MOUNT POLLEY MINING CORPORATION MOUNT POLLEY PROJECT

1996 GROUNDWATER MONITORING WELL INSTALLATION PROGRAM (REF. NO. 1628/4)

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Knight Piésold Ltd.

CONSULTING ENGINEERS

<u>Knight</u>	Piéso	ld	Ltd.
CON	SULTING	ENG	INEERS

IMPERIAL METALS CORPORATION MT. POLLEY PROJECT

1996 GROUNDWATER MONITORING WELL INVESTIGATION PROGRAM (REF. NO. 1628/4)

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SECTION 1.0 INTRODUCTION

1.1 **PROJECT DESCRIPTION**

The Mount Polley Project is located in central British Columbia approximately 56 kilometres north-east of Williams Lake, as shown on Figure 1.1. The nearest settlement is the community of Likely, on the northern tip of Quesnel Lake.

The Mount Polley Mine has reserves of 82.3 million tonnes of copper and gold ore contained in three ore bodies. Ore will be hauled to the crusher and then it will be processed in the mill by selective flotation to produce a copper-gold concentrate at a production rate of approximately 17,800 tonnes per day (6.5 million tonnes per year). Approximately 92.6 million tonnes of waste rock will be stored in waste rock dumps adjacent to the open pit.

After processing the ore to produce the copper/gold concentrate, the tailings will be discharged as a slurry into the tailings storage facility which will provide environmentally secure storage of the tailings solids. As the solids settle out of the slurry, process fluids are collected and recycled back to the mill for re-use in the milling process. No surface discharge of any process solution from the tailings facility is required or anticipated.

In 1996, the British Columbia Ministry of Environment, Lands and Parks (MELP), Environmental Protection Branch requested that a Groundwater Monitoring Program be designed and implemented for the Mount Polley Project. One of the requirements of the program was to "... establish monitoring wells down-gradient from the pit, waste rock piles, and tailings pond dams, and to sample aquifers in



both surficial deposits and bedrock ...", including the establishment of background wells up-gradient of any potential impacts by mining activities. The 1996 Groundwater Monitoring Well Installation Program was undertaken to fulfil this requirement. This report presents the details of the 1996 Groundwater Monitoring Well Installation Program, procedures followed during the work and results of the program.

1.2 PREVIOUS WORK

In 1989 Knight Piésold Ltd. was retained by Imperial Metals Corporation to conduct a geotechnical evaluation of the open pits, waste dumps and tailings storage facility for the proposed development of the Mount Polley Project. Monitoring wells were installed as part of this program. The 1989 Monitoring Well Program is summarized as follows:

1989 MONITORING WELL PROGRAM

- A total of nine (9) groundwater monitoring wells were installed in selected NQ diamond drillholes during the 1989 investigations by Knight Piésold, as shown on Figure 1. The 1989 monitoring wells were not installed in complete accordance to current industry practices. They were constructed using 38 mm diameter PVC well pipe with screened sections extending from approximately 3 metres below ground surface to the end of the well string. The screened sections were made using a hacksaw to cut the slots in the PVC pipe.
- Three wells (MP-89-107, MP-89-146 and MP-89-151) were installed in the open pit area. These wells were extended the full length of the exploration drill holes, approximately 150 metres. Bentonite seals were not installed below the well string. The surface seals consisted of a 1 metre concrete plug covered by two metres of bentonite that was installed just below the bedrock surface.



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Six wells (MP-89-231, MP-89-232, MP-89-233, MP-89-234, MP-89-235 and MP-89-236) were installed at the tailings facility. These monitoring wells varied from 15 to 40 metres in depth. Bentonite seals were installed below the well string and at the ground surface. Natural sand backfill was placed around the screened interval.

Additional groundwater wells were completed in the vicinity of the open pits and mill site with an air rotary water well drill rig in 1995. The program was coordinated and supervised by Imperial Metals Corporation. The 1995 Monitoring Well Program is summarized as follows:

1995 MONITORING WELL PROGRAM

• In August, 1995 seven groundwater wells (R-95-1 to R-95-7) were installed in the vicinity of the open pits and mill site, as shown on Figure 1. The wells were primarily for groundwater supply and were constructed with 110 mm PVC well pipe in 150 mm holes advanced with air rotary drilling methods. Well casings were installed over the full length of the holes, which ranged from 80 to 170 metres. Screened zones were installed at various levels, where high recharge was encountered during drilling. The well casings were sealed in accordance with standard BC water well practices.

1.3 <u>REFERENCE INFORMATION</u>

Prior to starting the 1996 Groundwater Monitoring Well Installation Program, a report containing detailed specifications for the drill program was issued, "Imperial Metals Corporation, Specification for Drilling, Monitoring Well Installations and Related Services, (Ref. No. 1628/3), September 18, 1996".

A summary of previous work on groundwater monitoring wells is presented in the Knight Piésold report "Imperial Metals Corporation, Groundwater Monitoring Program, Ref. No. 1624/2, June 3, 1996". This report is a compilation of the



hydrogeological conditions at the site and the anticipated impacts that will result from the project development.

Knight Piésold Ltd. has prepared a number of reports which contain information relevant to the Groundwater Monitoring Program, as summarized below:

- Imperial Metals Corporation, Report on Geotechnical Investigations and i) Design of Open Pit, Waste Dumps and Tailings Storage Facility, February 19, 1990.
- ii) Imperial Metals Corporation, Mount Polley Project, Stage I Environmental and Socio-Economic Impact Assessment, January 1991.
- Imperial Metals Corporation, Report on Project Water Management (Ref. iii) No. 1624/1), February 6, 1995.
- Imperial Metals Corporation, Tailings Storage Facility Design Report (Ref. iv) No. 1625/1), May 26, 1995.
- Imperial Metals Corporation, Manual on Sampling and Handling Guidelines **v**) for Determination of Groundwater Quality, (Ref. No. 1625/5), May 19, 1995.

A number of geotechnical investigations were conducted during construction of the Stage Ia tailings embankment in 1996. Detailed geologic and hydrogeologic information obtained from these investigations and the 1996 Groundwater Monitoring Well Installation Program will be presented in the report, "Mount Polley Mining Corporation, Mount Polley Project, Updated Design Report, Ref. No. 1627/2".



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1.4 SCOPE OF WORK

The 1996 Groundwater Monitoring Well Installation Program was conducted between October 30 and December 6, 1996. The drill Contractor (Drillwell Enterprises Ltd.) was responsible for the following:

- Mobilization of one drill rig (air rotary) and support equipment.
- Overburden drilling, using a dry drilling method.
- Standard penetration testing (SPT) and associated sampling in overburden.
- Bedrock drilling, using a dry drilling method.
- Monitoring changes in down hole water production and measuring water levels during drilling operations.
- Installation of groundwater monitoring wells in permeable zones and backfilling of drill holes. (Well pipe and supplies were provided by Mount Polley Mining Corporation.)
- Well development.
- Clean up of drill sites.

Access to the drill sites and drill site construction were the responsibility of Mount Polley Mining Corporation. The monitoring well locations were surveyed by the Mount Polley Mining Corporation survey crew.

The following services were provided by Knight Piésold for the 1996 Groundwater Monitoring Well Installation Program:

- Selection of location for drill sites.
- Supervision of drill activities and monitoring well installations.
- Logging of the drill holes, including SPT samples and drill cuttings. Detailed drill logs are included in this report.
- Laboratory testing of selected samples.
- Selection of completion zones for the groundwater monitoring wells. The monitoring well completion details are included in this report.
- Supervision of well development.
- Training and supervision of monitoring well sampling.



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SECTION 2 - 1996 MONITORING WELL INSTALLATIONS

2.1 <u>GENERAL</u>

The 1996 groundwater monitoring well installation program was conducted between October 30 and December 6, 1996. The 1996 groundwater monitoring wells were designed to serve as permanent groundwater monitoring points for the project. They will be utilized prior to operations, during the life of the mine and after mine closure.

A total of nine sites were selected for well installations, as follows:

- Six sites around the perimeter of the tailings storage facility (GW96-1, GW96-2, GW96-3, GW96-4, GW96-5, GW96-9).
- Three sites around the perimeter of the mine (GW96-6, GW96-7, GW96-8).

The locations of the drill sites are shown on Figure 1.

A total of 15 monitoring wells were installed at the nine locations. Most sites were targeted for one deep and one shallow well. Only GW96-6, GW96-7 and GW96-9 had a single well completed. If two wells were targeted for a site, the geologic formations and hydrogeologic conditions observed during drilling of the first (deep) hole were used to select the well completion zone for the second (shallow) hole. The completion zones of the monitoring wells were selected to target preferential groundwater flow pathways near surface and at depth.

A summary of the monitoring wells, their locations and completion zone details is provided on Table 2.1.

2.2 DRILLING

The drilling was conducted with an air-rotary rig, provided by Drillwell Enterprises Ltd., of Duncan B.C. The holes were advanced with a 149.2 mm (5 7/8 inch) O.D.



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Geologic descriptions and observations of moisture conditions, in-hole water levels and down-hole water production rates are provided on the drillhole logs in Appendix A.

2.3 **GROUNDWATER MONITORING WELL INSTALLATIONS**

After drilling and logging of the first (deep) drillhole was completed at each site, the zones of greatest groundwater yield within each of the overburden and bedrock units were selected for completion of the monitoring wells. If two wells were required, a second hole was then drilled for installation of the shallow well. At GW96-6 and GW96-7, bedrock was encountered at surface or beneath a very thin veneer of overburden and the bedrock permeability was relatively consistent. Therefore, only one well was installed at these locations. GW96-9 was a supplemental well specifically targeted for a near surface aquifer in the vicinity of GW96-3 and GW96-4 and only one well was considered necessary.

Each monitoring well consists of 50.8 mm (2 inch) diameter, decontaminated, flushjointed, threaded Schedule 40 PVC tubing (screens and risers) installed within a hole approximately 150 mm (6 inch) in diameter. Screen lengths from 1.8 m (6 ft) to 6.1 m (20 ft) were selected in the field, as required to capture the extent of the target zone. The screens were provided with #20 (0.020 inch or 0.25mm) slots. The screens were surrounded by a filter pack of uniformly graded #16 silica sand. The well completion zone was hydraulically isolated by an upper and, where necessary, lower bentonite chip seal. In most cases, the upper seal was separated from the #16 filter sand pack by a layer of fine-grained (#20-#30) silica sand in order to prevent downward migration of gelled bentonite into the primary filter pack. Above the upper seal, the hole was backfilled with a combination of bentonite chips and/or cement-bentonite grout (installed using a tremmie pipe) and/or washed gravel (19 mm to 37 mm). Each well installation was completed with a bentonite chip surface seal and a steel protective casing with locking cap at surface.

Monitoring well completion details are provided in Appendix B.



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2.4 IN-SITU TESTING

In-situ testing was limited to Standard Penetration Tests (SPT's) within the overburden in GW96-1A, GW96-2A and GW96-3A for the purpose of collecting further information on foundation conditions at the tailings embankments. Uncorrected SPT blow counts are included on the drillhole logs in Appendix A.

2.5 LABORATORY TESTING

Soil samples collected during Standard Penetration Testing in the 1996 groundwater monitoring well drillholes were sealed up and are in storage at the Mount Polley site. To date, no laboratory testing has been carried out on these samples.



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SECTION 3 - SUMMARY AND CONCLUSIONS

During the 1996 Groundwater Monitoring Well Installation Program, a total of 15 monitoring wells were installed at 9 different sites, 6 of which were located around the perimeter of the tailings storage facility and 3 of which were located around the perimeter of the mine. Monitoring wells were completed in overburden and in bedrock.

Groundwater quality sampling from the monitoring wells is required on a quarterly basis. Monitoring will be conducted prior to commencement of mining operations, in order to establish baseline water quality, during mining operations and for a period of at least 2 years after mine closure. The groundwater monitoring program will be administered and conducted by Mount Polley Mining Corporation.





TABLE 2.1

MOUNT POLLEY MINING CORPORATION MOUNT POLLEY PROJECT

SUMMARY OF 1996 MONITORING WELL INSTALLATIONS

J:\JOB\REPORT\1628\[4-tbl-21.xls|Sheet1

6-Feb-97

Monitoring	General	Coord	inates	Ground	Completion Zone	Geologic Unit
Well No.	Location	Northing	Easting	El. (m)	(m below ground surface)	
GW96-1A	Tailings Facility	5 819 939.06	595 415.82	927.89	52.4 - 60.1	Bedrock
GW96-1B	Tailings Facility	5 819 935.22	595 416.16	927.81	32.6 - 39.0	Overburden
GW96-2A	Tailings Facility	5 819 449.92	596 065.40	931.42	50.9 - 55.2	Bedrock
GW96-2B	Tailings Facility	5 819 447.08	596 074.73	931.42	29.7 - 35.7	Overburden
GW96-3A	Tailings Facility	5 818 308.97	595 768.75	912.06	47.0 - 53.0	Bedrock
GW96-3B	Tailings Facility	5 818 306.52	595 765.16	912.06	15.4 - 20.0	Overburden
GW10 ())						
GW96-4A	Tailings Facility	5 818 164.58	595 147.94	940.56	19.2 - 25.0	Bedrock
GW96-4B	Tailings Facility	5 818 162.87	595 151.26	940.46	2.7 - 7.3	Overburden
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GW96-5A	Tailings Facility	5 819 626.68	594 330.34	973.55	13.8 - 19.7	Bedrock
GW96-5B	Tailings Facility	5 819 629.64	594 329.79	973.44	3.0 - 7.1	Overburden
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GW96-6	Minesite Area	5 822 851.66	593 659.21	1058.53	34.4 - 43.0	Bedrock
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GW90-7	Ivilnesite Area	5 821 520.53	592 983.23	1021.32	9.9 - 14.3	Bedrock
CW06 9A	Minosito Area	5 900 469 46	501 961 50	1050 10	25.2 40.1	Deducals
CW06 PD	Minesite Area	5 822 408.40	591 801.59	1050.10	35.2 - 40.1	Bedrock
G W 90-8B	Minesite Area	5 822 469.40	591 859.31	1050.09	11.0 - 15.7	Overburden/Bedrock
CW06 0	Tailinga Essility	5 010 077 14	505 502 00	016 10	24 (1	Ourstander
C W 90-9	rannigs Facility	3 818 277.14	68.505 262	910.18	3.4 - 6.1	Overburden



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APPENDIX A

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		81	+			9.4 -	10.	- possibly	' w(ithered top of	+:11-> 507	ffer
		-				9.5 -	. + .	- Leromina	l de	nse to very der	se	
	1	ł		1	1	• ~	0+·-	~		- 1		

KNIGHT PIE consulting	SOL[ENGIN	D LT[eers).		TE	EST	HOLE L	OG	TEST HOLE NO. GW96-1A/16 SHEET 2 of 4
PROJECT LOCATION OF DATE BEGUN	M- TES Nov.	<u>t.</u> БТ Н(29/96	//ey DLE_ ;D	- H	rinish	gical ED_D	Investigation	PROJECT NO GROUND EL LOGGED BY	0. <u>/627.300</u>
NOTES Vater loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %	BLOWS/FOOT			DEPTH (m)	GRAPHIC LOG	DESCRIF	PTION AND CLASSI OF MATERIAL	FICATION
DRILLWELL - AIR ROTARY WO WATER - 57/8" & tricone bit - 6" steel casing							2		-
- 6" steel casing Nore: * Gw's A+B Installed in separate drill hotes.		SPT 22 402n= 32 79 79 79 79 79 79 79 79 79 79 79 79 79			10.7 12.1 12.1 12.55 12.55 13.7	0. + · + · + · + · + · + · + · · + · + ·	- becoming VC brown -> E Coarser SAND (TILL) (30/1-35%) Well graded, moist, grey - last 1" of Sand (thin - cont'd gro fine grou low perm fine grou low perm brown of brown of - becoming S SAND (TILL) clay, very brown of SILT and SAN Clay, very sti low permeab red - brown	- silty (25% to - silty (25% to , frace clay, ver massive, low to grey-brow symple silt w layer of glaci ouelly silty s ne grined to sind (20%) el "Fine Till" nes bility, mo - grevelly and dense, well gri moist brow times gravelly and o D (TILL) - grav iff to hard, wel iff to hard, wel	t and grey- , slightly 30%), gravelly y dense, permeability, y dense, permeability, n. some fn 1. istrine?) and till SILT (TILL) and some very stiff, ist, grey-green. SiHy, trace pded, massive, n to orange- mly some pelly, trace graded, massive, trown to siH, trace dense, well

	KNIGHT PIE consulting	SOLI ENGIN	D LT[eers).		TE	EST	HOLE LO	OG	TEST HOLE NO. GW96-IA/IB SHEET 3 of 4
	PROJECT LOCATION OF	M- TES	<u>н. В.</u> St но	<u>//ey</u> DLE_	H	Idro log	gica (Investigation	PROJECT NO GROUND EL	. /627.300
	DATE BEGUN	Nou	1.29/4	26 D.	ATE	FINISH	ED	DEC6/96	LOGGED BY	PJP
	NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %	SPT BLOWS/FOOT	L		DЕРТН (т)	GRAPHIC LOG	DESCRIP	PTION AND CLASSIF OF MATERIAL	FICATION
	DRILLWELL - AIR ROTARY W/O WATER -57/8" of tricone bit -6" steel casing					÷				
	Nore: * Gw's A+B Installed in separate drill hates.					27.7 _		SILT (GLACIO S>nd (10%) Coarse si H Permerbilit Massive?, -may be per	LACUSTRINE)- and clay (5-10 very stiff, y unit, non moist, grey iodic fine gro	trace fine %), mostly likely low plastic, to grey-green. vel and
	NOTE: Upon	24"/ 24" =100 %	45 437 n= 62 5700			- -30,2 - -30.65 -		SAND (GLACIO Fine groined, thin, very de Saturated, g	d loyers. FLUVIAL) - trac silt lominotion ase, poorly gr arey.	e coarse silt, s rare and aded, layered;
	Start-up in Am, whr at 60' below grade inside casing. Note: Begins making wate					- 7.05 - - 31.9 -		SILT (TILL) - S well groded to lower permes SAND (GLACIO Silt (3-10°	Sandy, some grz ace clay (10%) bility, moist OFLUVIAL) - gra b) resulting i	vel, very stilt, , massive, t, grey welly, trace n dirty wate.
AI Plot scole 1-1	-31.9m -2 g>///ni,		-					dense, period sind (fine) 4 w sind a g	ic thin layous 50mm as bro provol.	of silf / ught up
Cio Pro Ventros	-36.6m - 15grtfmil	-				-		between sind in gravel	medium to coa. some grave, to 10% fines	torth se groined to sondy as dirty.
	- 42.4m - 0.g>///nin	- - -		(JU)	96-1	B - 42.4 -		- clean wate	in and collises	t gravel
	steel Craing + Shoe cut-off and left in ground from 47.3 to 48.5							trace clay, Vi massive, low to red-bow	ery stiff to he permesbility	ne yine (2010) and, well groded moist, bown

	KNIGHT PIE CONSULTING	SOLI ENGIN	D LT[eers	Э.		TE	EST	HOLE L	OG	TEST HOLE NO. GW96-14/18 SHEET 4 of 4
	PROJECT LOCATION OF DATE BEGUN	M- TES	<u>н.</u> Бт. на	<u>//ey</u> DLED	- H ATE	<i>Idro loc</i> FINISHI	zical ED	Investigation	PROJECT NO GROUND EL. LOGGED BY	
	NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %	BLOWS/FOOT			DEPTH (m)	GRAPHIC LOG	DESCRIF	PTION AND CLASSIF OF MATERIAL	ICATION
	DRILLWELL - AIR ROTARY W/O WATER -57/8" & tricone bit -6" steel casing					47.6	_	Vokanic Cong	lomerate (Bei	VPVCK) -
	Nore: * Gw's A+B Installed in separate drill hats.					-		"fingments" werthered set of volcrnic - poriodic	t hematitics diment comp clasts. moist rock co	ily altered, ased primarily hips but
	. 30 . :	· •				2 2 		density priminily - no fult Zonos	ind moisture constant facture, wi inprepated	contrat the learning
						-	V V V V			
scole 1-1		-	-	-	0	- 61.3 (201ft)-		GW 96	A	
D RE 1 CO1 DC/A1 PIO				4		-		(59	3	
		-			÷				÷	
						-				2

	KNIGHT PIE consulting	SOLE ENGIN	D LTE).		T{	EST	HOLE L	TEST HOLE No. GW96-74/78	
	PROJECT LOCATION OF DATE BEGUN	M7 TES Nov	<u>F.</u> ST H(<i>10/9</i> ,	//ey DLE(T: 6D	'H' (5F)2A ATE	Vdro 10 N58194 N58194 FINISH	9 i ca / 49.92, 47.06, ED_ <u>M</u>	Investigation 53665.40 536074.73 69.17/96	PROJECT NO GROUND EL LOGGED BY). <u>/627.300</u> 2A: <u>931.42</u> . <u>28: 931.42</u> . <u>PJP</u>
	NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %	BLOWS/FOOT			DEPTH (m)	GRAPHIC LOG	DESCRI	PTION AND CLASSI OF MATERIAL	FICATION
	DRILLWELL - AIR ROTARY W/O WATER - 57/8" of tricone bit - 6" steel cosing									
	Note: * Gw's A+B Installed in separate drill hates.	-				-	+ · + - · · + · L - + · + · L	0-5.5m - C 0-3m - 3-5.5m	SET, WET - SET, WET - VERY DE- SE 2"0.0	"Je, Moist
	GEOLOGY INFERRED FROM CUTTINGS AND SAT SAMPLES	۲ ۲ ۲	h= 250	- PUSNIC ROCK	D	-	+ + + + + + - + - + + + + + + + + +	Y" RECOVER SILT/SAR VERY DI TRACE	Y - PUSHED R ND TILL - GRE ENSE, WELL CLAY, GRAUE	CRADED, MOIST CRADED, MOIST CLY, MASSING
							+ + + + + + + + + + + + + + + + + + +	5.5m - 7.01n Moist GREY	GRAVELLY, O	CIUE GREEN-
						-	++++	7 <u>.01 m 8,5 m</u> SILT/ S OCC ASI	- TILL AND, BROKEN CONAL COBRE	UP GRAUEL, ES.
Piol scole 1-1			-		đ		+ . + - + . + - + . + - + . +	156	18	
	-SAT @ 11.8m	24"	15	N=58	٠	1/m - (36')	+ 0 ⁺ + 0 + + + + + + + -+	GLACIOLACU SILT, SAND C VERY	STRINE GREY- GREEN 5%, SOME O MOIST	TRACE FING LAY (10-15%)
		 	38				++ + - - + + - - + . + - + . +	- MAY LAMIN VERY MINER STOP	ATIONS AS MOIST TO W WATER BUIL DRICCING.	MATRIX IS ET AND DS UP WHEN

KNIGHT PIE CONSULTING	SOL	D LTI	D.	TEST HOLE LOG TEST HOLE No. GW96-74/78 SHEET 2 of 4					
PROJECT LOCATION OF DATE BEGUN	M- TES	<i>t. Po</i> st h 	//eγ OLE_ [<u>96</u> _D	- H ATE	FINISH	gical ED	Investigation Nov. 17/96	PROJECT NO GROUND EL. LOGGED BY	
NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %	BLOWS/FOOT			DEPTH (m)	GRAPHIC LOG	DESCRIF	PTION AND CLASSIF OF MATERIAL	ICATION
DRILLWELL - AIR ROTARY W/O WATER -57/8"\$ tricone bit -6" steel casing									
Nore: * Gwis A+B installed in separate drill holes. SPT 2" 0.0.55 © 101.92 SPT 2" 0.0.55 © 10.55 SPT 2" 0.0.55 © 10.55 SPT 2" 0.0.55 © 10.55 SPT 2" 0.0.55 SPT 2" 0.0.55 SP		18 30 36 45	N=ú6	6011	-18.28	L + + + + + + + + + + + + + + + + + + +	SPT- S.S. 2 GGLACIOLACU - VERY BROWN; THI LAMINAT FINE SAM 30 mm THICH LAYER- CONTENT(LOW VERTIC MODERATE SEAMS (L TO SOMIE LAYERS TO 14.9 - SAT- LGUACIOLA SV. STIF GENERALLY CAMINATIONS RICH LAYER LAYERS OF BETTER GRAN FINE GRAVE LOW PLA PERME ARIC CT. BROWN SEAM(UP UNSATURAT - cuttings indicat till-like Unit SITY, gravely - Driller indicate IS VERY dense	O.D. <u>PII.8</u> <u>STRINE</u> <u>SILT</u> <u>STIFF</u> , OLIVE C INCY TO IRRE <u>ED</u> (2-10 mm <u>ALAYERS</u> , C <u>FINE-MED</u> . OAMP, VARIABO PRIMARILY MO- <u>ALK</u> , POTEN <u>HURIZONTA</u> DISCENTINUUS <u>CLAY</u> IN <u>CLAY</u> IN	(38'9") REEN-LICHIC GULAR THICK), ONTHINS ONE GRAINED SAND CE SILT CS GRAINED), NTIALLY LIC ALONG ') LOW FAIN SPT & 14.9 (49') OATED, YED SILT WITH MORE CMY ASIONAL 2-3cm ORLY SORTED LAYERS WITH MORE CMY ASIONAL 2-3cm ORLY SORTED LAYERS WITH MORE CMY ASIONAL 2-3cm ORLY SORTED LAYERS WITH MORE CMY ASIONAL 2-3cm ORLY SORTED LAYERS WITH D. SAND), RENSE, Well groded (TILL) W SMOOTH DAL

	KNIGHT PI	ESOLD	LT	D.	Γ	T	FST	HOLE I	00	TEST HOLE No.
	PROJECT_	ENGINE MH.	ERS Po	//ev		Vdro lo		Tourstiantin	DG PROJECT NO	SHEET 3 of 4
1	LOCATION OF	F TES	T H(OLE_	ATE	FINISH	FD /	1710C311931747	GROUND EL.	
-	NOTES		ь						LUGGED BY	<u> </u>
	Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY	BLOWS/FO			DEPTH (m)	GRAPHIC LO	DESCRIP	TION AND CLASSIF OF MATERIAL	CATION
	etc. DRILLWELL - AIR ROTARY W/O WATER -57/8"\$ tricone bit -6" steel casing		DT 5-PT 15-76" 0 +1/2" 	Doos ni make Water Dince dri Stopped oninut Stopped oninut Stopped oninut Stopped oninut Stopped oninut Stopped oninut Stopped oninut	ting so of	22.87 	GRA	- becomes fine some fine g moist to un low permean SAND AND SILT fine grained s with 1 to 2 m saturated silt thick fine to sand rayar. Un fine gravel, m moist. - cuttings return fine gravel, m moist. - cuttings return fine gravel, m fine gravel, medium to a dirtier "byers content. West (I.e. medium to a to subrounded - sendy gravel, medium to co % BO e/m - thin silt (Gu	grained to Sa ravel, train cla ery moist, brow Sility (Glacio lacustic Sond and coarse modium grained Mode coarse modium grained Mode coarse frace till-like SILE time gravel (Glacioflovial till-like SILE time gravel (Glacioflovial time gravel) (Coarse frace (Coarse frace (Coarse frace)) (Coarse gravel) is prounded to subr prove grained. Pa invite acciolacustrine) of lovial GRAVEL	ndy Silt, y, no cobbles, in, likely ne) - grained silt ations of tho 3 cm of, saturated permeability andy, trace lift, grey, tinued T-sandy) - believed ds and her and le afines tion S rounded, ounded, ounded, ounded, adves layor - some
		- - - -				- 35.2 - -		trale cobbles at BOElmin, -water test	Continues Mon 20-25 L/min	170), contains king water

		ESOL	D LT	D.		TI	ST	HOLFI	06	TEST HOLE No.
	PROJECT_	M-	t. Po	<u>//ey</u>	- '/	ydro loo	- Cal	Investigation	PROJECT NO	SHEET 4 of 4
	DATE BEGUN	- TES N <u>Nov.</u>	ST H 10/9	OLÉ 6D/	ATE	FINISH	ED	GROUND EL. LOGGED BY	PJP	
	NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %	BLOWS/FOOT			DEPTH (m)	GRAPHIC LOG	DESCRIP	TION AND CLASSIF OF MATERIAL	ICATION
	DRILLWELL - AIR ROTARY W/O WATER -57/8"\$ tricone bit -6"steel casing					36.0		- continued (Coarse SAND contrins 100 - becoming les cleaner way flow rates	Diaciofluvial Gen s, water test lo fines ss fines (15° ler and higher	IVELS and > 50-55 e/min ?/o) and - water
	Al.Im Not: Upon start up. No Water in bottom of hole	pon up. No in botlom hole						Water test SILT (Basal gravel to gra cobbles, slight to very mo grey. - beroming ver low permost - continued gravel are multilit	Till) - sandy Till) - sandy suelly, true cla ly westford, ist, no water stift to her bility, massiv ey till, grovel hic,	Some Some Y, rare moist produced, d, moist, c,giey. tragments
ce cult but see.	· · · · ·					50.3 - - - - 51.2 - - 51.4 - - 51.4 - - 51.4 - - -		- GRAVEL (weath Coarse sand, , Subrounded 7 multilithic, c erosion71 res likely weather - making water	hered bedrock?) - no fines matri to angular and inersily clasts istant qtz a ed conglomera at 10-12-e	Some X, clasts l a not so are nd cherts, ite, lmin
	BEDROCK not making any water	-				61.6m		Conglome RATE smooth drilling, resistant quarte intusive	BEDROCK - 1 closts composed , charts and oc	itry competent, of erosion/ coscons/

h									
	KNIGHT PI	ESOLD ENGINEEF	_TD.		Т	EST	HOLE L	OG	TEST HOLE No.
	PROJECT	Mt.	Polley	<u>' - '</u>	Hydro la	gical	Investigation	PROJECT NO	$1. \frac{1627300}{1627300}$
	LOCATION O	F TEST	HOLE	TSF)	3A: NS 38: NS	81830	.97 E595768.75 52, E595765.16	GROUND EL	3A: 912.06 38: 912.06
		<u> </u>	<u>196</u> 1	JATE 			Nov. 9/96	LOGGED BY	PJP
	NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY % BLOWS /FOOT			DEPTH (m)	GRAPHIC LOG	DESCRIP	TION AND CLASSIF OF MATERIAL	TCATION
	DRILLWELL - AIR ROTARY W/O WATER -57/8"\$ tricone bit -6" steel casing		-		3.0 -		SILT (FILL) - sandy, some clay (10%), k - fill is mixto glaciolacustr	- fill- composed graval (10-25 w prm, very ure of silt fill ine silt	of silt till - e/), some moist, brown and
	5.2m Note: 20min Wait 2 tazl f	5P 14"(18" 2 = 78% 125 			4.95 -		SILT (Glacioli trace fine sa stiff to very coarse silt - fr grey to br Very fine s grey	acustrine)-so and, weakly in stiff, low per me sond himinat own. parse silf en and, stiff, son	me cley, nto-bedded meability, is ns, light d trace two ted,
	standing water in bottomot hole.		-		6.7 -		- prechminsni with up to time sand,	tif well groded some clay for permeabilities	d sitt 1, 22°10 1, 42°10
	o.2 M Note: Water at pond ekustion in bottom of hole overnight.	24"/ 6 24" 97n = 24" 97n 13)2 18	2		8.2		SILT (Glacio) to clayey, ver ligers of sli change and grey-brown natural m/c a	locustrine) - se ry stift, inego ght composis color chang n, moist, moo a R.	ine clay lar tion e, grey to leaste plasticity
I culi . Pe	· -	- - -			9.8 - - -		- becoming SI Isminated w Silt layors	ith rare to . Imm.	acio lacustrine sond leorse
		24"/ 8 137 12,3 100% 22	2	ж.	11.6 - - - -		- continued lam (1 to 3 mm) as -2nd 12" -> Co is quickens u some unit as earlier in yea	insted SILT en above for Is parse silt (se inder viabrati tested with Ch (, saturated, gi	nd CLAY + 12" nsitive) ion. Note: PT incestigation rey, massive.
Sector Se					11.6 +o _ 14.7 _	-	- continued co Blove.	parse siltuni	4 25

Π	KNIGHT PI									
	CONSULTING	ENGINEERS		IEST HOLE LOG						
	PROJECT	<u>Mt. P.</u> F TEST HC	<u>//ey - '/</u> DLE	Hydro lo	<u> 9. ica</u>	(Investigation	PROJECT NO GROUND FI	. <u>/627.300</u>		
		N <u>Nov. 4/96</u>	DATE	FINISH	ED _	Nov. 9/96	LOGGED BY	РЈР		
	NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %		DEPTH (m)	GRAPHIC LOG	DESCRIF	PTION AND CLASSIF OF MATERIAL	TCATION	-	
	DRILLWELL - AIR ROTARY W/O WATER -57/8" & tricone bit	24", 0 - 24" 0]n - 24" 15=1 = 100% 4		14.7		SILT (Glacio la primarily with Note: Low blo continement	custrine) - coard in true for sance in counts due and distur bon	sitt , saturated, to loss of ce caucing		
	- 6" Steel Casing					quickening o unit. (CPT J: very stiff),	f silt (non- to showed vin grey, massive,	olactic) it was saturated.	k	
	1 			17.7 -		-becoming coars returning with water, water y glaciofluvial	e greined with the workings as lest - 50 to 6 sondy grad un	h gravel now gonorsting O elmin, likely	v	
		20", 15 4 55 2 n= 2 1 53 3 108 = 83 % 60		17.65-	-	SAND (Glaciofl medium to coa grey, medium SAND and SILT (uvial) - dense to rse greined, mo to high perm	ssive, saturated,		
						to some clay grad up to - likely Based - continued grad from 17.5 to	viell grodos "\$, mossive Till, no water Y very dense Ba	produced.		
		-		19.8m- - -		- becoming red to be due to volconic cong up in till	brown at tim drilling throug lamersk class unit.	nes believed h red-brown t caught		
lool 00		10"/ 23 10" 80/4" = 100% n = 75		23.6 - - -		SILT and SAM Very dense, moss - occasiono/ c	A (TILL) - consider, low permentions to 25	ability.		
	25m Note: Approx. 10m of wotr in bottom of hole overnight			25 -		- becoming slip silty sond cobbles, grey low permest	shilly more gre trace clay, like to red-brown bility likely,	ly continued mossive, moist		
				-		25m to 35m contid to grey,	glacis/fill-re moist.	dbrown		

		······································							
KNIGHT PII	ESOLD L	TD.	TEST HOLE LOG TEST HOLE NO. GW96-34/38						
PROJECT	<u>M+:</u> /	ο//eγ · HOLE	-	Idro los	gica	(Investigation	PROJECT NO GROUND FI	<u>5HEET 3 of 3</u> <u>/627.300</u>	
	Nov.4/	96 DA	TE I	FINISHI	ED	Nov. 9/96	LOGGED BY	PJP	
NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY % BLOWS/FOOT			DEPTH (m)	GRAPHIC LOG	DESCRIP	TION AND CLASSIF OF MATERIAL	ICATION	
eic. DRILLWELL - AIR ROTARY W/O WATER -57/8"\$ tricone bit -6" steel casing Note: Contact between till and bedrock is dry. Weit 20 minuts but no water. drilled dry to dusty wo occessional damp Zones.				35	GR	Volconiclestic "fragments" of Sediment com drilled with -rock chips ge, return dusty -possible fraction material com and damp t EOH (180f -wait 20 min of hole. -Pull rods and in bottom ot	Eonglomerate- hematically atta- prised of uok tricone bit nearly damp to inte (wet) zon hes out as c for 0.5 to 1.0 h temessure - thole.	Bedrock)- crad, westhend snic closts, > soft dry with re as lumps m. in bottom 1' of water	

[<u>.</u>							
		ESOL ENGIN	D LTC	D.	TEST HOLE LOG TEST HOLE No. <u>GW96-4A/48</u> SHEET / of /					
	PROJECT LOCATION O DATE_BEGUN	<u>M</u> - F TE: N <u><i>N</i>ov.</u>	<u>t. P.</u> st hc 18/96	<u>//ey -</u> DLE <u>(TSF</u> DAT	Hydro lo <u>4A: N58H</u> <u>4B: N58H</u> E FINISH	9, C. 2 / 8164.50 2162-85 ED <u>/</u>	Investigation PROJECT NO. 1627.300 E595147.98 GROUND EL. 48: 240.56 600.20 /96 LOGGED BY			
	NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %	BLOWS/FOOT		DEPTH (m)	CRAPHIC LOC	DESCRIPTION AND CLASSIFICATION OF MATERIAL			
	DRILLWELL - AIR ROTARY W/O WATER -57/8"\$ tricone bit -6" steel cosing				0		SAND (TILL) - gravelly, some silt to silty, trace clay, very dense, well graded, low permeability, moist, medium brown. -(Ablation till)			
	- ^{- 4} 				4.0		SAND (Glaciofluvial) - some gravel to gravelly, trace silt (10%), dense, clasts rounded to subrounded, saturated, moderate permeability, dense, clasts			
	4.5 m Weited 20 minuts, Water at 101 bolow grade .				4.5		grey - brown - becoming slightly cleaner (less finos) and still saturated but not making any water.			
1 cul Pot s		-			- - - - - -		SAND (TILL) - silty, some gravel, trace clay, rare cobbles, very dense, well graded, low permeability, moist, grey-brown.			
	Not: 20' of Water in bollom Of hole overnight.	-			9.8 -		Volconiclostic Conglomerate (Bedrock) - fregments of kempticolly altered volconic in sediment motrix, red-brown, hard, dry. No observable facture Zones. - miking dribble of water			
L	1				25.0		EoH			

Π									
	KNIGHT PII	ESOLI	D LT[D.]	EST	HOLE L	OG	TEST HOLE No. GW96-54/56
	PROJECT LOCATION OI DATE_BEGUN	<u>M-</u> F TES N <u>Nov.</u>	<u>t. B</u> ST H(21/90	//ey - DLE <u>(7</u> 6	- Hydro 1 SF) <u>58: N5</u> TE FINISI	09, CA 1 819626.6 9.8	Investigation 18, E59 4330.34	PROJECT NO GROUND EL.	0/627.300 54: 973.55 58: 973.44 PTD
	NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %	BLOWS/FOOT		DEPTH (m)	CRAPHIC LOG	DESCRIF	PTION AND CLASSIF OF MATERIAL	TICATION
	DRILLWELL - AIR ROTARY W/O WATER -57/8"\$ tricone bit -6" steel casing	-			2.1 -		SILT (Ablat gravel and a hell graded, to saturated - becoming Very mois	ion Till) - San clay, stiff, m low permeabin d, dark brown very stiff, mo st, light to m	dy, some nodentely ity, wet n. ist to nodium bonn
	No water generated in overburden we bedrock during drilling				4.9 -		- hit 0.6m	ø boukkr	
	Noto: 5.5m:left-for Iweek, water at surface upon re-startup.				6.0 -		- beroming gr	rzuelly and dem	se .
		-			6.7 -		- becoming and grey and no	very dense, m , still low p water ganera	oist ermerbility kd
Culty of sci	ب ب ب ب	-			10.4		SYENITE INTR	USIVE (Bedrock	-
					15.2 - - -		-no observable -nor observable for Im, w	to prometitic le tractures, dr tomp chips, no ter bearing?	c, massive, y to damp dust
Ļ					25.5		EoH		

-	·						3
	KNIGHT PIE CONSULTING	ESOLD ENGINEE	LTD. RS		T (EST	HOLE LOG TEST HOLE NO. GW96-6
	PROJECT LOCATION OF DATE BEGUN	<u>M+:</u> = TEST 1 <u>Oct.</u> 3	Polley HOLE 0/96 [<u>Mills;</u> DATE	14 <u>dro 10</u> 1e)- <u>N58</u> FINISHI	<i>gical</i> 22851 ED_(Investigation PROJECT NO 66,6593659.21 GROUND EL. 1058.53 0ct.31/96 LOGGED BY PTP
terration and the second s	NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	RECOVERY %	BLOWS/FUUI		DEPTH (m)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION OF MATERIAL
	etc. DRILLWELL - AIR ROTARY W/O WATER -57/8"\$ triccole bit -6" steel Casing				0 - - - - - - - - - - - - - - - - - - -	άζο Ο	Intermediate Volkanic (Bedrock)- fn grained, dark grey, andesite to besalt, miner epidate alteration, drills quickly, moderably competent, dry; dusty, no indication of water - becoming slightly coaser grained to micro diorite composition, epidate + K-spar alteration, dry, relatively massive, no water produced - let hole stand for 20 minutes, upon restart, 244 of water in bothom of thole, - treve pyrite and minor chalcopyrite for 1 m only, no water a dusty continued.
			2		24.4 - - - - - - - - - - - - - - - - - - -		 let hole stand for 20 minutes, upon start-up, rock chips moist initially only then dusty again. continued microdiorite intrusive, tight, no factures observed. becoming horder to drill No water produced during drilling.

Π								
	KNIGHT PII	ESOLI ENGIN	D LT IEERS	D.		T	EST	THOLE LOG TEST HOLE NO. GW96-7
	PROJECT	M-	+ P	110.		4.1.1	, ,	SHEET / of /
			<u>. 70</u> CT 11	OUT		<u>140-010</u>	2gica	1 Lovestigation PROJECT NO. 1627.300
	DATE DECLIN			ULE	Millen	e): N58	21520	0.53, E592983.23 GROUND EL. 1021.32
		VVov	1.4/91	<u>6</u> l	JAIE	FINISH	HED_	Nov.7/96 LOGGED BY PJP
	NOTES	8	от				ပ	
	Water loss, type	RY .	,FO				LC	
herror	drilling method,	OR OVE	WS/			E PT	HIC	DESCRIPTION AND CLASSIFICATION OF MATERIAL
	etc.	S S S S S S S S S S S S S S S S S S S	ЭГО				RAF	*
U	DRILLWELL -					+		
	AIR ROTARY						-	BILT (TILL) - SENdy, some grove/
	-57/0" & tricme						-	low permerbility, we'rd dense, massing
_	bit						1	moist, brown.
	-6" steel casing	-				-		
-		-				2.4	-	
		-				ļ	-	Diorite (Bedrock) - In gisined ->
							-	vokanie (inda plagioclase feldspar
		_					1	and colcite attered epidote magnetite
	N	_						alterion?, fractured and hashered
-	•••	-				3.0 -	4	- begins work:
		-					-	mening water at 5 to 10 lmin
		-				-	-	
		_				6.0 -	1	- water \$st at 16 2 min
		-				-]	
	-	-				9.0 -		- becoming highly () is the
Γ	+	-				-		fault grups returned with grey
4		-	1			_	1	Wisher Droduled at 19 11
Н		-				-		i je je min
L						10.7 -		- large fragments of rock bracking
		-						off forming pocket incide the
	-	- ·						Rock frigments contain numerous
21 30	-	-						Calcife stringers - fault zone.
đ		-		-		-		- still prototing water
	•	•				15.5 -		FOH (51')
100						_		
								o if drilled deeper many produce move
U	ŀ							water
Π	F					-	2	
	F					-		
H	F	-				-		
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	F							
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		ESOL	D LTI	D.	TEST HOLE LOG						
	PROJECT	ENGIN	t. P	<u>//ey</u>	- [•] h	ydro lo	9,001	Investigation	PROJECT NO	SHEET 1 of 1	2
New York		- ΤΕ: Ι <u>Νου</u>	ST HO .1/96	DLE(M	ATE	BA: N582 88: N5822 FINISH	468.46 462.40 ED	5591861.59 E 591859.31	GROUND EL.	<u>84: 1050.10</u> 88: 1050.09 PJP	-
	NOTES Water loss, type and size of hole, drilling method, groundwater level, etc.	CORE RECOVERY %	BLOWS/FOOT			DEPTH (m)	GRAPHIC LOG	DESCRIP	TION AND CLASSIF OF MATERIAL	TCATION	-
	DRILLWELL - AIR ROTARY W/O WATER -57/8"\$ tricone bit -6"stee/casing					2.4		SILT (FILL) - Sandy silt f Stiff, wet pull-out fo trace organics permeabili SILT and SAN Clay, trace co low permeab water, brow - becoming moist f - becoming GRAVEL (Glacio Subrounded c	fill composed fill with some to saturated, f r road const. s mixed in, fy. D (TILL) - gro bbles, very mo bbles, very mo bbles, very mo very mo ist kery dense and fluvial) - sandy losts, very mo	of reworked gravel, ill formerly ruction, grel, low welly, some oist, oducing dense, indense, ist to wet	
						12.8 - - - 27.4 - - 36.9 - - - 40.1 - -		 but not prod but not prod let stand 5ft of whole. Diorite (Bedroc. mossive some. chlorite alter. begins to a begins to a begins to a becomes much continues to hit frectured now produces continuing in a flow rates to E EOH 	1>sts, very mo lucing wotr, h tor 20 minu, 1>tr in both k) - medium g, what weather tion. what weather tion. whe ISR/m. produce ISR/ Zone (softer) 60 to 70 l /m fracture zone (04.	ist to wet igh permerbility. is and form of isined, i, wesk in ill and imin. land min. with high	

		0.170		······································	
	CONSULTING ENGIN	D LID. NEERS	TEST	T HOLE LOG	TEST HOLE NO. GW96-9
	PROJECTM	t. Pollev	- Hydro logica	1 Tourstingting PROJECT	SHEEL _ of _
_	LOCATION OF TE	ST HOLE 7	SF: N5818277.1	ESOSSO3.89 GROUND	NU. 1027.300
	DATE BEGUN <u>N</u>	<u>DV. 21 /96</u> D	ATE FINISHED	Nov. 21/26 LOGGED E	BY PTP
_	NOTES 🔊	5	y	5	
	Water loss, type ≻ and size of hole, ⊔₩	/FO		DESCRIPTION AND CLAS	SIEICATION
_	drilling method, 000 groundwater level, 000	SMO	DEP1	OF MATERIAL	SSIFICATION
	etc.		GR		
	AIR ROTARY			SILT (TILL) - Sandy, Som	ne grevel
	-57/8" & tricche -			to very stiff, low perm	ness; lity
_	bit -			grey to brown	st to wet,
-	- 6 Steel Casing				
_			-	to very moist	d moist
	-		_		13
	_	10 1	3.9		
			-	SAND (Glaciofluvial) - fin	e givined
			-	silt, moderste perme	bility some
	-			grey-brown.	1, 50101-101
m			-	- contains alternating m	nore anial
	_			rich leyers 0.2 to 0.3	m thick
	-			-producing only dribble of	e water
			5.1 -	saturated cutting	5 . ·
m	-			SILT (Glacio la custrine)	- layered
				and silt by the	fn sond
1	-			silter lamintions, a	suellas
scole 1				stiff to very stiff	w permeability
Plot	-		-	gret, moist to very m	oist.
olinela	·		6.0 -	FOH	
e 104					
Cura	-				
	-				
	F				

Knight Piésold Ltd. CONSULTING ENGINEERS

APPENDIX B

GROUNDWATER MONITORING WELL **COMPLETION DETAILS**







FIGURE B.2







<u>NOTES</u>

- 1. Cement-grout mixture installed using tremmie pipe.
- 2. Depths shown from surface in metres.



<u>NOTES</u>

- 1. Cement-grout mixture installed using
- tremmie pipe.
- 2. Depths shown from surface in metres.





FIGURE B.15