PHASE 2 INITIAL BOREHOLE DRILLING AND TESTING, IGNACE AREA

2019 Pressure Monitoring of Westbay MP38 System at IG_BH01

APM-REP-01332-0247 **August 2020**

Golder Associates Ltd.

nwmo
NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Nuclear Waste Management Organization
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GOLDER

REPORT

PHASE 2 INITIAL BOREHOLE DRILLING AND TESTING, IGNACE AREA

2019 Pressure Monitoring of Westbay MP38 System at IG_BH01

Submitted to:

Nuclear Waste Management Organization
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Toronto, Ontario
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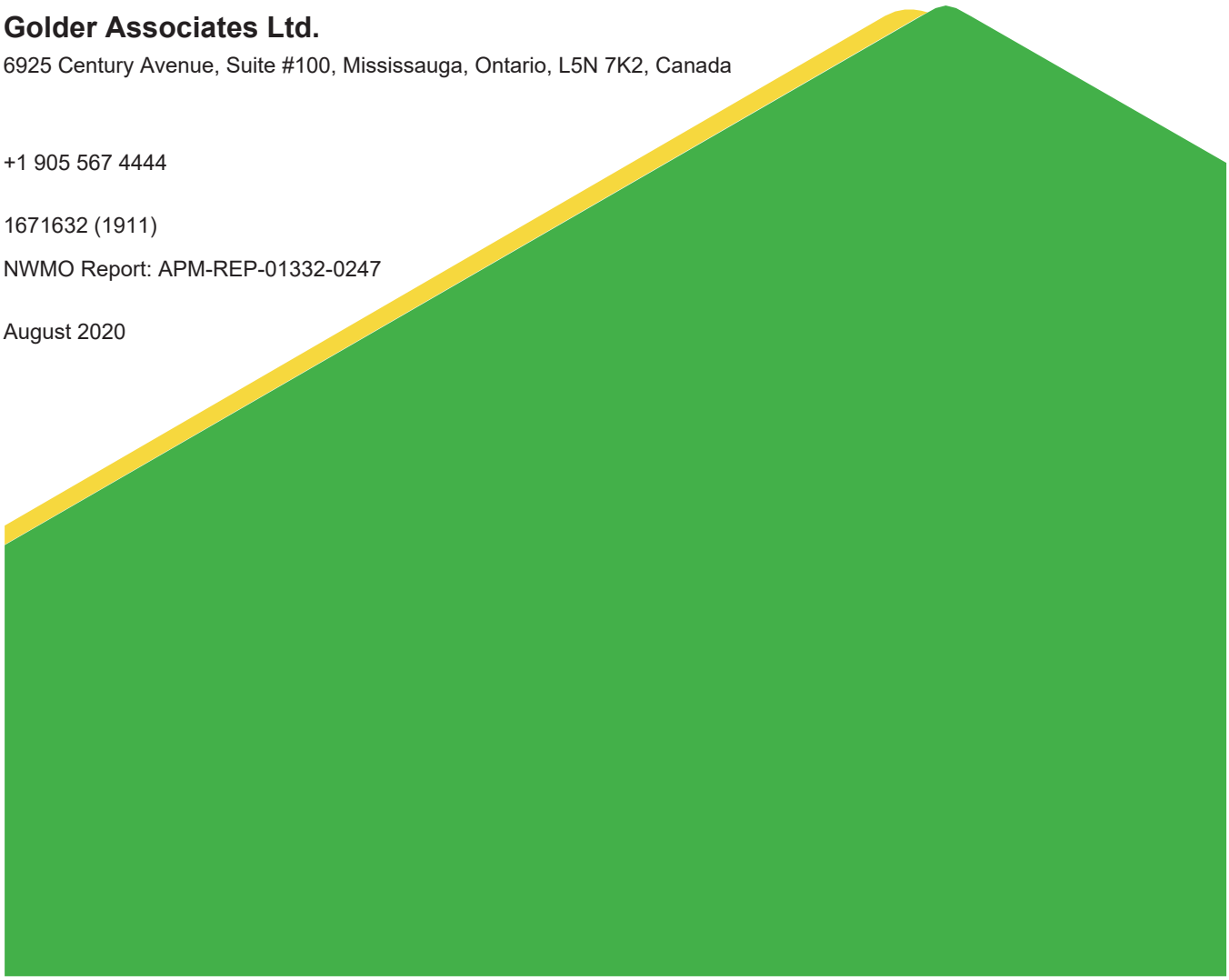
1671632 (1911)

NWMO Report: APM-REP-01332-0247

August 2020



Distribution List

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2019 PRESSURE MONITORING OF WESTBAY MP38 SYSTEM AT IG_BH01

CLIENT INFORMATION

Project Name: Phase 2 Initial Borehole Drilling and Testing, Ignace Area.

Project Number: 1671632

Client PO Number: 01559 A-TGS

Document Name: 1671632 (1911) IG_BH01 WP9 2019 Mon 19Aug2020 r1a

Client: Nuclear Waste Management Organization (NWMO)
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ISSUE/REVISION INDEX

Issue Code	Revision					Revision Details
	No.	By	Rev'd.	App.	Date	
RR	0	AK	MB	GWS	June 4, 2020	Draft report for review and comment
RI	1	AK	MB	GWS	August 19, 2020	Final report for NWMO acceptance

Issue Codes: RR = Released for Review and Comments, RI = Released for Information

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1.0 INTRODUCTION

The Initial Borehole Drilling and Testing project in the Wabigoon and Ignace Area, Ontario is part of Phase 2 Geoscientific Preliminary Field Investigations of the NWMO's Adaptive Phased Management (APM) Site Selection Phase.

This project involves the drilling and testing of the first of three deep boreholes within the northern portion of the Revell batholith. The first drilled borehole, IG_BH01, is located a direct distance of approximately 21 km southeast of the Wabigoon Lake Ojibway Nation and a direct distance of 43 km northwest of the Town of Ignace. Access to the IG_BH01 drill site is via Highway 17 and primary logging roads, as shown on Figure 1.

The project was carried out by a team led by Golder Associates Ltd. (Golder) on behalf of the NWMO. The overall program is described in the Initial Borehole Characterization Plan (Golder 2017). This report describes the methodology, monitoring activities, and results for the 2019 pressure monitoring of the Westbay MP38 System installed in IG_BH01 in 2018.

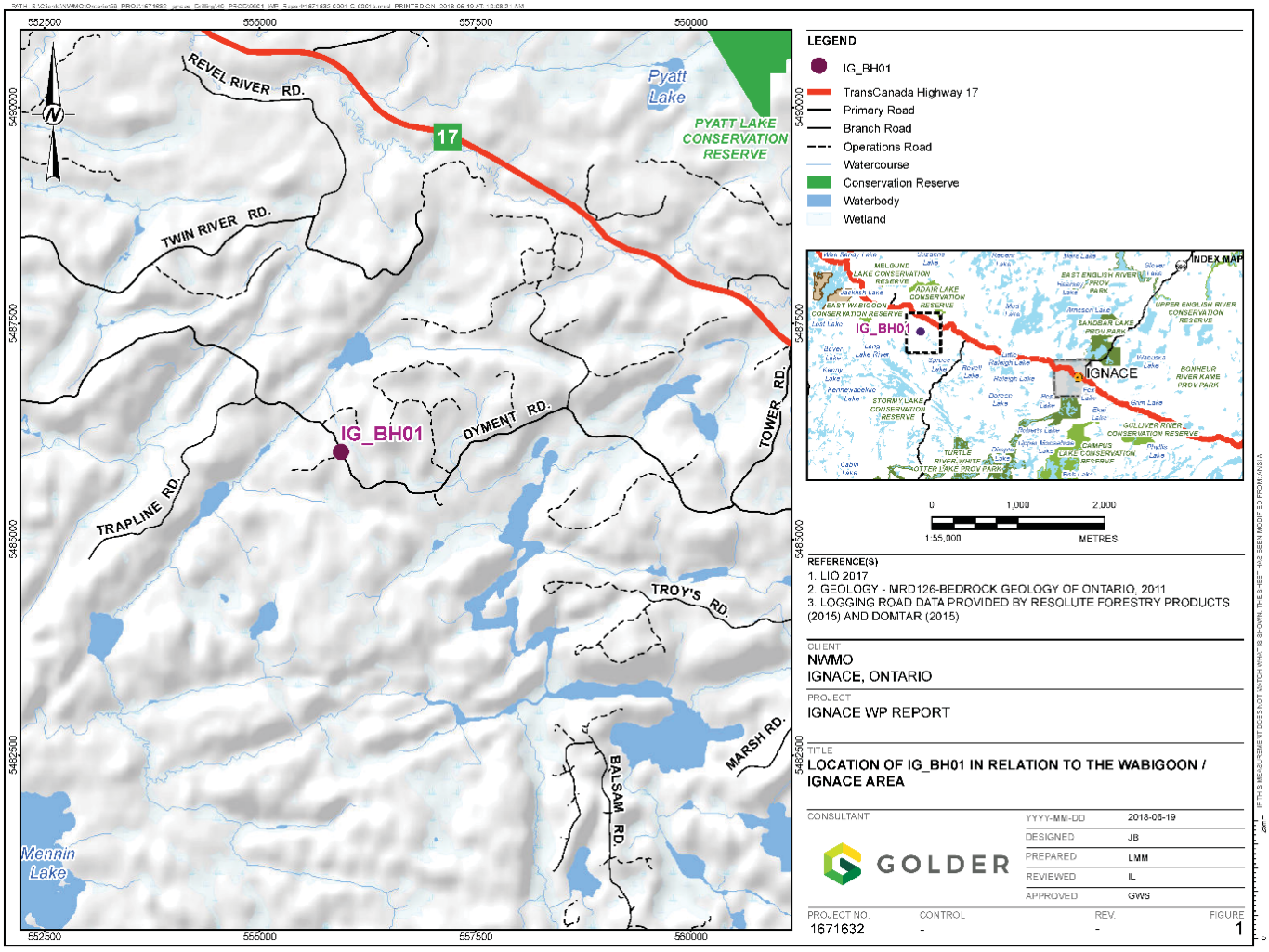

Figure 1: Location of IG_BH01 in relation to the Wabigoon / Ignace Area

2.0 BACKGROUND INFORMATION

2.1 Geological Setting

The approximately 2.7 billion year old Revell batholith is located in the western part of the Wabigoon Subprovince of the Archean Superior Province. The batholith is roughly elliptical in shape trending northwest, is approximately 40 km in length, 15 km in width, and covers an area of approximately 455 km^2. It is likely that the batholith is approximately 2 km to 3 km thick through the center of the northern portion (SGL 2015). The Revell batholith is surrounded by the Raleigh Lake (to the north and east) and Bending Lake (to the southwest) greenstone belts (Figure 2).

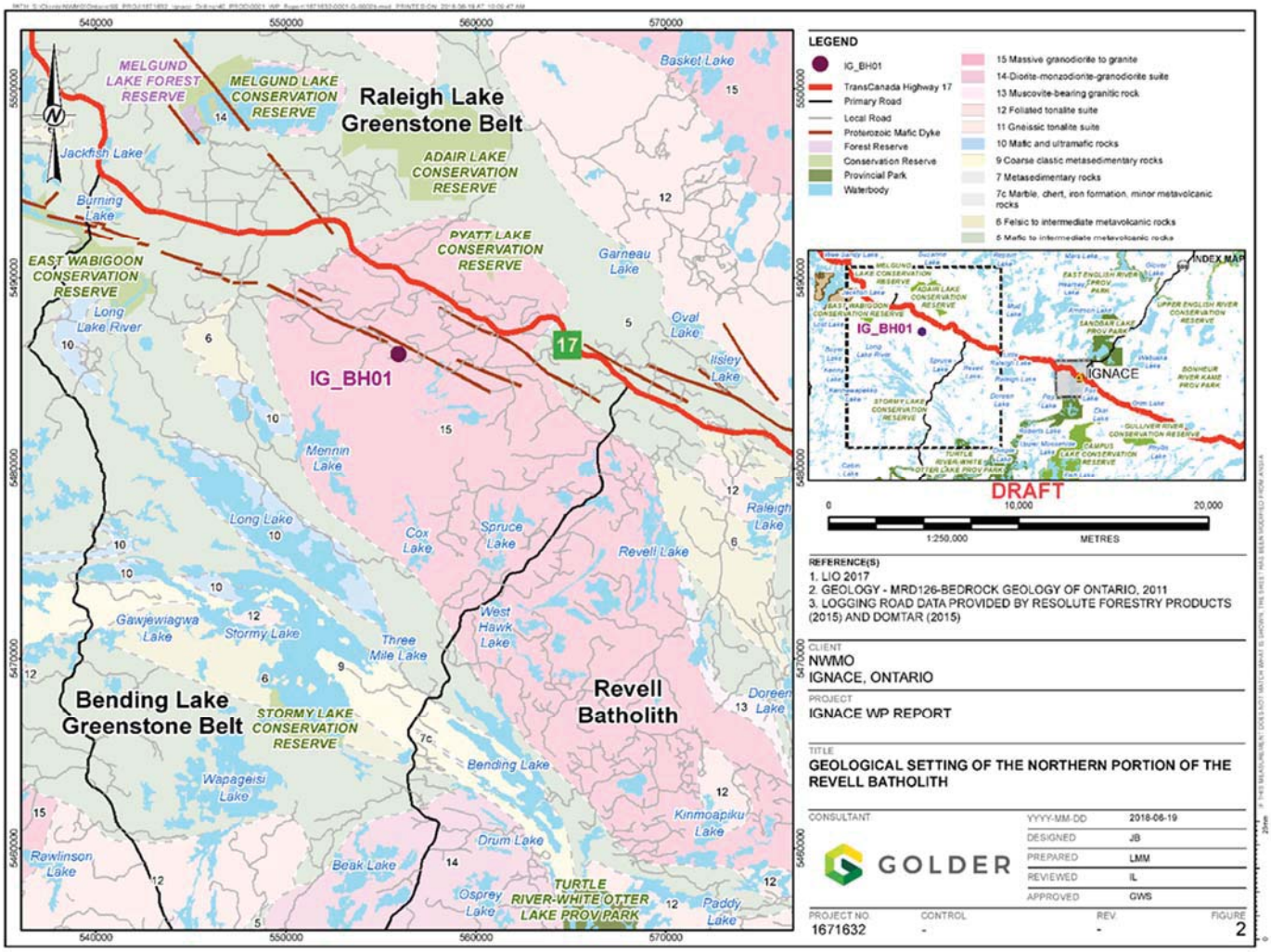

Figure 2: Geological setting of the northern portion of the Revell batholith

Borehole IG_BH01 is within an investigation area of approximately 19 km^2 in size situated in the northern portion of the Revell batholith. Bedrock exposure in this area is very good due to minimal overburden, few water bodies, and relatively recent logging activities. Ground elevations generally range from 400 to 450 m above sea level (masl). The ground surface broadly slopes towards the northwest as indicated by the flow direction of the main rivers in the area (Revell and Mennin rivers). Local water courses within the investigation area tend to flow to the southwest towards Mennin Lake.

The northern portion of the Revell batholith is composed mainly of granodiorite and tonalite, which together form a relatively homogeneous intrusive granitoid complex. The granodiorite and tonalite are massive to weakly foliated. Overall, the tonalite transitions gradationally into granodiorite and no distinct contact relationships between these two rock types are typically observed. There is also a younger granite intrusion, which is observed southeast of the investigation area and primarily in the central portion of the Revell batholith. The granite, which is massive to weakly foliated, post-dates and intrudes into the granodiorite-tonalite intrusive complex (Golder and PGW 2017).

Long, narrow valleys are located along the western and southern limits of the investigation area (Figure 1). These local valleys host creeks and small lakes that drain to the southwest and may represent the surface expression of structural features that extend into the bedrock. A broad valley is located along the eastern limits of the investigation area and hosts a more continuous, un-named water body that flows to the south. The linear and segmented nature of this waterbody's shorelines may also represent the surface expression of structural features that extend into the bedrock. Details of the lithological units and structures found within the investigation area are provided in Golder and PGW, 2017.

2.2 Design of MP38 Casing System

The design, installation, and initial monitoring of the MP-38 system in IG_BH01 is described in Golder (2019). Test intervals within the Westbay MP-38 system were selected to either target specific zones in the borehole where increased frequency of structures as well as in-flows during fluid flow electrical conductivity profiling were observed, or to broadly monitor the evolution of hydraulic pressures and groundwater chemistry in regularly spaced intervals of the rock mass with increasing depth in the borehole.

The length of test intervals is defined as the distance between the bottom of the upper packer and the top of the lower packer. The selected interval lengths were a function of the characteristics of specific zones and the purpose of the planned testing for that interval. A summary of test intervals and their rationale is provided in Table 1.

Table 1: Westbay MP38 Test Intervals and Selection Rationale

Interval No.	Depth Interval (bottom of upper packer to top of lower packer)		Reasoning for Test Interval Selection
	Top (mBGS)	Bottom (mBGS)	
IG_BH01_T_INT_020	65.9	124.3	Allow sampling of near-surface groundwater
IG_BH01_T_INT_019	125.2	144.8	Allow potential groundwater sample collection and pressure monitoring (increased fracture frequency observed in core logging and ATV log, inflow observed in fluid conductivity logging).
IG_BH01_T_INT_018	145.7	195.0	Interval between IG_BH01_T_INT_017 and IG_BH01_T_INT_019
IG_BH01_T_INT_017	195.9	227.0	Allow sampling of groundwater (Increased fracture frequency observed in core logging and ATV log, inflow observed in fluid conductivity logging).
IG_BH01_T_INT_016	227.9	303.1	Interval between IG_BH01_T_INT_015 and IG_BH01_T_INT_017
IG_BH01_T_INT_015	304.0	321.4	Permit groundwater sampling and hydraulic testing near the inferred transition to a potential intermediate groundwater system.

Interval No.	Depth Interval (bottom of upper packer to top of lower packer)		Reasoning for Test Interval Selection
	Top (mBGS)	Bottom (mBGS)	
IG_BH01_T_INT_014	322.3	405.1	Interval between IG_BH01_T_INT_013 and IG_BH01_T_INT_015
IG_BH01_T_INT_013	406.0	427.9	Permit groundwater sampling and hydraulic testing within the rock mass zone above the repository horizon.
IG_BH01_T_INT_012	428.8	488.8	Interval between IG_BH01_T_INT_011 and IG_BH01_T_INT_013
IG_BH01_T_INT_011	489.7	513.2	Allow for pressure monitoring and hydraulic testing over intact section of repository horizon.
IG_BH01_T_INT_010	514.1	536.1	Allow for pressure monitoring and hydraulic testing over intact section of repository horizon.
IG_BH01_T_INT_009	537.0	570.3	Permit groundwater sample collection, pressure monitoring and hydraulic testing over interval at repository horizon with observed increase in fracture frequency.
IG_BH01_T_INT_008	571.2	624.2	Interval between IG_BH01_T_INT_007 and IG_BH01_T_INT_009
IG_BH01_T_INT_007	625.1	645.6	Allow groundwater sample collection and pressure monitoring (increased fracture frequency observed in core logging and ATV log, inflow observed during fluid conductivity logging).
IG_BH01_T_INT_006	646.5	698.9	Packer required for load support.
IG_BH01_T_INT_005	699.8	765.1	Packer required for load support.
IG_BH01_T_INT_004	766.0	800.2	Allow sampling of groundwater (increased fracture frequency observed in core logging and ATV log, inflow observed during fluid conductivity logging).
IG_BH01_T_INT_003	801.1	884.6	Packer required for load support.
IG_BH01_T_INT_002	885.5	973.1	Packer required for load support.
IG_BH01_T_INT_001	974.0	1001.2	Allow sampling of the deepest bedrock horizons (increased fracture frequency observed in core logging and ATV log, inflow observed during fluid conductivity logging).

2.3 Objectives

Following installation and initial monitoring of the MP-38 system in 2018, Golder collected pressure measurements on three occasions in 2019 from each of the test intervals at IG_BH01. The pressure measurements were collected on April 24, 2019, August 29, 2019, and November 7, 2019, and when added to the measurements collected from previous programs on April 5, 2018, July 4, 2018, October 17, 2018, they form a monitoring data set of roughly quarterly pressure measurements in IG_BH01 since installation of the MP-38 Westbay system in March 2018.

The main objective of the pressure monitoring at IG_BH01 is to develop an understanding of formation pressures in the rock and the Revell batholith site, with the understanding that the pressures measured initially were in many cases affected by the drilling and testing, and will take time to re-equilibrate to actual formation conditions.

3.0 DESCRIPTION OF ACTIVITIES

3.1 Monitoring Events

Pressure measurements were collected on April 24, 2019, August 29, 2019, and November 7, 2019 following the general procedures described in the IG_BH01 WP9 test plan (Golder 2017). For each measurement event, two Golder staff mobilized to site, accompanied by NWMO and an environmental monitor from Wabigoon Lake Ojibway Nation (WLON). The measurements were carried out by experienced Golder personnel that have been previously trained and certified by Westbay to perform the required tasks.

Pressure measurements were collected using NWMO-owned equipment, the care and custody of which was transferred to Golder for use at IG_BH01 and returned to the NWMO upon completion of the monitoring event. NWMO-owned equipment included a covered trailer, MP-38 probe (and spare), winch and monopod set, replacement and maintenance tools, gas powered generator, and field supplies for environmental, health and safety protection. A photo of the typical monitoring setup at site is shown on Figure 3. The measurement probes are calibrated annually by Westbay, and that the NWMO arranges for the calibration and keeps these records in their files.

Figure 3: Facing north towards a typical pressure monitoring arrangement, as it is being set up at IG_BH01

3.2 Field Methodology

Following Golder's acceptance of custody for NWMO's groundwater monitoring equipment, the equipment was mobilized to Tower Road, where Golder met with representatives from NWMO and WLON, and drove to

IG_BH01. Following the arrival of all parties at IG_BH01, a health and safety meeting was conducted which covered the planned tasks for the day. Following the completion of the health and safety meeting, Golder set up the trailer to allow for downhole pressure measurements.

Prior to lowering the MOSDAX Sampler probe (herein referred to as “the probe”) down the borehole, the probe was connected to the MAGI interface, and was inspected to ensure that it was in good working order. Inspections included extending and retracting the probe arm and shoe, and inspecting them for evidence of wear. The sampler valve was also opened and closed on surface, and the O-Ring on the sampling face inspected for evidence of wear. All components showing evidence of wear were replaced, including the components of the sampling face, which are required to ensure that a strong seal is maintained during pressure measurements.

Following inspections, the probe was lowered to the top of the Westbay casing so that the odometers on the MAGI controller and monopod bracket could be zeroed to the depth reference point on the IG_BH01 installation. Ambient atmospheric pressure and temperature measurements were collected at this depth point and recorded for use in pressure head calculations, which are discussed later in Section 3.3. Following the collection of the ambient atmospheric pressure and temperature measurements, the MOSDAX probe was lowered downhole and monitored with the MAGI interface for the first indication of a pressure change, in order to measure the depth to water inside the Westbay MP-38 casing. Following the measurement of the water level inside the casing, the probe was lowered to measurement port 1, located at 976.6 m (below the reference depth point). Pressure measurements for each monitoring event were started at measurement port 1 and continued progressively upwards until reaching measurement port 20.

At each measurement port, the probe was stopped approximately 0.5 m above the measurement port and the location arm was extended. Following confirmation that the location arm was extended, the probe was slowly lowered until pressure measurements showed that the probe was hanging from the inside of the measurement port collar. Once the probe was hanging inside the measurement port collar, the “inside casing” pressure was allowed to stabilize and was then recorded. Following the collection of the inside casing pressure, the probe shoe was then extended, which pressed the faceplate of the probe into the measurement port and caused the measurement port to open. With the measurement port open to the formation outside of the casing, and the faceplate of the probe sealing the interface between the inner and outer casing water, the probe was able to measure the pressure and temperature of the formation water outside of the casing. The pressure and temperature were monitored until they stabilized and then recorded. Following completion of the formation pressure and temperature measurements, the probe shoe was retracted, which released the probe face from the measurement port and allowed it to close. A second “inner casing” pressure measurement was collected and compared to the pre-measurement pressure to ensure that the faceplate had adequately sealed against the measurement port and prevented leakage during the formation pressure and temperature measurements.

Following the completion of the second “inner casing” pressure measurement, the probe was then raised approximately 1.0 m above the measurement port, the location arm was retracted, and then the probe was raised to the next measurement port to continue measurements at the next interval. Pressure measurements were collected at each progressively higher measurement ports until the final measurement at interval 20 had been completed.

At the completion of the pressure measurements, the probe was raised to measure the water level inside the casing a second time to assess whether or not the water level had changed. The probe was then raised to the surface, and a second set of ambient atmospheric pressure and temperature measurements were completed. Field records collected during the three pressure profiling events are provided in Appendix A.

3.3 Data Analysis

The Westbay MOSDAX pressure probe is used to measure formation pressures (P_f) in the packer-isolated borehole intervals outside the Westbay casing. Pressures measured by this equipment are total, or absolute pressures, which include groundwater pressure and atmospheric pressure (P_a). The atmospheric pressure component is removed from the formation pressure by measuring the atmospheric pressure with the probe at ground level and subtracting the atmospheric pressure (at the time of measurement) from the formation pressure.

Formation fluid pressures measured in variable-density groundwater systems need to be expressed as freshwater hydraulic heads for estimation of horizontal hydraulic gradients and as environmental-water hydraulic heads for estimation of vertical hydraulic gradients. The approach used to calculate freshwater heads from formation pressures measured in the Westbay systems, described below, is based on work by Lusczynski (1961) and Jorgensen et al. (1982). The important input data to these calculations are depth/elevations of MP measurement ports, and measured formation fluid pressures. Calculation of environmental heads require data about formation water chemistry which was not yet available during the preparation of this report, therefore, environmental heads have not been calculated.

3.3.1 Calculating Freshwater Head

Hydraulic head (H) is the sum of the elevation head (Z) and the pressure head (ψ). Freshwater heads are calculated from measured pressures and MP system measurement port elevations as:

$$H_f = Z + \psi = Z + \frac{P_f - P_a}{\rho_f g} \quad [2]$$

Where: H_f = freshwater head [mASL];

Z = elevation of MP pressure measurement port [mASL];

P_f = pressure measured in MP measurement port [Pa or kg/ms^2];

P_a = atmospheric pressure measured at ground surface [Pa or kg/ms^2];

ρ_f = density of freshwater [1,000 kg/m^3 at ambient temperatures]; and

g = gravitational acceleration [9.8065 m/s^2].

The freshwater head calculations performed for each of the six visits to IG_BH01 are provided in Appendix B, as part of the data quality confirmation (DQC) workbooks that were accepted by the NWMO on May 1, 2020.

3.3.2 Calculation of Hydrostatic Pressure Lines

Freshwater hydrostatic pressures (P_h), or hydrostatic pressure heads, were calculated with depth, taking into account the density profile using the following formula:

$$P_h = g \int_{Z}^{Z_r} \rho(z)\mathrm{d}z \quad [5]$$

The hydrostatic pressure with depth provides a reference to help identify bedrock intervals with over-pressures or under-pressures relative to these reference lines. The freshwater hydrostatic pressure lines assume a uniform freshwater density of 1,000 kg/m^3 which equates to approximately 9.81 kPa per mBGS.

4.0 RESULTS

4.1 Pressure Profiles

The measured pressures with depth at IG_BH01 are shown on Figure 4 and are shown in comparison to a hydrostatic line to provide a reference for identifying bedrock formations or intervals with over-pressures or under-pressures. The red line on the graph shows the most recent pressure measurements collected on November 7, 2019. The data generally shows that on a large scale, the pressure measurements generally follow the hydrostatic pressure versus depth. Evaluation of the pressure measurements can be provided at a finer scale using Figures 5 (freshwater heads with depth) and Figure 6 (freshwater heads over time).

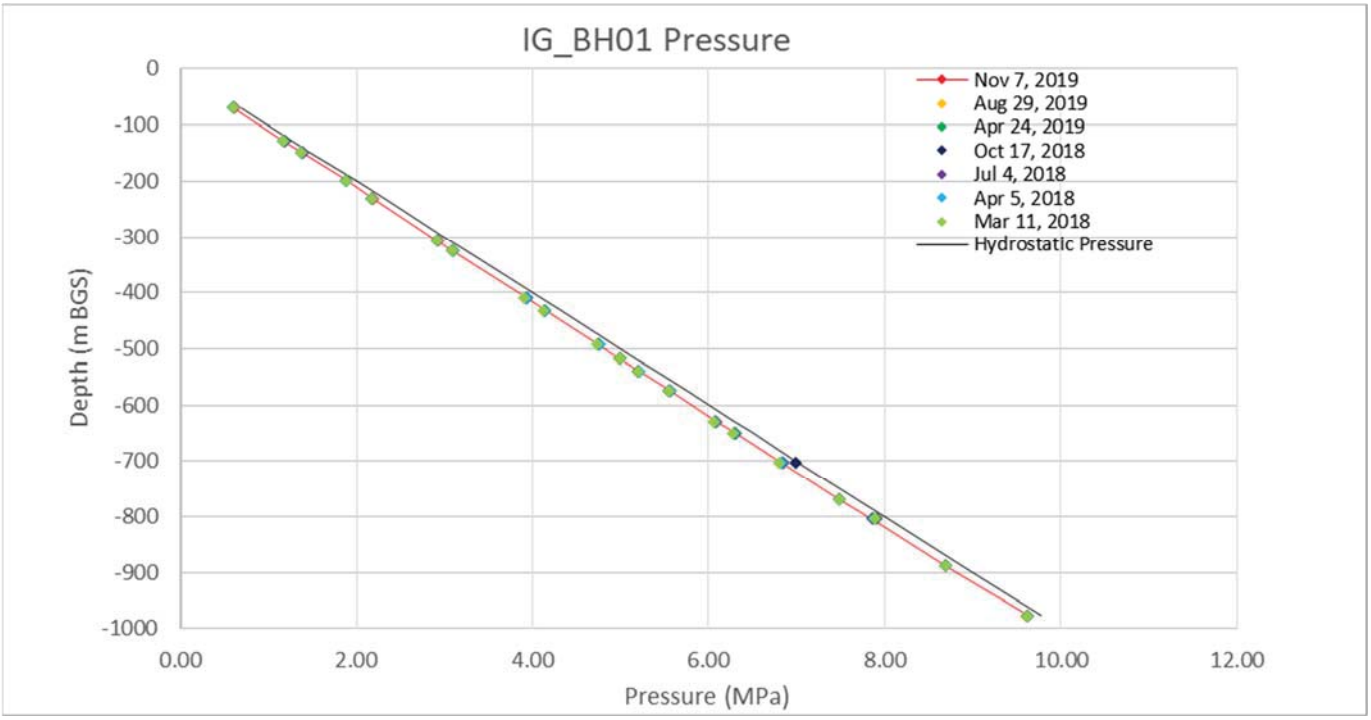

Figure 4: IG_BH01 Post-Inflation Pressures versus Depth – March 2018 to November 2019

Post installation freshwater head measurements from March 11, 2018 until November 9, 2019 are provided in Figure 5 below. A trendline has been added to emphasize the most recent freshwater head calculations which were collected on November 7, 2019. The pressure measurement collected from Interval 5 on October 17, 2018 is anomalous, and does not match with other measurements collected at this port/interval before or after this event, although the measurement was checked and found to be repeatable at the time of the measurement. The overall changes in formation pressures over time indicate that the formations are continuing to recover from the artificial pressures introduced during drilling and testing at the borehole, and appear to be reaching true formation pressures.

A notable inflection in formation pressures versus depth is evident below about 650 m which may indicate a transition zone in hydraulic conditions and/or water chemistry.

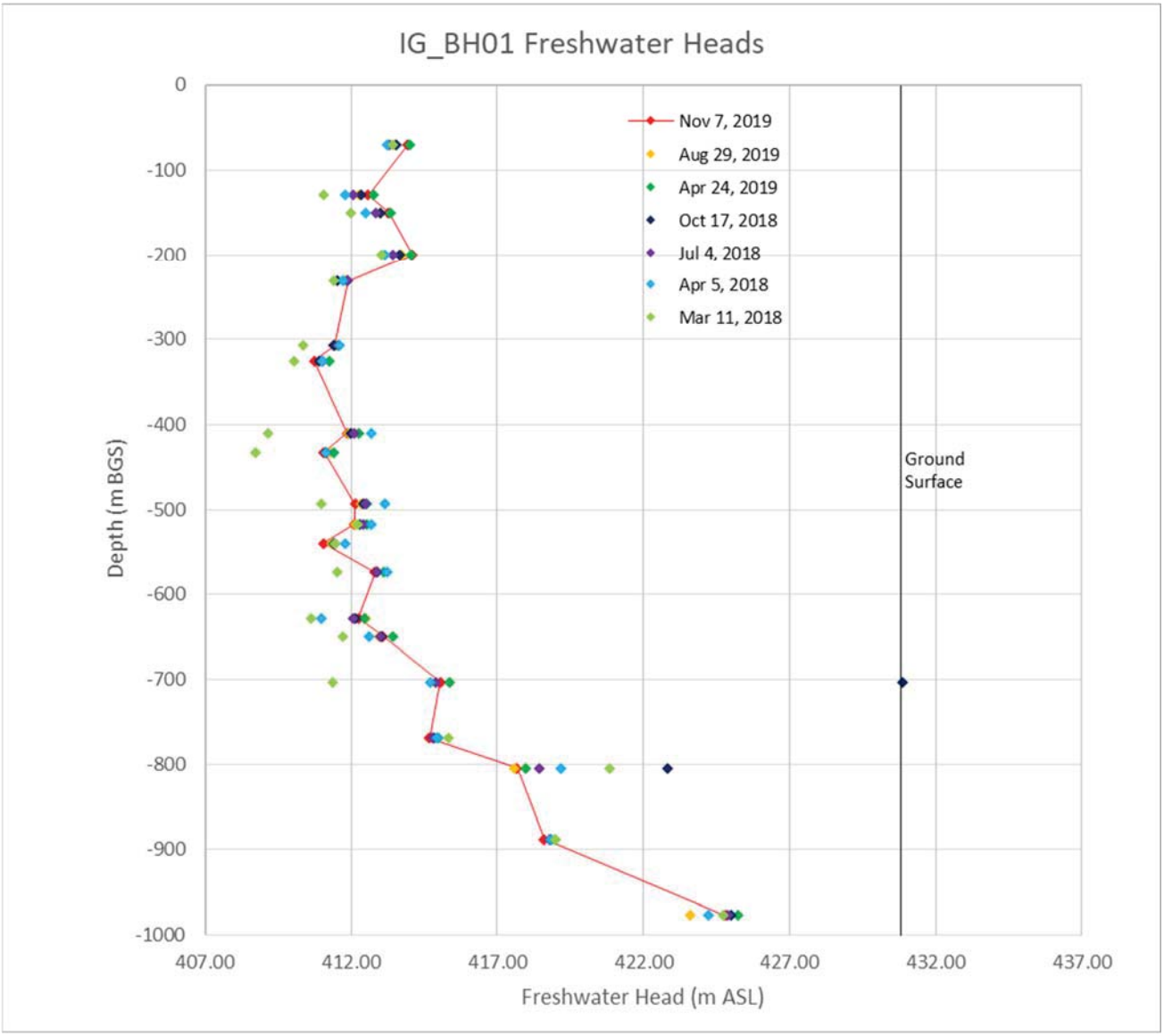

Figure 5: IG_BH01 Freshwater Heads versus Depth – March 2018 to November 2019

Plots of freshwater heads at each interval over time are provided on Figure 6. The figure clearly shows that the reading collected from Interval 5 on October 21, 2018 is anomalous relative to the other measurements collected at that interval and is therefore considered to be a measurement error not representative of formation conditions. The overall results from the plots show that the freshwater heads are stabilizing over time and are reaching true formation pressures.

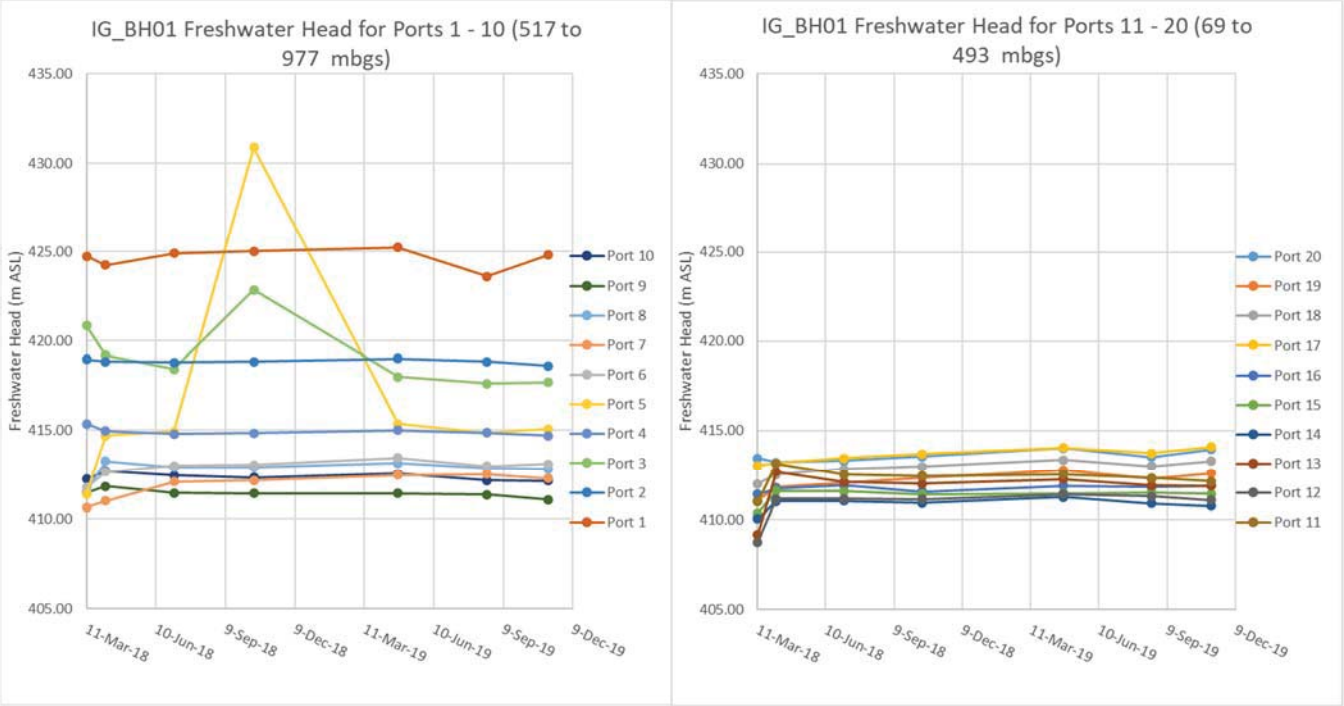

Figure 6: IG_BH01 Freshwater Heads versus Time – Ports 1 (deepest) to 20 (shallowest)

4.2 Summary

The 2019 pressure profiling results at IG_BH01 continue to follow the pressure trends established in 2018 and indicate that the pressures at IG_BH01 in the Westbay system are generally approaching what is inferred to be true pressures. Calculation of environmental heads requires the establishment of water densities, either by direct measurement (where possible), or by inference from the modelling porewater extraction data.

5.0 REFERENCES

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ATK/MB/GWS/

https://golderassociates.sharepoint.com/sites/13226g/technical work/wp9 westbay installation/41 pressure mon report/final report/1671632 (1911) ig_bh01 wp9 2019 mon 19aug2020 r1a.docx

APPENDIX A

Field Data Recording Sheets

Golder Associates

NWMO IGNACE DRILLING
WESTBAY SYSTEM
PIEZOMETRIC PRESSURES/LEVELS

Project No.: 1671632 (1900)

IG_BH01_HT_001

Datum: Ground level
Elev. G.S.:
Height of Westbay above G.S.:
Elev. Top of Westbay Casing:
Reference Elevation:
Borehole angle: Vertical

Probe Type: MP38
Serial No.: EMS 4960
Probe Range: 2000 kPa
Westbay Casing Type: MP 38
Sampler Valve Position: Closed

Weather: 18°C, Windy, Possible Rain in Afternoon.
Operator: MATT Bowman, Adrian Kowalchuk
Date: April 24 2019

Ambient Reading (P_{atm}) (pressure, temperature, time)

Start: Pressure 13.97
Temp. 17.88
Time 10:50
Probe WL 29.7
P_{atm} 13.945
TAPE WL 29.82 mbtop

Finish: Pressure 13.92
Temp. 5.29
Time 14:11
Probe WL 30.7
TAPE WL 30.510

Note: "Port position" in angled boreholes refers to position along drillhole. True depth (Dp) needs to be calculated using borehole angle and deviation data to calculate zone piezometric level (Dz)

Port No.	Port Position From Log (m)	Collar Port Position From Cable (m)	True Port Depth "Dp" (m)	Fluid Pressure Readings: Inside Casing (P1)	Outside Casing (P2)	Time (H:M:S)	Probe Temp. (°C)	Inside Casing (P1)	Pressure Head Outside Port (m) H=(P2-Patm)/w	Piezo Level Outside Port (m) Dz = Dp-H	Comments
1	977.7	975.8	976.8	1374.01	1376.15	11:29	13.52	1373.99	772.01	4.59	
2	888.8	887.7	887.6	1246.79	1261.42	13:30	13.29	1246.81	877.27	10.33	
3	804.4	No Collar	802.9	1125.49	1139.94	12:43	12.76	1125.49	791.84	11.06	
4	769.3	768.7	767.9	1075.08	1085.75	11:50	11.98	1075.17	753.73	14.17	
5	707.1	702.7	702.0	980.17	992.12 *	12:00	11.78	980.23	687.89	14.11	992.12 outside casing
6	649.8	No Collar	648.7	903.70	913.57	12:18	10.59	903.72	632.65	16.05	
7	628.4	628.2	627.5	872.89	881.73	12:35	10.31	873.11	610.26	17.24	Had trouble connecting to Bpt.
8	574.4	No Collar	573.4	795.64	805.91	12:45	9.86	795.66	556.94	16.46	
9	540.2	540.3	539.6	746.58	754.82	12:51	9.57	746.56	531.01	18.59	
10	517.4	517.6	516.8	713.80	723.97	12:58	9.27	713.77	499.31	17.49	
11	493.0	493.3	492.4	678.84	689.26	13:08	9.01	678.86	474.91	17.49	
12	432.1	No Collar	431.8	591.46	601.03	13:12	8.44	591.43	412.86	18.94	
13	409.3	409.8	409.0	558.69	569.82	13:17	8.19	558.72	390.91	18.09	
14	325.6	No Collar	325.5	438.62	449.35	13:24	7.45	438.66	306.19	19.31	
15	307.3	308.1	307.3	412.50	423.61	13:30	7.11	412.45	288.09	19.21	
16	231.2	No Collar	231.3	303.44	316.96	13:38	6.41	303.44	212.39	18.91	
17	199.2	200.3	199.4	257.50	273.55	13:44	6.05	257.51	182.56	16.84	
18	149.0	No Collar	149.2	185.61	201.18	13:51	5.63	185.61	131.5	17.53	

New Plunger, CAGE seal, Arm Piston. AT Beginning of DAY, Apr. 24, 2019, AT 07:00
Spring

Golder Senior Reviewer & Approver Sign-off

Reviewed by: Adrian Kowalchuk — May 17, 2019
Signature — Date

Approved by: Serge Scholz — May 17, 2019
Signature — Date

* only 1 spare Arm spring left in Probe case.
Logger time is 1 hour LAT → 9:44, instead of 10:44, Locked in mountain time.

Golder Associates

NWMO IGNACE DRILLING
WESTBAY SYSTEM
PIEZOMETRIC PRESSURES/LEVELS

Project No.: 1671632 (1904)

IG_BH01_HT_001

Datum: Ground level
Elev. G.S.:
Height of Westbay above G.S.:
Elev. Top of Westbay Casing:
Reference Elevation:
Borehole angle: Vertical

Probe Type: MP38
Serial No.: EMS 4960
Probe Range: 2000 PSI
Westbay Casing Type: MP38
Sampler Valve Position: CLOSED

Weather: 18°C, Windy, Possible Rain in Afternoon
Operator: MATT Bowman, Adrian Kowalchuk
Date: April 24, 2019

Ambient Reading (P_{atm}) (pressure, temperature, time)

Start: Pressure 13.97
Temp. 17.88
Time ~~23:32~~ 10:50
ProbeWL 297
P_{atm} 13.945
TAPE WL 29.82 mBTOP

Finish: Pressure 13.92
Temp. 5.29
Time 14:11
ProbeWL 30.7
TAPE WL 30.510

Note: "Port position" in angled boreholes refers to position along drillhole. True depth (Dp) needs to be calculated using borehole angle and deviation data to calculate zone piezometric level (Dz)

Port No.	Port Position From Log (m)	Port Position From Cable (m)	True Port Depth "Dp" (m)	Fluid Pressure Readings: Inside Casing (P1)	Outside Casing (P2)	Time (H:M:S)	Probe Temp. (°C)	Inside Casing (P1)	Pressure Head Outside Port (m) H=(P2-Patm)/w	Piezo Level Outside Port (m) Dz = Dp-H	Comments
19	128.5	Nocollar	128.9	156.24	171.18	13:57	5.43	156.24	110.57	18.33	
20	69.1	70.6	69.1	71.16	88.46	14:04	5.70	71.16	52.40	16.70	

Golder Senior Reviewer & Approver Sign-off
Reviewed by:

Adrian Kowalchuk
Signature

May 17, 2019
Date

Approved by:

Signature

May 17, 2019
Date

GOLDER

WP09 - Westbay MP38 Casing Installation
Record of Piezometric Pressures/Levels

Project No.: 1671632 (1901)

IG_BH01_HT_001

Datum: Ground Level
Elev. G.S.:
Height of Westbay above G.S.:
Elev. Top of Westbay Casing:
Reference Elevation:
Borehole angle: Vertical

Probe Type: TK O/C sampler
Serial No.: EMS 4416
Probe Range: 2000 PSI
Westbay Casing Type: MP38
Sampler Valve Position: Closed.

Probe Pre-use Checklist
O-Ring clean, intact, lubricated: ✓
Revolutions for location arm out: 15
Revolutions for shoe out: 23
Revolutions for shoe in: 23
Revolutions for location arm in: 16
Face plate condition: ✓

Weather: sunny, breezy, 15°C
Operator: MB/AK (AK)
Date: ~~Aug 14, 2019~~ Aug 29, 2019

Ambient Readings - Pre-Test
Pressure (P_{atm}) 13.92
Temperature (°C) 18.01
Time (hh:mm) 11:13

Ambient Readings - Post-Test
Pressure (P_{atm}) 14.00
Temperature (°C) 5.85
Time (hh:mm) 16:22

Average P_{atm} 13.96

Notes:
w = 1.422 psi/m of H2O
Port position in angled boreholes refers to position along drillhole.
True port depth (Dp) needs to be calculated using borehole angle and deviation data to calculate zone piezometric level (Dz)

Pre WL @ 30.63 m b top @ 11:00 (Waterline TAPE)

Pre-MP37 WL: 30.6

Post WL: ~~30.66~~ 31.620

Port No.	Collar depth mbgs[1]	Port Position From Log (m)	Measured Depth (in Field) (m)	True Port Depth "Dp" (m)	Fluid Pressure Readings: Inside Casing (P1)	Outside Casing (P2)	Time (H:M:S)	Probe Temp. (°C)	Inside Casing (P1)	Pressure Head Outside Port (m) H=(P2-Patm)/w	Piezo Level Outside Port (m) Dz = Dp-H	Comments
1	975.7	977.3	974.5		1372.5	1376.2 ~~7~~	~~10~~ 12:30	14.04	1372.80			Sampler valve open - int. P dropped ~~7~~
2	887.5	888.8	887.1		1245.70	1261.22	12:43	13.27	1245.74			
3	no collar	804.4	802.6		1124.41	1139.41	12:53	12.42	1124.39			
4	768.6	769.3	767.7		1074.01	1085.58	13:02	11.96	1074.05			
5	702.9	703.1	701.6		979.11	991.42	13:10	11.36	979.05			
6	no collar	649.8	648.7		902.61	912.91	13:19	10.76	902.57			
7	628.3	628.4	627.3		871.90	881.81	13:24	10.49	871.90			
8	no collar	574.4	573.4		794.47	805.54	13:36	9.84	794.49			
9	540.4	540.2	539.3		745.44	754.74	13:41	9.57	745.43			
10	517.6	517.4	516.6		712.64	723.43	13:51	9.20	712.60			
11	493.2	493.0	492.3		677.70	689.00	13:55	9.02	677.67			
12	no collar	432.1	431.6		590.20	600.90	14:07	8.46	590.23			
13	409.6	409.3	408.9		557.57	569.34	14:13	8.17	557.54			
14	No collar.	325.6	327.36		437.52.	448.86	14:30	7.12	437.52.			
15	307.0	307.3	307.02		411.33	423.69	14:34	7.01	411.34			
16	No collar	231.2	231.8		302.24	315.89	14:41	6.39	302.26.			
17	200.30	199.2	199.30		256.31	273.11	14:47	6.07	256.32			
18	No collar.	149.0	149.0		184.35	200.67	14:51	~~5.77~~ 5.68 AK	184.35			

replaced plunger & face seal prior to starting.

Golder Senior Reviewer & Approver Sign-off

Reviewed by:

Adrian Kowalchuk — Dec 20, 2019

Signature — Date

Approved by:

Greg Schuh — Dec 20, 2019

Signature — Date

P.2062

GOLDER

WP09 - Westbay MP38 Casing Installation
Record of Piezometric Pressures/Levels

Project No.: 1671632 (1901)

IG_BH01_HT_001

Datum: Ground LEVEL
Elev. G.S.:
Height of Westbay above G.S.:
Elev. Top of Westbay Casing:
Reference Elevation:
Borehole angle: Vertical

Probe Type: TK O/C Sample
Serial No.: EMS 4460
Probe Range: 2000 PSI
Westbay Casing Type: MP38
Sampler Valve Position: CLOSED

Probe Pre-use Checklist
O-Ring clean, intact, lubricated: ✓
Revolutions for location arm out: 15
Revolutions for shoe out: 27
Revolutions for shoe in: 27
Revolutions for location arm in: 16
Face plate condition: ✓

Weather: Sunny Breezy, 15°C
Operator: MR/AK
Date: ~~August 19, 2019~~ August 29, 2019

Ambient Readings - Pre-Test
Pressure (P_{atm}) 13.92
Temperature (°C) 18.01
Time (hh:mm) 11:13

Ambient Readings - Post-Test
Pressure (P_{atm}) 14.00
Temperature (°C) 5.85
Time (hh:mm) 16:22

Average P_{atm} 13.96

Notes:
w = 1.422 psi/m of H2O
Port position in angled boreholes refers to position along drillhole.
True port depth (Dp) needs to be calculated using borehole angle and deviation data to calculate zone piezometric level (Dz)

Port No.	Collar depth measured	Port Position From Log (m)	Measured Depth (in Field) (m)	True Port Depth "Dp" (m)	Fluid Pressure Readings: Inside Casing (P1)	Outside Casing (P2)	Time (H:M:S)	Probe Temp. (°C)	Inside Casing (P1)	Pressure Head Outside Port (m) H=(P2-Patm)/w	Piezo Level Outside Port (m) Dz = Dp-H	Comments
19	No collar	178.5	178.6		155.04	170.49	14:58	5.44	155.04			
20	70.3	69.1	69.5		69.96	87.77	15:04	5.31	69.96			
1	978.6	977.3	974.6		1372.61	1393.85	15:37	13.83	1372.56			

Golder Senior Reviewer & Approver Sign-off

Reviewed by:

Adrian Kowalchuk — Dec 20, 2019

Signature — Date

Approved by:

Greg Schmidt — Dec 20, 2019

Signature — Date

Expand Arm Springs & Ball Seal.

1/2

Golder Associates

NWMO IGNACE DRILLING
WESTBAY SYSTEM
PIEZOMETRIC PRESSURES/LEVELS

WL using Probe : 32.7m.
No water level to report. Available.

Project No.: 1671632 (1900)

IG_BH01_HT_001

Datum: Ground Level.
Elev. G.S.:
Height of Westbay above G.S.:
Elev. Top of Westbay Casing:
Reference Elevation:
Borehole angle: Vertical

Probe Type: TK/O/C Samplers.
Serial No.: EM8 4462
Probe Range: 2000 PSI
Westbay Casing Type: MP-38
Sampler Valve Position: CLOSED

Weather: -11°C, overcast.
Operator: ADRIAN KOMLETCHUK / MATT BOUMAN
Date: NOV. 7, 2019.

Ambient Reading (P_{atm}) (pressure, temperature, time)

Start: Pressure 14.43
Temp. 5.66
Time 10:35

Finish: Pressure 14.54
Temp. 5.72
Time 14:33

P_{atm} 14.485

Anchor - 15 Rotations
Shoe out 23 Rotations.
Shoe in 23 Rotations
Arm in. 17 Rotations.

Note: "Port position" in angled boreholes refers to position along drillhole. True depth (Dp) needs to be calculated using borehole angle and deviation data to calculate zone piezometric level (Dz)

Port No.	Port Position From Log (m)	Collar Mark Port Position From Cable (m)	Port Depth True Port Depth "Dp" (m)	Fluid Pressure Readings: Inside Casing (P1)	Outside Casing (P2)	Time (H:M:S)	Probe Temp. (°C)	Inside Casing (P1)	Pressure Head Outside Port (m) H=(P2-Patm)/w	Piezo Level Outside Port (m) Dz = Dp-H	Comments
1	977.3	978.0		1370.78	1396.10	11:20	13.43	1370.24			
2	888.8	~~887.7~~ 888.5		1243.20	1261.40	11:31	13.39	1243.21			
3	804.4	802.7		1122.00	1140.04	11:39	12.56	1122.03			
4	769.3	768.5		1071.57	1085.86	11:47	12.09	1071.59			
5	702.9	702.2	701.7	976.53	992.23	11:53	11.58	976.56			
6	649.8	No Collar	648.4	900.06	913.63	12:07	10.74	900.01			
7	628.3	628.0	626.0	869.24	882.01	12:12	10.54	869.29			
8	574.4	No Collar	573.3	791.89	805.99	13:00	9.90	791.91			
9	540.2	540.1	538.5	742.7	754.84	12:05	9.67	742.81			
10	517.6	517.1	515.5	710.00	722.94	13:13	9.35	709.97			
11	493.2	492.6	491.9	675.04	689.25	13:17	9.15	675.06			
12	432.1	No Collar	431.2	587.66	601.11	13:24	8.64	587.69			
13	409.6	409.4	408.4	554.93	569.83	13:29	8.32	554.86			
14	325.6	NO COLLAR	324.7	434.87	449.16	13:39	7.52	434.85			
15	307.0	307.5	306.6	408.71	424.11	13:45	7.16	408.68			
16	231.2	NO COLLAR	230.6	299.63	316.53	13:57	6.40	299.61			
17	200.3	199.5	198.7	253.77	274.16	14:04	6.08	253.75			
18	149.0	No Collar	148.2	181.88	201.60	14:16	5.55	181.86			

Golder Senior Reviewer & Approver Sign-off

Reviewed by:

Adrian Komletchuk — November 11, 2019

Signature — Date

Approved by:

Greg Schultz — November 11, 2019

Signature — Date

Golder Associates

NWMO IGNACE DRILLING
WESTBAY SYSTEM
PIEZOMETRIC PRESSURES/LEVELS

Project No.: 1671632 (1900)

IG_BH01_HT_001

Datum: GROUND LEVEL
Elev. G.S.:
Height of Westbay above G.S.:
Elev. Top of Westbay Casing:
Reference Elevation:
Borehole angle: VERTICAL

Probe Type: TK/OC SN04
Serial No.: EMS 4462
Probe Range: 2000 PSI
Westbay Casing Type: MP-38
Sampler Valve Position: CLOSED

Weather: -11° Overcast
Operator: ADRIAN KOWALCHUK / MATT BOWMAN
Date: NOV. 7, 2019

Ambient Reading (P_{atm}) (pressure, temperature, time)

Start: Pressure 14.43
Temp. 5.66
Time 10:35

Finish: Pressure 14.54
Temp. 5.32
Time 14:33

P_{atm} 14.485

Note: "Port position" in angled boreholes refers to position along drillhole. True depth (Dp) needs to be calculated using borehole angle and deviation data to calculate zone piezometric level (Dz)

Port No.	Port Position From Log (m)	collar depth Port Position From Cable (m)	Port depth True Port Depth "Dp" (m)	Fluid Pressure Readings: Inside Casing (P1)	Outside Casing (P2)	Time (H:M:S)	Probe Temp. (°C)	Inside Casing (P1)	Pressure Head Outside Port (m) H=(P2-Patm)/w	Piezo Level Outside Port (m) Dz = Dp-H	Comments
19	128.5	NO CABLE	127.6	152.56	171.46	14:17	5.40	152.57			
20	70.3	69.5	69.5	67.56	88.90	14:27	5.26	67.56			

Golder Senior Reviewer & Approver Sign-off

Reviewed by:

Adrian Kowalchuk — November 11, 2019

Signature — Date

Approved by:

Greg Schut — November 11, 2019

Signature — Date

APPENDIX B

DQCW Tables

GOLDER

NWMO IGNACE DRILLING
WESTBAY SYSTEM
PIEZOMETRIC PRESSURES/LEVELS

Project No.:
1671632A (1912)

IG_BH01_HT_001

Datum: Ground level
Elev. G.S.: 430.72
Height of Westbay above G.S.: 0.32
Elev. Top of Westbay Casing: 431.04
Reference Elevation: 430.72
Borehole angle: 90

Probe Type: Open/close sampler
Serial No.: EMS4960
Probe Range: 13790 kPa
Westbay Casing Type: MP38
Sampler Valve Position: Closed

Weather: Windy, possible rain showers (18 C)
Operator: NWMO
Date: 24-Apr-19

Ambient Reading (P_{atm}) (pressure, temperature, time)

Start: Pressure	96.32	Finish: Pressure	95.98
Temp.	17.88	Temp.	5.29
Time	10:50	Time	14:11

Note:
Arm Out 15 ROT, Shoe Out 23 ROT In Air, Shoe In 23 ROT in Air, Arm In 16 ROT "Port position" in angled boreholes refers to position along drillhole. True depth (Dp

P_{atm} 96.15

Port No.	Port Position From Log (m)	Port Position From Cable (m)	True Port Depth "Dp" (m)	Fluid Pressure Readings								Pressure Head Outside Port (m) H=(P2-Patm)/w	Piezo Level Outside Port (m) Dz = Dp-H	Comments
				Inside Casing (P1)	Inside Casing (P1) (kPa)	Outside Casing (P2)	Outside Casing (P2) (kPa)	Time (H:M:S)	Probe Temp. (°C)	Inside Casing (P1)	Inside Casing (P1) (kPa)			
20	69.1	69.1	69.1	71.16	490.63	88.46	609.91	14:04:00	5.1	71.16	490.63	52.40	16.70	
19	128.5	128.9	128.5	156.24	1077.24	171.18	1180.25	13:57:00	5.43	156.24	1077.24	110.58	17.92	
18	149	149.2	149	185.61	1279.74	201.18	1387.09	13:51:00	5.63	185.61	1279.74	131.67	17.33	
17	199.2	199.4	199.2	257.50	1775.40	273.55	1886.06	13:44:00	6.05	257.51	1775.47	182.57	16.63	
16	231.2	231.3	231.2	303.44	2092.15	315.96	2178.47	13:38:00	6.41	303.44	2092.15	212.40	18.80	
15	307.3	307.3	307.3	412.50	2844.09	423.61	2920.69	13:30:00	7.11	412.45	2843.74	288.10	19.20	
14	325.6	325.5	325.6	438.62	3024.18	449.35	3098.16	13:24:00	7.45	438.66	3024.46	306.20	19.40	Had trouble connecting to port
13	409.3	409	409.3	558.69	3852.03	569.82	3928.77	13:17:00	8.19	558.72	3852.24	390.92	18.38	
12	432.1	431.8	432.1	591.46	4077.97	601.03	4143.96	13:12:00	8.44	591.43	4077.77	412.87	19.23	
11	493	492.4	493	678.84	4680.44	689.26	4752.28	13:03:00	9.01	678.86	4680.58	474.92	18.08	
10	517.4	516.8	517.4	713.80	4921.48	723.97	4991.60	12:58:00	9.27	713.77	4921.27	499.33	18.07	
9	540.2	539.6	540.2	746.58	5147.49	754.82	5204.30	12:51:00	9.57	746.56	5147.35	521.03	19.17	
8	574.4	573.4	574.4	795.64	5485.75	805.91	5556.56	12:45:00	9.86	795.66	5485.88	556.96	17.44	
7	628.4	627.5	628.4	872.89	6018.37	881.73	6079.32	12:35:00	10.31	873.11	6019.88	610.28	18.12	
6	649.8	648.7	649.8	903.70	6230.79	913.57	6298.85	12:18:00	10.59	903.72	6230.93	632.67	17.13	
5	703.1	702	703.1	980.17	6758.04	992.12	6840.43	12:00:00	11.28	980.23	6758.45	687.91	15.19	
4	769.3	767.9	769.3	1075.08	7412.42	1085.75	7485.99	11:50:00	11.98	1075.17	7413.04	753.76	15.54	
3	804.4	802.9	804.4	1125.49	7759.98	1139.94	7859.61	11:43:00	12.36	1125.49	7759.98	791.87	12.53	
2	888.8	887.6	888.8	1246.79	8596.32	1261.42	8697.19	11:30:00	13.29	1246.81	8596.46	877.30	11.50	
1	977.3	976.6	977.3	1374.01	9473.47	1396.15	9626.12	11:21:00	13.52	1373.99	9473.33	972.05	5.25	

Golder Senior Reviewer & Approver Sign-off

Reviewed by:

Adrian Kowalchuk

20-Dec-19

Signature Date

Approved by:

Greg Schulz

20-Dec-19

Signature Date

GOLDER

NWMO IGNACE DRILLING
WESTBAY SYSTEM
PIEZOMETRIC PRESSURES/LEVELS

Project No.:
1671632A (1912)

IG_BH01_HT_001

Datum: Ground level
Elev. G.S.: 430.72
Height of Westbay above G.S.: 0.32
Elev. Top of Westbay Casing: 431.04
Reference Elevation: 430.72
Borehole angle: 90

Probe Type: Open/close sampler
Serial No.: EMS4960
Probe Range: 13790 kPa
Westbay Casing Type: MP38
Sampler Valve Position: Closed

Weather: Sunny, breezy (15 C)
Operator: NWMO
Date: 29-Aug-19

Ambient Reading (P_{atm}) (pressure, temperature, time)

Start: Pressure 95.98
Temp. 18.01
Time 11:13

Finish: Pressure 96.53
Temp. 5.85
Time 16:22

P_{atm} 96.25

Note:
Arm Out 15 ROT, Shoe Out 23 ROT In Air, Shoe In 23 ROT in Air, Arm In 16 ROT "Port position" in angled boreholes refers to position along drillhole. True depth (D

Port No.	Port Position From Log (m)	Port Position From Cable (m)	True Port Depth "Dp" (m)	Fluid Pressure Readings: Inside Casing (P1)	Inside Casing (P1) (kPa)	Outside Casing (P2)	Outside Casing (P2) (kPa)	Time (H:M:S)	Probe Temp. (°C)	Inside Casing (P1)	Inside Casing (P1) (kPa)	Pressure Head Outside Port (m) H=(P2-Patm)/w	Piezo Level Outside Port (m) Dz = Dp-H	Comments
20	69.1	69.5	69.1	69.96	482.36	87.77	605.15	14:58:00	5.31	69.96	482.36	51.91	17.19	
19	128.5	128.6	128.5	155.04	1068.96	170.49	1175.49	15:04:00	5.44	155.04	1068.96	110.08	18.42	
18	149	149	149	184.35	1271.05	200.67	1383.57	14:51:00	5.68	184.35	1271.05	131.31	17.69	
17	199.2	199.3	199.2	256.31	1767.20	273.11	1883.03	14:47:00	6.03	256.32	1767.26	182.25	16.95	
16	231.2	231.8	231.2	302.24	2083.87	315.89	2177.99	14:41:00	6.39	302.26	2084.01	212.34	18.86	
15	307.3	307	307.3	411.33	2836.02	423.69	2921.24	14:34:00	7.01	411.34	2836.09	288.15	19.15	
14	325.6	323.4	325.6	437.52	3016.60	448.86	3094.78	14:30:00	7.12	437.52	3016.60	305.85	19.75	
13	409.3	408.9	409.3	557.57	3844.31	569.34	3925.46	14:13:00	8.17	557.54	3844.10	390.58	18.72	
12	432.1	431.6	432.1	590.20	4069.29	600.90	4143.06	14:07:00	8.46	590.23	4069.49	412.77	19.33	
11	493	492.3	493	677.70	4672.58	689.00	4750.49	13:55:00	9.02	677.67	4672.37	474.73	18.27	
10	517.4	516.6	517.4	712.64	4913.48	723.43	4987.88	13:51:00	9.2	712.60	4913.21	498.94	18.46	
9	540.2	539.3	540.2	745.44	5139.63	754.74	5203.75	13:41:00	9.57	745.43	5139.56	520.96	19.24	
8	574.4	573.4	574.4	794.47	5477.68	805.54	5554.00	13:36:00	9.84	794.49	5477.82	556.69	17.71	
7	628.4	627.3	628.4	871.90	6011.54	881.81	6079.87	13:24:00	10.49	871.90	6011.54	610.32	18.08	
6	649.8	648.7	649.8	902.61	6223.28	912.91	6294.30	13:19:00	10.76	902.57	6223.00	632.20	17.60	
5	703.1	701.6	703.1	979.11	6750.73	991.42	6835.60	13:10:00	11.36	979.05	6750.31	687.41	15.69	
4	769.3	767.7	769.3	1074.01	7405.04	1085.58	7484.81	13:02:00	11.96	1074.05	7405.32	753.63	15.67	
3	804.4	802.6	804.4	1124.41	7752.54	1139.41	7855.96	12:53:00	12.42	1124.39	7752.40	791.48	12.92	
2	888.8	887.1	888.8	1245.70	8588.80	1261.22	8695.81	12:43:00	13.27	1245.74	8589.08	877.15	11.65	
1	977.3	974.6	977.3	1372.61	9463.82	1393.85	9610.26	15:37:00	13.83	1372.56	9463.47	970.42	6.88	Sampler valve open at first connection attempt - remeasured at end of profile

Golder Senior Reviewer & Approver Sign-off

Reviewed by:

Adrian Kowalchuk

20-Dec-19

Signature Date

Approved by:

Greg Schmid

20-Dec-19

Signature Date

GOLDER

NWMO IGNACE DRILLING
WESTBAY SYSTEM
PIEZOMETRIC PRESSURES/LEVELS

Project No.:
1671632A (1912)

IG_BH01_HT_001

Datum: Ground level
Elev. G.S.: 430.72
Height of Westbay above G.S.: 0.32
Elev. Top of Westbay Casing: 431.04
Reference Elevation: 430.72
Borehole angle: 90

Probe Type: Open/close sampler
Serial No.: EMS4960
Probe Range: 13790 kPa
Westbay Casing Type: MP38
Sampler Valve Position: Closed

Weather: Overcast (-11 C)
Operator: NWMO
Date: 07-Nov-19

Ambient Reading (P_{atm}) (pressure, temperature, time)

Start: Pressure	99.49	Finish: Pressure	100.25
Temp.	5.66	Temp.	5.32
Time	10:35	Time	14:33

Note:
Arm Out 15 ROT, Shoe Out 23 ROT In Air, Shoe In 23 ROT in Air, Arm In 16 ROT "Port position" in angled boreholes refers to position along drillhole. True depth (Dp

P_{atm} 99.87

Port No.	Port Position From Log (m)	Port Position From Cable (m)	True Port Depth "Dp" (m)	Fluid Pressure Readings							Inside Casing (P1) (kPa)	Pressure Head Outside Port (m) H=(P2-Patm)/w	Piezo Level Outside Port (m) Dz = Dp-H	Comments
				Inside Casing (P1)	Inside Casing (P1) (kPa)	Outside Casing (P2)	Outside Casing (P2) (kPa)	Time (H:M:S)	Probe Temp. (°C)	Inside Casing (P1)				
20	69.1	69.5	69.1	67.56	465.81	88.90	612.94	14:28:00	5.26	67.56	465.81	52.33	16.77	
19	128.5	127.6	128.5	152.56	1051.86	171.46	1182.18	14:21:00	5.4	152.57	1051.93	110.39	18.11	
18	149	148.2	149	181.88	1254.02	201.60	1389.98	14:16:00	5.55	181.86	1253.88	131.59	17.41	
17	199.2	198.7	199.2	253.77	1749.68	274.16	1890.27	14:04:00	6.08	253.75	1749.55	182.62	16.58	
16	231.2	230.6	231.2	299.63	2065.88	316.53	2182.40	13:57:00	6.4	299.61	2065.74	212.42	18.78	
15	307.3	306.6	307.3	408.71	2817.96	424.11	2924.14	13:45:00	7.16	408.68	2817.75	288.07	19.23	
14	325.6	324.7	325.6	434.87	2998.32	449.16	3096.85	13:39:00	7.52	434.85	2998.19	305.69	19.91	
13	409.3	408.4	409.3	554.93	3826.11	569.83	3928.84	13:29:00	8.32	554.86	3825.63	390.55	18.75	
12	432.1	431.2	432.1	587.66	4051.77	601.11	4144.51	13:24:00	8.64	587.69	4051.98	412.55	19.55	
11	493	491.9	493	675.04	4654.24	689.25	4752.21	13:17:00	9.15	675.06	4654.38	474.54	18.46	
10	517.4	515.5	517.4	710.00	4895.28	723.94	4991.39	13:13:00	9.35	709.97	4895.07	498.93	18.47	
9	540.2	538.5	540.2	742.70	5120.74	754.84	5204.44	13:05:00	9.67	742.81	5121.50	520.66	19.54	
8	574.4	573.3	574.4	791.89	5459.89	805.99	5557.11	13:00:00	9.9	791.91	5460.03	556.63	17.77	
7	628.4	626	628.4	869.24	5993.20	882.01	6081.25	12:12:00	10.54	869.29	5993.55	610.10	18.30	
6	649.8	648.9	649.8	900.06	6205.70	913.63	6299.26	12:07:00	10.74	900.01	6205.35	632.33	17.47	
5	703.1	701.7	703.1	976.53	6732.94	992.23	6841.19	11:53:00	11.5	976.56	6733.15	687.61	15.49	
4	769.3	-	769.3	1071.57	7388.22	1085.86	7486.74	11:47:00	12.09	1071.59	7388.36	753.46	15.84	
3	804.4	-	804.4	1122.00	7735.92	1140.04	7860.30	11:39:00	12.56	1122.03	7736.13	791.56	12.84	
2	888.8	-	888.8	1243.20	8571.57	1261.40	8697.05	11:31:00	13.39	1243.21	8571.63	876.91	11.89	
1	977.3	-	977.3	1370.28	9447.75	1396.10	9625.77	11:20:00	13.43	1370.24	9447.48	971.63	5.67	

Golder Senior Reviewer & Approver Sign-off

Reviewed by:

Adrian Kowalchuk

20-Dec-19

Signature Date

Approved by:

Greg Schmidt

20-Dec-19

Signature Date

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