PHASE 2 INITIAL BOREHOLE DRILLING AND TESTING, IGNACE AREA

WP04a Data Report - Petrophysical Testing of Core for IG_BH01

APM-REP-01332-0231 **January 2020**

Golder Associates Ltd.

nwmo
NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Nuclear Waste Management Organization
22 St. Clair Avenue East, 4th Floor
Toronto, Ontario
M4T 2S3
Canada

Tel: 416-934-9814
Web: www.nwmo.ca

REPORT

PHASE 2 INITIAL BOREHOLE DRILLING AND TESTING, IGNACE AREA

WP4a Data Report - Petrophysical Testing of Core for IG_BH01

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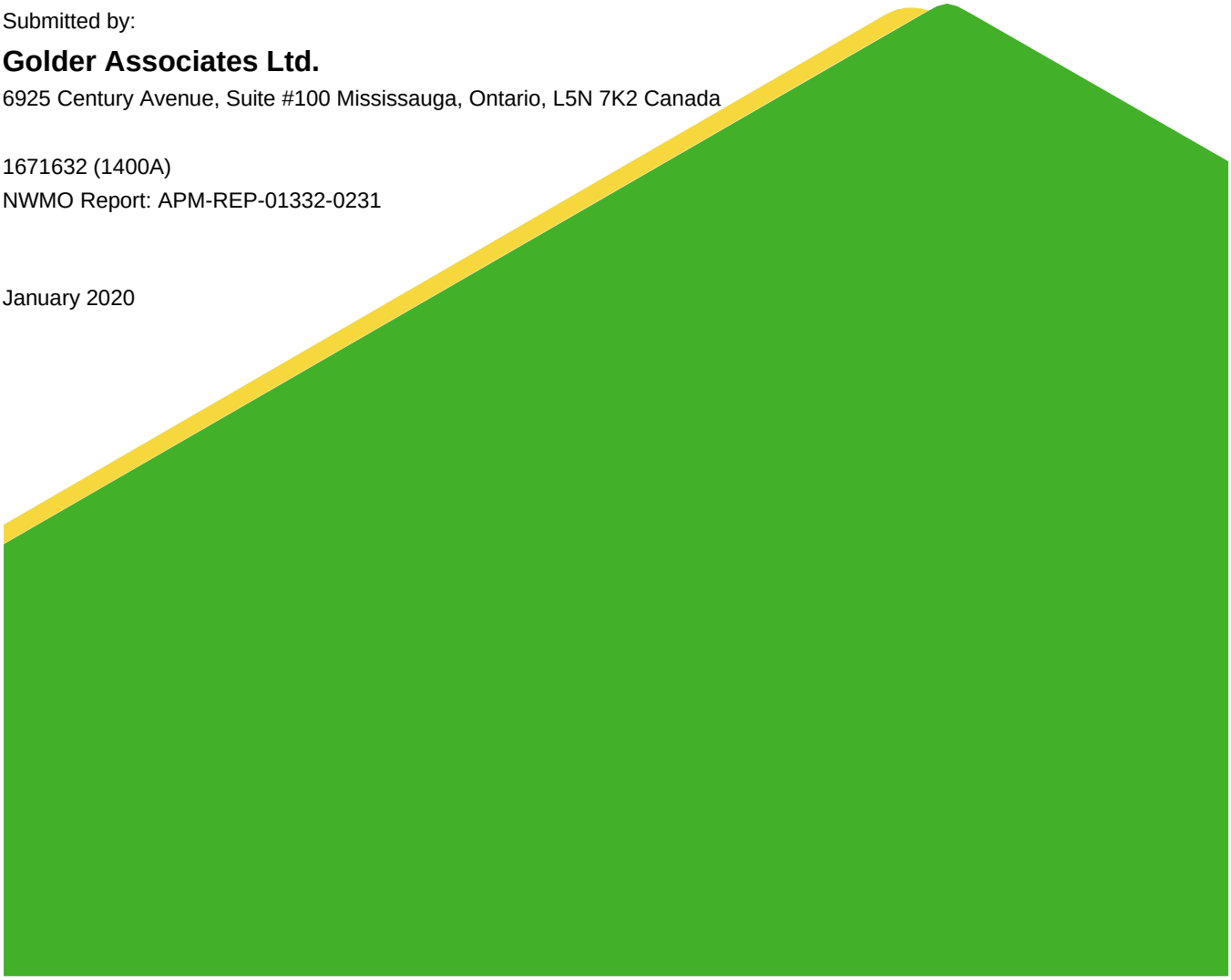
Nuclear Waste Management Organization
6th Floor
22 St. Clair Avenue East
Toronto, Ontario, M4T 2S3

Submitted by:

Golder Associates Ltd.
6925 Century Avenue, Suite #100 Mississauga, Ontario, L5N 7K2 Canada

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Client: Nuclear Waste Management Organization (NWMO)
22 St. Clair Avenue East, Sixth Floor
Toronto, Ontario
M4T 2S3

Client Contact:	Monique Hobbs	Maria Sánchez-Rico Castejón
Telephone:	647-259-3712	647-259-3720
Email:	mhobbs@nwmo.ca	msanchez@nwmo.ca

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SIGNATURES

Prepared by: _____

Dan Jones, Ph.D.
Geotechnical Engineering

Prepared by: _____

Aynsley Neufeld, M.Eng., P.Eng
Mining & Rock Engineering

Reviewed by: _____

Frank Barone, Ph.D., P.Eng.
Geotechnical Engineering - Principal

Reviewed by: _____

Joe Carvalho, Ph.D., P.Eng.
Mining & Rock Engineering - Principal

Approved by: _____

George Schneider, M.Sc., P.Geo.
Senior Geoscientist - Principal

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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 process.

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. This report describes the testing results for Work Package 4A (WP4A): Petrophysical Testing of Core for IG_BH01, which includes: bulk density, hydraulic conductivity, effective diffusion coefficient, specific gravity, total porosity and mercury intrusion (effective) porosity.

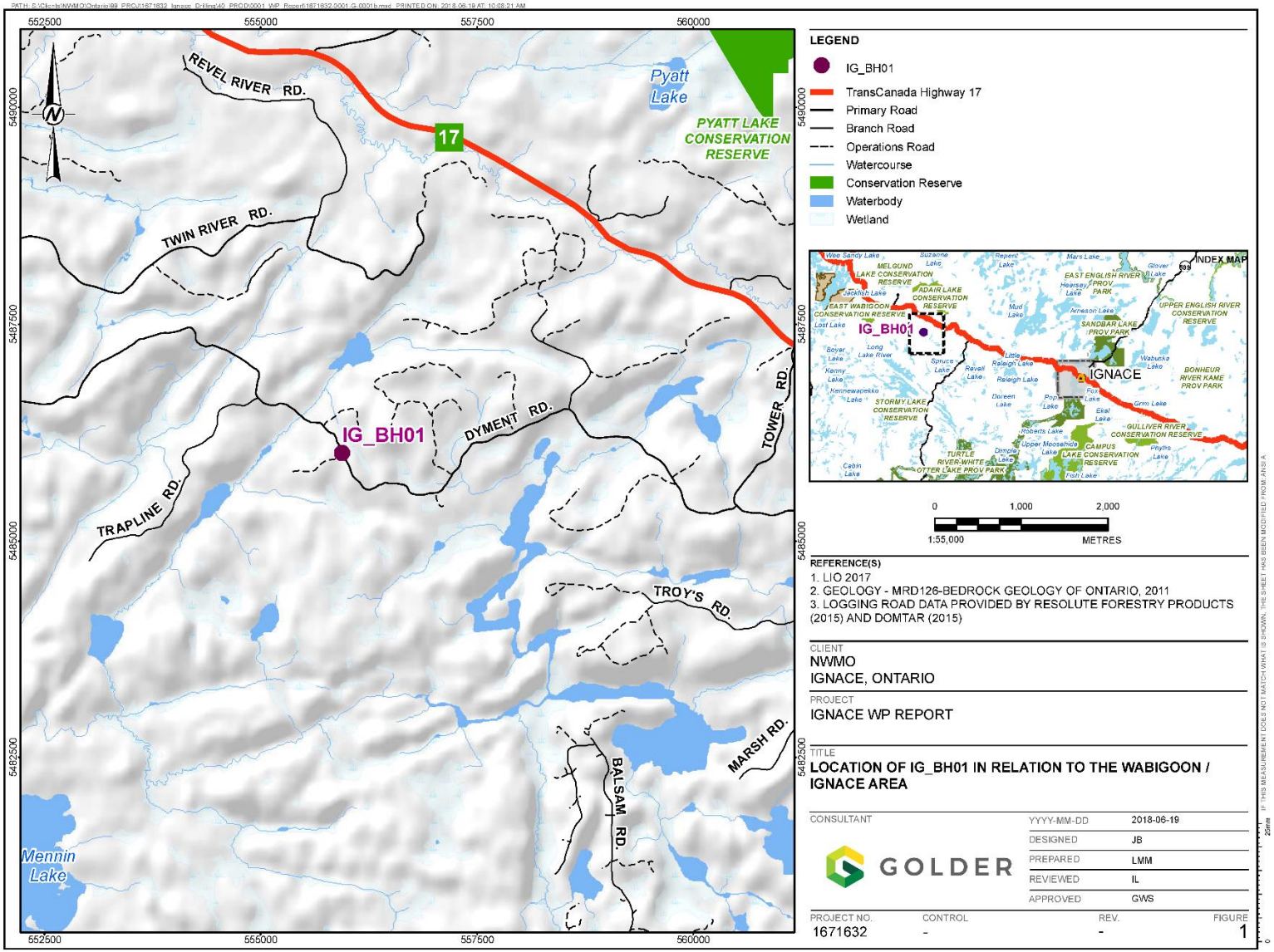


Figure 1: Location of IG_BH01 in Relation to the Wabigoon / Ignace Area

1.1 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).

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 m to 450 m above sea level. 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). In the centre of the investigation area, a west-northwest trending mafic dyke is interpreted from aeromagnetic data and observed during detailed mapping to be approximately 15 m to 20 m wide (Figure 2). This dyke is associated with a similarly-orientated mafic dyke that stretches along the entire northern limit of the investigation area. Both dykes, along with others in the northern portion of the Revell batholith, have a similar character and are interpreted to be part of the Wabigoon dyke swarm. It is assumed based on surface measurements that these mafic dykes are sub-vertical (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).

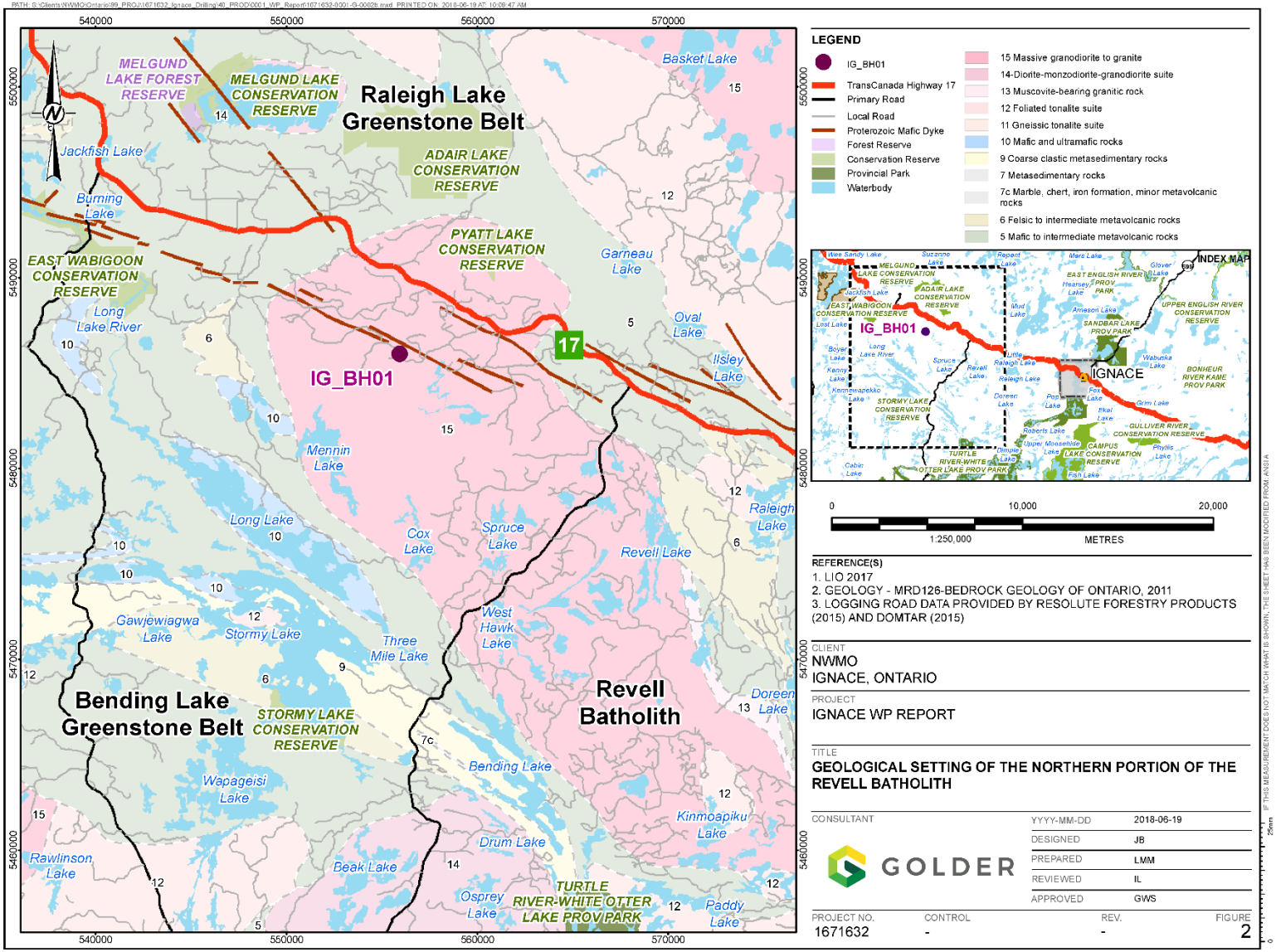


Figure 2: Geological Setting of the Northern Portion of the Revell Batholith

1.2 Technical Objectives

The technical objective of the petrophysical laboratory testing program is to assess the petrophysical properties of the crystalline host rock, with a focus on the rock within the repository horizon (presently assumed to be between depths of approximately 400 m and 600 m). The petrophysical properties examined include: bulk density, total porosity, mercury intrusion (effective) porosity, diffusion coefficient and hydraulic conductivity.

Bulk density and total porosity testing was performed on 20 and 10 intact core samples, respectively.

Mercury intrusion (effective) porosity testing was attempted on one sample.

Testing for diffusion coefficients of chloride, lithium, iodide and tritium was performed on 10 intact core samples.

Hydraulic conductivity testing was attempted on one intact core sample.

2.0 TEST APPARATUS AND PROCEDURES

2.1 Sample Inspection and Storage

The core samples for the petrophysical testing were received from the field wrapped in saran and foil wrap and coated with wax to minimize moisture loss. The samples were visually inspected at the laboratory to ensure the wax seal was intact.

For the bulk density, total porosity and mercury intrusion (effective) porosity testing, the samples remained sealed in wax and were stored in a humidity room until the time of testing.

For hydraulic conductivity and diffusion coefficient testing, the core samples were unwrapped (wax, foil and saran wrap removed) and their condition visually inspected for suitability for testing. All samples were deemed suitable and were wrapped with fresh saran wrap and placed in a humidity and temperature-controlled room until testing.

Before testing the samples were photographed and their condition documented.

2.2 Bulk Density Tests

Determination of bulk density was performed at the Golder Laboratory in Mississauga, Ontario. The testing was carried out in accordance with ASTM D7263-09 Method A, using water as the displacement fluid. For each core sample, two specimens of intact core approximately 20 mm in length were cut using a diamond saw and tested for build density.

In accordance with ASTM D7263-09 Method A, the bulk density of a specimen (ρ_m) was calculated by the following equation:

$$\rho_m = \frac{M_t}{\frac{(Mc-Msub)}{\rho_w} - \frac{(Mc-Mt)}{\rho_p}} \qquad \text{[Eqn. 1]}$$

where:

ρ_m = bulk density of the specimen [g/cm^3],
M_t = total mass of the specimen (includes porewater and solids phases) [g],
M_c = wax-coated mass of the specimen [g],
M_{sub} = submerged mass of the wax-coated specimen [g],
ρ_w = density of the water at the test temperature [g/cm^3], and

ρ_ρ = density of the wax [g/cm^3].

The test specimen was weighed (M_t), then coated in paraffin wax and weighed again (M_c). Non-shrinking, paraffin of known constant density (ρ_ρ) of 0.908 g/cm^3 was used. The density of the wax is independent of the temperature range of this experiment. The wax-coated specimen was then placed in a wire basket and submerged in a container of water. Prior to the test, the balance was tared to zero with the empty wire basket completely submerged and not touching the sides or bottom of the container. The submerged mass of the wax-coated specimen (M_{sub}) was recorded along with the temperature of the water in the container to 0.1 °C. The mass density of water at the test temperature (ρ_w) was obtained from standard tables with known water densities at various temperatures. The bulk density is reported to 0.01 g/m^3.

2.3 Total Porosity Tests

Total porosity is not measured directly; it is a calculated parameter. Bulk density, specific gravity and water content of the sample are required to calculate total porosity (n), as follows:

$$\varphi = 1 - \frac{\rho_m}{G_s\,(1+w)\rho_w} \qquad = 1\text{-}\ \frac{\rho_d}{G_s\,\rho_w} \qquad \text{[Eqn. 2]}$$

where:
φ = total porosity,
ρ_d = dry density [g/cm^3],
ρ_m = bulk density [g/cm^3],
ρ_w = density of water at 20°C [g/cm^3],
G_s = specific gravity 20°C, and
w = water content (mass of porewater per unit mass of solids).

The determination of bulk density (ρ_m) is described above. The determination of specific gravity and water content was performed in accordance with ASTM D854-14 and ASTM D2216-10, respectively. A summary of the testing procedures for specific gravity and water content is provided below. For each core samples, two specimens of intact core approximately 20 mm in length were cut using a diamond saw for total porosity determination. The total porosity results are reported to 0.001 (0.1%).

Specific Gravity

ASTM D854-14 covers the determination of the specific gravity of mineral solids, by means of a water pycnometer. For each core sample, three specimens of intact core approximately 10 mm in length were cut using a diamond saw, oven dried at 110ºC ± 5°C, pulverized to minus 75µm, and then tested for specific gravity.

Specific gravity (G_s) was calculated using the following equation:

$$G_S = \frac{M_s}{M_{\rho_{w,t}} - \left(M_{\rho_{ws,t}} - M_s\right)} \qquad \text{[Eqn. 3]}$$

where:
M_s = measured mass of the oven dried pulverized test specimen [g],
$M_{\rho_{w,t}}$ = mass of the pycnometer and water at the test temperature [g], and
$M_{\rho_{ws,t}}$ = mass of the pycnometer, sample and water at the test temperature [g].

Prior to testing, calibration of the pycnometer volume was required. The calibrated volume of the pycnometer (V_p) was calculated using the following equation:

$$V_\rho = \frac{(M_{\rho w,c} - M_\rho)}{\rho_{w,c}} \qquad \text{[Eqn. 4]}$$

where:

V_p = calibrated volume of the pycnometer [cm^3],
$M_{\rho_{w,c}}$ = mass of the pycnometer and water at the calibration temperature (avg. of five measurements) [g],
M_ρ = mass of the pycnometer determined during calibration (average of five measurements) [g], and
$\rho_{w,c}$ = mass density of water at the calibration temperature, from water density table given in ASTM D584-14 [g/cm^3].

The pycnometer volume calibration involved filling the pycnometer with de-aired water to above the calibration line and allowing it to thermally equilibrate to the calibration temperature for 3 hours, excess water was then removed to the calibration line. The mass of the pycnometer was recorded as the average of five independent measurements ($M_{\rho_{w,c}}$) and the calibrated volume V_p was calculated using Equation. 4.

The mass of the pycnometer with water only at the test temperature ($M_{\rho_{w,t}}$) was calculated using the following equation:

$$M_{\rho_{w,t}} = M_p + (V_\rho \times \rho_{w,t}) \qquad \text{[Eqn. 5]}$$

where:

$M_{\rho_{w,t}}$ = calculated mass of the pycnometer and water at the test temperature [g],
V_p = calibrated volume of the pycnometer [cm^3],
M_p = mass of the pycnometer determined during calibration (average of five measurements) [g], and
$\rho_{w,t}$ = mass density of water at the test temperature, from water density tables given in ASTM D854-14 [g/cm^3].

The testing procedure follows Method B of ASTM D584-14 which requires that the specimen be oven dried to 110°C ± 5°C. The specimen was kept in the oven for at least 24 hours, until there was no change in the mass (±0.01 g). The mass of pulverized oven dried specimen (M_s) was added to the empty pycnometer and then covered with de-aired, distilled water until the water level was between 1/3 and 1/2 of the depth of the main body of the pycnometer. The mixture was agitated by hand until a slurry formed. The pycnometer was placed under vacuum, with the vacuum held relatively constant to cause bubbling during de-airing of the slurry. De-aired, distilled water was then added to the pycnometer, adjusting the water line to the calibration mark. The mass of the pycnometer with the specimen and water ($M_{\rho_{ws,t}}$) was measured and recorded. The temperature of the slurry-water mixture was recorded to the nearest 0.1°C. The specific gravity was then calculated using Equation 3 and then corrected to 20°C using the temperature correction factor given in the ASTM D854-14 Method.

Water Content

Determination of water content was carried out on the bulk density test specimens in accordance with ASTM D2216-10.

The water content of the test specimen (w) was calculated using the following equation:

$$w = [(M_{cms} - M_{cds}) / (M_{cds} - M_c)] \qquad \text{[Eqn. 6]}$$

where:
M_{cms} = mass of container and moist specimen [g],
M_{cds} = mass of container and oven dried specimen [g],
M_c = mass of container [g].

Initially, a clean and dry specimen container was weighed (M_c). The moist test specimen was placed in the container and weighed (M_{cms}), then placed in the drying oven which was maintained at 110° C +/- 5° C. The test specimen was kept in the oven and weighed frequently. Once removed from the oven for weighing, the container was allowed to cool (or until it could be handled comfortably with bare hands) and the weight of the container with the oven dried specimen recorded (M_{cds}). This oven drying procedure was repeated until a constant weight (±0.01 g) was maintained for at least 14 days. The water content (w) was then calculated using Equation 6, using the last recorded specimen weight. For reporting purposes, the resulting water content is expressed as percentage by multiplying by 100.

2.4 Mercury Intrusion (Effective) Porosity Test

Determination of mercury intrusion (effective) porosity was attempted using ASTM D4404-10, Determination of Pore Volume and Pore Volume Distribution of Soil and Rock by Mercury Intrusion Porosimetry, at Particle Technology Laboratories in Downer's Grove, Illinois (USA). Mercury Intrusion Porosimetry uses a pressurized chamber to force mercury to intrude into voids of a porous medium. This technique is able to characterize both inter-particle pores (between individual particles), and intra-particle pores (within the particle). By measurement of the external pressure increase to fill increasingly small pores against the opposing force of the liquid's surface tension, both types of porosity may be determined. The pore diameter detection for this test ranges between 0.0035 and 200 µm. The mercury intrusion (effective) porosity of the core sample may be uncertain if pore sizes are less than the detection limit. ASTM D4404-10 recommends that Mercury Intrusion Porosimetry tests be run on a minimum of three specimens of a given sample.

The sample cell apparatus has a diameter of about 15 mm and a depth of about 25 mm. The specimens were sized to test specification as determined by specialists at the laboratory.

The pore diameter (d) is calculated through the following equation:

$$d = \frac{4T(\cos\theta)}{P_{abs}} \qquad \text{[Eqn. 7]}$$

Where:
d = pore diameter [m],
T = mercury surface tension [N/m],
θ = contact angle between mercury and the pore wall [degrees],
P_{abs} = P_G - P_L [N/m^2],
P_G = pressure of gas applied to the chamber [N/m^2], and
P_L = absolute pressure causing the intrusion of mercury [N/m^2].

The mercury intrusion (effective) porosity for a particular solute can be inferred based on comparison of the pore diameter distribution with the hydrated diameter of the solute. Pores that are larger than the hydrated diameter of the solute are assumed to contribute to the effective porosity available for transport of the solute through the pore structure. The mercury intrusion (effective) porosity is therefore calculated as the total volume of these larger diameter pores divided by the total volume of the test specimen.

As outlined in ASTM D4404-10, preconditioning of the test specimen was required through outgassing in a vacuum at least 1.3 MPa and at a temperature of 150°C for at least 24 hours. The sample was weighed after outgassing and then placed in a penetrometer and evacuated to a pressure of at least 1.3 Pa (10 µmHg). The penetrometer was then filled with mercury by pressurizing to a minimum pressure of 1.3 MPa in order to promote filling and then placed in the pressure vessel of the porosimeter. The pressure was raised incrementally, not being allowed to decrease, until the maximum pressure of interest was reached. Both the absolute pressure and the volume of intruded mercury were measured at each increment.

The choice of pressure intervals at which data are to be recorded was left to the judgment of the operator. Typically, at least 10 to 15 intervals are required to adequately define the pore volume distribution.

2.5 Diffusion Coefficient Tests

Background

Laboratory testing for diffusion coefficient does not have an ASTM standard associated with it. The testing was carried out in accordance with procedures developed by Barone et al. (1992). These procedures are presented for estimation of diffusion and adsorption coefficients in natural saturated clayey soil; however, they are also suitable for intact saturated rock core specimens. The testing generally followed the same overall approach used by others, including Widestrand et al. (2010), Skagius and Neretnieks (1986), Xu et al. (2001), Siitari-Kauppi et al. (1997), for determining diffusion coefficients in low porosity crystalline rocks.

A schematic drawing of the diffusion cell used for this study is presented in Figure 3. A source solution simulating NWMO's CR-10 reference groundwater solution but spiked with either tritium, or a mixture of chloride, iodide and lithium as the analytes was placed on one side of an intact rock core specimen and a collector solution consisting of simulated CR-10 solution but without these analytes was placed on the opposite side. The source solution analytes were then allowed to diffuse through the rock core sample and into the collector solution compartment over a period of up to 392 days. During this period, the collector solution compartment was periodically sampled to monitor each analyte's concentration variation with time.

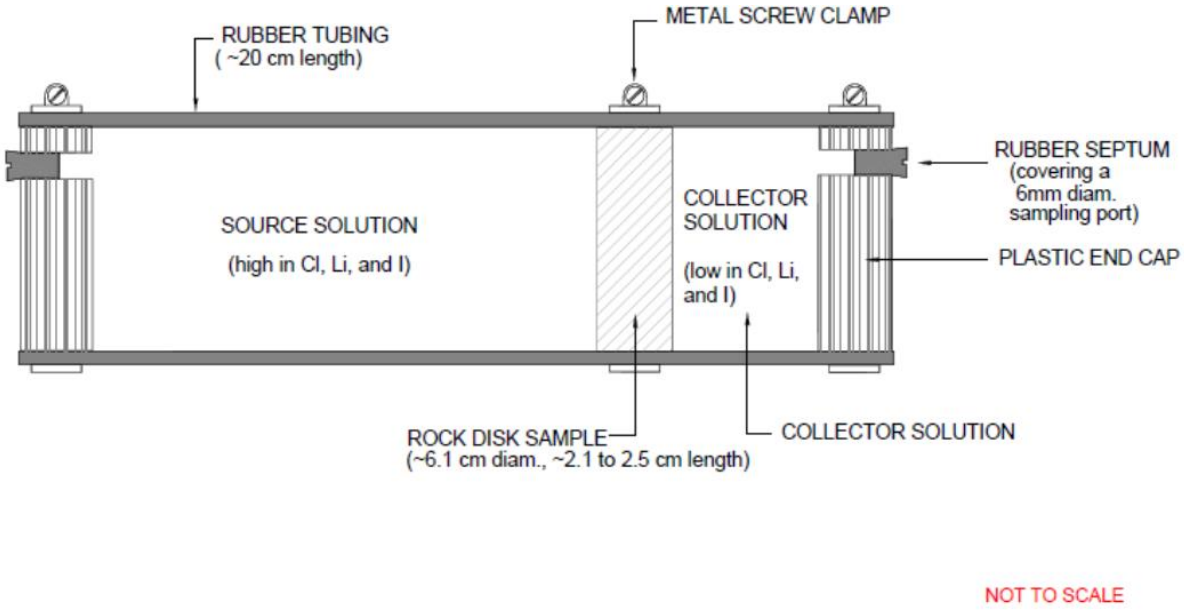


Figure 3: Typical schematic of a diffusion cell

The boundary condition representing the analyte concentration decrease with time in the source solution due to diffusion through the rock core can be written as (Rowe and Booker, 1985):

$$c_s(t) = c_{os} - \frac{1}{H_s}\int_0^t f_s(t)dt \qquad \text{[Eqn. 8]}$$

where: $c_s(t)$ = analyte concentration in the source solution at time t [M/L^3],

c_{os} = initial analyte concentration in the source solution [M/L^3],

H_s = equivalent height of source solution, calculated as the source solution volume divided by the cross-sectional area of the rock core sample perpendicular to the direction of diffusion [L], and

$f_s(t)$ = mass flux across the rock sample/source solution interface [M/L^2/T]

The mass flux across the sample/source solution interface at time t ($f_s(t)$), can be further related to the analyte concentration gradient across this interface at time t ($(\delta c/\delta z)_s$) by Fick's first law, viz.:

$$f_s(t) = -\varphi' D\left(\frac{\delta c}{\delta z}\right)_s \qquad \text{[Eqn. 9]}$$

Where: D = the diffusion coefficient of the analyte in the rock matrix [L^2/T].

φ' = effective porosity of the rock matrix through which the analyte diffuses through.

The boundary condition representing the analyte concentration in the collector solution at time t ($c_c(t)$) is given by:

$$C_c(t) = \frac{1}{H_c}\int_0^t f_{c(t)dt} - \frac{q_c}{V_c}\int_0^t c_c(t)dt \qquad \text{[Eqn. 10]}$$

where: $c_c(t)$ = analyte concentration in the collector solution at time t [M/L^3],

V_c = volume of the collector solution [L^3],

$f_c(t)$ = analyte mass flux into the collector solution at time t [M/L^2/T],

q_c = average rate of sampling of the collector solution reservoir [volume of collector solution sample /average sampling frequency] [L^3/T], and

H_c = equivalent height of collector solution, calculated as the collector solution volume divided by the cross-sectional area of the rock core specimen, perpendicular to the direction of diffusion [L].

The mass flux into the collector at time t ($f_c(t)$) can be further expressed in terms of the concentration gradient across the sample/collector solution interface at time t ($(\delta c/\delta z)c$), viz.:

$$f_c(t) = -\varphi' D\left(\frac{\delta c}{\delta z}\right)_c \qquad \text{[Eqn. 11]}$$

For these flux controlled boundary conditions and assuming negligible absorption of the analytes on the rock core solids, a semi-analytical solution to the one-dimensional diffusion equation,

$$\frac{\delta c}{\delta t} = D\frac{\delta^2 c}{\delta z^2} \qquad \text{[Eqn. 12]}$$

has been implemented in the computer program POLLUTE (Rowe and Booker, 2004). Using different values for the analyte diffusion coefficient, theoretical curves for the analyte concentration variation with time in the collector solution were generated using POLLUTE and then compared to the experimental concentration data. The diffusion coefficient (D) that gave the best fit "by eye" to the experimental data was chosen as the experimental value. For the POLLUTE modelling, the total porosity (φ) was used in the model in place of the "effective porosity" (φ'), which as noted in Section 3.3. could not be determined using Mercury Intrusion Porosimetry.

Based on the boundary condition for mass flux into the collector solution (Equation 11), use of total porosity (φ) instead of a typically lower effective porosity (φ') in the POLLUTE modelling will result in a higher D value to match the concentration variation with time in the collector solution. However, the product of the total porosity (φ) and the best fit diffusion coefficient (D) obtained using total porosity will be the same as the product of effective porosity (φ') and diffusion coefficient (D) obtained using effective porosity in the POLLUTE modelling. Hence, whereas the D value would be different, an "effective diffusion coefficient" (D_e) value calculated as the product of the total porosity (φ) and the best fit diffusion coefficient (D) will be the same as that if effective porosity is used for the POLLUTE modelling. Effective diffusion coefficient (D_e) values obtained from this diffusion test method can therefore be compared with those obtained in Work Package WP4C using effective porosity; whereas the diffusion coefficient (D) values cannot be directly compared to those obtained in Work Package WP4C.

Procedures

Diffusion tests for chloride, lithium, and iodide were conducted simultaneously on the same rock core specimen cut from a submitted core sample. These tests are collectively referred to as "salt diffusion tests". The diffusion tests for tritium were conducted on a separate specimen cut from a submitted core sample.

Chemical concentrations for the diffusion test source and collector solutions are provided in Table 1. The source solutions were prepared by Golder to approximate NWMO's CR-10 solution, but spiked to increase the concentrations of tritium, chloride, lithium and iodide. The collector solutions were prepared to approximate the CR-10 solution but with no chloride, lithium, iodide and tritium. To minimise the osmotic gradient across the test sample, sulphate and bromide were added (as $CaSO_4$ and NaBr, respectively) to replace the salinity lost by not including chloride in the collector solution.

Table 1: Chemical concentrations for diffusion test source and collector solutions

Compound	Salt Diffusion Test Source Solution	Salt Diffusion Test Collector Solution	Tritium Diffusion Test Source Solution	Tritium Diffusion Test Collector Solution
Sodium	1.86 g/L	1.90 g/L	1.89 g/L	1.89 g/L
Chloride	8.55 g/L *(8.2 g/L)*	0 g/L *(0.025 g/L*)*	6.15 g/L	6.15 g/L
Potassium	0.31 g/L	0 g/L	0.02 g/L	0.02 g/L
Calcium	2.11 g/L	2.12 g/L	2.15 g/L	2.15 g/L
Magnesium	0.05 g/L	0 g/L	0.05 g/L	0.05 g/L
Sulphate	0.96 g/L	5.08 g/L	1.0 g/L	1.0 g/L
Lithium	0.49 g/L	0 g/L	-	-

Compound	Salt Diffusion Test Source Solution	Salt Diffusion Test Collector Solution	Tritium Diffusion Test Source Solution	Tritium Diffusion Test Collector Solution
	(0.42 g/L)	*(<0.00005 g/L)*		
Iodide	0.99 g/L *(0.83 – 1.3 g/L)*	0 g/L *(<0.001 g/L)*	-	-
Bromide	-	6.6 g/L	-	-
Tritium	-	-	20 000 Bq/L	<15 Bq/L *(<15 Bq/L)*

Note: values provided in *italics* and parenthesis are laboratory measured values on the prepared solutions. All other values are target concentrations used to prepare the solutions.

*Bromide source used in making collector stock solution contained a chloride impurity.

The following procedures were used in the set-up and monitor the diffusion tests. Note that the diffusion tests were conducted at room temperature (~23°C).

1) A core specimen measuring approximately 2.1 cm to 2.5 cm in thickness and 6.1 cm in diameter was cut from each of the submitted core samples using a tungsten tip saw and tap water as the cutting fluid.

2) A thin layer of silicone grease was spread around the outer perimeter of each core specimen and the specimen was pushed into an approximately 20 cm long section of rubber tubing having an unstretched inner diameter slightly smaller than the core specimen. The core specimen was positioned as shown in Figure 3.

3) A screw clamp was slid over the outer part of the rubber tubing and tightened directly over the core specimen to ensure a good seal between the specimen and the rubber tubing. Plastic end caps were then positioned as shown in Figure 3 and clamped in a similar manner as the core specimen.

4) With the cell in a near horizontal position, collector solution was injected into the collector compartment through the injection port located on the end cap. Care was taken to minimize the air space remaining in the compartment. The total volume of collector solution injected into the collector compartment ranged from 103 mL to 203 mL.

5) With the apparatus in a vertical position (collector compartment at the bottom), the source solution was injected into the source compartment. Care was taken to minimize air space remaining in the compartment. The total volume of source solution injected into the source compartment ranged from 291 mL to 586 mL.

6) Immediately after inserting the source solution, the diffusion cell was placed in a horizontal position and the start time for diffusion (i.e. $t = 0$) was recorded.

7) A 5 ml (tritium) or 6 mL (salts) sample of the collector was taken periodically (approximately once per 14 days on average) through the sampling port. Once each sample was taken, an equal volume of fresh collector solution was re-injected into the collector compartment.

8) Coincident with sampling events, the mass of the cell was recorded to monitor for changes. Decreases in mass overtime were assumed to be loss due to evaporation. This evaporative loss was minimized by placing the cells inside of a temperature controlled high humidity storage room.

9) The duration of diffusion was 392 days for the salt diffusion tests and 245 days for the tritium diffusion tests. These durations allowed sufficient data to be collected for the collector solution concentrations, which in turn allowed fitting of the data using the POLLUTE model.

10) Control tests, using a polyethylene disk instead of a rock core as the test specimen, were set up (one for the salts, and one for tritium) and tested in the same manner as the rock core tests to check for short circuiting of the analytes across the core sample via diffusion through the rubber tubing.

11) All collector solution samples were analyzed by Maxxam Analytics (Mississauga, Ontario).

Using the above procedures, salt diffusion tests (for chloride, lithium and iodide) were carried out for ten (10) core specimens, and tritium diffusion tests were carried out for ten (10) core specimens. Specific details of the diffusion tests, such as the volumes of the source and collector solutions, core specimen dimensions and initial analyte concentrations in the source and collector solutions are provided in Appendix A.

Consideration of Evaporative Losses

Over time, the mass of the diffusion test cells was monitored and was noted to decrease due to evaporation of the source and collector solutions. A summary of the rates of mass loss recorded for the salt diffusion tests during testing is provided in Table 2 (note that the rate changed significantly on March 28, 2018, when the cells were moved from the open laboratory to a 100 % humidity room).

Table 2: Summary of mass losses recorded for salt diffusion tests

Core Sample	Average Rate of Mass Loss before Mar 28 2018 (g/day)	Average Rate of Mass Loss after Mar 28 2018 (g/day)
IG_BH01_ED002	0.11	0.017
IG_BH01_ED003	0.07	0.013
IG_BH01_ED005	0.12	0.018
IG_BH01_ED006	0.09	0.016
IG_BH01_ED008	0.12	0.020
IG_BH01_ED010	0.06	0.016
IG_BH01_ED011	0.07	0.010
IG_BH01_ED013	0.08	0.014
IG_BH01_ED014	0.06	0.012
IG_BH01_ED016	0.10	0.018

As a result of this evaporation, the concentration of salts in both the source and collector compartments slightly increased (as the salts do not evaporate, but the volume of water decreases). The POLLUTE model is not able to account for this increase in salt concentration, and therefore a calculation was performed on the output from

POLLUTE to allow for comparison to the laboratory measured values. The calculation is described in Appendix C. The tritium diffusion tests were kept in the humidity room from the start of testing and mass losses were negligible.

Consideration for Background Chloride Concentration in Salt Diffusion Test Collector Solution

To balance osmotic gradients inside of the salt diffusion cells, a high concentration of Sodium Bromide (NaBr) instead of sodium chloride was added to the collector compartment of all cells. The NaBr contained a small amount of chloride impurity. As a result, the initial concentration of chloride in the collector solution could not be assumed as zero.

When the collector solution was sampled, the volume removed was replaced with collector stock solution continuing the chloride impurity. The POLLUTE model cannot account for this small amount of chloride that is added and therefore a calculation was performed on the output from POLLUTE to allow comparison to the laboratory measured values. The calculation is described in Appendix C.

2.6 Hydraulic Conductivity Tests

Determination of hydraulic conductivity was attempted on one intact core sample using with ASTM D5084-16A (Method A), Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter (Constant Head Method).

The test specimen was cut from the core sample to approximately 50 mm length.

In accordance with ASTM D5084-16A (Method A), de-aired / distilled water permeant was flushed through the permeameter system. After all visible air had been removed from the flow lines, the control valves were closed. The specimen setup involved placing the core specimen in the permeameter with a soaked filter paper and porous stone on the top cap and bottom of the specimen (used to transmit permeant liquid to and from specimen). A thin coat of silicon grease was applied to the sides of the test specimen and a flexible membrane was then encased around the specimen. A gasket was then placed to seal the membrane at the base pedestal and top cap. A photograph of the test setup is provided in Figure 4.



Figure 4: Photograph showing Hydraulic Conductivity Test Setup

The permeameter cell and cell pressure reservoir were filled with de-aired / distilled water. The cell pressure and influent / effluent pressures were increased to 140 kPa and 130 kPa, respectively, for approximately 18 hours to allow moisture uptake and hence compensate for any drying that may have occurred on top and bottom of the sample during set up. The cell pressure was then increased to 500 kPa to achieve an effective confining stress of 370 kPa. This confining stress ensures a good seal against the membrane along the sides of the sample. The influent (headwater) pressure was then increased to 144 kPa to obtain a hydraulic gradient of 30. The sample was permeated for 55 days at this hydraulic gradient. Approximately steady state flow occurred after 40 days. The influent (headwater) pressure was then increased in two more increments of 10 kPa to obtain the hydraulic conductivity at hydraulic gradients of 50 and 70. Note that ASTMD 5084-16A recommends that the hydraulic gradient be set at 30; however, higher gradients are allowed to expedite the testing provided that the resulting hydraulic conductivity is not affected by the increased gradient. At the start and end of each permeation, the test time (t_1 and t_2) and temperature (to the nearest 0.1°C) were recorded.

The saturated hydraulic conductivity (k) was calculated at steady inflow and outflow rates using the following equation:

$$k = \frac{\Delta Q}{A\, i \Delta t} \qquad \text{[Eqn. 13]}$$

where:

k = hydraulic conductivity [m/s],
ΔQ = volume of flow through the sample under steady state inflow and outflow [m^3],
i = hydraulic gradient = change in water pressure head across the specimen (Δh), divided by the length of the specimen (L),
A = cross-sectional area of the sample [m^2], and
Δt = duration of steady state inflow and outflow[s].

3.0 LABORATORY RESULTS

3.1 Bulk Density

The results of the bulk density testing (including water content) are summarized in Table 3. Laboratory records are provided in Appendix A.

Table 3: Summary of bulk density testing results (including water content)

Sample Name	Sample Depth (mbgs)	Bulk Wet Density*, (g/cm^3)	Bulk Dry Density,* (g/cm^3)	Water Content* (%)
IG_BH01_BD001	150.03 – 150.20	2.660	2.654	0.2106
IG_BH01_BD002	200.84 – 201.05	2.692	2.687	0.1560
IG_BH01_BD003	249.02 – 249.18	2.655	2.649	0.2088
IG_BH01_BD004	297.84 – 297.98	2.681	2.678	0.1086
IG_BH01_BD005	327.21 – 327.32	2.660	2.653	0.2317
IG_BH01_BD006	388.36 – 388.49	2.667	2.661	0.2390
IG_BH01_BD007	405.16 – 405.28	2.653	2.647	0.2056
IG_BH01_BD008	447.10 – 447.20	2.664	2.661	0.1464
IG_BH01_BD009	464.62 – 464.73	2.668	2.663	0.1877
IG_BH01_BD010	504.42 – 504.54	2.677	2.672	0.1906
IG_BH01_BD011	526.89 – 527.04	2.677	2.672	0.1543
IG_BH01_BD012	553.09 – 553.19	2.673	2.669	0.1679
IG_BH01_BD013	585.70 – 585.79	2.672	2.668	0.1381
IG_BH01_BD014	620.67 – 620.83	2.675	2.672	0.1429
IG_BH01_BD015	666.68 – 666.80	2.676	2.673	0.1327
IG_BH01_BD016	705.47 – 705.59	2.684	2.680	0.1321
IG_BH01_BD017	768.81 – 768.93	2.688	2.685	0.1214
IG_BH01_BD018	800.53 – 800.63	2.698	2.694	0.1570
IG_BH01_BD019	869.88 – 870.02	2.703	2.699	0.1443
IG_BH01_BD020	900.00 – 900.11	2.691	2.686	0.1759

mbgs = metres below ground surface
*Average of values obtained for two specimens cut from the core sample. The same specimens were used for water content and density determination.

3.2 Total Porosity

The results of the total porosity determination, including the measured values of dry density, specific gravity, and water content are summarized in Table 4. Laboratory records are provided in Appendix B.

Table 4: Summary of total porosity determination results

Sample Name	Sample Depth (mbgs)	Water Content * (%)	Wet Density* (g/cm^3)	Dry Density* (g/cm^3)	Specific Gravity*** (-)	Calculated Total Porosity* (-)
IG_BH01_TP001	201.05 – 202.21	0.1580**	2.684	2.680	2.70	0.006
IG_BH01_TP002	297.98 – 298.11	0.1413	2.660	2.656	2.69	0.011
IG_BH01_TP003	405.28 – 405.40	0.2609	2.647	2.640	2.68	0.013
IG_BH01_TP004	446.86 – 446.98	0.1649	2.668	2.664	2.69	0.008
IG_BH01_TP005	504.54 – 504.64	0.1656	2.645	2.640	2.68	0.013
IG_BH01_TP006	553.49 – 553.59	0.1813	2.670	2.665	2.69	0.008
IG_BH01_TP007	585.79 – 585.90	0.1497**	2.662	2.658	2.68	0.007
IG_BH01_TP008	705.92 – 706.03	0.1583**	2.667	2.662	2.69	0.009
IG_BH01_TP009	800.94 – 801.05	0.1334	2.694	2.690	2.70	0.002
IG_BH01_TP010	900.43 – 900.55	0.1840	2.679	2.674	2.70	0.008

mbgs = metres below ground surface
*Average of values obtained for two specimens cut from the core sample. The same specimens were used for water content and density determination, where possible.
**natural water content used from adjacent specimen from the same sample, due to inability to remove all wax from specimen used to determine density
*** Average of values obtained for three specimens cut from the core sample.

3.3 Effective Porosity

Mercury intrusion (effective) porosity could not be determined. For the initial tests attempted on one core sample (IG_BH01_MP001), sub-samples displayed very low porosities, which caused the intrusion of mercury to fall below the instrument manufacturer's minimum recommendation. Any attempt to quantify the effective porosity would have resulted in a deviation from ASTM D4404-10, as well as the manufacturer's recommendation. This testing was not further pursued.

3.4 Diffusion Coefficient

The theoretical fitting of the diffusion test data is presented in Appendix C (Figures 1 to 10). The best-fit (by eye) diffusion coefficient (D) values (at 23°C) are summarized in Table 5. Maximum and minimum diffusion coefficients for each sample based on theoretical fitting are presented in Figures 1 to 10, Appendix C.

Table 5: Best-fit diffusion coefficient (D) values (at 23°C)

Sample Name	Sample Depth (mbgs)	Total Porosity* (-)	Chloride Diffusion Coefficient ($x10^{-11}$ m^2/s)	Iodide Diffusion Coefficient ($x10^{-11}$ m^2/s)	Lithium Diffusion Coefficient ($x10^{-11}$ m^2/s)	Tritium Diffusion Coefficient ($x10^{-11}$ m^2/s)
IG_BH01_ED002	202.03 – 202.35	0.006	2.0	3.0	2.2	9.0
IG_BH01_ED003	297.48 – 297.84	0.011	3.8	3.5	4.0	7.5
IG_BH01_ED005	405.52 – 405.83	0.013	3.7	3.7	3.3	6.0
IG_BH01_ED006	446.36 – 446.68	0.008	7.0	6.0	6.1	10
IG_BH01_ED008	504.11 – 504.42	0.013	3.4	3.8	3.3	5.5
IG_BH01_ED010	553.19 – 553.49	0.008	2.7	3.5	3.4	4.6
IG_BH01_ED011	586.01 – 586.32	0.007	5.3	6.5	6.0	34
IG_BH01_ED013	705.59 – 705.92	0.009	9.0	9.5	7.5	8.0
IG_BH01_ED014	800.63 – 800.94	0.002	22	24	20	170
IG_BH01_ED016	900.11 – 900.43	0.008	30	32	35	33

mbgs = metres below ground surface
*Total porosity values obtained from the total porosity test samples taken from adjacent depths (see Table 4).

For the majority of the samples examined from IG_BH01 (8 out of 10 samples), the best-fit diffusion coefficients (D) determined for Cl, I, and Li are on the order of 10^{-11} m^2/s; for the two deepest samples (IG_BH01_ED014 and IG_BH01_ED016), the Cl, I and Li diffusion coefficients determined were approximately one order of magnitude higher (Table 5). Similarly, the values of the tritium diffusion coefficients are one to nearly two orders of magnitude higher in these two samples. The reason for these differences is not currently known; no clear macroscopic differences (e.g. alteration, veins/fractures) were observed in photographs of these two core samples used in the experiments (before or after), compared to the samples used in the remaining 8 experiments.

Generally, the diffusion coefficients determined for tritium either agree well, or are slightly higher than, those measured for the dissolved constituents (Cl, I and Li).

The corresponding effective diffusion coefficient values (D_e) calculated as total porosity multiplied by the diffusion coefficient (D) are summarized in Table 6.

Table 6: Calculated effective diffusion coefficient (D_e) values (at 23°C)

Sample Name	Sample Depth (mbgs)	Chloride Effective Diffusion Coefficient ($x10^{-13}$ m^2/s)	Iodide Effective Diffusion Coefficient ($x10^{-13}$ m^2/s)	Lithium Effective Diffusion Coefficient ($x10^{-13}$ m^2/s)	Tritium Effective Diffusion Coefficient ($x10^{-13}$ m^2/s)
IG_BH01_ED002	202.03 – 202.35	1.2	1.8	1.3	5.4
IG_BH01_ED003	297.48 – 297.84	4.2	3.9	4.4	8.3

Sample Name	Sample Depth (mbgs)	Chloride Effective Diffusion Coefficient ($x10^{-13}$ m^2/s)	Iodide Effective Diffusion Coefficient ($x10^{-13}$ m^2/s)	Lithium Effective Diffusion Coefficient ($x10^{-13}$ m^2/s)	Tritium Effective Diffusion Coefficient ($x10^{-13}$ m^2/s)
IG_BH01_ED005	405.52 – 405.83	4.8	4.8	4.3	7.8
IG_BH01_ED006	446.36 – 446.68	5.6	4.8	4.9	8.0
IG_BH01_ED008	504.11 – 504.42	4.4	4.9	4.3	7.2
IG_BH01_ED010	553.19 – 553.49	2.2	2.8	2.7	3.7
IG_BH01_ED011	586.01 – 586.32	3.7	4.6	4.2	24
IG_BH01_ED013	705.59 – 705.92	8.1	8.6	6.8	7.2
IG_BH01_ED014	800.63 – 800.94	4.4	4.8	4.0	34
IG_BH01_ED016	900.11 – 900.43	24	26	28	26

The results of the separate control tests for the salts and tritium using a polyethylene disk instead of a rock core specimen are presented in Appendix C (Figure 11). The salt control test (i.e. for chloride, iodide and lithium), did not show any consistent trend of increasing concentrations in the collector solution over the 392 day testing period. This supports that migration of the salts across the specimen via diffusion through the rubber tubing is not controlling the trends noted in the actual rock core diffusion tests. For the tritium control test, the results show no consistent increasing trend for the first half of the control test (approximately 150 days) followed by a steady / sharp increasing trend over the second half (150 – 320 days). The sharp increasing trend for this control test after 150 days is not consistent with the trends noted for the actual rock core tritium diffusion tests and for this reason is not considered representative. The cause of the increasing trend is unknown, but may be related to a slight movement of the polyethylene disk during handling of the cell and consequently the formation of a migration pathway along the disk / rubber tubing interface. Such movement is more likely to occur in the control test than in the actual rock core tests due to the smoother perimeter surface of the disk compared to the rock core specimen.

3.5 Permeability (Hydraulic Conductivity)

One sample (IG_BH001_HC001) was analysed for hydraulic conductivity at three different hydraulic gradients (30, 50, and 70) using three different specimens cut from the same sample. The results from the three tests illustrated that the hydraulic conductivity of the specimens was very low and likely below the detection limit for the method (~10^{-12} m/s). Consequently, no further testing was performed using this method. Laboratory results are provided in Appendix D.

4.0 DATA QUALITY

All samples sent to the laboratory were accounted for and the raw testing data was checked by the laboratory manager and senior engineering staff. The results were also checked against expected values and deemed

reasonable. For the diffusion tests, photographs of the samples taken before and after testing were compared to confirm that the sample did not break apart and/or fissure during the test.

Although the results of the tests are very consistent, the number of specimens tested for a given core sample (e.g. two specimens for bulk density and porosity and one specimen for diffusion coefficient) is too small to establish statistical data and confidence limits.

5.0 REFERENCES

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APPENDIX A

Bulk Density Test Results

GOLDER

BULK DENSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK
ASTM D7263-09 Method A

Borehole Number	IG_BH01		IG_BH01	
Sample ID	IG_BH01_BD001		IG_BH01_BD002	
Depth, m	150.03-150.20		200.84-201.05	
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	247.276	234.275	242.849	243.908
Wet Mass of Rock + Wax in Air, g	252.305	239.914	249.157	250.138
Wet Mass of Rock + Wax in Water, g	154.100	145.850	152.190	152.960
Weight of Wax, g	5.029	5.639	6.308	6.230
Displaced Volume, cm^3	98.471	94.319	97.230	97.441
Displaced Wax, cm^3	5.539	6.210	6.947	6.861
Volume of Rock, cm^3	92.932	88.108	90.282	90.580
Moisture Content, % - ASTM D2216-10	0.2140	0.2071	0.1645	0.1474
Water Temperature ºC	24.0	24.0	24.0	24.0
Density of Water at test temperature, g/cm3	0.99730	0.99730	0.99730	0.99730
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.661	2.659	2.690	2.693
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.655	2.653	2.685	2.689

Project Number	1671632	Tested By	A. Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	
Date Tested	January 30, 2018		

GOLDER

DENSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK
ASTM D7263-09 Method A

Borehole Number		IG_BH01		IG_BH01
Sample ID		IG_BH01_BD003		IG_BH01_BD004
Depth, m		249.02-249.18		297.84-297.98
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	217.449	249.170	225.814	227.115
Wet Mass of Rock + Wax in Air, g	221.093	253.621	231.276	232.470
Wet Mass of Rock + Wax in Water, g	135.430	155.070	141.250	142.100
Weight of Wax, g	3.644	4.451	5.462	5.355
Displaced Volume, cm^3	85.895	98.818	90.270	90.615
Displaced Wax, cm^3	4.013	4.902	6.015	5.898
Volume of Rock, cm^3	81.882	93.916	84.254	84.717
Moisture Content, % - ASTM D2216-10	0.2148	0.2028	0.1095	0.1076
Water Temperature ºC	24.0	24.0	24.0	24.0
Density of Water at test temperature, g/cm3	0.99730	0.99730	0.99730	0.99730
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.656	2.653	2.680	2.681
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.650	2.648	2.677	2.678

Project Number	1671632	Tested By	A. Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	
Date Tested	January 30, 2018		

GOLDER

DENSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK

ASTM D7263-09 Method A

Borehole Number	IG_BH01		IG_BH01	
Sample ID	IG_BH01_BD005		IG_BH01_BD006	
Depth, m	327.21-327.32		388.36-388.49	
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	263.525	204.932	222.831	206.705
Wet Mass of Rock + Wax in Air, g	267.961	208.458	227.995	211.648
Wet Mass of Rock + Wax in Water, g	164.270	127.750	138.980	128.960
Weight of Wax, g	4.436	3.526	5.164	4.943
Displaced Volume, cm^3	103.977	80.931	89.260	82.916
Displaced Wax, cm^3	4.885	3.883	5.687	5.444
Volume of Rock, cm^3	99.091	77.047	83.573	77.472
Moisture Content, % - ASTM D2216-10	0.2228	0.2406	0.2370	0.2409
Water Temperature ºC	24.2	24.2	24.2	24.2
Density of Water at test temperature, g/cm3	0.99725	0.99725	0.99725	0.99725
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.659	2.660	2.666	2.668
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.653	2.653	2.660	2.662

Project Number	1671632	Tested By	A.Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	
Date Tested	January 29, 2018		

GOLDER

DENSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK

ASTM D7263-09 Method A

Borehole Number	IG_BH01		IG_BH01	
Sample ID	IG_BH01_BD007		IG_BH_BD008	
Depth, m	405.16-405.28		447.10-447.20	
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	237.595	202.084	257.409	234.571
Wet Mass of Rock + Wax in Air, g	242.024	205.984	262.287	239.451
Wet Mass of Rock + Wax in Water, g	147.840	125.730	160.540	146.330
Weight of Wax, g	4.429	3.900	4.878	4.880
Displaced Volume, cm^3	94.444	80.475	102.028	93.378
Displaced Wax, cm^3	4.878	4.295	5.372	5.374
Volume of Rock, cm^3	89.566	76.180	96.655	88.003
Moisture Content, % - ASTM D2216-10	0.2008	0.2103	0.1502	0.1426
Water Temperature ºC	24.2	24.2	24.2	24.2
Density of Water at test temperature, g/cm3	0.99725	0.99725	0.99725	0.99725
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.653	2.653	2.663	2.665
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.647	2.647	2.659	2.662

Project Number	1671632	Tested By	A. Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	
Date Tested	January 29, 2018		

GOLDER

DENSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK
ASTM D7263-09 Method A

Borehole Number	IG_BH01		IG_BH01	
Sample ID	IG_BH01_BD009		IG_BH01_BD010	
Depth, m	464.62-464.73		504.42-504.54	
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	248.080	251.089	238.267	255.691
Wet Mass of Rock + Wax in Air, g	253.271	256.513	241.959	259.961
Wet Mass of Rock + Wax in Water, g	154.820	156.720	149.100	160.050
Weight of Wax, g	5.191	5.424	3.692	4.270
Displaced Volume, cm^3	98.722	100.068	93.104	100.174
Displaced Wax, cm^3	5.717	5.974	4.066	4.703
Volume of Rock, cm^3	93.006	94.095	89.038	95.472
Moisture Content, % - ASTM D2216-10	0.1846	0.1908	0.2018	0.1794
Water Temperature ºC	24.2	24.2	23.7	23.7
Density of Water at test temperature, g/cm3	0.99725	0.99725	0.99737	0.99737
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.667	2.668	2.676	2.678
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.662	2.663	2.671	2.673

Project Number	1671632	Tested By	A. Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	
Date Tested	February 1, 2018		

GOLDER

DENSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK

ASTM D7263-09 Method A

Borehole Number	IG_BH01		IG_BH01	
Sample ID	IG_BH01_BD011		IG_BH01_BD012	
Depth, m	526.89-527.04		553.09-553.19	
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	234.742	240.384	255.278	233.331
Wet Mass of Rock + Wax in Air, g	239.214	245.200	260.629	238.625
Wet Mass of Rock + Wax in Water, g	146.780	150.370	159.540	145.730
Weight of Wax, g	4.472	4.816	5.351	5.294
Displaced Volume, cm^3	92.678	95.080	101.356	93.140
Displaced Wax, cm^3	4.925	5.304	5.893	5.830
Volume of Rock, cm^3	87.753	89.776	95.462	87.310
Moisture Content, % - ASTM D2216-10	0.1536	0.1550	0.1727	0.1631
Water Temperature ºC	23.7	23.7	23.7	23.7
Density of Water at test temperature, g/cm3	0.99737	0.99737	0.99737	0.99737
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.675	2.678	2.674	2.672
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.671	2.673	2.670	2.668

Project Number	1671632	Tested By	A. Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	
Date Tested	February 1, 2018		

GOLDER

DENSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK

ASTM D7263-09 Method A

Borehole Number	IG_BH01		IG_BH01	
Sample ID	IG_BH01_BD013		IG_BH01_BD014	
Depth, m	585.70-585.79		620.67-620.83	
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	216.095	216.257	102.325	116.228
Wet Mass of Rock + Wax in Air, g	221.616	221.829	105.936	120.135
Wet Mass of Rock + Wax in Water, g	134.820	135.020	63.840	72.480
Weight of Wax, g	5.521	5.572	3.611	3.907
Displaced Volume, cm^3	87.025	87.038	42.205	47.778
Displaced Wax, cm^3	6.080	6.137	3.977	4.303
Volume of Rock, cm^3	80.944	80.901	38.228	43.475
Moisture Content, % - ASTM D2216-10	0.1335	0.1427	0.1464	0.1393
Water Temperature ºC	23.7	23.7	23.5	23.5
Density of Water at test temperature, g/cm3	0.99737	0.99737	0.99742	0.99742
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.670	2.673	2.677	2.673
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.666	2.669	2.673	2.670

Project Number	1671632	Tested By	A. Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	
Date Tested	January/March, 2018		

GOLDER

DENSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK

ASTM D7263-09 Method A

Borehole Number	IG_BH01		IG_BH01	
Sample ID	IG_BH01_BD015		IG_BH01_BD016	
Depth, m	666.68-666.80		705.47-705.59	
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	109.535	102.647	103.428	113.669
Wet Mass of Rock + Wax in Air, g	113.572	106.689	107.511	117.417
Wet Mass of Rock + Wax in Water, g	68.320	63.980	64.560	71.070
Weight of Wax, g	4.037	4.042	4.083	3.748
Displaced Volume, cm^3	45.369	42.819	43.062	46.467
Displaced Wax, cm^3	4.446	4.452	4.497	4.128
Volume of Rock, cm^3	40.923	38.368	38.565	42.339
Moisture Content, % - ASTM D2216-10	0.1288	0.1365	0.1319	0.1322
Water Temperature ºC	23.5	23.5	23.5	23.5
Density of Water at test temperature, g/cm3	0.99742	0.99742	0.99742	0.99742
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.677	2.675	2.682	2.685
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.673	2.672	2.678	2.681

Project Number	1671632	Tested By	A. Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	
Date Tested	January/March, 2018		

GOLDER

DENSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK

ASTM D7263-09 Method A

Borehole Number	IG_BH01		IG_BH01	
Sample ID	IG_BH01_BD017		IG_BH01_BD018	
Depth, m	768.81-768.93		800.53-800.63	
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	114.668	126.940	241.197	244.636
Wet Mass of Rock + Wax in Air, g	120.065	132.621	245.115	249.129
Wet Mass of Rock + Wax in Water, g	71.580	79.280	151.640	153.760
Weight of Wax, g	5.397	5.681	3.918	4.493
Displaced Volume, cm^3	48.610	53.479	93.721	95.620
Displaced Wax, cm^3	5.944	6.257	4.315	4.948
Volume of Rock, cm^3	42.667	47.222	89.407	90.672
Moisture Content, % - ASTM D2216-10	0.1176	0.1252	0.1694	0.1445
Water Temperature ºC	23.5	23.5	23.7	23.7
Density of Water at test temperature, g/cm3	0.99742	0.99742	0.99737	0.99737
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.688	2.688	2.698	2.698
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.684	2.685	2.693	2.694

Project Number	1671632	Tested By	A. Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	
Date Tested	February/March, 2018		

GOLDER

DENSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK

ASTM D7263-09 Method A

Borehole Number	IG_BH01		IG_BH01	
Sample ID	IG_BH01_BD019		IG_BH01_BD020	
Depth, m	869.88-870.02		900.00-900.11	
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	233.587	241.904	226.895	242.792
Wet Mass of Rock + Wax in Air, g	238.530	247.027	231.347	248.512
Wet Mass of Rock + Wax in Water, g	146.800	152.220	142.300	152.310
Weight of Wax, g	4.943	5.123	4.452	5.720
Displaced Volume, cm^3	91.972	95.057	89.282	96.456
Displaced Wax, cm^3	5.444	5.642	4.903	6.300
Volume of Rock, cm^3	86.528	89.415	84.379	90.156
Moisture Content, % - ASTM D2216-10	0.1556	0.1329	0.1780	0.1737
Water Temperature ºC	23.7	23.7	23.7	23.7
Density of Water at test temperature, g/cm3	0.99737	0.99737	0.99737	0.99737
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.700	2.705	2.689	2.693
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.695	2.702	2.684	2.688

Project Number	1671632	Tested By	A. Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	MM
Date Tested	February 1, 2018		

APPENDIX B

Total Porosity Test Results

GOLDER

TOTAL POROSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK
ASTM D 7263-09 Method A / ASTM D2216-10 / ASTM D854-14

Borehole Number	IG_BH01		IG_BH01	
Sample ID	IG_BH01_TP001		IG_BH01_TP002	
Depth, m	201.05-201.21		297.98-298.11	
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	131.814	165.352	144.302	140.164
Wet Mass of Rock + Wax in Air, g	137.056	172.492	149.143	147.036
Wet Mass of Rock + Wax in Water, g	82.330	103.150	89.810	86.830
Weight of Wax, g	5.242	7.140	4.841	6.872
Density of paraffin, g/cm^3	0.908	0.908	0.908	0.908
Displaced Wax, cm^3	5.773	7.863	5.331	7.568
Volume of Rock, cm^3	49.094	61.658	54.155	52.793
Specific Gravity, ASTM D854-14	2.70	2.70	2.69	2.69
Volume of Solids, cm^3	48.830	61.255	53.662	52.128
Volume of Voids, cm^3	0.264	0.403	0.493	0.666
Total Porosity, calculated*	0.005	0.007	0.009	0.013
Moisture Content, % - ASTM D2216-10	0.1580	0.1580	0.1455	0.1370
Water Temperature ºC	23.5	23.5	23.5	23.5
Density of Water at test temperature, g/cm3	0.99742	0.99742	0.99742	0.99742
Density of Water at 20°C, g/cm3	0.99821	0.99821	0.99821	0.99821
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.685	2.682	2.665	2.655
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.681	2.678	2.661	2.651

$$Total\ Porosity = 1 - \left(\frac{Saturated\ Bulk\ Density}{Specific\ Gravity\ (1 + Moisture\ Content) x (Density\ of\ Water\ at\ 20℃)}\right)$$

Project Number	1671632	Tested By	A.Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	
Date Tested	January/March, 2018		

GOLDER

TOTAL POROSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK
ASTM D 7263-09 Method A / ASTM D2216-10 / ASTM D854-14

Borehole Number		IG_BH01		IG_BH01
Sample ID		IG_BH01_TP003		IG_BH01_TP004
Depth, m		405.28-405.40		446.86-446.98
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	209.533	219.263	235.634	228.237
Wet Mass of Rock + Wax in Air, g	215.566	225.162	246.252	240.957
Wet Mass of Rock + Wax in Water, g	130.110	135.960	146.440	141.740
Weight of Wax, g	6.033	5.899	10.618	12.720
Density of paraffin, g/cm^3	0.908	0.908	0.908	0.908
Displaced Wax, cm^3	6.644	6.497	11.694	14.009
Volume of Rock, cm^3	79.052	82.956	88.388	85.477
Specific Gravity, ASTM D854-14	2.68	2.68	2.69	2.69
Volume of Solids, cm^3	78.156	81.710	87.597	84.871
Volume of Voids, cm^3	0.895	1.245	0.792	0.606
Total Porosity, calculated*	0.011	0.015	0.009	0.007
Moisture Content, % - ASTM D2216-10	0.2148	0.3069	0.1788	0.1509
Water Temperature ºC	24.4	24.4	24.0	24.0
Density of Water at test temperature, g/cm3	0.99720	0.99720	0.99730	0.99730
Density of Water at 20°C, g/cm3	0.99821	0.99821	0.99821	0.99821
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.651	2.643	2.666	2.670
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.645	2.635	2.661	2.666

$$Total\ Porosity = 1 - \left(\frac{Saturated\ Bulk\ Density}{Specific\ Gravity\ (1 + Moisture\ Content) x (Density\ of\ Water\ at\ 20℃)}\right)$$

Project Number	1671632	Tested By	A.Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	
Date Tested	January, 2018		

GOLDER

TOTAL POROSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK
ASTM D 7263-09 Method A / ASTM D2216-10 / ASTM D854-14

Borehole Number		IG_BH01		IG_BH01
Sample ID		IG_BH01_TP005		IG_BH01_TP006
Depth, m		504.54-504.64		553.49-553.59
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	260.241	249.690	141.341	156.928
Wet Mass of Rock + Wax in Air, g	278.305	265.913	147.418	164.830
Wet Mass of Rock + Wax in Water, g	160.530	153.720	88.030	97.410
Weight of Wax, g	18.064	16.223	6.077	7.902
Density of paraffin, g/cm^3	0.908	0.908	0.908	0.908
Displaced Wax, cm^3	19.894	17.867	6.693	8.703
Volume of Rock, cm^3	98.200	94.630	52.849	58.892
Specific Gravity, ASTM D854-14	2.68	2.68	2.69	2.69
Volume of Solids, cm^3	97.113	93.186	52.550	58.327
Volume of Voids, cm^3	1.087	1.444	0.299	0.564
Total Porosity, calculated*	0.011	0.015	0.006	0.010
Moisture Content, % - ASTM D2216-10	0.1712	0.1600	0.1656	0.1969
Water Temperature ºC	24.0	24.0	23.5	23.5
Density of Water at test temperature, g/cm3	0.99730	0.99730	0.99742	0.99742
Density of Water at 20°C, g/cm3	0.99821	0.99821	0.99821	0.99821
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.650	2.639	2.674	2.665
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.646	2.634	2.670	2.659

$$Total\ Porosity = 1 - \left(\frac{Saturated\ Bulk\ Density}{Specific\ Gravity\ (1 + Moisture\ Content) x (Density\ of\ Water\ at\ 20℃)}\right)$$

Project Number	1671632	Tested By	A. Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	
Date Tested	January/March, 2018		

GOLDER

TOTAL POROSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK ASTM D 7263-09 Method A / ASTM D2216-10 / ASTM D854-14				
Borehole Number		IG_BH01		IG_BH01
Sample ID		IG_BH01_TP007		IG_BH01_TP008
Depth, m		585.79-585.90		705.92-706.03
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	137.465	134.415	118.644	146.388
Wet Mass of Rock + Wax in Air, g	143.563	140.658	124.460	154.846
Wet Mass of Rock + Wax in Water, g	85.420	83.380	73.660	90.840
Weight of Wax, g	6.098	6.243	5.816	8.458
Density of paraffin, g/cm^3	0.908	0.908	0.908	0.908
Displaced Wax, cm^3	6.716	6.876	6.405	9.315
Volume of Rock, cm^3	51.578	50.551	44.526	54.857
Specific Gravity, ASTM D854-14	2.68	2.68	2.69	2.69
Volume of Solids, cm^3	51.308	50.170	44.115	54.431
Volume of Voids, cm^3	0.269	0.381	0.411	0.426
Total Porosity, calculated*	0.005	0.008	0.009	0.008
Moisture Content, % - ASTM D2216-10	0.1497	0.1497	0.1583	0.1583
Water Temperature ºC	23.5	23.5	23.5	23.5
Density of Water at test temperature, g/cm3	0.99742	0.99742	0.99742	0.99742
Density of Water at 20°C, g/cm3	0.99821	0.99821	0.99821	0.99821
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.665	2.659	2.665	2.669
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.661	2.655	2.660	2.664

$$Total\ Porosity = 1 - \left(\frac{Saturated\ Bulk\ Density}{Specific\ Gravity\ (1 + Moisture\ Content) x (Density\ of\ Water\ at\ 20℃)}\right)$$

Project Number	1671632	Tested By	A. Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	
Date Tested	January/March, 2018		

GOLDER

TOTAL POROSITY DETERMINATIONS OF IRREGULAR SHAPE SAMPLES - ROCK
ASTM D 7263-09 Method A / ASTM D2216-10 / ASTM D854-14

Borehole Number		IG_BH01		IG_BH01
Sample ID		IG_BH01_TP009		IG_BH01_TP010
Depth, m		800.94-801.05		900.43-900.55
Subsample	A	B	A	B
Wet Mass of Rock in Air, g	222.171	314.411	281.922	235.095
Wet Mass of Rock + Wax in Air, g	229.060	320.891	292.774	245.673
Wet Mass of Rock + Wax in Water, g	139.240	197.350	176.010	146.440
Weight of Wax, g	6.889	6.480	10.852	10.578
Density of paraffin, g/cm^3	0.908	0.908	0.908	0.908
Displaced Wax, cm^3	7.587	7.137	11.952	11.650
Volume of Rock, cm^3	82.465	116.724	105.132	87.855
Specific Gravity, ASTM D854-14	2.70	2.70	2.70	2.70
Volume of Solids, cm^3	82.322	116.504	104.421	87.060
Volume of Voids, cm^3	0.143	0.220	0.711	0.795
Total Porosity, calculated*	0.002	0.002	0.007	0.009
Moisture Content, % - ASTM D2216-10	0.1349	0.1319	0.1741	0.1939
Water Temperature ºC	23.5	23.5	24.1	24.1
Density of Water at test temperature, g/cm3	0.99742	0.99742	0.99727	0.99727
Density of Water at 20°C, g/cm3	0.99821	0.99821	0.99821	0.99821
Saturated Bulk Density, g/cm^3 , ASTM D7263-09	2.694	2.694	2.682	2.676
Dry Bulk Density, g/cm^3 ,ASTM D7263-09	2.690	2.690	2.677	2.671

$$Total\ Porosity = 1 - \left(\frac{Saturated\ Bulk\ Density}{Specific\ Gravity\ (1 + Moisture\ Content) x (Density\ of\ Water\ at\ 20℃)}\right)$$

Project Number	1671632	Tested By	A. Hunwicks
Project Name	NWMO/Drilling/Ignace	Checked By	
Date Tested	January/March, 2018		

APPENDIX C

Diffusion Coefficient Test Results

Appendix C: Table 1
DESCRIPTION OF THE CORE SPECIMENS USED FOR THE DIFFUSION TESTS

Sample No.	Borehole No.	Sample Depth (m)	Sample Description[1]
BH01-ED002	IG_BH01	202.03 - 202.35	Tonalite
BH01-ED003	IG_BH01	297.48 - 297.84	Tonalite
BH01-ED005	IG_BH01	405.52 - 405.83	Tonalite
BH01-ED006	IG_BH01	446.36 - 446.68	Tonalite
BH01-ED008	IG_BH01	504.11 - 504.42	Tonalite
BH01-ED010	IG_BH01	553.19 - 553.49	Tonalite
BH01-ED011	IG_BH01	586.01 - 586.32	Tonalite
BH01-ED013	IG_BH01	705.59 - 705.92	Tonalite
BH01-ED014	IG_BH01	800.63 - 800.94	Tonalite
BH01-ED016	IG_BH01	900.11 - 900.43	Tonalite

Notes:
1. Description provided with sample when shipped from IG_BH01

Appendix C: Table 2
SUMMARY OF TEST RESULTS

Sample No.	Sample Depth (m)	Total[1,2] Porosity (-)		Chloride[3] Matrix Diffusion Coefficient, D @ 23°C (m^2/s)	Iodide[3] Matrix Diffusion Coefficient, D @ 23°C (m^2/s)	Lithium[3] Matrix Diffusion Coefficient, D @ 23°C (m^2/s)	Tritium[3] Matrix Diffusion Coefficient, D @ 23°C (m^2/s)
BH01-ED002	202.03 - 202.35	IG_BH01_TP001	0.006	2.0×10^{-11}	3.0×10^{-11}	2.2×10^{-11}	9.0×10^{-11}
BH01-ED003	297.48 - 297.84	IG_BH01_TP002	0.011	3.8×10^{-11}	3.5×10^{-11}	4.0×10^{-11}	7.5×10^{-11}
BH01-ED005	405.52 - 405.83	IG_BH01_TP003	0.013	3.7×10^{-11}	3.7×10^{-11}	3.3×10^{-11}	6.0×10^{-11}
BH01-ED006	446.36 - 446.68	IG_BH01_TP004	0.008	7.0×10^{-11}	6.0×10^{-11}	6.1×10^{-11}	1.0×10^{-10}
BH01-ED008	504.11 - 504.42	IG_BH01_TP005	0.013	3.4×10^{-11}	3.8×10^{-11}	3.3×10^{-11}	5.5×10^{-11}
BH01-ED010	553.19 - 553.49	IG_BH01_TP006	0.008	2.7×10^{-11}	3.5×10^{-11}	3.4×10^{-11}	4.6×10^{-11}
BH01-ED011	586.01 - 586.32	IG_BH01_TP007	0.007	5.3×10^{-11}	6.5×10^{-11}	6.0×10^{-11}	3.4×10^{-10}
BH01-ED013	705.59 - 705.92	IG_BH01_TP008	0.009	9.0×10^{-11}	9.5×10^{-11}	7.5×10^{-11}	8.0×10^{-11}
BH01-ED014	800.63 - 800.94	IG_BH01_TP009	0.002	2.2×10^{-10}	2.4×10^{-10}	2.0×10^{-10}	1.7×10^{-9}
BH01-ED016	900.11 - 900.43	IG_BH01_TP010	0.008	3.0×10^{-10}	3.2×10^{-10}	3.5×10^{-10}	3.3×10^{-10}

Notes:
1. Total Porosity results taken from adjacent sample
2. ASTM Method D7263
3. Chloride, Iodide, Lithium and Tritium matrix diffusion coefficient (D) obtained at 23°C using the test method described in this report

Appendix C: Table 3

SPECIFIC DETAILS OF THE CHLORIDE, IODIDE, and LITHIUM DIFFUSION TESTS

Parameter	BH01-ED002 202.03-202.35	BH01-ED003 297.48 - 297.84	BH01-ED005 405.52-405.83	BH01-ED006 446.36-446.68	BH01-ED008 504.11-504.42	BH01-ED010 553.19-553.49	BH01-ED011 586.01-586.32	BH01-ED013 705.59-705.92	BH01 - ED014 800.63 - 800.94	BH01 - ED016 900.11 - 900.43
Sample Thickness (cm)	2.3	2.2	2.2	2.4	2.3	2.2	2.1	3.4×10^{-11}	2.2	2.2
Sample Diameter (cm)	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
Cross-Sectional Area of Sample (cm^2) (perpendicular to direction of diffusion)	29.2	29.2	29.2	29.2	28.9	29.3	29.3	29.2	29.0	29.0
Initial Concentration of Chloride in the Source Solution Compartment (mg/L)	7500	8100	7800	7700	7500	8000	7900	7500	8000	8000
Initial Concentration of Iodide in the Source Solution Compartment (mg/L)	980	1000	1000	1000	1000	1000	1000	1100	1000	1000
Initial Concentration of Lithium in the Source Solution Compartment (mg/L)	340	350	400	400	400	400	400	400	430	420
Source Solution Volume (mL)	525.9	559.3	486.7	522.4	483.9	586.3	532.9	534.1	3.2×10^{-10}	3.5×10^{-10}
Equivalent Height of Source Solution, H_s (cm)	18.0	19.2	16.6	17.9	16.7	19.4	18.2	18.3	10.0	16.4
Initial Concentration of Chloride in the Collector Solution Compartment (mg/L)	20	20	20	20	23	23	25	23	23	23
Initial Concentration of Iodide in the Collector Solution Compartment (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Initial Concentration of Lithium in the Collector Solution Compartment (mg/L)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Collector Solution Volume (mL)	169.5	103.8	203.0	149.3	187.9	102.4	109.9	131.4	127.9	163.8
Equivalent Height of Collector Solution, H_c (cm)	5.8	3.6	6.9	5.2	6.5	3.5	3.8	4.5	4.4	5.0
Rock Matrix Total Porosity (-)[1]	0.006	0.011	0.013	0.008	0.013	0.008	0.0065	0.0085	0.002	0.008
Average Rate of Sampling of the Collector Solution, q_c[2] (cm^3/day)	0.38	0.39	0.38	0.38	0.38	0.37	0.38	0.38	0.37	0.37

Notes:

1. Total Porosity results taken from adjacent sample
2. Average rate of sampling of the collector solution (qc) was calculated as the volume of each sample (~6mL) divided by the average frequency of sampling.

Appendix C: Table 4

SPECIFIC DETAILS OF THE TRITIUM DIFFUSION TESTS

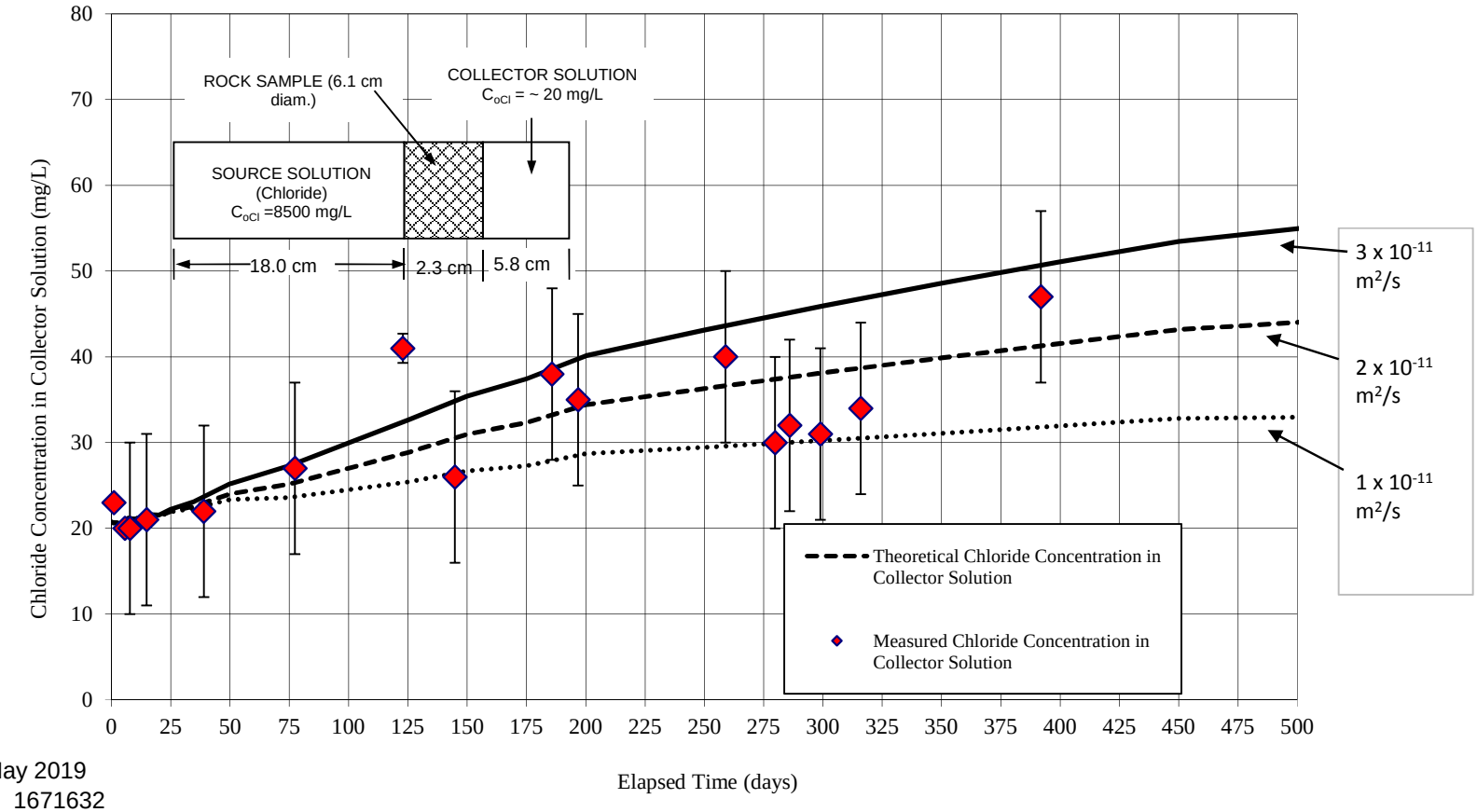
Parameter	BH01-ED002 202.03-202.35	BH01-ED003 297.48 - 297.84	BH01-ED005 405.52-405.83	BH01-ED006 446.36-446.68	BH01-ED008 504.11-504.42	BH01-ED010 553.19-553.49	BH01-ED011 586.01-586.32	BH01-ED013 705.59-705.92	BH01 - ED014 800.63 - 800.94	BH01 - ED016 900.11 - 900.43
Sample Thickness (cm)	1.9	2.1	2.1	2.1	2.2	2.2	2.0	3.4×10^{-11}	2.2	2.2
Sample Diameter (cm)	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
Cross-Sectional Area of Sample (cm^2) (perpendicular to direction of diffusion)	29.2	29.2	29.2	29.2	28.9	29.3	29.3	29.2	29.0	29.0
Initial Concentration of Tritium in the Source Solution Compartment (Bq/L)	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
Source Solution Volume (mL)	478.8	503.7	428.5	428.0	439.7	444.0	481.2	448.2	429.4	415.3
Equivalent Height of Source Solution, H_s (cm)	16.3	17.2	14.8	14.7	15.2	15.2	16.4	15.3	14.8	14.3
Initial Concentration of Tritium in the Collector Solution Compartment (Bq/L)	<15	<15	<15	<15	<15	<15	<15	<15	3.2×10^{-10}	3.5×10^{-10}
Collector Solution Volume (mL)	180.4	150.5	173.0	193.4	202.8	190.1	176.6	188.9	174.2	199.4
Equivalent Height of Collector Solution, H_c (cm)	6.2	5.1	6.0	6.7	7.0	6.5	6.0	6.5	6.0	6.9
Rock Matrix Total Porosity (-)[1]	0.006	0.011	0.013	0.008	0.013	0.008	0.0065	0.0085	0.002	0.008
Average Rate of Sampling of the Collector Solution, q_c[2] (cm^3/day)	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32

Notes:

1. Total Porosity results taken from adjacent sample
2. Average rate of sampling of the collector solution (q_c) was calculated as the volume of each sample (~5mL)

CHLORIDE DIFFUSION TEST RESULTS
BH01 ED002 202.03m - 202.35m

Appendix C
Figure 1A



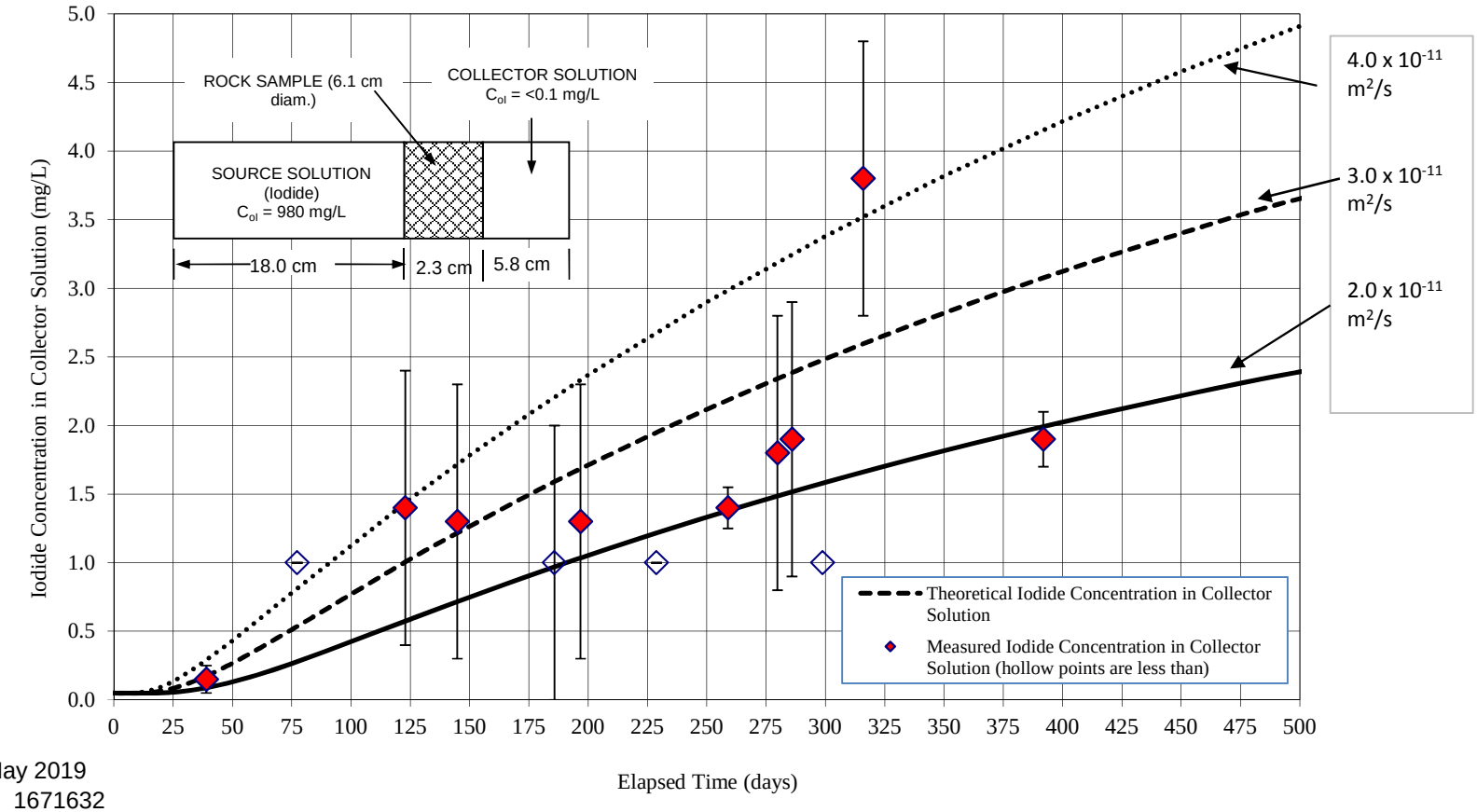
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Project: 1671632
*Hollow data points are below detection limit
**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

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IODIDE DIFFUSION TEST RESULTS
BH01 ED002 202.03m - 202.35m

Appendix C
Figure 1B



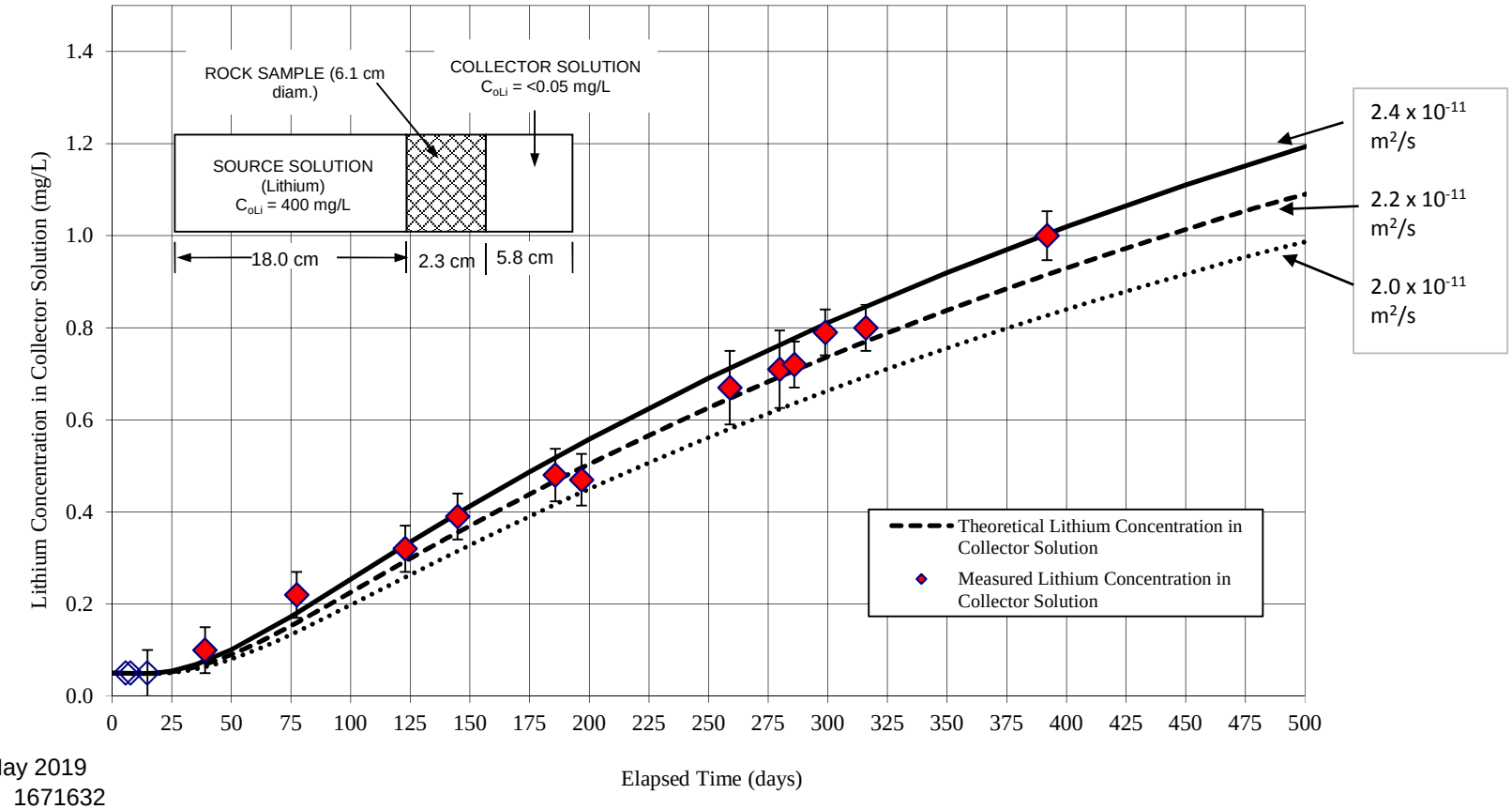
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LITHIUM DIFFUSION TEST RESULTS
BH01 ED002 202.03m - 202.35m

Appendix C
Figure 1C



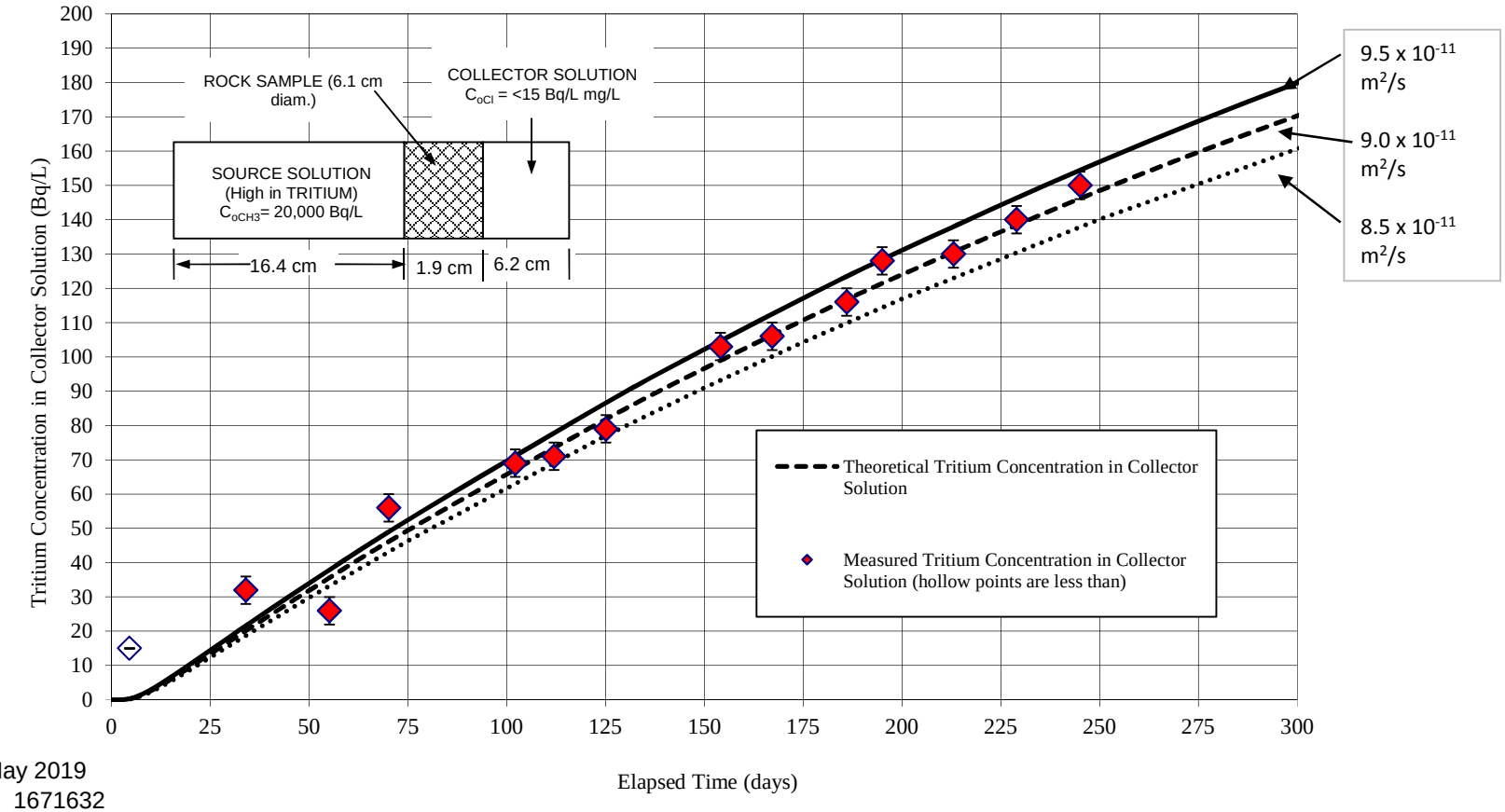
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TRITIUM DIFFUSION TEST RESULTS
BH01 ED002 202.03-202.35

Appendix C
Figure 1D



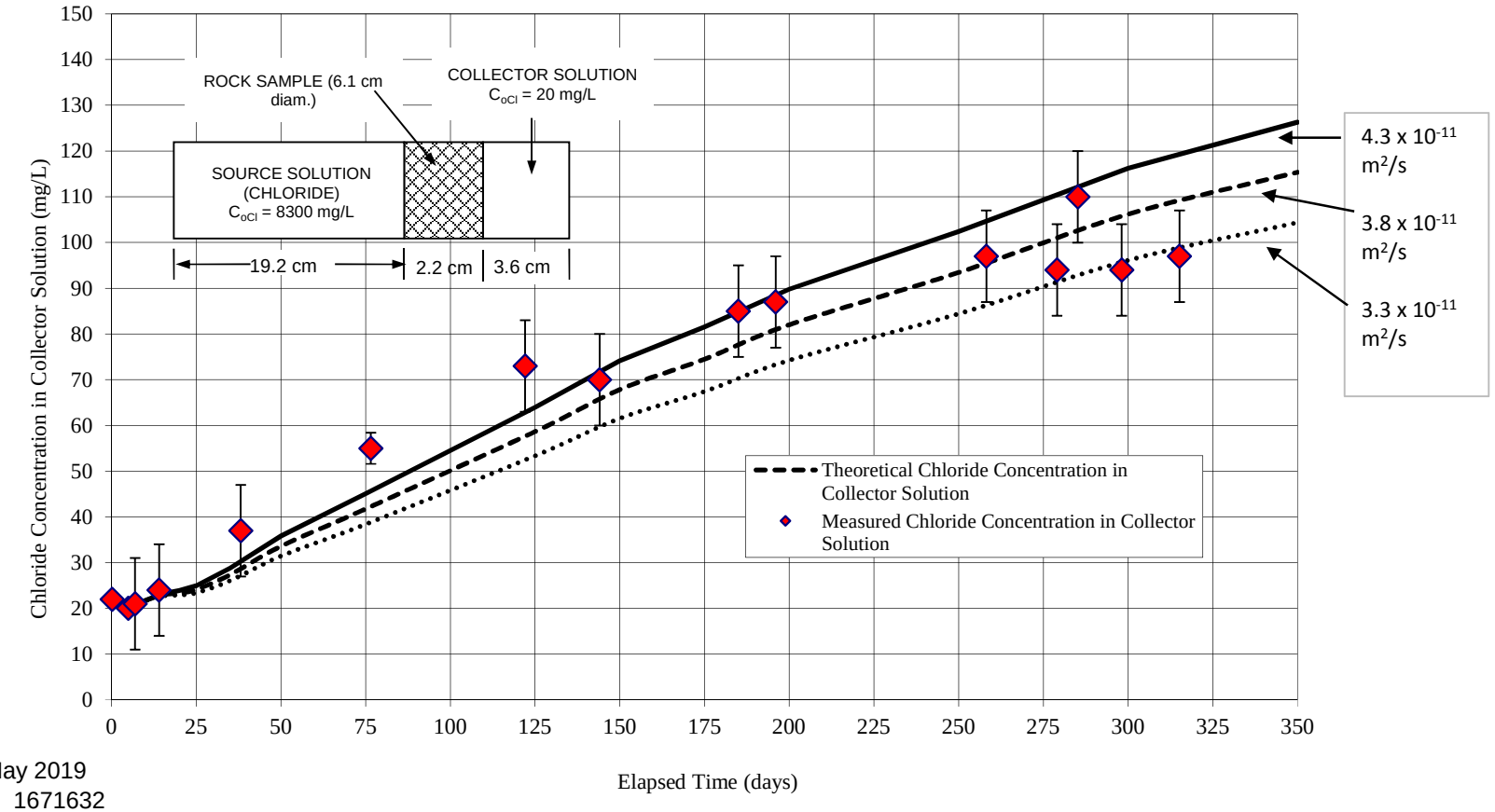
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CHLORIDE DIFFUSION TEST RESULTS
BH01 ED003 297.48 - 297.84

Appendix C
Figure 2A



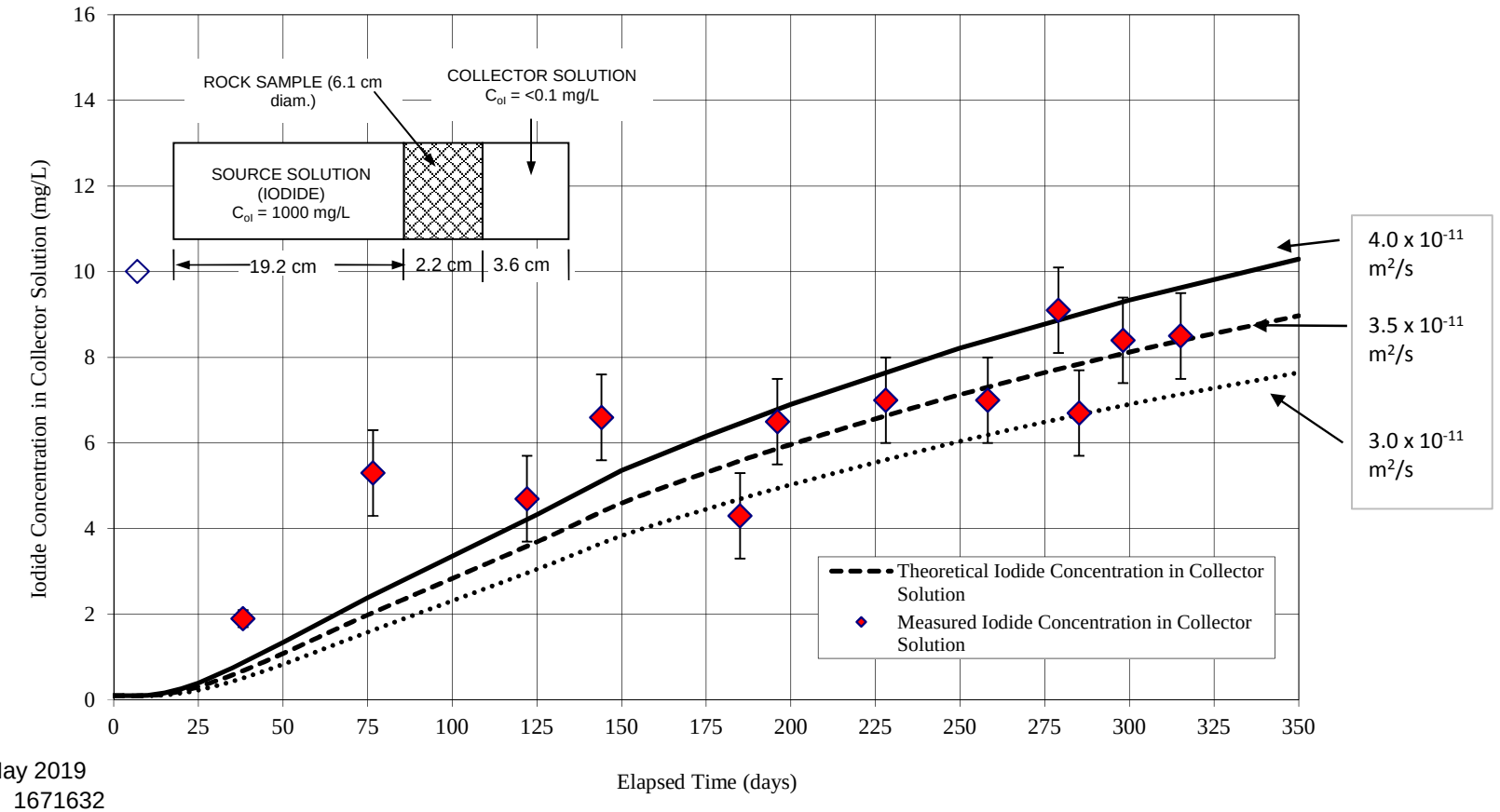
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IODIDE DIFFUSION TEST RESULTS
BH01 ED003 297.48 - 297.84

Appendix C
Figure 2B



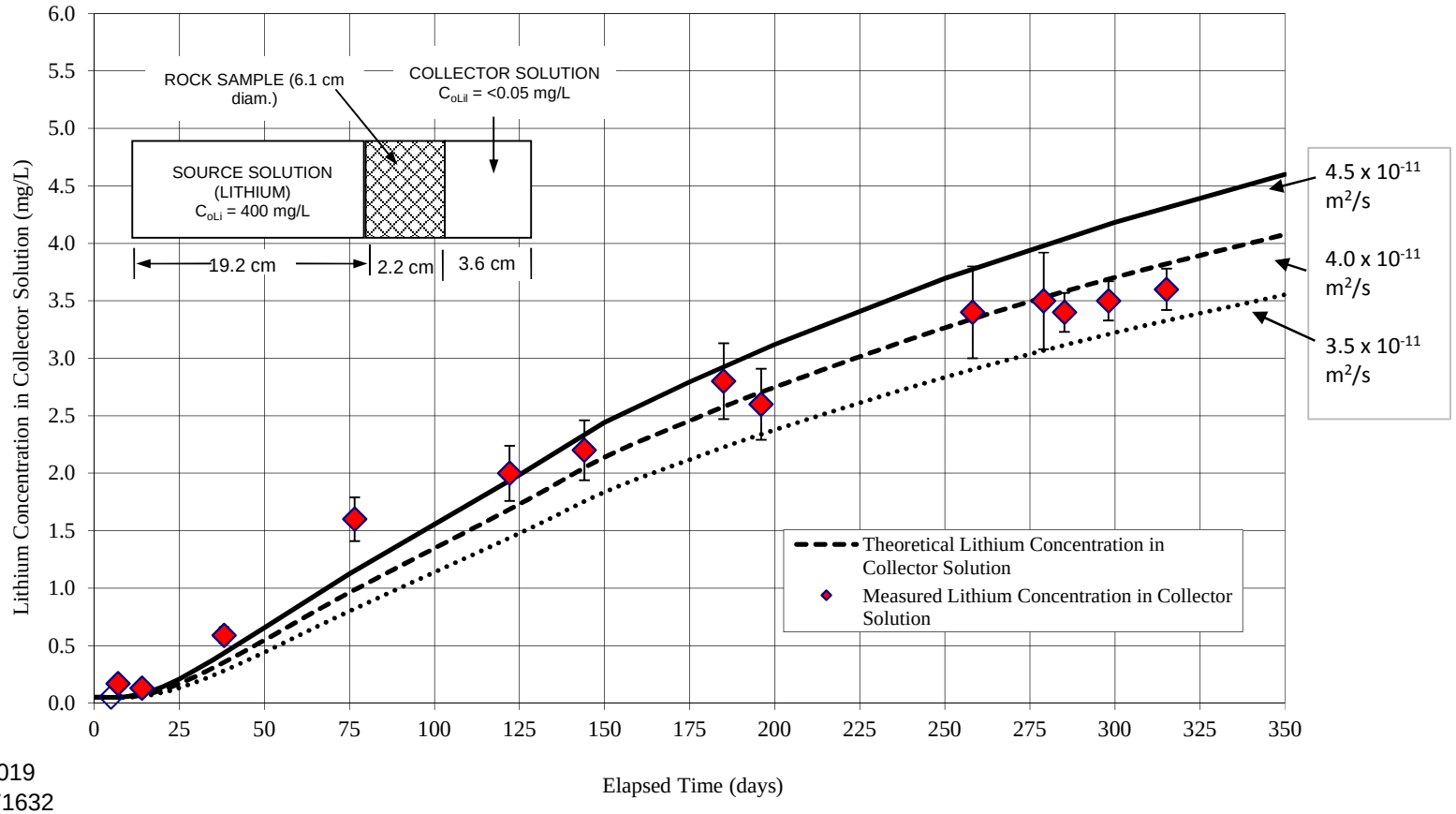
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LITHIUM DIFFUSION TEST RESULTS
BH01 ED003 297.48 - 297.84

Appendix C
Figure 2C



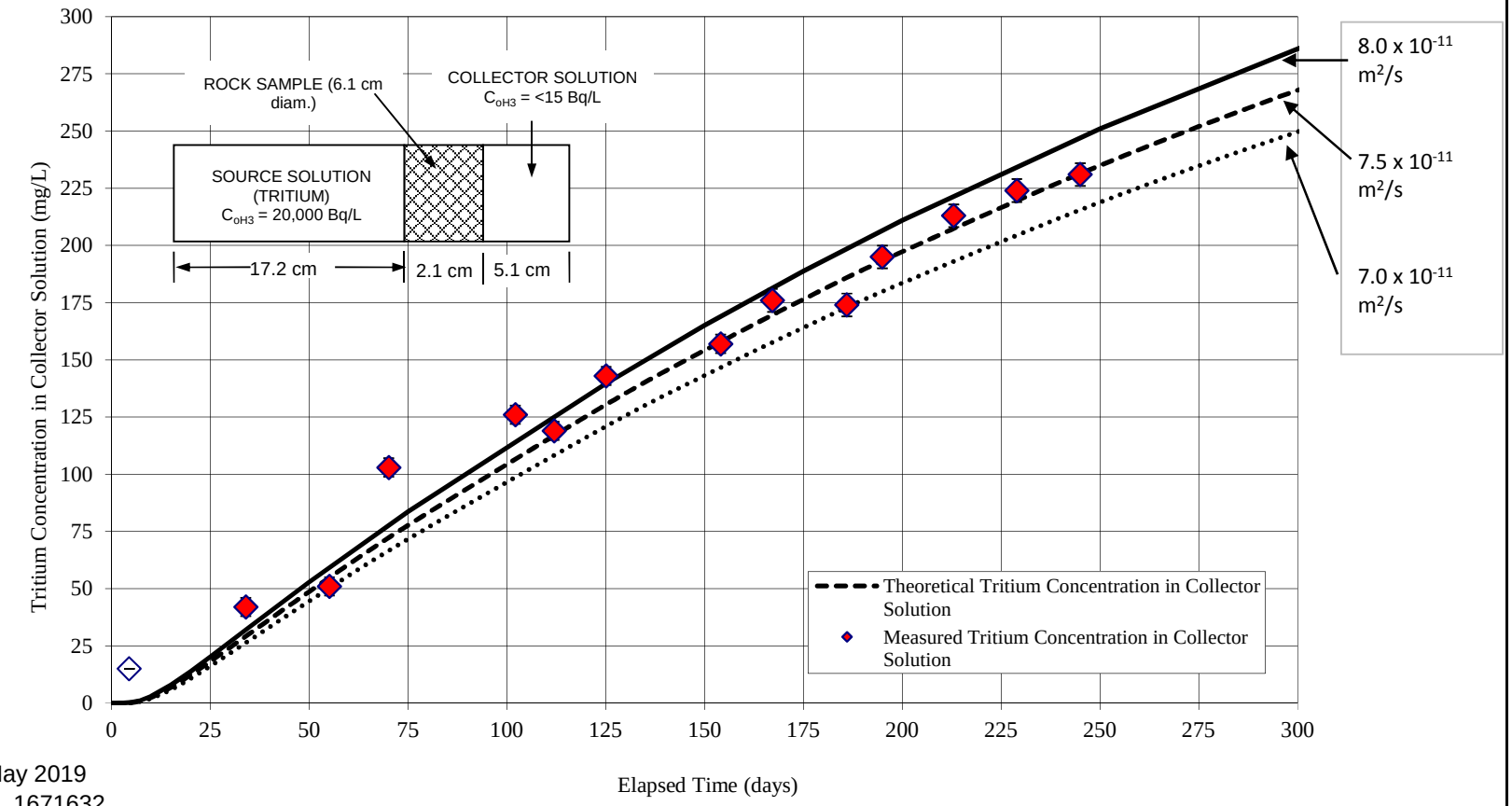
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TRITIUM DIFFUSION TEST RESULTS
BH01 ED003 297.48 - 297.84

Appendix C
Figure 2D



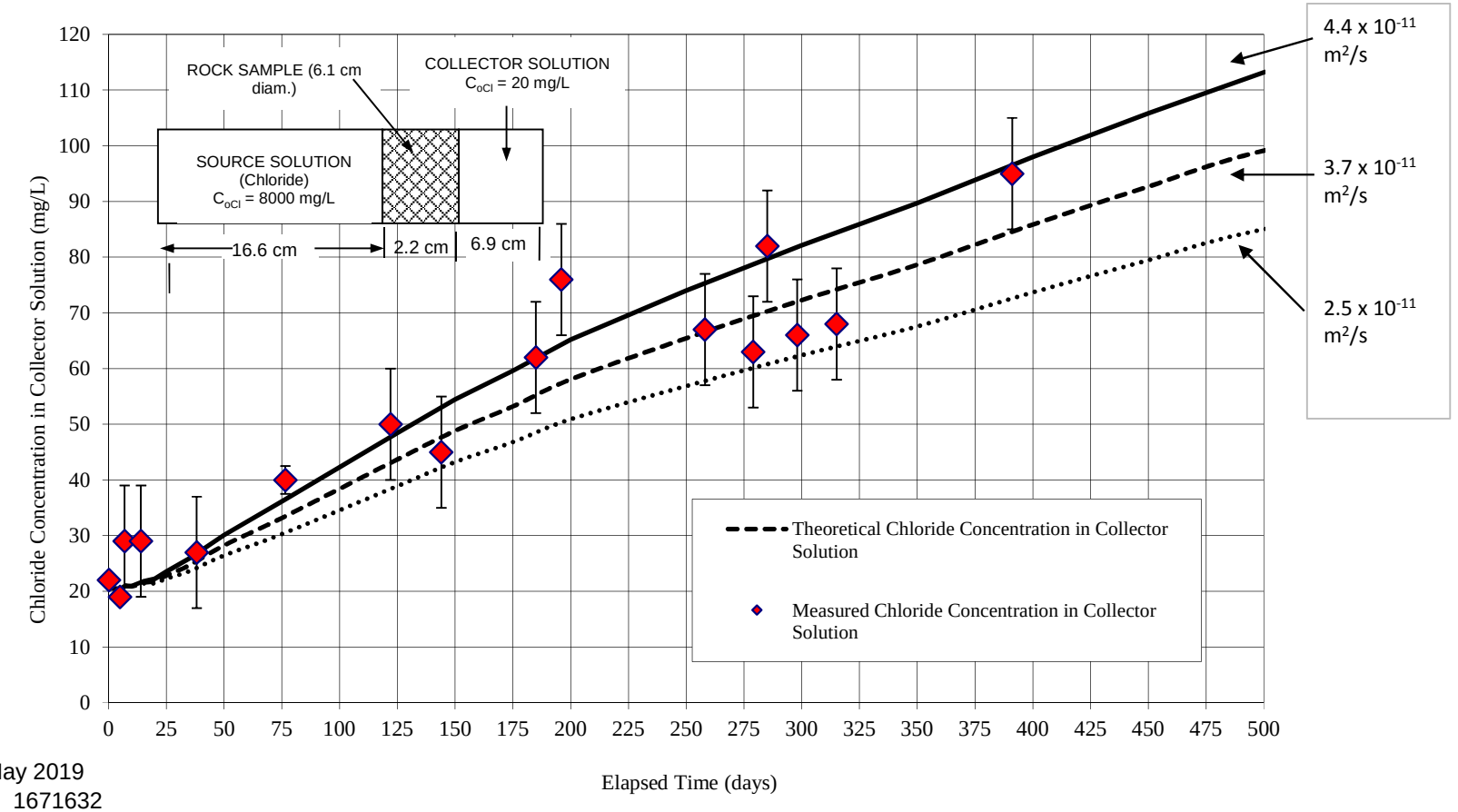
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CHLORIDE DIFFUSION TEST RESULTS
BH01 ED005 405.52m - 405.83m

Appendix C
Figure 3A



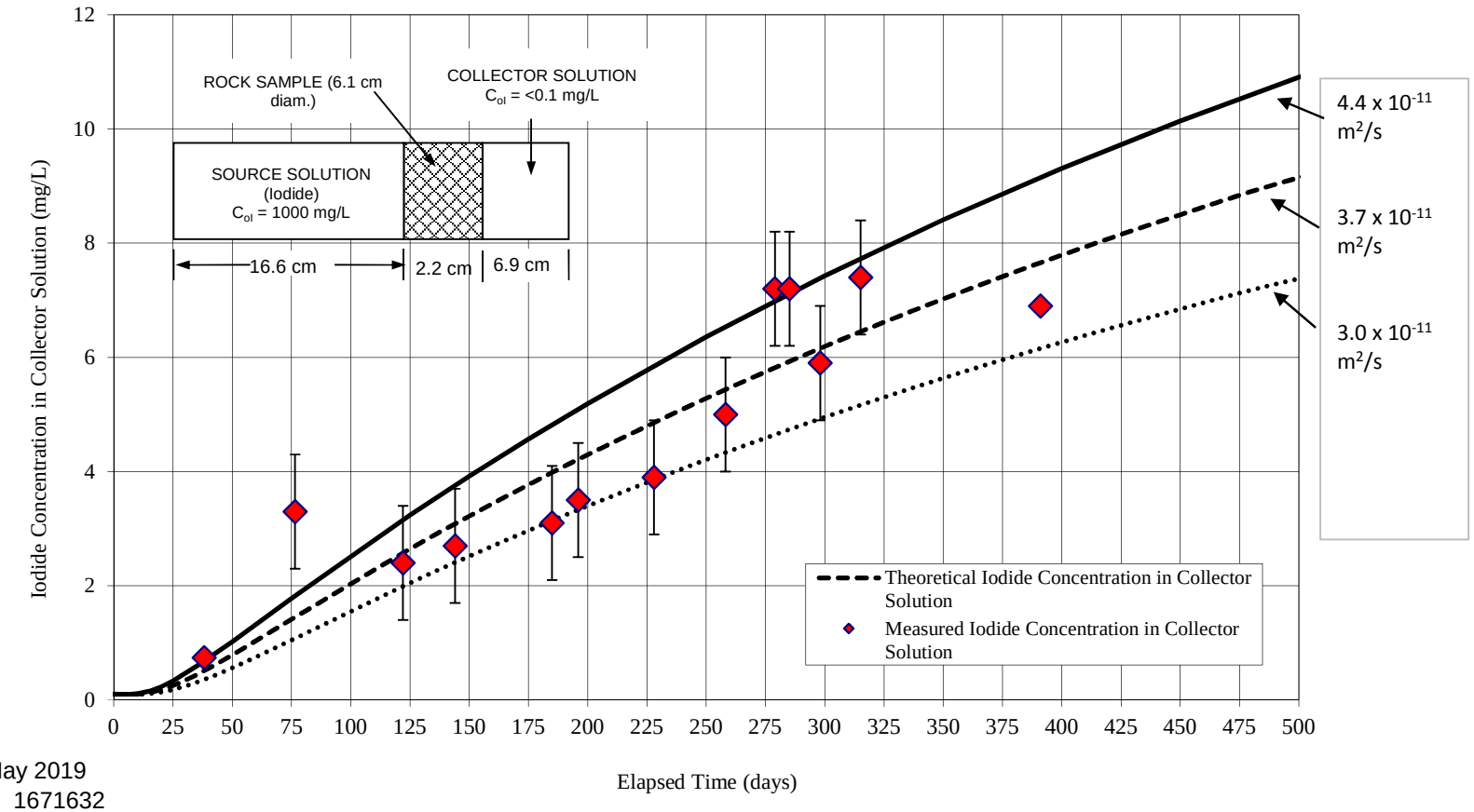
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IODIDE DIFFUSION TEST RESULTS
BH01 ED005 405.52m - 405.83m

Appendix C
Figure 3B



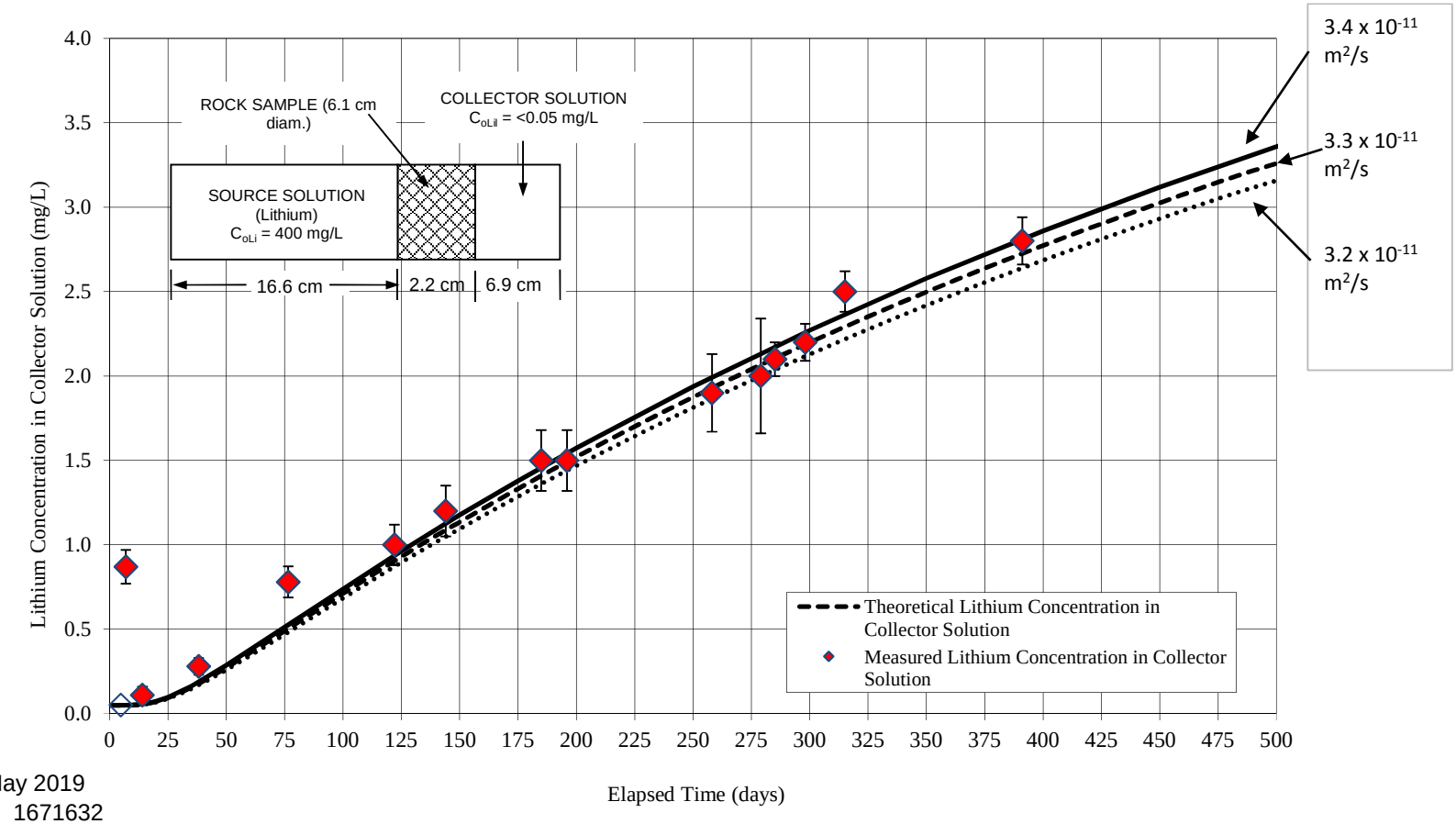
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LITHIUM DIFFUSION TEST RESULTS
BH01 ED005 405.52m - 405.83m

Appendix C
Figure 3C



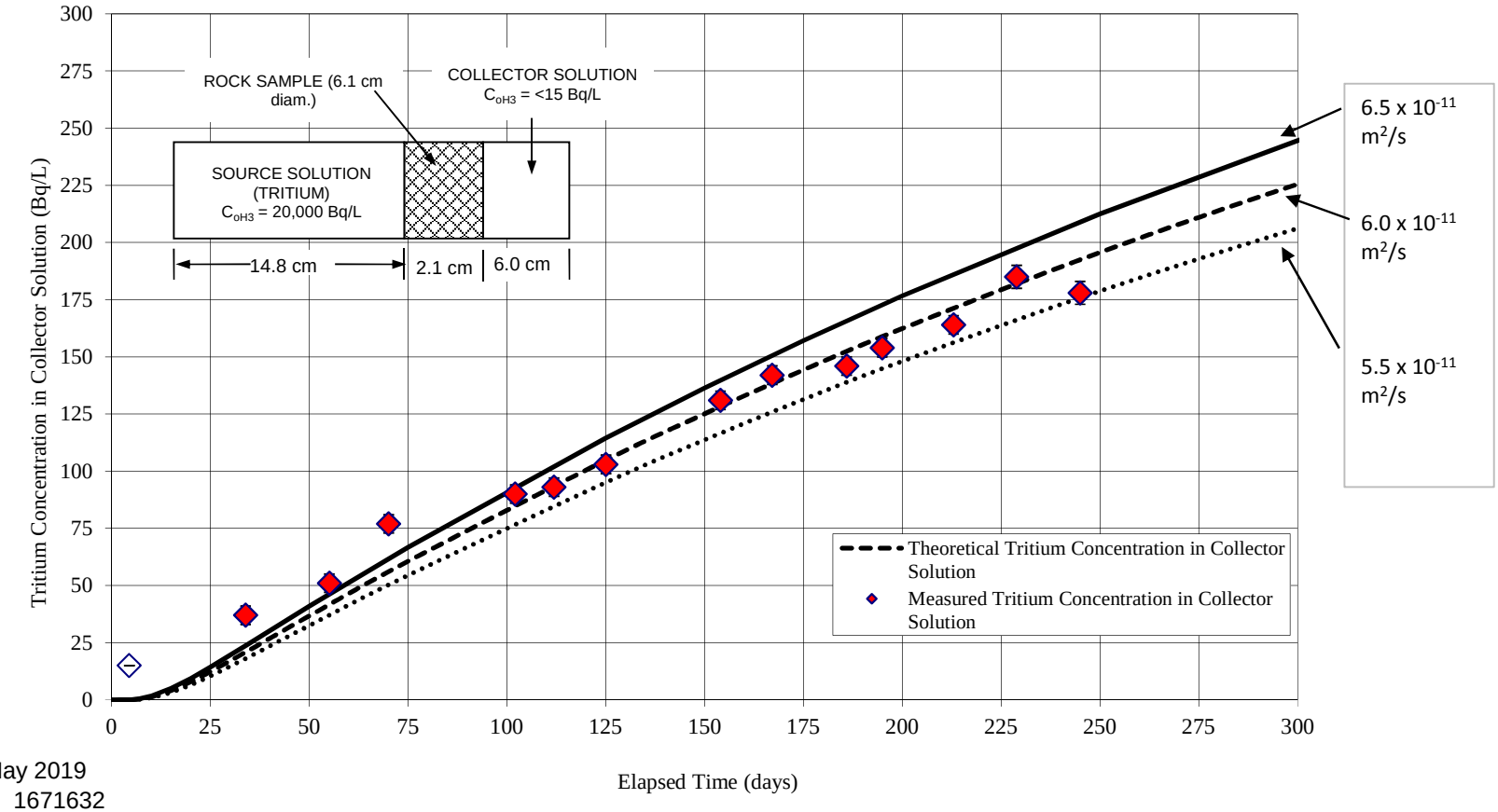
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TRITIUM DIFFUSION TEST RESULTS
BH01 ED005 405.52 - 405.83

Appendix C
Figure 3D



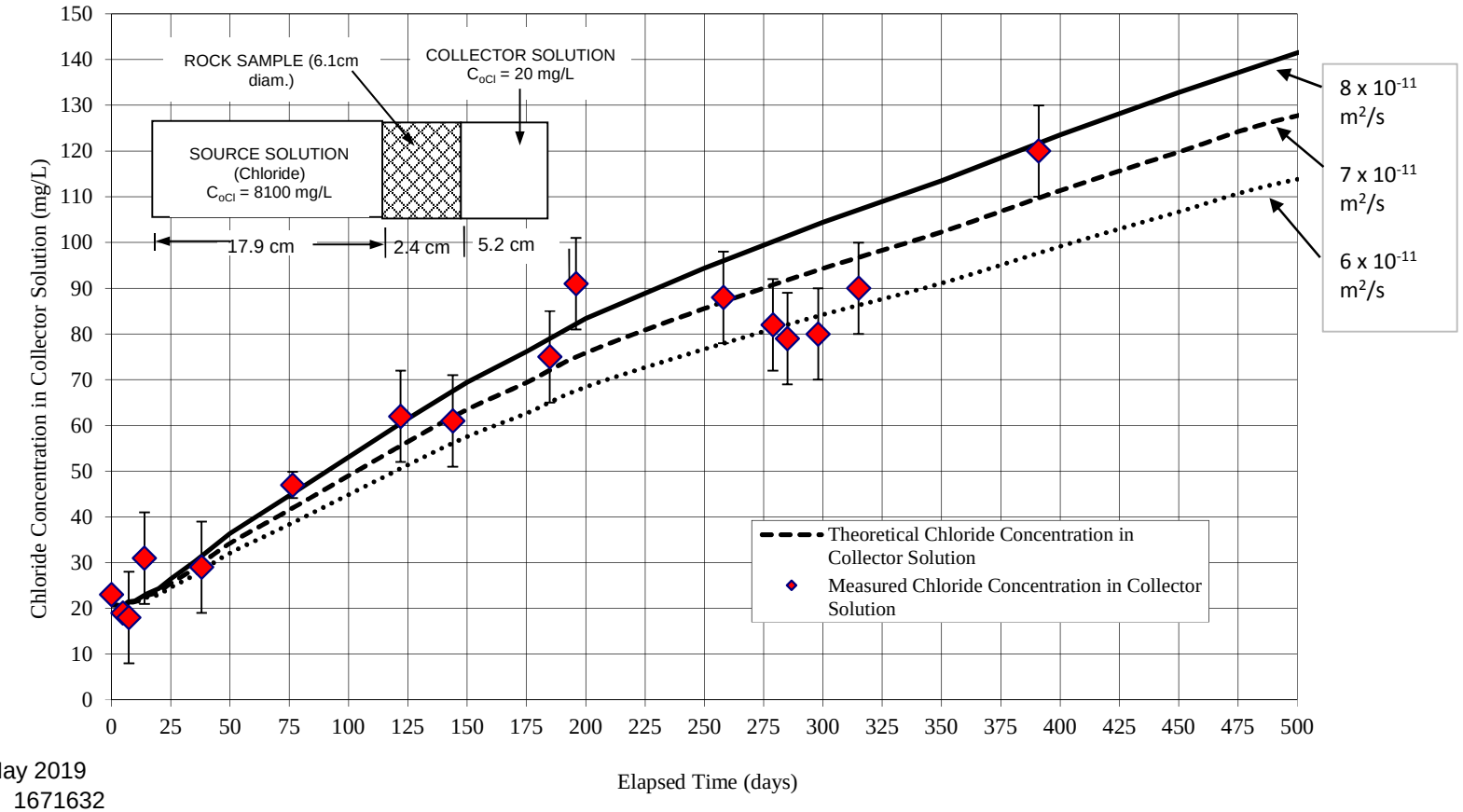
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CHLORIDE DIFFUSION TEST RESULTS
BH01 ED006 446.36m - 446.68m

Appendix C
Figure 4A



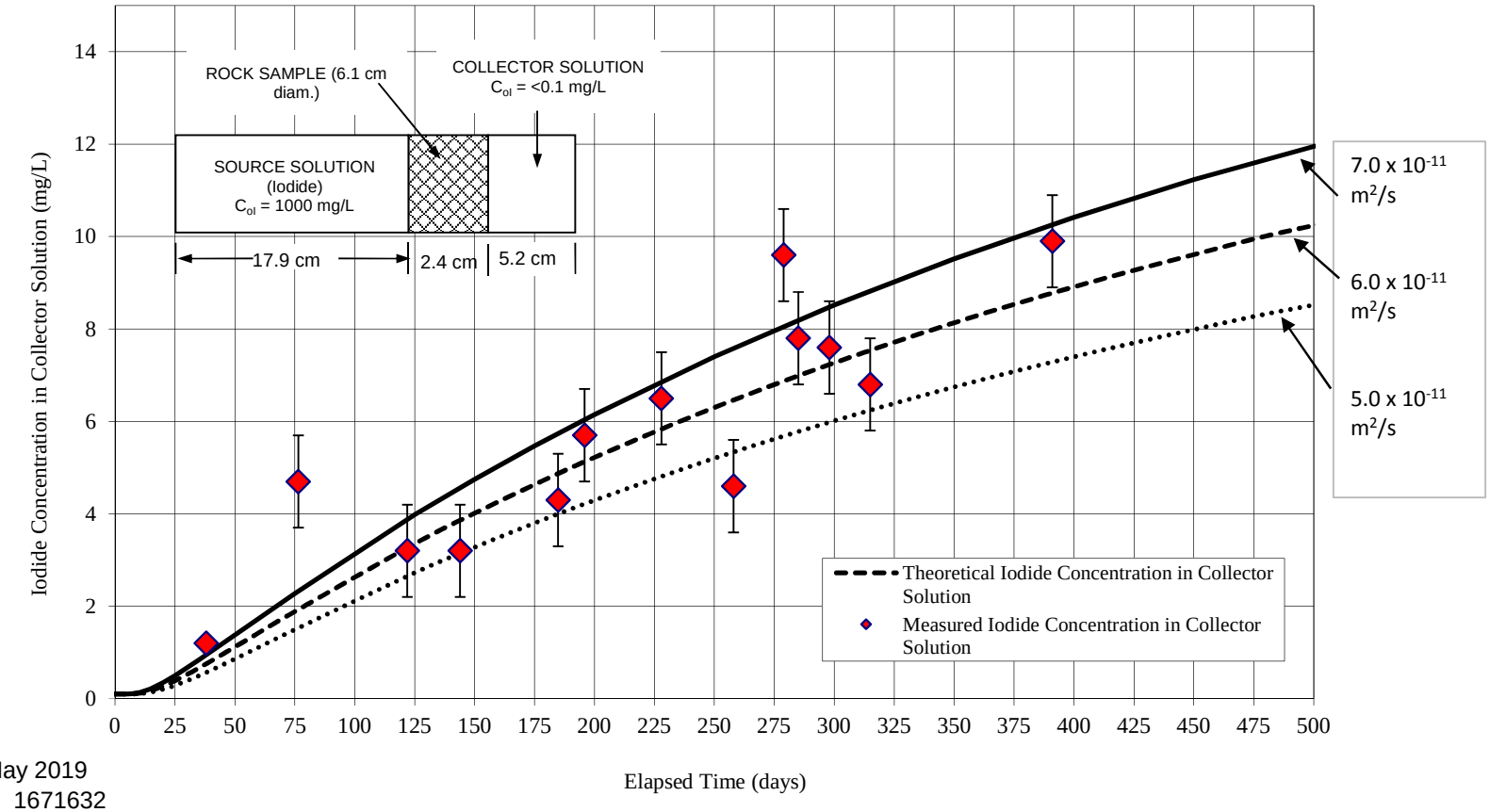
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IODIDE DIFFUSION TEST RESULTS
BH01 ED006 446.36m - 446.68m

Appendix C
Figure 4B



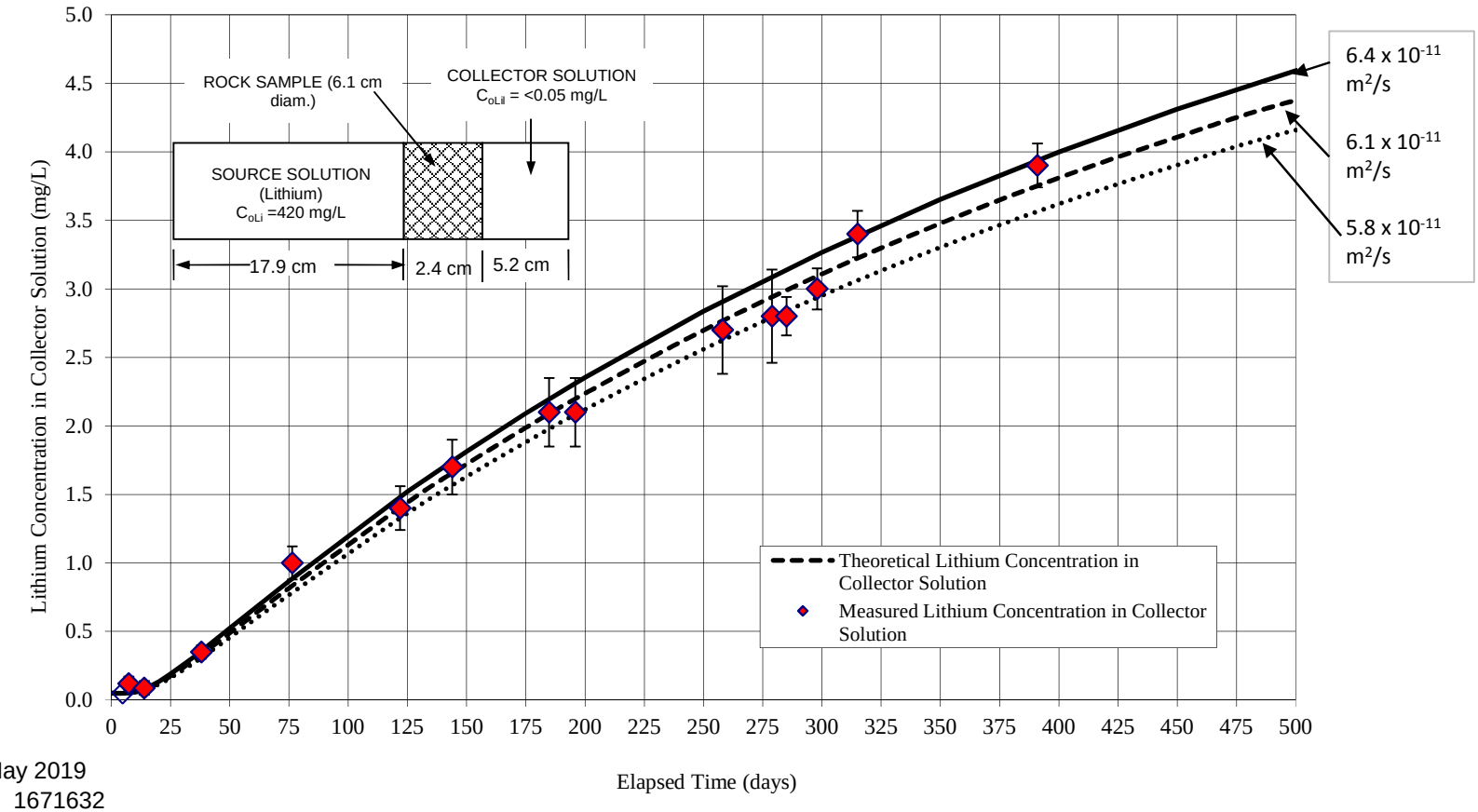
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Golder Associates

LITHIUM DIFFUSION TEST RESULTS
BH01 ED006 446.36m - 446.68m

Appendix C
Figure 4C



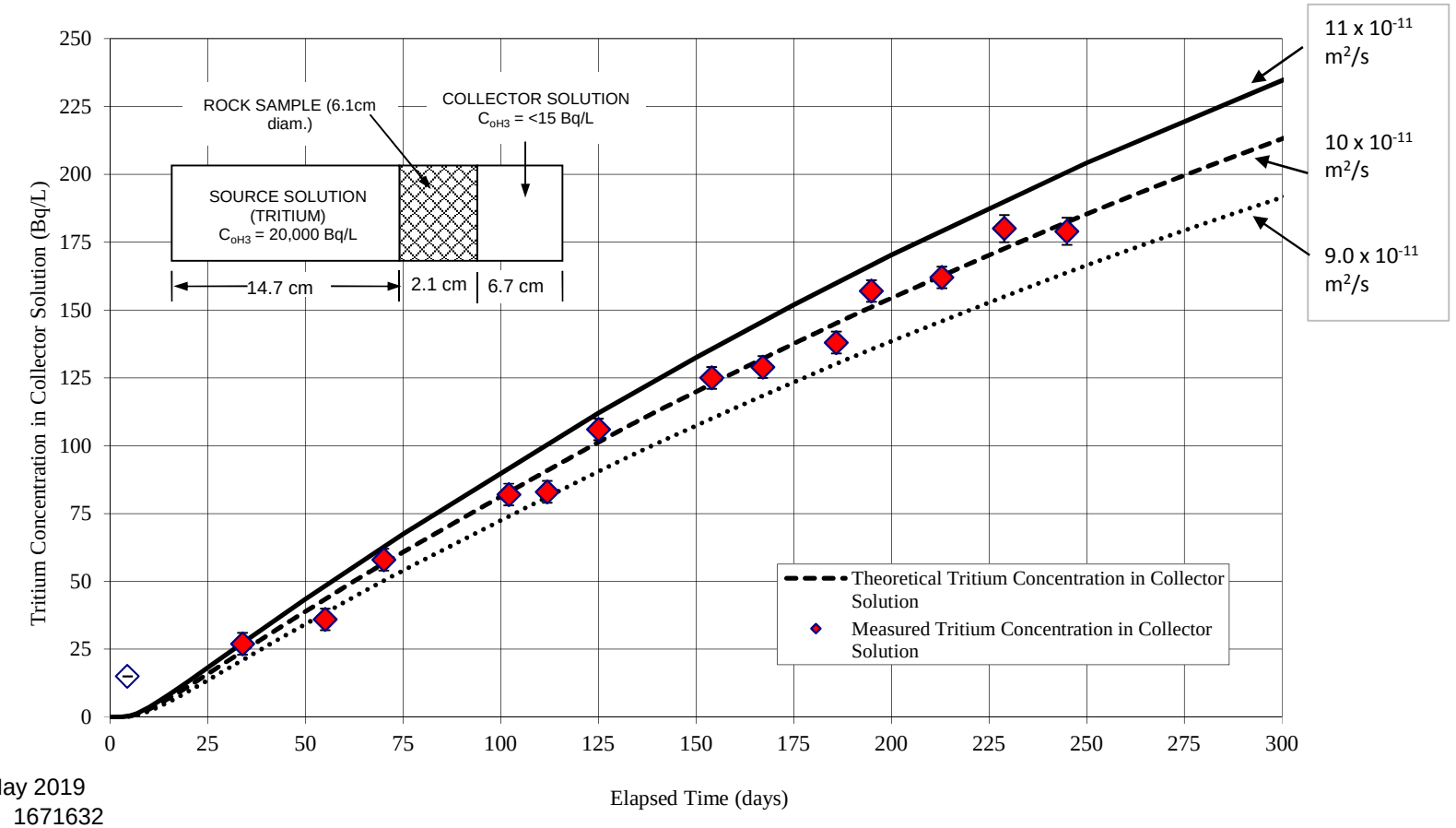
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TRITIUM DIFFUSION TEST RESULTS
BH01 ED006 446.36 - 446.68

Appendix C
Figure 4D



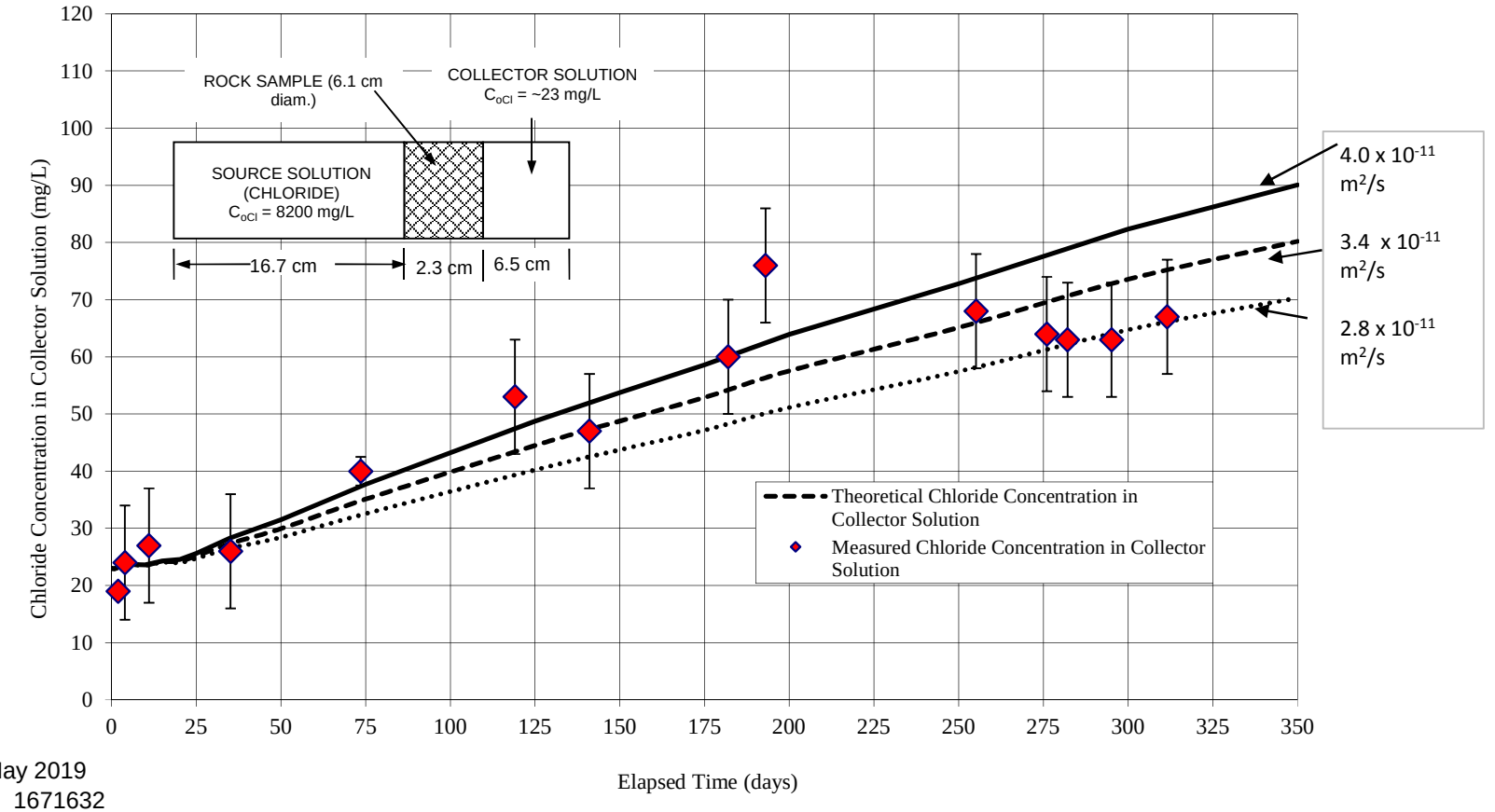
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CHLORIDE DIFFUSION TEST RESULTS
BH01 ED008 504.11m - 504.42m

Appendix C
Figure 5A



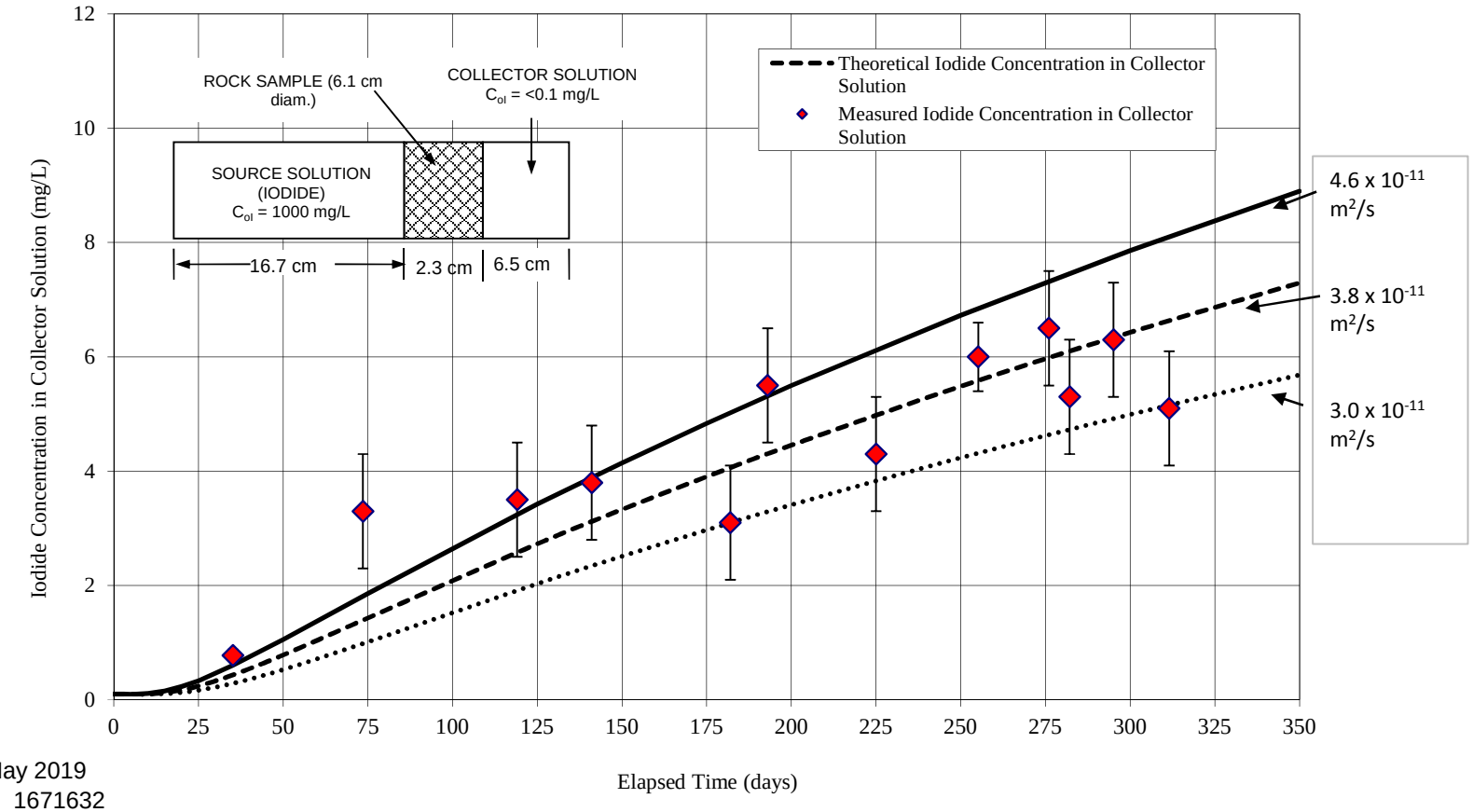
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IODIDE DIFFUSION TEST RESULTS
BH01 ED008 504.11m - 504.42m

Appendix C
Figure 5B



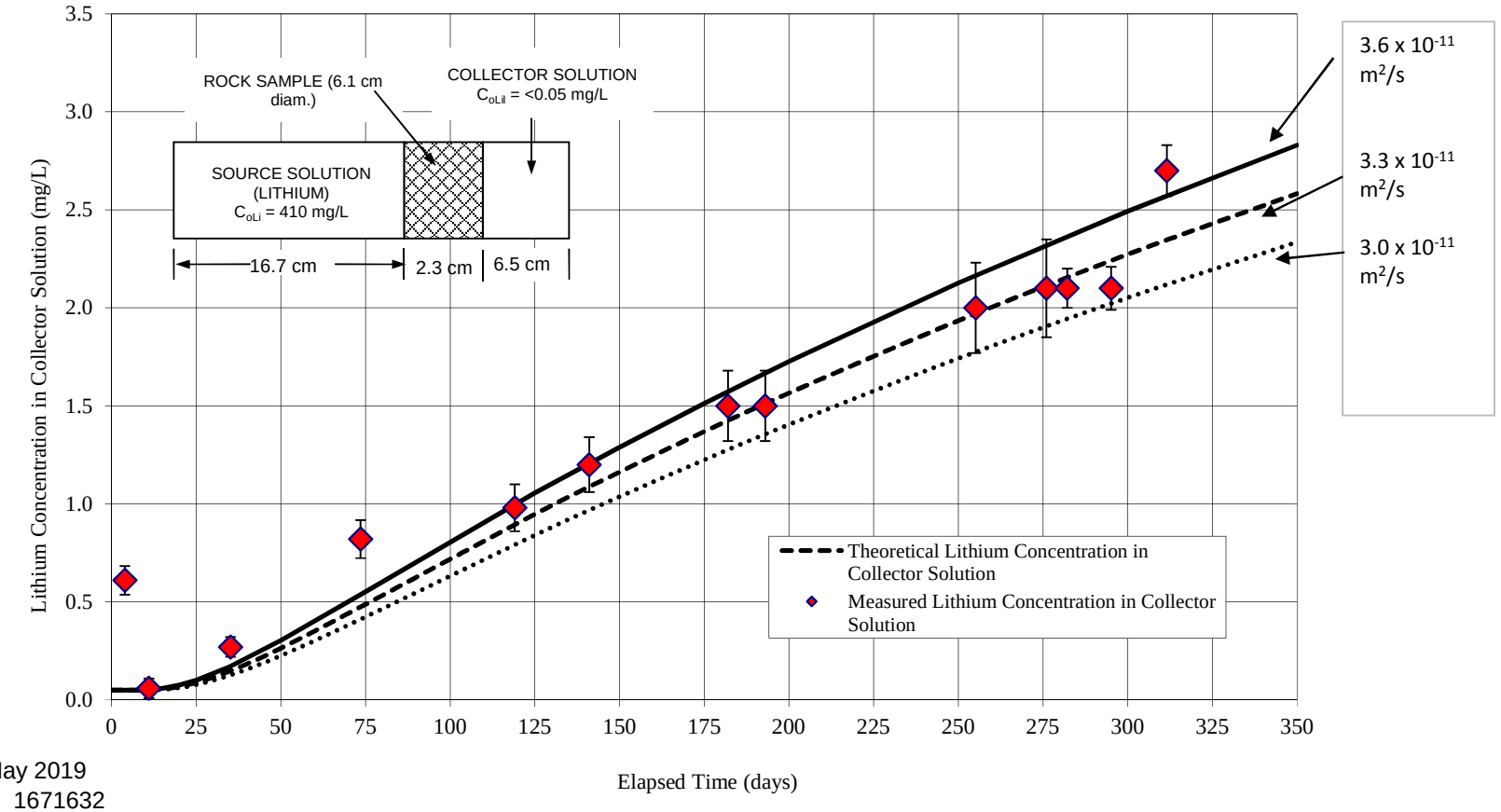
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Golder Associates

LITHIUM DIFFUSION TEST RESULTS
BH01 ED008 504.11m - 504.42m

Appendix C
Figure 5C



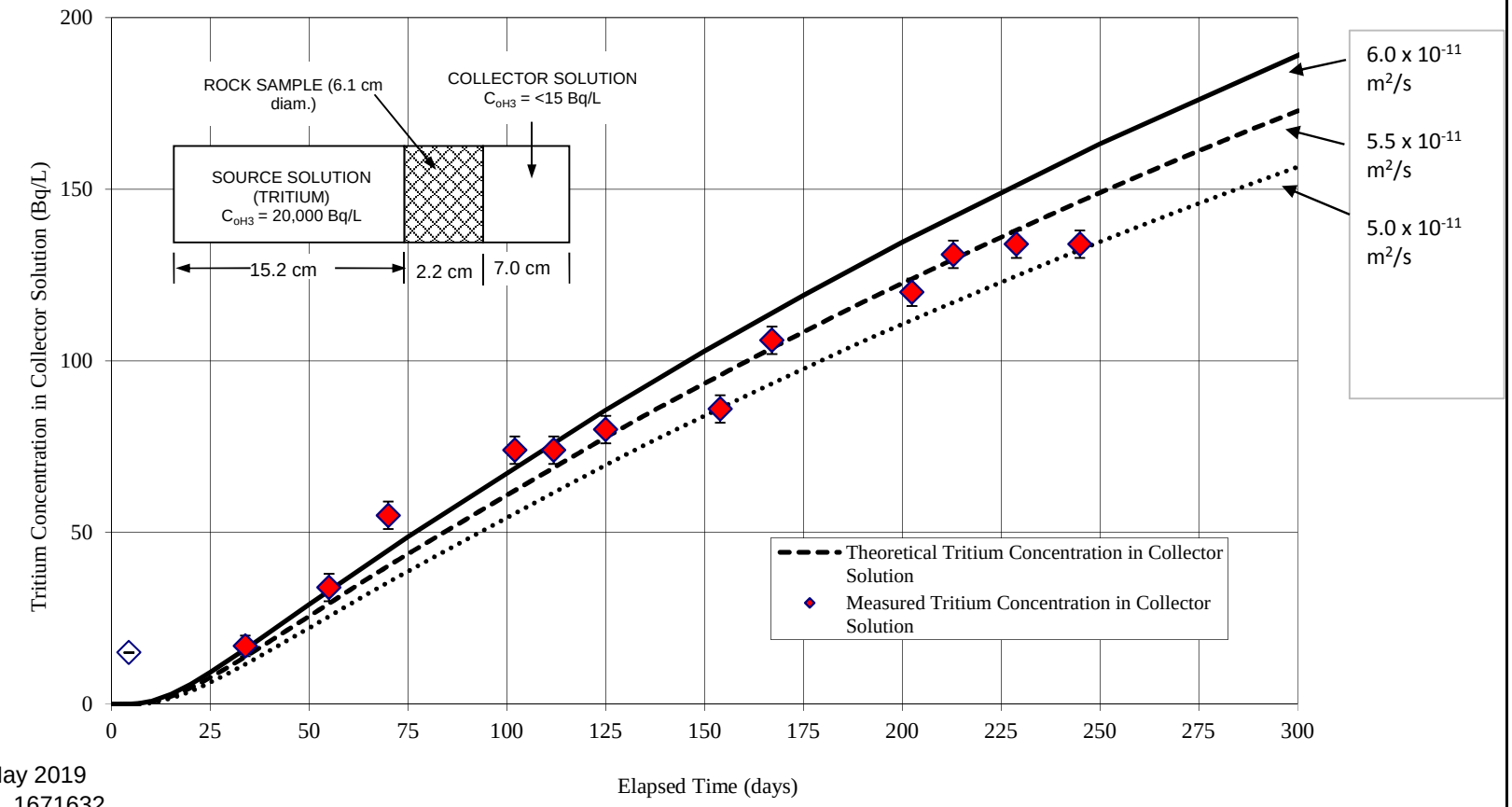
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TRITIUM DIFFUSION TEST RESULTS
BH01 ED008 504.11 - 504.42

Appendix C
Figure 5D



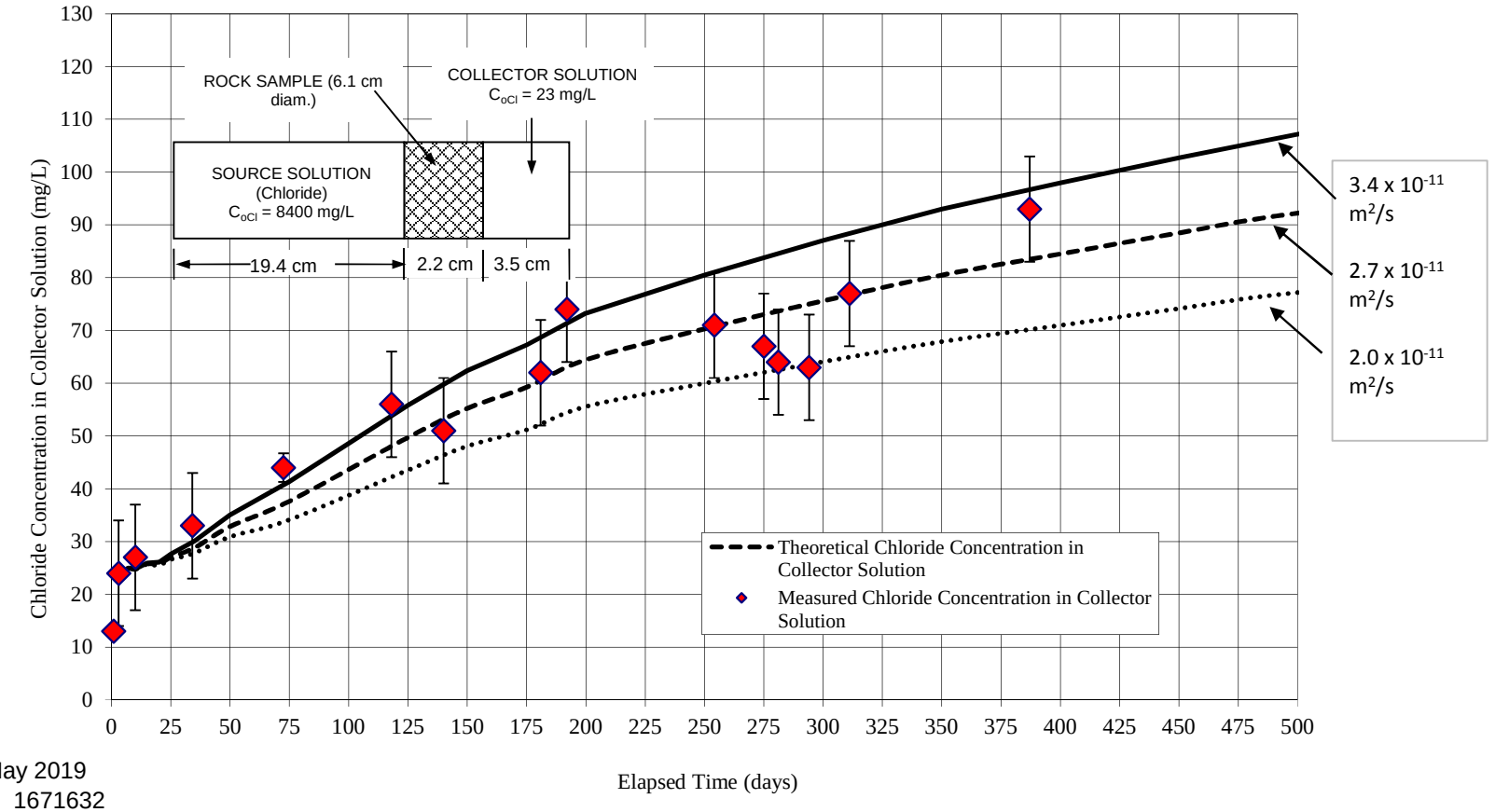
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CHLORIDE DIFFUSION TEST RESULTS
BH01 ED010 553.19m - 553.49m

Appendix C
Figure 6A



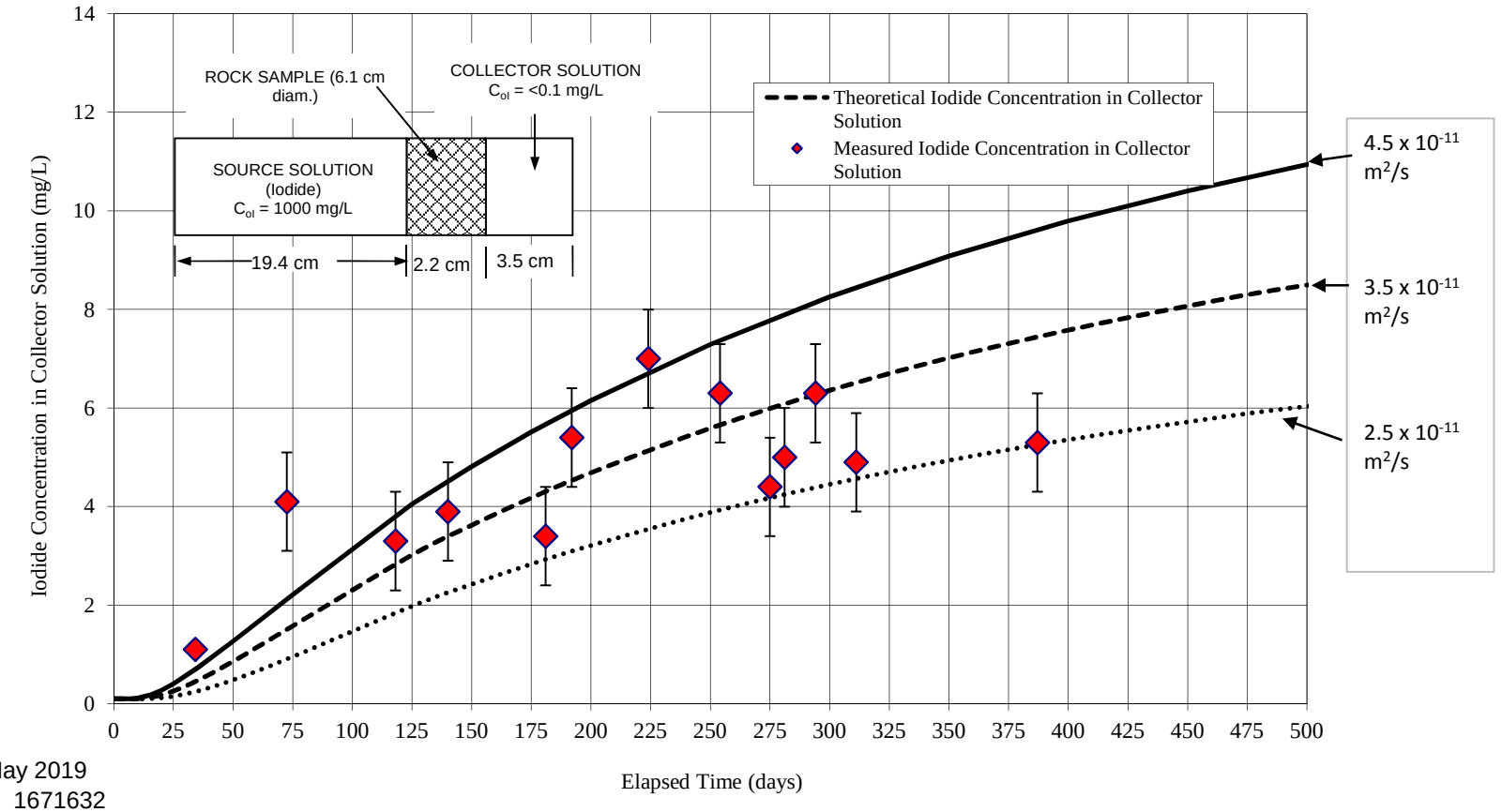
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**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

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Golder Associates

IODIDE DIFFUSION TEST RESULTS
BH01 ED010 553.19m - 553.49m

Appendix C
Figure 6B



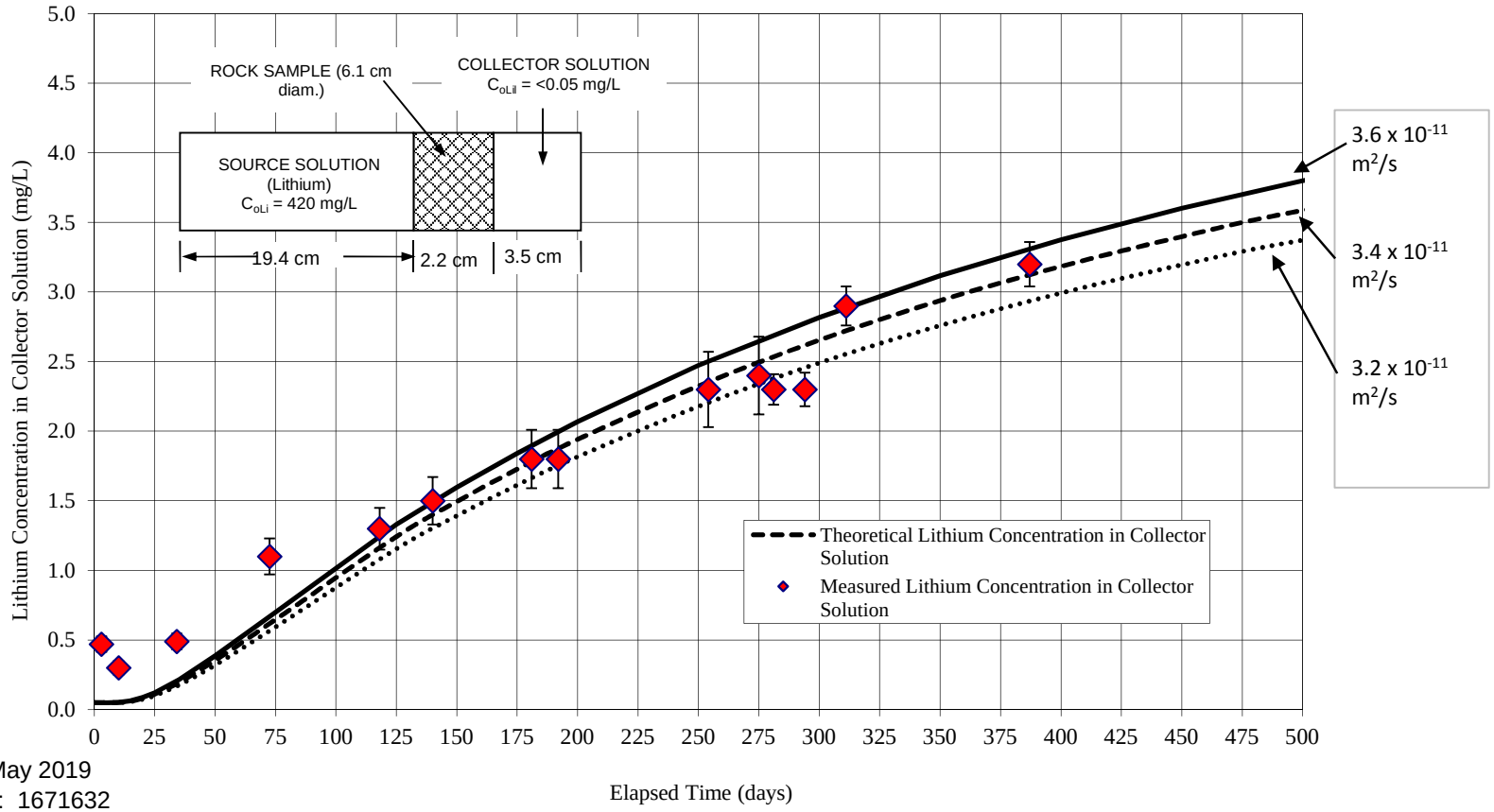
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Golder Associates

LITHIUM DIFFUSION TEST RESULTS
BH01 ED010 553.19m - 553.49m

Appendix C
Figure 6C



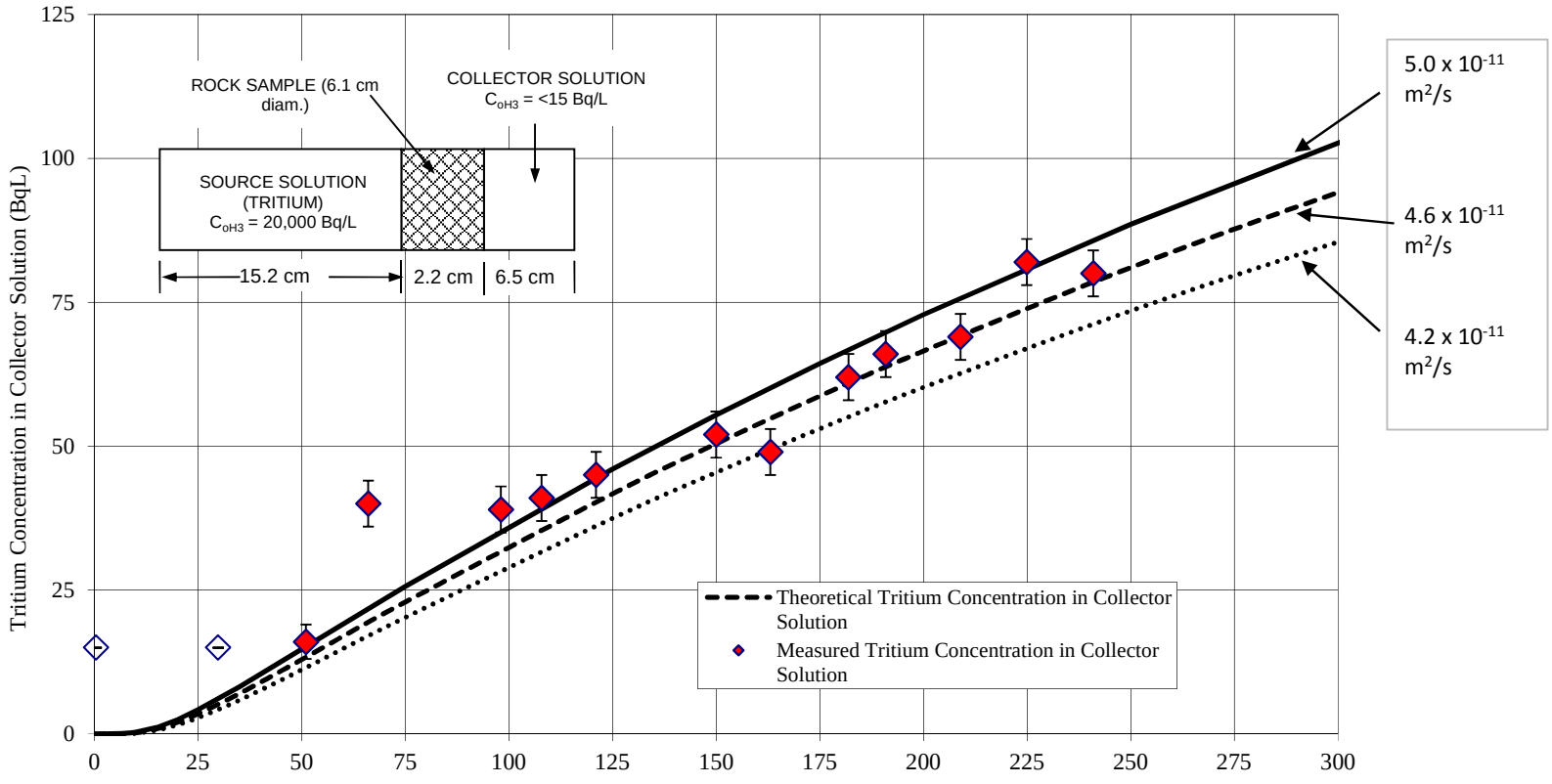
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**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

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Golder Associates

TRITIUM DIFFUSION TEST RESULTS
BH01 ED010 553.19 - 553.49

Appendix C
Figure 6D



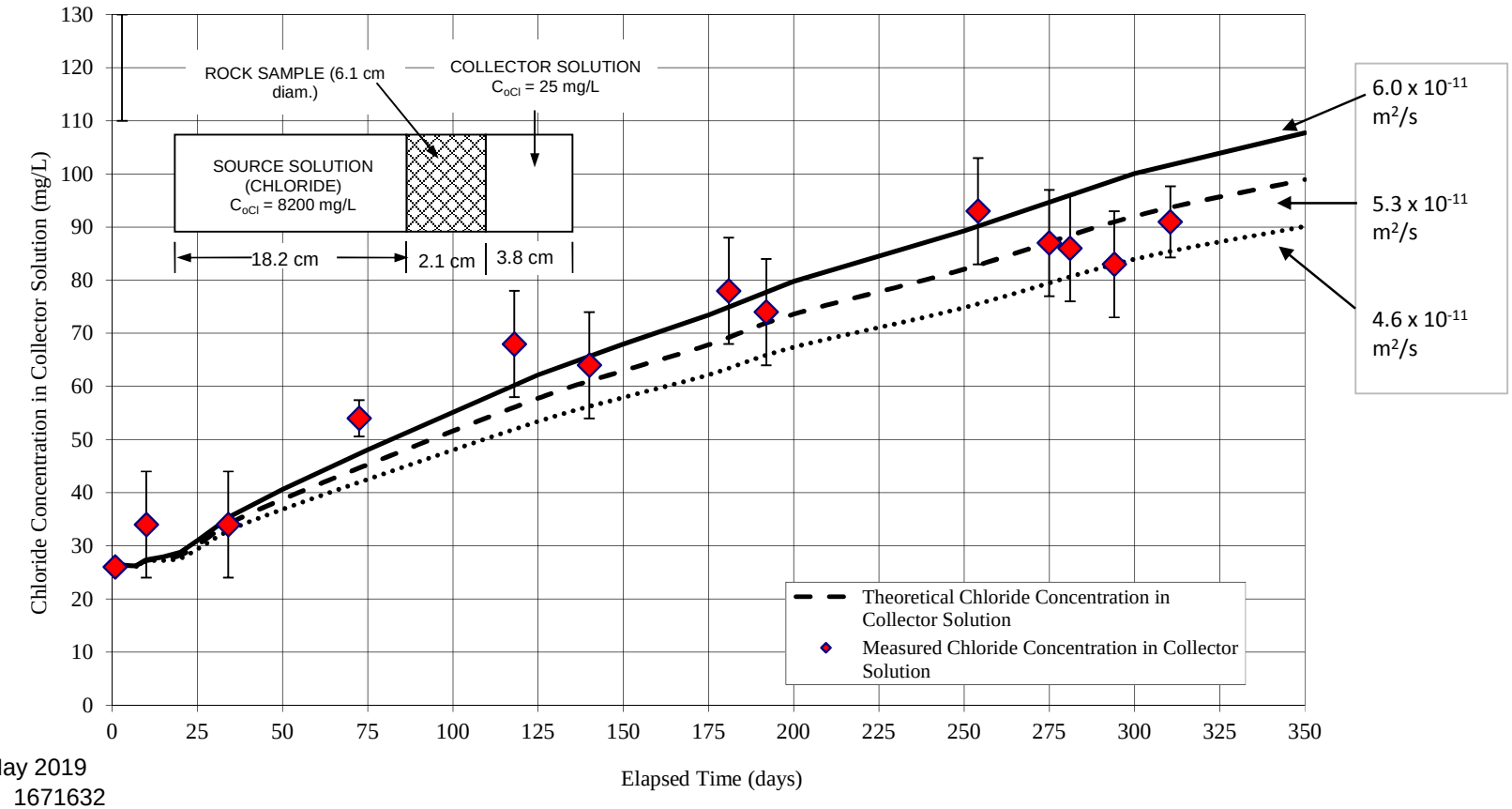
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**Error bars represent one standard deviation analytical error reported by Maxxam Laboratories for given sampling event

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Checked: FB

Golder Associates

CHLORIDE DIFFUSION TEST RESULTS
BH01 ED011 586.01 - 586.32

Appendix C
Figure 7A



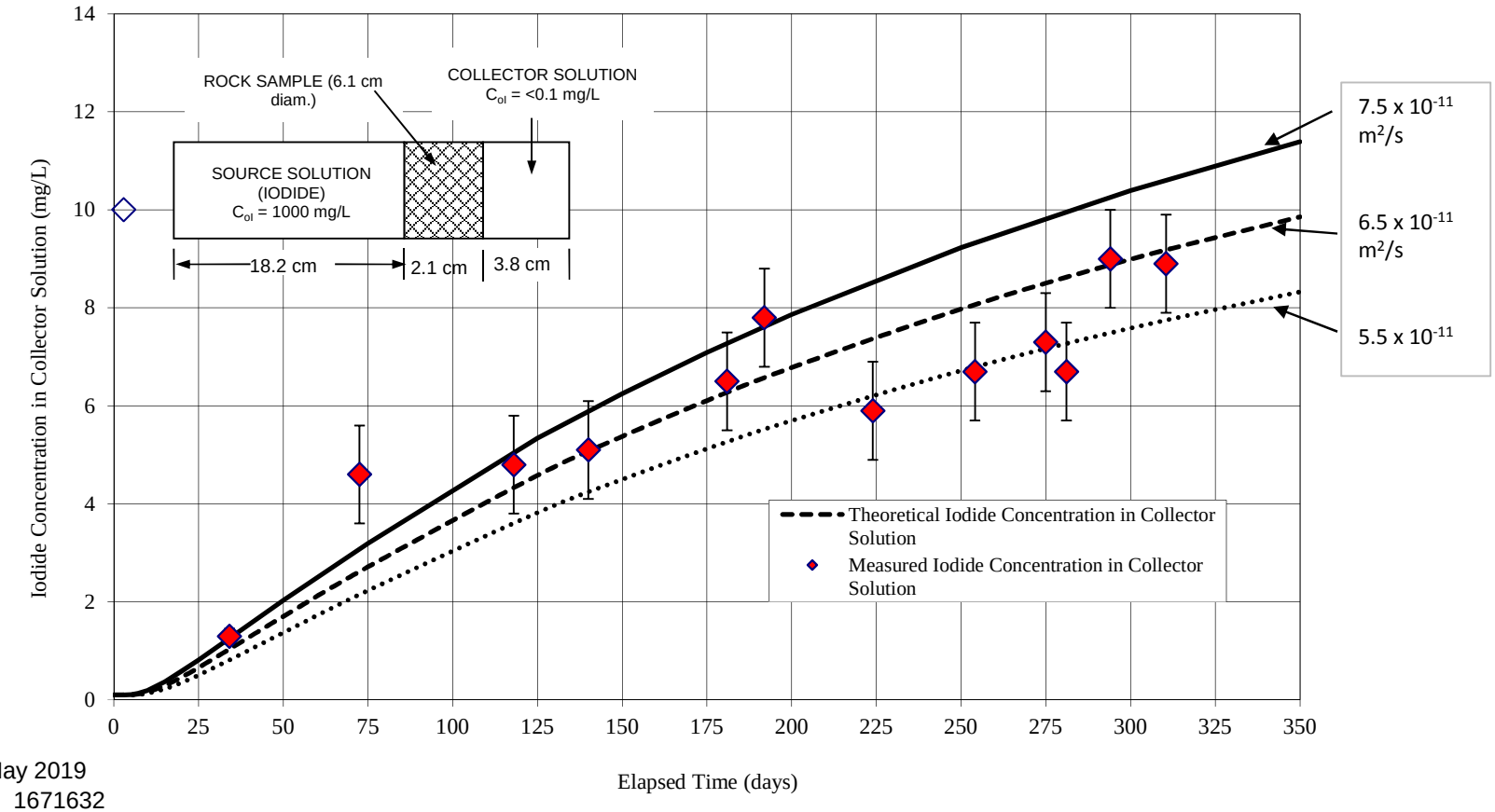
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**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

Golder Associates

IODIDE DIFFUSION TEST RESULTS
BH01 ED011 586.01 - 586.32

Appendix C
Figure 7B



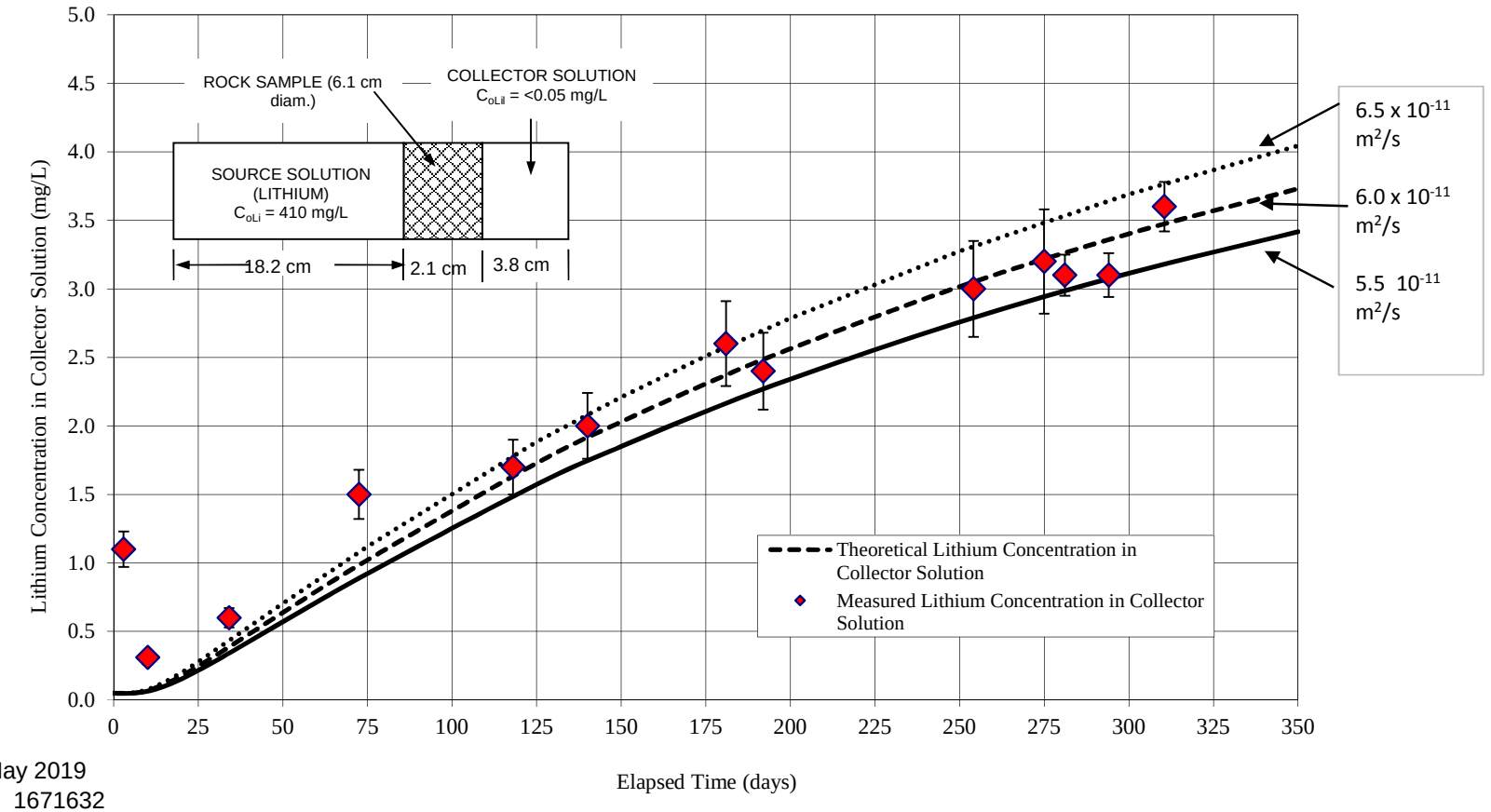
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Golder Associates

LITHIUM DIFFUSION TEST RESULTS
BH01 ED011 586.01 - 586.32

Appendix C
Figure 7C



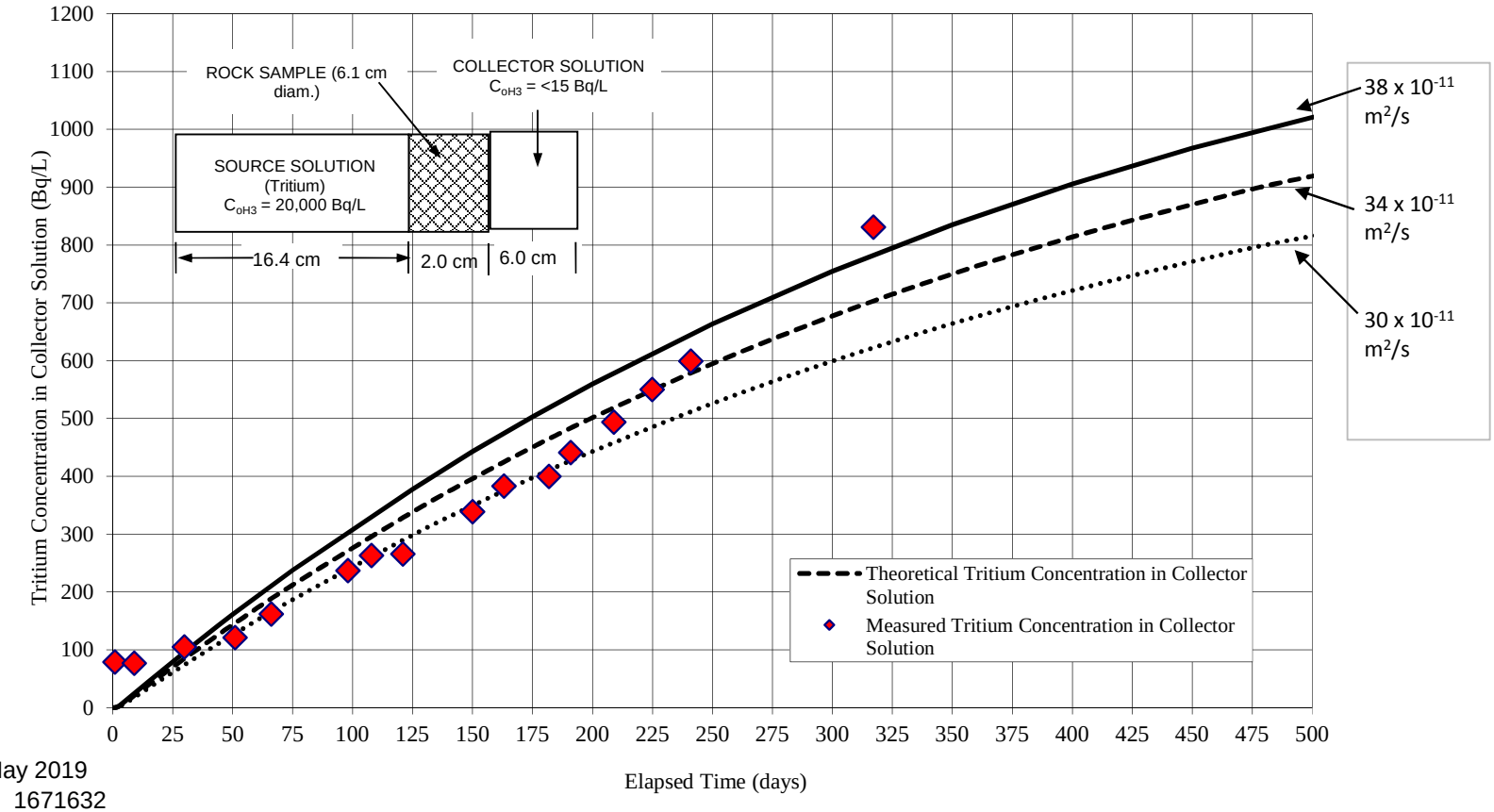
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TRITIUM DIFFUSION TEST RESULTS
BH01 ED011 586.01m - 586.32m

Appendix C
Figure 7D



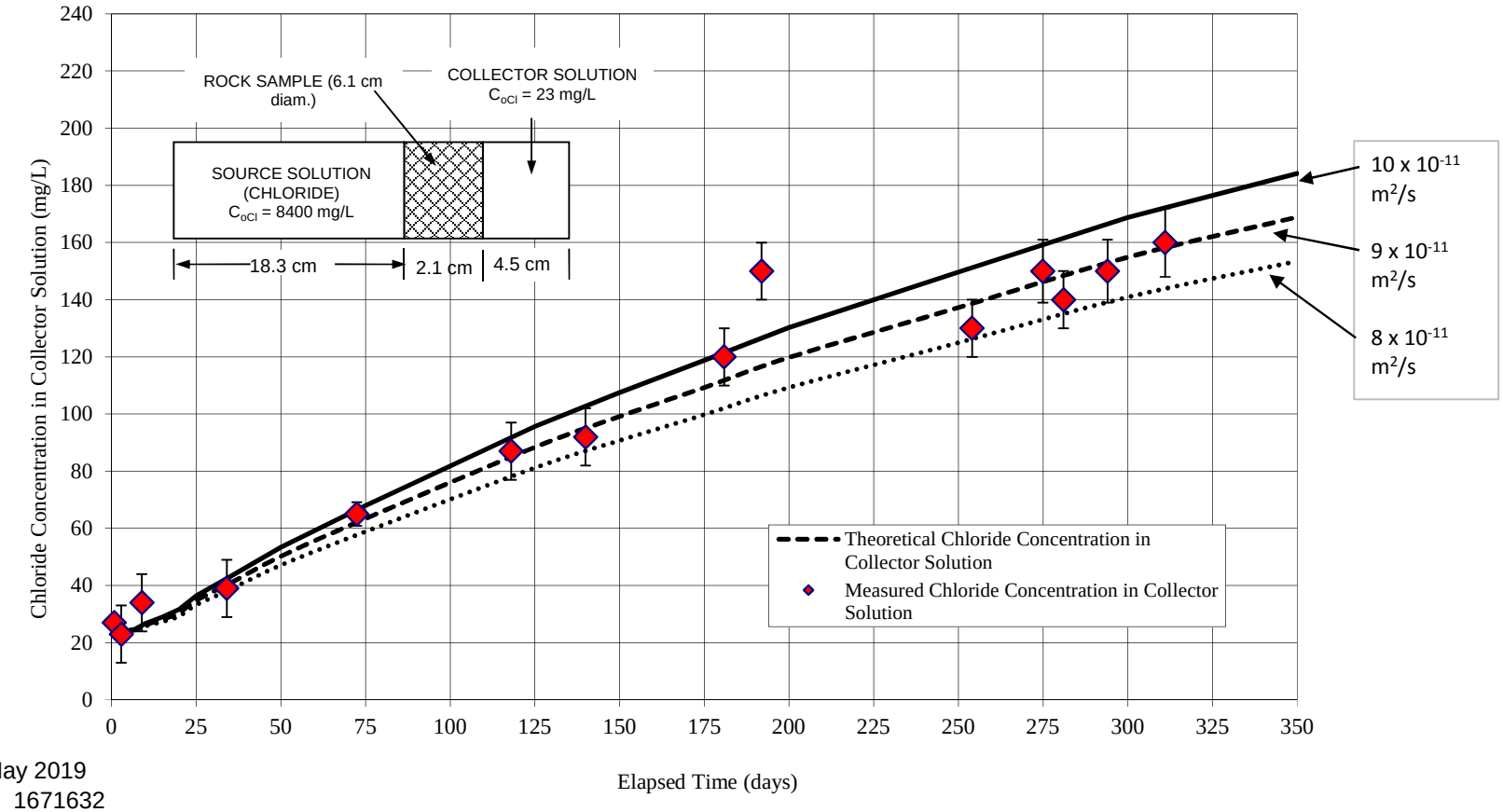
Date: May 2019
Project: 1671632
*Hollow datapoints represent less than detection limit
**Error bars, showing one stadard deviation, are too small to be visible at this scale

Drawn: DJ
Checked: FB

Golder Associates

CHLORIDE DIFFUSION TEST RESULTS
BH01 ED013 705.59 - 705.92

Appendix C
Figure 8A



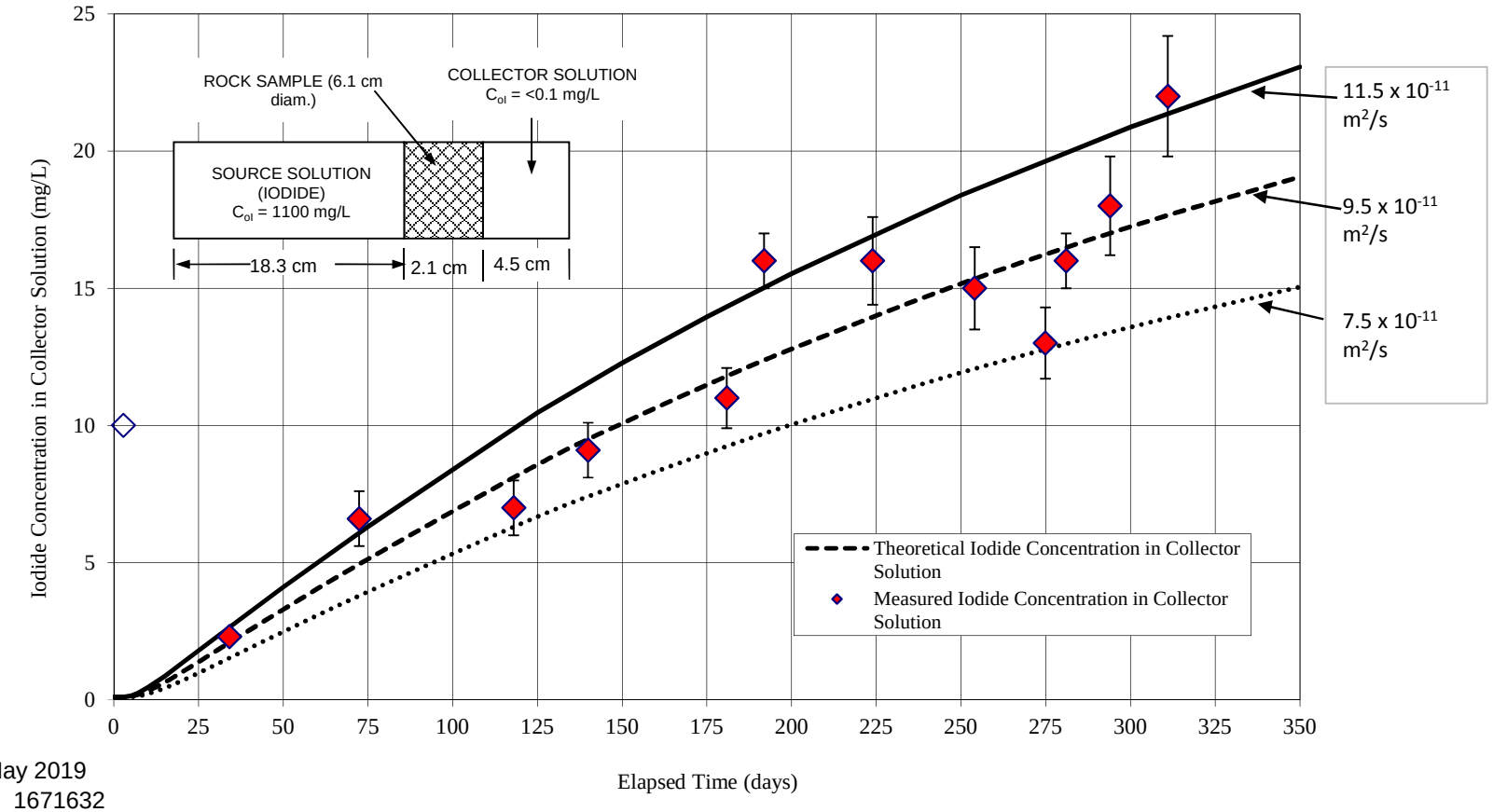
Date: May 2019
Project: 1671632
*Hollow data points are below detection limit
**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

Golder Associates

IODIDE DIFFUSION TEST RESULTS
BH01 ED013 705.59 - 705.92

Appendix C
Figure 8B



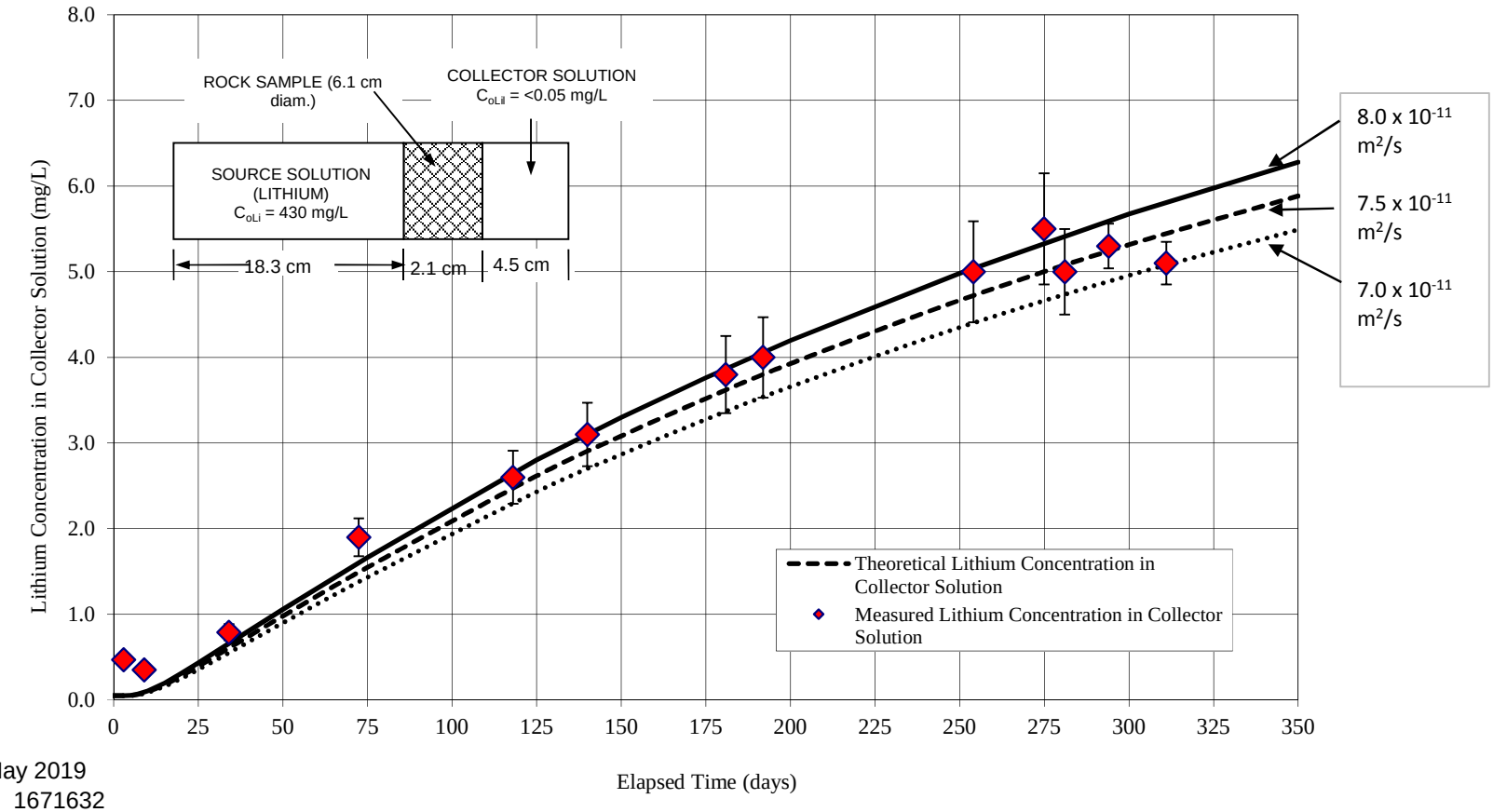
Date: May 2019
Project: 1671632
*Hollow data points are below detection limit
**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

Golder Associates

LITHIUM DIFFUSION TEST RESULTS
BH01 ED013 705.59 - 705.92

Appendix C
Figure 8C



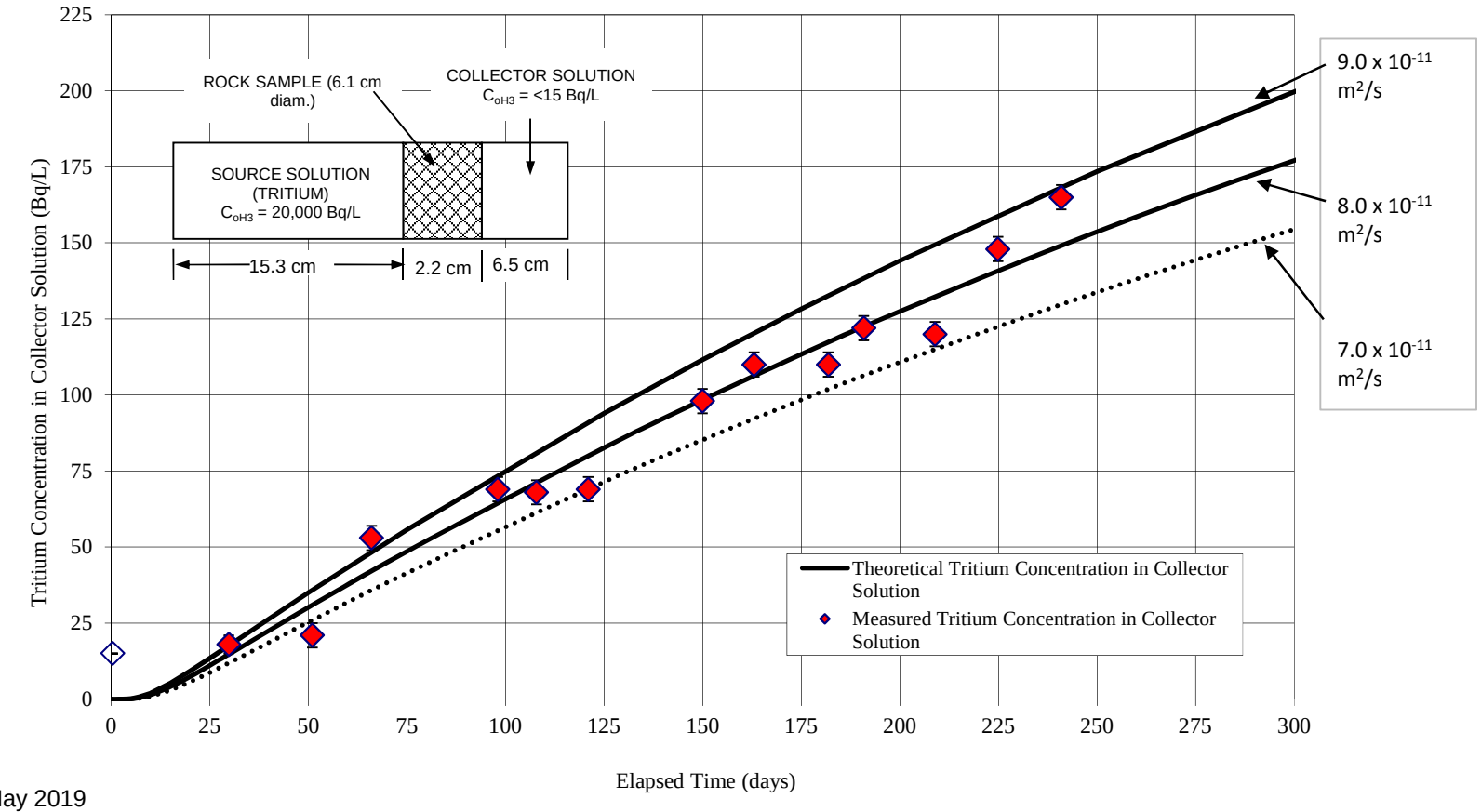
Date: May 2019
Project: 1671632
*Hollow data points are below detection limit
**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

Golder Associates

TRITIUM DIFFUSION TEST RESULTS
BH01 ED013 705.59 - 705.92

Appendix C
Figure 8D



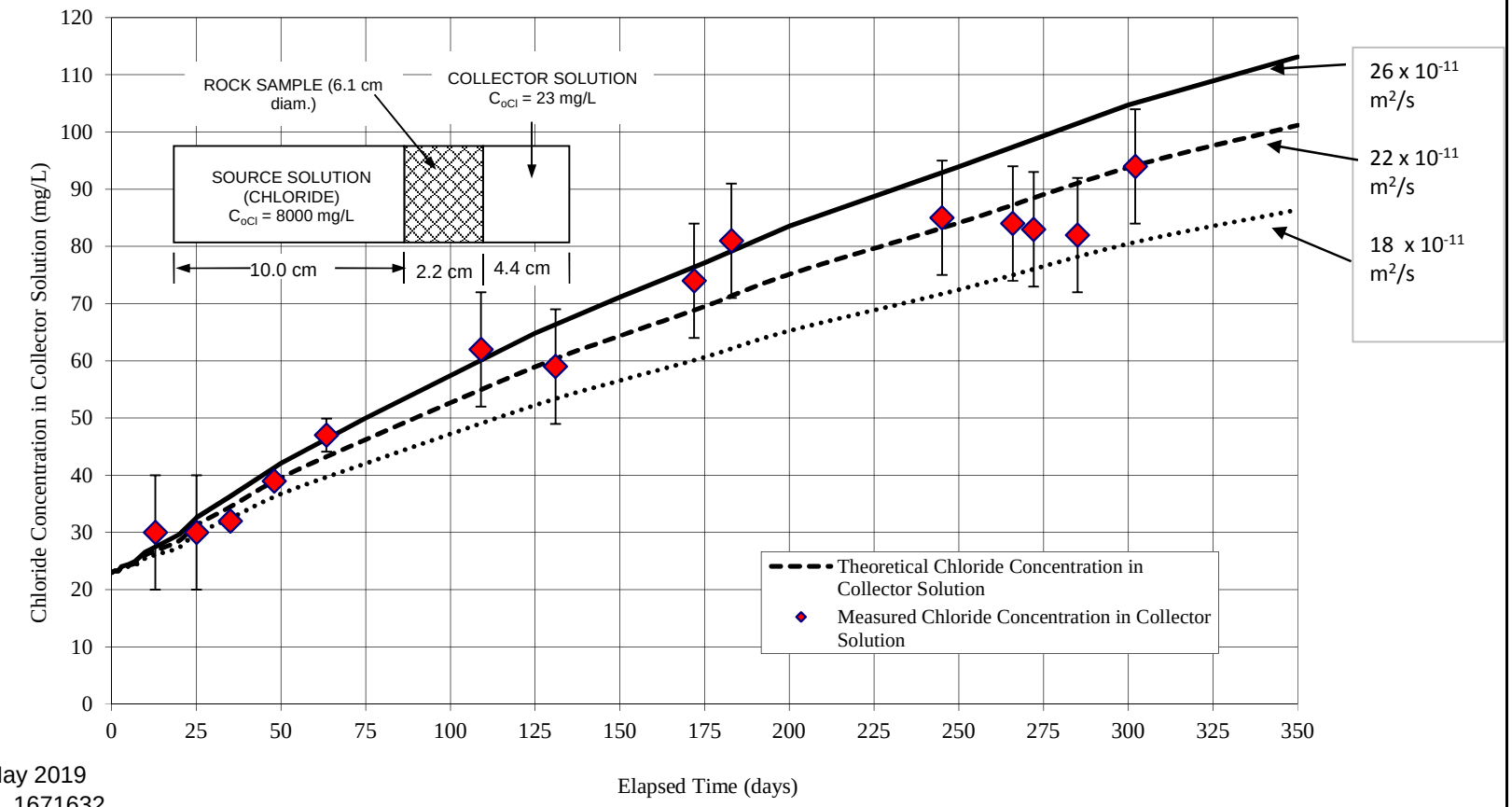
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Project: 1671632
*Hollow datapoints represent less than detection limit
**Error bars represent one standard deviation analytical error reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

Golder Associates

CHLORIDE DIFFUSION TEST RESULTS
BH01 ED014 800.63 - 800.94

Appendix C
Figure 9A



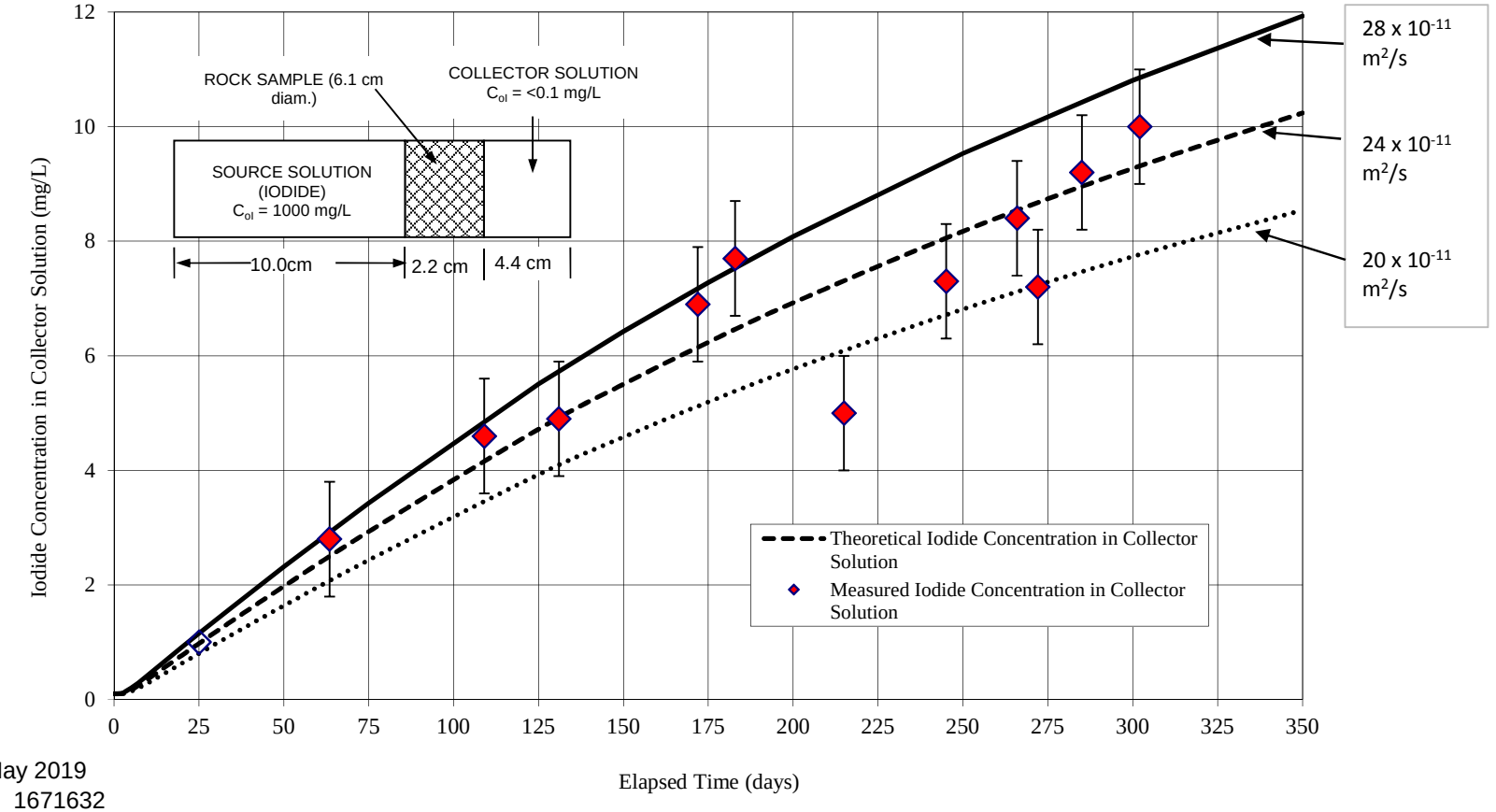
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Project: 1671632
*Hollow data points are below detection limit
**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

Golder Associates

IODIDE DIFFUSION TEST RESULTS
BH01 ED014 800.63 - 800.94

Appendix C
Figure 9B



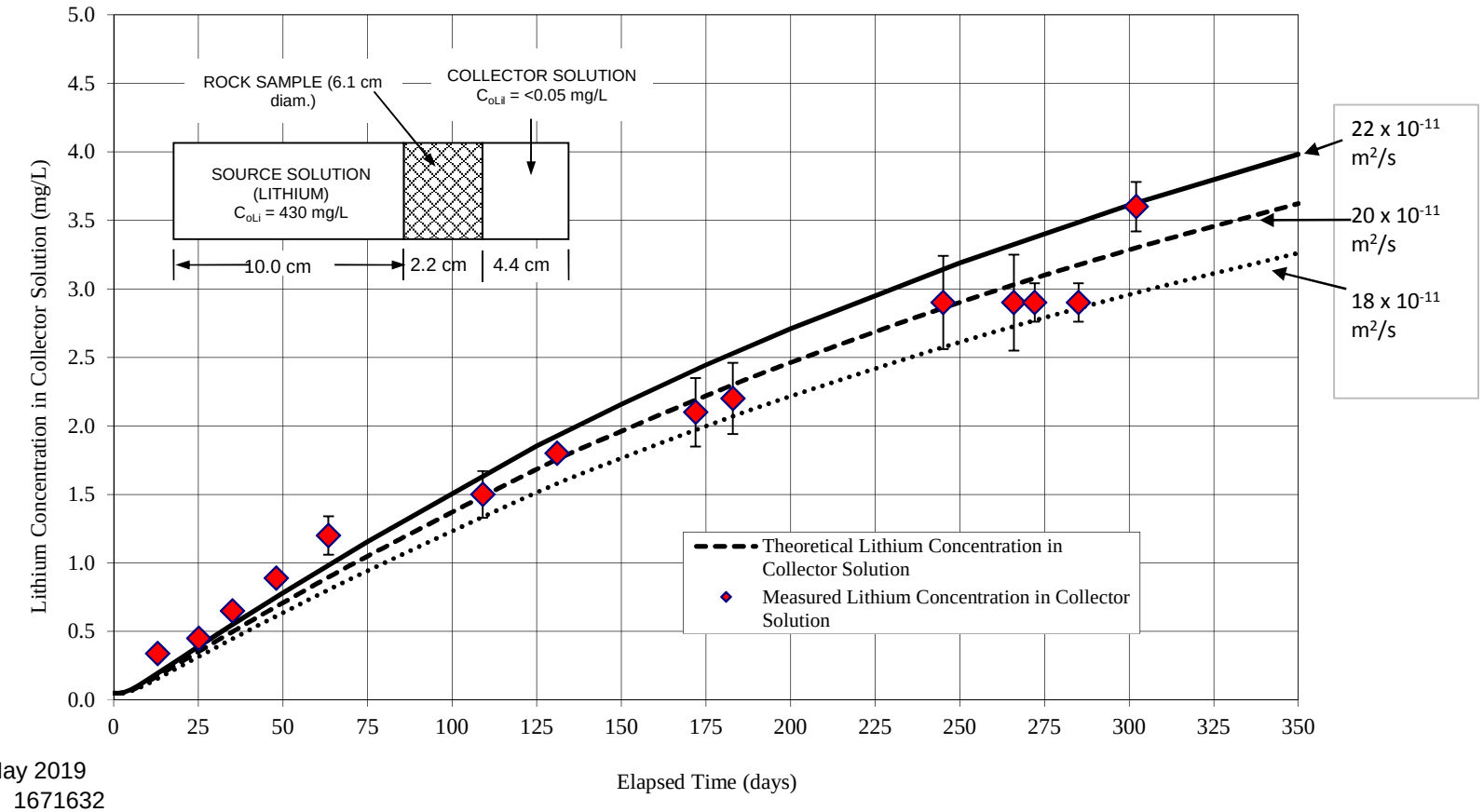
Date: May 2019
Project: 1671632
*Hollow data points are below detection limit
**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

Golder Associates

LITHIUM DIFFUSION TEST RESULTS
BH01 ED014 800.63 - 800.94

Appendix C
Figure 9C



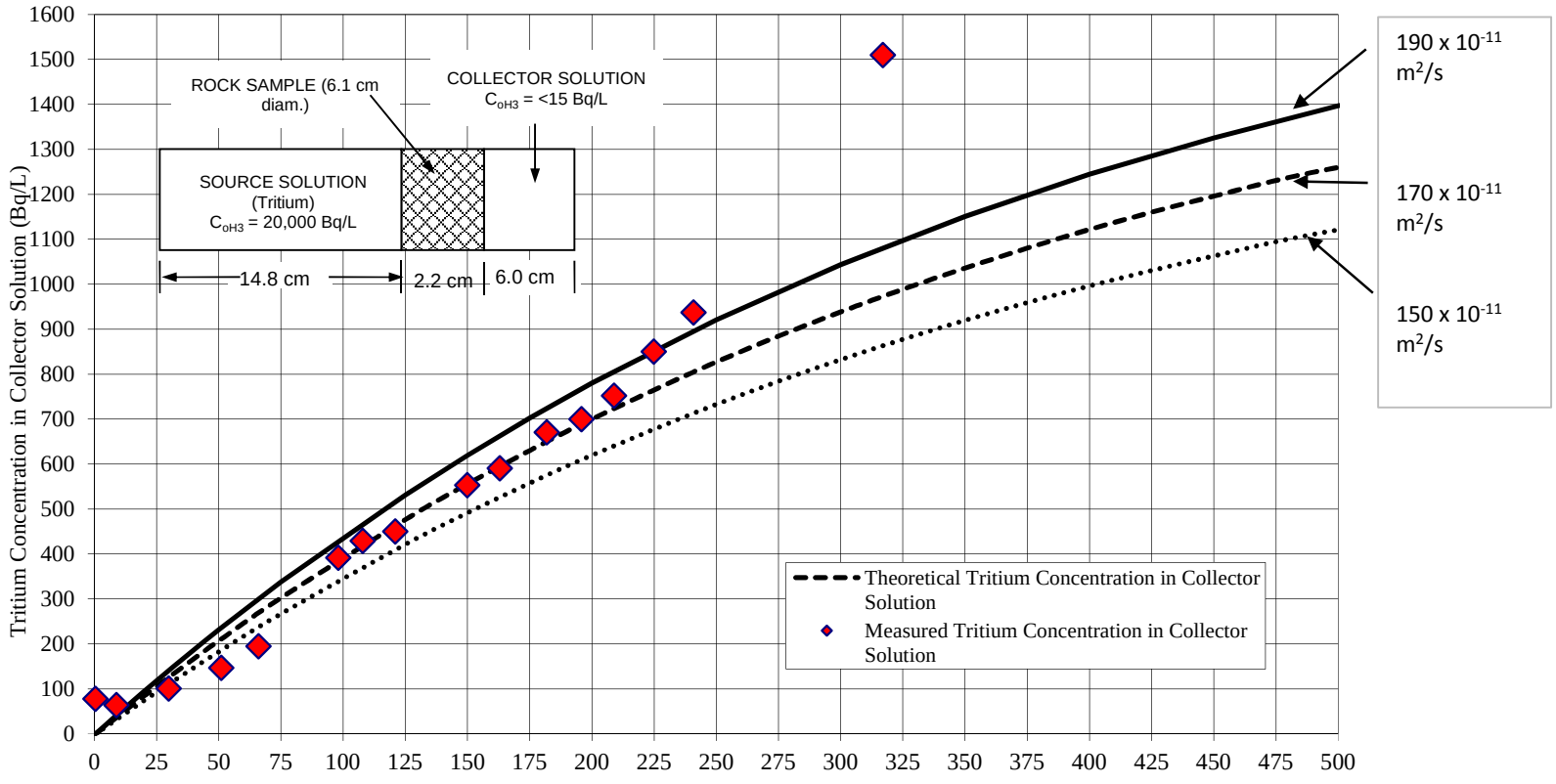
Date: May 2019
Project: 1671632
*Hollow data points are below detection limit
**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

Golder Associates

TRITIUM DIFFUSION TEST RESULTS
BH01 ED014 800.63m - 800.94m

Appendix C
Figure 9D



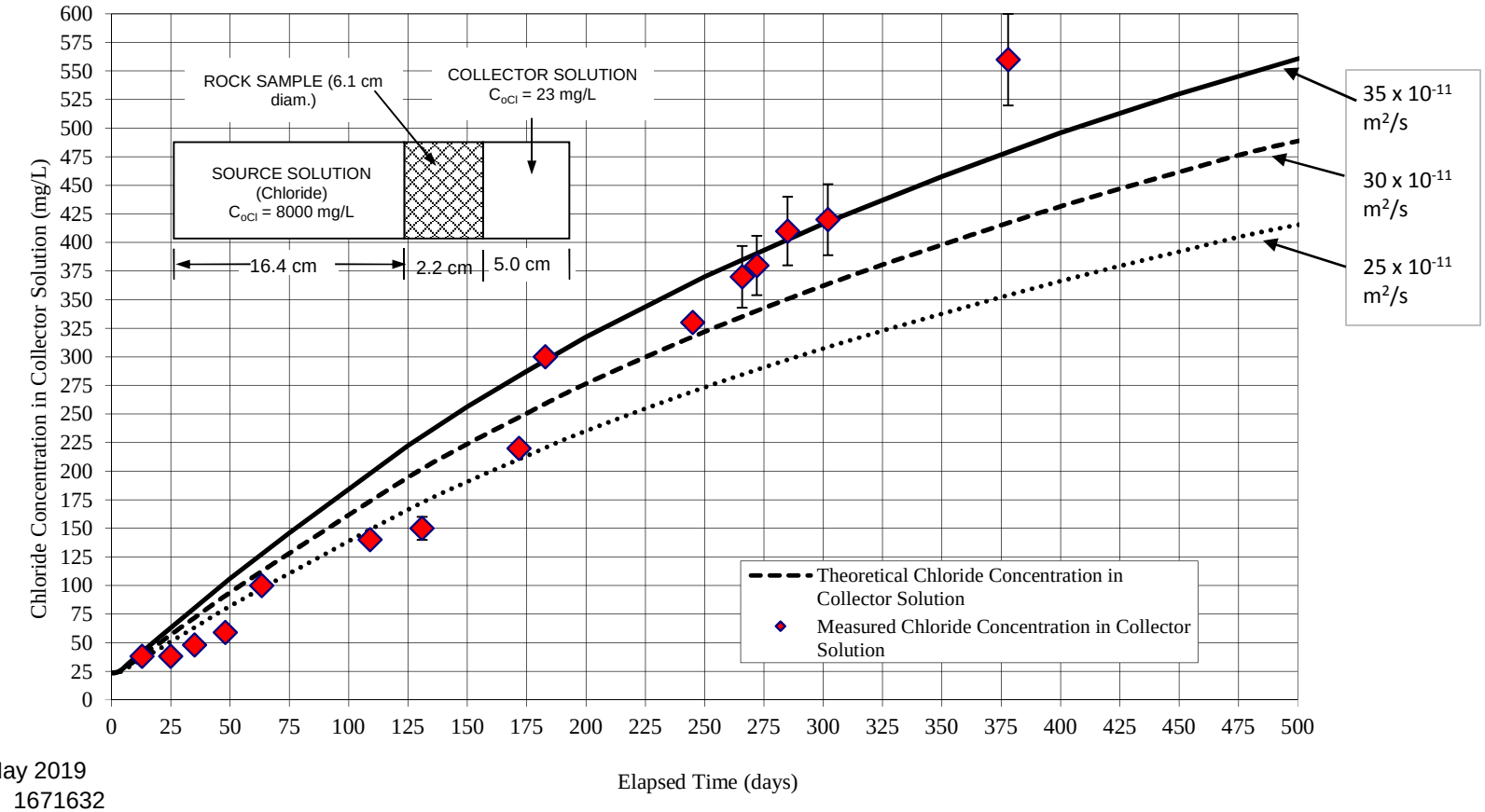
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Project: 1671632
*Hollow datapoints represent less than detection limit
**Error bars, showing one stadard deviation, are too small to be visible at this scale

Drawn: DJ
Checked: FB

Golder Associates

CHLORIDE DIFFUSION TEST RESULTS
BH01 ED016 900.11m - 900.43m

Appendix C
Figure 10A



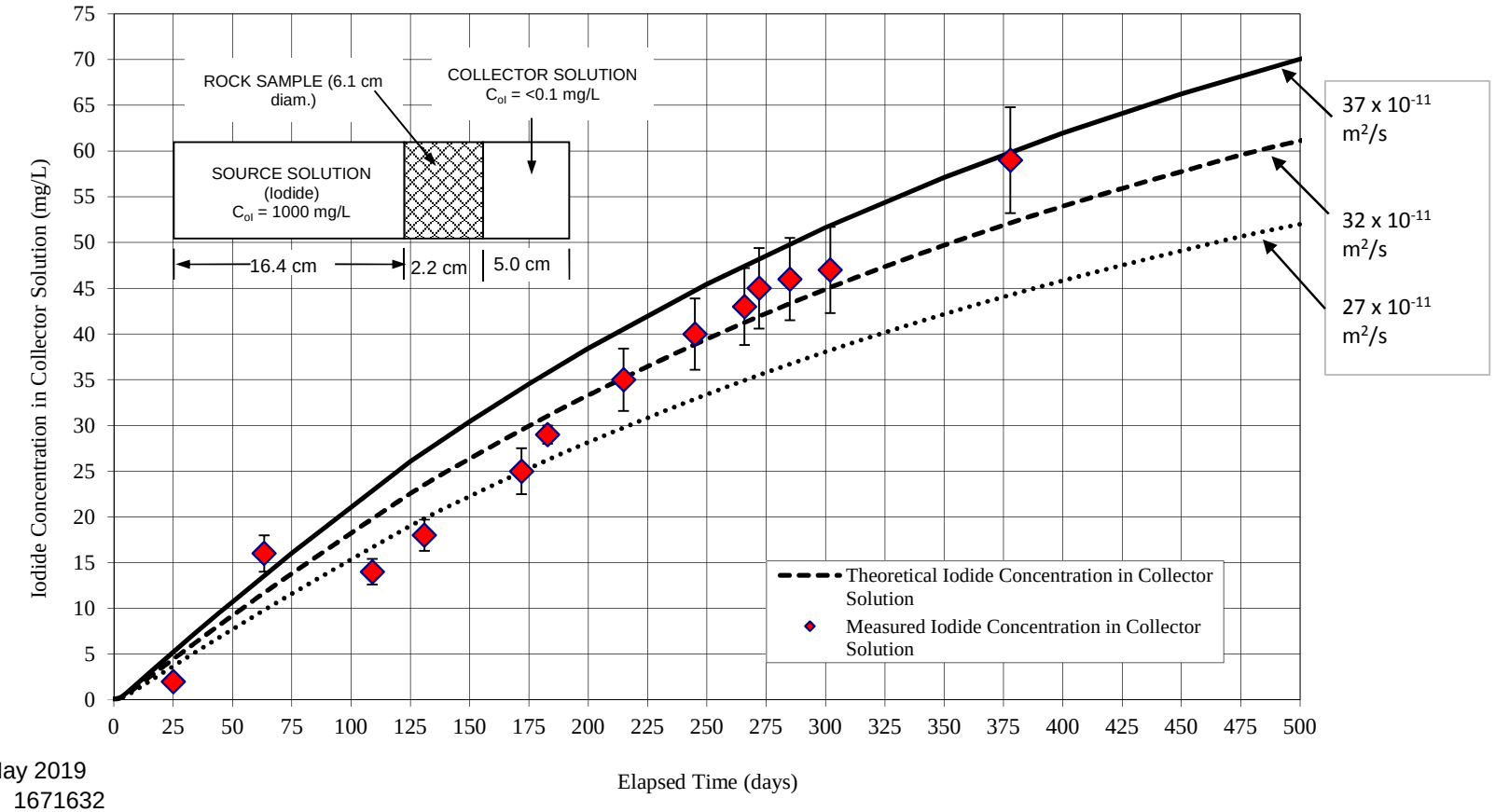
Date: May 2019
Project: 1671632
*Hollow data points are below detection limit
**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

Golder Associates

IODIDE DIFFUSION TEST RESULTS
BH01 ED016 900.11m - 900.43m

Appendix C
Figure 10B



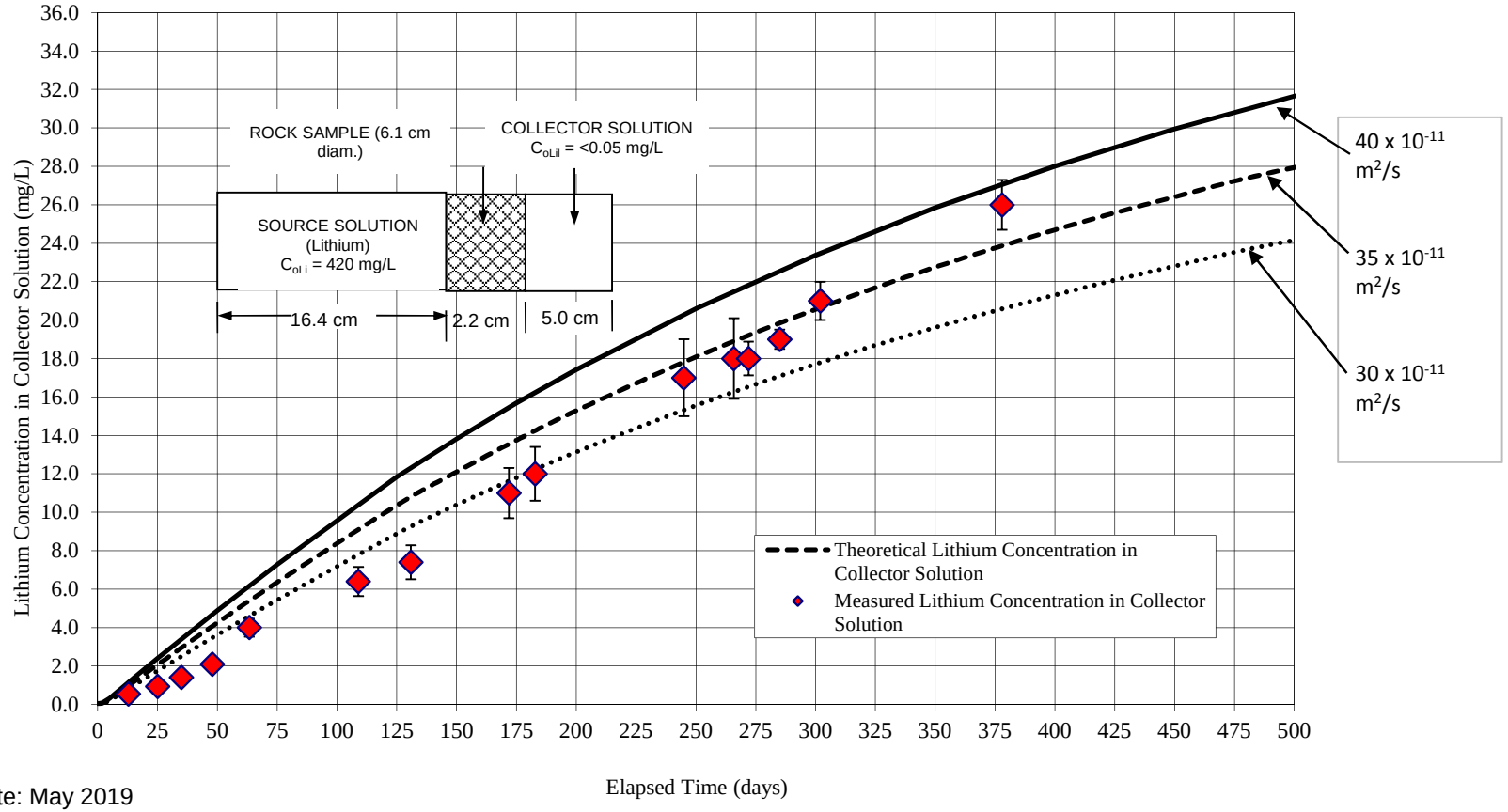
Date: May 2019
Project: 1671632
*Hollow data points are below detection limit
**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

Golder Associates

LITHIUM DIFFUSION TEST RESULTS
BH01 ED016 900.11m - 900.43m

Appendix C
Figure 10C



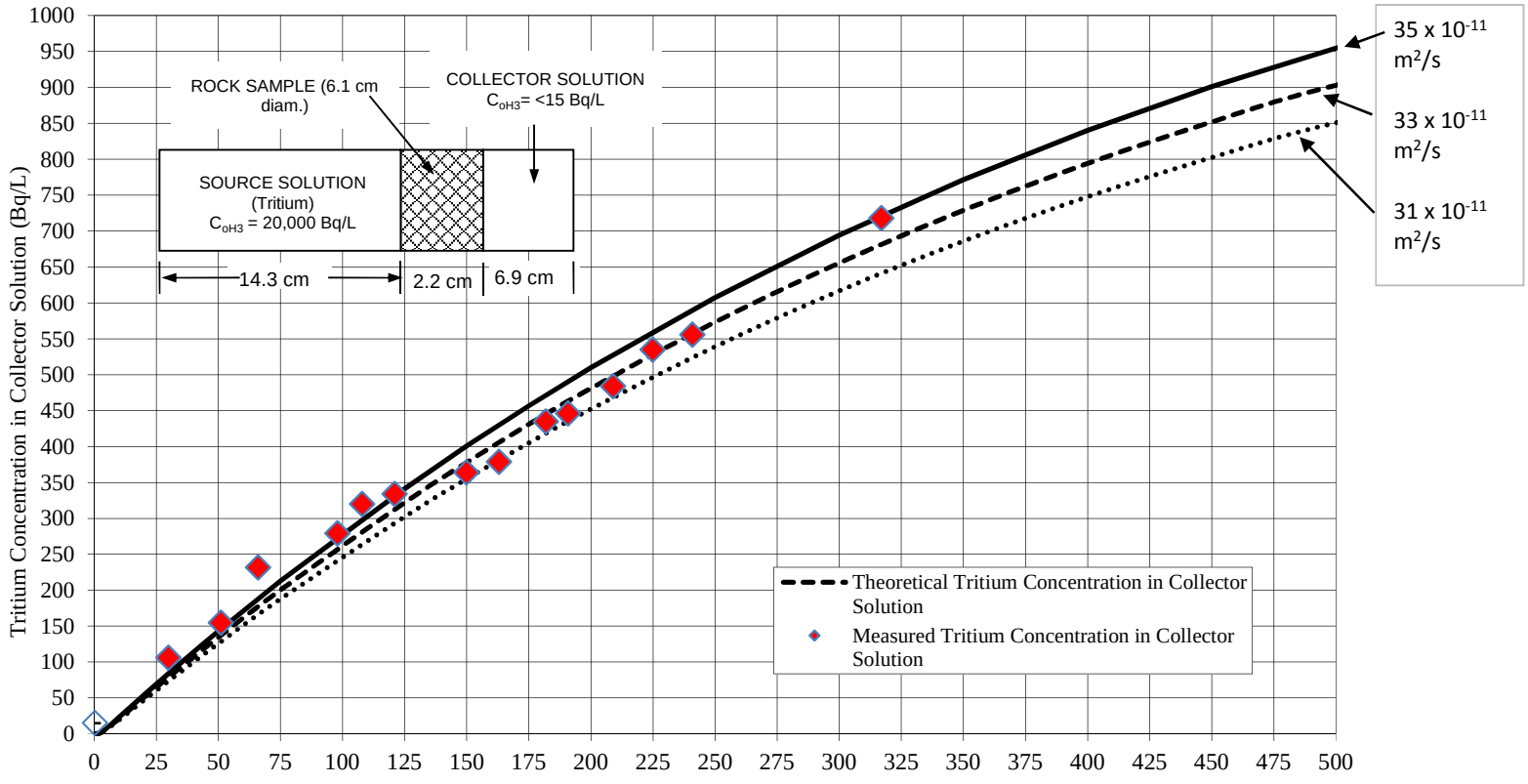
Date: May 2019
Project: 1671632
*Hollow data points are below detection limit
**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

Golder Associates

TRITIUM DIFFUSION TEST RESULTS
BH01 ED016 900.11m - 900.43m

Appendix C
Figure 10D



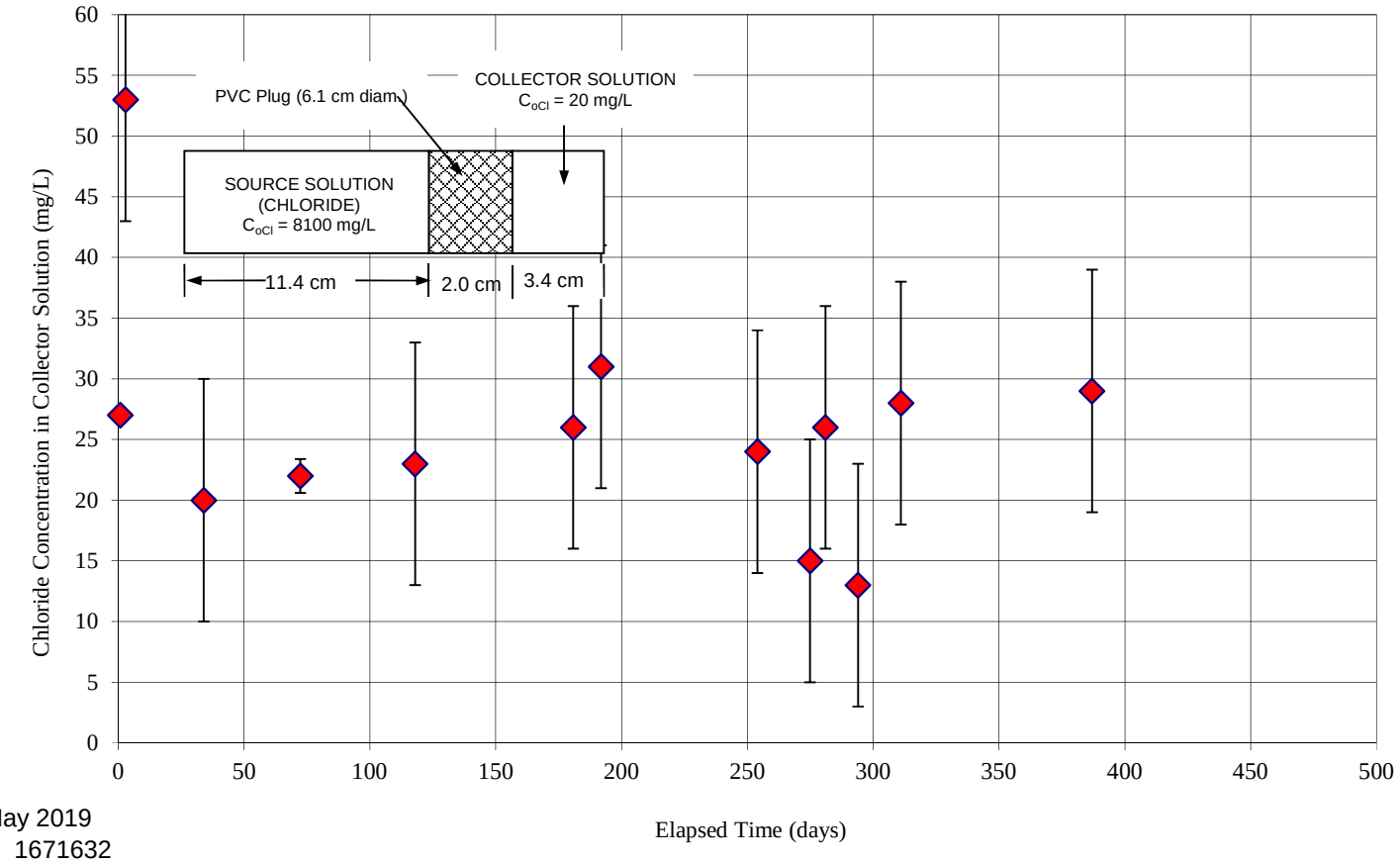
Date: May 2019
Project: 1671632
*Hollow datapoints represent less than detection limit
**Error bars, showing one standard deviation, are too small to be visible at this scale

Drawn: DJ
Checked: FB

Golder Associates

Salt Control Test (Chloride)

Appendix C
Figure 11A



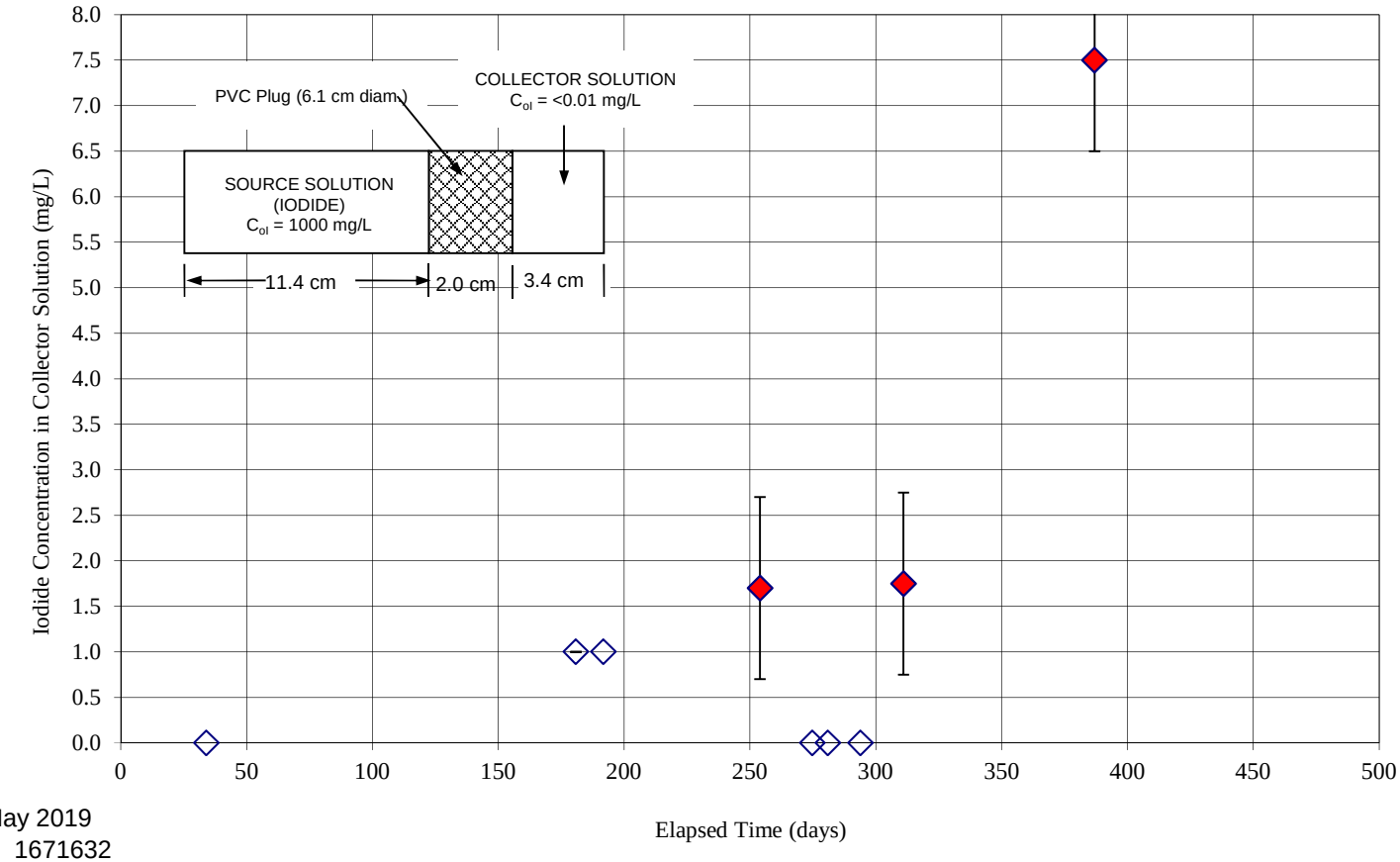
Date: May 2019
Project: 1671632
*Hollow data points are below detection limit
**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

Golder Associates

Salt Control Test (Iodide)

Appendix C
Figure 11B



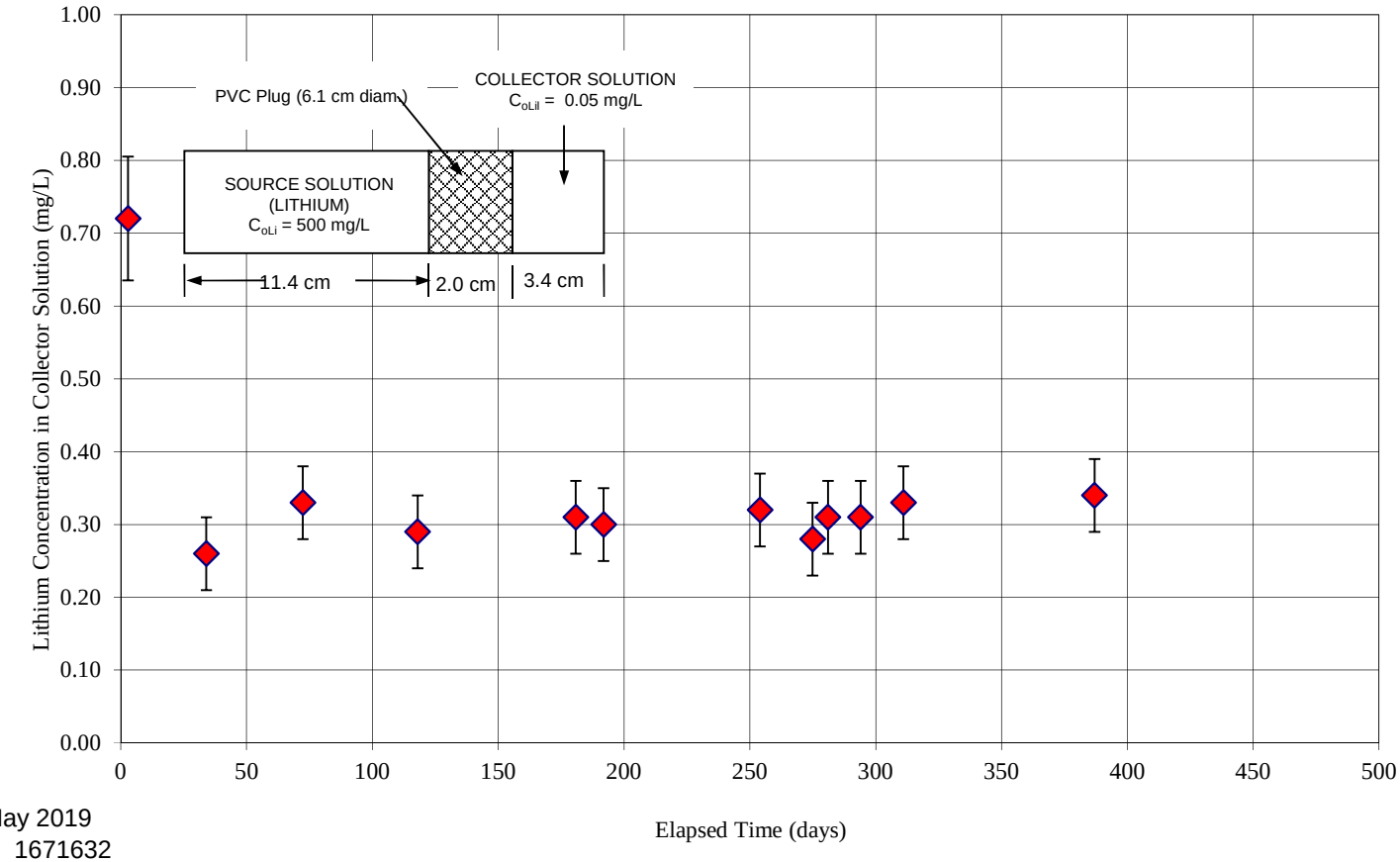
Date: May 2019
Project: 1671632
*Hollow data points are below detection limit
**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

Golder Associates

Salt Control Test (Lithium)

Appendix C
Figure 11C



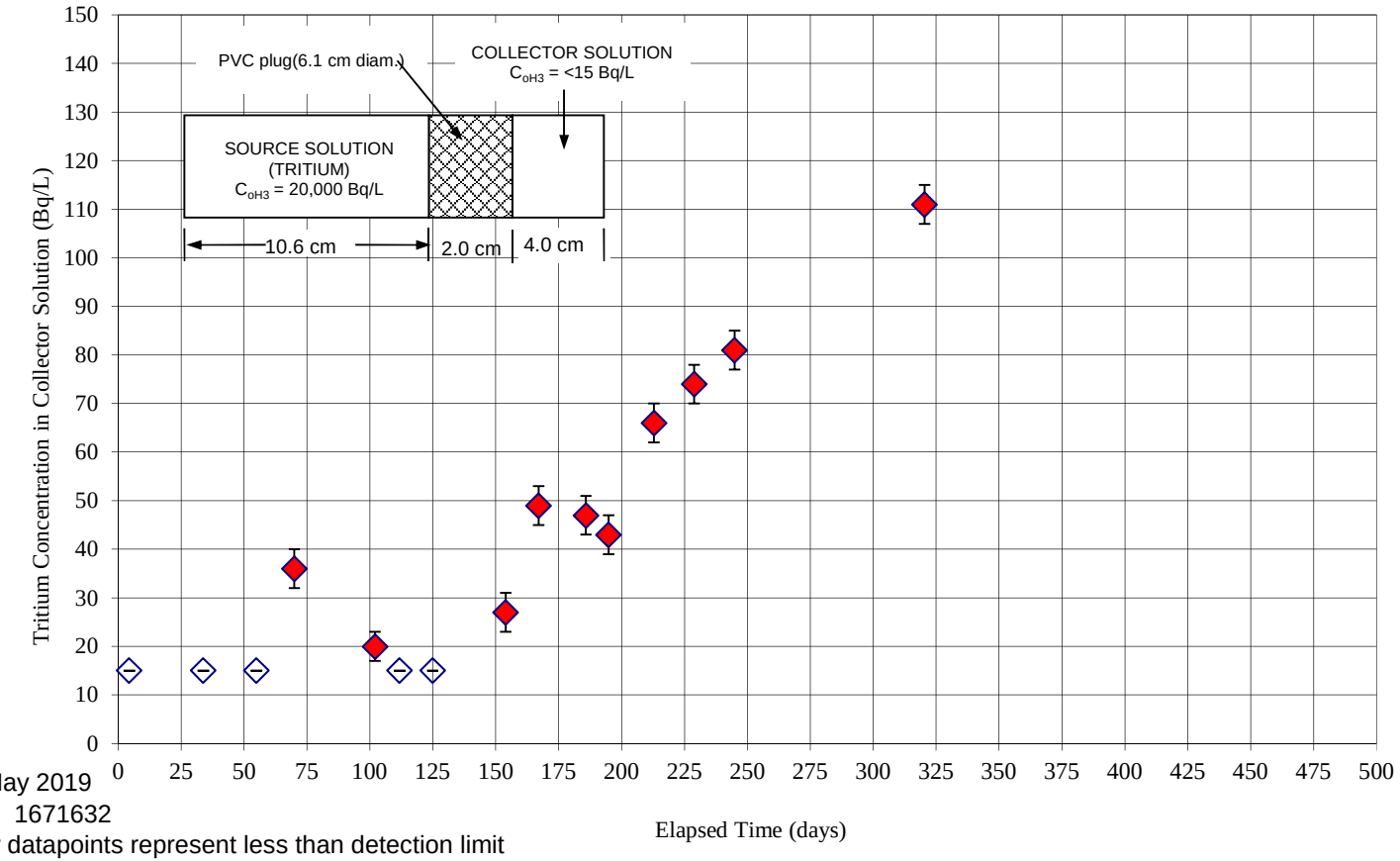
Date: May 2019
Project: 1671632
*Hollow data points are below detection limit
**Error bars represent measurment uncertainty as reported by Maxxam Laboratories for given sampling event

Drawn: DJ
Checked: FB

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Control Test (Tritium)

Appendix C
Figure 11D



Date: May 2019
Project: 1671632

*Hollow datapoints represent less than detection limit

**Error bars represent one standard deviation analytical error reported by Maxxam Laboratories for given sampling event

Drawn: DJ
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Appendix C.1 Calculation for Evaporative Losses from Diffusion Cells

Assumptions:

1) Losses are 100% evaporation (only water) and that no salts exit the cell other than during sampling.
2) Losses from the source and collector solutions are proportional to their respective initial masses and source and collector. Example, if the collector accounts for 0.2 of the weight of water in a cell, then it is assumed that 20% of the evaporative losses occurred from the collector, and that 80% of the evaporative losses occurred from the source.
3) That differences between the measured collector concentrations and the adjusted collector concentration values have negligible effect on the concentration gradient and hence diffusive flux through the specimen.

Calculations:

First, we must calculate the average loss per day from the collector.

$$M_{To} = Initial\ Total\ Mass\ of\ Cell\ (g)$$

$$M_{Tt} = Total\ Mass\ of\ Cell\ (g)\ at\ time\ t$$

$$M_{Lt} = Mass\ Lost\ from\ Cell\ (g)\ at\ time\ t$$

Equation 1: $$M_{Lt} = M_{To} - M_T$$

$$M_{So} = Initial\ Mass\ of\ Source\ (g)$$

$$M_{Co} = Initial\ Mass\ of\ Collector\ (g)$$

$$t = time\ since\ start\ of\ test\ (days)$$

$$M_C = Mass\ of\ Collector\ (g)\ at\ time\ t$$

$$M_S = Mass\ of\ Source\ (g)\ at\ time\ t$$

Equation 2: $$(M_{So} - M_S) + (M_{Co} - M_C) = M_L$$

$$M_{SL} = Mass\ Lost\ from\ Source\ (g)\ at\ time\ t$$

$$M_{CL} = Mass\ Lost\ from\ Collector\ (g)\ at\ time\ t$$

Equation 3: $$M_{So} - M_S = M_{SL}$$

Equation 4: $$M_{Co} - M_C = M_{CL}$$

Adding Equations 3 and 4 into Equation 2, and rearranging according to assumption 2 provides:

Equation 5: $$M_{LC} = \frac{M_L}{\left(\frac{M_{So}}{M_{Co}} + 1\right)}$$

$$M_{LCavg} = Average\ mass\ loss\ rate\ from\ collector\ (\frac{g}{day})$$

Equation 6: $$M_{LCavg} = \frac{M_{LCt}}{t}$$

As the cells were first stored outside of the humidity room, and then later added to the humidity room there are two distinct time periods where the average losses are different. These are accounted for by simply using two different averages, denoted as

$$M_{LCavg1} \text{ and } M_{LCavg2}$$

Next, we must adjust the concentration provided by Pollute for a given time period.

$$C_{CC} = concentration\ in\ collector\ calculated\ by\ Pollute\ \left(\frac{mg}{L}\right)$$

$$C_{CA} = concentration\ in\ collector\ adjusted\ \left(\frac{mg}{L}\right)$$

$$V_C = volume\ of\ collector\ (mL)$$

$$t_{TP1} = time\ \ when\ cells\ were\ placed\ in\ humidty\ room\ (days)$$

Time Period 1 (for $t\ <\ t_{TP1}$)

$$C_{CA} = \frac{(C_{CC}\ \times\ V_c)}{\left(V_c - \left(M_{LCavg1}\ \times\ t\right)\right)}$$

Time Period 2 (for $t >\ t_{TP1}$)

$$C_{CA} = \frac{(C_{CC}\ \times\ V_c)}{\left(V_c - \left(M_{LCavg1}\ \times\ t_{TP1}\right) - \left(M_{LCavg2}\ \times\ (t - \ t_{TP1})\right)\right)}$$

Appendix C.2 Calculation for Consideration of Background Chloride Concentration in Salt Diffusion Collector Solution.

Assumptions:

1) That differences between the measured collector concentrations and the adjusted collector concentration values have negligible effect on the diffusive flux of the system.

Calculation:

$$t = time\ since\ start\ of\ test\ (days)$$

$$s\ \ = number\ of\ sample\ occurances\ at\ time\ t\ (-)$$

$$V_C = volume\ of\ collector\ (mL)$$

$C_{CCt} = concentration\ in\ collector\ calculated\ by\ Pollute\ for\ time\ t\left(\frac{mg}{L}\right)$

$$C_{CAt} = concentration\ in\ collector\ adjusted\ for\ time\ t\left(\frac{mg}{L}\right)$$

$$V_x = volume\ of\ collector\ solution\ sample\ (mL)$$

$$C_{CS} = concentration\ in\ collector\ stock\ soltuion\ \left(\frac{mg}{L}\right)$$

$$C_{CAt} = C_{CCt} + \left(s\ \ \times \left(\frac{V_x \times C_{CS}}{V_C}\right)\right)$$

APPENDIX D

Hydraulic Conductivity Test Results

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1671632	SAMPLE DEPTH, m	411.14-411.39
PROJECT TITLE	NWMO/Drilling/Ignace	DATE STARTED	12/14/2017
SAMPLE ID	IG_BH01_HC001 Gradient 30		

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	4.83	SAMPLE AREA, cm^2	28.98
SAMPLE DIAMETER, cm	6.07	SAMPLE VOLUME, cm^3	140.01
TOTAL MASS, g	368.27		
DRY MASS, g	367.62		
WATER CONTENT, %	0.18		

SATURATION STAGE

CELL PRESSURE, kPa	140	EFFECTIVE CONSOLIDATION STRESS,	10
HEAD PRESSURE, kPa	130	DURATION, min	1060
BACK PRESSURE, kPa	130	B COEFFICIENT	0.96

CONSOLIDATION STAGE

CELL PRESSURE, kPa	500	EFFECTIVE CONSOLIDATION STRESS,	370
HEAD PRESSURE, kPa	130	DURATION, min	381
BACK PRESSURE, kPa	130	VOLUME CHANGE, cm^3	0.0
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	4.83	SAMPLE AREA, cm^2	28.98
SAMPLE DIAMETER, cm	6.07	SAMPLE VOLUME, cm^3	140.01

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	514	EFFECTIVE CONSOLIDATION STRESS,	370
HEAD PRESSURE, kPa	144	DURATION, min	78712
BACK PRESSURE, kPa	130	HYDRAULIC GRADIENT, i	30

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	4.83	SAMPLE AREA, cm^2	28.98
SAMPLE DIAMETER, cm	6.07	SAMPLE VOLUME, cm^3	140.01
TOTAL MASS, g	368.36		
DRY MASS, g	367.62		
WATER CONTENT, %	0.2		

TEST RESULTS

ELAPSED TIME TO STEADY STATE FLOW (min)	57482.2
DURATION OF STEADY STATE FLOW (min)	21230.0
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.1
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.1
INFLOW TO OUTFLOW RATIO	1.0
HYDRAULIC CONDUCTIVITY (INFLOW) (m/s)	9.2E-13
HYDRAULIC CONDUCTIVITY (OUTFLOW) (m/s)	9.2E-13
HYDRAULIC CONDUCTIVITY, K, m/s	9.2E-13
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, m/s	**9.4E-13**

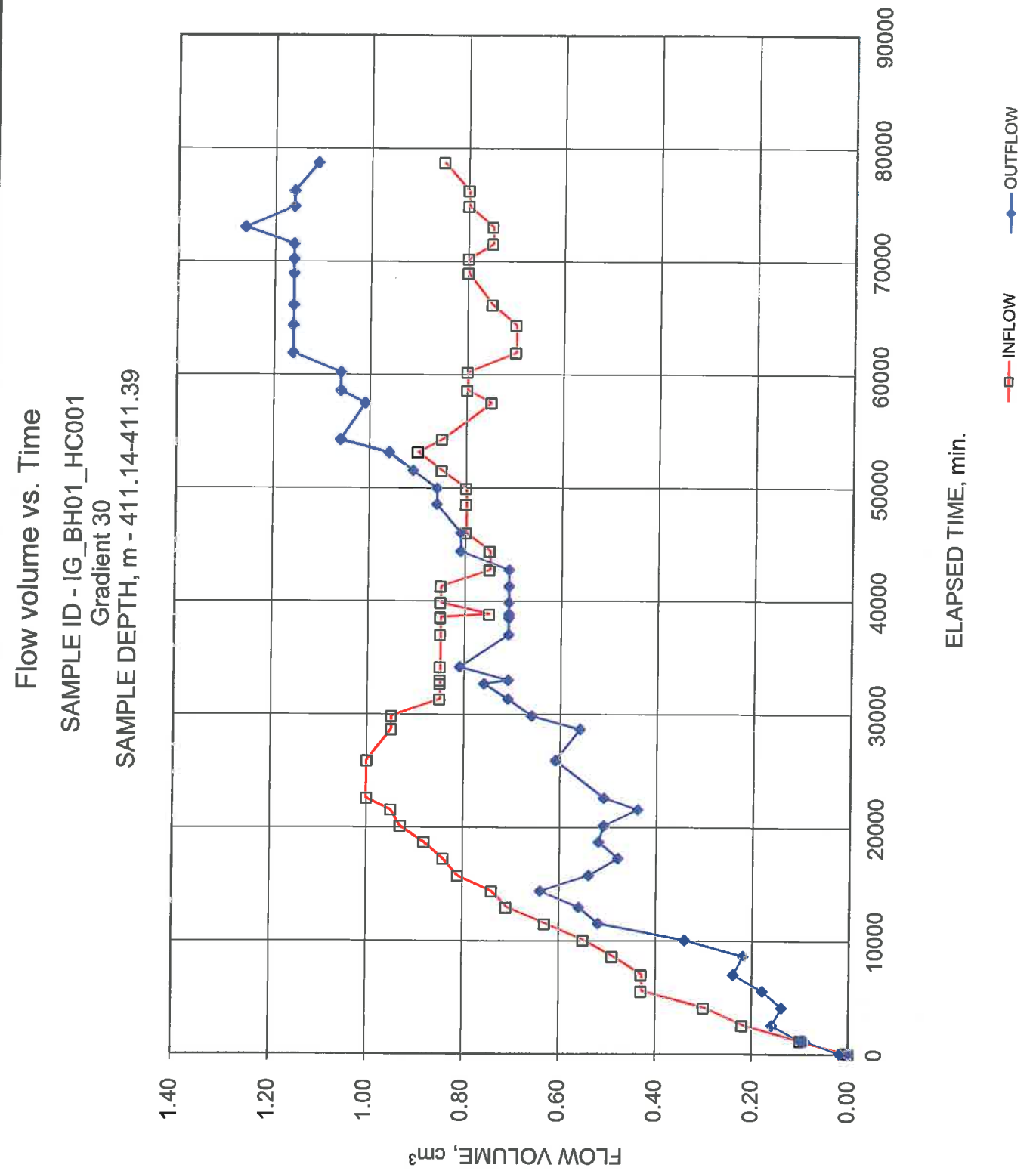
NOTES:

Effective consolidation stress assigned, according to ASTM D 5084.

PERMEANT FLUID	Deaired tap water
AVERAGE TEST TEMPERATURE	19.0 °C

HYDRAULIC CONDUCTIVITY TEST

Project title: NWMO/Drilling/Ignace
Borehole number: IG_BH01_HC001 Gradient 30
Sample depth: 12/14/2017



Project number : 1671632
Prepared by : AH

Golder Associates

Checked by :

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1671632	SAMPLE DEPTH, m	411.14-411.39
PROJECT TITLE	NWMO/Drilling/Ignace	DATE STARTED	02/12/2017
SAMPLE ID	IG_BH01_HC001 Gradient 50		

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	4.83	SAMPLE AREA, cm^2	28.98
SAMPLE DIAMETER, cm	6.07	SAMPLE VOLUME, cm^3	140.01
TOTAL MASS, g	368.27		
DRY MASS, g	367.62		
WATER CONTENT, %	0.18		

SATURATION STAGE

CELL PRESSURE, kPa	140.00	EFFECTIVE CONSOLIDATION STRESS,	10
HEAD PRESSURE, kPa	130.00	DURATION, min	1060.0
BACK PRESSURE, kPa	130.00	B COEFFICIENT	0.96

CONSOLIDATION STAGE

CELL PRESSURE, kPa	500.00	EFFECTIVE CONSOLIDATION STRESS,	370
HEAD PRESSURE, kPa	130.00	DURATION, min	381
BACK PRESSURE, kPa	130.00	VOLUME CHANGE, cm^3	0.00
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	4.83	SAMPLE AREA, cm^2	28.98
SAMPLE DIAMETER, cm	6.07	SAMPLE VOLUME, cm^3	140.01

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	524.00	EFFECTIVE CONSOLIDATION STRESS,	370
HEAD PRESSURE, kPa	154.00	DURATION, min	31110
BACK PRESSURE, kPa	130.00	HYDRAULIC GRADIENT, i	51

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	4.83	SAMPLE AREA, cm2	28.98
SAMPLE DIAMETER, cm	6.07	SAMPLE VOLUME, cm3	140.01
TOTAL MASS, g	368.36		
DRY MASS, g	367.62		
WATER CONTENT, %	0.20		

TEST RESULTS

ELAPSED TIME TO STEADY STATE FLOW (min)	11350.0
DURATION OF STEADY STATE FLOW (min)	19760.0
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.5
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.5
INFLOW TO OUTFLOW RATIO	1.0
HYDRAULIC CONDUCTIVITY (INFLOW) (m/s)	2.9E-12
HYDRAULIC CONDUCTIVITY (OUTFLOW) (m/s)	2.9E-12
HYDRAULIC CONDUCTIVITY, K, m/s	2.9E-12
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, m/s	**2.9E-12**

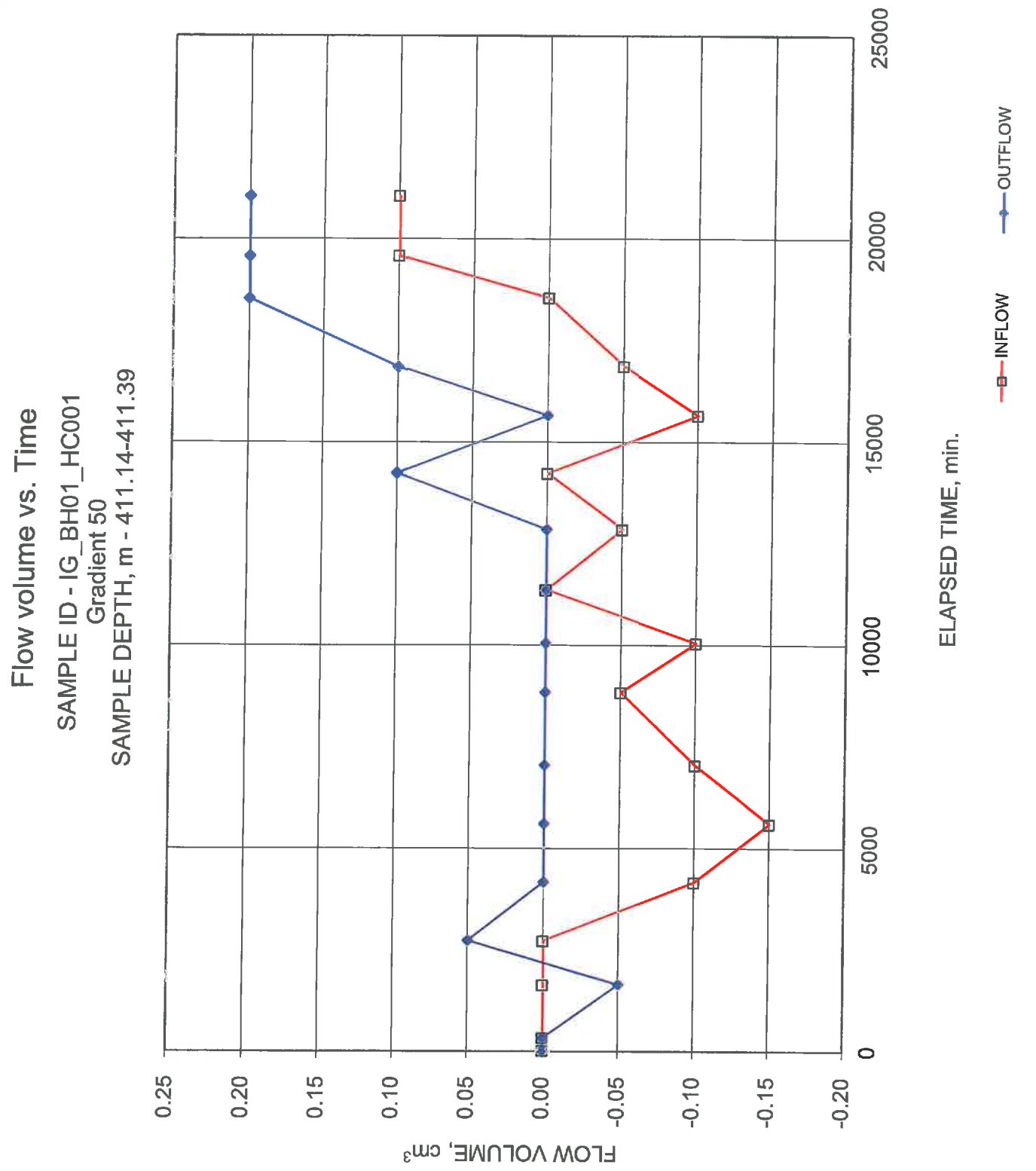
NOTES:

Effective consolidation stress assigned, according to ASTM D 5084.

PERMEANT FLUID	Dealred tap water
AVERAGE TEST TEMPERATURE	20.0 °C

HYDRAULIC CONDUCTIVITY TEST

Project title: NWMO/Drilling/Ignace
Borehole number: IG_BH01_HC001 Gradient 50
Sample depth: 02/12/2017



Project number : 1671632
Prepared by : AH

Golder Associates

Checked by :

HYDRAULIC CONDUCTIVITY TEST

ASTM D 5084 (CONSTANT HEAD)

SAMPLE IDENTIFICATION

PROJECT NUMBER	1671632	SAMPLE DEPTH, m	411.14-411.39
PROJECT TITLE	NWMO/Drilling/Ignace	DATE STARTED	03/07/2017
SAMPLE ID	IG_BH01_HC001 Gradient 70		

SPECIMEN PROPERTIES AND DIMENSIONS (INITIAL)

SAMPLE HEIGHT, cm	4.83	SAMPLE AREA, cm^2	28.98
SAMPLE DIAMETER, cm	6.07	SAMPLE VOLUME, cm^3	140.01
TOTAL MASS, g	368.27		
DRY MASS, g	367.62		
WATER CONTENT, %	0.18		

SATURATION STAGE

CELL PRESSURE, kPa	140.00	EFFECTIVE CONSOLIDATION STRESS,	10.0
HEAD PRESSURE, kPa	130.00	DURATION, min	1060.00
BACK PRESSURE, kPa	130.00	*B* COEFFICIENT	0.96

CONSOLIDATION STAGE

CELL PRESSURE, kPa	500.00	EFFECTIVE CONSOLIDATION STRESS,	370
HEAD PRESSURE, kPa	130.00	DURATION, min	381
BACK PRESSURE, kPa	130.00	VOLUME CHANGE, cm^3	0.00
		DRAINAGE	Top and Bottom

SPECIMEN PROPERTIES AND DIMENSIONS (AFTER CONSOLIDATION)

SAMPLE HEIGHT, cm	4.83	SAMPLE AREA, cm^2	28.98
SAMPLE DIAMETER, cm	6.07	SAMPLE VOLUME, cm^3	140.01

HYDRAULIC CONDUCTIVITY STAGE

CELL PRESSURE, kPa	533	EFFECTIVE CONSOLIDATION STRESS,	370
HEAD PRESSURE, kPa	163	DURATION, min	44643
BACK PRESSURE, kPa	130	HYDRAULIC GRADIENT, *i*	70

SPECIMEN PROPERTIES AND DIMENSIONS (FINAL)

SAMPLE HEIGHT, cm	4.83	SAMPLE AREA, cm^2	28.98
SAMPLE DIAMETER, cm	6.07	SAMPLE VOLUME, cm^3	140.01
TOTAL MASS, g	368.36		
DRY MASS, g	367.62		
WATER CONTENT, %	0.20		

TEST RESULTS

ELAPSED TIME TO STEADY STATE FLOW (min)	9980.0
DURATION OF STEADY STATE FLOW (min)	34663
INFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.4
OUTFLOW VOLUME UNDER STEADY STATE FLOW (cm^3)	0.6
INFLOW TO OUTFLOW RATIO	0.6
HYDRAULIC CONDUCTIVITY (INFLOW) (m/s)	8.8E-13
HYDRAULIC CONDUCTIVITY (OUTFLOW) (m/s)	1.5E-12
HYDRAULIC CONDUCTIVITY, K, m/s	1.2E-12
HYDRAULIC CONDUCTIVITY AT STANDARD TEMPERATURE, K_{20}, m/s	**1.2E-12**

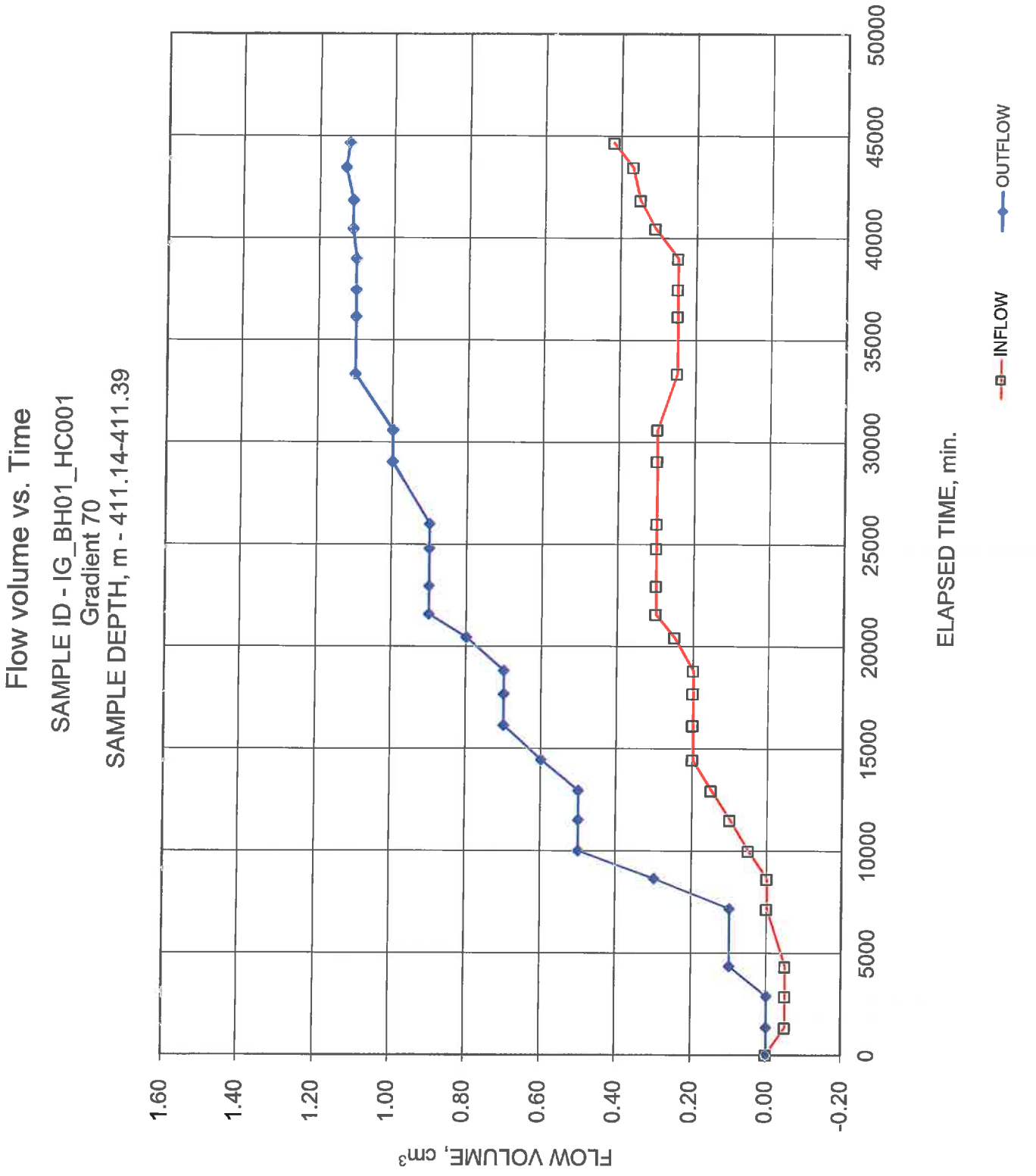
NOTES:

Effective consolidation stress assigned, according to ASTM D 5084.

PERMEANT FLUID	Deaired tap water
AVERAGE TEST TEMPERATURE	20.0 °C

HYDRAULIC CONDUCTIVITY TEST

Project title: NWMO/Drilling/Ignace
Borehole number: IG_BH01_HC001 Gradient 70
Sample depth: 03/07/2017



Project number : 1671632
Prepared by : AH

Golder Associates

Checked by :



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