GEO-LOGIC
LIMITED

Helen Bray

Geotechnical Stability Investigation
Two Building Sites, Coles Bay
Port Underwood

May 2002

ENGINEERING GEOLOGY & GEOTECHNICAL SERVICES

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This report is confidential and has been prepared solely for the benefit of Helen Bray, Smart Associates and the Marlborough District Council.

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This report must be reviewed for applicability in the event that any substantial modifications are made to the site or adjacent properties such that site conditions are changed substantially from current site conditions. Other time limitations may be imposed by regulatory authorities.

Contents

Attachments:
Site Plan - Sheet 1 (A3, reduced A4)
Hand Auger Boring Logs (2 Sheets)
Penetrometer Test Results (5 sheet)
Soil Terminology Description Sheet

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SECTION A: SYNOPSIS

1. Scope of Investigation

Geo-logic Ltd was requested to undertake a geotechnical site investigation of two undeveloped sections at Coles Bay in Port Underwood, Marlborough by the Project Engineer Smart Associates, on behalf of the owner Helen Bray. It appears that one of the sites is located within or near to a Natural Hazard Zone on Marlborough District Council (MDC) Resource Plan Map Sheet 4. The two sites, identified in our report as Sites "A" and "B", are located approximately 0.5 km apart being situated at the northern and southern extent of Coles Bay respectively (refer *Locality Plan*, Sheet 01). Our investigation was undertaken to identify stable building sites and develop appropriate engineering controls.

We reviewed geologic maps and reports of the site and vicinity. We then completed reconnaissance engineering geological mapping including detailed examination of both sites. Reconnaissance field mapping was completed on 25 October 2001 and other field work included loggings of existing track cut exposures, two hand auger borings (one per site) and Scala penetrometer testing on each site. Technical staff from Smart Associates accompanied us briefly on the site visit.

2. Summary and Conclusions

Areas indicated as *Suitable for Erection of a Residential Dwelling* have been identified for both Sites "A" and B". We consider the sites to be geotechnically suitable for the development of a residential structure provided it is located within the area identified on the *Site and Locality Plan*, Sheet 01. **Features shown on the *Site and Locality Plan*, Sheet 01, are in all cases approximately located relative to reference pegs established at the time of our field programme (one each at Site "A" and "B).** Survey of the reference pegs or position of features indicated has not been undertaken for our report. All conditions outlined below in **Section 3, *Recommendations*** must be fully implemented. All site developments must be overseen and approved by the project engineer or another qualified engineer.

3. Recommendations

In our professional opinion, not to be construed as a guarantee, giving due regard to land slope, geology, soil type and topography; the proposed site development is geotechnically feasible provided recommendations contained in this report are fully complied with consisting of:

3.1 Areas indicated as *Suitable for Erection of a Residential Dwelling* has been identified for Sites "A" and "B" as shown on the *Site Plan*, Sheet 1.

3.2 Access to the potential building sites appears geotechnically feasible for both sites. Set out and design of access by a qualified engineer will be required.

3.3 The siting of an appropriately designed and constructed effluent disposal system appears geotechnically feasible and must be carried out by a qualified engineer who must undertake the design and final positioning of any effluent disposal on both Sites "A" and "B".

3.4 In general earthworks excavations should be avoided or minimised and any excavations in excess of 0.8 m must be retained. All retaining walls must be designed and construction approved by a qualified engineer.

3.5 Limited soil testing to establish general foundation conditions was carried out with a hand auger and a Scala penetrometer. Test results are attached. A qualified engineer must undertake detailed foundation design. Areas of loose road spoil have been identified along the upper portions of both sites. Removal or remediation will be required to prevent these areas of creeping spoils from impacting on site developments within the designated building sites. Excavations for pole or other foundations must be observed, and confirmed as adequate by a qualified engineer.

3.6 Any spoils generated by earthworks within the building area must only be placed in an engineer-approved manner.

3.7 All collected stormwater runoff must be safely discharged well away from any building sites to the satisfaction of a qualified engineer.

3.8 All site developments are to be overseen and approved by the project engineer or another qualified engineer

SECTION B: REPORT

4. Introduction

Geo-logic Ltd was requested to undertake a geotechnical site investigation of two sections at Coles Bay in Port Underwood, Marlborough by the Project Engineer Smart Associates, on behalf of the owner Helen Bray. It appears that one of the sites is located within or near to a Natural Hazard Zone on Marlborough District Council (MDC) Resource Plan Map Sheet 4. The two sites, identified in our report as Sites "A" and "B", are located approximately 0.5 km apart being situated at the northern and southern extents of Coles Bay respectively (refer *Locality Plan*, Sheet 01). Our investigation was undertaken to identify a stable building sites and develop appropriate engineering controls. Both sections are undeveloped with Site "A" being located about 20 m below the Port Underwood Road and Site "B" located a similar distance above the Port Underwood Road and immediately adjacent (below) an access track. Some features of localised recent instability exist nearby (for Site "B") while features indicative of much older and apparently inactive large-scale slope failure exist (for Site "A). Our investigation was undertaken in terms of an IPENZ Agreement dated 4 October 2001.

5. Site Description and Geotechnical Setting

Both sites are covered in regenerating bush with large (0.9 m dia) "wilding" pines scattered (for Site "A") or nearby plantation pines and bracken (for Site "B") in evidence. Slopes across the sites are variable ranging from mild across Site "A" (15°, as measured in the field below horizontal) to moderate for Site "B" (32°) steepening moderately to sharply away from the identified stable building platforms (up to 50°).

For Site "A" the area identified as a suitable building site is located towards or within an area indicative of the headscarp of an apparently very old large landslide feature involving the northernmost end of Coles Bay. Site "B" is situated on the broad northeastern flank of a well developed northwest trending ridge.

Site "A" is located in the upper reaches of a broad area 100 or more metres wide indicative of a very old large-scale possibly multiple slope failure feature. No evidence of recent activity exists at the site, i.e. the somewhat irregular landform features are very subdued. For Site "B" localised, apparently shallow features of instability were observed to the northwest including along the road batter. For both site areas of unconsolidated "side cast" fill were observed associated with the existing tracks or roads. For Site "B" bedrock was observed with a consistent orientation above, below and to the east striking north-northeast, dipping steeply west (010; 68°W). No bedrock is exposed in the vicinity of Site "A". For both sites bedrock appears to exist within about 2 metres of the ground surface.

Soils are moderately thick (200 – 300 mm) on both sites with colluvium clays / weathered bedrock gravelly clay materials 2 or more metres thick at Site "A" and 1 to 2 m at Site "B". Within the potential building sites bedrock / and or competent ground was encountered in hand-auger and Scala tests at depths of about 2 metres for both sites.

Originally mapped to be underlain by Chlorite Schist of the Marlborough Schist Formation, Subzone II (Beck, 1964) the geology has been redefined as poorly bedded grey to greenish grey sandstone / siltstone and semi-schist of the Arapawa Lithologic Association, which is Late Jurassic in age (Begg and Johnston, 2000). The orientation of apparent bedding or primary schistosity measured at several locations is typically North-Northeast; dipping steeply beneath the site to the west. The dip of mapped schistosity differs from the more recent mapping (Begg and Johnston, 2000) possibly reflecting bedding orientation along the foreshore well below both sites which was not inspected for this investigation.

No active faults, i.e. those with confirmed movement during the past 125,000 years, are known to traverse the property and the nearest mapped trace of an approximately located NE trending inactive fault is 1 km to the NE. The active Wairau fault is located 25 km to the south (Begg and Johnston, 2000).

6. Geotechnical Investigations

We reviewed geologic maps and reports of the site and vicinity. We then completed reconnaissance engineering geological mapping of the areas indicated to us as potential building sites by a representative from Smart Associates. These areas appear to correlate with sites on a supplied plan portion prepared by others as "*existing approved building site*" in the north (for Site "A") and as "*proposed building site to be assessed by a registered engineer*" in the south (for Site "B"). We were unable to confirm a correlation, if any, in the absence of surveyed location of reference pegs established as a part of our site investigations. All site testing and building site designations presented in this report are relative to the location of these pegs which have not, to our knowledge, yet been surveyed. Previous site designations by others are shown on the *Locality Plan*, Sheet 01 sourced from a portion of a plan provided dated 16 April 1998, amended 22 May 2001 (reference 4126). Available geological maps and reports we reviewed consisted of Beck, 1964 and Begg and Johnston, 2000.

Reconnaissance field mapping was completed on 25 October 2001 and included logs of existing track and road cut exposures (for Site "B"), two hand auger bores to a maximum depth of 2.0 m (one each at Sites "A" and "B"), and five Scala penetrometer tests to a maximum depth of 1.9 m (two at Site "A" and three at Site "B"). Tests were terminated at competent ground or refusal on apparent bedrock. No survey pegs were observed during the course of our investigation. **Features shown on the *Site and Locality Plan*, Sheet 01, are in all cases approximately located relative to reference pegs established at the time of our field programme (one each at Site "A" and "B).** Survey of the reference pegs or position of features indicated has not been undertaken for our report.

The logs, which are appended to this report, indicates conditions on the date of exploration and may not represent conditions at other location and on other dates. Water levels and/or moisture content where shown are subject to variation. Stratification lines or depth intervals indicate approximate boundaries between material types and the transitions may be gradual unless otherwise indicated. Soil classifications shown are field classifications based on the Unified Soils Classification System (see attached sheet - Soil Exploration Log Terminology).

7. Geotechnical Assessment

7.1 Site Stability

<u>Site "A"</u>
The designated building site appears to be situated within or adjacent to the headscarp area of a large, very old, possible multiple slope failure extending between the foreshore and the Port Underwood Road. Features, which may represent "geologically recent" slope instability, estimated to be 1,000 or more years in age, are evident when viewed from across Coles Bay. A variety of ground slopes, including unusually oriented ridges and associated spurs supports this interpretation. We were unable to source suitable stereo-paired aerial photos of the area, which could help to confirm this interpretation. All features are subdued, confirming they are of considerable age, and no features of recent instability were observed. The site is considered to be stable at present.

Site "B"

An area exhibiting widespread, apparently shallow instability exists to the northwest of the identified building site. A batter failure several metres in height extends adjacent to the road towards the base of this area as indicated on *Site Plan "B"*, Sheet 01. The orientation of bedrock dips into the hillside, roughly perpendicular to the trend of the ridge. Outcrops of bedrock observed to the north, west and south of the designated building site reflect a consistent orientation (refer Sheet 01). No indications of instability were observed within or below the identified building site which is effectively protected from runoff by the existing access track above it.

7.2 Building Sites

Areas indicated as *Suitable for Erection of a Residential Dwelling* have been identified as shown on the *Site Plan*, Sheet 01 for both Sites "A" and "B". Localised areas of loose road spoil exist along the upper perimeter of both sites. Removal or remediation will be required to prevent these area of creeping spoils from impacting on site developments within the designated building sites.

7.3 Building Site Access

Access to the potential building sites appears geotechnically feasible for both sites. For Site "A" an existing 2 metre wide track provides limited access to the designated building site. It traverses a minor area of loose spoil and has locally been undermined by minor slumping. Set out and design of access by a qualified engineer will be required. For Site "B" access from the existing track along the upper perimeter should enable site access. Slopes steepen towards the lower portion of the site. Set out and design of access by a qualified engineer will be required.

7.4 Effluent Disposal

Soils and underlying silty clay colluvium/weathered bedrock of about 1 m appears to exist across much of the sites. Slopes are variable on both sites and no effluent shall be discharged to the steep slopes east of Site "A" or the 'unstable area' to the northwest of Site "B". The siting of an appropriately designed and constructed effluent disposal system appears geotechnically feasible and must be carried out by a qualified.

7.5 Excavations and Retaining Walls

In general earthworks excavations should be avoided or minimised and any excavations in excess of 0.8 m must be retained. All retaining walls must be designed and construction approved by a qualified engineer. Any spoils generated by earthworks within the building area must only be placed in an engineer-approved manner.

7.6 Foundation Design

We carried out limited soil testing to establish general foundation conditions using a hand auger and Scala penetrometer. Test results are attached. Our services have not included detailed foundation design, which should be undertaken by a qualified engineer. Areas of loose road spoil

have been identified along the upper portions of both sites. Removal or remediation will be required to prevent these area of creeping spoils from impacting on site developments within the designated building sites. Excavations for pole or other foundations must be observed, and confirmed as adequate by a qualified engineer

7.7 Stormwater Control

All collected stormwater runoff must be safely discharged well away from any building sites to the satisfaction of a qualified engineer. Soils are moderately erodible and easily impacted where slopes are moderate to steep.

7.8 Earthquake Hazard

While no active faults are within the property it can expect, along with the remainder of the Marlborough Sounds, moderate to strong ground shaking originating from distant earthquakes. No significant amplification of ground shaking is anticipated within the potential building site during earthquakes that may affect the Marlborough area. Earthquake ground shaking of MMVII or greater on the Modified Mercalli Scale can be anticipated on average every 25 years (Johnston *et al.* 1993).

7.9 Geotechnical Site Suitability

We consider the sites to be geotechnically suitable for the development of residential structures provided developments are located within the areas identified as *Suitable for Erection of Residential Dwelling* on the *Site and Location Plan*, Sheet 01. All conditions outlined below in **Section 9, *Control Measures*** must be fully implemented. All site developments must be overseen and approved by the project engineer or another qualified engineer.

8. Development Impact

In our professional opinion, not to be construed as a guarantee, giving due regard to land slope, geology, soil type and topography; the proposed site development is geotechnically feasible provided recommendations contained in this report are fully complied with.

9. Control Measures

9.1 Areas indicated as *Suitable for Erection of a Residential Dwelling* has been identified for Sites "A" and "B" as shown on the *Site Plan*, Sheet 1.

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9.8 All site developments are to be overseen and approved by the project engineer or another qualified engineer.

10. Management Plans

Provided the recommendations contained in this report are fully complied with no additional management plans are recommended.

11. References

BECK, A C 1964: Sheet 14 - Marlborough Sounds, Geological Map of New Zealand, 1:250,000. NZ Department of Scientific and Industrial Research, Wellington.

BEGG, J G and JOHNSTON, M R 2000: Geology of Wellington Region, Institute of Geological and Nuclear Sciences 1:250 000 Geological map 10. Lower Hutt New Zealand.

JOHNSTON, M R; HULL, A G AND DOWNES, G L, 1993: Earthquake, Landslide and Coastal Hazards in Nelson City. Report prepared by the Institute of Geological and Nuclear Sciences for the Nelson City Council.

SECTION C SITE PLAN

12. Site Plan

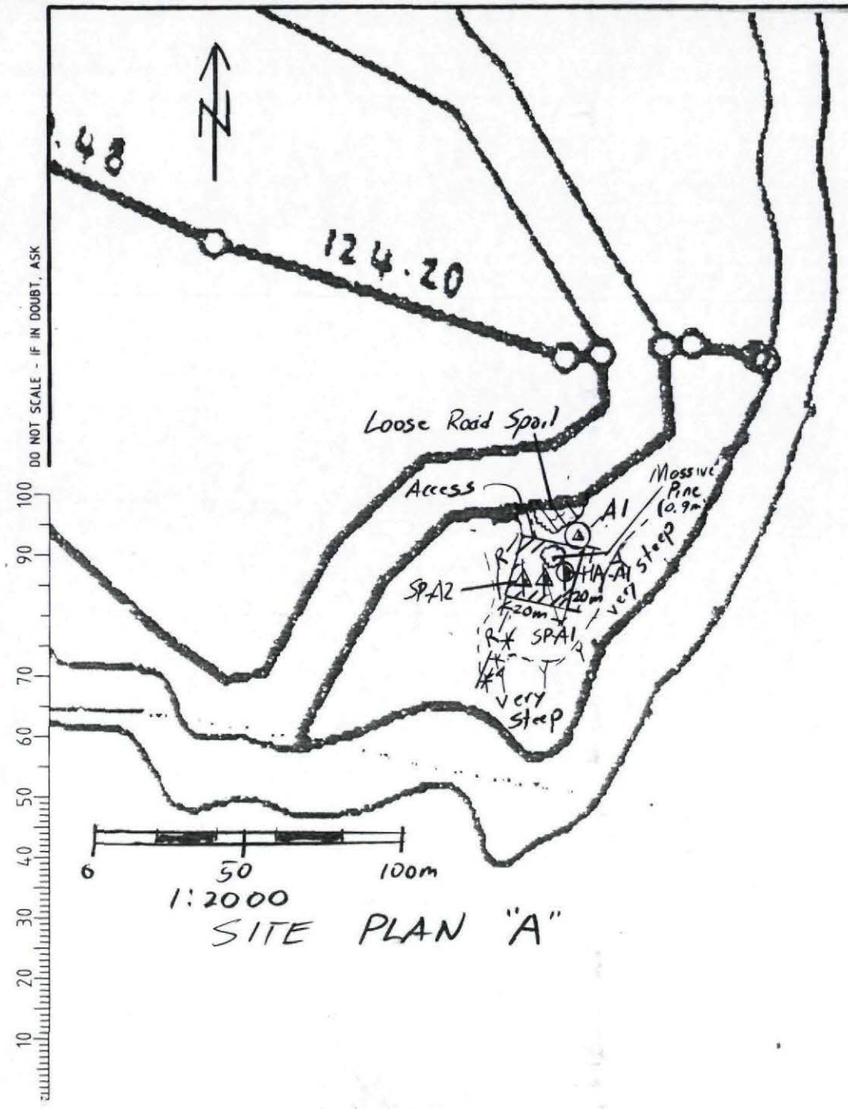
Refer attached Site Plan, Sheet 1

13. Detail Plans

There are no detail plans attached to this report.

DO NOT SCALE - IF IN DOUBT, ASK

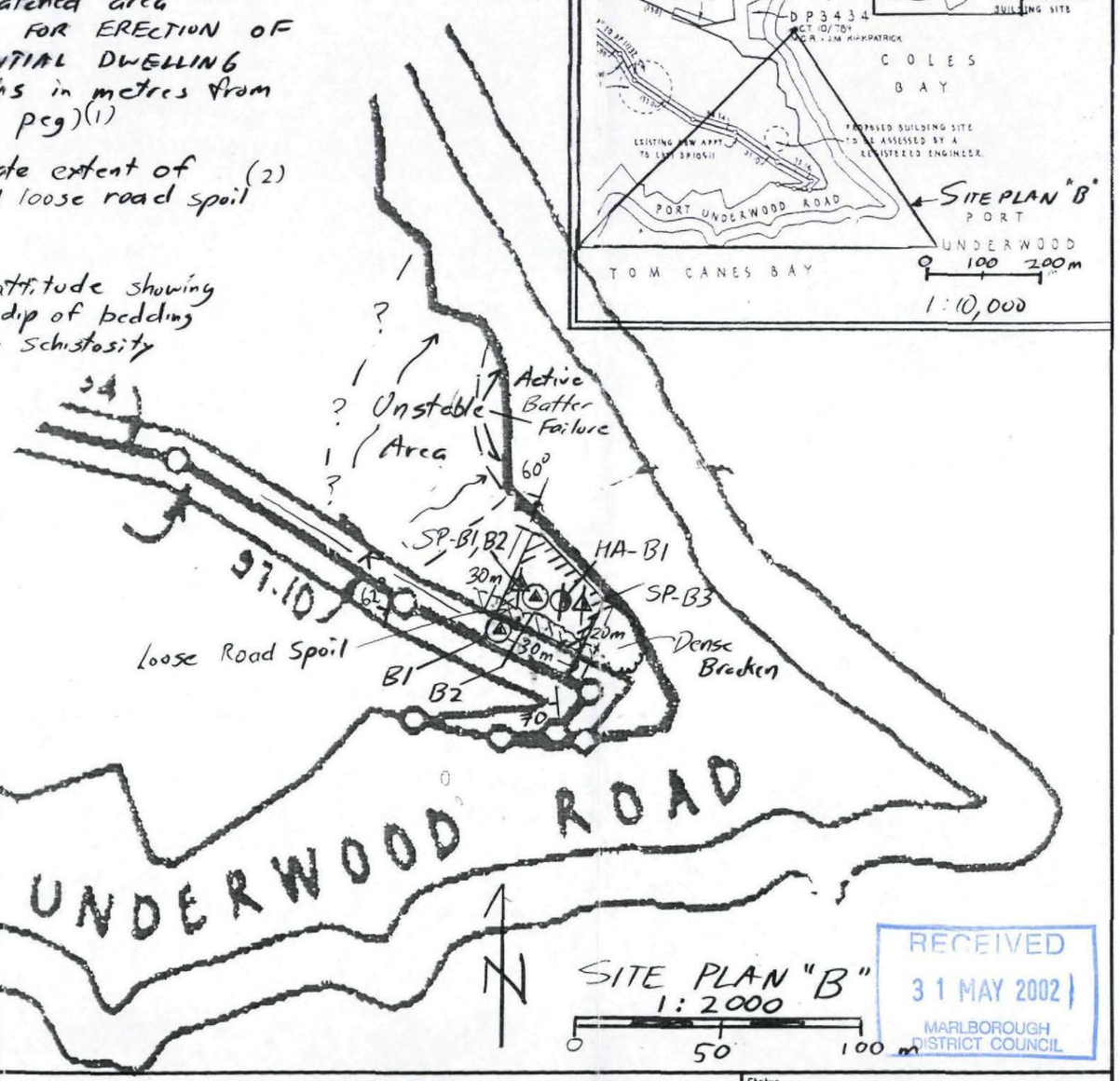
ORIGINAL SIZE A3

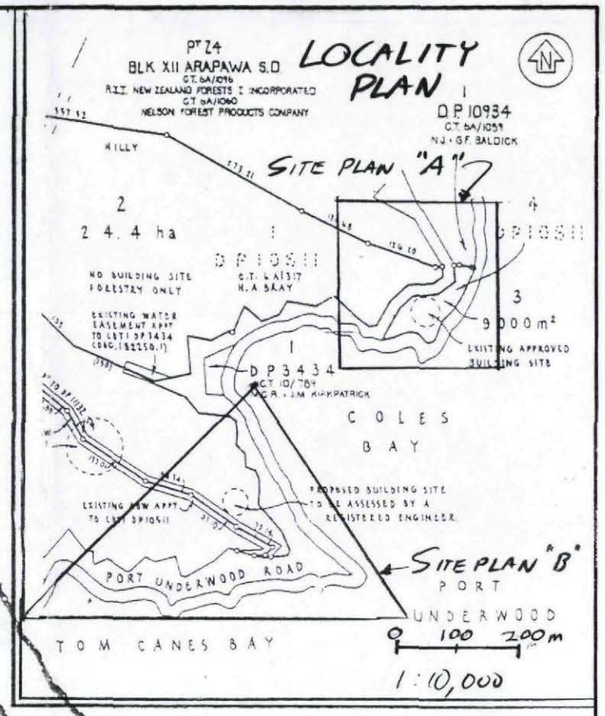


SITE PLAN "A"

LEGEND

- B2 — VERY APPROXIMATE location of reference peg (1)
- HA-B1 — Approximate location hand auger test
- SP-B3 — Approximate location Scala test
- R — Ridge feature
- 30m — Cross hatched area SUITABLE FOR ERECTION OF RESIDENTIAL DWELLING (Dimensions in metres from reference peg)(1)
- Approximate extent of confirmed loose road spoil (2)
- Fence
- 70 — Bedrock attitude showing strike and dip of bedding or primary schistosity





NOTES:
1) No surveying has yet been undertaken to locate pegs used to reference stable building platform areas and associated testing
2) Other areas of loose road spoil may exist elsewhere

Basemap Reference: Survey Plan forwarded by Smart Associates dated 16 April 1998 amended 22 May 2001 (Job ref 4126)

RECEIVED
31 MAY 2002
MARLBOROUGH DISTRICT COUNCIL

REV	AMENDMENTS	DATE	INIT

	BY	DATE
SCALES 1:10,000 / 1:2,000		
FIELDBOOK		
SURVEYED		
DESIGNED		
DRAWN	P Deaton	5/02
APPROVED		

GEO-LOGIC LIMITED

Helen Bray
Geotechnical Stability Assessment - Two Building Sites
Coles Bay, Port Underwood, MARLBOROUGH
SITE AND LOCALITY PLANS

Status: CONCEPTUAL
Date: 17 May 2002
Job No.: 61050
Sheet No.: 01
Rev.:

LEGEND

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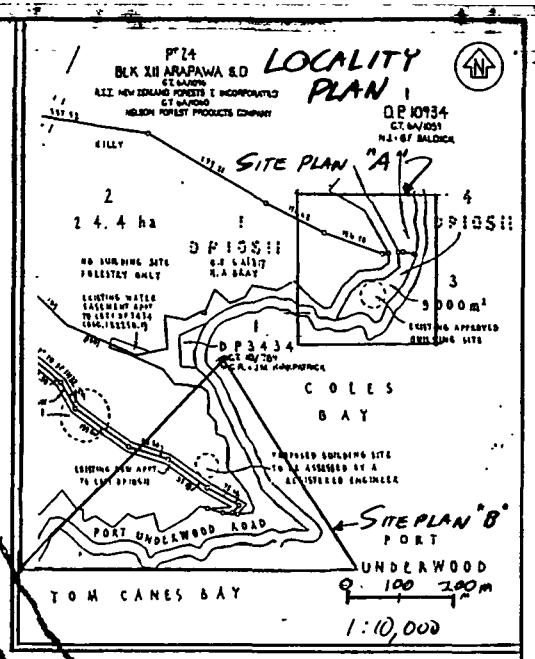
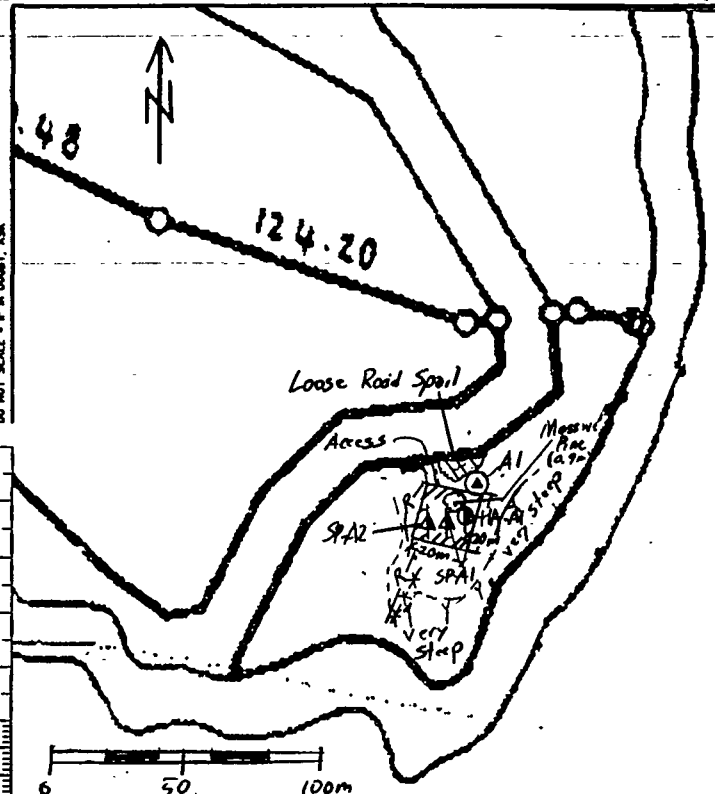
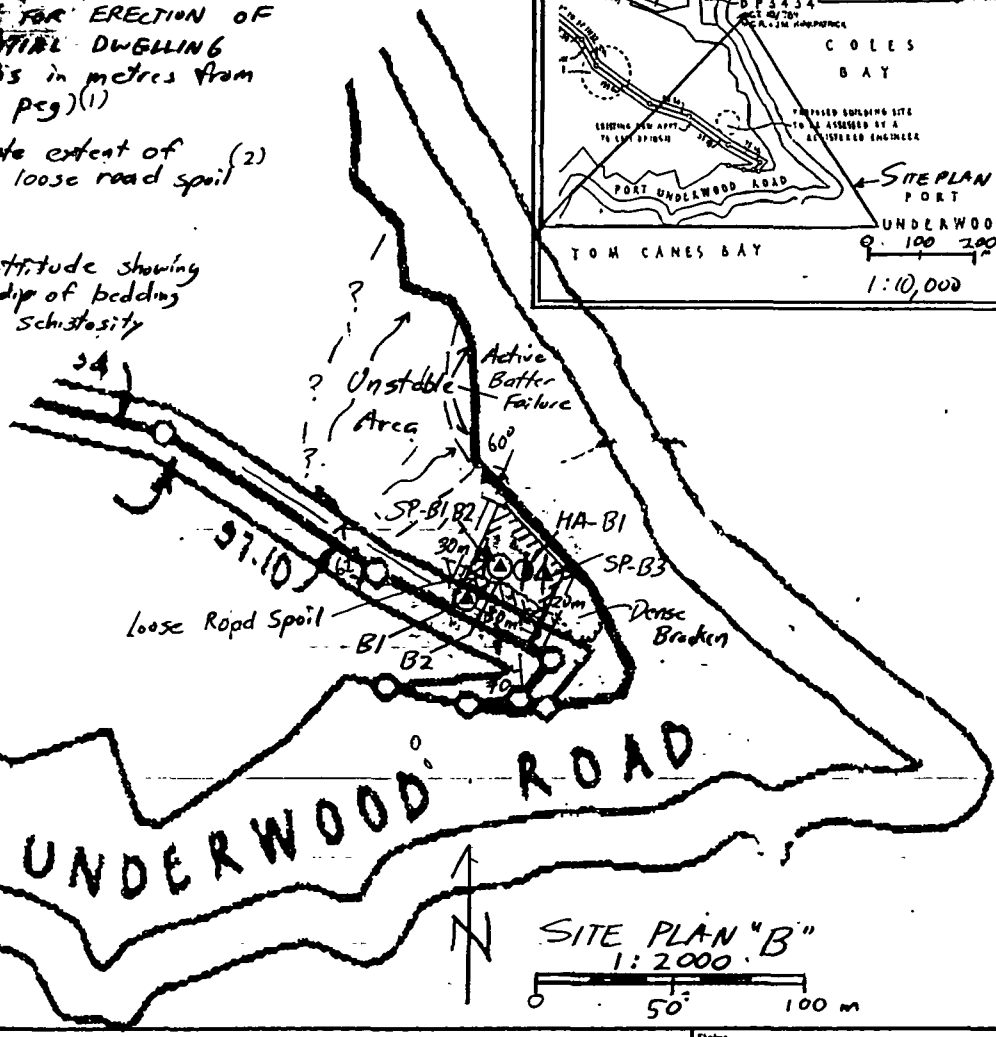
- HA-B1 — Approximate location hand auger test
- SP-B3 — Approximate location Scala test
- R — Ridge feature
- 30m — Cross hatched area SUITABLE FOR ERECTION OF RESIDENTIAL DWELLING (Dimensions in metres from reference peg) (1)
- Approximate extent of confirmed loose road spoil (2)
- Fence
- 70 — Bedrock attitude showing strike and dip of bedding or primary schistosity







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2) Other areas of loose road spoil may exist elsewhere

Basemap Reference: Survey Plan forwarded by Smart Associates dated 16 April 1998 amended 22 May 2001 (Job ref 4126)

REV	AMENDMENTS	DATE	INIT

SCALES 1:10,000 / 1:2,000
FIELDBOOK

	BY	DATE
SURVEYED		
DESIGNED		
DRAWN	PD	5/02
APPROVED		

GEO-LOGIC LIMITED

Helen Bray
Geotechnical Stability Assessment - Two Building Sites
Coles Bay, Port Underwood, MARLBOROUGH
SITE AND LOCALITY PLANS

Status: CONCEPTUAL
Date: 17 May 2002
Job No. 61050
Sheet No. 01
Rev.

"A" Site; HA-A1

Project Number	G1050	Drill Rig	Hand Auger
Geologist	PC Denton	Ground Elevation	—
Date Drilled	25 Oct 01	Total Depth of Borehole	2.0m
Borehole Diameter	70mm	Depth to Water	Groundwater NOT encountered

Graphic Log	Description	Depth	Sample	SP-A1	SP-A2		Completion
	TOPSOIL 0.0-0.3 BROWNISH GRAY SILTY CLAY: damp; mod plastic; organics; firm						
	COLLUVIUM/WEATHERED BEDROCK (Marlborough Schist/Awapawa Lithologic Assoc) 0.3-2.0 YELLOW BROWN CLAY: damp; mod to mod low plasticity; firm to stiff			0.46			
	0.4 slightly damp; crumbly and stiffer below 0.4						
	0.9 becoming drier	1.0					
	1.4 greenish gray sandstone fragments						
	1.9 harder and crumbly below 1.9				1.92		
	Bottom of Boring 2.0m	2.0					

"B" Site ; HA-B1

Project Number	G1050	Drill Rig	Hand Auger
Geologist	P C Denton	Ground Elevation	–
Date Drilled	23 October 2001	Total Depth of Borehole	1.1 m
Borehole Diameter	70 mm	Depth to Water	Groundwater NOT encountered

Graphic Log	Description	Depth	Sample	SP-B1	SP-B2		Completion
CL	TOPSOIL 0.0-0.2 BROWN SILTY CLAY; damp; moderate plasticity; roots & rootlets; firm COLLUVIUM/ WEATHERED BEDROCK (Marlborough Schist/Arapawa Lithologic Assoc) 0.2-1.1 YELLOW BROWN SILTY CLAY; damp; mod to mod low plasticity; crumbly; variably stiff to firm 0.5 becoming drier 0.8 becoming moist 0.9 increasingly stiff below 0.9 1.0 becoming drier below 1.0, very stiff to refusal on APPARENT BEDROCK	1.0		0.9			
	Bottom of Boring 1.1 m	2.0			1.1		

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Page

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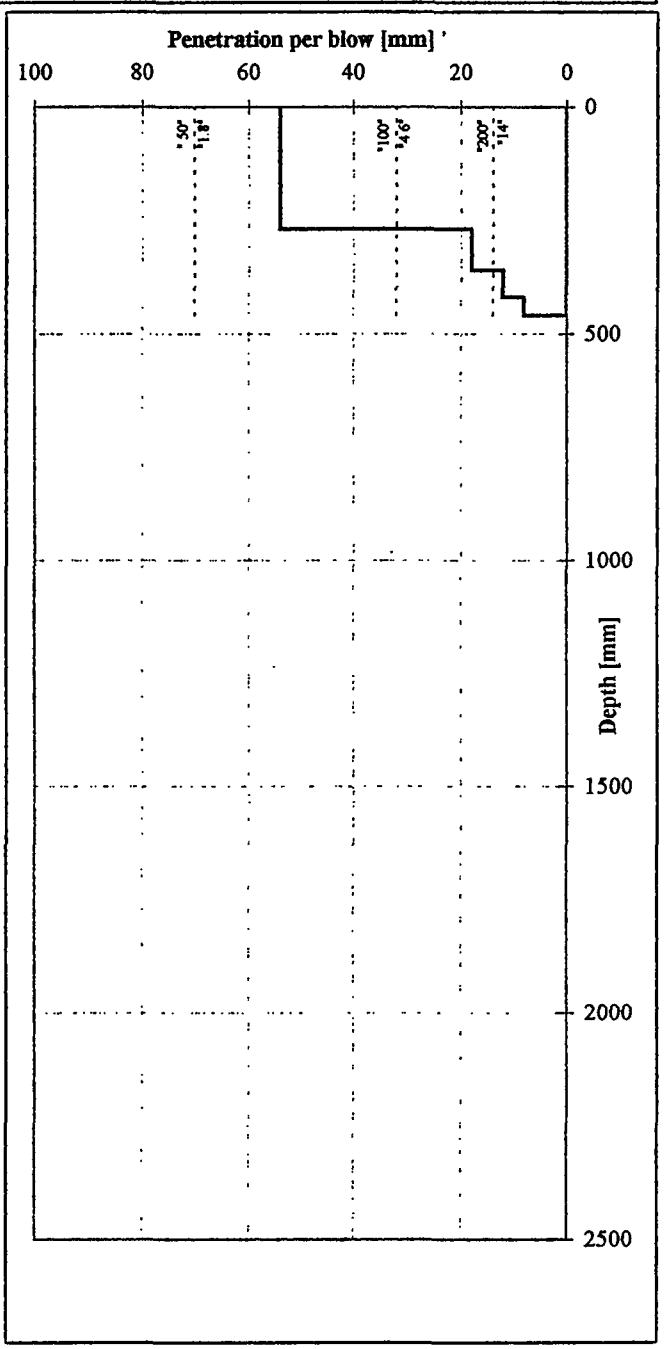
JOB	H Bray				
LOCATION	Coles Bay, Port Underwood, MARLBOROUGH				
WEATHER	Fine				
BY:	PCD	DATE:	Thu 25 Oct 2001	FILE:	G1050

SCALA PENETROMETER TESTS

TEST: SP - A1 *Refer to SITE PLAN for location* G

No. blows	Depth [mm]	SP - A1 Penetration per blow [mm]	Comments
5	270	54.0	Site "A"
5	360	18.0	
5	420	12.0	
5	460	8.0	Refusal on rock or roots
5			roots
5			
5			
5			
5			
5			
5			
5			
5			
5			
5			
5			

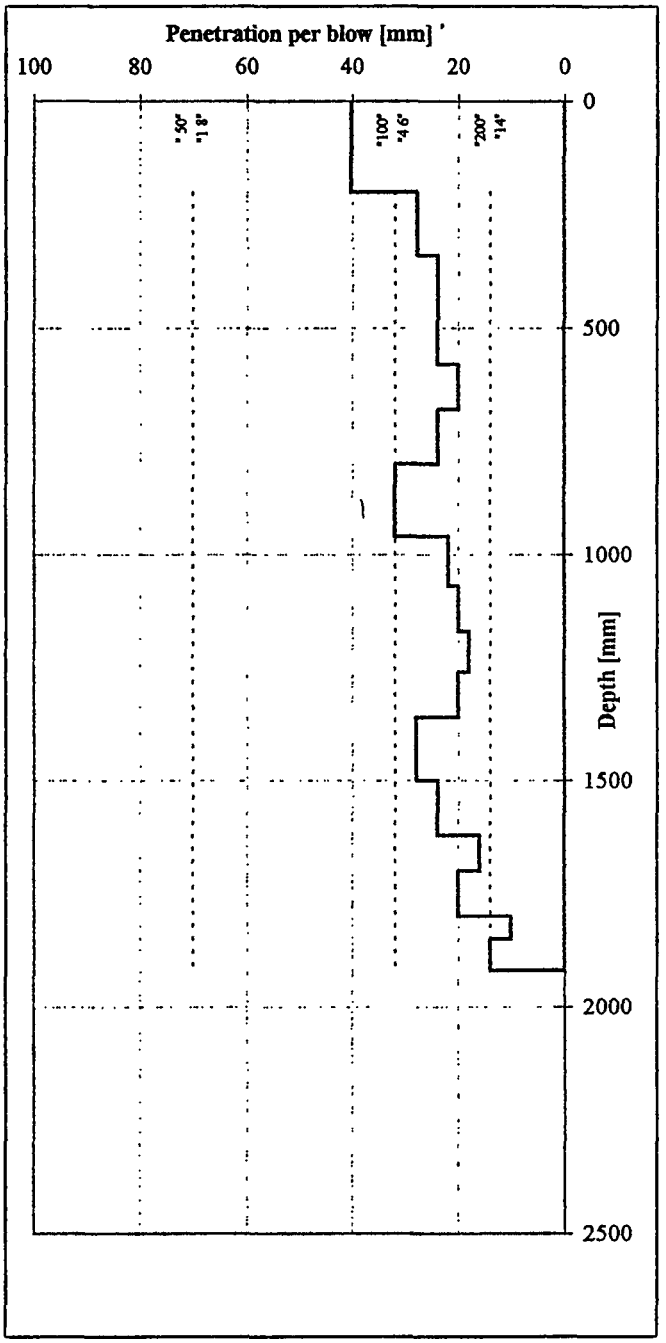


JOB	H Bray				
LOCATION	Coles Bay, Port Underwood, MARLBOROUGH				
WEATHER	Fine				
BY:	PCD	DATE:	Thu 25 Oct 2001	FILE:	G1050

SCALA PENETROMETER TESTS

TEST: SP - A2 *Refer to SITE PLAN for location* G

No. blows	Depth [mm]	SP - A2 Penetration per blow [mm]	Comments
5	201	40.2	Site "A"
5	340	27.8	
5	460	24.0	
5	580	24.0	
5	680	20.0	
5	800	24.0	
5	960	32.0	
5	1070	22.0	
5	1170	20.0	
5	1260	18.0	
5	1360	20.0	
5	1500	28.0	
5	1620	24.0	
5	1700	16.0	
5	1800	20.0	
5	1850	10.0	
5	1920	14.0	Dry yellow rock "flour"
			"flour" on tip

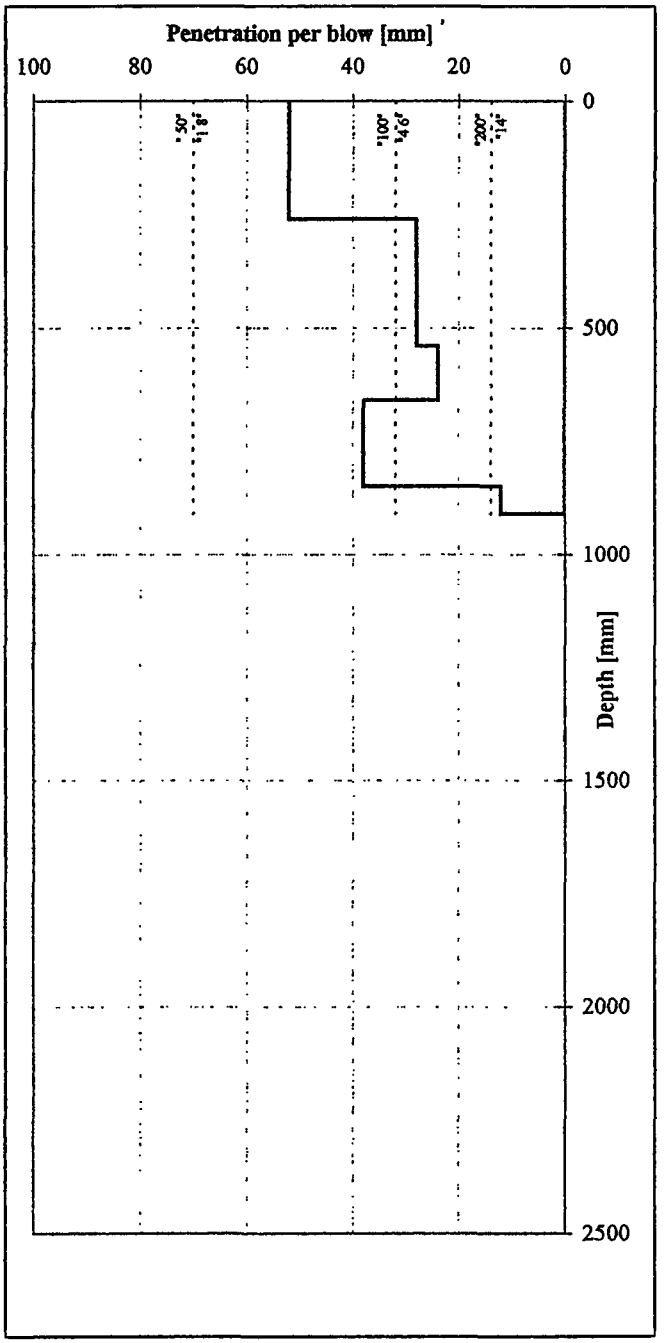


JOB	H Bray				
LOCATION	Coles Bay, Port Underwood, MARLBOROUGH				
WEATHER	Fine				
BY:	PCD	DATE:	Thu 25 Oct 2001	FILE:	G1050

SCALA PENETROMETER TESTS

TEST: SP - B1 *Refer to SITE PLAN for location* G

No. blows	Depth [mm]	SP - B1 Penetration per blow [mm]	Comments
5	260	52.0	Site "B"
5	400	28.0	
5	540	28.0	
5	660	24.0	
5	850	38.0	
5	910	12.0	

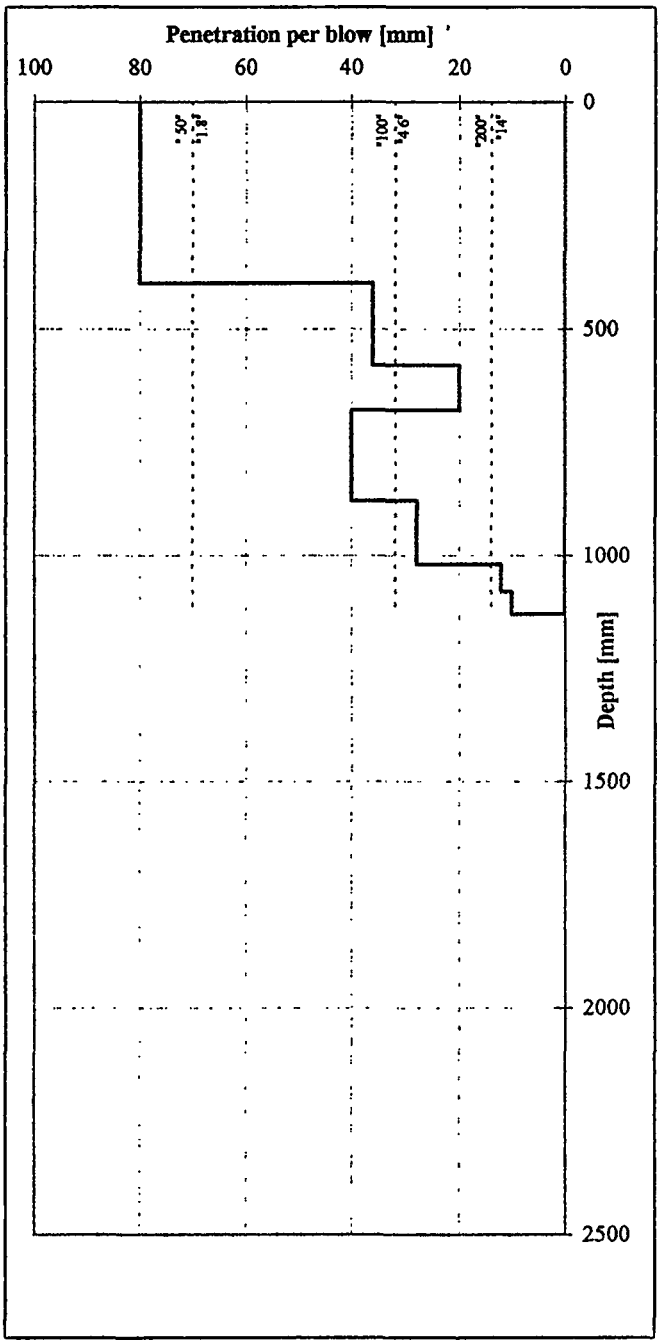


JOB	H Bray				
LOCATION	Coles Bay, Port Underwood, MARLBOROUGH				
WEATHER	Fine				
BY:	PCD	DATE:	Thu 25 Oct 2001	FILE:	G1050

SCALA PENETROMETER TESTS

TEST: SP - B2 *Refer to SITE PLAN for location* G

No. blows	Depth [mm]	SP - B2 Penetration per blow [mm]	Comments
5	400	80.0	Site "B"
5	580	36.0	
5	680	20.0	
5	880	40.0	
5	1020	28.0	
5	1080	12.0	
5	1130	10.0	"refusal"



JOB	H Bray				
LOCATION	Coles Bay, Port Underwood, MARLBOROUGH				
WEATHER	Fine				
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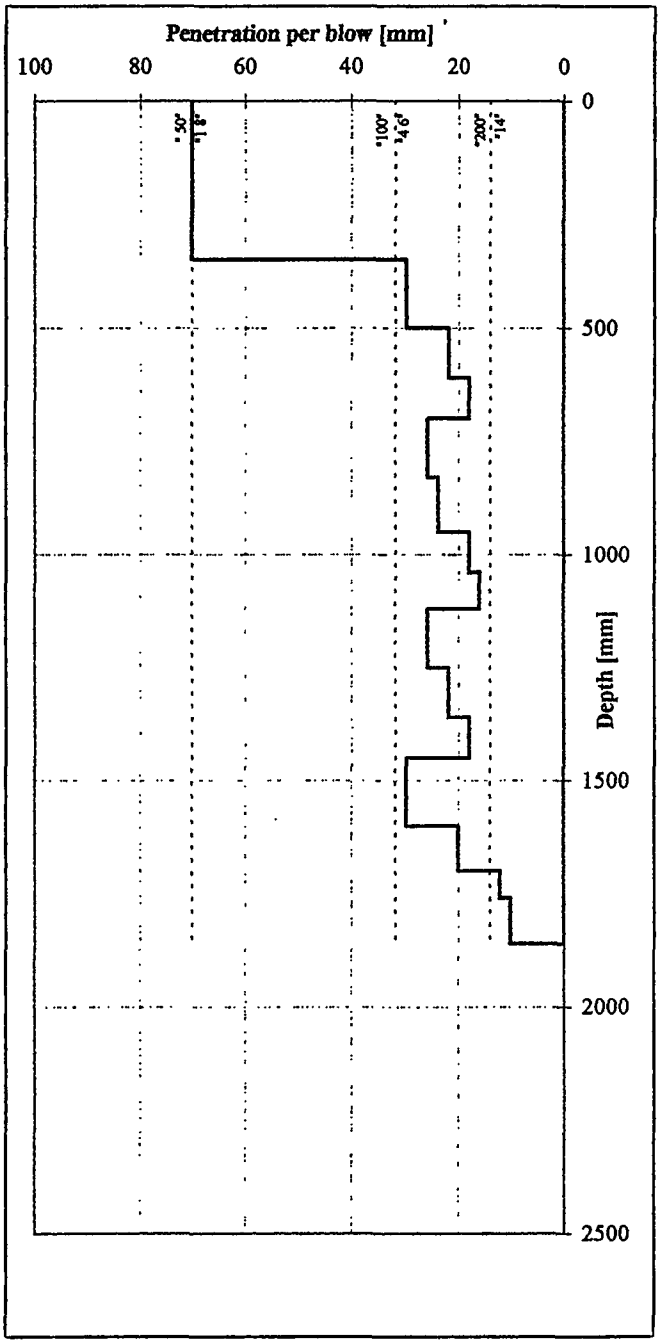
SCALA PENETROMETER TESTS

TEST: SP - B3 *Refer to SITE PLAN for location* G

No. blows	Depth [mm]	SP - B3 Penetration per blow [mm]	Comments
5	350	70.0	Site "B"
5	500	30.0	
5	610	22.0	
5	700	18.0	
5	830	26.0	
5	950	24.0	
5	1040	18.0	
5	1120	16.0	
5	1250	26.0	
5	1360	22.0	
5	1450	18.0	
5	1600	30.0	
5	1700	20.0	
5	1760	12.0	
5	1810	10.0	
5	1860	10.0	"refusal"



UNIFIED SOIL CLASSIFICATION

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3 inches and basing fractions on estimated weights)							GROUP SYMBOLS [1]	TYPICAL NAMES
COARSE GRAINED SOILS More than half of material is larger than No. 200 sieve size [2] (The No. 200 sieve size is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than No 4 sieve size. (For visual classifications, the ¼" size may be used as equivalent to the No. 4 sieve size)	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.				GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.				GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).				GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).				GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.
	SANDS More than half of coarse fraction is smaller than No 4 sieve size.	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.				SW	Well graded sands, gravelly sands; little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.				SP	Poorly graded sands, gravelly sands; little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).				SM	Silty sands, poorly graded sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).				SC	Clayey sands, poorly graded sand-clay mixtures.
FINE GRAINED SOILS More than half of material is smaller than No. 200 sieve size. (The No. 200 sieve size is about the smallest particle visible to the naked eye)	IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No. 40 SIEVE SIZE		DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)			
	SILTS AND CLAYS Liquid limit less than 50		None to slight	Quick to slow	None		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity.
			Medium to high	None to very slow	Medium		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			Slight to medium	Slow	Slight		OL	Organic silts and organic silt-clays of low plasticity.
	SILTS AND CLAYS Liquid limit greater than 50		Slight to medium	Slow to none	Slight to medium		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			High to very high	None	High		CH	Inorganic clays of high plasticity, fat clays.
			Medium to high	None to very slow	Slight to medium		OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS			Readily identified by color, odor, spongy feel and frequently by fibrous texture.				Pt	Peat and other highly organic soils.

Reference: Figure 7, Unified Soil Classification Chart (drawing 103-D-347), **Earth Manual**; US Department of the Interior, 1974

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TERMINOLOGY FOR DESCRIPTION OF SOILS IN THE FIELD

1. SOIL NAME

For coarse grained soils (>65% sand and gravel) the soil name is based on the particle sizes present. For fine grained soils (>35% silt and clay sizes) it is based on behavioural characteristics on remoulding.

Particle sizes

boulders		>200 mm	very coarse gravel		60-200 mm
gravel	coarse	20-60 mm	sand	coarse	0.6 -2.0 mm
	medium	6-20 mm		medium	0.2 -0.6 mm
	fine	2- 6 mm		fine	0.06-0.2 mm
silt		2-60μ	clay		<2μ

Proportions

	TERM	% OF SOIL MASS	EXAMPLE
SUBORDINATE FRACTION	(....)Y	20 - 50	SANDY
MAJOR FRACTION	... - ...	35 - 50	SAND - GRAVEL
	...	major constituent	GRAVEL
MINOR FRACTION	with trace of	<5	with trace of sand
	with minor	5 - 12	with minor sand
	with some	12 - 20	with some sand

Fine grained soils are silt (M) or clay (C) based on whether they plot below or above the A-line on a Casagrande chart. The boundry between 'lean' (L) or 'fat' (H) for either a silt or clay is at a liquid limit of 50 eg CL MH.

2. STRENGTH

a) Fine-grained soils (cohesive)

TERM	DIAGNOSTIC FEATURES	UNDRAINED COMPRESSIVE STRENGTH (kPa)
Very soft	Exudes between fingers when squeezed	< 25
Soft	Easily indented by fingers	25 - 50
Firm	Indented only by strong finger pressure	50 - 100
Stiff	Indented by thumb pressure	100 - 200
Very stiff	Indented by thumbnail	200 - 400
Hard	Difficult to indent by thumbnail	400 - 1000

b) Coarse-grained soils

A visual assessment is based on

Loosely packed - can be removed from exposure by hand or removed easily by shovel.

Tightly packed - requires pick for removal, either as lumps or as disaggregated material.

3. MOISTURE CONDITION

Dry - Soil looks and feels dry; cohesive soils usually hard, powdery or friable while granular soils run freely through hands.

Moist - Soil feels cool, darkened in colour; granular soils tend to cohere while cohesive soils usually weakened by moisture presence, but one gets no free water on hands when remoulding.

Wet - Soil feels cool, darkened in colour, granular soils tend to cohere, while cohesive soils usually weakened and free water forms on hands when handling.

Saturated - Soil feels cool, darkened in colour and free water is present on the sample. Fully saturated refers to the case where the soil is below the water table.

4. PLASTICITY

Plasticity of clays and silts is determined from the results of Atterberg limit tests. In the field the characteristics of fine grained soils are identified using dilatancy (reaction to shaking), dry strength (crushing) and toughness (consistency near the plastic limit) behaviour - see USBR chart. The most characteristic test of plasticity in a soil is dilatancy where on rapid shaking water appears and similar shaking gives no reaction for a plastic soil.

5. GRADING QUALIFICATIONS

The grading of gravels and sands may be qualified in the field as well graded (ie. good representation of all particle sizes from largest to smallest) or poorly graded. Poorly graded materials may be further divided into uniformly graded (ie. most particles about the same size) and gap graded (ie. absence of one or more intermediate sizes).

6. WEATHERING

Weathering of soils is more relevant to coarse grained soils and where weathering does not have an influence on the properties of a soil the term may be omitted.

7. BEDDING

Bedding Inclination Terms

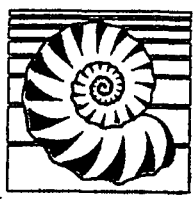
TERM	INCLINATION (from the horizontal)	TERM	BED THICKNESS
Sub horizontal	0°-10°	Very thick	>2 m
Gently inclined	10°-30°	Thick	600- 2 m
Moderately inclined	30°-60°	Moderately thick	200-600 mm
Steeply inclined	80°-90°	Moderately thick	60-200 mm
Sub vertical	80°-90°	Thin	20- 60 mm
		Very thin	6- 20 mm
		Laminated	2- 6 mm
		Thinly laminated	< 2 mm

8. PARTICLE SHAPE

Roundness Terms:

Rounded Angular Sub rounded Sub angular

Reference: New Zealand Geomechanics Society *"Guideline for the Field Description of Soils and Rocks in Engineering Use"* November 1988



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PROJECT H Bray Bldg Sites "A" and "B" PROJECT No. G1050

LOCATION Coles Bay Port Underwood

COMPUTED/PREPARED BY DATE 17 May 20 02

REVIEWED/CHECKED BY DATE 20

REF/DWGS Reference Photos SHEET 01 OF 01