	<0.05
hion	mg/kg	0.05	<0.05	<0.05	<0.05	<0.05
rbachenathion	a g/kg	0.05	<0.05	<0.05	<0.05	<0.05
inches-acthy!	ng/kg	0.05	<0.05	<0.05	<0.05	<0.05



BATCH QUALITY CONTROL

ALS EP-068 : PESTICIDES

QC LOT No. : OCOPS440

MATRIX: Soil

ANALYST: G. Greenland

COMPOUND Conc Level CCS CCS Average RPD Rec. Re		Blank	Spike		SPIKE QC R	ESULTS		Co	ntrol Lir	nits
COMPOUND Mg/kg		Conc	1 .	scs	DCS	Average	RPD			,
P-0-68A : ORGANOCHLORINE PESTICIDES	COMPOUND			Conc	Conc	_				
BP-068A : ORGANOCHLORINE PESTICIDES		mg/kg	mg/kg	mg/kg	mg/kg		%	Low	High	%
CEB	EP-068A : ORGANOCH	LORINE PES	TICIDES						· · · · · ·	
- 8 g-BHC		<lor< td=""><td>0.25</td><td>0.24</td><td>0.23</td><td>94</td><td>1</td><td>83</td><td>101</td><td>20</td></lor<>	0.25	0.24	0.23	94	1	83	101	20
Selection Color	-ICB	<lor< td=""><td>0.25</td><td>0.23</td><td>0.24</td><td>94</td><td>1</td><td>79</td><td>101</td><td>20</td></lor<>	0.25	0.23	0.24	94	1	79	101	20
Febrachion	o- & g-BHC	<lor< td=""><td>0.50</td><td>0.51</td><td>0.51</td><td>101</td><td>0</td><td>83</td><td>106</td><td>20</td></lor<>	0.50	0.51	0.51	101	0	83	106	20
Aldrin	1-BHC	<lor< td=""><td>0.25</td><td>0.24</td><td>0.23</td><td>94</td><td>2</td><td>.82</td><td>104</td><td>20</td></lor<>	0.25	0.24	0.23	94	2	.82	104	20
Heptachlor epoxide	rieptachlor	<lor td="" ·<=""><td>0.25</td><td>0.24</td><td>0.24</td><td>97</td><td>2</td><td>82</td><td>106</td><td>20</td></lor>	0.25	0.24	0.24	97	2	82	106	20
Fans-Chlordane	Aldrin	<lor< td=""><td>0.25</td><td>0.24</td><td>0.23</td><td>93</td><td>3</td><td>80</td><td>105</td><td>20</td></lor<>	0.25	0.24	0.23	93	3	80	105	20
Endosulfan 1	Heptachlor epoxide	<lor< td=""><td>0.25</td><td>0.24</td><td>0.23</td><td>94</td><td>2</td><td>80</td><td>107</td><td>20</td></lor<>	0.25	0.24	0.23	94	2	80	107	20
Section Color Co	rans-Chlordane	<lor< td=""><td>0.25</td><td>0.24</td><td>0.24</td><td>94</td><td>1</td><td>79</td><td>110</td><td>20</td></lor<>	0.25	0.24	0.24	94	1	79	110	20
Dieldrin	Endosulfan 1	<lor< td=""><td>0.25</td><td>0.23</td><td>0.22</td><td>91</td><td>3</td><td>81</td><td>109</td><td>20</td></lor<>	0.25	0.23	0.22	91	3	81	109	20
DDE	cis-Chlordane	<lor< td=""><td>0.25</td><td>0.24</td><td>0.24</td><td>96</td><td>4</td><td>81</td><td>108</td><td>20</td></lor<>	0.25	0.24	0.24	96	4	81	108	20
Indrin	Dieldrin	<lor< td=""><td>0.25</td><td>0.23</td><td>0.22</td><td>90</td><td>5</td><td>80</td><td>107</td><td>20</td></lor<>	0.25	0.23	0.22	90	5	80	107	20
Section Sect	ODE	<lor< td=""><td>0.25</td><td>0.24</td><td>0.23</td><td>94</td><td>2</td><td>82</td><td>106</td><td>20</td></lor<>	0.25	0.24	0.23	94	2	82	106	20
Section Sect	Endrin	<lor< td=""><td>0.25</td><td>0.20</td><td>0.22</td><td>85</td><td>12</td><td>81</td><td>108</td><td>20</td></lor<>	0.25	0.20	0.22	85	12	81	108	20
Indrin aldehyde	Endosulfan 2	<lor< td=""><td>0.25</td><td>0.23</td><td>0.23</td><td>92</td><td></td><td>82</td><td>107</td><td>20</td></lor<>	0.25	0.23	0.23	92		82	107	20
Endrin aldehyde	DDD	<lor< td=""><td>0.25</td><td>0.24</td><td>0.23</td><td>93</td><td>2</td><td>80</td><td>107</td><td>20</td></lor<>	0.25	0.24	0.23	93	2	80	107	20
DDT	Endrin aldehyde	<lor< td=""><td>0.25</td><td>0.26</td><td>0.24</td><td>99</td><td>9</td><td>76</td><td>103</td><td>20</td></lor<>	0.25	0.26	0.24	99	9	76	103	20
Indrin ketone	Endosulfan sulfate	< LOR		0.24	0.24	96	1	80	109	20
Indrin ketone	ODT			0.25	0.26	101	4	80	112	20
Aethoxychlor	Endrin ketone					102	12	80		20
P-068B : ORGANOPHOSPHORUS PESTICIDES O.24	Methoxychlor	<lor< td=""><td>0.25</td><td>0.25</td><td>0.27</td><td>104</td><td></td><td>80</td><td>110</td><td>20</td></lor<>	0.25	0.25	0.27	104		80	110	20
Dichlorvos	P-068B : ORGANOPH	OSPHORUS F	ESTICID	ES						
Annocroptophos					0.24	97	1	80	107	20
Dimethoate	Demeton-s-methyl	<lor< td=""><td>0.25</td><td>0.24</td><td>0.24</td><td>97</td><td>1</td><td>67</td><td>114</td><td>20</td></lor<>	0.25	0.24	0.24	97	1	67	114	20
Diazinon	/lonocroptophos	<lor< td=""><td>0.25</td><td>0.23</td><td>0.25</td><td>94</td><td>8</td><td>75</td><td>124</td><td>20</td></lor<>	0.25	0.23	0.25	94	8	75	124	20
Color	Dimethoate	<lor< td=""><td>0.25</td><td>0.24</td><td>0.24</td><td>96</td><td>2</td><td>82</td><td>111</td><td>20</td></lor<>	0.25	0.24	0.24	96	2	82	111	20
Parathion,methyl	Diazinon	<lor< td=""><td>0.25</td><td>0.23</td><td>0.23</td><td>92</td><td>4</td><td>82</td><td>104</td><td>20</td></lor<>	0.25	0.23	0.23	92	4	82	104	20
Alalathion	Chlorpyrifos methyl	< LOR	0.25	0.24	0.24	95	1	81	106	20
Internation Clor	'arathion methyl	<lor< td=""><td>. 0.25</td><td>0.23</td><td>0.25</td><td>94</td><td>0</td><td>79</td><td>108</td><td>20</td></lor<>	. 0.25	0.23	0.25	94	0	79	108	20
Chlorpyrifos	/lalathion	<lor< td=""><td>0.25</td><td>0.24</td><td>0.24</td><td>96</td><td>2</td><td>81</td><td>107</td><td>20</td></lor<>	0.25	0.24	0.24	96	2	81	107	20
Parathion	enthion	<lor< td=""><td>0.25</td><td>0.24</td><td>0.23</td><td>94</td><td> 1</td><td>83</td><td>105</td><td>20</td></lor<>	0.25	0.24	0.23	94	1	83	105	20
Sirimphos ethyl	Chlorpyrifos	<lor< td=""><td>0.25</td><td>0.24</td><td>0.23</td><td>94</td><td>2</td><td>83</td><td>105</td><td>20</td></lor<>	0.25	0.24	0.23	94	2	83	105	20
Strimphos ethyl			0.25	0.23	0.23	93	1	79	109	20
Chlorfenvinphos E		<lor< td=""><td>0.25</td><td>0.22</td><td>0.24</td><td>91</td><td>7</td><td>81</td><td>106</td><td>20</td></lor<>	0.25	0.22	0.24	91	7	81	106	20
Chlorfenvinphos Z			0.25	N/A	N/A					
P-068D : SYNTHETIC PYRETHROIDS O.25 O.23 O.24 O.24 O.24 O.24 O.25 O.			0.25	0.24	0.24	96	2	82	109	20
enamiphos	iromophos ethyl	<lor< td=""><td>0.25</td><td>0.24</td><td>0.24</td><td>95</td><td>2</td><td>81</td><td>105</td><td>20</td></lor<>	0.25	0.24	0.24	95	2	81	105	20
thion	enamiphos	<lor< td=""><td></td><td>0.23</td><td>0.24</td><td>93</td><td>3</td><td>77</td><td>114</td><td>20</td></lor<>		0.23	0.24	93	3	77	114	20
ithion < LOR 0.25 0.24 0.24 96 1 82 107 20 Carbofenthion < LOR 0.25 0.24 0.24 98 0 76 110 20 Carbofenthion < LOR 0.25 0.22 0.25 95 11 58 137 20 P-068C : TRIAZINE PESTICIDES Simazine < LOR 0.25 0.20 0.24 87 20 79 107 20 drazine < LOR 0.25 0.20 0.24 89 18 77 109 20 P-068D : SYNTHETIC PYRETHROIDS	The same of the sa			0.24	0.23	94	3	80	107	20
Carbofenthion < LOR 0.25 0.24 0.24 98 0 76 110 20 Zinphos methyl < LOR 0.25 0.22 0.25 95 11 58 137 20 P-068C : TRIAZINE PESTICIDES Simazine < LOR 0.25 0.20 0.24 87 20 79 107 20 drazine < LOR 0.25 0.20 0.24 89 18 77 109 20 P-068D : SYNTHETIC PYRETHROIDS				0.24	0.24	96	1	82	107	20
Complete Complete	arbofenthion				0.24	98	0	76	110	20
P-068C : TRIAZINE PESTICIDES	Zinphos methyl					95	11	58	137	20
simazine < LOR 0.25 0.20 0.24 87 20 79 107 20 drazine < LOR	P-068C : TRIAZINE PI									
trazine < LOR 0.25 0.20 0.24 89 18 77 109 20 P-068D : SYNTHETIC PYRETHROIDS	imazine		0.25	0.20	0.24	. 87	20	79	107	20
P-068D : SYNTHETIC PYRETHROIDS	trazine					89	18	77	109	20
	P-068D : SYNTHETIC									
	ypermethrins			0.24	0.23	94	3	68	127	20

:OMMENTS:

⁾ The control limits are based on ALS laboratory statistical data. (Method QWI-ORG/07)

^{:) • :} Recovery or RPD falls outside of the recommended control limits.

Contaminated Soil Sampling

NOTE: NOT TO SCALE

BORDER-TECH 6/12 Greenway Drive. South Tweed Heads 2486

CLIENT: Terranora Group PROJECTI
Management

PROJECT: Terranora Resort Project

BT 4466

Form R19 Issue

RISE – Major Project Application No. MP08-0234 Rise Concept Plan Response to Director General's Environmental Assessment Requirements Key Assessment Requirement No. 12 Site Preparation Works

APPENDIX C

Gilbert & Sutherland Report dated December 1997

GILBERT AND SUTHERLANDETS

Soil and Water Resource Consultants ACN 077310840

Addendum Report & EMP - Onsite Sewage Treatment & Effluent Reuse

Prepared for Terranora Group Management in Response to issues raised by Tweed Shire Council in association with;

Heilbronn & Partners

December, 1997

Robina Office

South Building East Quay Corporate Park 34-36 Glenferrie Drive Robina Q4226

PO Box 857 Robina Q4226

P. 07 5578 9944 F. 07 5578 9945 Brisbane Office

29 Mein Street Spring Hill Brisbane Q4000

PO Box 2057 Bardon Q4065

P. 07 3839 3950 F. 07 3839 3530

GILBERT AND SUTHERLANDETS

Soil and Water Resource Consultants
ACN 077310840

Addendum Report & EMP - Onsite Sewage Treatment & Effluent Reuse

Prepared for Terranora Group Management in Response to issues raised by Tweed Shire Council in association with;

Heilbronn & Partners

December, 1997

Robina Office

South Building East Quay Corporate Park 34-36 Glenferrie Drive Robina Q4226

PO Box 857 Robina Q4226

P. 07 5578 9944 F. 07 5578 9945 **Brisbane Office**

29 Mein Street Spring Hill Brisbane Q4000

PO Box 2057 Bardon Q4065

P. 07 3839 3950 F. 07 3839 3530

3.3 Proximity to dwellings and roads

The guidelines state that "Spray irrigation systems should be surrounded by vegetated buffer zones and should not be sited in proximity to dwellings, public roads and parks to avoid nuisance and health problems. Aerosols that result from spraying should be contained on site. In general a buffer zone of 20 metres should be provided around the perimeter of the site."

After ascertaining which areas meet the topographical requirements, a buffer zone 20m wide was imposed around the site boundaries, the proposed internal roads and resort buildings. The remaining areas suitable for spray irrigation were then estimated to be 28.4ha. Further landscaped areas totalling 21.6ha within the buffer zones can be irrigated with a trickle system, buried under pine or tea tree mulch as aerosols associated with the effluent will not prove problematic.

The total area available for effluent disposal therefore equates to 50.0ha.

3.4 Soil classification

The main issues relating to soil types and properties are:

- Type
- Structure
- Permeability
- Drainage
- Depth

An investigation of the soil types on the site has been carried out by BorderTech as part of the original report (1996) and additionally, by Gilbert & Sutherland. Samples were collected from the locations shown on Drawing No GJ9737-1.DG6.

Soils at the site were classified according to the Australian Soil Classification (Isbell, 1996).

A total of three main soil orders (or types) were identified on the site. These were Ferrosols, Dermosols and Kurosols. A brief description of the characteristics of each soil order is given below (Isbell, 1996) and described in the borelogs attached as appendix A.

3.3 Proximity to dwellings and roads

The guidelines state that "Spray irrigation systems should be surrounded by vegetated buffer zones and should not be sited in proximity to dwellings, public roads and parks to avoid nuisance and health problems. Aerosols that result from spraying should be contained on site. In general a buffer zone of 20 metres should be provided around the perimeter of the site."

After ascertaining which areas meet the topographical requirements, a buffer zone 20m wide was imposed around the site boundaries, the proposed internal roads and resort buildings. The remaining areas suitable for spray irrigation were then estimated to be 28.4ha. Further landscaped areas totalling 21.6ha within the buffer zones can be irrigated with a trickle system, buried under pine or tea tree mulch as aerosols associated with the effluent will not prove problematic.

The total area available for effluent disposal therefore equates to 50.0ha.

3.4 Soil classification

The main issues relating to soil types and properties are:

- Type
- Structure
- Permeability
- Drainage
- Depth

An investigation of the soil types on the site has been carried out by BorderTech as part of the original report (1996) and additionally, by Gilbert & Sutherland. Samples were collected from the locations shown on Drawing No GJ9737-1.DG6.

Soils at the site were classified according to the Australian Soil Classification (Isbell, 1996).

A total of three main soil orders (or types) were identified on the site. These were Ferrosols, Dermosols and Kurosols. A brief description of the characteristics of each soil order is given below (Isbell, 1996) and described in the borelogs attached as appendix A.

3.4.1 Ferrosols

These are soils with B2 horizons in which the major part has a free iron oxide content greater than 5% iron in the fine earth fraction (<2mm).

3.4.2 Dermosols

These are soils with a B2 horizon structure more developed than weak and have no clear or abrupt textural B horizons.

3.4.3 Kurosols

These are soils with a clear or abrupt textural B horizon and in which the major part of the upper 0.2m of the B2 horizon is strongly acidic (pH 1:5 H_2O of <5.5).

3.5 Soil distribution

The distribution of soils reflect the overall geology of the site with Ferrosols associated with the Tertiary age basalt lava flows (Lamington Volcanic Group) and Kurosols/Dermosols associated with the younger volcanic rhyolitic lava and the older metasediments of the Neranleigh-Fernvale group.

The low lying land adjacent to Cobaki Road and considered to be of recent alluvium was found to consist of Dermosols, although alluvial sands and gravels are known to historically exist in the vicinity as well.

This distribution is described in more detail below and shown on Drawing No GJ9737-1.DG7.

3.5.1 Ferrosols

Ferrosols were predominantly identified in the areas sampled for effluent disposal purposes (N and P-Sorption) and correspond to those areas, on the Geotechnical Assessment Unit Map supplied by BorderTech¹, as GAU 3A, 3B and 3C.

These soils consisted mainly of dark reddish brown clay loams of depth > 0.6m with strong structure and 2-5mm polyhedral peds.

The main distinguishing factor of these soils is the free iron oxide content >5% Fe in the fine earth fraction contributing to the soil's dark reddish colour.

¹ Geotechnical Assessment Unit Map presented as three figures in Site Investigation Report by BorderTech (Attachment E) in Statement of Environmental Effects, 1996.

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¹ Geotechnical Assessment Unit Map presented as three figures in Site Investigation Report by BorderTech (Attachment E) in Statement of Environmental Effects, 1996.

3.5.2 Kurosols/Dermosols

Soils exhibiting characteristics of both Kurosols and Dermosols were identified in those areas on the Geotechnical Assessment Unit Map as 2A,2B, 4A and 4B that is the metasediments of the Neranleigh-Fernvale Group occurring on the footslopes of the northern property boundary and, the younger rhyolitic lava overlying basalt and forming the high points of the property.

These soils consisted mainly of brown to dull yellowish brown clay loam (fine sandy) A1 horizons of strong structure and 2-5mm angular blocky peds changing to reddish brown light medium clay to medium clay B2 horizons of moderate to strong structure and 2-5mm polyhedral peds.

These soils are very similar, the difference related to slight textural changes between the A and B horizons with an abrupt or clear texture change from A to B horizon being classified as a Kurosol (provided the pH 1:5 H_2O of the upper 0.2m of the B2 horizons of both soils < 5.5).

A combination of Kurosols and Dermosols can therefore exist in the same vicinity and be derived from the same parent material. A Kurosol was identified in Borehole 1 with Boreholes 2,3 and 4 having less of a clear texture change from A to B horizons. In the absence of particle size analysis, enough similar characteristics exist between these soils at the site to classify them as Kurosols/Dermosols.

3.5.3 Dermosols

The area of low lying land considered to be of recent alluvium on the northern boundary of the property (Borehole 5) contained soils identified as Dermosols. These soils had no clear textural change from A to B horizon and consisted of brown to bright brown clay loams of moderate to strong structure and 2-5mm angular blocky peds.

3.6 Soil analysis (N and P-Sorption)

Sampling was undertaken in the proposed effluent irrigation areas to determine the Nitrogen and Phosphorus adsorption capacity of the soils.

Eight samples were recovered to 0.6m depth from eight boreholes, the location of which are shown on Drawing No GJ9737-1.DG6. The samples were analysed by Tweed laboratory Centre.

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These soils are very similar, the difference related to slight textural changes between the A and B horizons with an abrupt or clear texture change from A to B horizon being classified as a Kurosol (provided the pH 1:5 H_2O of the upper 0.2m of the B2 horizons of both soils < 5.5).

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Subject: Terranora Job number: GJ9737-1

Client: Terranora Group Management

Date: 25/11/97

SOIL TYPE

BROWN KUROSOL

Depth NSL (m)	Horizon	Sample Description	pH 1:5	Colour
0.0 - 0.1	A1	Brownish black CLAY LOAM (CLFS); weak to moderate (2-5mm) polyhedral		10YR 3/2
0.1 – 0.4	B21	Dark reddish brown MEDIUM CLAY (MC); weak to moderate (2-5mm) polyhedral	4.49	10YR 4/2
0.4 – 0.6	B22	Dark reddish brown MEDIUM TO HEAVY CLAY (M-HC); with mottled 10YR 4/3 dull yellowish brown; weak to moderate (2-5mm) polyhedral.		2.5YR 3/6

Subject: Terranora Job number: GJ9737-1

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0.4 - 0.6	B22	Dark reddish brown MEDIUM TO HEAVY CLAY (M-HC); with mottled 10YR 4/3 dull yellowish brown; weak to moderate (2-5mm) polyhedral.		2.5YR 3/6

Subject: Terranora Job number: GJ9737-1

Client: Terranora Group Management

Date: 25/11/97

SOIL TYPE

BROWN KUROSOL/DERMOSOL

Depth NSL (m)	Horizon	Sample Description	pH 1:5	Colour
0.0 – 0.3	A1	Brown CLAY LOAM (CLFS); fine sandy; strong angular blocky; weathered rock near surface (pieces).		7.5YR 4/3
0.3 - 0.55	B21	Light dull yellowish brown LIGHT CLAY; strong polyhedral.	4.51	10YR 4/3
0.55 – 0.7	B22	Reddish brown MEDIUM CLAY; strong polyhedral; basalt at depth visible.		5YR 4/4

Subject: Terranora Job number: GJ9737-1

Client: Terranora Group Management

Date: 25/11/97

SOIL TYPE

BROWN KUROSOL/DERMOSOL

Depth NSL (m)	Horizon	Sample Description	pH 1:5	Colour
0.0 – 0.3	A1	Brown CLAY LOAM (CLFS); fine sandy; strong angular blocky; weathered rock near surface (pieces).		7.5YR 4/3
0.3 – 0.55	B21	Light dull yellowish brown LIGHT CLAY; strong polyhedral.	4.51	10YR 4/3
0.55 - 0.7	B22	Reddish brown MEDIUM CLAY; strong polyhedral; basalt at depth visible.		5YR 4/4

Subject: Terranora Job number: GJ9737-1

Client: Terranora Group Management

Date: 25/11/97

SOIL TYPE

REPLAN KUROSOI /DERMOSOL

Depth NSL (m)	Horizon	Sample Description	pH 1:5	Colour
0.0 - 0.1	A1	Dull yellowish brown CLAY LOAM (CLFS); strong angular blocky.		10YR 4/3
0.1 - 0.3	B21	Bright brown LIGHT CLAY (LC); moderate (2-5mm) polyhedral.	4.67	7.5YR 5/6
0.3 - 0.6	B22	Reddish brown MEDIUM CLAY (MC); moderate (2-5mm) ployhedral.		5YR 4/6

Subject: Terranora Job number: GJ9737-1

Client: Terranora Group Management

Date: 25/11/97

SOIL TYPE

BRPWN KUROSOL/DERMOSQL

Horizon	Sample Description	1:5	Colour
A1	Dull yellowish brown CLAY LOAM (CLFS); strong angular blocky.		10YR 4/3
B21	Bright brown LIGHT CLAY (LC); moderate (2-5mm) polyhedral.	4.67	7.5YR 5/6
B22	Reddish brown MEDIUM CLAY (MC); moderate (2-5mm) ployhedral.		5YR 4/6
	A1	A1 Dull yellowish brown CLAY LOAM (CLFS); strong angular blocky. B21 Bright brown LIGHT CLAY (LC); moderate (2-5mm) polyhedral. B22 Reddish brown MEDIUM CLAY (MC);	B21 Bright brown LIGHT CLAY (LC); moderate (2-5mm) polyhedral. B22 Reddish brown MEDIUM CLAY (MC);

Subject: Terranora Job number: GJ9737-1

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Date: 25/11/97

SOIL TYPE

nple Description pH Colour	Horizon	Depth NSL (m)
I yellowish brown CLAY LOAM (CLFS); 10YR 4/3 ong angular blocky (2-10mm).	A1	0.0 - 0.15
ght brown LIGHT CLAY (LC); Moderate 4.85 7.5YR 5/6 mm polyhedral.	B21	0.15-0.30
ght reddish brown LIGHT_MEDIUM AY (LMC); moderate (2-5mm) lyhedral. 5YR 5/8	B22	0.30-0.60

Subject: Terranora Job number: GJ9737-1

Client: Terranora Group Management

Date: 25/11/97

SOIL TYPE

BROWN KUROSOLS/DERMOSOLS

Sample Description	1:5	Colour
Dull yellowish brown CLAY LOAM (CLFS); strong angular blocky (2-10mm).		10YR 4/3
Bright brown LIGHT CLAY (LC); Moderate 2-5mm polyhedral.	4.85	7.5YR 5/6
Bright reddish brown LIGHT_MEDIUM CLAY (LMC); moderate (2-5mm) polyhedral.		5YR 5/8
	Duli yellowish brown CLAY LOAM (CLFS); strong angular blocky (2-10mm). Bright brown LIGHT CLAY (LC); Moderate 2-5mm polyhedral. Bright reddish brown LIGHT_MEDIUM CLAY (LMC); moderate (2-5mm)	Duli yellowish brown CLAY LOAM (CLFS); strong angular blocky (2-10mm). Bright brown LIGHT CLAY (LC); Moderate 2-5mm polyhedral. Bright reddish brown LIGHT_MEDIUM CLAY (LMC); moderate (2-5mm)

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Date: 25/11/97

SOIL TYPE

BROWN DERMOSOL

Depth NSL (m)	Horizon	Sample Description	рН 1:5	Colour
0.0 - 0.2	A1	Brown CLAY LOAM (CL); strong angular blocky (2-5mm)		10YR 4/4
0.2 - 0.6 B2	B2	Bright brown CLAY LOAM (CLFS); Moderate to strong angular blocky (2-5mm)	5.32	7.5YR 5/6

Subject: Terranora Job number: GJ9737-1

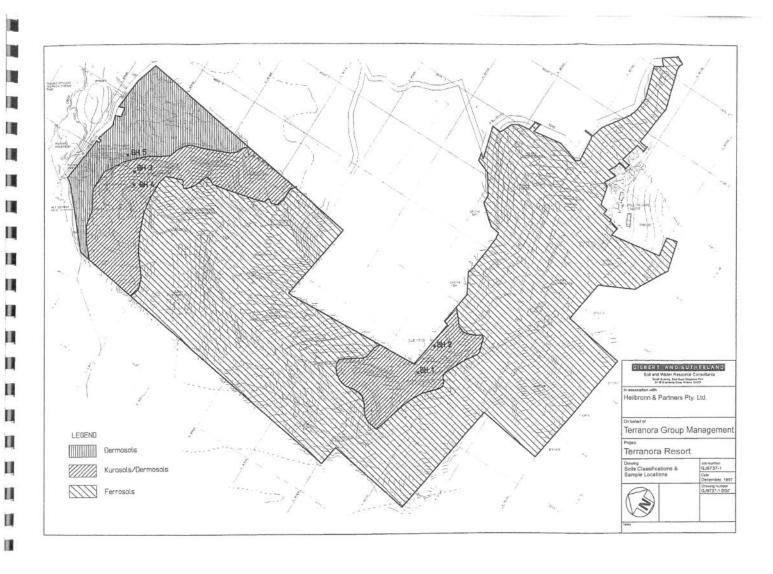
Client: Terranora Group Management

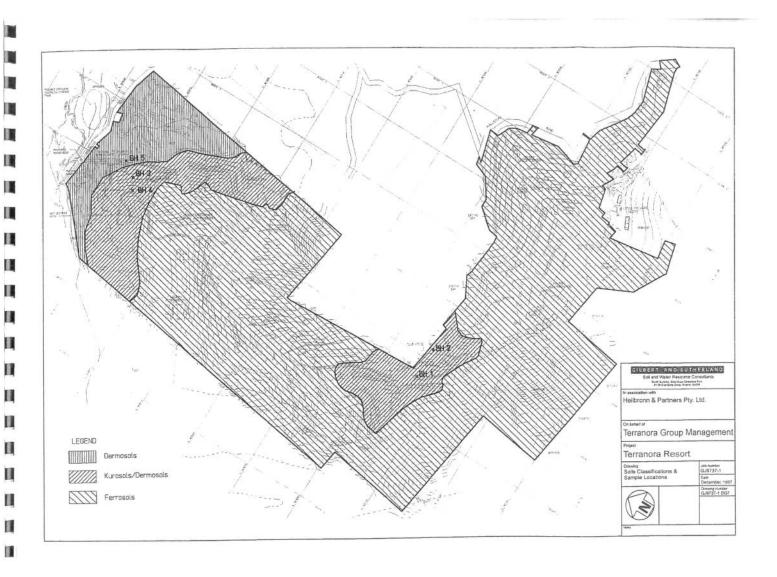
Date: 25/11/97

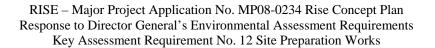
SOIL TYPE

BROWN DERMOSOL

Depth NSL (m)	Horizon	Sample Description	pH 1:5	Colour
0.0 – 0.2	A1	Brown CLAY LOAM (CL); strong angular blocky (2-5mm)		10YR 4/4
0.2 - 0.6	B2	Bright brown CLAY LOAM (CLFS); Moderate to strong angular blocky (2-5mm)	5.32	7.5YR 5/6

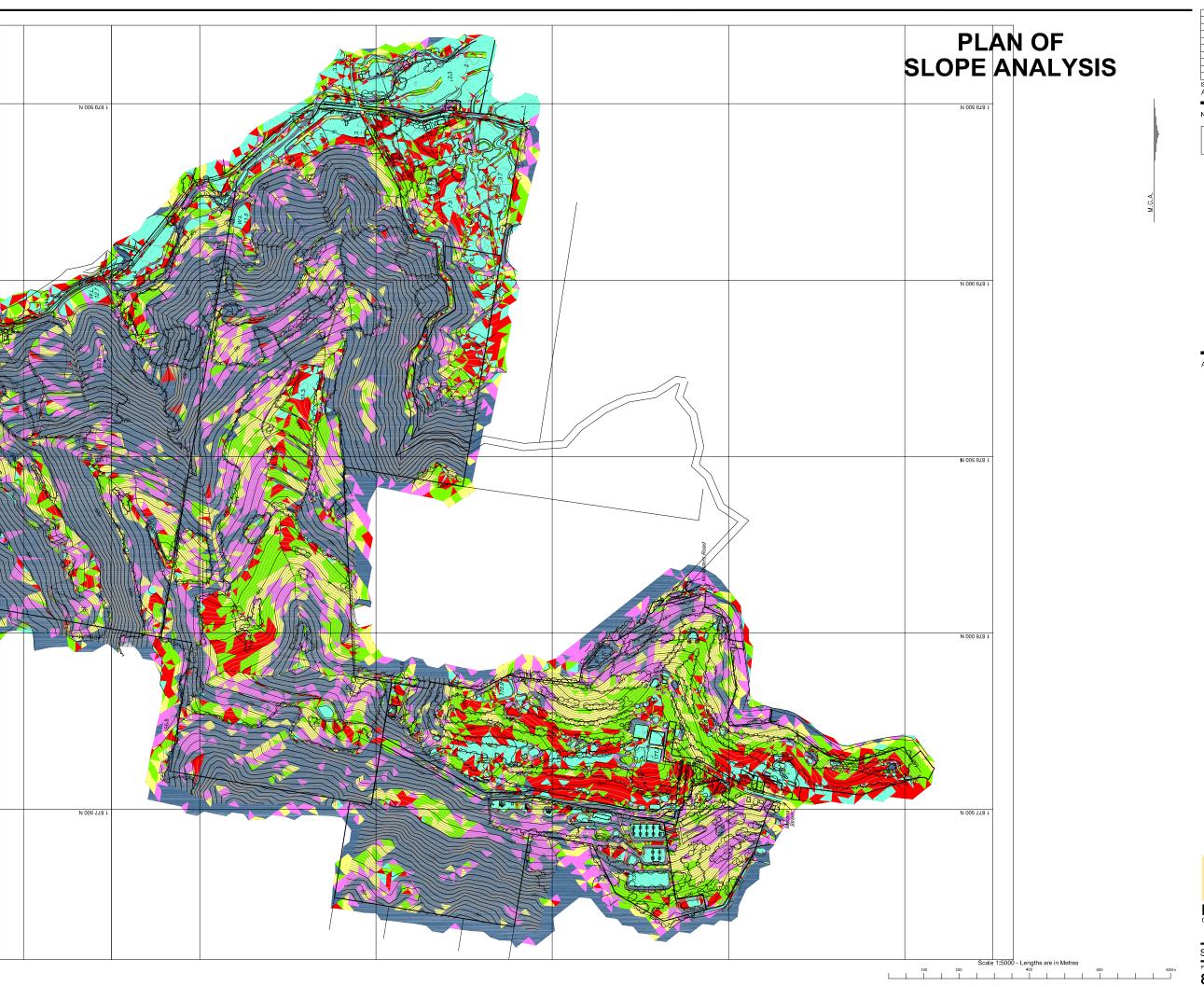








Slope Analysis Plan No. 8715-8 prepared by Michel Group Services





ISSUE AMENDMENTS

NOTES & DISCLAIMERS

Note. Boundaries & Contour detail from Brown & Pluthero Pty. L plan 10811A 1/11/1996. Photography date 28/6/1996.

Slope Legend

0% to 5%
5% to 10%
10% to 15%
15% to 20%
20% to 25%

ADDITIONAL INFORMATION





HYDROGRAPHIC SURVEYING
TOWN PLANNING SERVICES

23 Cotton Stree

Nerang QLD Australia 4211 lephone 07 5502 2500

061 750 132

SHEET NUMBER 1 OF 1

PLAN No. **8715-8**

ISSUE **B**

