Report prepared for: **Dunedin City Council** Report prepared by: GeoSolve Ltd Distribution: **Dunedin City Council** GeoSolve Limited (File) November 2016 GeoSolve Ref: 160658



143-193 Moray Place, Dunedin







Table of Contents

1	In	itroduct	tion	. 1
			eral	
2			nical Investigations	
3			ce Conditions	
3				
			logical Setting	
		.1.1		
			Seismicity	
	3.2		tigraphy	
	3.3	Grou	undwater	. 3
4	C	onclusio	ons and Recommendations	. 4
5	Α	pplicabi	ilitv	. 5



1 Introduction

1.1 General

This report presents the results of geotechnical investigations carried out by GeoSolve Ltd in order to determine subsoil conditions and provide geotechnical inputs for a potential commercial development at 143-193 Moray Place, Dunedin.



Figure 1.1 – Site photo, 1432-193 Moray Place (Source: Google Street View)

The investigations detailed in this report were carried out for Dunedin City Council in accordance with GeoSolve Ltd's proposal dated 22 September 2016, which outlines the scope of work and conditions of engagement.

We understand that the proposed development is for a potential hotel complex on the above sites and that several proposals are under consideration.

As no development plans are available, this investigation and report is general in nature and is intended to provide potential developers and their advisors a general overview of the ground conditions at the site. Additional investigations will be required as part of the detailed design of any scheme proposed.

No geotechnical assessment of the data has been carried out and no geotechnical recommendations are provided as the development plans are not defined.

We note that 62 York Place is also potentially part of the hotel development site. A separate report is provided for this site because it may not be applicable to all potential development proposals. The data from that site has been included in the geological cross sections in this report.

2 Geotechnical Investigations

GeoSolve have supervised seven machine boreholes (BH) with Standard Penetration Testing (SPTs) on site from 18-27 October 2016 comprising BH3-8. Note that BH7 was planned but not carried out due to time and budgetary constraints.

Investigation depths for each BH ranged from 7.60-21.28 m in total. BH logs and preliminary cross sections are attached at the end of this report.

An initial desktop review of existing information on the GeoSolve, DCC and Otago Regional Council databases has also been carried out.



3 Subsurface Conditions

3.1 Geological Setting

3.1.1 Regional Geology

The geology of the Dunedin area is dominated by volcanic rock types of basaltic to andesitic composition that were intruded through pre-existing marine sediments during Miocene times. Extensive volcanism at that time produced lava flows and bedded volcanoclastic materials were widely distributed by eruptions.

More recently (Pleistocene times), the hills of Dunedin have been extensively mantled by windblown loess to depths of up to several metres. Watercourses and tidal embayments such as Otago Harbour have locally deposited alluvial, estuarine and marine deposits and generally modified the volcanic landscape by deep incision and sedimentation. Fill and refuse has been placed locally during post-settlement times. Landslips have occurred on steeper hillsides particularly where springs emerge or where fills have been placed.

3.1.2 Seismicity

Dunedin has traditionally been considered to have lower than average seismic activity when compared to other areas in New Zealand, however nearby active faults are known and strong shaking is certain to occur periodically.

McCahon et al 1 states that the earthquake hazard in Dunedin is dominated by relatively infrequent moderate to large earthquakes (magnitude up to M_w 7.5) in eastern Otago, and large to very large earthquakes in the much more seismically active Fiordland and Westland regions.

The nearest active faults with demonstrated Late Quaternary movement history are the Green Island Fault and the Akatore Fault. The Green Island Fault is currently considered to be the cause of the 1974 earthquake that caused damage in Dunedin. It is mapped approximately 5km to the south of the subject site, but its projection is believed to continue through South Dunedin and may run northeast up the harbour in which case it would pass within about 4km of the site. The Akatore Fault has also been projected beneath South Dunedin; the nearest mapped trace of the fault is truncated about 6km southwest of the site, but the fault likely continues beneath South Dunedin and may run northeast up the harbour as well. Sheared fault rocks have been identified in recent drilling near Portsmouth Drive indicating continuation of fault traces up the harbour is very probable.

It should be noted the fault terminations shown on fault trace maps are often approximations (owing to lack of data) and the presence of other active faults may be unknown because they may be obscured by overburden soils. Both of these faults are likely to be capable of generating magnitude 7.5 earthquakes in Dunedin. Other known faults that have some potential to cause strong shaking in Dunedin are the Titri Fault and the North Taieri Fault, located roughly 9km and 15km southwest/west of the site, respectively.

The above faults are not included in Table 3.6 of NZS 1170.5:2004 as major faults requiring near fault factors when assessing structural design actions. Recent events in Canterbury have highlighted the issue that previously unidentified faults may be very significant factors in the actual future risk applying to any particular site.

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¹ McCahon, I.F., Yetton, M.D., Cook, D.R.L. (1993). The Earthquake Hazard in Dunedin. EQC report 91/56.



GeoSolve ref: 160658 November 2016

Strong ground shaking throughout the South Island is likely to be associated with a rupture of the Alpine Fault, located along the West Coast of South Island. There is a high probability an earthquake with an expected magnitude of over 7.5 will occur along the Alpine Fault within the next 50 years.

Average return periods for shaking intensity are: MM 7 = 100 years, MM 8 = 450 years and MM 9 = >2,500 years. The most recent major earthquake to affect Dunedin occurred in 1974 and produced damage consistent with MM 7 intensity.

3.2 Stratigraphy

An engineering geological model for the site is shown in the cross section appended at the end of this report. More detailed geotechnical description of soils is provided in the attached borehole logs.

Published geological mapping and reporting (Benson, 1968) indicates that the site is likely to be underlain Dunedin Volcanic Group rock, possibly overlain by loess/colluvium. Localised man-made fill soils or alluvial channels are also reported in the vicinity

The generalised subsoil profile at the site comprises a surficial uncontrolled fill layer overlying gravelly and silty slopewash soils.

Uncontrolled fill generally comprised firm or medium dense gravelly SILT and sandy GRAVEL up to 1.5 m in thickness.

The slopewash soils are composed of firm silty CLAY and clayey SILT, locally with some gravel and cobbles. Due to the observed variability within these soils and the lack of shear surfaces or slickensides, these units are inferred to be an accumulation of soils derived from erosion and mass wasting further upslope. The thickness of the slopewash unit also increases in thickness with decreasing elevation on the slope (approximately 3 m near the top compared to 6.5m near the base), typical of a debris fan morphology.

These deposits are underlain by extremely to highly weathered basaltic and basanitic bedrock of the Dunedin Volcanic Group. SPT refusal was generally reached within these units.

3.3 Groundwater

The local water table was observed at approximately 4.00-4.15 m below ground level in BH3 and BH6 and was not observed in any other BHs.

Groundwater levels across the site will need to be confirmed by detailed investigation and design. Piezometers for the purposes of groundwater monitoring have been constructed in BH3, BH5 and BH7(8) to full depth. All other BHs were backfilled upon completion.



4 Conclusions and Recommendations

- The generalised subsoil profile at the site comprises a surficial uncontrolled fill layer overlying slopewash deposits, with volcanic rock underlying the site at moderate depth.
- The local water table was observed at approximately 4.00-4.15 m below ground level in BH3 and BH6 and was not observed elsewhere.
- Further subsurface investigations and geotechnical analysis of earthworks and foundation proposals is required at detailed design stage.



5 Applicability

This report has been prepared for the benefit of Dunedin City Council with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

This report does not provide a detailed geotechnical investigation and assessment of the site and additional investigations and assessment will be required for specific developments on the site.

Please do not hesitate to contact the undersigned if we can provide any assistance at a later stage of the project.

Report prepared by: Reviewed and authorised for GeoSolve Ltd by:

D Gainslord CEMandraux

David Gainsford Colin Macdiarmid

Engineering Geologist Senior Geotechnical Engineer

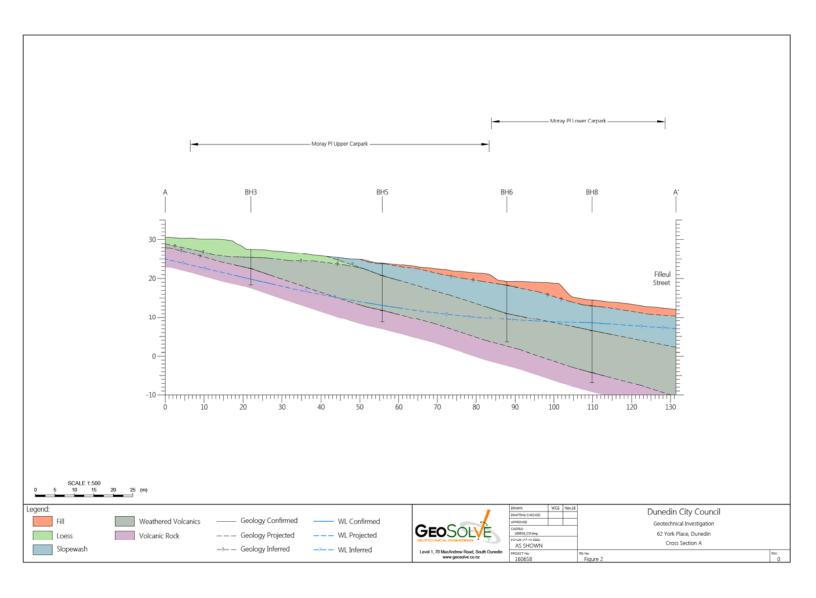
GEOSOL/E

70 Macandrew Road, PO Box 2427, South Dunedin 9044, ph 03 466 402



Appendix A: Site Plan & Cross-sections





7

Appendix B: Site Borehole Logs



PROJECT: DCC 143-193 MORAY PLACE

GEOSOLVE LTD

BORE HOLE LOG

R.L. GROUND: 33,36m

Survey method: GPS (NZTM)

R.L. COLLAR:

BOREHOLE No:

BH3

SHEET ..!... OF ...!...

DRILLED BY: MªMILLAN'S LOGGED BY: D GAINS FORD

CHECKED: M WALROND START DATE: 26/10/2016 FINISH DATE: 26/10/2016

CO-ORDINATES: N4917057
E1406089

ANGLE FROM HORIZ.: 90° DATUM: 6400ND LEVEL
DRILL TYPE/METHOD/FLUID: 50NIC D.T. 45

JOB No: 160658

DIRECTION: VEKTICAL

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity	Sampling Method	Core Recovery (%)	Moisture Condition	Strength/Density Classification	RL (m) Depth (m)	Graphic Log	Drillers Notes	TESTING Hammer Efficiency: 91.4*/, Borehole Diameter: 116 mg, Liner: NO	25 50 Water Loss (%) 75	Water Level	Casing	Installation	Core Box
J 1	0.00m sitty GRAVEL; dark grey; fine to median subangular growel, well graded; non plastic sitt median dense, wet. 0.05m clayey SILT; light brown-grey mottled orange-brown; low plasticity, localised dark flecks, soft to firm, noist.	Sound	001		50FT - FIRM	1-	, X X X X X X X X X X X X X X X X X X X							
LOES	2.08m CLAY, brown, high plasticity, firm,	367	100	Morst	YERY STIFF	2—	- x x x x x x x x x x x x x x x x x x x		58T @ 1.52m 2, 4, 5, 7, 7, 8 N=27				ALL PORTO SIGNED SPECIAL SPECI	
	2.65m silty CLAY, brown notited yellow, orange and black, low plasticity, minor fine to median subangular gravel breaks down into sand and	SONIC	001		站	3	× × × × ×		SPT Q 3.04n		26/10 /16		Skirkenicz skilana i i i berea	
	non-plastic silt (reliet crystals in residual soil) very stiff, moist 2.84-3.04 Crystalliae texture 3.04,m CLAY with minor silt; brown with yellow, pinks and brown motting, stiff, moist	JUC SPT	001 01		VERY STIFF	4	X X .		3, 4, 5, 8, 6, 4 N= 23		4.00mbg)		KORIZIA GARANTE ANTONIO DE LA CONTRA	
	4.00m Becoming saturated	SPT SBN16	001		STRONG		1 1 X 1	,	SPT @ 4.56m 6, 7, 8, 10, 9, 8					
VOLCANICS	4.95n Extremely weathered ROCK; black nothed dark red, bown-yellow and orange, weak to moderately strong; breaks down to non plaske sitty clay, moderately strong, sourrated	SONNE	001		MODERATELY S	6	+ +		N = 35					
TERED	6.70m Vesicular textures present.	± 35	0	SATURATED		6-	+		SPT @ 608m 7, 12, 20, 22,18,- N= 60+ for 365mm		/11 /16			
	Becoming moderately strong to strong.	SOMIC	001	SATI		7-	+ +				7.67mbg1 18			
ş		547	0		STRONG	8-	+		SPT @ 7.60m 10, 39, 47, 13, -, - N=60+ for Z35mm		•			
- 1	EOH a.12m	SOMIC	100			9	+		SPT @ 9.12m 4, 18, 34, 26, - N= 60+ &r 250mm					
-	S: ALL SPT 'N' VALUES ARE UNCORRE	CT	ED			-								_



Log Scale 1:50

PROJECT: DCC 143-193 MORAY PLACE

GEOSOLVE LTD

BORE HOLE LOG

JOB No: 160658

DIRECTION: VERTICAL

R.L. GROUND: 28.74m

Survey method: GPS (NZTM)

R L COLLAR:

BOREHOLE No:

BH 4

SHEET OF ..7...

DRILLED BY: Mª MILL ANS
LOGGED BY: D GAINSFORD

CHECKED: M WALROND

START DATE: 26/10/2016

CO-ORDINATES: N 4917052 DATUM: GROUND LEVEL | FINISH DATE: 26/10/2016 ANGLE FROM HORIZ.: 90° E 1406129 DRILL TYPE/METHOD/FLUID: SONIC DTUS DESCRIPTION OF CORE **TESTING** Core Recovery (%) Hammer Efficiency: 91.4.7 Borehole Diameter: 1114,555 Liner: 41.0 Moisture Condition Strength/Density Classification Sampling Method SOIL: Classification, colour, consistency / density, Water Loss (%) Installation RL (m) Depth (m) Core Box moisture, plasticity Casing Drillers ! WaterL 0.00m organic SILT, brown, non plastic, grass and roothelts, soft, moist.
0.15m gravelly SILT, grey-brown, low plasticity, moderately exidised fine to consc angelor gravel (basalt and brick frequents) 60mm & cobble at 1.22m, firm to very stiff, 19/97 × 0 / O × × a 100 ٥ х. О 1.40m Dark brown manganese flechs SPT @ 1.52m 3, 3, 5, 5, 7, 7 60. ×× N= Z4 00 2.70m Becoming dark brown. Manganese flechs absent. SPT @ 3.04m 0 × 1, 1, 3, 6, 6, 6 001 N= 21 × 001 o K SPT@4.56m 2,3,3,6,7,9 STIFF 00 o x N=25 × , × ° 200 5.80m Becoming wet. SPT@ 6.08m X D SPT 603 2,3,4,6,6,7 6.42m clayey SILT; light grey, nottled dark brown and arrange-brown, low plasticity, iron and manganese staining, very stiff, moist Х N=23 50 20 5 ×× ~× SPT@ 7.60m 8 _ × 3, 10, 9, 5, 8, 8 ×_-x 11:30 8.59m CLAY: light brown-purple, mothed yellow, red and orange-brown, high plasticity, rare relief crystalline texture, very stiff, moist (residual soil) 8 WEATHERED SPT @ 9.12m 2, 6, 8, 7, 7, 8 267 100 N=30 COMMENTS: ALL SPT 'N' VALUES ARE UNCORRECTED.



CO-ORDINATES: N 491705Z

Log Scale 1:50

PROJECT: DCC 143-193 MORAY PLACE

E 140 6 129

GEOSOLVE LTD

BORE HOLE LOG

R.L. GROUND:

R.L. COLLAR:

Survey method: GPS (NZTM)

DATUM:

BOREHOLE No:

BH 4

SHEET OF

DRILLED BY: ME MILLANS
LOGGED BY: DE GAINSFORD

CHECKED: M WALROND START DATE: 26/10/2016 FINISH DATE: 26/10/2016

ANGLE FROM HORIZ.: 90"

JOB No: 160658

DIRECTION: VERTICAL

DRILL TYPE/METHOD/FLUID: SONIC DT45

	Ę	DESCRIPTION OF CORE			_					TESTING					
	GEOLOGICAL UNIT	SOIL: Classification, colour, consistency / density, moisture, plasticity	Sampling Method	Core Recovery (%)	Moisture Condition	Strength/Density Classification	RL (m) Depth (m)	Graphic Log	Drillers Notes	Hammer Efficiency: 91.4%, Borehole Diameter: 114 mm Liner: NO	Water Loss (%)	Water Level	Casing	Installation	Core Box
	:OFOG		Samplin	Core Rec	Aoisture	Strength	RL Dept	Graph	Drillers		Water L	Water	Cas	Instal	Core
	GE	In a city (1 AV 18th and equal and									2822				
=		10.10m sith CLAY with rare gravel, purple red with orange oxidation mottling, low plasticity; fine angular white gravels (cystals) which break down to non-plastic sitt	JIN 05	100				× 0		SPT @ 10.64m					
11	RED	which break down to non-plastic silf, very stiff, noith 10.60m Becoming silty CLAY with some growel.	267	٥	15	STIFF	11	× - ×		7, 8, 9, 8, 9, 10 N=36					
112	WEATHERED VOLCANICS		Sourc	100	W015	VERY		x		SPT C 12.16m					
-		EOH 12.61m	TYS	0			12-	×-		7, 8, 9, 8, 9, 10 N=36					
13							13-								
13							13								
14-							14-								
15							15								
16—							16								
17=							17								
							=								
18-							18								
							19-								
18							19-								
Ξ	COMMENT	S: ALL SPT 'N' VALUES ARE UNCO	2.8	50	TED		=								
- 1	COMMENT	O, 11000 211 11 VIII VIII VIII VIII VIII VIII VI	-,						Current	athed (PS () 3 Th					\sqcup



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LOCATION: SEE SITE PLAN

CO-ORDINATES: N 4917080

PROJECT: DCC 143-193 MORAY PLACE

E 1406118

GEOSOLVE LTD

BORE HOLE LOG

R.L. GROUND: 29.28m

DATUM: GROUND LEVEL

Survey method: 4PS (NZTM)

R.L. COLLAR:

BOREHOLE No:

BH 5

SHEET OF

DRILLED BY: Mª MILLANS LOGGED BY: D GAINS FORD

CHECKED: M WALROND START DATE: 21/10/2016 FINISH DATE: 25 /10 / 2016

ANGLE FROM HORIZ.: 90° DRILL TYPE/METHOD/FLUID: SONIC D.T. 45

JOB No: 160658

DIRECTION: VERTICAL

Log Scale 1:50

SOIL: Classification, colou moisture, plasticity	RIPTION OF CORE ur, consistency / density,	Sampling Method	Core Recovery (%)	ndition	sity				TESTING Hammer Efficiency: 91.4%					
ASSHAL	ır, consistency / density,	npling Method	covery (%)	ndition	sity				Hammer Efficience 81 2.1/	1 _	1	- 1		1
FILL 0.00m ASPHAL		San	Core Re	Moisture Condition	Strength/Density Classification	RL (m) Depth (m)	Graphic Log	Drillers Notes	Hammer Emiclency: ₹1, ₹7. Borehole Diameter: 11 ₹1.60 Liner: № 0	25 50 Water Loss (%) 75	Water Level	Casing	Installation	Core Box
clay pipe at 0. 0.19 ~ clayer 5 -brown, low plash gravel, soft to fi	LT; black, hard. SILT; light brown, low fine angular grovel, broken lom, soft to firm, moist. SILT; light gray, mottled craye city, rare fine rounded rm, moist.	SOMIC	800			111111111111111111111111111111111111111					10.50 mbg 18/11/16		T TO the manage play in the state of the sta	
4	KEP.	1.73	400		STIFF	2-			SPT@1.52m 1, 2,3, 3,5,5 N=16				Carde and Carden	
J. 25m silty CLI 3 and dark brown to subrounded 5 stiff to very stiff, 4.01m silty C light brown mott black, low plast subrounded to soil		Some	100		STIFF	3-								
J. 2.25m silty CLA and dark brown to subcounded a stiff to very stiff,	AY; light brown motiled black n, some fine subangular gravel and non-plasks silt, moist	28-7	(fot		VERY S	, , , , , , ,			2, 2, 4, 6, 6, 7 N= 23					
4.01 m silty C light brown moth	moist LAY with some gravel; ted yellow, orange-brown and sicity, gravel free to nedimn, congular, shiff, moist.	SONK	001		ų.	4			SPT @ 4.56m					
	vengular, STAT, moist.	267	100	MOIST	STIFF	5-			2, 2, 3, 3,4,4 N=14				STATE OF THE PARTY	
5.46 - 6.08m Le	ocally wet.	20005	001	MC		,,,,,,,,,,,,								
		261	100		STIFF	6			SPT @ 6.08m 2, 3, 5, 5, 5, 5 N=20					
6.92m silty CLA red born, mother low to medium p subrounded grave	It with core grovel; light of orange-brown and gellow, plasticity; fixe to medium , , stiff, moist	JINOS	001			7-							AND THE PROPERTY OF THE PERSON NAMED IN	
7.90m Locally in	cludes grey non plastic silt.	T-ds	100		STIFF	8-			SPT @ 7.60m 2, 2, 3, 3, 3, 5 N=14				The State of the S	
8.30m Rounded (8.35m silty CLA) dark brown and do fine to coase rou	cobble // light brown mothed orange, who grey, low plasticity, rare unded gravels stiff, noist.	50N1C	001			, I								
1) 32 - 9.28 - 9.32 m Lens	of dark red, low plasticity	SPT	100		タイルドド	1			SPT @ 9.12m 2, 3, 3, 3, 4, 4 N=14				Manager of the Control of the Contro	
Q.28-9.32m Lens clay.	'N' VALUES ARE UNCO	ν,	e C	TED		=							2007000	



PROJECT: DCC 143-193 MORAY PLACE

GEOSOLVE LTD

BORE HOLE LOG

R.L. GROUND: 29.28m

R.L. COLLAR:

BOREHOLE No:

BH 5

SHEET OF

DRILLED BY: MCMILLANS LOGGED BY: D GAINS FORD

CHECKED: M WALROND START DATE: 21/10/2016 FINISH DATE: 25/10/2016

ANGLE FROM HORIZ.: 90° DATUM: GROUND LEVEL

JOB No: 160658

DIRECTION: VERTICAL

Log Scale 1:50

DESCRIPTION OF CORE TESTING Hammer Efficiency 7 11 1/2 1	CO-ORD	E1406118	DRILL TV		_					T 1. C	FINISH DAT	E	-5711	- / -		_
OMMENTS: ALL SPT 'N' VALUES ARE UNCORRECTED.	<u> </u>		DRILL III	F L/1	IVIL	ITIOL	1	D. 30		71.45	TESTING					Г
0.05-03-00. Less of fice to cabile submiddle provided bread provided provid	GEOLOGICAL UNI	SOIL: Classification, colour, consistency / density,		Sampling Method	Core Recovery (%)	Moisture Condition	Strength/Density Classification	RL (m) Depth (m)	Graphic Log	Drillers Notes	Hammer Efficiency: 91.41/2 Borehole Diameter: 11400		Water Level	Casing	Installation	
13.8 In Extremely to highly weathered ROCK 379, high town and light red-bound, nastree, sity clay and the to coluble grand, moderately shows to sharp set. 14	vor canics	subrounded bosalt gravels. 10.20m silty CLAY, dark red, reliet crystalline texture minor fin medium subangular gravel, v. stiff, moi 11.26m clayed GRAVEL, black mother red fine to coarse subangular bargravel; low plasticity clay, highly oxi some medium to coarse sand, deas very deast, wet. 12.07m Extremely weathered ROC cystalline, massive, breaks down to gravel with low plasticity clay, highly avery weather of the coarse with low plasticity clay, highly avery gravel with low plasticity clay, highly avery comments of the coarse which the gravel with low plasticity clay, highly avery comments of the coarse which is a comment of the coarse which is a comment of the coarse when the coarse we have the coarse when the coarse we can be commented to the coarse when the coarse we can be commented to the coarse when the coarse we can be coarse when the coarse when the coarse we can be coarse when the coarse we can b	brown and sall dised, c to	TAS JIMES TAS	001 001		VERY	12	1×1×1×00000 + + +		7, 10, 10, 9, 10, 14 N= 43 SET @ 12.16m 5, 17, 15, 17, 15, 17		10.80 m			
COMMENTS: ALL SPT 'N' VALUES ARE UNCORRECTED.	WEATH	arey, light brown and light red-brown crystalline, breaks about to low plants if y clay and fine to cobble a	ed ROCK, massive, skicity	792	0	YEY.			+ +		S, 11, 17, 33, 10, - N=60+ for \$10mm					
OMMENTS: ALL SPT 'N' VALUES ARE UNCORRECTED.		EOH IS.45m		7 B T	0		ı		+		4, 5, 6, 7, 7, 10					
Survey method: GPS (NZTM)														-		_
a Social 150			E UNCO	RR	EC	TED),			Survey m	nethod: GPS (NZTM)		_		_	



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LOCATION: SEE SITE PLAN

PROJECT: DCC 143-193 MORAY PLACE

GEOSOLVE LTD

BORE HOLE LOG

R.L. GROUND: 24.44m

R.L. COLLAR:

BOREHOLE No:

BH 6

SHEET OF

DRILLED BY: MEMILL ANS LOGGED BY: D GAINSFORD

CHECKED: M WALROND START DATE: 18/10/2016

ANGLE FROM HORIZ.: 90° DATUM: GROUND LEVEL FINISH DATE: 18/10/2016

CO-ORDINATES: N 4917072 E 140 6154 DRILL TYPE/METHOD/FLUID: SONIC D.T. 45

DIRECTION: VERTICAL

JOB No: 160658

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity	Sampling Method	Core Recovery (%)	Moisture Condition	Strength/Density Classification	RL (m) Depth (m)	Graphic Log	Drillers Notes	TESTING Hammer Efficiency: %1 . 4*/k Borehole Diameter: 11 12	25 50 Water Loss (%) 75	Water Level	Casing	Installation
7714	0.00m gravelly SILT, brown mottled red and block; non plastic silt fine angular gravel and brick fragments; firm moist 0.27m clayer SILT; light grey-brown mottled orange-brown; low plasticity, firm to stiff moist. 0.80m gravelly SILT; brown mottled grey and	20005	0 01			-	x ax x - x x ax x				RECORDED 18/10/16		
	red; non plastic silt, the angular gravel and brick fragments firm, moist. 1.00m clayer SILT, light brown-grey mothled orange-brown, low plasticity, rare white and black clay inclusions and fine subangular basalt gravel very stiff, moist	58-7	eOI		VERY STIFF	2-	- 1 × × 1 × × 1 × × 1 ×		SPT@1.52m 2,3,5,7,7,8 N=27		NO STATIC W.L.		
	1.82m Occasionally with black manganese flecks 2.90m sitty CLAY; light brown mothed orange low plasticity, frequent iron and manganese	SONIC	0.01	TSIOM	V. STIPF	3—	× × × × × × × × × × × × × × × × × × ×						
-	low plasticity, frequent iron and manganese of oxidation from to sliff, moist. 3.04 - 3.34 SPT disturbance in core. 3.24m Becoming soft and wet with rance fine subrounded basalt gravels 3.94m & Smm thick laminations visible	ال كوسل	0	VET	57166.70		x 0 x 0 x		2, 3, 5, 5, 6 N=21				
LOPEWASH	4.30-4.56m Locally soft and saturated. 4.62m clayer silt; light brown mottled orange brown dark brown and black low	TJS LJS	001		STIFF	4	x		SPT@4.56m 2,4,4,5,5,6 N=20				
W	plasticity, manganese and iron exidation throughout shift, saturated. S.46-5.76m Minor rounded to subrounded fine Enselt grown. S.80m Becoming light brown-grey.	Sprate	001			5—	× × × 0 1 0 × × × × × × × × × × × × × ×						
	6.08n Becoming very shift	36.1	0		VERY STIFF	6	× × × × × × × × × × × × × × × × × × ×		SPT @ 6.08m 3, 5, 5, 8, 7, 8 N=28				
	6.95 m grovelly CLAY; brown mottled black and orange-brown, high plasticity; fine angular to subongular gravel, poorly graded, soft to firm saturated. 743-7.53. "Gravel locally rounded, fine to	5 OP4 16.	001	CATED		7	× 01 00 10 × × 01 00 10 11		SPT @ 7.60m				
	coarse, wet. 7.60m CLAY with rare growel; brown high plasticity; fine subrounded besoit gravel, firm, saturated. 8.20m CLAY with rare silt and gravel, brown nottled arrange, red black and yellow, high plasticity, reliet crystallize texture.		0	SATURA-	FIRM	8			1, 2, 2, 2, 3, 3 N=10				
WEATHERED VOLCANICS	high plasticity, relief crystalline texture. (residual soil) firm, saturated.	SPT SONIC	001 041		FIRM	9-	· ×		SPT@9.12m				
COMMEN	TS: ALL SPT 'N' VALUES ARE UNCOKRE	C.T.	E 0.			-	× =						



PROJECT: DCC 143-193 MORAY PLACE

GEOSOLVE LTD

BORE HOLE LOG

R.L. GROUND: 24. 44m

R.L. COLLAR:

BOREHOLE No:

BH 6

SHEET ..Z.. OF ..Z..

DRILLED BY: MEMILLANS LOGGED BY: D GAINSFORD

CHECKED: M WALROND START DATE: 18/10/2016

JOB No: 160658

DIRECTION: VERTICAL

11-12-13-14-16-18

		N: >EE SITE PLAN VATES: N 4917072	ANGLE FF	RON	и н	ORIZ	.: 90	0	DATUN	DLLAR: 1: GROUNG	> TEAET	START DAT					
	—	E 1 40 6154	DRILL TY	PE/	ME.	THO	D/FLU	D: 50	MIC	0745		OTING.					_
	GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity		Sampling Method	Core Recovery (%)	Moisture Condition	Strength/Density Classification	RL (m) Depth (m)	Graphic Log	Drillers Notes	Hammer Effic	STING ciency: ٩\.\.º/, meter: \\\\	25 50 Water Loss (%) 75	Water Level	Casing	Installation	Core Box
		10.29 m silty CLAY, light brown mo orange-brown and black; non pla low plasticity, some extremely wen cock fragments up to 100mm 0; moist.	chic to	Jimes July	901 0		VERY STIFF	11-	- × - × - × - × - × - × - × - × - × - ×		SP+ @ 3, 3, 6, N=						
	VOLCANIC.S	11.66-11.79 m Less of black claggy non phostic with some ned yellow. 11.79 m silty CLAY light brown grey black red and orange-brown; low plackety, locally clayed SILT and ex- to highly weathered rock fragments,	silt. mothing. mothed to no remely relief	SPT SONIE	001 0	+	VERN STIFF	12—	× - × -		SPT 0 3, 6, 6,	10, 15, 11					
	WEATHERED VO	erystalling + coduce, x stiff, moist.		7 CO001C	001	MOIST	VERY STIFF	13-	(X X X X X X X X X			13.68m 6,7,8					
		14.45m clayed SILT, light grey, non moist 14.92m slack bosalt fragmet (subangula 14.96m sithy CLAY, brown mottled ora red and block, low plaskeity, reliet texture, stiff, moist.	- (-111)	SOME	001		14	14	× - × - × - × - × - × - × - × - × - × -			?15.20m					
		EOH 15 65m	-	T98	0			17 17 18 18 19 19 19 19 19 19 19 19 19 19 19 19 19	×		2, 2, 4 N=	(³ , ³ , ³					
Ť	COMMENT	S: ALL SPT 'N' VALUES ARE	UNCOKE	EC	TE	D.				Cuntout	othod: (a c	(NZTM)	1111				4
L	og Scale 1:50			_	_					Jourvey m	ethod: GPS	(WC1F()					



E1406175

CO-ORDINATES: N 4917084

Log Scale 1:50

PROJECT: DCC 143-193 MORAY PLACE JOB No: 160658

GEOSOLVE LTD

BORE HOLE LOG

BOREHOLE No:

BH 8

SHEET OF

DRILLED BY: MEMILLAN'S LOGGED BY: D GAINSFORD

CHECKED: M WALROND START DATE: 17/10/2016 DATUM: GROUND LEVEL FINISH DATE: 19/10/2016

ANGLE FROM HORIZ.: 90°

DIRECTION: VERTICAL

DRILL TYPE/METHOD/FLUID: SONIC D.T. 45

R.L. GROUND: 19.69 m

Survey method: SPS (NZTM)

R.L. COLLAR:

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity	Sampling Method	Core Recovery (%)	Moisture Condition	Strength/Density Classification	RL (m) Depth (m)	Graphic Log	Drillers Notes	TESTING Hammer Efficiency: 91.4°/. Borehole Diameter: 114°/. Liner: NO	25 50 Water Loss (%) 75	Water Level	Casing	Installation	200
FILL	0.25m generally SILT; black-dark grey, non-plastic sift; fine to medium, angular growd; firm, noist	20016	001			1-	× × × × × × × × × × × × × × × × × × ×							
	1.52m SILT with some clay; light brown mothed light grey and block, low plasticity, firm, moist	T 1/5	100			2—	× × × × × ×		SPT@ 1.52m 2, 3, 5, 5, 6, 6 N=22					
	2.30 Becoming light grey, nother orange, brown and brack.	20 N C	001			-	× = ×							
		SP T	10.0			3-	- × × -		SPT@3.04m 1, 2, 4, 5, 6, 7 N= 22					
I	4.38m silty CLAY; light grey-brown mothed	SOPNIC	001		FIRM	4-	× - ×							
SLOPEWASH	4.38m silty CLAY; light grey-brown mottled orange-brown, low to medium plasticity, firm, moist, minor manganese and iron steekes, 5.02m - 5.22m Leas of fine to medium subangular basalt growel, with cobble	- >c -	100	7.5104		5-	× - × - × - × - × - × - × - × - × - × -		SPT@4.56m 1,3,4,4,6,8 N=ZZ		9102/11/81			
	5.50m Becoming light grey, nothled orange-	SONIC	001	٤			- × - ×				6.01mbgl			
	6.02 m silty CLAY; light brown, mothed gray, yellow-brown, orange and black, low to madium plasticity, firm, moist, rore fine subangul basalt grovels.	- JS	100			6			SPT @ 6.08m 2, 3, 5, 5, 6, 7 N=Z3		*			
	7.06-7.12m Lens of basalt cobbles, subangular to subrounded 7.12-7.36m Lens of fine to course,	SONIC	100			7-	- ×						Septimination of the septimina	
- 1	subongular to subrounded bosalt grovel 7.36m CLAY light brown, minor orange- brown mothing, soft noist care fine to medium subrounded thing, soft grovels. 7.90m Becoming wet. 8.03m CLAY. Tight brown mattled succle	192	001		2017	8-			SPT@7.60m 1,1,0,1,1,3 N=5				December of the Control of the Contr	
0.3	7.90m Seconing wet. 8.03m CLAY, light brown mottled purple, red and white high plasticity, relief crystalline texture (fine angular genuels, break down to non-plastic sitt), soft, moist 9.12 m = 9.57m SPT disturbance in core.	Sourc	001		TO FIRM	9			0 T (2) C 12					
VOLCE	Becoming soft to firm.	SPT	001		S0FT 7	,			SET @ 9.12m 1, 0, 0, 2, 2, 2 N=6				Sasa unocroamentamentamenta	
COMMENT	S: ALL SPT 'N' VALUES ARE UNCORR	2 =	CT	E D										



PAVEMENTS • HYDROGEOLOGY • HYDROLOGY

Log Scale 1:50

GEOSOLVE LTD

BORE HOLE LOG

BOREHOLE No:

BH 8

SHEET OF

DRILLED BY: MCMILLANS LOGGED BY: D GAINSFORD

CHECKED: M WALROND START DATE: 17 /10 /2016

DATUM: GROUND LEVEL FINISH DATE: 19/10/2016

PROJECT: DCC 143-193 MOKAY PLACE JOB No: 160658 LOCATION: SEE SITE PLAN

CO-ORDINATES: N4917084 E1406175

DIRECTION: VERTICAL ANGLE FROM HORIZ.: 90°

R.L. GROUND: 19.69m R.L. COLLAR:

Survey method: GPS (NZTM)

DRILL TYPE/METHOD/FLUID: SONIC DTUS

	⊢	DESCRIPTION OF CORE								TECTINO					\dashv
	N	DESCRIPTION OF CORE	٦	(%	5	_				TESTING Hammer Efficiency: 91. 4*/,	_				
	GEOLOGICAL UNIT	SOIL: Classification, colour, consistency / density, moisture, plasticity	Sampling Method	Core Recovery (%	Moisture Condition	Strength/Density Classification	RL (m) Depth (m)	Graphic Log	Drillers Notes	Hammer Efficiency: 41, 4 / ₆ Borehole Diameter: 11 4 mm Liner: NO	25 50 Water Loss (%) 75	Water Level	Casing	Installation	Core Box
11111	-	10.25m silty CLAY; orange-brown with light grey-brown and black veining, non-plastic, stiff, moist	Sorvic	10.0		NFF	11111	1 × 1		SPT@ 10.64m					
11 —		10.43 m sith CLAY, light brown to dark brown motted orange, black, yellow and red low plasticity rare fine to motion subrounded basalt gravel, stiff moist	705	001		V. STI	"-	× × × ×		8, 8, 7, 7, 11, 13 N=38					
12—		10.64 - 11.10 m SPT disturbance 10.71 m sitty CLAY; light brown notted orange brown, and plastic to low plasticity, my stiff most. 11.05 m Becoming nottled light area. 11.05 m Becoming nottled light area. 11.36 m sitty CLAY; purple-brown with white red and black motting town plasticity, reliet crystalline texture, stiff, moist.	Sonaic	60)		TO V. STIFF	12-	× × × × × ×		SPT @ 12.16m					
12—		firm mainty, highly oxidized, rare fine sand	SPT	100		STIFF		× _ ×		0, 2, 4, 6, 6, 7 N = 23					
13		12.16-12.32 m Locally purple, high plasticity 13.15 m CLAY with minor gravel; purple with minor orange-brown, white and red flecks (reliet crystalline texture); high plasticity, five subangular gravel breaks down to non-plastic silf stiff to we alse	JINOS	100			13	- × × ×		SPT@13.68m					
14=	2212	13.72m Ruple-black angular-subangular cobbles 13.90m Puple-black angular-subangular cobbles 13.98-14.55m Locally soft and saturated. 14.20-14.50m Included fine to cobble, angular growels of weathered basalt.	SPT	100		V. STIFF	14-	× - × × × × × × × × × × × × -		4, 12, 14, 9, 7, 20 for 55mm N=50+					
(5	2 10 2	ILF, SSM gravelly CLAY light brown nottled red, white and blacky non plastic to low plasticity, minor sith and the sand, relict castalline technosistic to medium, subangular to angular gravel, breaky down to non-plastic sit; stiff wet. 15.15m sithy CLAY: brown-red low plasticity.	Sonic.	10.0	MOIST	STIFF TO	15	X 0 1 0 0 X		SPT @ 15.20m					
	ATHERET	rane fine black and (capitals), me are to make anywher, black basalt growel and red gellow or arrange - brown mothing; stiff, moist	792	0				^ _ ×		6, 5, 10, 10, 8, 12 N= 40					
16—	S E	W 772	135	001		1	16	- × - × × ×		SPT @ 16.72m					
17-		16.72-17.02m SPT disturbance. 17.02m Locally with some white, fire, angular gravels (crystas)	SONIC	0		STIFE	17	- x o x - x o x		2, 3, 3, 4, 4, 5 N=16					
18—			SOLVIC	001			18	× - ×							
		18.78m Extremely to highly weathered ROCK:	TOS.	0						SPT @ 18.24m 20, 40, -, -, -, - N= 60+					
19-		18.78m Extremely to highly weathered ROCK; nod-brown method block, yellow and orange, crystallive texture massive highly fractured breaks down to charge GENET with some sit; strong most 19.27m Moderately weathered ROCK; orange-brown matted black, 0-30m defect spacing, very strong, most;	NI) C	(00)		50	19	+ + +		SFT @ 19.76m					
		mothed black, 10-30nn defect spring, very strong, moist. 20,60n Unwanthered ROCK, black basalt, 10-50nn defect special extremely stong, moist	-	0		V. STRONG	1	++		15, 45, -, -, -, -, N=60+ SPT @ Z1. Z8m 50, 10, -, -, -, -, -, -, -, -, -, -, -, -, -,					
7	COMMEN	S: ALL SPT 'N' VALUES ARE UN COR	12	EC	TE	>,				H = 60 +	ш		13	-(\dashv