

GEOLOGICAL SURVEY OF CANADA OPEN FILE 7658

Shallow Drilling and Piezometer Installations near Killarney, Manitoba for Hydrogeological Investigations of the Spiritwood Buried Valley Aquifer

M.J. Hinton and D.R. Sharpe

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Abstract

The Geological Survey of Canada (GSC) is investigating the hydrogeology of the Spiritwood buried valley aquifer in southwestern Manitoba as part of its Groundwater Geosciences Program. This Open File reports on a drilling program conducted in November 2010 in which one shallow and one intermediate depth piezometer were installed within separate boreholes at each of three sites near Killarney, Manitoba to complement existing deep wells monitored by Manitoba Conservation and Water Stewardship (Government of Manitoba, Ministry of CWS). Boreholes were advanced without drilling fluids by the cable tool method and by driving core tubes which allowed for accurate borehole logging and the collection of sample cores at selected depths. This Open File includes the geological logs of the boreholes, the piezometer construction details and the geotechnical data measured on sampled core. Geotechnical analyses included measurement of approximate shear strength using a pocket penetrometer (n=21), grain size distribution (n=8), gravimetric water content (n=91), and wet bulk density (n=22) from which dry bulk density (n=22) and volumetric water content (n=22) were calculated and porosity (n=22) estimated.

The drilling program was a collaborative effort between the Agri-Environmental Services Branch (AESB) of Agriculture and Agri-Food Canada (AAFC) and the Geological Survey of Canada of Natural Resources Canada (NRCan).

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Introduction

The Geological Survey of Canada (GSC) is investigating the hydrogeology of the Spiritwood buried valley aquifer in southwestern Manitoba as part of its Groundwater Geosciences Program. The Spiritwood buried valley aquifer is a cross-border aquifer extending from Manitoba, through North Dakota and into South Dakota (Figure 1). This aquifer has been studied extensively in North Dakota but is less known in Manitoba. The Water Resources Branch of Manitoba Natural Resources (currently Water Science and Management Branch of Manitoba Conservation and Water Stewardship, CWS) had previously drilled boreholes in the study area in 1974 and again in 2000-02. Eight monitoring wells drilled along the Spiritwood buried valley aquifer between Margaret, Manitoba, and the international border are currently being monitored by CWS. Most of these monitoring wells are screened at depth in confined units; interpretation of their water level fluctuations is problematic since there are no records of groundwater level response near the ground surface and at intermediate depths. A drilling program was undertaken in November 2010 to install piezometer nests at four sites with active CWS monitoring wells along the Spiritwood buried valley aquifer. One site was not accessible and, at the conclusion of fieldwork, two additional piezometers (one shallow, one intermediate depth) were installed at each of three existing sites. The purpose of this GSC Open File is to present the logs and geotechnical data collected from the six boreholes drilled near Killarney, Manitoba in November 2010.

The drilling program was a collaborative effort between Agriculture and Agri-Food Canada (AAFC) and Natural Resources Canada (NRCan). AAFC provided the drill rig with the field crew and technical support for geotechnical analysis of collected samples and compilation of field logs. NRCan selected the sites, ensured utility clearances before drilling, consulted with drillers to select piezometer installation depths, developed piezometers and installed water level recording dataloggers.

Study area

The study area is located in southwestern Manitoba near the town of Killarney (Figure 2). Four active CWS monitoring well sites were targeted for shallow piezometer installations: G05OA008, G05OA009, G05OA010, and G05OA011, however site G05OA011 was not accessible to the drill rig due to water ponding at the surface in a ditch. AAFC and GSC assigned their own site numbers to the new boreholes and the GSC also assigned new piezometer numbers to the completed piezometers. All borehole and piezometer designations are presented in Table 1 along with their GPS coordinates.

Previous and current studies

The groundwater resources of the Brandon map area were first mapped and summarized by Halstead (1959). By mapping the bedrock topography, he recognized the presence of deep valleys in the bedrock that were subsequently filled with glaciofluvial and glacial sediments. Although he acknowledged the potential of these buried valley aquifers for higher yield wells, there was minimal information available about them. More information existed for the shallower sand and gravel bodies found locally within the till. He observed that the volume of water recovered from these inter-till aquifers varied depending on their thickness, extent and interconnection with other aquifers and the ground surface.

Bedrock topography was subsequently mapped for all southern Manitoba by Klassen et al. (1970). Teller et al. (1976) similarly compiled bedrock topography and sediment thickness for southern Manitoba, whereas Sie and Little (1976) produced several maps and cross-sections of the Brandon

map area for the Groundwater Availability Map Series produced by Manitoba Natural Resources, Water Resources Branch. These maps indicate the presence of a broad buried valley that crosses the international border in a north-south direction just south of Cartwright, Manitoba, and then extends from Cartwright to the northwest towards the Souris River near Margaret.

The province of Manitoba has undertaken test drilling of the Spiritwood aquifer in 1961-62, 1974 and then installed 8 monitoring wells in 2000-02. The results of these drilling programs were never published, although the logs are available within the provincial water well records. In 2009, the province drilled 23 boreholes to specifically target buried valleys to the north and west of the current study area between Margaret and Brandon (Toop, 2010). Test drilling and a short-term pump test were conducted for the development of a groundwater supply for the Town of Killarney (Friesen Drilling Ltd., 2007; W. L. Gibbons & Associates Inc., 2009).

The Spiritwood buried valley aquifer was studied in greater detail in North Dakota where it is a significant water source for irrigation and municipal supply (Randich and Kuzniar, 1984; Shaver, 1984; Shaver and Pusc, 1992). Several cross-sections of mud-rotary holes were drilled at approximately one mile intervals to define the extent of the Spiritwood buried valley aquifer as well as the shallower inter-till aquifers in the area just south of the international boundary (Randich and Kuzniar, 1984).

As part of the GSC's Groundwater Geoscience Program, airborne and ground electromagnetic (Oldenborger, 2010b; Oldenborger, 2010a; Oldenborger et al., 2010; Oldenborger et al., 2011; Oldenborger et al., 2013), seismic reflection (Oldenborger et al., 2011; Oldenborger et al., 2013; Pullan et al., 2013; Pugin et al., 2014) and borehole (Crow et al., 2012a) geophysical surveys were conducted to help define the location, depth and composition of the Spiritwood buried valley aquifer in Manitoba. A borehole was cored to a depth of 97.5 m (320 feet) south of Cartwright, Manitoba, and two piezometers were installed at the site (Crow et al., 2012b).

Methods

All six boreholes were advanced with a B-12 cable tool rig owned and operated by the Agri-Environmental Services Branch (AESB) of AAFC without adding drilling fluids (water or mud; Figure 3 and Appendix B). A 3 1/8" diameter excavator bit was used to drill the initial borehole and bring cuttings to the surface for geological logging. Sediments were described and classified in the field using a modified unified soil classification system (USCS). A pocket penetrometer was used on site to provide estimates of unconfined compressive strength and assist sample descriptions. Intact cores were retrieved for selected intervals in 0.75 m length brass liner tubes driven into the sediment. Cores were sealed and stored for subsequent gravimetric water content and wet bulk density analysis in the laboratory. A core catcher was occasionally used at the base of the tube depending on the nature of the cored sediment. The upper portions of the borehole were usually reamed out using 5 \%" and sometimes 7 1/8" bits to assist with the advance of a temporary 4" casing to keep the borehole open in sandy sections and allow for installation of piezometers and filter sands. The 4" casing was removed following piezometer installation. Piezometers were completed with 2" nominal PVC pipe (schedule 40 thickness) fitted with 20-slot screens (20/1000" slot width). Filter sand was emplaced adjacent to (and slightly above) screened intervals (Table 2). The borehole annulus was sealed with bentonite and followed by borehole cuttings. Lockable steel casing protectors (5'x6"x6") were installed over each piezometer and extended approximately 0.75 m above ground surface (stick up). Locks on the wells were supplied by CWS and were keyed alike to all the CWS monitoring wells.

Cores were extruded from the tubes at AAFC laboratories in Regina to log the geology and obtain samples for geotechnical analysis. Samples were analyzed for gravimetric moisture content (ASTM Committee D18 on Soil and Rock, 2005), wet bulk density (AAFC internal method, described below), and compressive strength using a pocket penetrometer. Grain size analysis (ASTM Committee D18 on Soil and Rock, 2006; ASTM Committee D18 on Soil and Rock, 2007) was conducted to determine the sand and gravel fractions (>75 μ m) of the non-till units. Particles passing through the 75 μ m sieve (silt and clay sized particles) are reported in aggregate as "fines".

Wet bulk density is measured by weighing a wet sample sealed in wax both in air and in water, and includes the following steps (PFRA, no date):

- 1. The soil sample was coated with paraffin wax.
- 2. The waxed sample was weighed on a balance.
- 3. On the same balance, the sample was suspended into a large container of water and weighed while it was submerged in water.
- 4. The sample density was calculated using the following equation:

$$\rho_{wet} = \frac{\mathbf{m}_{a} \cdot \rho_{water}}{\mathbf{m}_{a} - \mathbf{m}_{w}} \tag{1}$$

where

 ρ_{wet} is wet bulk density (g/cm³),

 ρ_{water} is the density of water (g/cm³), assumed to be 1 g/cm³,

 m_a is the sample weight in air (g), and

 m_W is the sample weight in water (g).

From the measured values of gravimetric water content and wet bulk density, both the dry bulk density and volumetric water content were calculated by the following equations:

$$\rho_{dry} = \frac{\rho_{wet}}{(1+w)} \tag{2}$$

$$\theta = \frac{\rho_{wet} \cdot w}{\rho_{water}} \tag{3}$$

where

 ρ_{drv} is dry bulk density (g/cm³),

Wis gravimetric water content (g water/g of soil), and

 θ is volumetric water content (cm³/cm³).

Porosity was also estimated from the following equation by assuming a specific gravity of sediment particles of 2.65:

$$n = \frac{(G_S \cdot \rho_{wet}) - \rho_{dry}}{G_S \cdot \rho_{wet}} \tag{4}$$

where

 $n = \text{porosity } (\text{cm}^3/\text{cm}^3), \text{ and }$

 $G_S = \text{specific gravity (g/cm}^3 / \text{g/cm}^3).$

Results

Two boreholes were advanced at each of three sites and a piezometer was constructed in each borehole for a total of six piezometers (Figure 4, Table 1). Piezometer construction is summarized in Table 2. Borehole logs for each borehole are presented graphically in Figures 5 to 10 and tabulated in Tables 3 to 8. The legend for borehole logs is shown in Figure 11. Borehole logs were based both on field observations of sediment samples during drilling and laboratory inspection of extruded cores. Field borehole descriptions are reproduced in Appendix A. Grain size distributions of non-till units are presented in Figures 12 to 19. Geotechnical results are compiled in Tables 9 to 11.

Site GSC-BH-SW-02 (CWS well G050A010)

The well log for the mud-rotary drilled monitoring well G05OA010 (Table 12) corresponds closely with that obtained from borehole GSC-BH-SW-02A (Figure 6, Table 3). A shallow sand unit was encountered between 0.45 and 1.15 m and was instrumented with piezometer GSC-SW-02-p1 (in borehole GSC-BH-SW-02B) which will provide an effective measurement of the water table depth. The deepest observation of oxidation in borehole GSC-BH-SW-02A was 3.15 m whereas beige till was noted to a depth of 3.7 m (12') for well G05OA010.

Although the borehole log for GSC-BH-SW-02A only indicates one deeper sand unit from 8.00 m to 8.60 m, another thinner sandy seam was encountered at 9.75 m (Appendix A1) and is also recorded in well G05OA010 from 33-34′ (10.1-10.4 m). The screen for piezometer GSC-SW-02-p2 straddles this thin sandy seam. Borehole GSC-BH-SW-02A was not extended deeper because there were no other sandy units reported above the deeper aquifer in well G05OA010 (Table 12) and drilling progress was hampered by a cobble at 9.1 m.

Grain size analyses of the shallow (Figure 19) and intermediate (Figure 18) sand units yielded similar size distributions that indicate a predominance of medium sand with 18% and 16% of fines (silt and clay sized sediment), respectively. Geotechnical data show fairly consistent measurements within the till (Table 9). Average values of wet and dry bulk densities (n=5) were 2.08±0.06 and 1.78±0.08 g/cm³, respectively. Results showed consistency as the average volumetric water content (n=5) was 0.30±0.02, whereas the average estimated porosity (n=5) was 0.33±0.03. Pocket penetrometer readings indicated a very stiff to hard consistency. The sand at 8.0 to 8.6 m depth had higher gravimetric water contents than the till (Table 9), which suggests that the porosity of the sand is higher than that of the till and/or that the dry bulk density of the sand is lower than that of the till.

Site GSC-BH-SW-03 (CWS well G05OA009)

The well log for the mud-rotary drilled monitoring well G05OA009 (Table 13) indicates a clayey beige till (i.e. oxidized) to a depth of 5.5 m (18') which is comparable to the observed maximum depths of 6.75 m of joint oxidation and the presence of gypsum in borehole GSC-BH-SW-03A (Figure 8, Table 5). The shallow piezometer GSC-SW-03-p1 is completed in a silty seam within the oxidized till of borehole GSC-BH-SW-03B and provides a measurement of the water table depth. The sand seam from 1.4 to 1.5 m depth would not have been suitable for piezometer installation since the water table is below this depth most of the time.

The numerous descriptions of "clay shale" within borehole GSC-BH-SW-03A either as fragments or as "shale' units are testimony to the high proportion of reworked shale within the till (Figure 8, Table 5, Appendix A3). The shale is present throughout much of the thickness of till as the first "clay shale" unit in borehole GSC-BH-SW-03A is recorded at 17.8-18.0 m depth (and at 18.6-19.2 m (61-63') depth in G05OA009) and the depth of the true shale bedrock surface is recorded as 59.7 m (196') in well G05OA009.

A five foot thick "sand and gravel layer" was recorded in well G05OA009 at a depth of 32.0-33.5 m (105-110'). In borehole GSC-BH-SW-03A only a few thin sandy and silty seams were encountered within the till between depths of 22.8 and 33.4 m. Piezometer GSC-SW-03-p2 straddles the lowermost of these thin sandy seams with a filter pack extending from 31.4 to 35.0 m depth.

The greater variability in the till was also observed in the geotechnical properties. Gravimetric water contents exhibited a wide range from 13.0 to 30.8 g of water/100 g of dry soil even below the water table with an average for all measurements of 21.3±4.9 g/100 g. Average values of wet and dry bulk densities (n=11) were 1.97±0.11 and 1.64±0.14 g/cm³, respectively, whereas average volumetric water content and porosity were 0.33±0.04 and 0.38±0.05, respectively. Pocket penetrometer readings had the largest range of the three sites and indicated stiff to hard consistency.

Grain size analyses from the only non-till or clay shale units encountered characterize the sandy and silty seams. The sand seam is predominantly fine sand (75%), has no sediment coarser than medium sand (8%) and has 17% fines (24.0-24.1 m depth, Figure 16). The underlying sandy silt unit has only 1% medium sand, 44% fine sand and is predominantly (55%) fines (24.1-24.3 m depth, Figure 17).

Site GSC-BH-SW-04 (CWS well G05OA008)

The well log for the mud-rotary drilled monitoring well G05OA008 (Table 14) differs significantly with that obtained from borehole GSC-BH-SW-04A (Figure 10, Table 7). Whereas the well log for G05OA008 records brown coarse sand (0-5.5 m, 0-18') and brown coarse gravel (5.5-6.7 m, 18-22'), the description of borehole GSC-BH-SW-04A makes no mention of sand or gravel and simply reports stiff to hard till with oxidized fractures or joints to a depth of 7.90 m. Similarly, the sandy non-till units in borehole GSC-BH-SW-04A (between 12.19 and 14.80 m depth) are offset from the gravel recorded in well G05OA008 (between 18.9 and 19.5 m, 62-64'). As the UTMs on well G05OA008 (Table 14) concur with those for GSC-SW-04-p1 and -p2 (Table 1), even though they were obtained independently, it is concluded that the correct well log for G05OA008 was likely used but that the site geology may have been misinterpreted in the mud-rotary borehole.

Piezometer GSC-SW-04-p1 was completed near the base of the oxidized zone (filter pack from 4.00 to 7.50 m depth), slightly below the water table (2.6-3.8 m deep). The intermediate depth piezometer GSC-SW-04-p2 straddles the sand and gravel units in borehole GSC-BH-SW-04A with a filter pack extending from 11.40-15.10 m depth.

Compared to borehole GSC-BH-SW-03A, the grain size distributions of non-till units in GSC-BH-SW-04A (Figures 12-15) are coarser and slightly less uniform (better graded). In particular, the sample at 13.4 m depth has 42% gravel, 49% sand and 9% silt and clay (fines; Figure 13). The presence of fines even in gravel units suggests that high hydraulic conductivities are unlikely within the inter-till sands and gravels of these boreholes.

Geotechnical data show considerable variability (Table 11). Gravimetric water contents are generally lower that for site GSC-BH-SW-03 with an average value of 16.3 ± 3.8 g/100 g that may reflect the coarser grain size in borehole GSC-BH-SW-04A. Although average values and standard deviations of porosities and volumetric water contents are similar to those for borehole GSC-BH-SW-03A, the estimated porosities $(0.37\pm0.06, n=6)$ are consistently higher than the calculated volumetric water contents $(0.28\pm0.04, n=6)$ even if only those samples below the water table are considered (n=5). Average values of wet and dry bulk densities (n=5) were 1.96 ± 0.13 and 1.68 ± 0.15 g/cm³, respectively. Pocket penetrometer readings indicated very stiff to hard consistency.

Additional work and installations

The piezometer nests are being used to assess groundwater conditions at these three sites as part of the investigation of the Spiritwood buried valley aquifer. These piezometers have also been developed, bail and slug tested and instrumented to allow for continuous monitoring. The piezometers have also been purged and sampled for groundwater geochemical and isotopic analyses. Soil moisture probes have been installed at sites GSC-BH-SW-02 and GSC-BH-SW-04 to provide data on the timing of infiltrating precipitation in relation to groundwater recharge.

Summary

This report documents geological, geotechnical and piezometer data collected during the drilling of six boreholes at three sites near Killarney, Manitoba. A piezometer was successfully installed in each borehole such that each monitoring site now has a vertical nest of three piezometers, including a shallow piezometer near the water table, an intermediate piezometer that straddles a sandy seam or layer, and a deeper Manitoba CWS monitoring well. As these boreholes were advanced without drilling fluids and cores were retrieved, the geology logs were expected to be more accurate than mudrotary logger boreholes. The boreholes predominantly intercepted till with occasional gravel and sand or silt seams or thin layers. The depth of oxidation within the till varied from 3.15 m to 7.90 m. Till was mostly stiff to very hard. Geotechnical measurements were most uniform at site GSC-BH-SW-02 and most variable at site GSC-BH-SW-03. These piezometer installations will permit interpretation of the hydraulic relations between the groundwater table and the Spiritwood buried valley aquifer.

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Figures

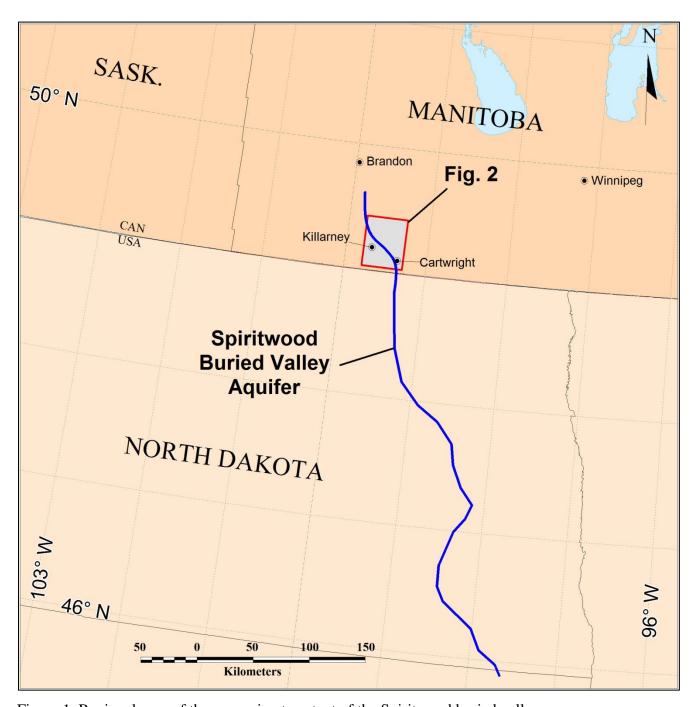


Figure 1. Regional map of the approximate extent of the Spiritwood buried valley.

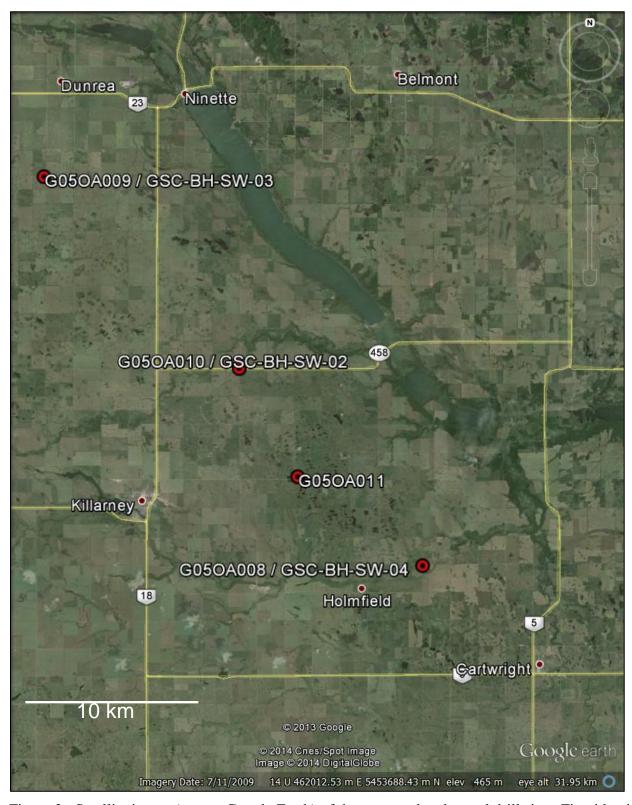


Figure 2. Satellite image (source Google Earth) of the proposed and actual drill sites. First identifiers are the Manitoba Water Stewardship well numbers, second identifiers are the GSC borehole site numbers.



Figure 3. B-12 cable tool rig and field core logging trailer at site G05OA010 (GSC-BH-SW02), November 2010.



Figure 4. Photographs of piezometer sites. a) GSC-SW-02-p1 (foreground), GSC-SW-02-p2 (middle) and G05OA010 (distant), facing NNW.



b) GSC-SW-03-p1 (left), GSC-SW-03-p2 (middle) and G05OA009 (right), facing NNE.



c) G05OA008 (left), GSC-SW-04-p2 (middle), GSC-SW-04-p1 (right), facing south.

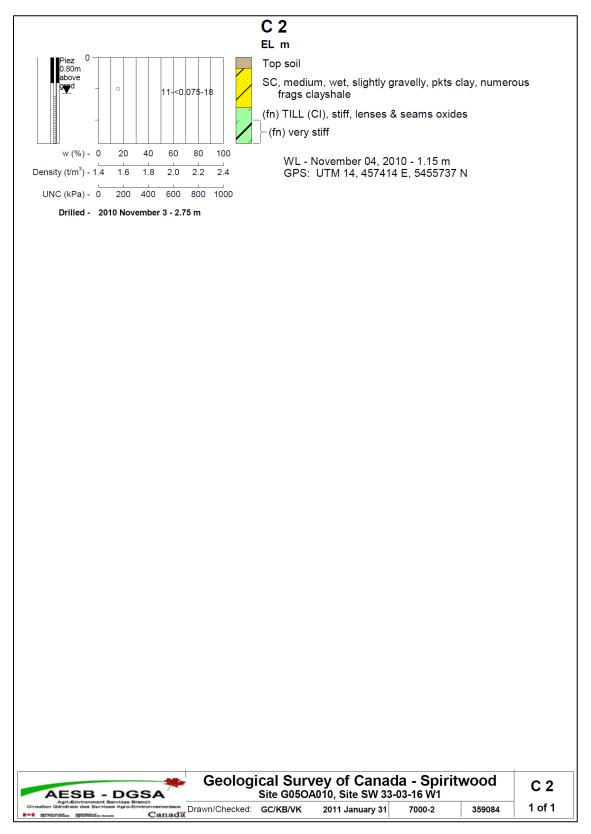


Figure 5. Borehole log for GSC-BH-SW-02B completed with piezometer GSC-SW-02-p1.

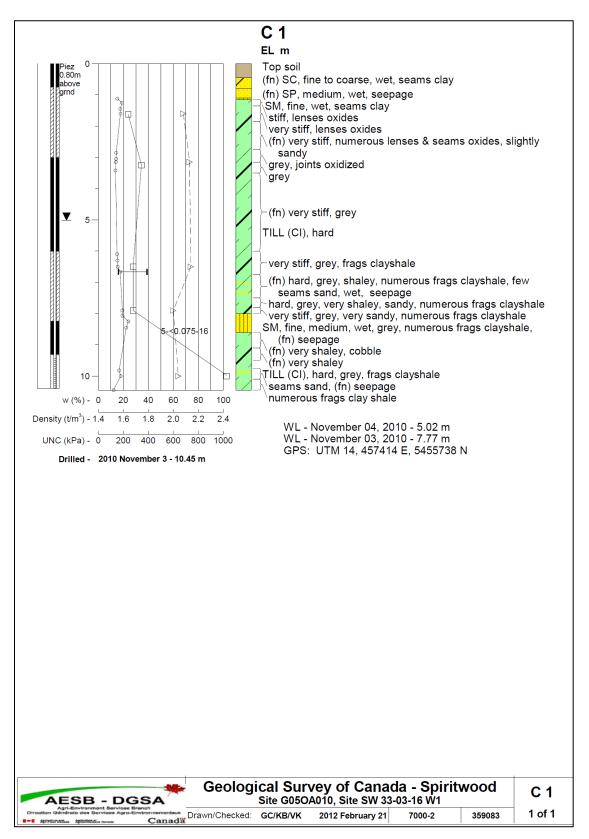


Figure 6. Borehole log for GSC-BH-SW-02A completed with piezometer GSC-SW-02-p2.

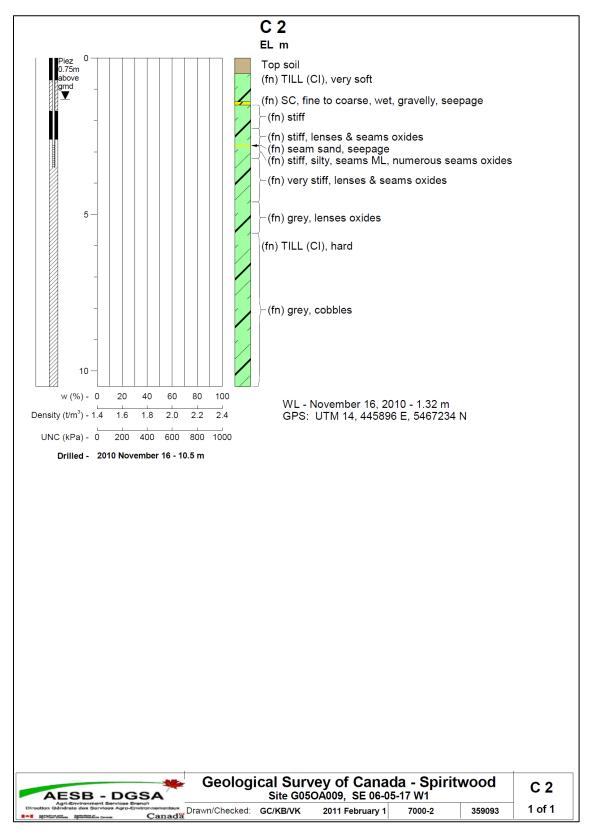


Figure 7. Borehole log for GSC-BH-SW-03B completed with piezometer GSC-SW-03-p1.

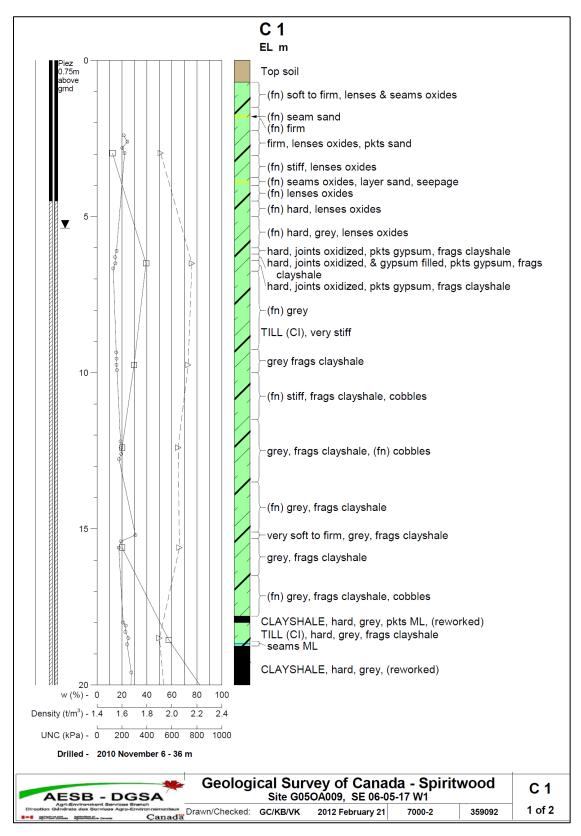


Figure 8a. Borehole log for GSC-BH-SW-03A completed with piezometer GSC-SW-03-p2, 1 of 2.

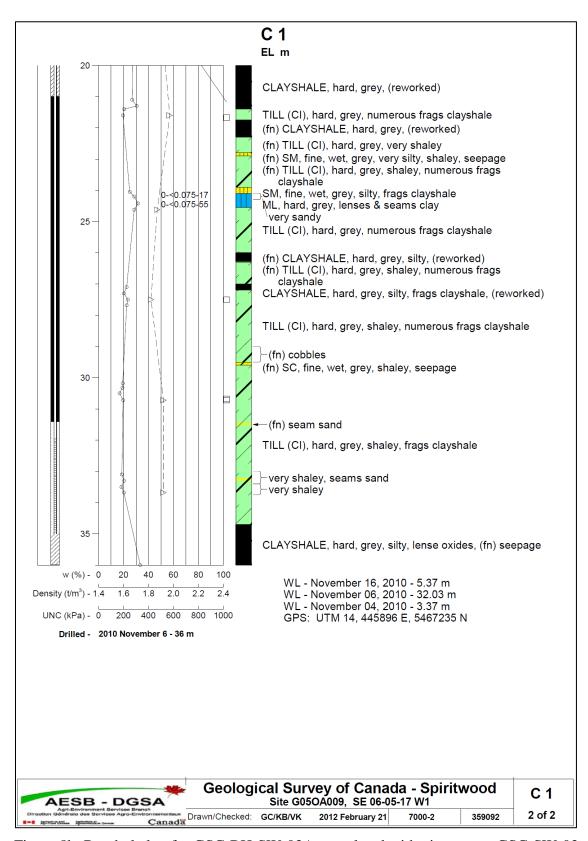


Figure 8b. Borehole log for GSC-BH-SW-03A completed with piezometer GSC-SW-03-p2, 2 of 2.

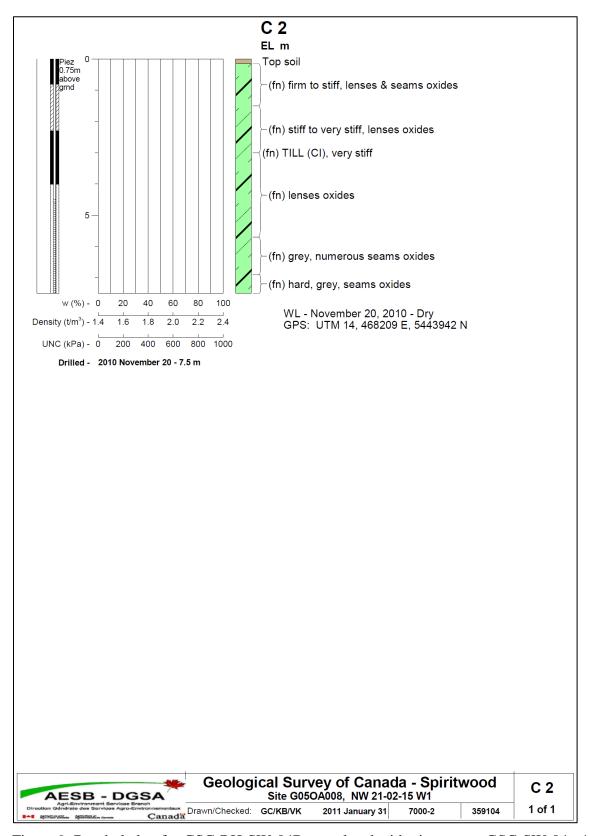


Figure 9. Borehole log for GSC-BH-SW-04B completed with piezometer GSC-SW-04-p1.

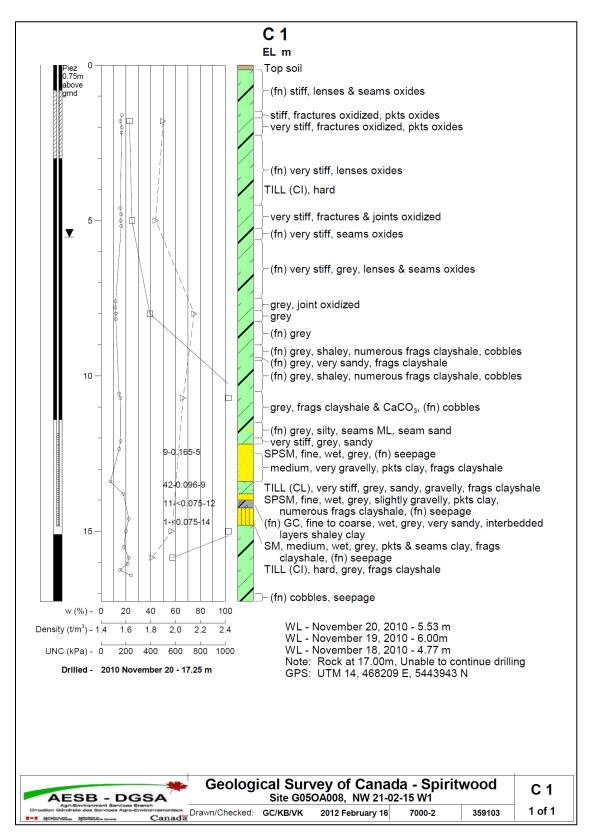


Figure 10. Borehole log for GSC-BH-SW-04A completed with piezometer GSC-SW-04-p2.

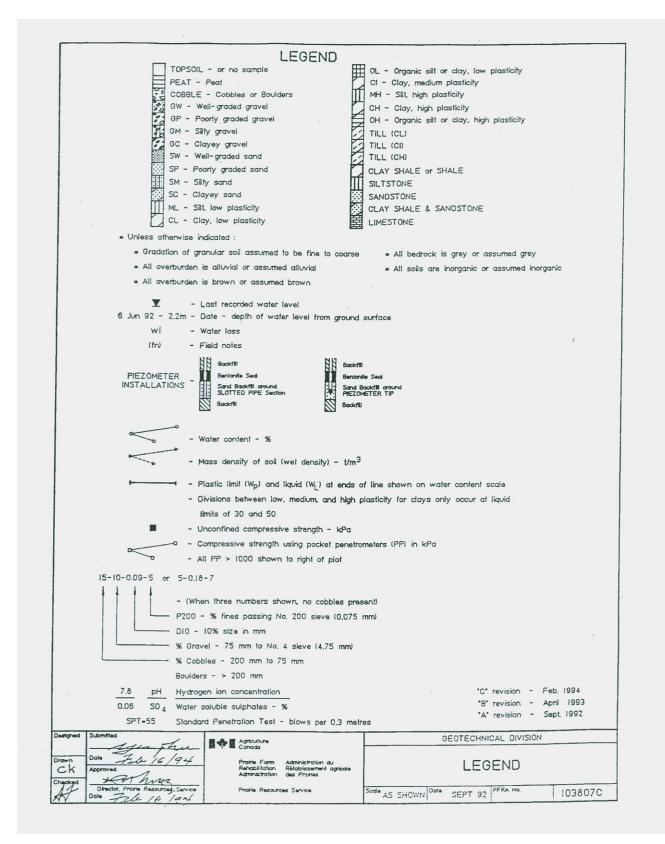


Figure 11. Legend for borehole logs in Figures 5-10 (provided by AAFC).

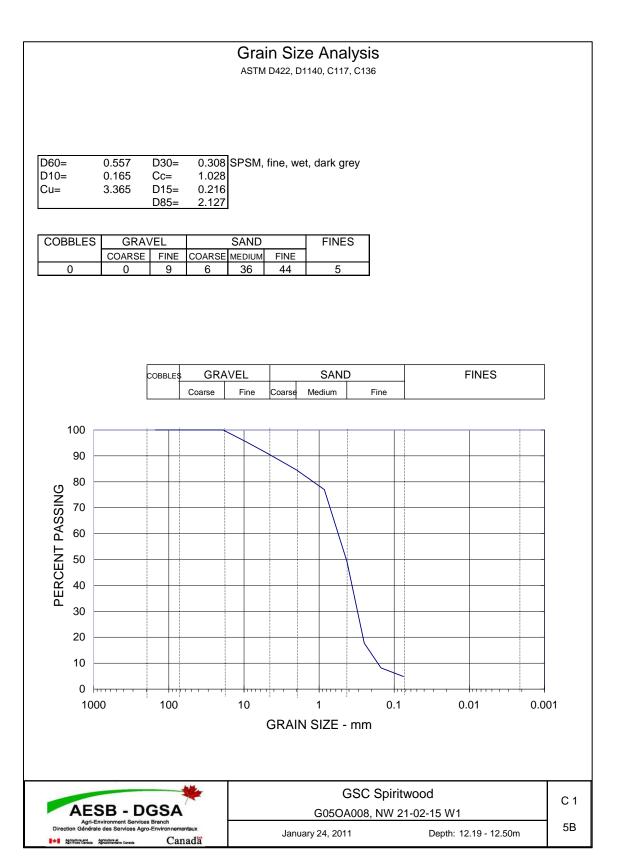


Figure 12. Grain size analysis, borehole GSC-BH-SW-04A, 12.19-12.50 m depth.

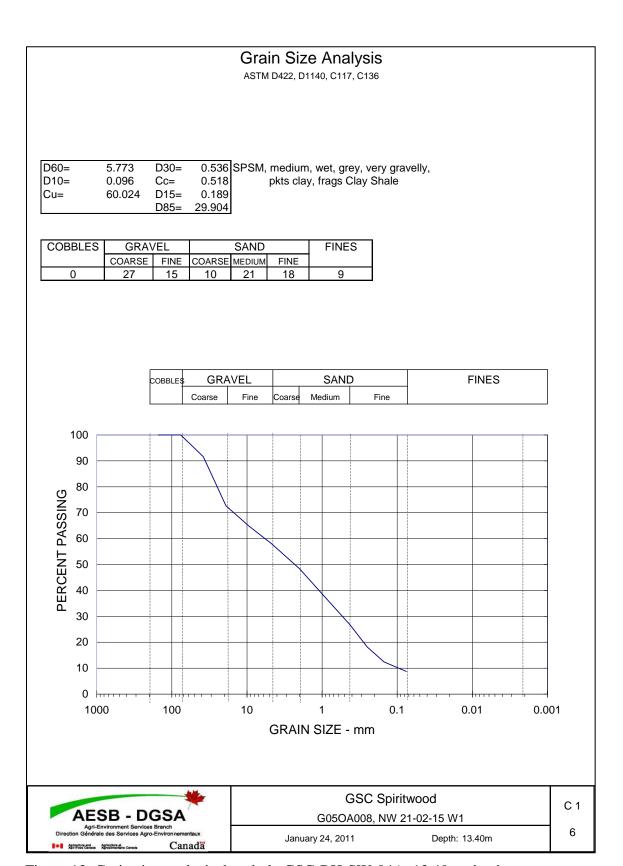


Figure 13. Grain size analysis, borehole GSC-BH-SW-04A, 13.40 m depth.

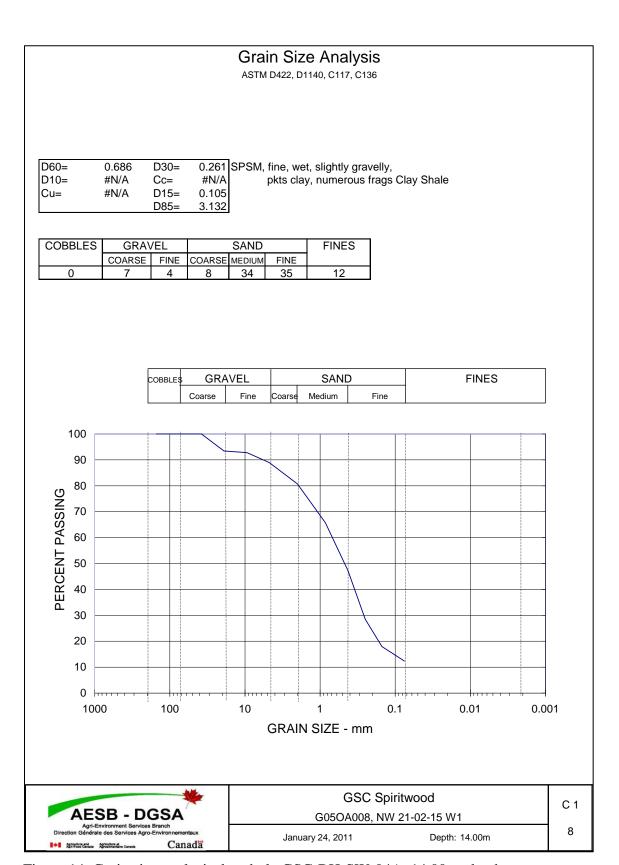


Figure 14. Grain size analysis, borehole GSC-BH-SW-04A, 14.00 m depth.

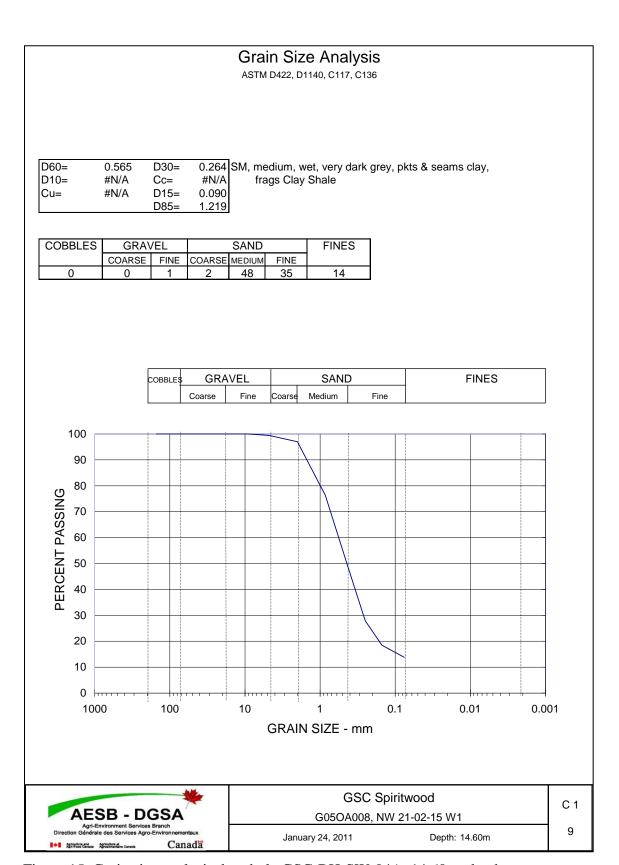


Figure 15. Grain size analysis, borehole GSC-BH-SW-04A, 14.60 m depth.

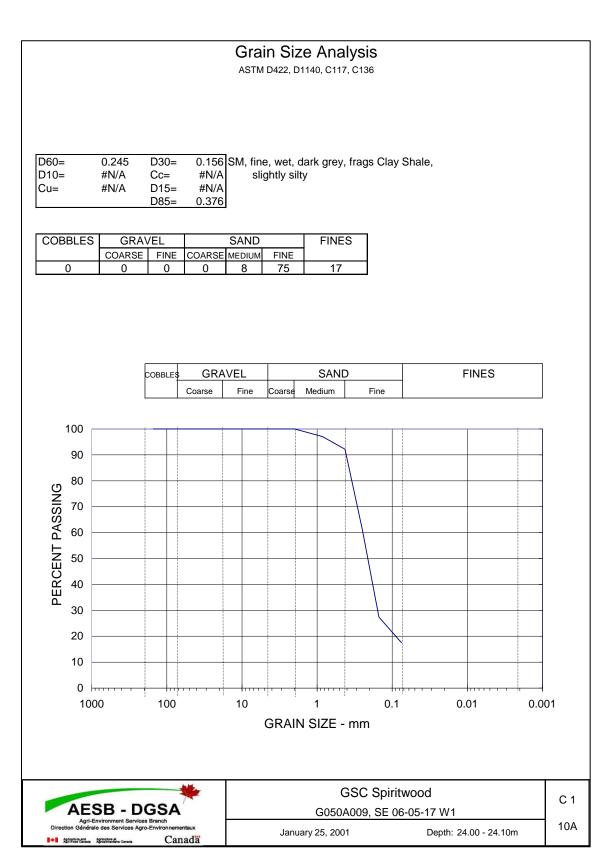


Figure 16. Grain size analysis, borehole GSC-BH-SW-03A, 24.00-24.10 m depth.

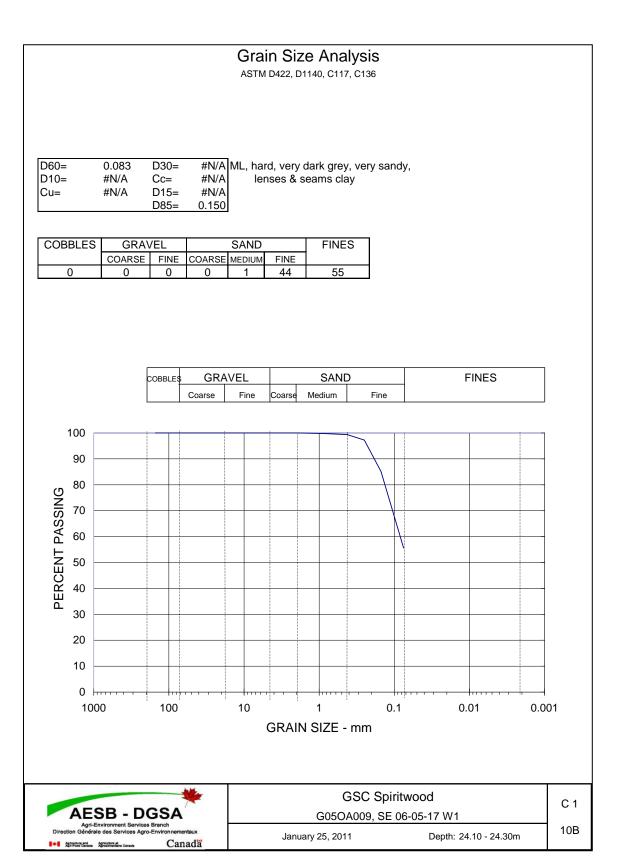


Figure 17. Grain size analysis, borehole GSC-BH-SW-03A, 24.10-24.30 m depth.

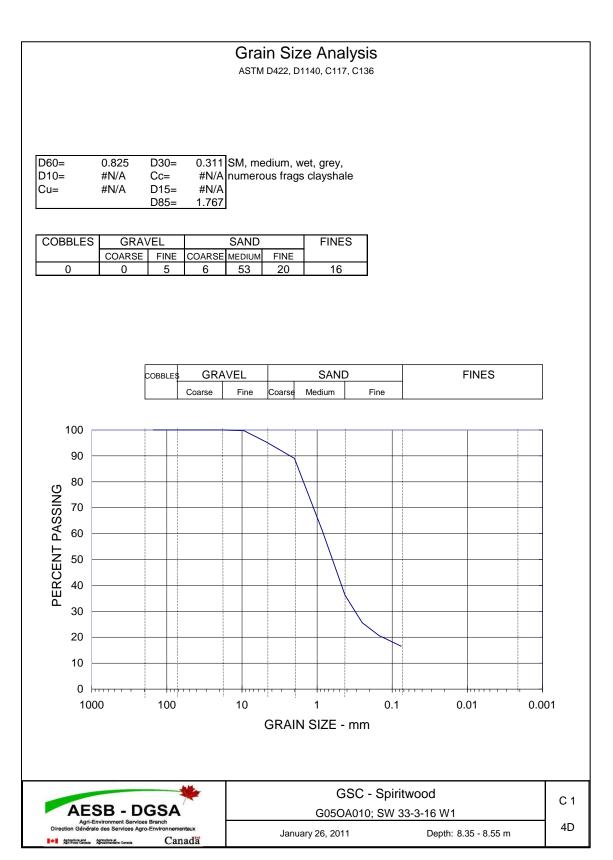


Figure 18. Grain size analysis, borehole GSC-BH-SW-02A, 8.35-8.55 m depth.

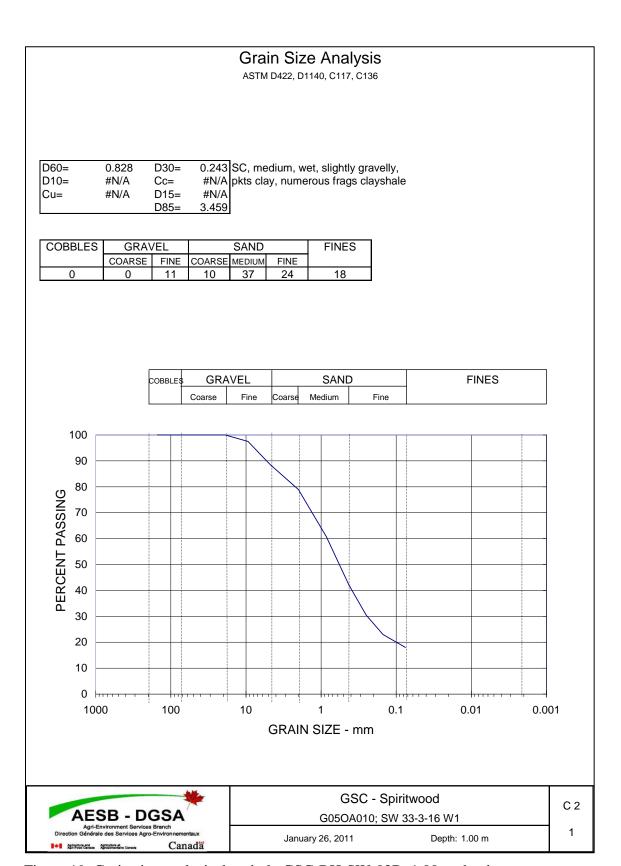


Figure 19. Grain size analysis, borehole GSC-BH-SW-02B, 1.00 m depth.

Tables

Table 1. Borehole and piezometer designations and locations.

AAFC borehole ID	Nearby CWS	GSC borehole ID	GSC piezometer ID	UTM E	UTM W	Quarter section
	monitoring well ID			NAD83,	NAD83,	
				Zone 14	Zone 14	
G05OA010 C1	G05OA010	GSC-BH-SW-02A	GSC-SW-02-p2	457414.6	5455734.3	SW33-3-16-W1
G05OA010 C2	G05OA010	GSC-BH-SW-02B	GSC-SW-02-p1	457414.7	5455732.9	SW33-3-16-W1
G05OA009 C1	G05OA009	GSC-BH-SW-03A	GSC-SW-03-p2	445897.5	5467233.2	SE6-5-17-W1
G05OA009 C2	G05OA009	GSC-BH-SW-03B	GSC-SW-03-p1	445895.5	5467232.9	SE6-5-17-W1
G05OA008 C1	G05OA008	GSC-BH-SW-04A	GSC-SW-04-p2	468211.5	5443940.0	NW21-2-15-W1
G05OA008 C2	G05OA008	GSC-BH-SW-04B	GSC-SW-04-p1	468209.8	5443939.9	NW21-2-15-W1

GPS data were collected in October 2011 using a Trimble Pathfinder ProXT GPS receiver with an integrated SBAS (Satellite Based Augmentation Systems) to provide 2 to 5 meter horizontal accuracy.

Table 2. Piezometer installations.

GSC piezometer	er Stick Depth to		Depth to	Mid-screen	Screen	Total casing	Measured depth	Approx. length of
	up	screen top	screen bottom	depth	length	depth	from measuring	pipe at installation
	(mags)	(mbgs)	(mbgs)	(mbgs)	(m)	(mbgs)	point to bottom (m)	(m)
GSC-SW-02-p2	0.771	9.43	10.40	9.92	0.97	10.396	11.167	11.15
GSC-SW-02-p1	0.737	1.25	2.75	2.00	1.50	2.733	3.47	3.50
GSC-SW-03-p2	0.690	31.96	34.95	33.46	2.99	34.967	35.657	35.70
GSC-SW-03-p1	0.690	2.80	3.50	3.15	0.70	3.553	4.243	4.25
GSC-SW-04-p2	0.767	11.85	14.85	13.35	3.00	14.442	15.209	15.60
GSC-SW-04-p1	0.730	4.51	7.50	6.01	2.99	7.437	8.167	8.25

GSC piezometer	Approx.	Filter	Depth to	Depth to	Type of seal	Top of seal	Bottom of seal
	elevation	pack	top of filter	bottom of		(mbgs)	(mbgs)
	top of	material	pack	filter pack			
	casing		(mbgs)	(mbgs)			
	(masl)						
GSC-SW-02-p2	470.461 ^a	sand	9.30	10.45	Hole Plug bentonite 1/4" pellets	8.25	9.30
					Hole Plug bentonite chips	3.00	6.00
GSC-SW-02-p1	470.427 ^a	sand	0.80	2.75	Native material	0.00	0.80
GSC-SW-03-p2	468.137 ^b	sand	31.40	35.00	Hole Plug bentonite 1/4" pellets	21.00	31.40
					and Econo Hole Plug		
GSC-SW-03-p1	468.137 ^b	sand	2.60	3.50	Hole Plug bentonite chips	1.70	2.60
GSC-SW-04-p2	470.987 ^c	sand	11.40	15.10	Hole Plug bentonite chips	3.00	11.40
GSC-SW-04-p1	470.950 ^c	sand	4.00	7.50	Hole Plug bentonite chips	2.30	4.00

Table 2. Piezometer installations (continued).

GSC piezometer	Piezometer	Piezometer	Piezometer	Slot	Screen	Method of drilling	Drilling	Date	Date
	material	diameter,	inside diameter	size	material		fluid	drilling	completion
		nominal	(cm)	"/1000				start	
		(in)							
GSC-SW-02-p2	PVC, sch 40	2	5.17	20	PVC	B14 cable-tool rig	none	02-Nov-10	03-Nov-10
GSC-SW-02-p1	PVC, sch 40	2	5.17	20	PVC	B14 cable-tool rig	none	03-Nov-10	03-Nov-10
GSC-SW-03-p2	PVC, sch 40	2	5.17	20	PVC	B14 cable-tool rig	none	04-Nov-10	06-Nov-10
GSC-SW-03-p1	PVC, sch 40	2	5.17	20	PVC	B14 cable-tool rig	none	16-Nov-10	16-Nov-10
GSC-SW-04-p2	PVC, sch 40	2	5.17	20	PVC	B14 cable-tool rig	none	17-Nov-10	20-Nov-10
GSC-SW-04-p1	PVC, sch 40	2	5.17	20	PVC	B14 cable-tool rig	none	20-Nov-10	20-Nov-10

^a Not surveyed yet. Approximate elevation obtained by adding casing stick up to the reported ground surface elevation of 469.690 masl of Manitoba CWS well G05OA010.

^b Not surveyed yet. Approximate elevation obtained by adding casing stick up to the reported ground surface elevation of 467.447 masl of Manitoba CWS well G05OA009.

^c Not surveyed yet. Approximate elevation obtained by adding casing stick up to the reported ground surface elevation of 470.220 masl of Manitoba CWS well G05OA008.

Table 3. Borehole log descriptions, GSC-BH-SW-02A.

Top	Bottom	USCS	Description
Depth	Depth	description	
(m)	(m)		
0.00	0.45	TOPSOIL	
0.45	0.80	SC	(fn) SC, fine to coarse, wet, seams clay
0.80	1.10	SP	(fn) SP, medium, wet, seepage
1.10	1.15	SM	SM, fine, wet, seams clay
1.15	8.00	TILL (CI)	TILL (CI), hard
1.15	1.35	TILL (CI)	stiff, lenses oxides
1.35	1.85	TILL (CI)	very stiff, lenses oxides
1.85	2.75	TILL (CI)	(fn) very stiff, numerous lenses & seams oxides, slightly sandy
2.75	3.15	TILL (CI)	grey, joints oxidized
3.15	3.50	TILL (CI)	grey
3.50	6.00	TILL (CI)	(fn) very stiff, grey
6.00	6.75	TILL (CI)	very stiff, grey, frags clayshale
6.75	7.50	TILL (CI)	(fn) hard, grey, shaley, numerous frags clayshale, few seams
			sand, wet, seepage
7.50	7.80	TILL (CI)	hard, grey, very shaley, sandy, numerous frags clayshale
7.80	8.00	TILL (CI)	very stiff, grey, very sandy, numerous frags clayshale
8.00	8.60	SM	SM, fine, medium, wet, grey, numerous frags clayshale, (fn)
			seepage
8.60	10.45	TILL (CI)	TILL (CI), hard, grey, frags clayshale
8.60	9.10	TILL (CI)	(fn) very shaley, cobble
9.10	9.50	TILL (CI)	(fn) very shaley
9.75	10.10	TILL (CI)	seams sand, (fn) seepage
10.10	10.45	TILL (CI)	numerous frags clay shale

Table 4. Borehole log descriptions, GSC-BH-SW-02B

Top	Bottom	USCS	Description
Depth	Depth	description	_
(m)	(m)		
0.00	0.35	TOPSOIL	
0.35	1.60	SC	SC, medium, wet, slightly gravelly, pkts clay, numerous frags
			clayshale
1.60	2.75	TILL (CI)	(fn) TILL (CI), stiff, lenses & seams oxides
2.00	2.75	TILL (CI)	(fn) very stiff

Table 5. Borehole log descriptions, GSC-BH-SW-03A

Тор	Bottom	USCS	Description
Depth	Depth	description	
(m)	(m)	_	
0.00	0.70	TOPSOIL	
0.70	17.80	TILL (CI)	TILL (CI), very stiff
0.70	1.50	TILL (CI)	(fn) soft to firm, lenses & seams oxides
1.50	2.25	TILL (CI)	(fn) firm
1.80		TILL (CI)	(fn) seam sand
2.25	3.05	TILL (CI)	firm, lenses oxides, pkts sand
3.05	3.75	TILL (CI)	(fn) stiff, lenses oxides
3.75	4.00	TILL (CI)	(fn) seams oxides, layer sand, seepage
4.00	4.50	TILL (CI)	(fn) lenses oxides
4.50	5.00	TILL (CI)	(fn) hard, lenses oxides
5.00	6.00	TILL (CI)	(fn) hard, grey, lenses oxides
6.00	6.20	TILL (CI)	hard, joints oxidized, pkts gypsum, frags clayshale
6.20	6.40	TILL (CI)	hard, joints oxidized, & gypsum filled, pkts gypsum, frags
			clayshale
6.40	6.75	TILL (CI)	hard, joints oxidized, pkts gypsum, frags clayshale
6.75	9.25	TILL (CI)	(fn) grey
9.25	10.00	TILL (CI)	grey frags clayshale
10.00	11.50	TILL (CI)	(fn) stiff, frags clayshale, cobbles
11.50	13.50	TILL (CI)	grey, frags clayshale, (fn) cobbles
13.50	15.10	TILL (CI)	(fn) grey, frags clayshale
15.10	15.30	TILL (CI)	very soft to firm, grey, frags clayshale
15.30	16.50	TILL (CI)	grey, frags clayshale
16.50	17.80	TILL (CI)	(fn) grey, frags clayshale, cobbles
17.80	18.00	SHALE	Clay shale, hard, grey, pkts ML, (reworked)
18.00	18.75	TILL (CI)	TILL (CI), hard, grey, frags clayshale
18.60	18.75	TILL (CI)	seams ML
18.75	20.01	SHALE	Clay shale, hard, grey, (reworked)
20.00	21.40	SHALE	Clay shale, hard, grey, (reworked)
21.40	21.75	TILL (CI)	TILL (CI), hard, grey, numerous frags clayshale
21.75	22.30	SHALE	(fn) CLAY SHALE, hard, grey, (reworked)
22.30	22.80	TILL (CI)	(fn) TILL (CI), hard, grey, very shaley
22.80	22.90	SM	(fn) SM, fine, wet, grey, very silty, shaley, seepage
22.90	23.90	TILL (CI)	(fn) TILL (CI), hard, grey, shaley, numerous frags clayshale
23.90	24.10	SM	SM, fine, wet, grey, silty, frags clayshale
24.10	24.55	ML	ML, hard, grey, lenses & seams clay
24.10	24.30	ML	very sandy
24.55	26.00	TILL (CI)	TILL (CI), hard, grey, numerous frags clayshale
26.00	26.30	SHALE	(fn) Clay shale, hard, grey, silty, (reworked)
26.30	27.00	TILL (CI)	(fn) TILL (CI), hard, grey, shaley, numerous frags clayshale
27.00	27.20	SHALE	Clay shale, hard, grey, silty, frags clayshale, (reworked)
27.20	29.50	TILL (CI)	TILL (CI), hard, grey, shaley, numerous frags clayshale
29.00	29.50	TILL (CI)	(fn) cobbles
29.50	29.60	SC	(fn) SC, fine, wet, grey, shaley, seepage

Table 5 (continued). Borehole log descriptions, GSC-BH-SW-03A

Top	Bottom	USCS	Description
Depth	Depth	description	
(m)	(m)		
29.60	34.70	TILL (CI)	TILL (CI), hard, grey, shaley, frags clayshale
31.50		TILL (CI)	(fn) seam sand
33.00	33.40	TILL (CI)	very shaley, seams sand
33.40	33.75	TILL (CI)	very shaley
34.70	36.00	SHALE	Clay shale, hard, grey, silty, lense oxides, (fn) seepage

Table 6. Borehole log descriptions, GSC-BH-SW-03B

Top	Bottom	USCS	Description
Depth	Depth	description	-
(m)	(m)		
0.00	0.50	TOPSOIL	
0.50	1.40	TILL (CI)	(fn) TILL (CI), very soft
1.40	1.50	SC	(fn) SC, fine to coarse, wet, gravelly, seepage
1.50	10.50	TILL (CI)	(fn) TILL (CI), hard
1.50	2.25	TILL (CI)	(fn) stiff
2.25	2.79	TILL (CI)	(fn) stiff, lenses & seams oxides
2.80		TILL (CI)	(fn) seam sand, seepage
2.81	3.20	TILL (CI)	(fn) stiff, silty, seams ML, numerous seams
			oxides
3.20	4.60	TILL (CI)	(fn) very stiff, lenses & seams oxides
4.60	5.60	TILL (CI)	(fn) grey, lenses oxides
5.60	10.50	TILL (CI)	(fn) grey, cobbles

Table 7. Borehole log descriptions, GSC-BH-SW-04A.

Top	Bottom	USCS	Description
Depth	Depth	description	
(m)	(m)		
0.00	0.15	TOPSOIL	
0.15	12.19	TILL (CI)	TILL (CI), hard
0.15	1.50	TILL (CI)	(fn) stiff, lenses & seams oxides
1.50	1.70	TILL (CI)	stiff, fractures oxidized, pkts oxides
1.70	2.25	TILL (CI)	very stiff, fractures oxidized, pkts oxides
2.25	4.50	TILL (CI)	(fn) very stiff, lenses oxides
4.50	5.25	TILL (CI)	very stiff, fractures & joints oxidized
5.25	5.60	TILL (CI)	(fn) very stiff, seams oxides
5.60	7.50	TILL (CI)	(fn) very stiff, grey, lenses & seams oxides
7.50	7.90	TILL (CI)	grey, joint oxidized
7.90	8.25	TILL (CI)	grey
8.25	9.00	TILL (CI)	(fn) grey
9.00	9.40	TILL (CI)	(fn) grey, shaley, numerous frags clayshale, cobbles
9.40	9.50	TILL (CI)	(fn) grey, very sandy, frags clayshale
9.50	10.50	TILL (CI)	(fn) grey, shaley, numerous frags clayshale, cobbles
10.50	11.50	TILL (CI)	grey, frags clayshale & CaCO ₃ , (fn) cobbles
11.50	12.00	TILL (CI)	(fn) grey, silty, seams ML, seam sand
12.00	12.19	TILL (CI)	very stiff, grey, sandy
12.19	13.40	SPSM	SPSM, fine, wet, grey, (fn) seepage
12.50	13.40	SPSM	medium, very gravelly, pkts clay, frags clayshale
13.40	13.80	TILL (CL)	TILL (CL), very stiff, grey, sandy, gravelly, frags clayshale
13.80	14.00	SPSM	SPSM, fine, wet, grey, slightly gravelly, pkts clay, numerous
			frags clayshale, (fn) seepage
14.00	14.25	GC	(fn) GC, fine to coarse, wet, grey, very sandy, interbedded
			layers shaley clay
14.25	14.80	SM	SM, medium, wet, grey, pkts & seams clay, frags clayshale,
			(fn) seepage
14.80	17.25	TILL (CI)	TILL (CI), hard, grey, frags clayshale
17.00	17.25	TILL (CI)	(fn) cobbles, seepage

Table 8. Borehole log descriptions, GSC-BH-SW-04B

Тор	Bottom	USCS	Description
Depth	Depth	description	-
(m)	(m)		
0.00	0.15	TOPSOIL	
0.15	7.50	TILL (CI)	(fn) TILL (CI), very stiff
0.15	1.50	TILL (CI)	(fn) firm to stiff, lenses & seams oxides
1.50	3.00	TILL (CI)	(fn) stiff to very stiff, lenses oxides
3.00	5.70	TILL (CI)	(fn) lenses oxides
5.70	6.90	TILL (CI)	(fn) grey, numerous seams oxides
6.90	7.50	TILL (CI)	(fn) hard, grey, seams oxides

Table 9. Geotechnical data, site GSC-BH-SW-02 (G05OA010).

AAFC borehole	Sample	Depth	Measured	Measured	Measured	Calculated	Calculated	Estimated
ID		(m)	Gravimetric	Wet	Pocket	Dry Density	Volumetric	porosity
			Water	Density	Penetrometer	(g ₂ dry soil	water content	(cm ³ void
			Content	(g wet	(kPa)	/cm ³ wet soil)	(cm ³ water	/cm ³ total
			(g water	soil			/cm ³ wet soil)	volume)
			/100g dry	/cm ³ wet				
C050 4 010 C 1	1 A	1 17	soil)	soil)				
G05OA010 C 1	1A	1.17	15.2					
G05OA010 C 1	1B	1.25	18.9					
G05OA010 C 1	1C	1.45	17.6					
G05OA010 C 1	1D	1.60	17.7	2.08	239	1.77	0.31	0.33
G05OA010 C 1	2A	2.85	14.3					
G05OA010 C 1	2B	3.05	14.2					
G05OA010 C 1	2C	3.25	14.0	2.13	345	1.87	0.26	0.29
G05OA010 C 1	2D	3.42	13.7					
G05OA010 C 1	3A	6.10	15.0					
G05OA010 C 1	3B	6.30	15.2					
G05OA010 C 1	3C	6.50	15.4	2.14	278	1.85	0.29	0.30
G05OA010 C 1	3D	6.66	17.4					
G05OA010 C 1	4A	7.90	19.2	2.00	278	1.68	0.32	0.37
G05OA010 C 1	4B	8.10	19.3					
G05OA010 C 1	4C	8.25	24.1					
G05OA010 C 1	4D	8.45	22.3					
G05OA010 C 1	5A	9.85	16.6					
G05OA010 C 1	5B	10.00	17.9	2.04	1036	1.73	0.31	0.35
G05OA010 C 1	6	10.45	12.2					
G05OA010 C 2	1	1.00	15.7					

Table 10. Geotechnical data, site GSC-BH-SW-03 (G05OA009).

AAFC borehole	Sample	Depth	Measured	Measured	Measured	Calculated	Calculated	Estimated
ID	_	(m)	Gravimetric	Wet Density	Pocket	Dry Density	Volumetric	porosity
			Water	(g wet soil	Penetrometer	(g dry soil	water content	(cm ³ void
			Content	/cm ³ wet soil)	(kPa)	/cm ³ wet soil)	(cm ³ water	/cm ³ total
			(g water				/cm ³ wet	volume)
			/100g dry				soil)	
			soil)					
G05OA009 C 1	1A	2.40	21.4					
G05OA009 C 1	1B	2.60	24.4					
G05OA009 C 1	1C	2.80	20.3					
G05OA009 C 1	1D	2.97	22.1	1.91	124	1.56	0.35	0.41
G05OA009 C 1	2A	6.10	15.7					
G05OA009 C 1	2B	6.30	14.5					
G05OA009 C 1	2C	6.50	14.7	2.16	393	1.88	0.28	0.29
G05OA009 C 1	2D	6.68	13.0					
G05OA009 C 1	3A	9.35	15.4					
G05OA009 C 1	3B	9.55	15.7					
G05OA009 C 1	3C	9.75	15.6	2.13	297	1.84	0.29	0.30
G05OA009 C 1	3D	9.92	16.1					
G05OA009 C 1	4A	12.20	18.8					
G05OA009 C 1	4B	12.40	19.5	2.05	201	1.72	0.33	0.35
G05OA009 C 1	4C	12.60	19.4					
G05OA009 C 1	4D	12.78	17.7					
G05OA009 C 1	5A	15.20	30.8					
G05OA009 C 1	5B	15.40	19.2					
G05OA009 C 1	5C	15.60	17.5	2.06	201	1.75	0.31	0.34
G05OA009 C 1	6	18.00	20.9					
G05OA009 C 1	7A	18.10	23.1					
G05OA009 C 1	7B	18.30	22.8					
G05OA009 C 1	7C	18.50	25.1	1.90	576	1.52	0.38	0.43

Table 10 (continued). Geotechnical data, site GSC-BH-SW-03 (G05OA009).

AAFC borehole	Sample	Depth	Measured	Measured	Measured	Calculated	Calculated	Estimated
ID		(m)	Gravimetric	Wet Density	Pocket	Dry Density	Volumetric	porosity
			Water	(g wet soil	Penetrometer	(g dry soil	water content	(cm ³ void
			Content	/cm ³ wet soil)	(kPa)	/cm ³ wet soil)	(cm ³ water	/cm ³ total
			(g water				/cm ³ wet	volume)
			/100g dry				soil)	
			soil)					
G05OA009 C 1	7D	18.68	24.1					
G05OA009 C 1	8	19.60	27.5					
G05OA009 C 1	9A	21.10	26.9					
G05OA009 C 1	9B	21.30	30.6					
G05OA009 C 1	9C	21.50	20.5					
G05OA009 C 1	9D	21.68	19.6	1.97	1112	1.65	0.32	0.38
G05OA009 C 1	10A	24.05	25.0					
G05OA009 C 1	10B	24.20	28.5					
G05OA009 C 1	10C	24.42	31.7					
G05OA009 C 1	10D	24.62	28.6	1.87		1.45	0.42	0.45
G05OA009 C 1	11A	27.10	22.5					
G05OA009 C 1	11B	27.30	20.3					
G05OA009 C 1	11C	27.50	23.5	1.82	1036	1.47	0.35	0.44
G05OA009 C 1	11D	27.68	22.5					
G05OA009 C 1	12A	30.17	19.4					
G05OA009 C 1	12B	30.32	19.1					
G05OA009 C 1	12C	30.50	16.8					
G05OA009 C 1	12D	30.67	19.7	1.92	1532	1.60	0.32	0.39
G05OA009 C 1	13A	33.10	18.6					
G05OA009 C 1	13B	33.30	20.4					
G05OA009 C 1	13C	33.50	18.3					
G05OA009 C 1	13D	33.68	20.3	1.92	1492	1.60	0.32	0.40
G05OA009 C 1	14	36.00	33.4					

Table 11. Geotechnical data, site GSC-BH-SW-04 (G05OA008).

AAFC borehole	Sample	Depth	Measured	Measured	Measured	Calculated	Calculated	Estimated
ID		(m)	Gravimetric	Wet Density	Pocket	Dry Density	Volumetric	porosity
			Water Content	(g wet soil	Penetrometer	(g dry soil	water content	(cm ³ void
			(g water	/cm ³ wet soil)	(kPa)	/cm ³ wet soil)	(cm ³ water	/cm ³ total
			/100g dry soil)				/cm ³ wet	volume)
							soil)	
G050A008 C-1	1A	1.60	16.8					
G050A008 C-1	1B	1.80	15.6	1.90	230	1.64	0.26	0.38
G050A008 C-1	1C	2.00	16.7					
G050A008 C-1	1D	2.17	16.6					
G050A008 C-1	2A	4.60	15.5					
G050A008 C-1	2B	4.80	16.3					
G050A008 C-1	2C	5.00	15.9	1.84	249	1.59	0.25	0.40
G050A008 C-1	2D	5.18	16.3					
G050A008 C-1	3A	7.60	11.8					
G050A008 C-1	3B	7.80	11.4					
G050A008 C-1	3C	8.00	11.9	2.15	393	1.92	0.23	0.27
G050A008 C-1	3D	8.18	11.9					
G050A008 C-1	4A	10.58	14.5					
G050A008 C-1	4B	10.72	15.6	2.06	1148	1.78	0.28	0.33
G050A008 C-1	5A	12.10	15.8					
G050A008 C-1	5B	12.40	14.6					
G050A008 C-1	6	13.40	7.5					
G050A008 C-1	7	13.80	17.9					
G050A008 C-1	9	14.60	22.4					
G050A008 C-1	10	15.00	20.0	1.97	1112	1.64	0.33	0.38
G050A008 C-1	11	15.50	18.4					
G050A008 C-1	12A	15.85	22.3	1.81	576	1.48	0.33	0.44

Table 11 (continued). Geotechnical data, site GSC-BH-SW-04 (G05OA008).

AAFC borehole	Sample	Depth	Measured	Measured	Measured	Calculated	Calculated
ID		(m)	Gravimetric	Wet Density	Pocket	Dry Density	Volumetric
			Water Content	(g wet soil	Penetrometer	(g dry soil	water content
			(g water	/cm ³ wet soil)	(kPa)	/cm ³ wet soil)	(cm ³ water
			/100g dry soil)				/cm ³ wet soil)
G050A008 C-1	12B	16.05	21.4				
G050A008 C-1	12C	16.25	15.3				
G050A008 C-1	12D	16.47	24.1				

Table 12. Borehole log, CWS well, G05OA010 as recorded in the CWS database.

Well PID: 116770

LOCATION: SW33-3-16W

UTMX:457411.7 UTMY:5455641.5 XY Accuracy:1 EXACT [<5M] [GPS]

UTMZ:469.69 (ground surface elevation) Z Accuracy:1 EXACT < 10CM

Owner: WRB

Driller: Ralph Edwards & Sons Drilling LTd.

Well Name: G05OA010 KILCART #11

Date Completed: 2001 Aug 22 Well Use: OBSERVATION

Well Status: ACTIVE Aquifer: SAND AND GRAVEL

REMARKS:

PUMPED WITH AIR, EC=1990

WELL LOG (Imperial units)

From	To(ft.)	Log
1 1 0 111	10(10)	

- 0.0 2 TOPSOIL, BLACK
- 2.0 5 SAND AND GRAVEL, LIMESTONE
- 5.0 12 TILL, BEIGE, SAND
- 12.0 26 TILL, GREY, CLAYEY, STONY
- 26.0 27.5 SAND AND GRAVEL, MAINLY SHALE
- 27.5 33 TILL, GREY, CLAYEY, STONY
- 33.0 34 SAND AND GRAVEL, LAYER 50/50 SHALE AND LIMESTONE
- 34.0 80 TILL, DARK GREY, CLAYEY, STONY
- 80.0 85 SHALE, BALCK, RUBBLY, LOSING WATER
- 85.0 124 SAND AND GRAVEL, 80% SHALE & 20% LIMESTONE
- 124.0 140 SHALE, SOFT, BLACK

WELL CONSTRUCTION

			Inside	Outside	Slot		
From	To(ft)	Const.Method	Dia.(in)	Dia.(in)	Size(in)	Type	Material
0.0	115.0	CASING	5.0			INSERT	BLACK IRON
115.0	120.0	PERFORATIO	NS 5.0		0.010	WIRE WOUND	S. S.
Top of	Casing	g: 3.0 ft. above	ground				

PUMPING TEST

Date: 2001 Aug 23 Pumping 10.0 Imp. gallons/minute

Water level before test : 6.0 ft below ground Water level at end of test : 35.0 ft below ground

Test duration: 1:00:00

Test Zone: from 115.0 ft to 120.0 ft

Table 13. Borehole log, CWS well, G05OA009 as recorded in the CWS database.

Well PID: 116814

LOCATION: SE6-5-17W

UTMX:445899.6 UTMY:5467232.5 XY Accuracy:1 EXACT [<5M] [GPS]

UTMZ:467.447 (ground surface elevation) Z Accuracy:1 EXACT < 10CM

Owner: WRB

Driller: Ralph Edwards & Sons Drilling LTd.

Well Name: G05OA009 KILCART #8

Date Completed: 2001 Jul 25 Well Use: OBSERVATION

Well Status: ACTIVE Aquifer: SAND AND GRAVEL

REMARKS:

PUMPED WITH AIR, EC=2320

WELL LOG (Imperial units)

From To(ft.) Log

0.0 18 TILL, BEIGE, CLAYEY

18.0 61 TILL, GREY, CLAYEY

61.0 63 SHALE LAYER, BLACK, BRITTLE

63.0 105 TILL, GREY, CLAYEY, SOME STONE

105.0 110 SAND AND GRAVEL LAYER

110.0 150 TILL, GREY, CLAYEY

150.0 175 SAND AND GRAVEL, 50% SHALE, 50% LIMESTONE

175.0 194 SAND AND GRAVEL, VERY COARSE, 1/2 TO 1 INCH DIAMETER

194.0 196 STONE

196.0 200 SHALE, HARD, BLACK

WELL CONSTRUCTION

Inside Outside Slot

From To(ft) Const.Method Dia.(in) Dia.(in) Size(in) Type Material

0.0 163.0 CASING 5.0 INSERT BLACK IRON

163.0 168.0 PERFORATIONS 5.0 0.010 WIRE WOUND S. S.

Top of Casing: 2.5 ft. above ground

PUMPING TEST

Date: 2001 Jul 26 Pumping 20.0 Imp. gallons/minute

Water level before test : 23.0 ft below ground

Water level at end of test:

Test duration:

Test Zone: from 163.0 ft to 168.0 ft

Table 14. Borehole log, CWS well, G05OA008 as recorded in the CWS database.

Well PID: 116767

LOCATION: NW21-2-15W

UTMX:468210.4 UTMY:5443941.9 XY Accuracy:1 EXACT [<5M] [GPS]

UTMZ:470.22 (ground surface elevation) Z Accuracy:1 EXACT < 10CM

Owner: WRB

Driller: Ralph Edwards & Sons Drilling LTd.

Well Name: G05OA008 KILCART #1

Date Completed: 2001 Sep 05 Well Use: OBSERVATION

Well Status: ACTIVE Aquifer: SAND AND GRAVEL

REMARKS:

PUMPED WITH AIR, EC=1490

WELL LOG (Imperial units)

From To(ft.) Log

0.0 18 SAND, COARSE, BROWN

18.0 22 GRAVEL, COARSE, BROWN

22.0 62 TILL, GREY, CLAYEY

62.0 64 GRAVEL, SHALE, SOME LIMESTONE

64.0 130 TILL, GREY, CLAYEY

130.0 140 ROCKY TILL, CARBONACEOUS

140.0 180 SAND AND GRAVEL, GREY, SAND, GRAVEL, 80 % SHALE, 20%

LIMESTONE

180.0 198 TILL, GREY, VERY CLAYEY

198.0 200 TILL, GREY

200.0 220 SHALE, HARD, DARK GREY, VERY STIFF

WELL CONSTRUCTION

Inside Outside Slot

From To(ft) Const.Method Dia.(in) Dia.(in) Size(in) Type Material

0.0 175.0 CASING 5.0 INSERT BLACK IRON

175.0 180.0 PERFORATIONS 5.0 0.010 WIRE WOUND S. S.

Top of Casing:

PUMPING TEST

Date: 2001 Sep 12 Pumping Imp. gallons/minute

Water level before test : 50.0 ft below ground

Water level at end of test:

Test duration:

Test Zone: from 175.0 ft to 180.0 ft

Appendices

Appendix A: Field borehole descriptions.

A1. Field borehole description, GSC-BH-SW-02A, page 1 of 8.

			8 6 4							200		
	+ GSC.			-		PFR	A TES	THOLE	E LOC	•		
Site .	G0501	1010	.7	-					4-0-4-6			
Hole I	vo. C-1(50	2021	4) Elev	m I	· t:		2 00 - 200 - 200					
Locati	ou <u>ζω ζ</u>	5-/6	-WI GPS COOPMINATE	she Ca	sing	1744	045	7414				
Drilled	d by Da	<i>).</i>	Date Started Nov3/2010	2 100	rining	154.	5573	8				
Logge		502	m Top Pipe Time-Date Nov.4/10	2.40	1m							
water	ation 2 1 F	VC-	Sch 40 Pipe pissome	te -		LC	CATIO	N SKE	тсн			
	L of 8		301.1.7.7.3	(A)		ssure , R						
Gener	B-14	cal	ble toolria	100000000000000000000000000000000000000		tion flui ample we						
			Formation and Water Data	_		ata and I		-			e Data	_
	Depths - m			100		(A) kPa	1				PP	-
Time	(Underline sample	Group	Description, Characteristics, Abnormal Conditions,	Depth Casing	Depth Hole	-	cm3/s	% Loss	Leng	th-m	kPa	No.
	drive)		Sample Type	Shoe	Fluid	(C) kg	Drop-m	Blows	Drive	Rec.	Test	
		_	11 - 1			27	11 -					
	0-0.45	10%	soil Black, organic, si	177		29	EXC	ava 6	-	-		_
		1	Fibers (roots)									100
	-		Jai Ders (1003)	-								_
						- 7	,					
	0.45-0.8	6SC	fine - coarse, brown, as	1		3%	" Ex	cava	tor			^
			1 1 1 1 1 1	,								
		-	clay binder, with a few	2/14		+		-	-			
			seams									
		1	Seams	1							*	
	_	_						31				
_0	80-110	St	fine-coarse brown	we		- 4	-	**	-	-		_
			med Predom water		1.							
			med fredom, water	Smin	4	1			\vdash			
			intohole								1-000	
					_					-	-	_
		100	0: 2	1			, .		-	- 11	22	1
	1.10-1.85	158	Coarse-fine, Brown,	wet	-	Bass	MAY.	,	-/5	-56	2.3	1
			18 + 10	+	6	rith	calor	102	1			
			some gravel Particles			1						
		CI	tup till, Brown, very	1stic	4							
-			1									
			lenses of axides		-	-		-	-	-	-	_
0.000	-			100								
									_			

A1. Field borehole description, GSC-BH-SW-02A, page 2 of 8.

Dunkan	. G.S.C	<	Piritwood	1		PFR	A TES	THOLE	LOG			
	6050			-							-	
Hole I	No. 6-1 cos	TEL	_ Elevn	n								
Locati	ion			-								
			Date Started	-								
			Date Completed	-								
176			m Top Pipe Time-Date	-		LO	CATIO	N SKE	тсн			
	2 of 8					sure, R						
Page . Gener						ion fluid						
Gener			5			ta and F		p uisiu			e Data	
	Depths – m		Formation and Water Data		1	(A) kPa		Γ			PP	
Time	(Underline sample	Group	Description, Characteristics, Abnormal Conditions,	Depth Casing	Depth . Hole		cm ³ /s	% Loss	Lengi		kPa	No.
	drive)		Sample Type	Shoe m	Fluid	(C) kg	Drop-m	Blows	Drive	Rec.	Test	
		Real	med holout to 1.8.	Im a	eith	55/2	1/5	cau	tor			
		1	- 3.36m of 4" cosi		,	١,						
		Dr	or easing down to	1.85	n							
			•									
	1-85-22	CI	cup Till, Bonus, very	sT. 66		3%	Ex	Caus	tor		2.2	
	-2.75	1	numerous lenses+ sea	ms.	1				_			
			oxides, slighty sand	4					-		-	
				2.2:				-		_	-	_
	2.75-3.5	CI.	- up Till, darkgrey, h	ard	B	rassi	inel	21	.75	-75	4.5	2
			few lenges of oxides +	-	-			-	-	-	_	-
(1)			Shale Particles	-		-	-		-	-	-	
×	-			3.36	6	+		-	+	-	-	-
_		-	*		-	-	-		-	-	+	-
						27	3"E	-	4		2.2	F
	3.5-4.0	CI	tup Till, dark gray,			3.	9 6	Xcac	ralox		10.0	φ
	1		stift, few shale par	- Niche	اک							1

Projec	+ G.S.C	. S	oinitwood				PFR	A TES	THOLE	LOG	i		
Hole I	vo. <u>C-1eo:</u>	ntel	Elev	m _									
Logge Water	d by Level Final		Date Started Date Completed m Top Pipe Time-Date	-			LO	CATIO	N SKE	тсн			
	ation 3_ of _8 al			(B) (Circula	sure , R tion flui imple we	d, Pump	pressur	e,Volu			
	Depths - m		Formation and Water Data		C	Orill Da	ta and l	Remarks		,	Sampl	e Data	
Time	(Underline sample drive)	Group	Description, Characteristics, Abnormal Conditions, Sample Type	Dep Cas Sh	ing oe	Depth Hole Fluid m	(A) kPa (B) kPa (C) kg	rpm cm ³ /s Drop-m		Lengt Drive	h−m Rec.	PP kPa Test	No
	4.0-50	CI	twp till, darkgrey, ve			sei nussassi	3	B"EX	cava	tor		3.0	+
			Lew Shale Porticle as	1									-
-			ofew limestone Pebe	ske:	+C	066	5_						
	5.0-60	CI	captill, dark, gray, we		sti	C4	3	3°E	keno	etor		2.75	
			from shale Particles a		al	cobi	Ne						
				-			-			_			
	6.0-6.7.	CI	+uptill, darkarcy,			1	Bras	line	-13	- 75	72	2.75	13
			shale Particles, and Is	166	les								T
			ot IImesiono		10								
	6.75-7.5	CI	-up till, Darkgre,	, H	lar	0					-		-
_			shaly, numerous s										+
			7.5, water comm			1000							\dagger

Proiec	C.S.C	. Sp	intwood			PFR	A TES	THOLE	E LOC	3		
Site _ Hole N Locati	6050, 10. C-1601	nTa	3	m —								
Water	Level Final		Date Completed m Top Pipe Time-Date	-		LO	CATIO	N SKE	тсн			
age _	4 of 8			(B)	Circulat	sure , R ion fluid imple we	d, Pump	pressur	e, Volu			
	Depths - m		Formation and Water Data		Drill Data and Remarks							
ime	(Underline sample drive)	Group	Description, Characteristics, Abnormal Conditions, Sample Type	Depth Casing Shoe	Depth Hole Fluid	(A) kPa (B) kPa (C) kg	rpm cm ³ /s Drop-m			Rec.	PP kPa Test	No.
		Too	Kwater level of t			at	6.5	7m	fr	om	gn	1.100
		an	dis still coming i	to 1	ole	c/0/2	1/9					-
			tall 3.10m + 2.90 m		4110	4511	giv	toh	o/e			_
			tal casing is 9.36m	1)2							
			TIST CUSING COLON	7.0								
	75-78	CI	-up till, dark gre		1	37	316	cac	ato	F		L
95			very shary, crumbe									\vdash
			Paintile and lines									
	*		Pebbles	-								
								-			-	-
							-	-	-	-	\vdash	-
												T
			L									T

Projec	G. S.	Ci	Spiritwood			PFR	A TES	STHOL	E LO	3		
Site	G050A	010										1
Hole	No. C-lean	Td .	Elev.	_m								
Locat	ion			_								
Drille	d by		Date Started	_								
Logge	d by		Date Completed	_						12		
Water	Level Final		m Top Pipe Time-Date	_								
Instal	lation					_	_	N SKE				
Page.	5 of 8			- 30.23		ssure , R tion flui				ıme %	1055	
Gener	ol	_				ample we						
	Depths - m		Formation and Water Data	T	Drill Do	ita and f	Remarks			Sampl	e Data	_
T:	(Underline		Paraription Characteristics	Depth	Depth	(A) kPa	rpm	Γ	Lengt		PP	
Time	sample	Group	Description, Characteristics, Abnormal Conditions,	Casing		(B) kPa	-	% Loss	-		kPa	No.
	drive)		Sample Type	Shoe	Fluid	(C) kg	Drop-m	Blows	Drive	Rec.	Test	
	28-855	CI	-up till, darkgray,	Hard		Bras	Shin	-26	.75	.75	>	4
	-860	29	erum bly, very shaley	10								
	8	Br	An shale Porticles	cuith								
			Timestone Pepples, a	reter	bear	ný						_
		- 0	vater coming into	hole								_
				8.60	,							
	8.6-9.1	CI	+ wp Till, dark grey,	Hord	1	3%	EXC	ava	ton			_
-			limestone cobble at	9.1m								_
_			very shatey	9.1n	H1.						-	_
	7*		end of Day	-								_
y	trug		Nov. 3/2010	-:								_
			G.W.L 7.77	'n								_
	91-95	CI	-uptill, dar Kgroy,	haid	a		33	"Exc		· To		_
	1.1-1.5	01	crumbly, very shall	Navo	meh	see s		-XC	0.00	,		
			Shale Particles + Chunk	1 + 10	mesi	ans P	e661	es				

A1. Field borehole description, GSC-BH-SW-02A, page 6 of 8.

Projec	or G.S.	2. 5	piritwood			PFR	A TES	THOL	E LO	3				
Site	(2050	A01	0	_										
Hole	No. C-100	nTol	Elev	m										
Locat	ion			-										
Drille	d by		Date Started											
			Date Completed	-										
Water	Level Final		_m Top Pipe Time Date				CATIO	N CKE	TOU					
	lation			LOCATION SKETCH (A) Bit pressure, Revolutions per minute										
	6 of 8			(B)	Circula	tion flui	d, Pump	pressur	e,Volu					
Gener	rice -			(c)			eight, Dro	p dista						
	Depths - m	_	Formation and Water Data		Drill Da		Remarks			Sample	e Data			
Time	(Underline sample	Group	Description, Characteristics,	Depth	Depth	(A) kPa	rpm cm ³ /s	9/ 1 000	Lengt	h-m	PP kPa	No.		
	drive)	огоар	Abnormal Conditions, Sample Type	Shoe m	Fluid m	(C) kg	Drop-m		Drive	Rec.	Test	140,		
		Bai	led water out of hole	Tide										
	95-97	(014	Y Shall TILD	1	2	100	Exca	-				a.		
	1.5-7.73	01	-cop (111, dark grof, hi	110	-	19 1	rxca	ua lo	-	_				
			exempley, very shaly									_		
			numerous shale chounks	and								_		
			Line stone Rebbles											
	1			9.30	-									
		Too	Vs Rinding in hole du		0651	ate	llm	caus	· ·					
					,				7					
		Ca	sing to go crooked to	allec	cas	rig t	ack!	09.	Dm.	dos	-			
	975-10	Sm	fine-coarse, grafice	-		Russ	chie		.35	35	>	5		
			mostly shale + limes	,	±		: NO	blow	000	unt	100	ls alsos e		
		(C 19	7 Shala Till	1	0	1	e and in	900	1211	100	GF) 6	emov (
		61	-wp Till, gray, has	2/	Λ	loto:	0.000	eus 7	60	Th	'n			
			crumbles, very shall	4	11	terk	edde	leve	ts	ana	16	ner		
			numerous shale chu	iks	<	With	int	ho c	67.	cha	17	7/-		
Recommen			and linestone Pebble			- 20111								
			custer coming into											

A1. Field borehole description, GSC-BH-SW-02A, page 7 of 8.

Projec	G.S.	· S	piritwood		-8	PFR	A TES	STHOLE	E LOC	3		in
Site	3050	AO	10									
Hole	No. C-1 co	nTd	Elev	n								
Locat	ion			-								
Drille	d by		Date Started	-								
			Date Completed	-								
Water	Level Final		m Top Pipe Time-Date									
	lation			- (A)	Dit pres		510-05-31-0-0-0	N SKE				
Page .	2018							ns per m pressur		ıme %	Loss	
Gener	al	-		- (c)	Drive so	mple we	ight , Dro	op dista	nce, B	low cou	int	
	Depths - m		Formation and Water Data	1	Drill Da	ta and l	Remorks			Sample	Data	
Time	(Underline		Description, Characteristics,	Depth	Depth	(A) kPa	rpm		Lengt	h-m	PP	_
, ,,,,,,	sample	Group	Abnormal Conditions,	Casing	Hole	(B) kPa	cm3/s	% Loss			kPa	No.
	drive)	~/	Sample Type	Shoe	Fluid	(C) kg	Drop-m	Blows	Drive	Rec.	Test	
	1-1 1-1	Glay	Till A 11		1	270	15	7	- 1	B	_	6
	10.1-10.5	C. L.	wp 1111, elevis gray, hand		-	0.0	-XC0	oale	i jun	Lee	7	
			com the new chalas as	msh								
			crumbity, sery sharry, no	271510	1972							_
			Shale chunks + limestone	Pet	bles							
				,								
							,					
		0 -	+ 1110	_		+11	1	011	_	01	4	
		100	Iom of hole Prepar	0 10	1115	1011	29	F.V.	C.	1/43	666	-
		0	411									
_		14	opiez into hale.				-					
		Len	ath of 2" sch 40 slotts	1/10.	pois	09	D	#20	0/0	40	20	
-		/(0//	9111 31 6 3511. 10 31511	100	200	-	100	-00.0	310	-	50	
		Le	Noth of the 2" solid P.	160	iners	1001	Bin.	Tivo				
10			J	1								100
			Total length of Pipe	in	0/1	110	1511	re les	5			
		87	0 4 111 1.60						1,		,	,
-		- 6	Bottom of the slatter	0,00	150	71	2.40	m.	11/00	0.90	di	1001
	W.	.	Top of the slotted,		120	40	112	Les 1	1.		. 1	1000
		_	op 81 Ins Stolled	100	134	- /-	73	Mr. FO	C.20	9		142711
		7	op of the 2" P.V.C.	رفر ، م	150	2.75	ten.	about	0	ud	140	10/
			,			1		1 .				
		Be	effilled the hole ar	oun	dH	K 5/	otto	py	10	wit	4	
					V 15]	1		GI I			-
		F	Iter sand, Top o	- 50	nel	pa	KH1	507	19	. 30	24	\vdash
			,					1				100
		1	om grd. level- 7	hen	150	411t	11/10	Cho	110	4 20	///	14
			Bentonite Pellets an									
			wentorille lellers an	BL J	app		4511	19 0	6 /6	6 53	am	UM

A1. Field borehole description, GSC-BH-SW-02A, page 8 of 8.

Projec	+ G. S.	C. S	Spiritwood				PFR	A TES	THOL	E LO	3		2300000
Site _	6050	AOI	6	_									Consult
Hole f	40. C-1e	onTo	Elev.	m									_
Locati	on		<u> </u>										
Drilled	by		Date Started	-									
Logge			Date Completed	-									
Water	Level Final _		_m Top Pipe Time-Date	-									
Install	ation			-	(A)	Rit nres		CATIO levolution					
Page .	3 of 8							d, Pump			ıme %	Loss	
Genero	ol	191		_	(C)	Drive so	imple we	ight , Dro	p dista	nce, B	ow co	unt	_
	Depths - m		Formation and Water Data			Drill Da	ta and I	Remarks			Sampl	e Data	1
Time	(Underline		Description, Characteristics,		epth	Depth	(A) kPa			Lengt	h-m	PP kPa	
	sample drive)	Group	Abnormal Conditions, Sample Type		asing Shoe	Hole Fluid	(B) kPa (C) kg	cm3/s Drop-m		Drive	Rec.		No.
	3			t	m	m	(C) Ng	Drop-III	BIOWS				_
		Ton	of Bontonite Pellets	1	01	1-8:	251	Pages.	ano	1/0	se /	on.	0
				1				-	1	1	-		_
		Ca	sing shoe is at 8.2	b	me	ten f	on	and	levi	/-			
		0	1101 41	١,	, ,,			1,	1	1	0		,
		Ko	lled 6.0 meters of	19	"	1511	900	to	ho	e.	507	on	01
		Ca	sing shoe is at 3.	b	2 m	Bei	bus a	val l.	evel				_
		Ho		П			Ų	d 1.	wel.				
		Be	ckfilled hale from	1	3	reter	to	3.0,	, w	th	Bon	toni	te
		ch	ips Then Pulleda	L	l ve	mai	กลัย		051	100	out	of	the
		60	le. Backfilled rem			()	1		to	0.	10	4.1	
-			with clay cuttin						,		ote	. 7	
		1	ripe around the 2	4		· /			The	0	#	100	-
	- 3	1	(1.5mx15cmx150	, ,,	1	8.4	P V	ing		1	D	-	_
		-	1	1				0			0	,	1
	Ęį.		the Protective Py				1		Doug	qu	de	Lu	1
		-	Pipe is marked			1	app	ed					-
-			endo	-	Ha	11e				-			
		-		+									_
-	-	-		-				1					

Proje	, G.S.C	- 5	Piritwood			PFR	A TES	THOL	E LO	3		
	G0501			_								
Hole	No. C-2(Sa	0021	B) Elev	m								
Locat	ion Sw33	-3-/	6-62 and it is 1.5 meter	south	ofh	ole C.	-1					
	d by R	D	Date Started Nov 3/2010				-					
45.0000	1)/	2	11 1 1/2 1/2 0/2	5								
Water	Level Final	15	m Top Grid Time Date Nov. 4/10	3:30	91112							
Instal	lation 2"PU	10 5	ch. 40 Plustiz Pipe Piez			LC	CATIO	N SKE	тсн			
	2 or 2			(A)			evolution					
Gener				1000000			d , Pump light , Dro					
		1		Т'								_
	Depths - m		Formation and Water Data		Drill Do		Remarks			Sample	e Data	
Time	(Underline		Description, Characteristics,	Depth	Depth	(A) kPa	-		Lengt	th-m	kPa	No.
	sample drive)	Group	Abnormal Conditions, Sample Type	Casing	Fluid	(C) kg	cm ³ /s	-	Drive	Rec.	Test	INO.
-				m	m	(C) Ng	Di op - III	DIOWS				_
	0-034	Tar	soil Black, organic	ctil	1	3%	"EN	cau	1/2	-		
_	0 0,1.	101		2011			-	340.50	V. J. S.A.			
			Fibers (roots)									
						0						4
	0.35-1.0	SC	fine-coarse, brown	we	<u> </u>	3	1811 6	Kea	207	02.	Bag	1
		-	fine - coarse, brown, slight eloy binder								U	
			slight elay hinder	-		-			_	_		
				-					-	_	-	_
	1. 10	00	p · /	1		1 0		1	v			
_	1.0-1.6	20	Fine-coarse, brown,	vel.		- 1		-				
			with a few interber	11.1		63						
_			WITH A FRED IN HERDE	100 00			(1)			-		
			clay seams	1								
			They Salve									
										100000	027	
	1.6-2.0	CI	two till, Brown, sti	4		12		+1			1.50	2
			lenses + seams of ax	de					_			_
				-								
		-		1	-	- 52			-			_
		0	med hole out to 2.		1	65/	11 5		1			-
		Kea	ned hope out lod.	m c	0177	5.8	10	cau	2/0			-
										_		_
	-											
-	-				-	-	*		•	•	-	-

	000		. /- 1	0								
Proje	of G.S.C.	- S	oiritwood	_		PFR	A TES	THOLE	E LOC	<u> </u>		
Site	6050	10/	Elev	-								
		מומ	Elev									
	ion		Date Started									
			Date Completed									
			m Top Pipe Time-Date									
	lation		lop Gra			LC	CATIO	N SKE	тсн			
Page	2012			250	Bit pres Circulat					ma %	Loss	
Gener	ol			100000	Drive so			and the same of th				
	Depths - m		Formation and Water Data		Drill Da	ta and F	Remarks			Sample	e Data	_
Time	(Underline		Description, Characteristics,	Depth	Depth	(A) kPa	rpm		Lengt	h-m	PP kPa	
	sample	Group	Abnormal Conditions,	Casing	Hole		cm ³ /s			Rec.	-	No.
-	drive)	-	Sample Type	Shoe	Fluid	(C) kg	Drop-m	Blows	01.149	Nec.	1631	_
_	2.0-2.75	CZ	top till, Brown, very	STA	-	33	3 E	cau	otor			_
			numerous seams of	xid	5							_
			more ot a gr. brown s	olo	4× a7	2.6	5m					
		Bo	Tom of Hole, insta	110	2"1	PUC	sch	401	Plas	ties	o if	-
		Pi	ig. into hale		7							_
		Lei	igth of the 2"PUCS	6/1	dp.	pe T	1.5	ono	20:	3/07	tsi	38
		hen	athof the 2" Pur &	lid	pipe	is	20,	net	2-5			_
		70	tala "pipe in ho	41	\$	3	.50	mej	16			
		Bo	tom of 2" statted.	is a	×2.	75	m f	rom	gw	1./	eve	_
		To	pofthez'slotted	13.9	+10	25,	n fr	omo	red	. le	vel	_
		To	o of the Filter son	dj	100/	Tis	at	0.8	0,	n /	pol	21
		90	d. level			1						
		To	Pot the 211 Pipa (1.5 mx 15 em x 15 cm)	13	0.7	5 m	abo	000	red	les	ve/	
	-	1/10	0 a 5 x 6 x 6" Prot			1	ua	Pu	70	noc	o.	me
		900	P.V.G. Pipe for Protes	Re	d+0	app	d E	Nel .	of 1	tole	00	abou

te ole	No. C-3 (SC	209	A) Elev			444	145	29/	-3"	100		
ille	d by $R.L$	2.	Date Started Nov 4/2010	No.		5						
itei	lation 2"PV	50h.	m Top Pipe Time-Date 100 16/1	0		1.0	CATIO	N CVE	TCH			
ge	_ of 18		Tool rig Plan# 359092	(A)	Circula	ssure , F tion flui ample we	Revolutio d , Pump	ns per r pressu	ninute re,Volu			
	Depths - m		Formation and Water Data			ita and I					e Data	_
ne	(Underline sample drive)	Group	Description, Characteristics, Abnormal Conditions,	Depth Casing	Depth Hole	(A) kPa	-	% Loss	Leng	h – m	PP kPa	No.
		Tar	sample Type soil, Black, organ	Shoe	Fluid m	(C) kg	Drop-m		Drive	Rec.	Test	
	0.76	- 5/	Fibers (roots)	(C, P)	m	218	2 ZX	COLOR	los			
	N. ive		The state of the s									
	7.0-1.5	CIA	uptill, Brown, soft	to Fivi	20	3%	"Ex	ava	tor			
			lenses + seams of or	1								
			Habi is squeezing									
7		Rea	med hole out to 1.5	in ce	ith s	5%	exc	ava	Tox			_
	1.5-2.25	CI	two till, gubrown,	Airin		32	1 Exc		+			-
			wet sand seam at	1.80	m	2.9		<i>72.01</i>				
			Hole squeezing, sear	ns or	_							
			oxides				2 /					_
		23	treed hole out To's							1	-	-(
		1000	1.69m of 6" casi			rive	Sho	cint	o h	ale		-

A3. Field borehole description, GSC-BH-SW-03A, page 2 of 18 Project G.S.C. Spiritwood PFRA TESTHOLE LOG Hole No. C-Beanted Location 🗘 Drilled by Date Started Date Completed m Top Pipe Time-Date Water Level Final _ Installation _ LOCATION SKETCH Page 2 of 18 (A) Bit pressure, Revolutions per minute (B) Circulation fluid, Pump pressure, Volume % Loss General (C) Drive sample weight, Drop distance, Blow count Depths - m Formation and Water Data Drill Data and Remarks Sample Data Time (Underline Description, Characteristics, (A) kPa Depth Depth rpm Length-m sample Group kPa Abnormal Conditions, Casing (B) kPa cm3/s %Loss Hole drive) Sample Type Shoe Fluid Rec. Drive Test (C) kg Drop-m Blows 2-2570 "casing total casing 3.75

Projec	G050H	2000	givitwood			PF	RA TE	STHOL	E LO	G		
Hole	No. C-300	nTel	Elev							H		
	ion C-\		Date Started	_								
	d by		Date Completed	-								
Install	lation		_m Top Pipe Time-Date	-			OCATIO					
	3_ of <i>18</i>	etan	John Streetschiller H	(B)	Circula	ssure , l tion flu	Revolutio	ons per :	ninute re,Vol	ume %	6 Loss	
	Depths - m		Formation and Water Data		-		eight , Dr Remarks			88.1 3	e Date	_
Time	(Underline sample	Group	Description, Characteristics, Abnormal Conditions,	Depth	Depth	(A) kPd			Leng	th-m	PP kPa	No
	drive)	100	Sample Type	Shoe	Fluid	(C) kg	Drop-m	-		Rec.	Test	NO
		Sta	Tie unter levelin	hol	101	Ver	to m	an e	2.44.5	3.	37	n
			from ground lev	1								
		Rea	ned hole out to 4.	O m	w	K 5	56"	exca	oal.	5		
	4.0-4.5	CI.	t up till, dark grbron	מע		3%	YEX	avai	-		3.75	_
-			very stift, longes+sp	reck	c							
-			of oxides, few shale Pa	tole								_
		Ada	led 10m of 6 "casin	a, to	talc	esii	ais	4.25	m			=
-			wie easing down to				1					
	4.5-5.0	CI	-up till, darkgrb	-000	1	3%	1 Exc	ava	top			
+			Hard, few langue + spe	eks								_
+			of oxides, Publicy					-		-	-	_
-			few shale Particles		-						-	

roje	ct 5.0	7	pintwood	e lue		PFF	RA TES	STHOL	E LO	G		
				_						-		-
Hole	No. 6300	ntel	Elev.	_m								
ocat	ion C-		1100									
rille	d by		Date Started									
ogge	ed by		Date Completed									
Vate	Level Final		m Top Pipe Time-Date									
nstal	lation				A	L	CATIO	N SKE	ТСН			
age	401/8		territy of strength by	(A)	Bit pre	ssure , F	evolutio	ns per n	ninute			
ener	al		ACT THE PERSON - 11	(8)	Circula	tion flui	d , Pump	pressu	re,Volu	ıme %	Loss	
50.10	Depths - m		Farmation and the control of	(c)		ample we			nce, B	low co	unt	_
			Formation and Water Data		Drill Do	ara and	Remarks	Los		Sampl	e Date	
ime	(Underline sample	Group	Description, Characteristics,	Depth	Depth	(A) kPa	-		Lengt	h-m	PP kPa	
	drive)		Abnormal Conditions, Sample Type	Casing	Hole Fluid	(B) kPa	_		Drive	Rec.		Ne
- 22	1-1			m	m	(O) Ng	Drop-m	DIOWS				-
	5.0-6.0	CI.	-up till, gray, hard			2%	11/5	1000	2/01	-		
						1469		50 C C	2100			
			lenses + specks of ox	iles								
			Row Shale particles, a	ew						k I		
				1							1	
			slight Traces of water	ing	fore	1		LINES S				
			1.1-									
			oxidized Joints	-								_
				-			_	-		-		_
	6.0-679	-07	- un till and he de	0	0	/		10		_	_	2
	2.0	04	Squilly grey, hava	-		255/	ner	13	./5	75		Ø.
3			Fece oxides shale Par	12/		NO1		/	1/4			_
-			Salv System Fav	100			very	sug	4-1	2/11/0	M 57	-
			Few cobbles			ati	uto	care	dia no		- 1	1
						C.	3.0	Jul 2	10-4	96	41 2	He
						600	3-8 95111	, 560	4			
	200 200				110		-					
		-						2				
	17-0	01	Fiz 1 1 1 1 11	, '		37	11		,		4.0	e-sille
	6.75-8.8	CL.	-up Till, grey, Ham	16		58	Exc	000	OF		3.75	
					751			70.1				
			very stiff, few shale	Par	4/45						-	_
			and cabbles Chineston									
			Comestons Chimeston		-					-	-	_
				H								
					777				-	-	-	-
3		Kon	ned hale out to 8			11 9	14	5	7	from 1		

A3. Field borehole description, GSC-BH-SW-03A, page 5 of 18

Locat Drille Logge Water	No. 2-3ci	en Ta	Elev Date Started Date Completed Top Pipe Time Date	_m			DCATIO		тсн			
age . ener	5 of <u>8</u>	7	Last Settlementals a district	(B)	Circulo	ssure , F Ition flui	d , Pump	pressu	re, Vol	ume %	6 Loss	
	Depths - m	Pin	Formation and Water Data	— (c)		ample we			nce, B	100000	-	_
ime	(Underline		Description, Characteristics,	Depth	Depth	Laves		-	Lana	Sampi th-m	e Date	1
	sample drive)	Group	Abnormal Conditions, Sample Type	Casing Shoe m		(B) kPo	cm3/s Drop-m	% Loss	-	Rec,	kPa Test	No
	6.0-9.25	CI	cuptill, ghey, very si	14		3%	"Exc	ava	5r			
1			Rewshale Particles									-7
	925-10.	CI	teup, till, grey, still			Bugs	lines	12	.75	-75	2.5	3
			Cen Shale Particles 1	tree		Note	: 50 m	aple at co	Perl	100	2011	0
-			of conto seeping into	lede		rel	viewes	Vsai	espl	2.2		
-			No visual sand seen	15 110/1	Eed							
						3						_
	10m-115	CI.	temp Till, arm, stiff			3	B'EX	cavã	tor		a.5	
	-10		few shale partides									
			and limestone cobb	les								
1		Ra	med pole out tolls		·11	r5/	11-				-	-

A3. Field borehole description, GSC-BH-SW-03A, page 6 of 18 Project G.S.C. Spirituood PFRA TESTHOLE LOG Drilled by _ Date Started Date Completed Installation _ LOCATION SKETCH Page 6 of 18 (A) Bit pressure , Revolutions per minute (B) Circulation fluid, Pump pressure, Volume % Loss General (C) Drive sample weight, Drop distance, Blow count Depths-m Formation and Water Data Drill Data and Remarks (Underline (A) kPa rpm Description, Characteristics, Length-m kPa sample Group Abnormal Conditions, Casing Hole (B) kPa cm³/s % Loss drive) Sample Type Shoe Fluid Rec. Test (C) kg Drop-m Blows Lime tone

A3. Field borehole description, GSC-BH-SW-03A, page 7 of 18

Projec	+ GSC	- Sp	intwood		URB	A THE	PFR	A TES	THOL	E LO	3		
Sife	90007	100				Anna Terror							
	No. 6-300		Eley,	_m									
	11.00		Date Started	_									
			Date Started	_									
	37.07.75		m Top Pipe Time-Date										
	lation	DOT HE ST	Top Grd Time Dute	_			LC	CATIO	N SKE	тсн			
100000000	7 01 18	artest	tenning of the high - her		100000		ssure , F	Revolution	ns per n	inute			_
Gener	al		nat singenii - u		70.0-6			d , Pump light , Dro					
	Depths - m		Formation and Water Data	Т	(0)			Remorks	pp disid			e Data	
Time	(Underline	TO A SE		+	D		(A) kPa					PP	
ime	sample	Group	Description, Characteristics, Abnormal Conditions,		Depth	Depth	-		% Loss	Leng	th-m	kPa	No.
	drive)	100	Sample Type		Shoe	Fluid	(C) kg	Drop-m	Blows	Drive	Rec.	Test	
	7777 100	07	71/1/1			100	27	4				2	
1178	14.6-15.1	0.7	+ up Till, dark gray,	4	Jay 5	11:44	3/9	Exc	ruali	1	-	5.0	
			Low shale partiels		1								
				-							Trans.		-
			Linestone Pebbles										
		+		+		-	-		-		-		_
	151-155	25 CT	two Till dark que			1	2,000	liner	10	70	16	26	5
TV		+					1	1210		87.3	000	0,0	_
			Stiff, Gus Shalepar	160	les								_
			and linestone Peppe										
			and Junes long Peppi	4			+		-	-			_
	15 3140	-		+	-		-						<u> </u>
		H					-						
		TE		1			27.	1.					_
	15.85-16	1/6	I +uptill, Asabo	40			39	Exc	2001	34			
		-		+	-		-	-	-	-			
		Res	med holo out to	14	1/m		W.	556	4E	ica	1007	50	
							-						
	11/11/11	T	11.00	7	01								
	16:1-/6.	01	+ wptill, gray very s			-	1		-	-			-
			faw limestone sopbles	+	hale	Park	Elec						
	1		7	-		- Andrew State							

A3. Field borehole description, GSC-BH-SW-03A, page 8 of 18

Site _	6050	1009	rituard									- Contract	
	10. 23 co	ntd	Elev	m									
			Date Started										
	by			-									
			m Top Pipe Time-Date										
	ation		Top Grd Time-Date				10	CATIO	N SKE	TCU			
	3 of 18	160	manyer or warter - to	-	(A)	Bit pres	ssure , R		The second second	-			
Senero			not elemental - ii.	_			tion flui ample we						
	Depths - m		Formation and Water Data	2	1	Drill Do	ta and l	Remorks			Sample		
ime	(Underline sample	Group	Description, Characteristics,	100000	pth	Depth	(A) kPa			Leng	th-m	PP kPa	
in i	drive)	Oroup	Abnormal Conditions, Sample Type	11000	sing hoe	Hole Fluid		cm3/s Drop-m		Drive	Rec.	Test	No
				+	m	m	(C) Ng	Drop-m	Blows				-
		Set	3.27 with short 3.38	<u> 4 3.</u>	23	-43.	2	2.90	+1.4	Sm	= /7	238	, 253
		07	64"casing into he	ole,		stal	4"2	esinq	is 1	7.39	32		10
		0	His casing down to				1	•					
			end of Day.										
			Nov 5/2010										
		D	ill out inside of e	as L	in	to/	6.5	m					
					7		-						211000
	16.5-17.8	CI	tup Till, Parkgry,	uce	~		3%	EXC	asate				
			stiff exples of hi	mes	ton	•							
	9.		and shale Particles										2016
					7.3	5-							
	17.8-18	Clar	Shale, silt, darkg				3%	EXC	u wah	dem-	Bas	,	6
			med hard few ML								,)	
								30-311					_
-													

A3. Field borehole description, GSC-BH-SW-03A, page 9 of 18

Projec	G050	400	pirituood	Tue	IR Te	PFR	A TES	THOL	E LO	G		-
Hole Locat	No. 2-300	nto	Elev Date Started	.m								
			Date Completed	-								
	lation	per la la	_m Top Pipe Time-Date	_		LC	CATIO	N SKE	тсн			
Page . Sener	9 of <u>18</u>	ries	THE MAY WE WINDOW - MAY 1997 - 1897 - 1888 - Party - 18	(B)	Circula	ssure , R tion flui	evolution d , Pump	ns per n pressu	ninute re,Voli	ume %		888
	Depths - m		Formation and Water Data	ater Data Drill		ample we				Sample		
ime	(Underline sample	Group	Description , Characteristics , Abnormal Conditions ,	Depth	Depth	(A) kPa	rpm			th-m	PP kPa	
tan d	drive)	0.00	Sample Type	Shoe m	Fluid m	-	cm ³ /s Drop-m	-	Drive	Rec.	Test	No
	18.0-18:	25 C	lay shale, silty, Rewor	Ked		Bus	stines	26	.75	:75	>	2
-			with semmerous line	tone								-
			Pebbles, med hard, Do	Kgr	7							
												_
	18.75-19.	6 Cla	Shale, Reworked, Day	Kart	y, ha	nd	3省4	Exc	007	5 C	300	8
			silty, numerous, shale	stane	Ĺ						7	
			concretions,	-								
			noved 1.48m ofcas	ing,	Add.	13.	33 m	of4	"ca	sin	9	
			tal cosing 19.28m									_
		Dr	we casing down To	19.0	43		-					_
												-
												_
						L	enent,					

A3. Field borehole description, GSC-BH-SW-03A, page 10 of 18

			Pirituod				RA TE	31 HOL	E LU	G		and the same
	State of the state		Elev	.m								
	ion			_								
	d by		Date Started	_								
			Date Completed	-								
	Level Final	100.00	_m Top Pipe Time-Date	_								
	10 of 18	etra	Designation and Application of the Control of the C	(0)	Dit nee	LC ssure , F	CATIO					
000	al			(B)	Circula	tion flui	d , Pump	ns per n pressu	ninute re.Voli	ıme %		
oener				(c)	Drive s	ample we	ight , Dr	op dista	nce, B	low co	unt	
	Depths - m		Formation and Water Data		Drill Do	ata and	Remarks			Sample	e Data	
Time	(Underline		Description, Characteristics,	Depth	Depth	(A) kPo			Lengt	h-m	PP	
	drive)	Group	Abnormal Conditions, Sample Type	Casing Shoe	Hole Fluid		cm3/s	The state of the s			kPa	N
-		1		m	m	(C) kg	Drop-m	Blows	DI IVE	Rec.	Test	
	19.6-21.0	Cla	Shale, Reworked, day	le an	01	3	200	xcas				.3
	-12		11 1	1	1	1	29	2500	25104			
	1		Hard, with shalestone	COM	weat	ins						
						Less of the second						
			erumbley.		_						1	
						-		-		-		_
	210-21.75	Ch	Shale Reworked, H	end		Runss	liner	100	75	.75	>	9
						1000	HAT F	100	43	-/->		1
			silty, Crumbley, with,	ac								
		-										
		-	few limistone Pebbles	021.	5 m							_
							-			-	-	_
		Add	ed 148 mofcasing,	total	1- 1	20.7	6					
			7.			120	W.FF.					_
				20.5	ha							
	ninn	21.	01.1.0. 411	1,		2	24		1			
	0 10/2 milds	3-19	Shale Reworked, dar	19 gr	4	51	S'E	cau	alak			
			Hard, numerous line	+								
								-				_
			Pebble, appears to	11/1	40							
-		-										
	22 2 22 6	DT	101 1 1 1 1 1	A		1	36"	-		1		-
-	UNAS-CINIC	Le de l'	-up till darligray h	avel			9	Kca	val	01	-	
- 1			cery shalog, crumbley,	200			57/47/11					

A3. Field borehole description, GSC-BH-SW-03A, page 11 of 18 PFRA TESTHOLE LOG ocation _ _ _ (orilled by __ Date Started _ogged by ___ Date Completed . m Top Pipe Time-Date Water Level Final _ LOCATION SKETCH nstallation _ (A) Bit pressure , Revolutions per minute Page 11 of 18 (B) Circulation fluid, Pump pressure, Volume % Loss General _ (C) Drive sample weight, Drop distance, Blow count Depths-m Formation and Water Data Drill Data and Remarks Sample Data (A) kPa rpm (Underline Description, Characteristics, Depth Depth Length-m kPa sample Group Abnormal Conditions, (B) kPa cm³/s % Loss Casing No. Hole drive) Sample Type Shoe Fluid Drive Rec. (C) kg Drop-m Blows -23.94 Very slight water seepage coming into hale from the 228-229/ayer
Added 1.48mot Casing, total=24.10m

Drive casing down To 23.75 A3. Field borehole description, GSC-BH-SW-03A, page 12 of 18 PFRA TESTHOLE LOG Hole No. 8=3 conTd Location C-Drilled by . Logged by ____ Date Completed Water Level Final Installation _ LOCATION SKETCH Page 12 of 18 (A) Bit pressure , Revolutions per minute (B) Circulation fluid, Pump pressure, Volume % Loss General _ (C) Drive sample weight, Drop distance, Blow count Depths - m Formation and Water Data Drill Data and Remarks Sample Data ime (Underline (A) kPa Description, Characteristics, Depth Depth rpm Length-m kPa sample Group Abnormal Conditions, (B) kPa cm⁸/s Casing Hole % Loss drive) Sample Type Fluid Drive Rec. Test (C) kg Drop-m Blows 24.

A3. Field borehole description, GSC-BH-SW-03A, page 13 of 18 Project C. S.C. Spiritused Site GOSOA009 PFRA TESTHOLE LOG Hole No. 23 contel Elev. Location C Drilled by _ Date Started Logged by ____ Date Completed Water Level Final __ m Top Pipe Time-Date Installation _ LOCATION SKETCH Page 13 of 18 (A) Bit pressure , Revolutions per minute (B) Circulation fluid, Pump pressure, Volume % Loss General (C) Drive sample weight, Drop distance, Blow count Depths - m Formation and Water Data Drill Data and Remarks Sample Data Time (Underline (A) kPa rpm Description, Characteristics, Depth Depth Length-m kPa sample Group Abnormal Conditions, (B) kPa cm3/s % Loss Casing Hole drive) Sample Type Fluid Drive Rec. Test (C) kg Drop-m Blows 26.3.220 CI - cup Till, dark gray, Hard Shale partiales + chunks Added 1.48m of casing, total = 27.34m 27.0. chunks, crumbles

A3. Field borehole description, GSC-BH-SW-03A, page 14 of 18

Site	G050	1000	pirituood	-	-	PFI	RA TE	STHOL	E LO	G		O-topic
Hole	No. 2-3 C	onPa	Elev.	_m								
		wh	OTHER SERVICE AND ASSESSMENT OF THE	-								
			Date Started	-								
	r Level Final		Date Completed	-								
	ligition	Sales O	m Top Pipe Time-Date	-			ALL DES					
000000000000000000000000000000000000000	14 of 18	After	Indiana and Alexander and Alexander	(0)	Dit aus	L	DCATIO	N SKE	TCH			
ener			sen message, a	(B)	Circula	tion flu	Revolutio id , Pump eight , Dro	pressu	re, Vol	ume %	6 Loss	
	Depths - m		Formation and Water Data	1 ,,,,	17-17-17		Remorks			4070		_
ime	(Underline	1 00	Description, Characteristics,	Danak		(A) kPa					PP Date	
	sample	Group	Abnormal Conditions,	Depth	Depth Hole	-	cm ⁸ /s	% Loss	Leng	th-m	kPa	No.
7	drive)	303	Sample Type	Shoe	Fluid	_	Drop-m		Drive	Rec.	Test	-
	2275-29.0	CI	-wptill, dark grey, ha			3号	Exca	vator				
			very shaley, limestone cas									
			rumerous shale particle		en Ks							_
			crumbley									
			moved 1.48 m easing,			.34	m, to	ta/=	29	20	m	_
-	29.0-29.5	CI	-wp Till, dark grey	29.0	m							
			Hard very chaly, limesto,	re.								
			cobbles, numerous shale	che	els							
	29.5-29.6					3%	4 Bxc	urati	5-			
	29.5-29.6	SG	Shaley, very shift trace	V		3%	BXC	unt	5-			_
	29.5-29.6	SG	fine, dark grey, wetour	V		3%	Exc	avati				_
		SC	Shaley, very shift trace	s of				avat	5-			_
and control of the co		SC	Shaley, very shight trace water in the hole	s of	cinq			avall	-			

A3. Field borehole description, GSC-BH-SW-03A, page 15 of 18

Site	G050A	1009	intwood	-	_	-	RA TE	THOL		3	-	-
Hole	No. Los co	nTEl	Elev	m								
Locat	ion C-		and the second s									
Drille	d by	110	Date Started									
Logge	ed by	- 40	Date Completed									
Water	Level Final		m Top Pipe Time-Date									
	lation			_	appear of		CATIC					
1000	1501 18			(A)	Bit pre	ssure , F	Revolutio	ns per n	ninute			
Gener	01			— (c)	Drive s	tion flui ample we	ight Dr	pressur op dista	nce. R	ume %	Loss	
	Depths - m		Formation and Water Data			ata and I				Sample	d eleven	
Time	(Underline		Description, Characteristics,	Depth	Depth	(A) kPa	rpm			-	PP	_
	sample drive)	Group	Abnormal Conditions,	Casing	Hole	(B) kPa		% Loss	Leng	th-m	kPg	No
-	urive	of being	Sample Type	Shoe	Fluid	(C) kg	Drop-m	Blows	Drive	Rec.	Test	
	29.6-30-	CI-	up Till, doukgrey, h	and		3%	Exe	a val	T.			1
_			very shaley, shale che									
			+ limestone cobbles									
	30.0m To			30	n							
	30-1-30-8	5 C]	-up Till, dark grey,	have	1	Bras.	Show	55	75	.75	>	12
			very shalo, with sha									
			limestone subbles									
				30.5		15						
												_
	2 2 2 2 1	OT	Tu A .			-7	b				4	_
	20 82-3d-6		-wpTill, dark grow, h			3/8 No	Exc	oval	20		-	_
			slightly sand, shaley, c		1;		ies seeps	75/				-
			shale chunks, limesto									_
			thin sand seam, wet oud 1.48 moteasing,					20		+	-	
		Hem	ouca 1.70mor casing.	rada	2 3.	59.1	olal +	200	59	m		

A3. Field borehole description, GSC-BH-SW-03A, page 16 of 18

ole I	8050 A No. 6-3 co			_m								
	d by		The same of the sa									
			Date Started	-								
	Level Final		_m Top Pipe Time Date	-								
	lation		Top Grd Time Date	-			204710	N OVE				
	16 of 18	a figur	Introducial execute - ma	(A) Bit pre		OCATIO Revolutio				-	
HTERRI	al						id , Pump			ume %	Loss	
rirea	ui						eight , Dr					
- 1	Depths - m		Formation and Water Data		Drill D	ata and	Remarks			Sample	e Date	
ne	(Underline		Description, Characteristics,	Depti	Depth	(A) kPd	rpm			th-m	PP	
	sample	Group	Abnormal Conditions,	Casin	Hole	(B) kPc	cm3/s	% Loss	Leng	III-III	kPa	No
-	drive)	100	Sample Type	Shoe	Fluid	(C) kg	Drop-m	Blows	Drive	Rec.	Test	
			11/1/2									
-		-	Nov. 6/2010	-								
		~	+ + 1 1	,								
		5/0	tie water level in hal	150	7 3	2.03	mE	nom	25	9 1.	evel	377
	201 22	pr	+111	1	h	22	11.		1			
	34-6-336	101	-wp till, darlegrey,	Mary	1	2/3	Exc	avato	7			
-			very shalo, with sha	4	-						-	
		-	Partioles + chunks									
-			Farnolis + Chunis	-	+	-						
1				-		-		_				
	330-33.79	CI	-up Till, darkgray,	1.1	,	2	liner	51	7-		_	10
			Springary,	A VOL	1-1	21455	unte	200	0/5	-/5	-	12
			very shaley, with shall	1					-4			
-				*	1			-		-		-
			Particles + chuncks						- 3		1	
			1 2 2 2 1 3 1 3			1						_
											$\neg \neg$	_
1												
1		27	41:	. ,		_						
-	33.75=34.	7CL	-coptill, Asabove	rith		3/3	"Es	cau	top			
				1.								
-			a few limestone cob.	165								
						100						
- 1												
-				-						and the second	man and the	

	4 - 12				II.	RA TES		-	_	-	
6050A			-								
State of the state	1111-000	Elev.	_m								
on _C_			_								
by		Date Started	_								
1 by	-	Date Completed	_								
Level Final	2000	m Top Pipe Time-Date									
0.00											
Zot 18											
H											
Depths - m	N James	Formation and Water Date	1 (0)				ор атата	nce, B	low co	unt	_
		- or marion and water bora	1	Drill Do	ra and	Remarks	100		Sampl		0
	Group	Description, Characteristics,	Depth	Depth	_	-		Leng	th-m	kPa	
drive)	0.000	Sample Type	Shoe	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	-			Drive	Rec		No.
			_ m	m	(C) Ng	Drop-m	Blows				
34.7-36	Clm	shale dukano citt	4.	1	27/2	15.		-	2.		14
	1	and a sure of the sure of	Narg	-	20	-20	avai	10	Day	9	17
		few oxides slight to	-						`		
									-	-	-
		of water of the sha	le con	tant	1						
			-	SHEEK.	750						-
	AFI	er approx 30 min cu	ster 1	level	in A	· how	213	32	69	· ho	
	-			and a second				-			
	400	in grd level.									
	0	40.01 1		, ,							
	Pa	cktill hote to 35.0m	with	clay	cutti	rids o	40 Th	mp.	ed		
						/			4	,	
	76	en installed a day	0- 1/as	116 10	De,	Diez	into	heel	25	chs	10
	17000			1020				H		9	
	261	ng th the slotted a P.V.	Pipe	150	1.99	me	Ters	20	56	1.5/	20
	11	11 11 14 24 24	10			J				-	
	106	Hugh of the & solid	Pipe	153	10/	mel	15				
177	7	+/2"0"D:	1.5	26	20						
	101	ald for lipe + Scheen	1/5		-/0	met	7-5				_
	0	The CHI. 24-141.		10		-			,		,
	00	HOME OF THE & STONES PY	Deisa	1 30	1.954	2.00	3 m	gn	14	1011	_
	Tal	2 06 the D" - 1. Hel 2 3		671	91	-		'	1	1	1
	.01	action of 2 course bib	15 07	31.	16 1	n fe	one	90	21	100	1_
	Tal	2 2 4 4 60 2 4 9 110 2 4	1 2	6		. 1			0 1		1
	- 83								- 1		_
Tr.	Jan	red 4" come back	1/2	22	2	0		1	1	./	
	-1										
-	on C-last by Company of the Company	on C-I i by — d by — Level Final — ation — (7 of 18 all — Depths-m (Underline sample drive) 34.7-36.6 Cla Ba Tota Tota Tota Tota Tota	Date Started d by	Date Started d by Date Completed Level Final Top Pipe Time-Date ation (Tof 18 at	Date Started Level Final mopping Time-Date Control of the started mopping of the sample drive) Depth Sample Type Shale contact	Date Started d by	Date Started Dote Completed Level Final mosping Time-Date Too IB all (a) Bit pressure, Revolution (B) Circulation fluid, Pump (C) Drive sample weight, Dre Bopths-m Formation and Water Data Depths-m Formation, Characteristics, Abnormal Conditions, Sample Type Shoe Fluid (C) kg Drop-m 34.7-360 Clay Shale, duck gray, silk, Hard 3/4 Exc from and level. Back fill hale to 35.0 m. with clay cuttings of Their installed a 24 PUS Plate propers at 34.75 met Total 2" PVC Pipe & Server 15 35.70 met Bottom of the 2" slotted pipe is at 34.95 met Top of the 2" PUS Pipe is 0.25 me about Janath 4" Casing back to 32.0 met for the propers of the 2" PUS Pipe is 32.0 met Top of the 2" PUS Pipe is 0.25 me about Janath 4" Casing back to 32.0 met for the propers of the 2" PUS Pipe is 0.25 met about Janath 4" Casing back to 32.0 met for the propers of the 2" PUS Pipe is 0.25 met about Janath 4" Casing back to 32.0 met for the propers of the 2" PUS Pipe is 0.25 met about Janath 4" Casing back to 32.0 met for the propers of 32.0 met for the propers of 32.0 met for the 2" PUS Pipe is 0.25 met about Janath 4" Casing back to 32.0 met for the propers of 32.0 met for the 2" PUS Pipe is 0.25 met about Janath 4" Casing back to 32.0 met for the propers of 32.0 met for the 2" PUS Pipe is 0.25 met about 150 met 1	Date Started Date Completed Level Final mopping Time-Date Top Ping (B) Time-Date Control of 18 Control of	on C-1 by Date Started d by Date Completed Location SKETCH Top Pipe Time Date Top Grd Time Date (A) Bit pressure, Revolutions per minute (B) Circulation fluid, Pump pressure, sold (C) Drive somple weight, Drop distance, B Depths-m Formation and Water Data Description, Characteristics, Capital Anormal Conditions, Sample Type Shoe Fluid (C) kg Drop-m Blows Drive Shoe Fluid (C) kg Drop-m Blows Drive 34.7-36.5 Clay Shale, dwk gray, silly, Hard 3/8 Excavator few axides, Slight Trace of water at the shale contact After approx 30 min water kneep in the hale is 32. From the stalled a 24 P Va Platia properation for Length of the 2" sold. Prope is 3.2.71 metric Bottom of the 2" slotted pripe is at 34.95% for metric Bottom of the 2" slotted pripe is at 34.95% for metric Top of the 2" PVC Pripe is 0.25 m above and Janeed 4" Casing back to 32.0 m form grad	Depths—m Depths—m Depths—m Depths—m Depths—m Depths—m Depths—m Condition, Characteristics, Abnormal Conditions, Sample Type After approx 30 min water Luce in the hale is 32.0 m. Length the slotted 2 RVC Plate pipe is 0.75 m. above and the standard of the 3" slotted pipe is 0.75 m. above and the standard of the 3" slotted pipe is 0.75 m. above and the standard of the 3 m. and the st	Date Storted d by

A3. Field borehole description, GSC-BH-SW-03A, page 18 of 18 PFRA TESTHOLE LOG Drilled by Date Started Date Completed m Top Pipe Time-Date LOCATION SKETCH Installation (A) Bit pressure, Revolutions per minute Page 18 of 18 (B) Circulation fluid, Pump pressure, Volume % Loss General (C) Drive sample weight, Drop distance, Blow count Depths - m Formation and Water Data Drill Data and Remarks Sample Data (A) kPa ime (Underline Description, Characteristics, Depth rpm Depth Length-m kPa sample Group Abnormal Conditions, Casing Hole (B) kPa cm3/s % Loss drive) Fluid Sample Type Shoe Drive Rec. Test (C) kg Drop-m Blows elay cultings and 5x6"x6" Protective steel Pipepiez, Pipe is capped and Markel A water level will be obtained

Hole Local	d by A	ωο3 -/7-		_m		tole (:-1 Cs	w03A)	della			
Water	Level Final	1.32	m Top Pipe Time-Date 1/00 16	PM	-			CATIO					
age Gener	Depths-m	16/0	Formation and Water Data	93	(B)	Circula Drive s	ssure , f tion flui ample we	d , Pump ight , Dr	pressu op dista	re, Vol	ume %	6 Loss unt	8
ime	(Underline sample drive)	Group	Description, Characteristics, Abnormal Conditions, Sample Type	C	epth asing Shoe	Depth Hole Fluid	_	rpm cm³/s	% Loss	Leng	Sampl th-m Rec.	PP kPa	N
15.5	0-0.5	Top	soil, Black organis	2, 5/	m T:44	m	(C) kg	Exce	-		Red.	Test	
			Fihers (nouts)										
	0.5-1.40	CI,	copy Till, Brown,	les	,		37	26.6	xean	ator			_
	1.4-1.50	SC	fino-coarse, brown, a	1		3	78 4 G)	cac	ator				
			hole	èg 11	ito								_
			med hole on to 1.5			- Control of Hills	Z'es	eava	tor				_
			1.69 m of 6 acosing ,										- -
	15-2.25		up till, Brown, still	e/			3番	Exea	va lor	2			

A4. Field borehole description, GSC-BH-SW-03B, page 2 of 5

	Cosa	100	9		-		A TES	-			-	-
	vo. C-2 co											
		ril or	Elev,	_m								
cati												
	l by		Date Started									
			Date Completed	-								
	Level Final	JAN 21	.m Top Pipe Time-Date									
	ation	la pro		(A)	Bit pres	ssure, R	CATIO		-		-	-
				08.937		tion flui				me %	Loss	
ner	01			(c)	Drive s	ample we	ight , Dro	op dista	nce , Blo	ow co	unt	
	Depths - m	To take	Formation and Water Data		Drill Do	ita and l	Remarks		s	ample	e Data	,
me	(Underline		Description, Characteristics,	Depth	Depth	(A) kPa	rpm		Lengti	h-m	PP	
	sample	Group	Abnormal Conditions,	Casing	Hole	(B) kPa	cm3/s	% Loss	\vdash	N. W	kPa	No
	drive)	100	Sample Type	Shoe m	Fluid	(C) kg	Drop-m	Blows	Drive	Rec.	Test	
		00	11100 111		41	-						
		HAA	led 1.56 m of 6" cas	119,10	(al :	33	12 11		-			_
		0	e cosing down to	100							1	
-		PPIO	e coising down 10	123		-		-		-	-	-
	225 39	CT	up till, Boson stiff	2		3%	11/18	caus	7			
-	61-6-7 - WOO	0+1	open, sier			- 5		Calla	100			- 0
			14430s+ seams of aci	1								
			, and see the see of the									
			cust sand seom al	-2.8m								
			center coming into	hele								
					=======================================			NG-SHIPSA				
-1	28-30	CZ	up Till, Borara, STI	24		_	3"1	Redu	ales			
						1/02	4				, ,	
	- 3.20		silty, with interbed	1.1	_	64	ater	come	12/11	to	w/s	_
				Am			,					
-		0.77	This loyers + scome	27/11/6	ene	1501	cly-					
				41. 2	1							
			numerous seams o			-	-					
	-	Re	med hole out to	30-		1 5	5/4	15.		to		
						-	-	-20	4.0	-sek		
		Dr	is casing down t	0 3.0	m							
			The state of the s									
									-			
										085		
	3.20-370	CI	up, till, grhrown, ve	w = 174		3	30"	Exc	wa	tor		
		76	lenses + seams of oxi	1								

A4. Field borehole description, GSC-BH-SW-03B, page 3 of 5

by	ntel	pirituado	.m								200
by by evel Final tion											
evel Final		Date Started	-								
tion		Date Completed									
3.37	DESCRIPTION OF	m Top Pipe Time-Date									
							N SKE				
of <u>S</u>		TOT THE STATE OF T	(B)		tion flui	d , Pump	pressur	e,Volu			
Depths - m		Formation and Water Data	(0)								
(Underline		Description, Characteristics,	Depth	Depth .	(A) kPa	-				PP	
drive)	Group		Casing		-		-	Drive	Rec		No
			m	_m_			Blows	51 146	net.	1681	
	Add	ed 1.0 m. of 6 "casing	to	to/ :	4-2	5m					1
	Dec	be coming down to	3-70	Man.							
	Ba	iled water out of He	10								
3.70-4.60	CT:	two till dark ar brown	*N		3%	" = "	Ca.	top	-		
		ofoxides									
						_				-	_
	Rea	med have out to 4	6m	wi	1/5	196	Ex	cas	rato	F	_
4.60-50	CI.	- up Till ores han	0	3	7/24	Exe		_			_
	0.	111 4+5		,	11	51				,	_
	nec	emed hold out to 5.	Om	wi	1 5	19	Ex	cal	val	02-	-
										+	
	Depths-m (Underline sample drive)	Depths-m (Underline sample drive) Ra Rea 1.60-50 CT	Depths-m Formation and Water Data (Underline sample drive) Description, Characteristics, Abnormal Conditions, Sample Type Added 1.0 m. of 6 "Casing Description of the Casing Device example down to Bailed water out of the Casing Bailed water out of the Casing State of the Casing State of the Casing State of the Casing Bailed water out o	Depths-m Formation and Water Data (Underline sample drive) Description, Characteristics, Abnormal Conditions, Sample Type Adhed 1.0 m. of 6 "Casing, to Device casing down to 3-70 Bailed water out of Hole 3-70-4.60 CT tup till, dark ar brown wery stiff, I suses seen 3 Pearned habe out to 4.6 m. Reamed habe out to 4.6 m. Reamed habe out to 4.6 m. 1.60-50 CT - up Till, grey, hard - 5.6 lenses of oxides 4-ac	Depths-m Formation and Water Data Description, Characteristics, Abnormal Conditions, Sample Type Added 1.0 m. of 6 "Casing, to to! = Description, Characteristics, Abnormal Conditions, Sample Type Added 1.0 m. of 6 "Casing, to to! = Description, Characteristics, Depth Hole Shoe Fill m. Added 1.0 m. of 6 "Casing, to to! = Description, Characteristics, Depth Hole Shoe Fill of m. Added 1.0 m. of 6 "Casing, to to! = Description, Characteristics, Depth Hole Shoe Fill of m. Added 1.0 m. of 6 "Casing, to to! = Description, Characteristics, Depth Hole Shoe Fill of m. Added 1.0 m. of 6 "Casing, to to! = Description, Characteristics, Depth Hole Shoe Fill of m. Added 1.0 m. of 6 "Casing, to to! = Depth Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing, to to! = Depth Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing, to to! = Depth Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing, to to! = Depth Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing, to to! = Depth Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing, to to! = Depth Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing, to to! = Depth Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing, to to! = Depth Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing, to to! = Depth Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing, to to! = Depth Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of 6 "Casing Shoe Fill of m. Added 1.0 m. of	Depths-m Formation and Water Data Depth Depth Description, Characteristics, Abnormal Conditions, Sample Type Depth Hole Shop Shop Fill (B) KPG (B)	Depths-m Formation and Water Data Drill Data and Remarks Drill Data and Remarks Depth Casing Hole Shop Fluid (B) kPa cm³/s Sample Type Added 1.0 p. of 6 "Cassing, to 60 = 4-25 m. Deve casing down to 3-70 m. Bailed water out of Hole Brown stiff, Innses yearn? Pearned hole out to 4.6 m with \$56 Rearned hole out to 4.6 m with \$56 Also 50 CT - up Till, grey, hard 3 % 4 & xc 4.20	Depths-m Formation and Water Data Depths-m Formation and Water Data Drill Data and Remarks Drill Data and Remarks Depth Casing Hole Gills Re arry 96 Loss Sample Type Description, Characteristics, Abnormal Conditions, Sample Type Shoe Find Bird Come of 6 "Casing, to 6/= 4-25 m Drive cosing down to 3-70 m Baild water out of Hole Brown Blows Brown Brown Blows Brown Brown	Depths—m Formation and Water Data Depths—m Formation and Water Data Depths—m Formation and Water Data Description, Characteristics, Abnormal Conditions, Sample Type Sample Group Abnormal Conditions, Sample Type Shoe Shoe Shoe Shoe Shoe Shoe Shoe Shoe	Depths—m Formation and Water Data Description, Characteristics, Abnormal Conditions, Sample Type Description, Characteristics, Abnormal Conditions, Sample Type Depth Casing Box completed (B) NPa cm³/s % Loss Drive Rec. Albed 1-0 m. of 6 "Cassing, to lo] = 4-25 m Dente casing down to 3-70 m Bailed water out of Hole Bailed water out of Hole Reamed habe out To 4-6 m with 5 96" Excustor Reamed habe out To 4-6 m with 5 96" Excustor 160-50 CT—up Till, grey, hard Jay 4 Excustor Length—m Length—m Length—m Length—m Length—m Length—m Shoe Fill (B) NPa cm³/s % Loss Drive Rec. 3 7/3 " Excustor 160-50 CT—up Till, grey, hard Jay 4 Excustor Length—m Sample Type Length—m Length	Depths—m Formation and Water Data Depths—m Formation and Water Data Description, Characteristics, Abnormal Conditions, Sample Type Sample Type Description, Characteristics, Abnormal Conditions, Shoe Brief Casing Colk (Disko cm³/s % Loss) Real Local of Casing, to to 1 = 4-25 m Description of Characteristics, Shoe Shoe Shoe Shoe Shoe Shoe Shoe Shoe

A4. Field borehole description, GSC-BH-SW-03B, page 4 of 5 Project G.S.C. Spiritwood PFRA TESTHOLE LOG Hole No. C-2 contd ocation Date Started ogged by _ Date Completed m Top Pipe Time Date Water Level Final _ nstallation . LOCATION SKETCH age 4 of 5 (A) Bit pressure, Revolutions per minute (B) Circulation fluid, Pump pressure, Volume % Loss General (C) Drive sample weight, Drop distance, Blow count Depths - m Formation and Water Data Drill Data and Remarks Sample Data (A) kPa rpm (Underline ime Description, Characteristics. Depth Depth Length-m kPa sample Group Abnormal Conditions, Casing Hole (B) kPa cm3/s % Loss drive) Shoe Sample Type Fluid Drive Rec. (C) kg Drop-m Blows Exequalor 9.0-10.5 CI tuptill darkgrey, Hand and quatter at 10.5 m Bottom of hole Prepare hole for a 2" silup PSS. Plastic pipe tight into the hole with the rig Tool ste Palled casing back To 3.5m. Then back clay cuttings to 3. So matis from ground Length of exposed slotted paper is 0.70 Kength of Just 2" PUC Pipe is

A4. Field borehole description, GSC-BH-SW-03B, page 5 of 5 Project G.S.C. Spiritwood PFRA TESTHOLE LOG Hole No. C-2conTel Drilled by . Date Started Logged by __ Date Completed Water Level Final Installation _ LOCATION SKETCH Page 5 of 5 (A) Bit pressure , Revolutions per minute (B) Circulation fluid, Pump pressure, Volume % Loss General (C) Drive sample weight, Drop distance, Blow count Depths - m Formation and Water Data Drill Data and Remarks Sample Data (Underline Description, Characteristics, Depth (A) kPa rpm Depth Length-m kPq sample Group Abnormal Conditions, Casing Hole (B) kPa cm3/s % Loss drive) Sample Type Shoe Fluid Drive Rec. (C) kg Drop-m Blows

A5. Field borehole description, GSC-BH-SW-04A, page 1 of 11 Project Geological Survey of Canada Spiritural PFRA TESTHOLE LOG Hole No. C-/(SWO4A) Elev. ocation NW21-2-15-W2 GPS coordinates are & esting 1440468209 R.D. Date Started Nov 19/2010 Northing 5443943

D.G. Date Completed Nov 20/2010 Daill along the worth side of the road Water Level Final 5.53 m Top Pipe Time-Date Neu 30/2017 in the R.M. Ditok nstallation 2" schoop P.C. Plastic Pipe piez LOCATION SKETCH (A) Bit pressure , Revolutions per minute Page of // (B) Circulation fluid, Pump pressure, Volume % Loss seneral B-14 cable Tool rig Plan # 359103 (C) Drive sample weight, Drop distance, Blow count Formation and Water Data Depths - m Drill Data and Remarks Depth (A) kPa rpm (Underline Description, Characteristics, Depth Length-m kPa Group Abnormal Conditions. sample (B) kPa cm3/s % Loss Casing Hole No. Shoe drive) Sample Type Drive Rec. (C) kg Drop-m Blows 3 6" Excagato Topsoil, Black, organic, stiff 3 %" Excavator 0.15-1.5 CItuptill, Brown, stiff 1.25 lenses aseums of oxides 1.5-2.25 CI + up Till, Brown, stiff to -75 75 275 2 very stiff louses of oxide few organic streaks Reamed Hale out to 2.25 m with 5 3 1/4 Execuator 2.25-40 CI top till, Brown very stiff 25 few cobbles, langes of oudes, and a few organis stracks

A5. Field borehole description, GSC-BH-SW-04A, page 2 of 11

rojec	G.S.C.	Sp	B	ETAMES		PFR	A TES	THOL	E LOC	3		_
	No. G-1eas			 .m								
	2000		Date Started									
ogge	d by		Date Completed									
ater	Level Final		m Top Pipe Time Date	_								
stall	ation					LC	CATIO	N SKE	тсн	-		
age .	2 of 11			755		sure, R						
ener	al			100		tion flui imple we	13 THE 53					
	Depths - m		Formation and Water Data	1		ta and F				Sample		_
me	(Underline		Description, Characteristics,	Depth	Depth	(A) kPa					PP	
ine	sample	Group	Abnormal Conditions,	Casing	Hole	-	cm3/s	% Loss	Leng	th-m	kPa	1
	drive)		Sample Type	Shoe	Fluid	(C) kg	Drop-m	Blows	Drive	Rec.	Test	
		Re	smed hole out to 4.	an.	with	59	6º 6	KCA	val	1		
	40-45		up Till, gr. brown,									
			Lenses + seams at oxid	4		-						
	45-5.25	CI	teep till, Darkgrbras	en		Brees	shine	19	.75	7.75	3.0	, 0
			very stiff lenses of		les							
	1100											L
						-						
-		-	-11.				7.4					
	5.25-5.6	CL	tup Till, darkar brown	r. very	STE	4	96	Exce	eral	ol-	3.0	1
	-		seams of oxides		_	_						-
	5.6-70	CI	twp till, gray, ve	ary.	2	33"	Ex	car	ato			L
			stift, linges + sean		-			-				-
			of axido									L

A5. Field borehole description, GSC-BH-SW-04A, page 3 of 11 Project G. S. C. Spiritwood PFRA TESTHOLE LOG Hole No. C-leanTd Elev. Location Drilled by _ _ Date Completed Water Level Final Installation _ LOCATION SKETCH Page 3 of 11 (A) Bit pressure , Revolutions per minute (B) Circulation fluid, Pump pressure, Volume % Loss General (C) Drive sample weight, Drop distance, Blow count Depths - m Formation and Water Data Drill Data and Remarks Sample Data ime (Underline (A) kPa rpm Description, Characteristics, Depth Depth Length-m kPa sample Group Abnormal Conditions, (B) kPa cm3/s % Loss Casing Hole drive) Sample Type Fluid Shoe Drive Rec. (C) kg Test Drop-m Blows Regimed hole out to 7.0 m with 5 5/6" seams of oxides 7.5-8.25 CI - wp till, darkgrey, Hard 26 75 75 numerous seams + lenses of axides (oxidized Joints) 3% Excavator 3.25-90 CI-uptill, dark gray, Hard as above, cobbleat 9.0m. Reamed hale out to 9.0m with 5 % Executor

A5. Field borehole description, GSC-BH-SW-04A, page 4 of 11

rojec	G. S.C	. 5	piritwood	Tues	8 18	PFR	A TES	THOLI	E LO	3		Tremas
dole l ocati orilled ogge Vater	No. <u>C-1co</u> ; ion d by Level Final	n Td	Elev Top Pipe Time=Date									
19 Et (2) Table	4 of 11	after	TOWN AND ADDRESS OF THE TOWN A	(B)	Circula	ssure , R tion fluid	d , Pump	pressur	ninute re,Volu			
	Depths - m	D. S. Ive	Formation and Water Data			ita and f			_		e Data	_
ime	(Underline sample drive)	Group	Description, Characteristics, Abnormal Conditions, Sample Type	Depth Casing Shoe	Depth Hole Fluid	(A) kPa (B) kPa	rpm cm ³ /s Drop-m		-	h-m Rec.	PP kPa	No
	9.0-9.4	CI	-up till, darkgra, he	end	m	-	Exc		Br			
			Shaley, numerous shale		eKs.							
			and limestone pubbles +	cobb	Kes							
	9.4-9.5	CI	-cop Till, dark gray,	han	1	3/	"Ex	cava.	tor			
		-	very sandy, shale part	ites								
	9.5- 9.7	CI	-cop Till, dark gray,	Vard		3%	"Ex	Lave	tor			
			shaley, with numerous shale chanks and lim									
	*		Pebble	145/0	ne							
		Rea	med hole out to 9.7m	wit	45	56"	Exe	ne ati				
			help divill out the									_

A5. Field borehole description, GSC-BH-SW-04A, page 5 of 11 roject G.S.C. Spiritwood PFRA TESTHOLE LOG ole No. C-I conTil Elev. ocation _ ___ Date Started rilled by _ ogged by ___ _ Date Completed _m Top Pipe Time-Date ater Level Final _ LOCATION SKETCH stallation _ (A) Bit pressure, Revolutions per minute age 5 of 11 (B) Circulation fluid, Pump pressure, Volume % Loss eneral (C) Drive sample weight, Drop distance, Blow count Depths - m Formation and Water Data Drill Data and Remarks (A) kPa rpm (Underline Description, Characteristics, Depth Depth Length - m kPo Group Abnormal Conditions, (B) kPa cm3/s % Loss sample Hole Casina drive) Shoe Fluid Drive Rec. Test Sample Type (C) kg Drop-m Blows 9.7-10.5 CI-up till, dark grey hard Shaley, numerous lines tone copples and shale partilo 10.5-10.8 CI-up Till, Dank grey, hard 30207 Note: cobble at 10.8m shale particles, and lineston Pebblos + cobbles Reamed holo out to 10. 8m with 5% "Excus 11.5-12.0 CI-up till, dark grey, hard 7 silty, with a fow, damp

A5. Field borehole description, GSC-BH-SW-04A, page 6 of 11

ojec	GS.C.	Sp	intwood	Tues		PFR	A TES	THOL	E LO	G		
te . le l	40. C-1cox	Td	Elev,	m								*1
lilec	1 by		Date Started	-								
	Level Final		Date Completed	-								
	6 of //	orfini)	facilities of address — to for strangery) — if	(B)	Circulat	sure , F	CATIO Revolution d , Pump eight , Dro	ns per n pressu	ninute e,Volu			
	Depths - m	I libror	Formation and Water Data	1 (0)			Remarks				e Data	1
ne	(Underline sample	Group	Description, Characteristics, Abnormal Conditions,	Depth Casing	Depth . Hole	(A) kPa	cm3/s	% Loss	-	th-m	PP kPa	No
	drive)	0-	Sample Type	Shoe		(C) kg	2	Blows		Rec.		6
	1 d.0 -12.5		slighty sands, to		- 6	2255	bher		e50	-50		
			m fine -coarse, grey,									
-			water coming into h									-
+			cobble at 12.5m									
			end of Day									
_			Nov. 18/2010									
		STa	tic water level is 4.7	7m	Fro	122 9	roun	11	eve.	4	ļ.,	
_		Set	+ 3.27m+ 3.37m+ 3.24	din +	3.13	mo	£4°	Cus	ing	in	hol	e
-		Tota	/ casing is 1301m	-	-		-				\vdash	\vdash
-			ive casing down to			-	-		\vdash	-	-	-
-			ciled water out of							,	\vdash	
_		Dr	illed sand out of h	tole 1	y B	1+	Bail	m	Tho	1		-
	-										\vdash	
											<u></u>	L

A5. Field borehole description, GSC-BH-SW-04A, page 7 of 11

LOCATION Ske, Revolutions per fluid, Pump press e weight, Drop dis nd Remarks kPa rpm kPa cm³/s %Lo kg Drop-m Blov	ETCH r minute sure, Valu tance, Bi	Sample h-m Rec.	PP kPa	No.
LOCATION Ske, Revolutions per fluid, Pump press e weight, Drop dis and Remarks kPa rpm kPa cm³/s % Lo kg Drop-m Blov	ETCH r minute sure, Volu tance, Bl Lengt	Sample h-m Rec.	PP kPa	
LOCATION Ske, Revolutions per fluid, Pump press e weight, Drop dis and Remarks kPa rpm kPa cm³/s % Lo kg Drop-m Blov	ETCH r minute sure, Volu tance, Bl Lengt	Sample h-m Rec.	PP kPa	
LOCATION SK P, Revolutions per fluid, Pump press e weight, Drop dis and Remarks kPa rpm kPa cm³/s % Lo kg Drop-m Blow	ETCH r minute sure, Volu tance, Bi Lengt	Sample h-m Rec.	PP kPa	
Revolutions per fluid, Pump press weight, Drop dis and Remarks kPa rpm kPa cm³/s % La kg Drop-m Blov	r minute sure, Valu tance, Bi Lengt	Sample h-m Rec.	PP kPa	
Revolutions per fluid, Pump press weight, Drop dis and Remarks kPa rpm kPa cm³/s % La kg Drop-m Blov	r minute sure, Valu tance, Bi Lengt	Sample h-m Rec.	PP kPa	
fluid, Pump presi e weight, Drop dis nd Remarks kPa rpm kPa cm³/s % Lo kg Drop-m Blov	tance, Bi	Sample h-m Rec.	PP kPa	
e weight, Drop dis nd Remarks kPa rpm kPa cm³/s % La kg Drop-m Blov	Lengt	Sample h-m Rec.	PP kPa	
kPa rpm kPa cm³/s % La kg Drop-m Blov	Lengt	h-m Rec.	PP kPg	
kPa cm³/s % Lo kg Drop-m Blov	Drive	Rec.	kPg	No.
kg Drop-m Blov	Drive			No.
Samples	15		1651	
Sarrel	130			
		29	-	6
49m				-4
				_
Barrel	16	Bag	_	7
	-			
amplet	+			0
Barrel	B	99	-	8
	-			
	+			
				\vdash
	Barrel	sampler Barrel B	samplet Bag	Barrel Bag -

A5. Field borehole description, GSC-BH-SW-04A, page 8 of 11 Project GS.C. Spiritural
Sire G050A00B PFRA TESTHOLE LOG Hole No. C-1 CONTA Elev. Location _ Date Started Drilled by _ Logged by _____ Date Completed _ m Top Pipe Time Date Water Level Final ___ nstallation _ LOCATION SKETCH age 8 of 11 (A) Bit pressure, Revolutions per minute (B) Circulation fluid, Pump pressure, Volume % Loss General (C) Drive sample weight, Drop distance, Blow count Depths - m Formation and Water Data Drill Data and Remarks Sample Data (A) kPa rpm (Underline ime Description, Characteristics, Depth Depth Length-m kPa sample Group Abnormal Conditions, Casing Hole (B) kPa cm3/s % Loss drive) Sample Type Fluid Shoe Rec. (C) kg Drop-m Blows Lost opprox. I meter of hale due to the formation coming up the hole with the water Samples 14.0-142 GC fine -coarse, grey, wet interbedded lovers of shelve END OF Day Nou19/2010 Badwet, comented, with a water coming into hake Few thin into bedded Note: sample w Gemen Ad Proce before if was clay layers, many shale Placed into the sample by and limestone Particles

A5. Field borehole description, GSC-BH-SW-04A, page 9 of 11

ilea.	G050 A	2008	oiritwood	_			RA TE	STHUL	E LU	G	_	-
	No. C-100			-								
ocat		211.04	Elev,	_m								
	d by	-										
	d by		Date Started Date Completed									
	Level Final		_m Top Pipe Time-Date	-								
	ation		Top Grd Time-Date	-		10	OCATIO	M SKE	TCH			
	9 01 11	160	temperal of months - ma	(A) Bit pre		Revolutio					
ener	ol			(8) Circulo	ition flu	id , Pump	pressu	re, Vol	ume %	6 Los	5
	2			_ (c) Drive s	ample w	elght , Dr	op dista	nce, B	low co	unt	
	Depths - m	Formation and Water Data			Drill D	ata and	Sample Data					
me	(Underline sample	Group	Description, Characteristics,	Depti					Length-m		PP kPa	
	drive)	Group	Abnormal Conditions, Sample Type	Casin	6 / DAGGERS	-	cm ³ /s	% Loss	Drive	Rec.		No
US				m	m	(C) kg	Drop-m	Blows	Dille	nec.	Test	-
		Rem	oved 1.48m of essing, A	111	120	20.	r-t-				,	
- 1			, occasing, a	THE R.	4.7	var,	Samp		9-1	5.9	-	-
	14.8-15.0	CI-	up till, dark grey, have	14.	Som		Ban		R.	Rei	>	10
				1			4.355,77	-	- EX	7		-
			Shale particles									
					No	te						
				15	9 =	Bail	Sur	tero	ato	1/1	Yole	
			+11111	1		-21						Ι.,
1	15-0-15.5	.62	-wp Till, dark gray, have	4_	-	3%	Exca	vator	B	49	>	11
										0		
-	-15.75%		numerous shale Particles	-		-			_			-
- //		-		15.5								
				13.5	th	-			-		-	-
	15.75-16.5	C.I.	-up till, dark grey, Har	1		0	liner	2-			>	10
			ap in justingery, mar	9		rass	uner	20_	15	13	-	10
			coumpley, shaley, with							1		
			777									
			numerous shale partie	Nes								
				100000000			-					
4												
				1								
-		-			-							
				12								
		-		-								
	11 - 17	0-	2 2 1 1 1			3%	Exc					
-	16.3-11.0	01	-wptill, Asabous	1	-	0.0	Exe	ava	lor			
			capple at 17.0 meters									
			Capper at 11.0 Miles				-					
1		111	d1.48m of casing, to	-1		-						

A5. Field borehole description, GSC-BH-SW-04A, page 10 of 11 roject G.S.C. Spiritwood PFRA TESTHOLE LOG ole No. C-1 contal Elev. Date Started rilled by _ _ Date Completed m Top Pipe Time-Date ater Level Final _ LOCATION SKETCH stallation (A) Bit pressure , Revolutions per minute age 10 of // (B) Circulation fluid, Pump pressure, Volume % Loss eneral . (C) Drive sample weight, Drop distance, Blow count Depths - m Formation and Water Data Drill Data and Remarks (A) kPa rpm (Underline Description, Characteristics, Depth Depth Length-m kPa (B) kPa cm3/s % Loss Group Abnormal Conditions, sample Casina Hole Fluid Drive Rec. Test drive) Sample Type Shoe Drop-m Blows (C) kg Slight water seepage into hole 17.00 at 17.0 meters. Put 4" sheed Bit on to drill rock 17.0-17.25 Copples at 17m and another at 1725m custon coming into hole at 1225 and very small amount of 30 Unable to duil Past 17.25m due to the combles of 17 and 1725 meters, Bottom of hoke static water level after 35 minute 6.0 m below and level Pulled 4"casing Back To 14.80m for Backfilled hate from 17-25m to 15. I neter with Bantonit chips to seal off the Battom loyer Then Pouved litter sand into hale Fitter sand & from 15.1-14.8 m from grd. level.

_	\sim

Then installed a 2" P.KC- Plastic Proce pris

hole sch. 40 wall Thickness

A5. Field borehole description, GSC-BH-SW-04A, page 11 of 11

jec	G.S.C.	Sp	witwood	ET UE 3	R TES	PFR	A TES	THOLE	LOG			
	G-160	400	8	_m					*/-			
led ged	by by Level Final	raj cu t	Date Started Date Completed m Top Pips Time-Date	Harming graduation Harming bings are now word outstand - now words of the table - not								
200	ortion	1Ast	Total and analysis of the	(B)	Circula	sure, R	d, Pump	ns per m pressur				
	Depths-m Formation and Water Data					ta and f				ple Date	3	
	(Underline sample drive)	Group	Description, Characteristics, Abnormal Conditions, Sample Type	Depth Casing Shoe	Depth Hole Fluid	(A) kPa (B) kPa (C) kg	rpm cm ³ /s Drop-m		Length-r	KPG	No.	
		Lan	gth of exposed slotte	124		is 3.	0 111	#2	0.5/07	5138		
			Longth of Just 2" Pip							-	-	
			of Pipe in the hole	=					1.1/	-01		
			of the 2" statted pro						1	100	1	
		Top	of the 2" PUCI	200	15 0	25	maj	bour	grd.		100	
		Pu	Hed casing and				110	1				
		fr	on and level Po	1			sina		is at	1		
		-	Khillad hate to 3.0									
		Be	ntonite chips (5-			sof	Hole)	Hug	-		-	
			end of			1 + 1					+	
		Bac	Nov. 20/2010 Klilled hole with cla	yeut	mpl.	to 0.	8m	bale	wan	A lee	1	
		Put	(1.5 m x 15 x 15) 2 5 & 6 " x 6" Protective	steel	Pip	2 00	er th	2"	PVCP	lastic	Ry	
		-	is markedan						180			

Final 1 2'sch4 3 3-14 e pths-m inderline sample drive)	Group Top:	Formation Description	on and Waription, C Abnormal Sample	ater Dater Dater Dater Condition e Type	a ristles, ons,	Depth Casing Shoe	Drive s Drill Do Depth Hole Fluid	tion flu ample w ta and (A) kPc (B) kPc	OCATIO Revolutio id , Pump eight , Dro Remarks rpm cm³/s Drop-m	pressur pp dista % Loss Blows	ninute re,Voli nce, B	ume %	e Data PP kPa	
nderline sample drive)	Тор	Described to the post of the p	Sample Banco	haracter Condition e Type	ristics, ons,	Casing Shoe	Depth Hole Fluid	(A) kPc (B) kPc (C) kg	rpm cm ³ /s Drop-m	% Loss Blows	Leng	th-m	PP kPa	
ample drive)	Тор	soil, B	Sample Sa	Condition of Type	ons,	Casing Shoe	Fluid m	(B) kPe (C) kg	om ³ /s Drop-m	Blows	-		kPa	N
-0.15		p till	lack, o	ing an	em =5h	-A	m	考"。	Reas		Drive	Rec.	Test	*
		p till	, Brown	n fir	em =5h	74	3			ator				*
5-1.5	CI+	25.0						*	4-1					
		CZ 805 es	PS Can	M1 005	CORP. LOT 41								1.25	•
- 3.0					to 1	.5m			"E		rato	-		
		237			2010				ZCSC	a co				
		Creso	ngan	ic sh	Teak	-								
	Real	ned	hole o	out	to 3.0	om ce	ith s	%	Exc	avs	ton			
3-47								3/	"Ex	cavo	tor			
		slife	Jens	5.454	spec	As								
					-									
	-47	Reas -4.7 CI+	Reamed -47 CT+ up 7	-47 CT+ up Till, 1	Reamed hote out	-47 CI + up Till, Brown, ve	-4.7 CItup Till, Brown, very still, lenses+speaks	Reamed hole out to 3.0m with 5	Reamed hole out to 3.0 m with 5 % -4.7 CI + up Till, Brown, very 3% still, lenses+ specks	Reamed hole out to 3.0 m with 5 % Exc -4.7 CI + up Till, Brown, very 3% Ex Still, I wers + speaks	Reamed hole out to 3.0m with 5 % Excave -4.7 CI+up Till, Brown, very 37 Excave slift, Inses+speaks	Reamed hole out to 3.0 m with 5 % Exequator -4.7 CT+up Till, Brown, very 3% Exequator STill, Inses+speaks	Reamed hole out to 3.0 m with 5 % Excavator -4.7 CI+up Till, Brown, very 3% Excavator slift, /enses+speaks	Reamed hole out to 3.0 m with 5 % Excavator -4.7 CI+up Till, Brown, very 3% Excavator slift, /enses+speaks

A6. Field borehole description, GSC-BH-SW-04B, page 2 of 3

ite	G050A	008	intwood								- Line		
ole	vo. C-2001	red	Elev	m									
cat			100										
ille	1 by		Date Started										
gge	d by		Date Completed										
ater	Level Final		m Top Pipe Time-Date										
stal	ation		felancia value and a					CATIO					
ge .	2013				0.0000			tevolution d , Pump			ıma 94	Loss	
ner	al							ight, Dro		300			
	Depths - m	1,000	Formation and Water Data		-			Remarks			Sample		
me	(Underline	(C)	Description, Characteristics,		Depth	Depth	(A) kPa	rpm	3.65.1	Lengt		PP	
	sample	Group	Abnormal Conditions,	C	Casing	Hole	(B) kPo	cm ³ /s	% Loss			kPa	No
	drive)		Sample Type		Shoe	Fluid	(C) kg	Drop-m	Blows	Drive	Rec.	Test	
	4.7-5.70	CI	up till, dork grbro	wn		3	704	xca	vator				
			very still, longes of		Je								
	67/2	PT	1. 0 FILL	-	_		27	"Exc		4			
-	3./- 6.0		ecoptill, brownish qu				2.8	CXL	aua	VOF			_
	6.9		grey, very stiff nur	214.00	us								
1			seamotoxides	-									
		Rea	med hole out to 4.	5,	, en	H:	5 %	Exe	aud	Tor			
							_					3	
	6.9-7.5	CI:	tepTill, grey, Har			_3	190	Keac	ator				
			with seoms of or	Kick								_	_
	-		a few cobbles										
		Bo	Tom of Hole Ins	Tak	lai	211 8	ve	Plas	tis F	ips	pi	31	t
		ho	Le with a sch 4	0	sal	110	lick	ess					

A6. Field borehole description, GSC-BH-SW-04B, page 3 of 3

			initwood 8	_			RA TE	***				
	No. C-2001	nlev	Elev	_m								
ocati	by	-										
	d by	-	Date Started	-								
	Level Final		Date Completed _m Top Pipe Time-Date	-								
	ation	-			CATIO	N OVE						
age _	5 of 3	integr	trained of mental - up	(A)	Bit pre	ssure, F	evolutio	ns per n	ninute			-
ener	ol		AND SHARMOON H	(B)	Circula	tion flui	d , Pump	pressu	re, Vol	ume %	6 Loss	E.
	Depths - m	N Home	(C) Drive sample weight, Drop distance, Blow count									
me	(Underline		Formation and Water Data		Drill De	ata and	0.0000000000000000000000000000000000000			Sampl	e Date	3
	sample	Group	Description, Characteristics, Abnormal Conditions.	Depth	Depth Hole	(A) kPa	rpm cm ³ /s	0/ 1	Leng	th – m	kPa	
	drive)		Sample Type	Shoe	Fluid		Drop - m	-	Drive	Rec.	Test	No.
		,	11 10. 146					44				
-		Len	oth of 2's slotted pipe	15 2	99	m- 6	with	#20	5/0	1/50	20	
		100	H . CT + 240		,					,	7	
		~6/19	oth of Just 2" Puc pipo	15 3.	76	20107	242					
		Total	12" Pipe in hole is	0	5	me	4					
				177		1					-	_
_	1 2 4 4	Botte	om of the slotted pip	0 120	+7	5m	6.1	2010	.1	1.	1	
												_
+		lop	of the slotted pipe 1	sat	4.	5/100.	bel	acu	ake	01	evel	/
		11	P. 1615	1,	,	, ,			J	-		
1		LAC	n Pauved Filto sand	does	n he	14 6	for	na	501	dp	94	4
		and	and the 2" Pipe pier	to	0 1		1 .	10		1	, -	
		1000				1					-	m
4		Fin	m ground level. The	1 6	ack!	611	14	06	1		11	
1									.	200		_
+		Des	stonik chips to 2.	000	fu	om	gun	and	le	vel	_	2 N
								.,				
1		Da	ck fill the remaind	04	tho	hole	wi	8 d	lex	cu	thin	25
		to	2. 80 m from anner	101								
			2. 80 m from grous					-	-	-	-	_
-		Pul	ta 526" 6" Protection	stee	1 Pie	10 00	en A	6-21	PO	11	Ris	0
		0	, , ,		1			- 60	-	-6	170	P
+		rip.	e is marked and e	app	ecl.				100			
				11 ' 1		0.		0				
+		11/	this time the was	Fr 164	14	113	150	-y	-			
	000		0.75 above god			_						
						-				-		-
1		1	END OF Hole	-		- 1				1		

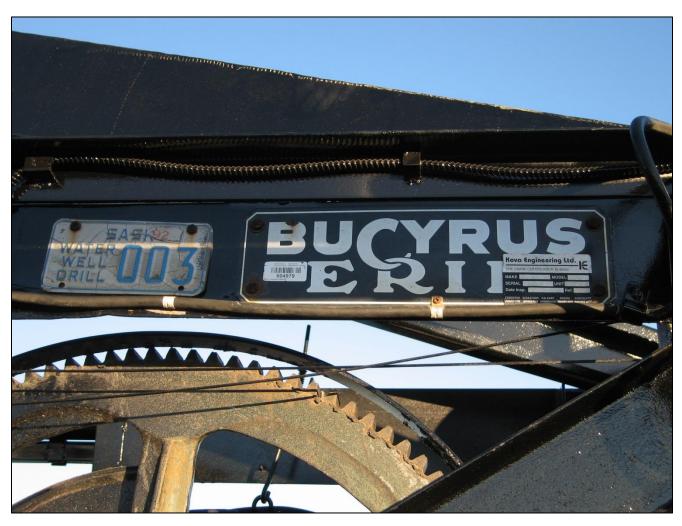
Appendix B: Additional photographs.



Photograph B1. AAFC B-12 drill rig setup with crew.



Photograph B2. AAFC B-12 drill rig at site G05OA010/GSC-BH-SW-02, November 2010, facing east.



Photograph B3. AAFC B-12 drill rig name plate.



Photograph B4. Site G05OA010/GSC-BH-SW-02, October 2011, facing east.



Photograph B5. Site G05OA009/GSC-BH-SW-03, October 2012, facing north.



Photograph B6. Site G05OA009/GSC-BH-SW-03, October 2012, facing east with loading station well in the distance.