BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

THE VILLAGE OF NEW MARYLAND

GROUNDWATER SUPPLY IN THE SUNRISE WELLFIELD

HYDROGEOLOGICAL ASSESSMENT OF TW21-01

FINAL

PROJECT NO.: 2231001 DATE: March 31, 2021

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY
330 Alison Blvd
Fredericton, NB Canada E3C 0A9
Telephone (506) 460-8660
Fax (506) 460-8679

March 31, 2021
Project No.: 2231001

Cynthia Geldart
The Village of New Maryland
584 New Maryland Highway (Route 101)
New Maryland, NB E3C 1K1

Dear Cynthia,

Re: Groundwater Supply – Hydrogeological Assessment of TW21-01, New Maryland, NB

BGC Engineering Inc. is pleased to provide you with this report relating to the continuing development of the Sunrise Wellfield in New Maryland, NB. This report provides a record of observation well installation (OW20-01 through OW20-04), production-scale well construction (TW21-01), hydraulic testing, and water quality sampling associated with this phase of the project, including nine private residential wells in the monitoring network.

This work followed the Water Supply Source Assessment process, as directed by the Environmental Impact Assessment Branch of the New Brunswick Department of Environment and Local Government. Should you have any questions regarding this report, please feel free to contact the undersigned.

Yours sincerely,

BGC ENGINEERING INC.
per:

Kent Wiezel, M.A.Sc., P.Eng.
Senior Hydrogeological Engineer

EXECUTIVE SUMMARY

In December 2020, BGC was retained by the Village of New Maryland (the Village) to assist with the further development of the Sunrise Wellfield, located south of the Sunrise Estates subdivision. The purpose of the current work was to construct a second production-scale well (TW21-01) and complete a Hydrogeological Assessment in accordance with the requirements in the New Brunswick Department of Environment and Local Government's Water Supply Source Assessment guidelines. BGC previously completed a Hydrogeological Assessment for the first production-scale well (TW17-01) constructed in the Sunrise Wellfield (BGC, April 9, 2018).

In this latest phase of the work, four 152 mm diameter observation wells (OW20-01, OW20-02, OW20-03, and OW20-04) were drilled between the Sunrise Wellfield and Sunrise Estates, and a 305 mm diameter production-scale well (TW21-01) was constructed, developed, and tested. The observation wells were drilled to depths between approximately 30 m below ground surface (bgs) and 150 m bgs, and TW21-01 was drilled to 106.7 m bgs. OW20-01, OW20-03, and TW21-01 incepted a large water-bearing fracture (up to 0.3 m thick) with artesian pressures, which provides the bulk of the yield for the confined bedrock aquifer. OW20-02 and OW20-04 were shallower to simulate the construction of residential wells in nearby Sunrise Estates.

The testing program of TW21-01 included two step-drawdown tests (step-tests) and a 72-hour constant-rate pumping test (CRT) followed by recovery monitoring. The step-tests consisted of pumping rates between 884 m^3/d and 1,833 m^3/d, and the CRT was completed at 1,635 m^3/d (300 US gpm) based on the results of the step-tests. Available test wells and a network of nine private residential wells were monitored during testing for water quantity (water levels and drawdown) and water quality (geochemical sampling). From the testing program, three general well groupings were classified:

- Group A wells – intersect the artesian fracture within the sandstones (strongly connected)
- Group B wells – intersect the artesian fracture within the shales (moderately connected)
- Group C wells – do not intersect the artesian fracture (not connected).

Based on the results of the hydraulic testing and monitoring programs, the recommended safe yield of TW21-01 was rated at 1,365 m^3/d (250 US gpm). At that rate, the predicted long-term interference drawdown at the most impacted private residential wells is estimated to be up to 10 m after 10 years of continuous pumping. The safe yield for TW21-01 was determined using the following limitations and assumptions:

- The selected analytical model adequately characterizes the drawdown response with sustained pumping, to an approximate drawdown of 18 m after 10 years.
- The pumping level always remains within the casing, and above approximately 31.1 m bgs, or at an elevation greater than 23.5 m.
- Seasonal variation, observed as up to 3 m in the wellfield and up to 6 m in the Victoria Hall well over a similar period, is considered.
- The drawdown interference when pumping from other wells around TW21-01, including that of the nearby domestic wells (particularly those in Group A or Group B), is considered.

TW21-01 is the second municipal production well in the Sunrise Wellfield, to be operated in tandem with the existing and previously approved TW17-01, also rated at 1,365 m^3/d (250 US gpm). The overall yield of the Sunrise Wellfield is subject to continued evaluation of ongoing pumping and corresponding water elevations as pumping progresses. A robust monitoring program for water quantity and quality should be put in place for the Sunrise Wellfield with a particular focus on the nearby residential wells in Sunrise Estates and along NB Route 101.

Groundwater chemistry samples from the wellfield suggest that treatment will be required for manganese and perhaps turbidity. Groundwater chemistry in samples from the residential wells may have been masked by water softeners in some locations and indicate that there may be existing impacts from road salt application in some wells.

The long-term challenges in operating the Sunrise Wellfield could include:

- Availability of recharge to the wellfield from the north/northwest where the artesian fracture appears to be within the less productive shales and eventually could intersect the bedrock surface northwest of Route 101.
- Limitations on the available drawdown in the pumping wells owing to seasonal trends, observed as up to 3 m in the wellfield.
- Possible long-term impacts from road salt application near the wellfield.

It is recommended that the flowing artesian wells be fully closed after the risk of freezing has subsided, and the pumping water levels and recovery be assessed in summer (dry) conditions.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

Acronyms and abbreviations used in this report:

AO	aesthetic objective
B	Aquifer Loss Coefficient
BGC	BGC Engineering Inc.
bgs	below ground surface
C	Well Loss Coefficient
CRT	constant-rate pumping test
ECCC	Environment and Climate Change Canada
EIA	Environmental Impact Assessment
GCDWQ	Guidelines for Canadian Drinking Water Quality
MAC	maximum acceptable concentration
NBDELG	New Brunswick Department of Environment and Local Government
Opus	Opus International Consultants
OWLS	online well log system
RPC	Research and Productivity Council
S	Storativity
SCC	Standards Council of Canada
Sullivan’s	Sullivan’s Well Drilling Ltd.
T	Transmissivity
t	time since pumping started
t’	time since pumping ceased
t/t’	ratio of time since pumping started to time since pumping ceased
VOCs	Volatile Organic Compounds
WSP	WSP Canada
WSSA	Water Supply Source Assessment
WfPADO	Wellfield Protected Area Designation Order

UNITS OF MEASURE

Units of measure used in this report:

d	days
mg/L	milligram per litre
min	minutes
m^2/d	square metres per day
m^3/d	cubic metres per day
m^3/yr	cubic metres per year
US gpm	US gallons per minute (1 US gpm = 5.451 m^3/d)

LIMITATIONS

BGC Engineering Inc. (BGC) prepared this document for the account of The Village of New Maryland. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

As a mutual protection to our client, the public, and ourselves all documents and drawings are submitted for the confidential information of our client for a specific project. Authorization for any use and/or publication of this document or any data, statements, conclusions or abstracts from or regarding our documents and drawings, through any form of print or electronic media, including without limitation, posting or reproduction of same on any website, is reserved pending BGC's written approval. A record copy of this document is on file at BGC. That copy takes precedence over any other copy or reproduction of this document.

1.0 INTRODUCTION

BGC Engineering Inc. (BGC) has been providing hydrogeological support for the municipal groundwater supply for the Village of New Maryland ("the Village") since 2014. Previous work scopes were completed for WSP Canada (WSP, formerly Opus International Consultants [Opus]) on behalf of the Village. In December 2020, BGC was retained directly by the Village to assist with the further development of their water supply in the area which is now referred to as the Sunrise Wellfield. Development of this wellfield began in 2017 with the construction, testing and approval of production well TW17-01 (BGC, April 9, 2018). The project was re-initiated following a public open house session for Village residents on July 9, 2020.

This report provides the methods and results of the construction and hydraulic testing of a new well (TW21-01) in the Sunrise Wellfield. Activities included baseline monitoring, observation well installation, production-scale well construction, well development, hydraulic testing, and water quality sampling. The monitoring network included test wells, observation wells, and private residential wells in the surrounding area. This work was completed between December 2020 and March 2021 per the scope outlined in BGC (November 25, 2020).

1.1. Project Background

In 2005, four bedrock test wells were drilled (by others) on an undeveloped private property (PID 75062174, Figure 1-1 and Figure 1-2), south of the Sunrise Estates subdivision. The depths of the four test wells ranged from 91.5 m below ground surface (bgs) to 103.6 m bgs, with estimated well yields between approximately 130 m^3/d and 650 m^3/d (Gemtec, July 14, 2005). These test wells are labeled TW05-01, TW05-02, TW05-03, and TW05-04, and shown on Figure 1-2.

BGC was initially retained in 2014 by WSP to continue the exploration for additional groundwater supply. In 2016 BGC, WSP, and the Village revisited the test area south of Sunrise Estates, deepened test wells TW05-02 (from 109.7 m to 147.5 m) and TW05-04 (from 103.6 m to 144.1 m); they found a high-yielding water-bearing bedrock fracture at depth with a static water level above ground surface (i.e., flowing artesian) at the TW05-02 and TW05-04 locations. Hydraulic testing was subsequently completed, consisting of a step-test and 72-hour constant rate test (CRT), and a preliminary sustainable yield of 1,365 m^3/d (250 US gpm) was estimated for TW05-02 (BGC, March 24, 2017).

Following a recommendation from BGC (March 24, 2017), one production-scale well (TW17-01) was drilled near TW05-04 to intercept the artesian fracture. A hydrogeological assessment program was completed and the safe yield of TW17-01 was estimated to be 1,365 m^3/d, or 250 US gpm (BGC, April 9, 2018). A Hydrogeological Assessment Report was then submitted to the New Brunswick Department of Environment and Local Government (NBDELG) for their approval of TW17-01 as a municipal groundwater supply well for the Village within the new Sunrise Wellfield. The Village is now seeking a second (redundant) pumping well for the wellfield.

The wellfield is approximately 500 m southwest of the Sunrise Estates subdivision, which is entirely serviced by individual private domestic wells. BGC understands that the Village does not currently intend to connect Sunrise Estates to the municipal drinking water distribution system.

1.2. Scope of Services

The scope of the current phase of the project was defined in a BGC proposal dated November 25, 2020 to the Village and followed recommendations from BGC (March 24, 2017 and April 9, 2018). The scope in the current phase of the project included the following tasks:

1. Construct and develop one production-scale well near TW05-02.
2. Install four bedrock observation wells between the Sunrise Wellfield and the Sunrise Estates subdivision.
3. Install automatic pressure transducers in the test wells, bedrock observation wells, and in select nearby residential wells (completed by BGC and WSP).
4. Collect baseline water quality samples for subsequent laboratory analyses from each of the monitoring wells and residential wells (completed by the Village and WSP).
5. Complete a hydraulic testing program at the new production-scale well.
6. Submit a Hydrogeological Assessment report.

This report documents Tasks 1 through 5, and acts as the deliverable for Task 6.

1.3. Regulatory Setting

Commercial, industrial and community groundwater supply investigations in New Brunswick follow the Water Supply Source Assessment (WSSA) process, as directed by the Environmental Impact Assessment (EIA) Branch of NBDELG. The latest revision of the WSSA document can be found online (NBDELG, 2017). The intent of the WSSA process is to develop water supplies that are ultimately protected by controlling the potential factors that can be controlled during well construction and testing. These include mandating a minimum amount of protective casing, grouting around the protective casing, a minimum suite of chemical parameters for analytical water sampling, and timing of pumping tests to reduce the possibility of overestimating the sustainable well yield.

The WSSA process involves two main steps: the WSSA Initial Application (formerly ‘Step One’) and the Hydrogeological Assessment (formerly ‘Step Two’). The WSSA Initial Application involves siting drilling targets (typically a desktop evaluation supported by ground truthing), and the Hydrogeological Assessment includes the actual field program (drilling, well construction and development, hydraulic testing and analytical sampling), analysis and reporting. As quoted in the WSSA document, “WSSAs must be completed to the satisfaction of the Department of Environment and Local Government. Incomplete or inadequate submissions will be returned to the applicant for completion. The Hydrogeological Assessment and yield testing must be completed under the direct supervision of a qualified Professional Engineer or Geoscientist registered with the Association of Professional Engineers and Geoscientists of New Brunswick. All final work must be signed and professionally sealed.” This report is to be submitted to satisfy the requirement of the Hydrogeological Assessment portion of the WSSA process.

2.0 SITE DESCRIPTION

The project site (Sunrise Wellfield) is located in the southeastern portion of New Maryland, NB, south of the Sunrise Estates subdivision on parcels 75534586, 75062174, and 75064840. Two production-scale wells, four test wells, and four observation wells exist on the project site. The area surrounding the wellfield is a combination of undeveloped forest area and homes with individual private wells in Sunrise Estates and along NB Route 101 (Figure 1-2).

2.1. Climate, Topography and Drainage

Annual temperature and precipitation for the New Maryland area have been estimated based on climate data between 2010 and 2021 from Environment and Climate Change Canada (ECCC, n.d.). Average monthly temperatures ranged from -14.8°C to 21.4°C with a mean annual average of 6.1°C. Average annual precipitation over this period is estimated to be 1,158 mm, varying between a low of 867 mm in 2020 and a high of 1,411 mm in 2018.

The surface elevation in the greater New Maryland area ranges from approximately 10 m to 200 m, with the highest ground elevation to the northwest. The surface elevation of the site ranges from approximately 50 m to 70 m and generally slopes to the southeast. The site is primarily undeveloped, forested land, and has a wetland in the approximate centre. Two brooks are located near the site: Burpee Brook and its tributary Berry Brook. Burpee Brook flows north to south across the site, and Berry Brook flows roughly parallel with the site to the south before entering Burpee Brook. Burpee Brook then joins the North Branch Rusagonis Stream, which flows roughly northwest to southeast through the immediate project area. The Rusagonis Stream is a tributary to the Oromocto River, which ultimately drains into the St. John River.

As discussed in BGC (April 9, 2018), the potential drainage area that is considered to provide recharge to the aquifer is approximately 12 km^2. This area is estimated to provide between approximately 1,400,000 m^3/yr and 4,000,000 m^3/yr of recharge to the aquifer, with approximately 146,000 m^3/yr of the recharge extracted by private residential wells (BGC, April 9, 2018).

2.2. Geology and Hydrogeology

The overburden of the site is a silt-dominated till, which is typically 1 m to 20 m thick, deposited by advancing glaciers (Allard and Gilmore, 2016). The bedrock in the area is part of the Minto Formation of the Pictou Group of rocks, consisting of Late Carboniferous aged, coarse-to-fine-grained sediments, including grey and red-brown beds of conglomerate, sandstone, siltstone, mudstone, and shale, with thin seams of coal (St. Peter and Fyffe, 2005).

An interpreted sub-surface cross section of the site from northwest to southeast (section A-A’ as shown on Figure 1-2) is depicted on Figure 2-1. The majority of the yield at the site is derived from the artesian fracture, which appears to act as a confined aquifer. The artesian fracture was encountered during previous investigations, while deepening test wells TW05-02 and TW05-04 (BGC, March 24, 2017), and during drilling of TW17-01 (BGC, April 9, 2018). A fractured zone was identified between 65 m bgs and 95 m bgs in Test well TW05-01, as reported by others. The shallower elevation for the artesian fracture (65 m bgs) was adopted for the conceptual model as this elevation was consistent with the fracture plane when considering observations from all test wells and observation wells. Flowing artesian conditions are absent at TW05-01 due to the higher ground elevation at that location, as depicted on the conceptual model (Figure 2-1). Figure 2-1 also shows that the general topography and water levels slope from northwest to southeast, and that the artesian fracture is interpreted to occur in the shales to the northwest and in the sandstones to the southeast, with a dip of approximately 10% (generally aligned with the section in Figure 2-1) that is steeper than the bedding dip. The artesian fracture could intersect the bedrock surface between approximately 1 km and 2 km northwest of TW21-01.

From previous BGC investigations, water levels at the site fluctuate by approximately 3 m seasonally, typically being lowest near the end of summer and highest in the winter/spring, in the wells that intercept the artesian fracture. This is corroborated by a monitoring well owned by the Province of New Brunswick at Victoria Hall, which shows seasonal fluctuations of up to 6 m (BGC, April 9, 2018). Flowing artesian conditions appear to prevail within the Sunrise Wellfield (e.g., at the TW05-02/TW21-01 and TW05-04/TW17-01 locations) even when water level elevations are at their seasonal lowest.

2.3. Monitoring Network

A total of 21 wells were monitored throughout the hydraulic testing program, which included the two production-scale wells (TW17-01 and TW21-01), four test wells (TW05-01, TW05-02, TW05-03, and TW05-04), four observation wells (OW20-01, OW20-02, OW20-03, and OW20-04), nine private residential wells (labelled OW-01, OW-02, OW-05, OW-06, OW-09, OW-10, OW-15, OW-16, and OW-17), the provincial monitoring well at Victoria Hall, and one older (1970's) exploration well north of Route 101. Refer to Figure 1-2 for the locations of the wells within the monitoring network. The specific locations of private residential wells are not shown on Figure 1-2 or reported herein to respect the privacy and confidentiality of the homeowners.

The NBDELG online well log system (OWLS) was queried to return available residential well logs in the database within a 1 km radius of the project site. The OWLS database returned 33 well logs within that radius (specific locations not provided). Summary details are provided in Table 2-1. From the database, the average (mean) well depth is 76 m.

Table 2-1. Summary of available well logs within 1 km of the Sunrise Wellfield.

	Well Depth (m)	Depth to Bedrock (m)	Estimated Yield (m^3/d)
Mean	76	7	279
Median	73	5	78
Mode	91	1	131
Maximum	148	45	2,293
Minimum	18	0	0

Notes:

1. All data in the table provided by the NBDELG OWLS database and is based on driller well logs.
2. Specific well locations not provided by the OWLS database for confidentiality.

3.0 METHODS

As part of this scope of work, BGC completed the following tasks:

- Designed the test well TW21-01 as a production-scale well, based on the stratigraphy encountered in TW05-02.
- Oversaw the drilling, construction and development of OW20-01 through OW20-04 and TW21-01.
- Designed and monitored the hydraulic testing and sampling program completed at production-scale well TW21-01.
- Presented the associated methodology and findings in this report.

3.1. Well Drilling and Development

Between December 2020 and February 2021, four observation wells (OW20-01, OW20-02, OW20-03, and OW20-04) were drilled at two nested locations (refer to Figure 1-2) and one production-scale well (TW21-01) was constructed adjacent to TW05-02. Access to the site was established by the Village via Sunrise Estates, and drilling services were provided by Sullivan's Well Drilling Ltd. (Sullivan's) using an air-rotary drill rig. The stratigraphy was interpreted and logged in the field based on the drill cuttings, which were collected at regular intervals. The log and construction details for the four observation wells and TW21-01 are provided in Appendix A. Logs for the previously drilled wells at the site were provided in BGC (April 9, 2018).

The observation wells and production-scale well were cased into bedrock and drilled as open holes to the target depths. Observation wells were drilled at a 152 mm diameter and the production scale-well was drilled at a 305 mm diameter. Wells OW20-01, OW20-03, and TW21-01 targeted the depth of the artesian fracture, up to an estimated maximum of 150 m bgs at OW20-01 and OW20-03. Wells OW20-02 and OW20-04 were intended to simulate the construction and yield of typical private residential wells in nearby Sunrise Estates but remain shallow enough to avoid the artesian fracture. The well depths of OW20-02 and OW20-04 are consistent with the reported depths in Table 2-1. The observation wells were each developed by means of an air-lifting tool for one hour and the discharge water was visually assessed for turbidity and sediment with time.

Production-scale well TW21-01 was initially developed via air-lifting for approximately four hours on February 1, 2021 until the discharge water was considered to be clear with minimal sediment. The well was then further developed after initial hydraulic testing (refer to Section 4.2.2) using a surge block for eight hours between February 8 and 9, 2021 and air-lifted for an additional two hours on February 10, 2021 to remove the material loosened during surging. Turbid water and fine sediment were discharged from TW21-01 and TW05-02 during the surging and subsequent air-lifting of TW21-01, which was not observed during the initial air-lifting.

3.2. Water Level Monitoring

Water level elevations were recorded throughout the monitoring network between December 21, 2020 and March 1, 2021, to cover a period of background before the intrusive site activities, followed by drilling and hydraulic testing at TW21-01.

Automatic pressure transducers with integrated dataloggers (Divers manufactured by Van Essen Instruments) were installed by BGC in TW21-01, TW17-01, TW05-02, TW05-03, OW20-03, and OW20-04, The transducers were set to automatically collect water level data at a ten-minute interval. The water level data were corrected for barometric pressure effects using atmospheric data collected by a Baro-Diver installed near TW21-01. Manual water level measurements were also recorded periodically throughout the monitoring well network to calibrate the automatic water level data. Vertical standpipes connected to gate valves at the well heads were installed at flowing artesian wells TW21-01, TW17-01, TW05-02, TW05-03 and the 1970's exploration well to collect manual water level readings above top of casing. These wells were generally allowed to overflow to mitigate the risk of water in the standpipes and wells from freezing.

The 1970's exploration well was flowing artesian at what seemed like a restricted rate controlled by a ball valve at the well head. The well head assembly appeared fragile due to its age, so an automatic pressure transducer was not installed in the well. Water level elevations in the Victoria Hall monitoring well were downloaded from the NBDELG website (NBDELG, n.d.) for the period of record and presented in Figure 3-1. The figure shows that water levels in that well historically fluctuate by up to 6 m.[1] The remaining test wells and observation wells (TW05-01, TW05-04, OW20-01 and OW20-02) were instrumented by WSP with Solinst Leveloggers at an initial data collection interval of six hours, which was changed to ten minutes on February 5, 2021. WSP installed a flowing well packer as part of the Levelogger system in TW05-04.

It is BGC's understanding that flowing artesian wells (TW17-01, TW05-02, TW05-03, TW05-04 and the 1970's exploration well) have typically been allowed to overflow at restricted rates since their construction. It is estimated that the combined discharge of these wells is approximately 500 m^3/d (100 US gpm).[2] Flowing artesian wells TW21-01, TW05-02, TW05-03, and TW17-01 were restricted to approximately 2 m^3/d (0.5 US gpm) of overflow at each well between February 12 and 17, 2021. The wells were restricted but not sealed during this period to mitigate the risk of the wells freezing above the frostline. The pre-pumping water levels for the constant-rate pumping test (CRT) were taken at 9:00 am on February 17, 2021 immediately prior to the installation of the pump in TW21-01.

Nine private residential wells from areas surrounding the project site were instrumented by WSP with Solinst Leveloggers at an initial data collection interval of six hours, which was changed to

---

1 The maximum water level fluctuation in the Victoria Hall well of approximately 6 m over the period of record occurred between 2017 and 2018, during the TW17-01 testing phase, over the same period that the water level in the artesian fracture at the wellfield fluctuated by approximately 3 m.

2 Previous field estimates put the overflow at TW17-01 at 150 m^3/d (approximately 30 US gpm), which was multiplied by the four overflowing wells (five counting the new TW21-01) then scaled back by 20 to 50 percent to be conservative.

ten minutes on February 5, 2021. Processed water level elevations from these wells were provided to BGC by WSP for evaluation of potential drawdown during the pumping test and prediction of long-term pumping effects on nearby private domestic wells.

3.3. Pumping Tests

The hydraulic testing program involved completion of step-drawdown tests (step-tests) on February 4 and 11, 2021, a 72-hour CRT at TW21-01 between February 17 and 20, 2021, and post-pumping (recovery) monitoring between February 20 and March 1, 2021.

The step-tests and CRT completed at TW21-01 were designed and monitored by BGC and conducted by Sullivan's using a submersible pump and mobile generator. The objective of this program was to estimate the average hydraulic parameters (transmissivity, T, and storativity, S) of the bedrock aquifer and the sustainable yield of TW21-01. The pump was installed at a depth of approximately 60 m to maximize the available drawdown. A check valve was present in the pump column and pumped water was piped approximately 20 m east to a nearby surface water feature to mitigate effects of artificial recharge of the aquifer. The risk of artificial recharge is considered to be low, due to the silt-dominated till overburden, the 31.1 m of grouted and cased construction of TW21-01, and the confined nature of the fracture-flow aquifer itself (as evidenced by the artesian pressures observed).

The step-tests consisted of four 1-hour steps at pumping rates between 884 m^3/d and 1,833 m^3/d (162 US gpm and 336 US gpm), and the CRT was completed at 1,635 m^3/d (300 US gpm). Pumping rates were monitored periodically during each test using an in-line cumulative flow meter. The change in water level due to pumping (i.e., drawdown) was calculated at each well during the step-tests, CRT, and recovery. Drawdown over time was calculated as the difference in water level from the pre-pumping water level measurement. Manual water level measurements were recorded in TW21-01 every 30 seconds at the beginning of each step of the step-test, at the onset of the CRT, and at the cessation of pumping. The frequency of manual measurements decreased to a minimum of hourly as testing proceeded and the rate of change in water levels slowed.

The results of the step-tests were assessed by calculating specific capacity for each step, the Aquifer Loss Coefficient (B) and Well Loss Coefficient (C) for each test, and plotting the results of each test as inverse specific capacity versus pumping rate.[3] Lower values of inverse specific capacity, B, and C indicate improved well performance.

The results of the CRT were analyzed using AQTESOLV (Duffield, 2007), an industry standard software package for the design and interpretation of aquifer tests. The Cooper-Jacob (1946) and Theis (1935) analytical solutions, which are suitable for confined aquifers, were selected to evaluate the drawdown data at the pumping well and monitoring well locations. The Papadopulos

[3] Specific capacity is the ratio of a well's pumping rate and the associated change in water level (drawdown) induced by this pumping rate. The Aquifer Loss Coefficient (B) and Well Loss Coefficient (C) are the y-intercept and slope, respectively, of the line-of-best-fit associated with the results of a step-test using linear regression of inverse specific capacity and pumping rate.

and Cooper (1967) analytical solution, which also considers wellbore storage for a confined aquifer, was selected to evaluate the drawdown data at the pumping well. The analyses assume that the aquifer is effectively homogeneous and isotropic with a uniform thickness. A hydraulic no-flow boundary was incorporated into the analytical model. This boundary was set to be approximately 1.5 km northwest of the pumping well (TW21-01) to coincide with the conceptual model which suggests the fracture may intersect the bedrock surface at that distance if the fracture dip of 10% is maintained to the northwest (Section 2.2). The sensitivity of the analytical solution to the orientation and distance to the boundary was investigated. Additionally, a rate of 400 m^3/d was added to the analytical model for three hours prior to commencement of the CRT. This initial flow simulated the overflow at TW21-01 that occurred while the well cap was removed and the pump was being installed.

3.4. Water Quality Sampling

Three water quality samples were collected from TW21-01 during the 72-hour CRT by BGC at approximately 24 hours, 48 hours, and 72 hours through the test. Samples were obtained from the discharge line.

Samples collected by BGC from TW21-01 were submitted to the Research and Productivity Council (RPC) Science and Engineering Analytical Services laboratory in Fredericton, NB for the following analyses:

- General chemistry and anions (not filtered, no preservative): pH, conductivity, alkalinity, turbidity, total organic carbon, chloride, fluoride, sulfate, and sulfide (not filtered, lab-preserved).
- Dissolved metals (field-filtered, field-preserved with nitric acid – HNO_3): Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Hg, Mo, Ni, K, Rb, Se, Ag, Na, Sr, Te, Tl, Sn, U, V, and Zn.
- Volatile organic compounds, EPA-624 suite (not filtered, lab-preserved with sodium thiosulfate): BTEX compounds, chlorinated ethenes, chloroform, bromoform, carbon tetrachloride, and total trihalomethanes.
- Microbiology (not filtered, lab-preserved with sodium thiosulfate): total coliforms, total faecal coliforms, and E. coli.

The final microbiology sample from TW21-01 was collected on February 22, 2021 (Monday) during the recovery portion of the test after pumping had ceased (Saturday), as microbiology samples have a 24-hour submission guideline and could not be submitted to RPC on the weekend.

A total of 18 water quality samples were collected by the Village from the remaining wells within the monitoring network, excluding the 1970's exploration well and TW21-01. The samples were collected prior to the CRT between January 12 and February 3, 2021 to establish baseline chemical concentrations. For the test wells and observation wells, it was reported that three well volumes were purged prior to sampling in accordance with their sampling protocol. For the residential wells, the water samples were collected from exterior hose taps. The water quality data were later provided to BGC.

Samples collected by the Village prior to the CRT were submitted to RPC for the following analyses:

- Potable Water (inorganic): pH, alkalinity, turbidity, chloride, fluoride, sulfate.
- Dissolved metals: Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Hg, Mo, Ni, K, Rb, Se, Ag, Na, Sr, Te, Tl, Sn, U, V, and Zn.
- Volatile organic compounds, Clean Water Act suite: BTEX compounds, chlorinated ethenes, chloroform, bromoform, and total trihalomethanes.
- Microbiology: total coliforms and E. coli.

Each water sample (by BGC and the Village) was collected in a sample container provided by RPC and kept in refrigerated storage until being submitted to RPC for analyses. RPC is accredited with the Standards Council of Canada (SCC), and the analytical results provided from the lab were compared against the most recent Guidelines for Canadian Drinking Water Quality (GCDWQ), as published by Health Canada (2020).

4.0 RESULTS

4.1. Well Construction

In December 2020, four 152 mm diameter observation wells were drilled at two nested locations, with each location containing a monitoring well pair (i.e., OW20-01/OW20-02 and OW20-03/OW20-04, refer to Figure 1-2). OW20-01 and OW20-03 were drilled as deep observation wells and intersected the artesian fracture at approximately 79 m bgs and 101 m bgs, respectively. The artesian fracture was interpreted to be in the shales in OW20-01 and sandstones in OW20-03 (Figure 2-1). The wells were not flowing artesian due to the higher ground elevation at these locations. Wells OW20-02 and OW20-04 were drilled as shallow observation wells to depths of 30.5 m bgs and 61.0 m bgs, respectively, and neither intersected the artesian fracture.

Production-scale well TW21-01 was drilled between January 18 and 29, 2021. TW21-01 was cased to 31.1 m bgs, drilled to a depth of 106.7 m bgs, and intercepted the artesian fracture (approximately 0.3 m thick) at approximately 93 m bgs. The upper 30.8 m of TW21-01 was drilled at 406 mm diameter, and the annulus between the 406 mm borehole and 305 mm casing was grouted using a cement grout mixture. The overburden thickness was approximately 2 m at TW21-01, 9 m at OW20-01/OW20-02, and 7 m at OW20-03/OW20-04. The overburden was till, and the bedrock was primarily sandstone and shale, with beds of mudstone and conglomerate, and occasional traces of lignite (coal) and pyrite.

A summary of well construction details and estimated yield from field observations for each well is shown in Table 4-1, and the well logs and construction details are provided in Appendix A.

Table 4-1. Summary of 2020 and 2021 well construction details.

Well ID	Northing (m) (1)	Easting (m) (1)	Ground Elevation (m) (1)	Stickup (m)	Casing Depth (m)	Total Depth (m)	Estimated Yield (m^3/d) (2)
OW20-01	2485530	7430560	69.40	0.82	30.5	152.4	80
OW20-02	2485532	7430559	69.35	0.52	17.7	30.5	20
OW20-03	2485855	7430258	59.65	0.41	30.1	102.1	550
OW20-04	2485857	7430256	59.71	0.48	11.7	61.0	30
TW21-01	2485537	7430012	54.60	0.77	31.1	106.7	800

Notes:

1. Coordinates were provided by WSP and use the NAD83CSRS New Brunswick Stereographic horizontal projection and the Geodetic 1928 vertical datum.
2. The yield estimates were estimated during air-lift development.

4.2. Hydraulic Testing

4.2.1. Water Levels

Water level elevations with time are shown on Figure 4-1. Transducers at TW05-04 and OW-17 failed and data between February 5 and March 1, 2021 were lost at these locations. In addition, manual water level readings in the 1970's exploration well proved somewhat useful in determining a pre-pumping water level elevation (approximately 58 m on February 1, 2021), but the well intermittently froze during the hydraulic testing program due to cold temperatures, the tree-covered location of the well, and heavily restricted overflow rate. The limited monitoring data could not be used for quantitative analysis of hydraulic parameters at this location.

The water level elevation at the Victoria Hall well steadily declined by approximately 2 m over the two-month period (January and February 2021) plotted on Figure 4-1. The trend and magnitude are consistent with the seasonal variation in that well (Figure 3-1). Intra-well water elevations fluctuated by up to approximately 0.4 m between January 1 and 18, 2021 at the test wells and observation wells. The water level elevation throughout the observation well network was affected by the drilling, development and testing of TW21-01 as shown by water level variations on Figure 4-1. A prevailing background trend in water elevations throughout the monitoring network, outside of the Victoria Hall well, could not be confirmed from the available data.

Water elevations in residential wells fluctuated by up to 8 m when pumping due to their use as domestic water supply wells. Three of the monitored residential wells had water level elevations similar to those in the wellfield connected to the artesian fracture, one was much higher (at approximately 76 m), one was much lower (at approximately 51 m), and the remainder were in line with the water level elevation in OW20-02, the shallowest observation well in the network. OW20-02 appeared to behave similar to a residential well and responded to residential well use.

Additionally, the water elevation in TW05-01 was lowered by approximately 1 m on February 1, 2021 during water quality sampling (by the Village), and it did not fully recover prior to the hydraulic testing program. Hence, the drawdown calculated at TW05-01 may be underestimated as the drawdown response may include a portion of recovery from the sampling event.

Total daily precipitation data and snow-pack depth with time (Environment and Climate Change Canada, n.d.) are shown on Figure 4-1. Approximately 72 mm of precipitation fell during background monitoring, 14 mm during the step-tests, and 34 mm during recovery. The precipitation appeared to be primarily snow and consequently had little influence on water level responses throughout the monitoring network during the testing period.

4.2.2. Step-Drawdown Test

The results of the two step-tests completed at production-scale well TW21-01 are summarized in Table 4-2 and graphically on Figure 4-2 (drawdown with time). The pre-pumping water elevations at TW21-01 were estimated based on the 5-day period prior to the CRT when the flowing artesian wells were restricted to approximately 2 m^3/d of overflow. The corresponding inferred pre-pumping water elevation at TW21-01 was 58.4 m.

Table 4-2. Summary of step-test results.

TW21-01 step-test #1 (February 4, 2021)				
Step	**Pumping Rate (m^3/d)**	**Drawdown (m)**	**Specific Capacity (m^2/d)**	**Inverse Specific Capacity (d/m^2)**
1	884	13.0	68.0	0.0147
2	1047	18.3	57.2	0.0175
3	1277	29.9	42.7	0.0234
4	1573	51.4	30.6	0.0327
TW21-01 step-test #2 (February 11, 2021)				
Step	**Pumping Rate (m^3/d)**	**Drawdown (m)**	**Specific Capacity (m^2/d)**	**Inverse Specific Capacity (d/m^2)**
1	884	5.1	173.3	0.00577
2	1178	7.7	153.0	0.00654
3	1473	11.0	133.9	0.00747
4	1833	16.7	109.8	0.00911

To evaluate the hydraulic performance of the well, the step-test results were plotted as inverse specific capacity versus pumping rate on Figure 4-3. The current results are presented along with the five previous step-tests completed in the Sunrise Wellfield as part of BGC (April 9, 2018) for comparison. As shown on Figure 4-3, the well performance of TW21-01 was significantly improved following the additional surging and air-lifting development effort and appears to be hydraulically similar to TW17-01.[4]

4.2.3. Constant-Rate Pumping Test

The 72-hour CRT began at 12:00 pm on February 17, 2021 and ended at 12:00 pm on February 20, 2021. Production-scale well TW21-01 was pumped at an average rate of 1,635 m^3/d (300 US gpm) as selected based on the step-test results. The calculated drawdowns at the end of the CRT in each well within the monitoring network are shown in Table 4-3 along with the well coordinates and well construction details. Table 4-3 also summarizes the interpreted hydraulic parameters (transmissivity and storativity) calculated using AQTESOLV by individually fitting the appropriate analytical solution to the measured water level data at each well. The AQTESOLV analyses are presented in Appendix B.

Hydraulic parameters were not calculated for TW05-04, OW-17 and the 1970's exploration well because the water level data were not obtained. Hydraulic parameters were also not calculated for OW20-02, OW-02, OW-05, OW-06, OW-10, OW-16 and the Victoria Hall well because these wells did not show sufficient connection to the CRT (defined as more than 0.1 m of drawdown).

4 The B and C values at TW21-01 improved from 9.4 x 10^{-3} d/m^2 and 2.6 x 10^{-5} d^2/m^5, respectively (February 4, 2021) to 2.5 x 10^{-3} d/m^2 and 3.5 x 10^{-6} d^2/m^5, respectively (February 11, 2021). The final B and C values at TW17-01 were 2.9 x 10^{-3} d/m^2 and 3.6 x 10^{-6} d^2/m^5, respectively (BGC, April 9, 2018).

Table 4-3. Summary of monitoring location details and pumping test results.

Well ID (1)	Northing (2) (m)	Easting (2) (m)	Top of Casing Elevation (2) (m)	Ground Elevation (2) (m)	Casing Stickup (m)	Well Diameter (mm)	Depth to Bedrock (3) (m bgs)	Casing Depth (4) (m bgs)	Well Depth (m bgs) (5)	Distance from TW21-01 (m)	Pre-Pumping Water Elevation (2) (m)	Drawdown After 72 Hours of Pumping (m)	Transmissivity, T (6) (m^2/d)	Storativity, S (6)	Well Group
TW21-01	7,430,012	2,485,537	55.37	54.60	0.77	305	1.50	31.10	106.70	0.15 (7)	58.37	13.24	406	- (8)	A
TW17-01	7,429,862	2,485,674	56.20	55.66	0.54	305	7.30	30.50	148.40	203	58.31	2.86	392	5.9×10^{-5}	A
TW05-01	7,430,335	2,485,192	71.47	70.82	0.65	152	0.30	6.10	109.73	473	58.90	1.72	497	1.0×10^{-4}	B
TW05-02	7,430,009	2,485,540	55.40	54.65	0.75	203	2.44	7.32	147.60	3	58.38	4.36	447	6.8×10^{-5}	A
TW05-03	7,430,007	2,485,544	55.13	54.63	0.50	152	2.44	7.32	91.44	8	58.31	4.23	400	1.6×10^{-4}	A
OW20-01	7,430,560	2,485,530	70.22	69.40	0.82	152	9.45	30.48	152.40	549	59.51	1.12	300	6.1×10^{-4}	B
OW20-02	7,430,559	2,485,532	69.87	69.35	0.52	152	9.45	17.68	30.48	547	62.39	0.05	- (9)	- (9)	C
OW20-03	7,430,258	2,485,855	60.06	59.65	0.41	152	6.71	30.15	102.11	402	58.27	2.93	456	1.4×10^{-5}	A
OW20-04	7,430,256	2,485,857	60.18	59.71	0.48	152	6.71	11.73	60.96	402	55.67	1.18	223	1.4×10^{-3}	B
OW-01	- (10)	- (10)	81.13	80.67	0.46	152	- (11)	- (11)	>52.36 (12)	838	59.77	1.11	410	2.8×10^{-4}	B
OW-02	-	-	77.96	77.31	0.64	152	-	-	33.53	708	75.26	0.05	-	-	C
OW-05	-	-	72.34	71.85	0.49	152	-	-	38.33	647	62.69	0.02	-	-	C
OW-06	-	-	69.87	69.58	0.29	152	-	-	>41.30 (12)	589	62.63	0.02	-	-	C
OW-09	-	-	61.31	60.75	0.56	152	-	-	26.97	613	55.50	2.33	405	4.7×10^{-5}	A
OW-10	-	-	52.10	51.42	0.68	152	-	-	73.15	575	50.73	0.10	-	-	C
OW-15	-	-	64.49	64.12	0.37	152	-	-	85.95	313	58.57	2.40	450	5.1×10^{-5}	A
OW-16	-	-	66.43	66.02	0.41	152	-	-	>24.05 (12)	702	62.40	0.00	-	-	C

Notes:

1. Wells TW05-01, TW05-02, and TW05-03 were originally drilled by others, and TW05-02 was later deepened by BGC.
2. Coordinates were provided by WSP and use the NAD83CSRS New Brunswick Stereographic horizontal projection and the Geodetic 1928 vertical datum.
3. The depth to bedrock and casing depths for TW05-01, TW05-02, and TW05-03 were taken from the original well logs.
4. The casing depth for TW05-03 is not shown on the original well log but is assumed to be similar to that of TW05-02.
5. Well depths for OW-01 through OW-16 were provided by the Village and are consistent with those reported from the NB OWLS database in Table 2-1.
6. Transmissivity and storativity were estimated using the Theis (1935) and Papadopulos and Cooper (1967) analytical model in AQTESOLV (Duffield, 2007) with overflow pumping and a no-flow recharge boundary.
7. The distance from TW21-01 was represented as the well radius for TW21-01.
8. Storativity was not calculated at the pumping well (TW21-01) or immediately adjacent monitoring test well (TW05-02).
9. Hydraulic parameters were not estimated at OW20-02, OW-02, OW-05, OW-06, OW-10, and OW-16 (Group C wells) as these wells did not show a sufficient response to the CRT (more than 0.1 m).
10. Coordinates are not shown for residential wells (OW-01 through OW-16) to maintain confidentiality.
11. Depth to bedrock and casing depth are unknown in the residential wells.
12. Total well depth is greater than the reported value (measurement was blocked by the top of the pump or the torque arrestor).

The results of the CRT are plotted on Figure 4-4 (drawdown with linear time), Figure 4-5 (drawdown with logarithmic time), and Figure 4-6 (drawdown with distance from the pumping well). Extrapolation of the drawdown curves on Figure 4-5 was completed to 10 years of continuous pumping using the selected analytical model.

The distance-drawdown plot on Figure 4-6 indicates a highly transmissive flow system through the artesian fracture in the vicinity of the wellfield (represented by the solid black line). The responses to pumping on Figure 4-6 show three general well groupings:

- Group A: Wells TW21-01, TW05-02, TW05-03, TW17-01, and OW20-03 (which each intersected the artesian fracture during drilling), OW-09 and OW-15 show a response to pumping indicating they are highly connected to the artesian fracture (i.e., they are near the black line). Each of these wells is deep and interpreted to intersect the artesian fracture in the bedded sandstones (refer to TW21-01, TW17-01 and OW20-03 in Figure 2-1).
- Group B: Wells TW05-01, OW20-01, OW20-04 and OW-01 responded to pumping but appear less connected to the artesian fracture. This is consistent with observations during drilling of TW05-01 and TW20-01 which appeared to have a less conclusive fracture zone. These wells are interpreted to intersect the artesian fracture in the bedded shales (refer to TW05-01 and TW20-01 in Figure 2-1).
- Group C: Wells OW20-02 and the remaining residential wells (OW-02, OW-05, OW-06, OW-10 and OW-16 showed negligible drawdown responses during pumping. Other than OW-10, the reported depths of these wells are less than 50 m, meaning they are likely too shallow to have intersected the artesian fracture. These wells are interpreted to be disconnected from the artesian fracture.

These generalized well groupings are carried forward through the remainder of the report.

Transmissivity and storativity values were calculated for wells in Group A and Group B (i.e., those connected to the artesian fracture, Table 4-3). Transmissivity ranged from 223 m^2/d to 497 m^2/d with a geometric mean of 390 m^2/d. Storativity ranged from 1×10^{-5} to 1×10^{-3} (dimensionless) with a geometric mean of 1×10^{-4}. Though there is overlap in the distribution of calculated parameters for Group A and Group B, generally Group A wells appeared to have higher transmissivity and lower storativity values (400 m^2/d to 500 m^2/d and 10^{-5}, respectively) than Group B wells (200 m^2/d to 400 m^2/d and 10^{-4}, respectively)[5]. The radius of influence of the CRT, which is the maximum distance from the pumping well that drawdown was induced by pumping, can be inferred from Figure 4-6 as approximately 1,000 m. Figure 4-6 also indicates a theoretical drawdown in TW21-01 of approximately 6 m, compared to a measured drawdown of 13.2 m. The ratio of theoretical drawdown and measured drawdown provides an estimate of well efficiency of 45%. This is similar to the calculated well efficiency at TW17-01 (BGC, April 9, 2018).

---

[5] Test well TW05-01 did not recover fully following sampling prior to the CRT, and the water level was approximately 1 m lower after sampling than before sampling. The calculated T value of 497 m^2/d may therefore be over-estimated, making it appear as though it is more similar to a Group A well. The calculated S values of 1.0×10^{-4} is within the range for Group B wells.

The analyses are consistent with the conceptual model which assumes that the aquifer (in this case the artesian fracture) is uniform, homogeneous and isotropic, with a hydraulic boundary northwest of the pumping well. The addition of the boundary improved the match of the analytical model to the observed data. Sensitivity of the solution to the distance to the boundary was examined within a range of 1 km (inferred from Figure 4-6) to 2 km (inferred from extrapolating the fracture plane in Figure 2-1); however, it was determined that the analytical model was generally insensitive to the exact distance to the boundary. A distance of 1.5 km from the pumping well to the boundary was selected for subsequent analyses and predictions.

4.2.4. Recovery Test

Recovery began at 12:00 pm on February 20, 2021, 72 hours after pumping began. Production-scale well TW21-01 recovered to overflow conditions 80 seconds after pumping ended, at which point the pump was removed. An automatic pressure transducer was then installed in TW21-01 and the well was sealed at 1:30 pm, following the removal of the pump. The water level recovery in TW21-01 (and the broader aquifer) was affected during the 1.5 hours that TW21-01 was overflowing while the pump was removed. The recovery results are shown in Table 4-4 (residual drawdown after 72 hours and 213 hours of recovery) and Figure 4-7. Note that the horizontal axis of Figure 4-7 is normalized, with the parameter being “time since pumping started” (t) divided by “time since pumping ended” (t’); consequently, actual recovery time increases to the left on the plot as the ratio of recovery time to overall time since pumping time started approaches 1. Note that 72 hours of recovery results in a t/t’ ratio of 2.[6]

As shown in Table 4-4, the wells that showed a significant response (greater than 0.10 m) to the CRT had not returned completely to their respective pre-pumping water elevations after 72 hours of recovery. The residual drawdown within the monitoring network after 72 hours of recovery ranged between 0.30 m and 0.44 m. Each of the wells were within 0.10 m of full recovery after 213 hours of recovery, when the automatic pressure transducers were removed on March 1, 2021. It also appears that Group B wells (e.g., TW05-01 and OW20-01 located north to northwest of the site) recovered more slowly than Group A wells in the wellfield. This is consistent with the observation of slow recovery at TW05-01 following water quality sampling, and with drilling notes that did not clearly identify a highly productive fracture zone at TW05-01 or TW20-01.

[6] Theoretically, an ideal aquifer would fully recover to pre-pumping water levels in the same recovery duration as pumping duration (a t/t’ ratio of 2). In this ideal case, the recovery curve would intercept the vertical axis at 0 m drawdown when the horizontal axis is at t/t’ = 2 (dimensionless).

Table 4-4. Summary of TW21-01 pumping test recovery results.

Well ID	72 Hours of Recovery (February 23, 2021)		213 Hours of Recovery (March 1, 2021)	
	Residual Drawdown (m)	Percent Recovered	Residual Drawdown (m)	Percent Recovered
TW21-01	0.43	93% (1)	0.09	99% (1)
TW17-01	0.43	85%	0.08	97%
TW05-01	0.34	80%	-0.03	100%
TW05-02	0.42	90%	0.07	98%
TW05-03	0.36	92%	0.01	100%
OW20-01	0.44	60%	0.10	91%
OW20-03	0.42	86%	0.06	98%
OW20-04	0.33	72%	-0.02	100%
OW-01	0.44	60%	0.10	91%
OW-09	0.30	86%	0.06	97%
OW-15	0.41	83%	0.07	97%

Notes:

3. The percent recovery in the pumped well is based on the theoretical 6 m drawdown from Figure 4-6.

4.3. Water Quality

Analytical results in the three samples collected from TW21-01 remained relatively constant throughout the 72-hour CRT. Results were compared against the GCDWQ (Health Canada, 2020) and exceedances are summarized in Table 4-5. Exceedances relative to a maximum acceptable concentration (MAC) are health-based and more stringent, and therefore require treatment. Exceedances relative to an aesthetic objective (AO) are not health-based and relate more to taste and odour, staining on clothing or appliances, and the like, and treatment for these parameters becomes the prerogative of the municipality. GCDWQ exceedances in TW21-01 include manganese, turbidity, and one instance of total coliforms (all exceeding the MAC).

It should be noted that the exceedance of total coliforms in the February 19, 2021 sample collected from TW21-01 may have been influenced by sampling efforts. That microbiology sample was collected from the discharge hose, which was submerged in discharged water and surrounding vegetation, and may have resulted in cross-contamination. Total coliforms were absent in the February 18 and February 22, 2021 microbiology samples.[7] Faecal coliforms and e-coli were not-detected in any of the three samples collected from TW21-01. None of the 37 separate volatile organic compounds (VOCs) in the analysis suite were detected in either of the two samples collected from TW21-01.

[7] Each of the three microbiology samples was collected in a different manner. The February 18 sample was decanted during sample collection and the February 22 sample was collected directly from the artesian overflow at the wellhead.

Table 4-5. List of GCDWQ exceedances in TW21-01.

Parameter (units)	GCDWQ (1)		TW21-01 (2)		
	MAC	AO	Feb. 18, 2021	Feb. 19, 2021	Feb. 20, 2021/ Feb. 22, 2021 (3)
Turbidity (NTU)	0.1	-	0.1	**<u>0.3</u>**	**<u>0.3</u>**
Dissolved Manganese (µg/L)	120	20	**<u>347</u>**	**<u>365</u>**	**<u>358</u>**
Total Coliforms (MPN/100 mL)	0	-	0	**<u>64</u>**	0 (3)

Notes:

4. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2020), MAC = maximum acceptable concentration, and AO = aesthetic objective.
5. Values that exceed the GCDWQ are bolded and underlined.
6. The final microbiology sample from TW21-01 was collected on February 22, 2021 (Monday) as microbiology samples have a 24-hour submission guideline and could not be submitted to RPC on the weekend.

Refer also to Appendix C for complete tables of water quality results: Table C-1 (general chemistry), Table C-2 (dissolved metals) and Table C-3 (microbiology and VOCs). Exceedances of the GCDWQ are also flagged in the tables. Appendix D contains the signed laboratory certificates from the RPC analytical laboratory.

The water sampled from within the Sunrise Wellfield does not appear to have a dominant water type, ranging from a mixed bicarbonate type at the TW21-01/TW05-02/TW05-03 location, a mixed chloride type at the TW17-01/TW05-04 location, and both sodium chloride and calcium bicarbonate types generally in residential wells. Refer to Figure 4-8 for the trilinear Piper diagram of sampled groundwater wells showing the general water chemistry groupings.

The test wells in the wellfield (TW-series) generally fall within similar water types, and the observation wells (OW20-series) show more scatter in the data. Water chemistry types from the residential wells appear to vary mostly by sodium and chloride levels, and generally fall within three categories:

- Sodium and chloride levels similar to the observation wells (OW-05, OW-15, and OW-02).
- High sodium concentrations with chloride levels similar to the observation wells (OW-01, OW-06, OW-09, and OW-10).
- High sodium and chloride levels (OW-16 and OW-17).

The residential wells with similar groundwater chemistry types to the observation wells validate the depth and construction of the observation wells as replicating ‘typical’ wells in Sunrise Estates. The residential wells with high sodium could be from homes with water softeners. The residential wells with high sodium and chloride could be impacted by road salt application. Road salt application along Route 101 and within Sunrise Estates upgradient of the wellfield could become a source of elevated chlorides with time in the production wells.

5.0 DISCUSSION

Contours of the pre-pumping water level elevations and artesian fracture elevation within the Sunrise Wellfield are shown on Figure 5-1. The contours show the fracture sloping upward toward the northwest, and higher water level elevations north to northwest. The interpreted groundwater flow direction is approximately northwest to southeast with a hydraulic gradient of approximately 0.1%. Based on the well logs and construction details, response to pumping, and chemistry results, the wells in the monitoring network were divided into three broad categories:

- Group A wells – intersect the artesian fracture within the sandstones (strongly connected).
- Group B wells – intersect the artesian fracture within the shales (moderately connected).
- Group C wells – do not appear to intersect the artesian fracture (not connected).

The discussion is framed around these well groupings where applicable.

5.1. Artesian Water Levels

The water pressure in the artesian fracture causes high water elevations in the wells that intercept the fracture compared to wells that do not intercept the fracture and flowing artesian conditions are observed where the water elevation is above ground surface. These flowing artesian conditions presented several challenges in establishing accurate non-pumping water levels throughout the testing program (refer to Sections 3.2 and 4.2.1). The challenges included:

- Wells with flowing artesian conditions (TW05-02, TW-05-03, TW05-04, and TW17-01) had been discharging at an estimated combined rate of 500 m^3/d for some time before this phase of the project commenced, essentially pumping over that time and depressing long-term water level elevations.
- Flowing artesian wells were intermittently capped, restricted, or allowed to overflow as various steps of the work plan were executed.
- Freezing winter conditions interfered with the standpipe setups for collection of water levels when wells were capped, and valves were fully closed.
- Water level elevations had not yet stabilized to completely non-pumping levels during the five days when the flowing artesian wells were capped and valves were fully closed immediately preceding the CRT.
- Water level elevations vary seasonally in the wellfield and surrounding areas, as noted in previous phases of the project and in the nearby Victoria Hall well. These seasonal fluctuations (~3 m observed in the wellfield and up to 6 m at the Victoria Hall well) and the changes in flowing artesian well discharge in the wellfield made it difficult to interpret potential seasonal gradients in the water levels during drilling and testing.

Consequently, some pre-pumping water level elevations were assumed and may be subject to uncertainty. The discussion sections below acknowledge this, and recommendations are based on limits to water level elevation during pumping rather than limits to drawdown.

5.2. Potential Impacts

The development of the Sunrise Wellfield to date includes two pumping wells (the previously approved TW17-01 and the currently assessed TW21-01). The potential impacts to consider from operating this wellfield are interference between the pumping wells and drawdown experienced at nearby private residential wells due to long term operation of the wellfield.

5.2.1. Wellfield Interference

Table 5-1 shows the estimated 10-year drawdowns caused from pumping each TW17-01 (Figure 4-6 in BGC, April 9, 2018) and TW21-01 (Figure 4-5) independently and combined. The estimated well interference[8] at TW21-01 was expected to be 5.5 m after 10 years of continuous pumping at TW17-01 (BGC, April 9, 2018). Similarly, the estimated well interference at TW17-01 after 10 years of continuous pumping at TW21-01 was 7.5 m. However, these cumulative yields and drawdowns have not yet been proven, and the boundary was not considered in BGC (April 9, 2018). If both production wells are to be operated simultaneously, well interference and long-term aquifer yield would need to be evaluated and considered in the operational plans.

Table 5-1. Predicted interference drawdown for 10 years of pumping.

Well ID	10-Year Drawdown Induced from Pumping TW17-01 (m)	10-Year Drawdown Induced from Pumping TW21-01 (m)	10-Year Drawdown Induced from Pumping TW17-01 and TW21-01 (m) (1) (2)
TW21-01	5.5	18.0	23.5
TW17-01	24.0	7.5	31.5
TW05-01	4.5	5.5	~10
OW20-01	~5	7.0	~12
OW20-03	~8	7.0	~15
Residential well with the highest response to pumping from monitoring (3)	~5 (4)	~7	~12
Residential well with the lowest response to pumping from monitoring	0.0	~1	~1

Notes:
1. Using drawdown superposition (i.e., adding the previous two columns).
2. Hypothetical pumping rate only, as the wellfield is not rated for a full combined withdrawal rate.
3. Residential wells that did not show a sufficient response to the CRT (Group C wells) are not included.
4. Inferred from Figure 4-7 in BGC (April 9, 2018).

8 Well interference is the drawdown experienced at a well due to pumping from another well. From the principle of superposition, the cumulative drawdown at any well due to pumping from other well(s) is the sum of the individual well drawdowns.

5.2.2. Residential Wells

A monitoring network of nine nearby private residential wells was incorporated into the current phase of the project to examine the potential for interference drawdown, particularly in the Sunrise Estates subdivision. Baseline water quality was also monitored in the residential well network (by the Village and WSP).

Table 5-1 shows the residential wells in the monitoring network with the highest and lowest response to pumping, supported by the pumping test data on Figure 4-4, Figure 4-5 and Figure 4-6. The range of predicted impacts after 10 years of continuous pumping is between 0.5 m and 11.5 m of drawdown, depending on the connectivity of each well to the artesian fracture (i.e., depending upon membership of residential wells in Groups A, B, or C).

In general, of the nine residential wells included in the network, three wells appeared to respond to the pumping test with drawdown between approximately 1.0 and 2.5 m (Group A and B wells that are interpreted to be connected the artesian fracture), and the remainder showed minimal drawdown (less than 0.1 m, Group C wells that are interpreted to be disconnected from the artesian fracture). The pre-pumping water level elevations and responses to pumping in the nine residential wells included in the monitoring network are summarized as follows:

- Three residential wells (OW-01, OW-09 and OW-15 in Groups A and B) had pre-pumping water level elevations similar to the Group A and Group B test wells and observation wells connected to the artesian fracture. These residential wells appeared to respond to the pumping test with drawdown between approximately 1.0 and 2.5 m. Wells OW-01 and OW-15 are in Group A with reported well depths similar to the test wells (Table 4-3), and OW-09 is in Group B with a shallower reported well depth (Table 4-3).
- One residential well (OW-02 in Group C) had a pre-pumping water level elevation that was much higher at approximately 76 m, a shallow reported well depth (Table 4-3) and showed little response to the pumping test with a drawdown of approximately 0.05 m.
- One residential well (OW-10 in Group C) had a pre-pumping water level elevation that was much lower at approximately 51 m, a deeper reported well depth (Table 4-3) and showed little response to the pumping test with a drawdown of approximately 0.10 m.
- The remaining residential wells (OW-05, OW-06 and OW-16 in Group C) had pre-pumping water level elevations similar to that in the shallow OW20-02 (also in Group C), and each of these did not appear to react to the pumping test (drawdown less than 0.05 m). These residential wells also have shallow reported well depths (Table 4-3).

These observations suggest that, from the limited dataset during testing, residential wells that would be included in Group A or Group B based on well depth, well construction and connectivity to the artesian fracture in Sunrise Estates and along Route 101 could have reasonably impacted water levels (possibly up to 10 m in the long term) due to the operation of the Sunrise Wellfield.

The baseline water quality shows that, in general, the geochemical water type of the residential wells is either similar to that in the observation wells or differs because of high sodium (possibly due to water softeners) or high sodium and chloride (possibly due to road salt application).

The Village distributed notices to residents in advance of the CRT inviting notification of impacts to their wells during testing. BGC understands that the Village did not receive any comments or complaints during the test. However, it is possible that nearby residential wells may be adversely affected by long term pumping, so mitigation (e.g., adjusting the pump depth if practical, well deepening, well replacement, or connection to a municipal supply) may be required following the development and continued use of the Sunrise Wellfield. It may also be that streamflow in nearby water courses may also be affected during long-term pumping, through a reduction in the component of baseflow (i.e., the amount of groundwater received by the streams); however, that possibility was not part of the current study.

5.3. Long-Term Safe Yield

Production-scale well TW21-01 was inferred to have a maximum available drawdown of up to 35 m under testing conditions, which coincides with the bottom of the installed protective steel casing. The bottom of the casing is judged to be the minimum allowable pumping level, to help prevent the dewatering of fractures and to reduce the risk of over pumping. It is recommended that the pumping water level be maintained within the casing (i.e., above approximately 31.1 m bgs, as currently constructed, or at an elevation greater than 23.5 m).

To estimate the long-term safe yield of TW21-01, the pumping test data were extrapolated to estimate the drawdown that would occur after 100 days and 10 years of continuous pumping, as shown on Figure 4-5. Applying the selected analytical model with the no-flow recharge boundary, the predicted (extrapolated) drawdown after 100 days and 10 years would be approximately 16 m and 18 m, respectively. Based on the extrapolated drawdown data and consideration of potential impacts on nearby private wells, the preliminary long-term safe yield of TW21-01 is estimated to be 1,365 m^3/d (250 US gpm).

The safe yield for TW21-01 was determined using the following limitations and assumptions:

- The selected analytical model adequately characterizes the drawdown response with sustained pumping, to an approximate drawdown of 18 m after 10 years.
- The pumping level always remains within the casing, and above approximately 31.1 m bgs, or at an elevation greater than 23.5 m.
- Seasonal variation, observed as up to 3 m in the wellfield and up to 6 m in the Victoria Hall well over a similar period, is considered.
- The drawdown interference when pumping from other wells around TW21-01, including that of the nearby domestic wells (particularly those in Group A or Group B), is considered.

Note that during prolonged dry periods, such as those experienced in 2017 and 2020 (NBDELG, n.d.), less regional recharge will likely be available. This could cause increased drawdowns and a higher risk of over pumping during those periods. This recommended withdrawal rate could be subject to change based on findings and confirmatory monitoring results from the subsequent longer-term operation of the wellfield. It is recommended that the flowing artesian wells be fully closed after the risk of freezing has subsided, and the pumping water levels and recovery be assessed in summer (dry) conditions.

It is also important to note that, most of the time, the flowing artesian wells have been discharging to waste at a cumulative estimated rate of 500 m^3/d (100 US gpm) and the wells have remained flowing artesian, i.e., the water level elevation has remained above ground surface in the wellfield despite sustained periods of "pumping" at the above-noted rate.

5.4. Wellfield Operation

The Village's anticipated demand for the Sunrise Wellfield is 1,365 m^3/d (250 US gpm), to be extracted from TW21-01 and TW17-01 on a schedule that will be determined by the Village and WSP. With individual well ratings of 1,365 m^3/d (250 US gpm) at TW17-01 and TW21-01, and no combined pumping assessment to date, the total wellfield withdrawal should be limited to 1,365 m^3/d (250 US gpm) in the short term (Table 5-2). The potential to increase the overall wellfield withdrawal would be determined with a robust monitoring program and continued evaluation of ongoing pumping and corresponding water level elevations as pumping progresses.

Table 5-2. Production wells in the Sunrise Wellfield.

Well ID	**Rated Safe Yield** (m^3/d [US gpm])	**Operating Comments**
TW17-01	1,365 [250] (1)	Water level to remain above bottom of steel casing (30.5 m bgs, or elevation 25.1 m)
TW21-01	1,365 [250]	Water level to remain above bottom of steel casing (31.1 m bgs, or elevation 23.5 m)
Overall Sunrise Wellfield (potentially)	1,365 [250]	Combined pumping of TW17-01 and TW21-01 with an approved groundwater quantity and quality monitoring program

Notes:
1. The safe yield of TW17-01 was previously determined in BGC (April 9, 2018) and subsequently approved by NBDELG.

The long-term challenges in operating the Sunrise Wellfield could include:

- Availability of recharge to the wellfield from the north/northwest where the artesian fracture appears to be within the less productive shales and eventually could intersect the bedrock surface northwest of Route 101.
- Limitations on the available drawdown in the pumping wells owing to seasonal water level variations, observed as up to 3 m in the wellfield.
- Possible long-term impacts from road salt application near the wellfield.

Development of a new municipal wellfield will trigger the regulatory requirement for protection measures, which would be implemented within designated wellfield protection zones, as per New Brunswick's Wellfield Protected Area Designation Order (WfPADO), as released by NBDELG (2000). BGC understands the Village's other existing municipal groundwater supply is already designated with the Province and is being managed in accordance with the WfPADO regulatory protocol.

6.0 CONCLUSIONS

1. The water level elevations in the Sunrise Wellfield have remained above ground surface in the wellfield despite sustained periods of "pumping" when the overflow valves are open and the wells discharge to waste.
2. The testing occurred during flowing artesian conditions, making it difficult to assess the pre-pumping water levels or to maintain control of overflow discharge over the testing period.
3. Where the artesian fracture is interpreted to be in the sandstone-conglomerate aquifer (Group A wells), the calculated transmissivity was approximately 400 m^2/d or higher and storativity was approximately 1 x 10^{-5} (dimensionless) based on testing at TW21-01. The aquifer appears to be confined. These are consistent with what was reported in BGC (April 9, 2018) based on testing at TW17-01.
4. The expanded monitoring network during the current testing suggested a hydraulic boundary may exist to the northwest and could align with where the fracture intersects the bedrock surface. This boundary was included in the current (TW21-01) analysis but was not considered in the previous (TW17-01) analysis.
5. The sustainable yield of production-scale well TW21-01 is estimated to be 1,365 m^3/d (250 US gpm), based on variable seasonal water levels, a minimum pumping water level elevation of 23.5 m to prevent dewatering fractures, and interference with other pumping wells and nearby private residential wells.
6. Of the nine residential wells included in the monitoring network, three showed a drawdown response that indicate a direct connection to the artesian fracture in the wellfield, either in the sandstones or the shales (Group A and Group B wells).
7. The remaining residential wells were at variable water level elevations, showed minimal response to pumping (i.e., less than 0.1 m of observed drawdown) and appear to be disconnected from the artesian fracture (Group C wells).
8. Wells located north to northwest of the wellfield where the artesian fracture is interpreted in the shales (Group B wells) had incomplete recovery to pre-pumping water levels, suggesting that there could be more pronounced impacts in those locations due to long-term pumping. These observations align with drilling observations where the artesian fracture was more difficult to detect in that area, suggesting the fracture may be less productive there. Calculated transmissivity was generally lower than 400 m^2/d and storativity was approximately 1 x 10^{-4} for Group B wells.
9. Pumping from the Sunrise Wellfield will cause interference drawdowns in some nearby domestic wells. At the recommended pumping rate of 1,365 m^3/d (250 US gpm), the predicted long-term interference drawdown at the most impacted private residential wells is estimated to be 7 m after 10 years of continuous pumping. It is possible that marginal domestic wells could be impacted, and require mitigation (e.g., well deepening, well replacement, or connection to a municipal supply).
10. Water quality in TW21-01 meets the Health Canada Guidelines for Canadian Drinking Water Quality except for manganese and turbidity, which will require treatment.
11. Road salt application along Route 101 and within Sunrise Estates upgradient of the wellfield could become a source of elevated chlorides with time in the production wells.

7.0 RECOMMENDATIONS

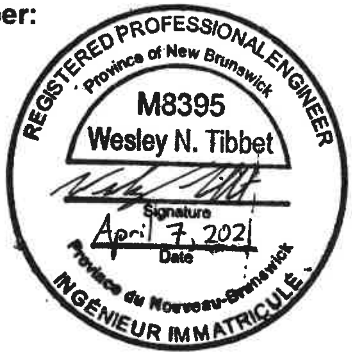
1. Connect production well TW21-01 to the Village of New Maryland's municipal water supply, as the second potable supply well in Sunrise Wellfield.
2. Cap and close the flowing artesian wells after the end of the winter season and the risk of freezing is minimized, and keep the wells capped and closed until late fall to further assess seasonal variations and non-pumping/non-overflow water levels.
3. Assess non-pumping water levels and recovery in the summer via transducers in the capped wells, when conditions are dry and after the flowing artesian wells have been capped and closed for at least one month.
4. Consider performing longer-term pumping tests and well interference tests at both TW17-01 and TW21-01 to better define the impacts of long-term pumping from both wells.
5. Monitor drawdown and water quality in the monitoring network during operation of the Sunrise Wellfield to determine the long-term effects of well interference, and any potential changes in water quality.
6. Monitor for chlorides during wellfield operation and consider reducing road salt application near the Sunrise Wellfield if necessary.
7. Initiate a Wellfield Protection Study for the Sunrise Wellfield.

8.0 CLOSURE

We trust the above satisfies your requirements at this time. Should you have any questions or comments, please do not hesitate to contact us.

Yours sincerely,

BGC ENGINEERING INC.
per:



Wesley Tibbet, M.Eng., P.Eng.
Hydrogeological Engineer

Calvin O'Neill, B.Sc.E, EIT
Hydrogeological Engineer-In-Training

Kent Wiezel, M.A.Sc., P.Eng.
Senior Hydrogeological Engineer

Reviewed by:

Carl Mendoza, Ph.D., P.Eng.
Principal Hydrogeological Engineer

TKW/CAM/ksj/syt

REFERENCES

Allard, S., & Gilmore, W.F. (2016). *Surficial geology of the Fredericton area (NTS 21 G/15), New Brunswick* [Map]. Scale 1:50 000. New Brunswick Department of Energy and Mines, Plate 2016-1.

BGC Engineering Inc. (2017, March 24). *Groundwater Supply – Drilling and Test Pumping of TW-02, New Maryland* [Report]. Prepared for Opus International Consultants.

BGC Engineering Inc. (2018, April 9). *Groundwater supply for the Village of New Maryland* [Report]. Prepared for Opus International Consultants.

BGC Engineering Inc. (2020, November 25). Scope of Work for Construction and Hydraulic Testing of a New Production-Scale Well – Village of New Maryland Sunrise Wellfield [Proposal]. Prepared for the Village of New Maryland.

Cooper, H.H., & Jacob, C.E. (1946). A generalized graphical method for evaluating formation constants and summarizing well field history. *Am. Geophys. Union Trans., 27*, 526-534.

Duffield, G.M. (2007). AQTESOLV for Windows (Version 4.5) [Computer Software]. Reston, VA: HydroSOLVE, Inc.

Environment and Climate Change Canada. (n.d.). *Historical Climate Data for Fredericton CDA CS* [Data]. Extracted February 28, 2021: https://climate.weather.gc.ca/historical_data/search_historic_data_e.html

Gemtec. (2005, July 14). *Groundwater Exploration, PID 75062174, New Maryland, NB* [Letter Report]. Prepared for ARSAM Ltd.

Health Canada. (2020). *Guidelines for Canadian Drinking Water Quality* (GCDWQ). Retrieved from https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table.html

New Brunswick Department of Environment and Local Government. (2000). Wellfield Protected Area Designation Order – Clean Water Act. New Brunswick Regulation 2000-47 filed September 12, 2000.

New Brunswick Department of Environment and Local Government. (2017). Water Supply Source Assessment Guidelines. Retrieved from https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/EIA-EIE/WaterSupplyAssessmentGuidelines.pdf

New Brunswick Department of Environment and Local Government. (n.d.). *Water Quantity Information* [Data]. Extracted February 27, 2021: https://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/water/content/water_quantity.html

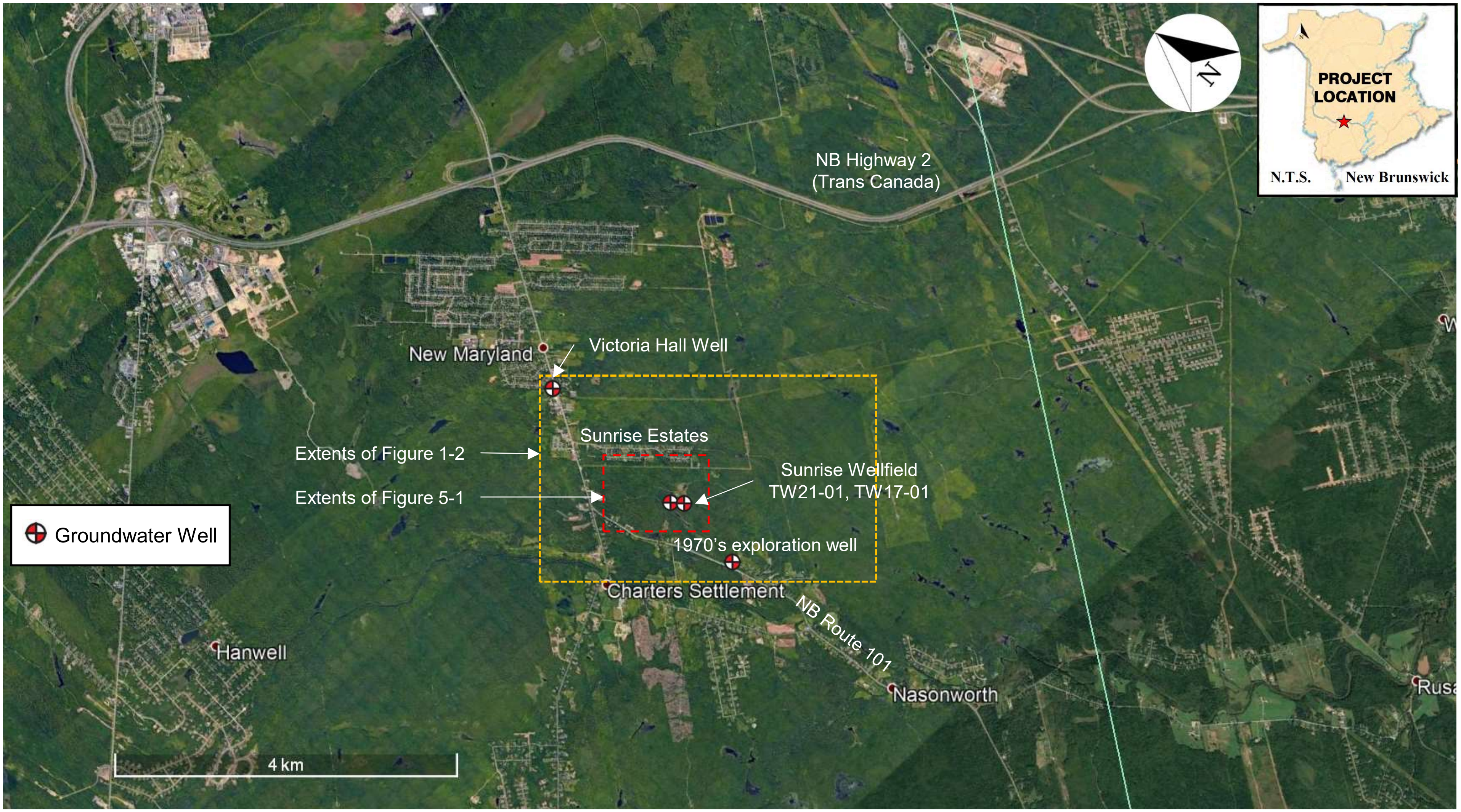
Papadopulos, I.S., & Cooper, H.H. (1967). Drawdown in a well of large diameter. *Water Resources Research, 3*(1), 241-244.

St. Peter, C.J., & Fyffe, L.R. (2005). *Bedrock geology of the Fredericton area (NTS 21 G/15), York and Sunbury counties, New Brunswick* [Map]. Scale 1:50 000. New Brunswick Department of Natural Resources, Minerals, Policy and Planning Division, Plate 2005-38.

Theis, C.V. (1935). The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage. *Am. Geophys. Union Trans., 16,* 519-524.

FIGURES

03-2021



NOTES

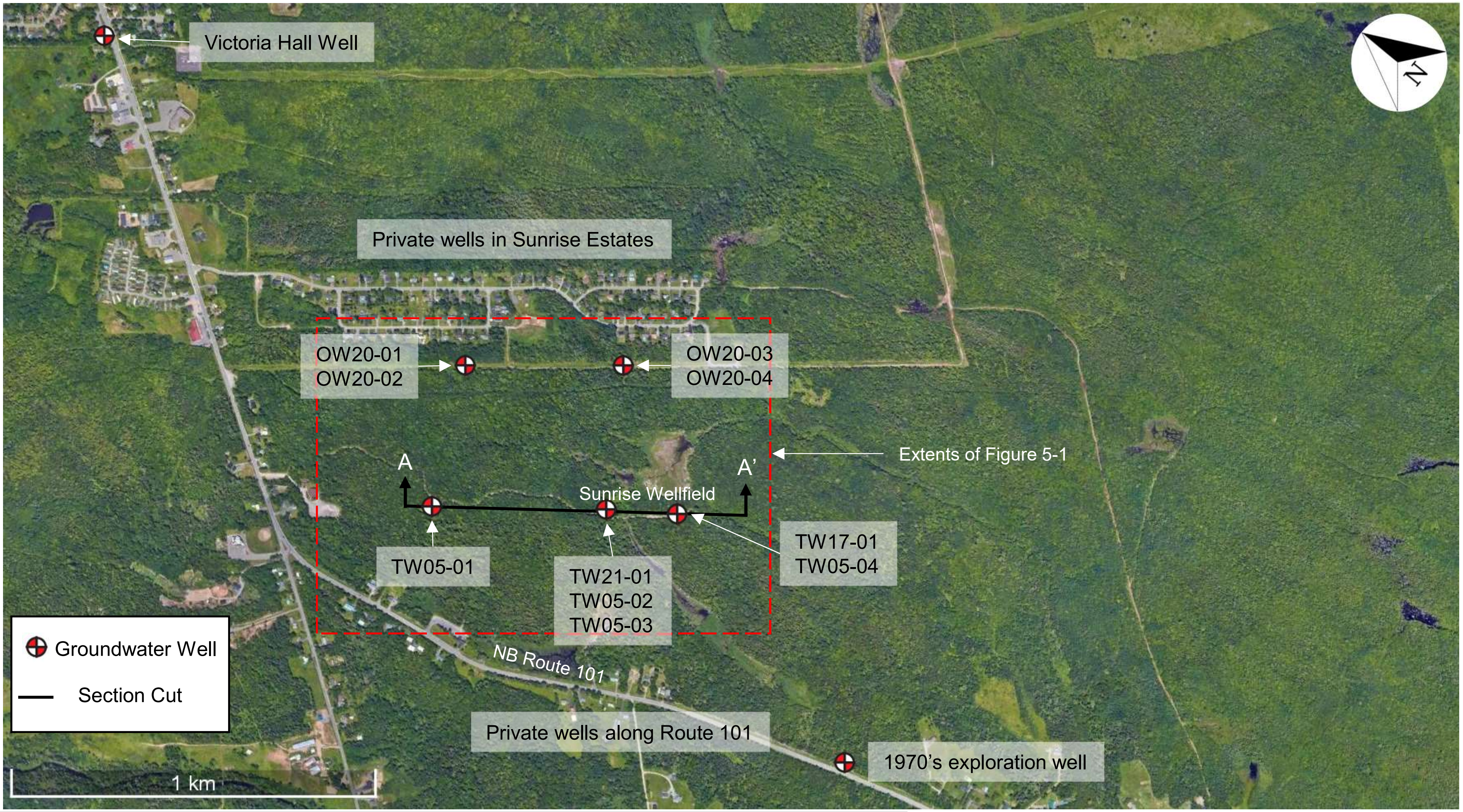
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNDWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.
2. SOURCE IMAGERY OBTAINED FROM GOOGLE EARTH.

PREPARED BY: CO	FIGURE TITLE: PROJECT LOCATION		
CHECKED BY: WT	CLIENT: VILLAGE OF NEW MARYLAND		
APPROVED BY: KW	SCALE: AS SHOWN	PROJECT NO: 2231001	FIGURE NO: 1-1

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

03-2021



NOTES

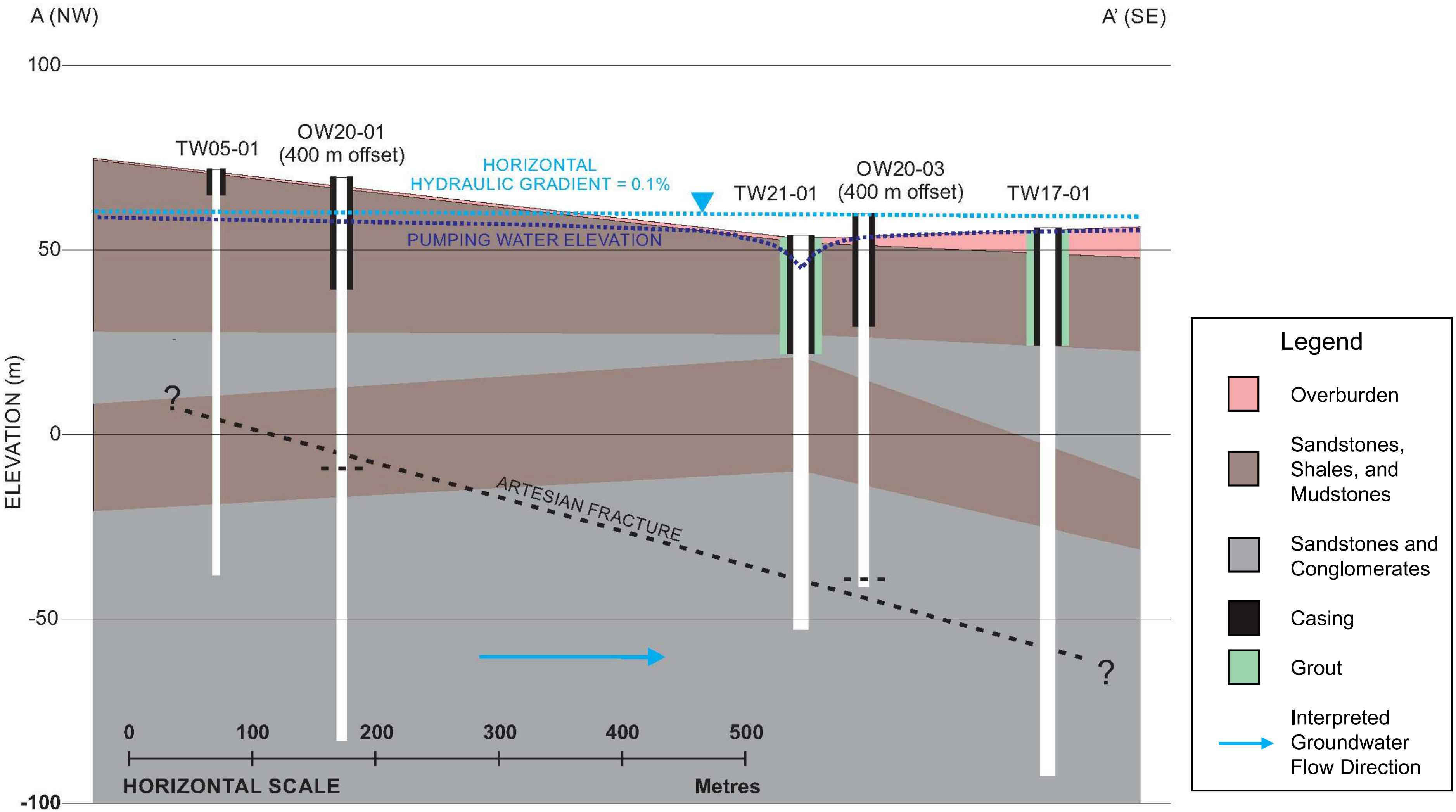
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNDWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.
2. THE EXTENTS OF THIS FIGURE CAN BE FOUND WITHIN FIGURE 1-1.
3. CROSS-SECTION A-A' IS SHOWN ON FIGURE 2-1.
4. SOURCE IMAGERY OBTAINED FROM GOOGLE EARTH.

PREPARED BY: CO	FIGURE TITLE: SITE PLAN		
CHECKED BY: WT	CLIENT: VILLAGE OF NEW MARYLAND		
APPROVED BY: KW	SCALE: AS SHOWN	PROJECT NO: 2231001	FIGURE NO: 1-2

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

03-2021



NOTES
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNDWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.
2. SECTION LINE IS PRESENTED ON FIGURE 1-2.
3. WELL ELEVATIONS WERE PROVIDED BY WSP AND USE THE GEODETIC 1928 VERTICAL DATUM.
4. GROUNDWATER ELEVATIONS ARE BASED ON SITE MEASUREMENTS BEFORE AND DURING PUMPING FROM TW21-01.
5. VERTICAL EXAGGERATION IS APPROXIMATELY 3:1.
6. GEOLOGIC SECTION BASED ON TW05-01, TW21-01, AND TW17-01 (WELLS WITH NO OFFSET).

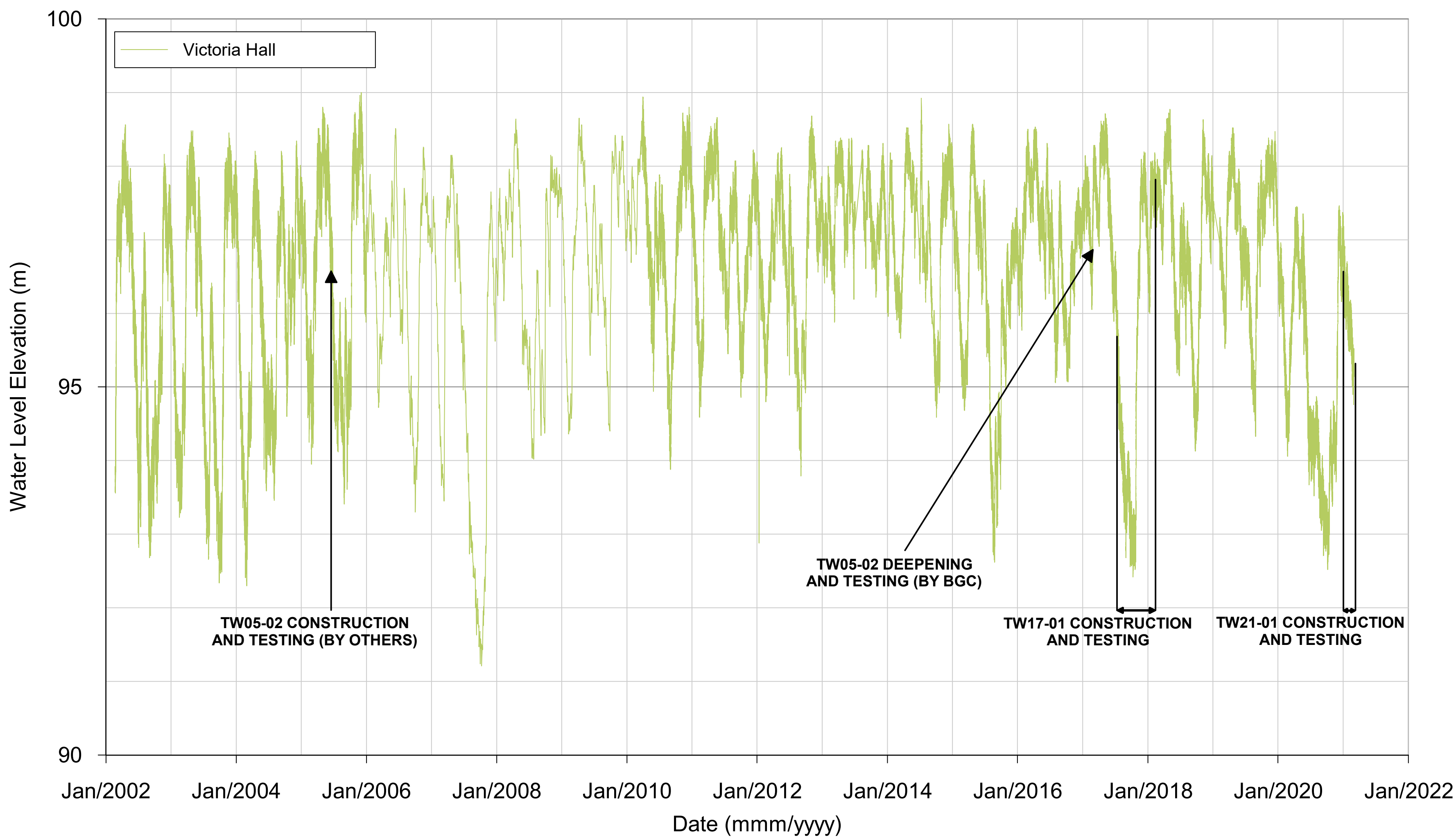
PREPARED BY: WT	FIGURE TITLE: CONCEPTUAL CROSS-SECTION THROUGH THE SUNRISE WELLFIELD		
CHECKED BY: CO	CLIENT: VILLAGE OF NEW MARYLAND		
APPROVED BY: KW	SCALE: APPROXIMATE	PROJECT NO: 2231001	FIGURE NO: 2-1

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

DRAFT

03-2021



NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNDWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.
2. WATER LEVEL ELEVATION DATUM IS GEODETIC 1928 VERTICAL DATUM.
3. VICTORIA HALL GROUNDWATER ELEVATION DATA WERE RETRIEVED FROM *NEW BRUNSWICK DEPARTMENT OF ENVIRONMENT AND LOCAL GOVERNMENT, WATER QUANTITY INFORMATION - NEW MARYLAND GROUNDWATER OBSERVATION WELL* (NBDELG, N.D.), ACCESSED ON MARCH 1, 2021.

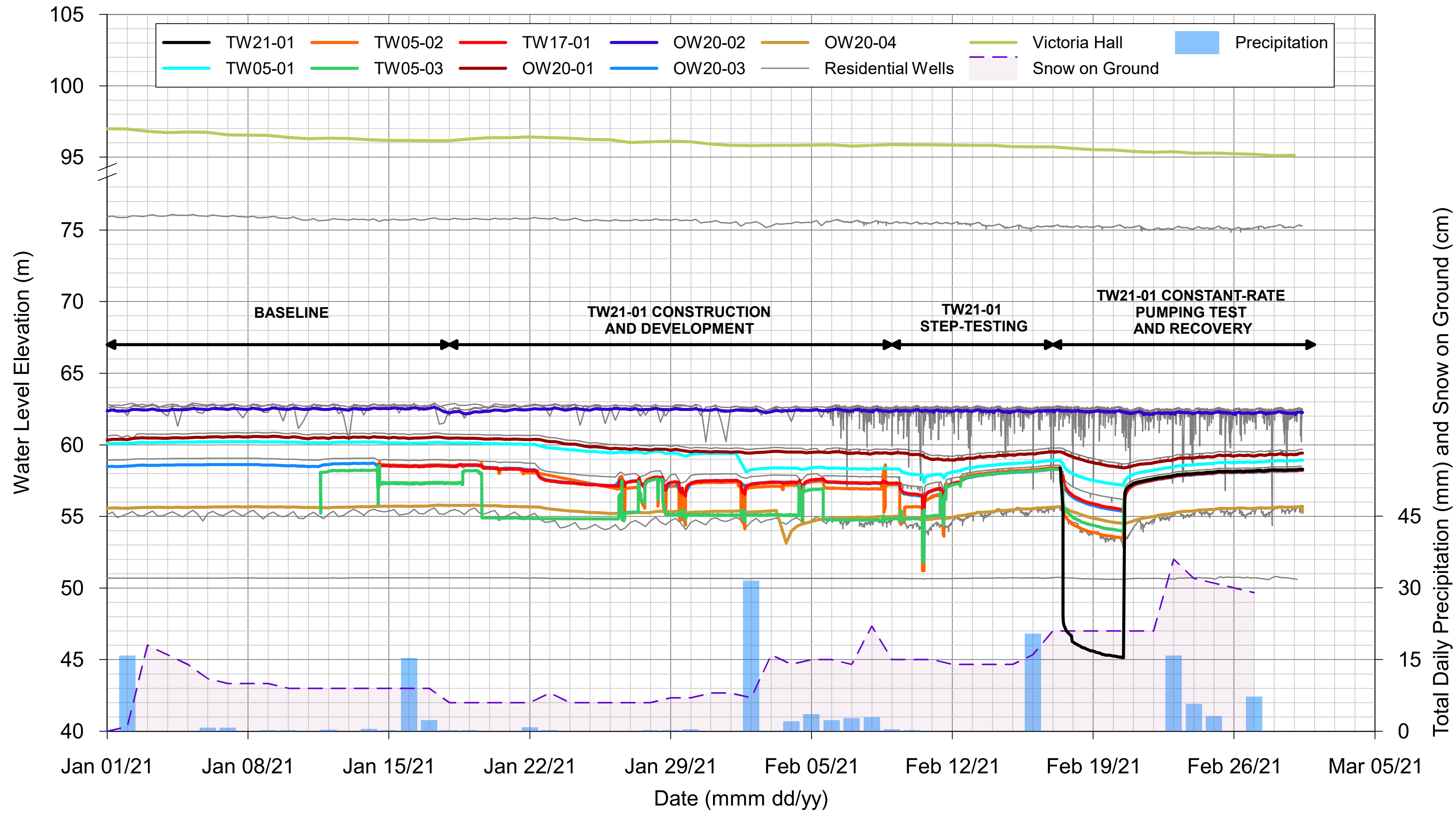
PREPARED BY:	FIGURE TITLE:		
CO	HISTORICAL WATER ELEVATIONS IN THE VICTORIA HALL WELL		
CHECKED BY:	CLIENT:		
WT	VILLAGE OF NEW MARYLAND		
APPROVED BY:	SCALE:	PROJECT NO:	FIGURE NO:
KW	AS SHOWN	2231001	3-1

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

DRAFT

03-2021



NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNDWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.
2. WATER LEVEL ELEVATION DATUM IS GEODETIC 1928 VERTICAL DATUM.
3. VICTORIA HALL GROUNDWATER ELEVATION DATA WERE RETRIEVED FROM *NEW BRUNSWICK DEPARTMENT OF ENVIRONMENT AND LOCAL GOVERNMENT, WATER QUANTITY INFORMATION - NEW MARYLAND GROUNDWATER OBSERVATION WELL* (NBDELG, N.D.), ACCESSED ON MARCH 1, 2021.
4. PRECIPITATION AND SNOW ACCUMULATION DATA WERE RETRIEVED FROM *HISTORICAL CLIMATE DATA FOR FREDERICTON CDA CS* (ENVIRONMENT AND CLIMATE CHANGE CANADA, N.D.), ACCESSED ON FEBRUARY 28, 2021.
5. SOLINST LEVELOGGERS PROGRAMMED BY WSP WERE INITIALLY SET TO RECORD AT 6-HOUR INTERVALS, WHICH WERE CHANGED TO 10-MINUTE READINGS ON FEBRUARY 5, 2021 FOR THE TESTING PERIOD.
6. EIGHT OF THE RESIDENTIAL WELLS WITHIN THE MONITORING NETWORK ARE INCLUDED IN THIS PLOT (SENSOR FAILURE AT OW-17).

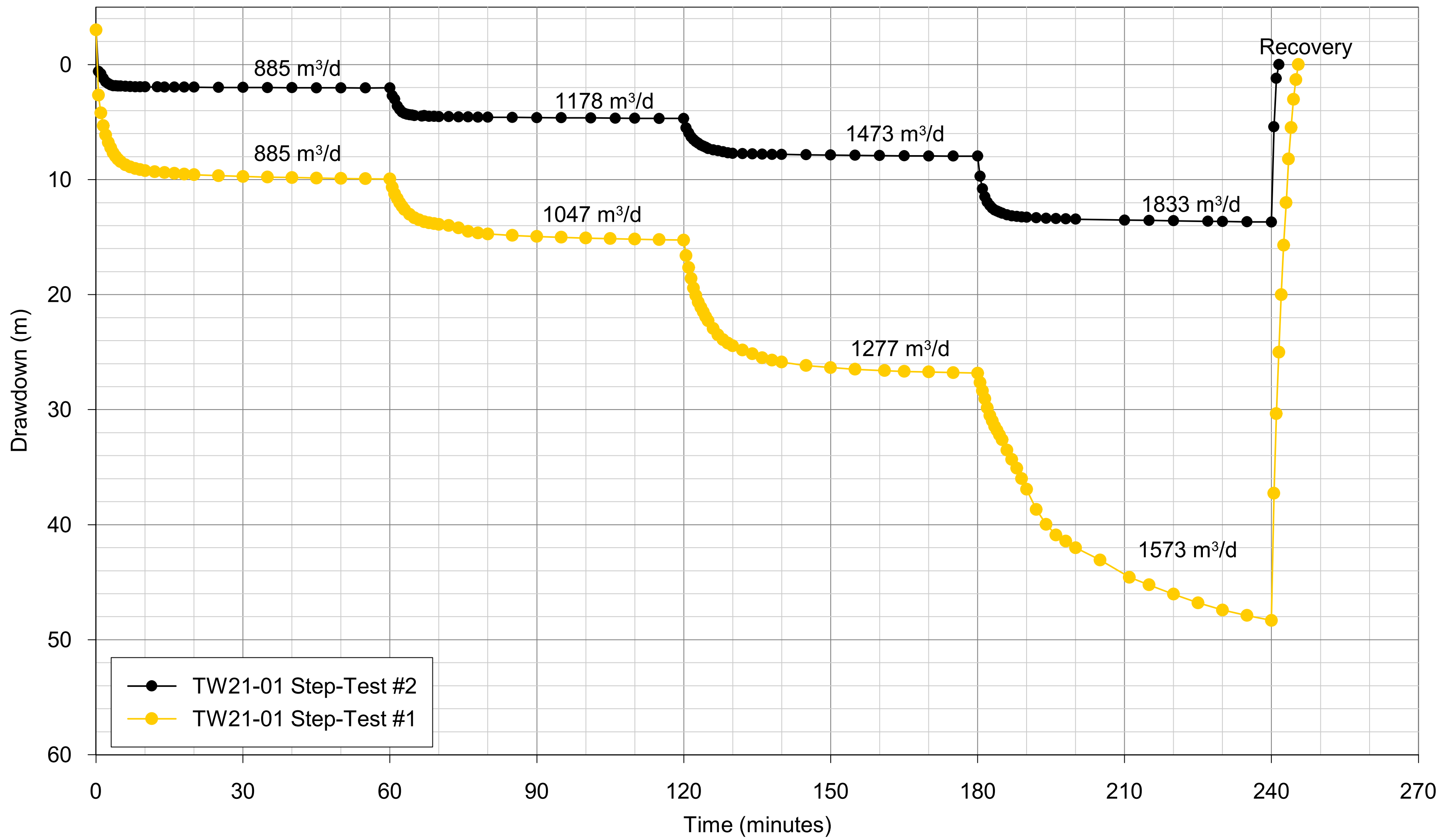
PREPARED BY:	FIGURE TITLE:		
CO	WATER LEVEL ELEVATION WITH TIME		
CHECKED BY:	CLIENT:		
WT	VILLAGE OF NEW MARYLAND		
APPROVED BY:	SCALE:	PROJECT NO:	FIGURE NO:
KW	AS SHOWN	2231001	4-1

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

DRAFT

03-2021



NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNDWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.
2. STEP-DRAWDOWN TESTS #1 AND #2 WERE COMPLETED ON FEBRUARY 4, 2021 AND FEBRUARY 11, 2021, RESPECTIVELY.
3. THE PRE-PUMPING WATER ELEVATION FOR THE STEP-DRAWDOWN TESTS WAS ESTIMATED TO BE 58.4 m.

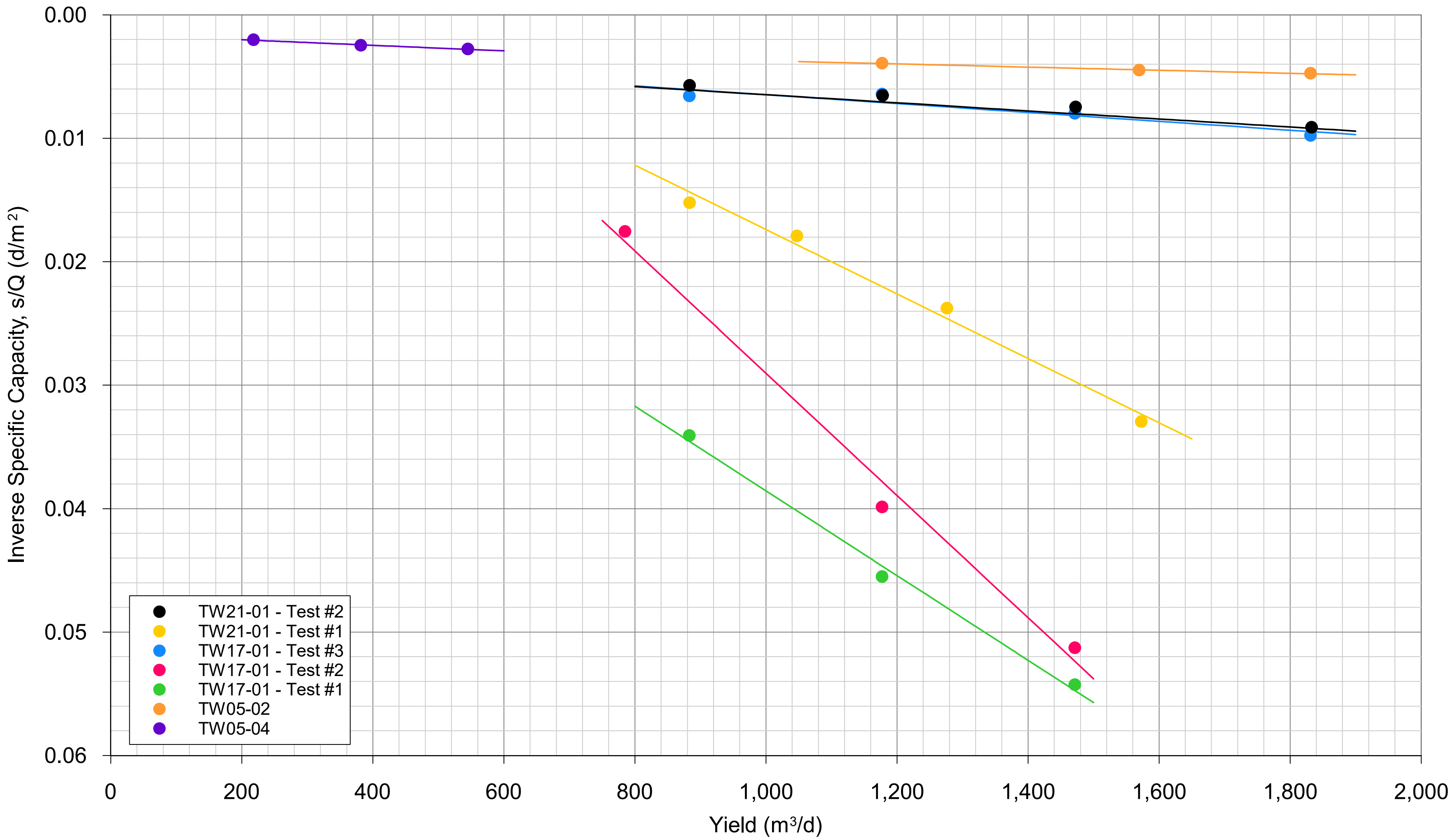
PREPARED BY:	FIGURE TITLE:		
CO	TW21-01 STEP-DRAWDOWN TEST		
CHECKED BY:	CLIENT:		
WT	VILLAGE OF NEW MARYLAND		
APPROVED BY:	SCALE:	PROJECT NO:	FIGURE NO:
KW	AS SHOWN	2231001	4-2

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

DRAFT

03-2021



NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNDWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.
2. STEP-TEST DATA FOR TW21-01 WERE COLLECTED BETWEEN FEBRUARY 4 AND FEBRUARY 11, 2021.
3. STEP-TEST DATA FOR TW17-01, TW05-04 AND TW05-02 WERE COLLECTED BETWEEN SEPTEMBER 18 AND DECEMBER 19, 2017.

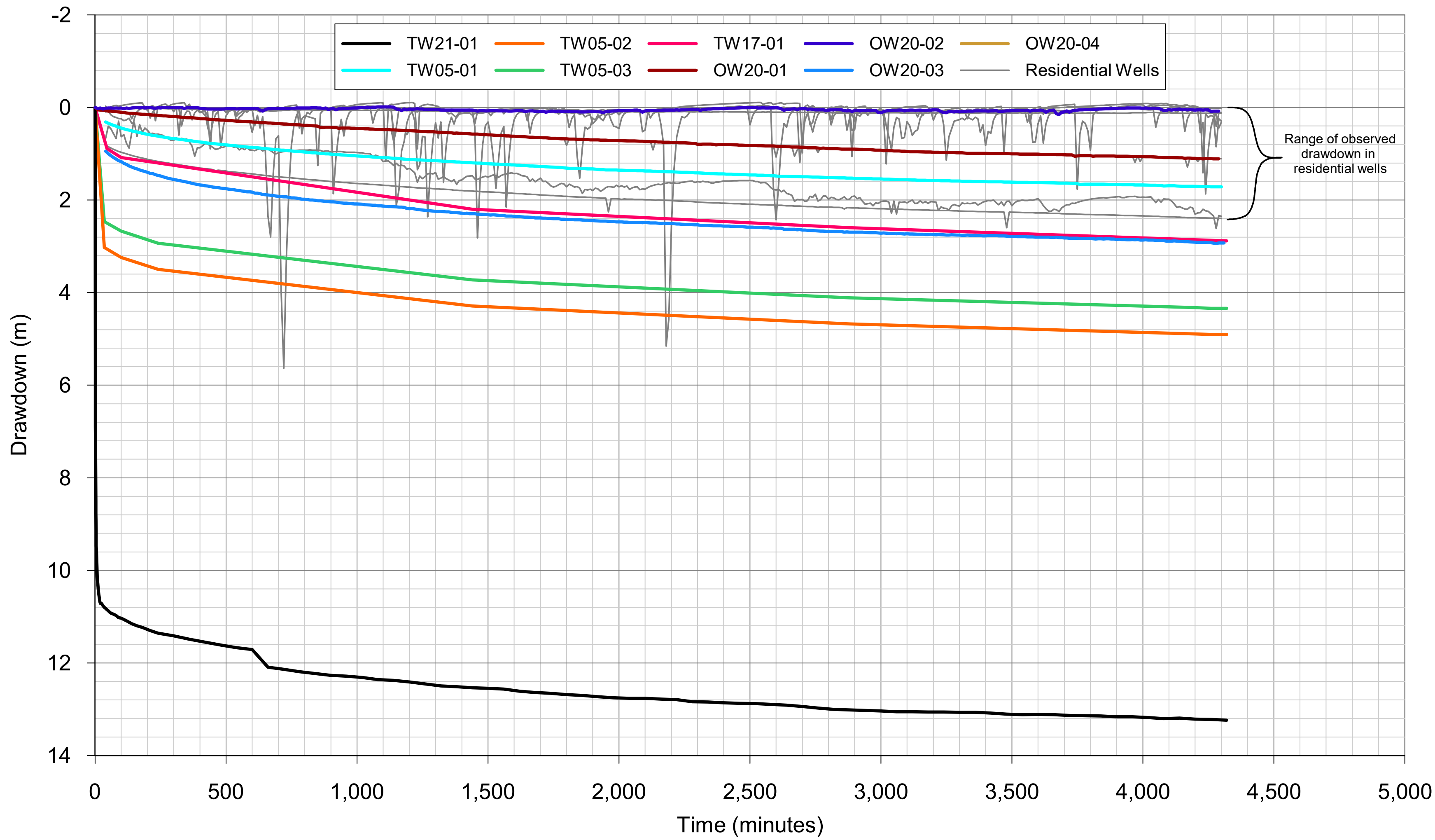
PREPARED BY: CO	FIGURE TITLE: SUNRISE WELLFIELD WELL PERFORMANCE		
CHECKED BY: WT	CLIENT: VILLAGE OF NEW MARYLAND		
APPROVED BY: KW	SCALE: AS SHOWN	PROJECT NO: 2231001	FIGURE NO: 4-3

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

DRAFT

03-2021



NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNDWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.
2. THE CONSTANT-RATE PUMPING TEST BEGAN AT 12:00 ON FEBRUARY 17, 2021 AND ENDED AT 12:00 ON FEBRUARY 20, 2021.
3. EIGHT OF THE RESIDENTIAL WELLS WITHIN THE MONITORING NETWORK ARE INCLUDED IN THIS PLOT (SENSOR FAILURE AT OW-17).

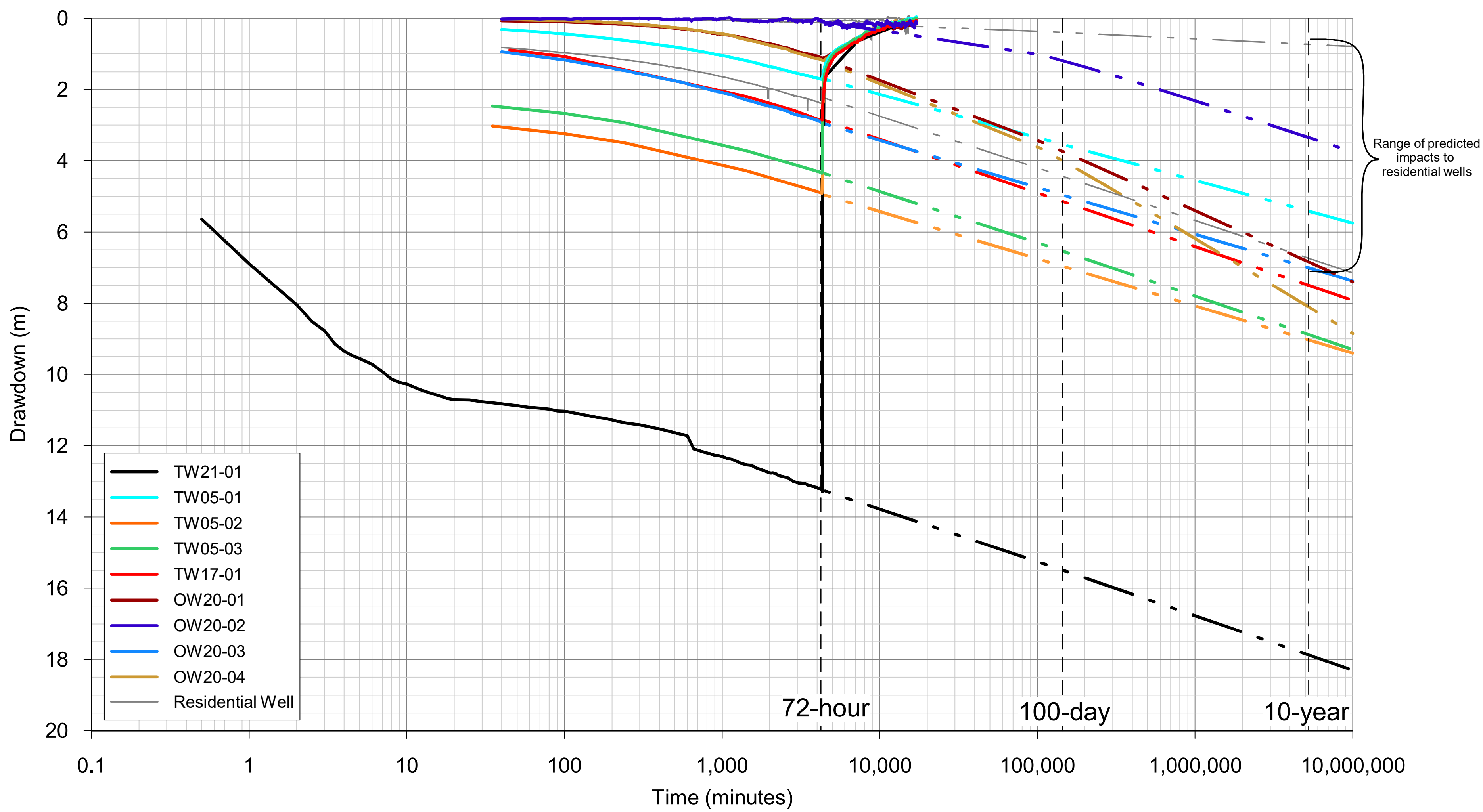
PREPARED BY:	FIGURE TITLE:		
CO	CONSTANT-RATE PUMPING TEST - DRAWDOWN AND PUMPING RATE WITH TIME		
CHECKED BY: WT	CLIENT: VILLAGE OF NEW MARYLAND		
APPROVED BY: KW	SCALE: AS SHOWN	PROJECT NO: 2231001	FIGURE NO: 4-4

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

DRAFT

03-2021



NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNDWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.
2. THE CONSTANT-RATE PUMPING TEST BEGAN AT 12:00 ON FEBRUARY 17, 2021 AND ENDED AT 12:00 ON FEBRUARY 20, 2021.
3. THE X-AXIS (TIME) IS IN LOGARITHMIC SCALE.
4. DASHED LINES REPRESENT PROJECTIONS OF DRAWDOWN UNDER CONSTANT RATE PUMPING FROM TW21-01 (1635 m^3/day) BY EXTRAPOLATING THE SELECTED ANALYTICAL MODEL (THEIS WITH BOUNDARY) TO 10 YEARS OF PUMPING.
5. PREDICTIONS ARE PLOTTED FOR THE RESIDENTIAL WELLS IN THE MONITORING NETWORK WHICH SHOWED THE MOST AND LEAST RESPONSE TO PUMPING (OW-09 AND OW-10, RESPECTIVELY).

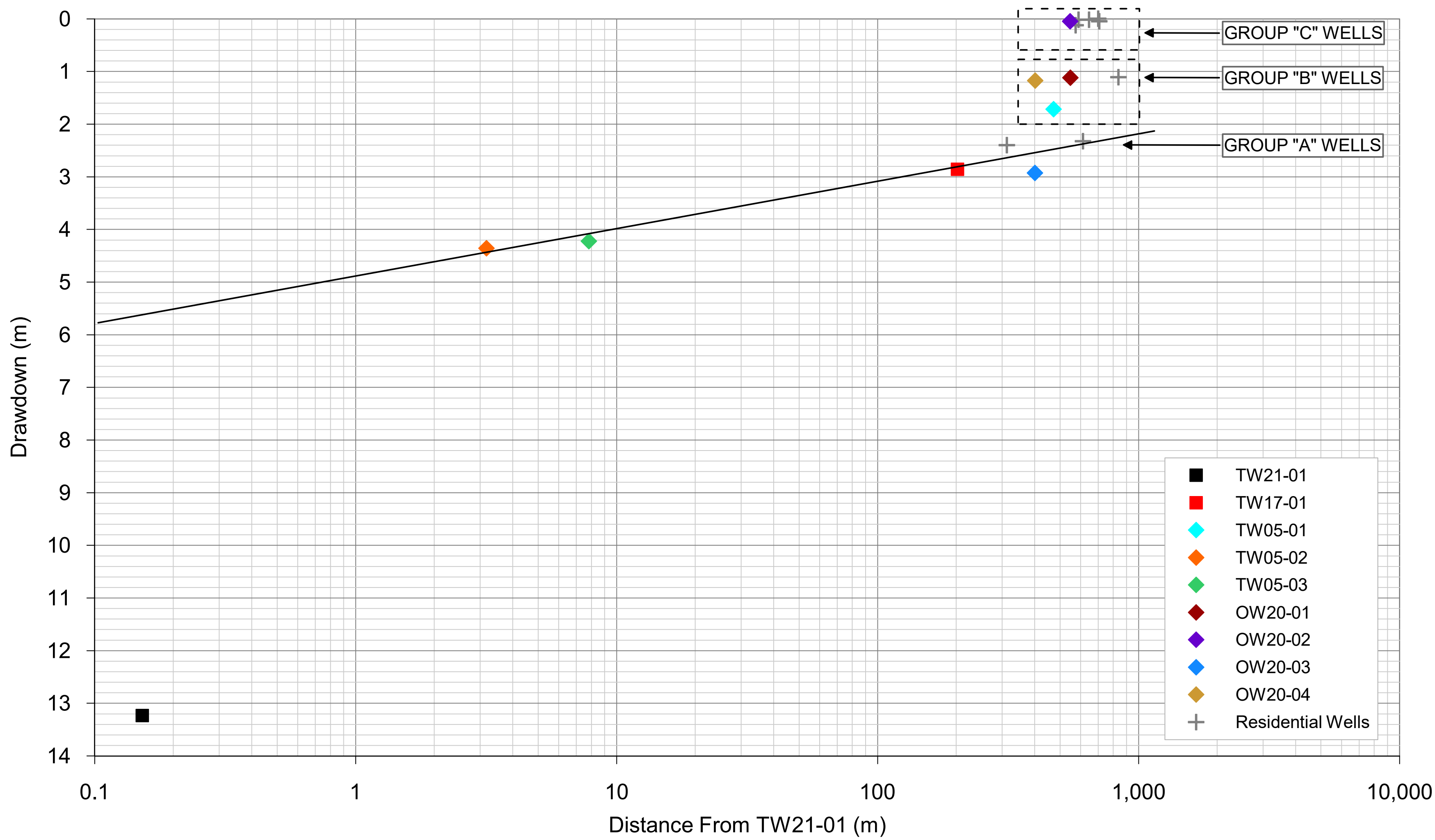
PREPARED BY: CO	FIGURE TITLE: CONSTANT-RATE PUMPING TEST - DRAWDOWN WITH LOGARITHMIC TIME
CHECKED BY: WT	CLIENT: VILLAGE OF NEW MARYLAND
APPROVED BY: KW	SCALE: AS SHOWN / PROJECT NO: 2231001 / FIGURE NO: 4-5

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

DRAFT

03-2021



NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNDWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.
2. THE DISTANCE OF TW21-01 IS REPRESENTED AS THE WELL RADIUS.
3. THE DRAWDOWN SHOWN FOR EACH WELL WAS THE DRAWDOWN FROM THE PRE-PUMPING WATER LEVEL INDUCED AFTER 72 HOURS OF PUMPING.
4. THE BLACK LINE REPRESENTS A STRONG CONNECTION TO THE FRACTURE DURING THE CONSTANT RATE TEST (GROUP "A" WELLS). GROUP "B" WELLS RESPONDED TO PUMPING BUT APPEAR LESS CONNECTED TO THE FRACTURE. GROUP "C" WELLS SHOWED NEGLIGIBLE RESPONSE DURING PUMPING.

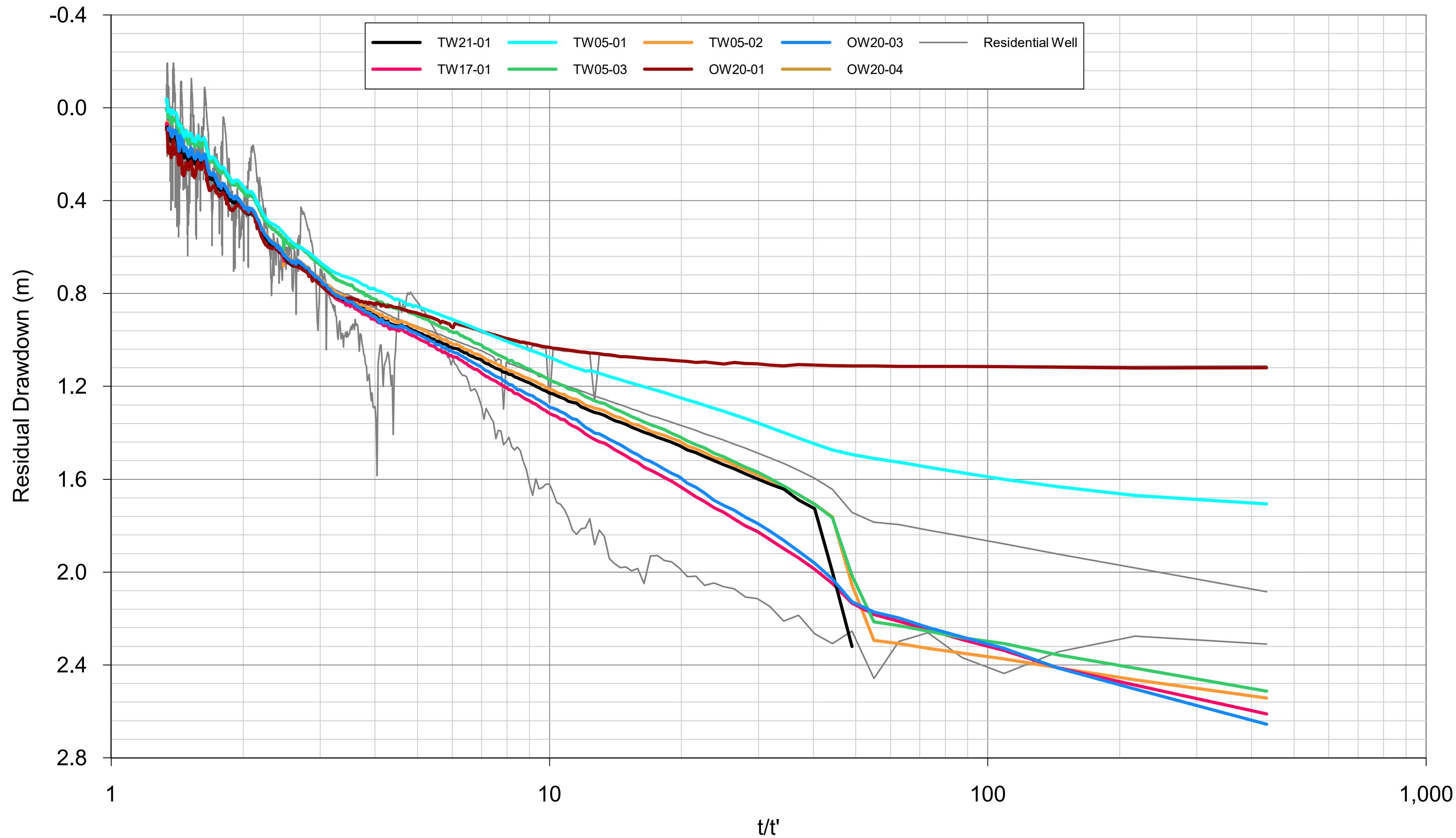
PREPARED BY: CO	FIGURE TITLE: CONSTANT-RATE PUMPING TEST - DISTANCE VERSUS DRAWDOWN		
CHECKED BY: WT	CLIENT: VILLAGE OF NEW MARYLAND		
APPROVED BY: KW	SCALE: AS SHOWN	PROJECT NO: 2231001	FIGURE NO: 4-6

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

DRAFT

03-2021



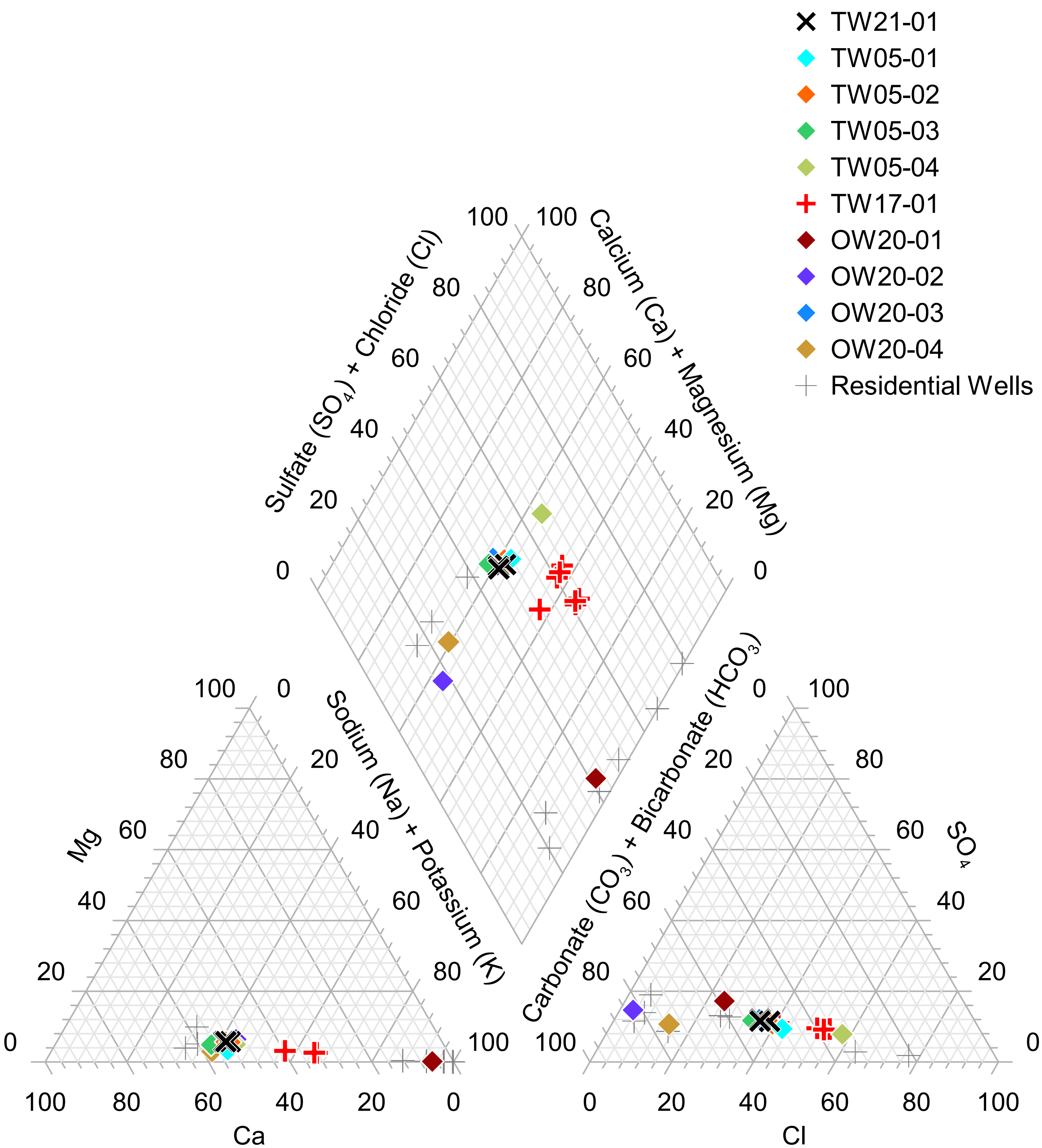
NOTES:

1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNDWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.
2. THE HORIZONTAL AXIS IS NORMALIZED, WITH THE PARAMETER BEING "TIME SINCE PUMPING STARTED" (t), DIVIDED BY "TIME SINCE PUMPING ENDED" (t'); CONSEQUENTLY, ACTUAL RECOVERY TIME INCREASES TO THE LEFT ON THE PLOT.
3. RESIDUAL DRAWDOWNS ARE PLOTTED FOR TWO OF THE RESIDENTIAL WELLS IN THE MONITORING NETWORK (OW-01, OW-09, and OW-15) WHICH SHOWED SIGNIFICANT RESPONSE TO PUMPING.

PREPARED BY:	FIGURE TITLE:		
CO	CONSTANT-RATE PUMPING TEST - RECOVERY		
CHECKED BY:	CLIENT:		
WT	VILLAGE OF NEW MARYLAND		
APPROVED BY:	SCALE:	PROJECT NO:	FIGURE NO:
KW	AS SHOWN	2231001	4-7

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.



NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNDWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.
2. WATER SAMPLES FROM THE TW21-01 AND TW17-01 PUMPING TESTS WERE COLLECTED BY BGC FROM THE DISCHARGE LINE.
3. WATER SAMPLES FROM THE TEST WELLS AND OBSERVATION WELLS WERE COLLECTED BY THE VILLAGE AFTER PURGING THREE WELL VOLUMES.
4. WATER SAMPLES FROM THE RESIDENTIAL WELLS WERE COLELCTED BY THE VILLAGE AT THE EXTERIOR TAP.

PREPARED BY: CO	FIGURE TITLE: TRILINEAR PIPER DIAGRAM OF GROUNDWATER CHEMISTRY		
CHECKED BY: WT	CLIENT: VILLAGE OF NEW MARYLAND		
APPROVED BY: KW	SCALE: AS SHOWN	PROJECT NO: 2231-001	FIGURE NO: 4-8

K:\Projects\2231 New Maryland Water Supply\Chemistry

0 5 10mm in ANSI A sized paper

03-2021

NOTES

1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNDWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.
2. THE EXTENTS OF THIS FIGURE CAN BE FOUND WITHIN FIGURE 1-1 AND FIGURE 1-2.
3. WELL ELEVATIONS WERE PROVIDED BY WSP AND USE THE GEODETIC 1928 VERTICAL DATUM.
4. SOURCE IMAGERY OBTAINED FROM GOOGLE EARTH.
5. ARTESIAN FRACTURE ELEVATION CONTOURS AND GROUNDWATER ELEVATION CONTOURS ARE APPROXIMATE, AS INFERRED FROM THE MEASUREMENTS IN THE WELLS.

PREPARED BY:	FIGURE TITLE		
CO	FRACTURE ELEVATION AND WATER LEVEL ELEVATION CONTOURS		
CHECKED BY: WT	CLIENT: VILLAGE OF NEW MARYLAND		
APPROVED BY: KW	SCALE: AS SHOWN	PROJECT NO: 2231001	FIGURE NO: 5-1

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

APPENDIX A
BOREHOLE LOGS

DRILL HOLE # TW21-01

Project: Village of New Maryland Water Supply
Location: New Maryland, NB
Project No.: 2231-001

Survey Method: WSP Survey
Coordinates (m): 2,485,537.E, 7,430,012.N
Assumed Ground Elevation (m): 54.6
Datum: NAD83
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation: Drilltech
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary Hammer
Core:
Fluid: Water
Casing: 305 mm ***Cased To (m):*** 31.10

Start Date: 18 Jan 21
Finish Date: 29 Jan 21
Final Depth of Hole (m): 106.70
Logged by: CO
Reviewed by: WT / KW

Depth (m)	Symbol	Lithological Description	Estimated Water Return (m3/d) (0 – 500 – 1000)	Installation Details	Comments	Elevation (m)
0 – 1.5		SILT and CLAY Some sand, trace gravel, low plasticity, light brown. [TILL]		Casing to 31.10		54.6
1.5 – 27.5		SHALE Dark grey, fine grained. [BEDROCK]				
27.5 – 32.1		SANDSTONE Light grey, medium grained, trace lignite. [BEDROCK]				
32.1 – 50		SHALE Reddish brown, fine grained. [BEDROCK]				

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50
Elevation scale: 54, 53, 52, 51, 50, 49, 48, 47, 46, 45, 44, 43, 42, 41, 40, 39, 38, 37, 36, 35, 34, 33, 32, 31, 30, 29, 28, 27, 26, 25, 24, 23, 22, 21, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5

(Continued on next page)

All noted depths are in metres along hole.

Project: Village of New Maryland Water Supply

DRILL HOLE # TW21-01

Location: New Maryland, NB

Project No.: 2231-001

Survey Method: WSP Survey
Coordinates (m): 2,485,537.E, 7,430,012.N
Assumed Ground Elevation (m): 54.6
Datum: NAD83
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation: Drilltech
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary Hammer
Core:
Fluid: Water
Casing: 305 mm **Cased To (m):** 31.10

Start Date: 18 Jan 21
Finish Date: 29 Jan 21
Final Depth of Hole (m): 106.70
Logged by: CO
Reviewed by: WT / KW

Depth (m)	Symbol	Lithological Description	Estimated Water Return (m3/d) (0 – 500 – 1000)	Installation Details	Comments	Elevation (m)
50–66						4 to -11
66–100		SANDSTONE Light grey, medium grained, trace lignite. [BEDROCK]				-12 to -45
93.0		At 93.0 m - Fracture with estimated yield of 800 m3/d.	800 (93.0–100)			-38.4

Depth scale: 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100

Elevation scale: 4, 3, 2, 1, 0, -1, -2, -3, -4, -5, -6, -7, -8, -9, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -20, -21, -22, -23, -24, -25, -26, -27, -28, -29, -30, -31, -32, -33, -34, -35, -36, -37, -38, -39, -40, -41, -42, -43, -44, -45

(Continued on next page)

All noted depths are in metres along hole.

DRILL HOLE # TW21-01

Project: Village of New Maryland Water Supply
Location: New Maryland, NB
Project No.: 2231-001

Survey Method: WSP Survey
Coordinates (m): 2,485,537.E, 7,430,012.N
Assumed Ground Elevation (m): 54.6
Datum: NAD83
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation: Drilltech
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary Hammer
Core:
Fluid: Water
Casing: 305 mm **Cased To (m):** 31.10

Start Date: 18 Jan 21
Finish Date: 29 Jan 21
Final Depth of Hole (m): 106.70
Logged by: CO
Reviewed by: WT / KW

Depth (m)	Symbol	Lithological Description	Estimated Water Return (m3/d) (0 – 500 – 1000)	Installation Details	Comments	Elevation (m)
100 – 106.70 (102, 104, 106)			~800			-46, -47, -48, -49, -50, -51, -52
		END OF HOLE AT 106.70 m				

NOTES:
1. Borehole was drilled at a diameter of 305 mm.
2. The soil and bedrock structure was not visible in recovered drill cuttings due to disturbance of the drilling method.
3. Steel casing installed to 31.1 m below ground surface.
4. A cement grout seal was installed from 0.0 m to 30.8 m below ground surface.
5. The well stick-up height was 0.77 m above ground surface.
6. The well was developed for approximately 14 hours using a combination of air-lifting and surging.
7. The well was flowing artesian at the time of completion (January 29, 2021).
8. The estimated yield of the well after development was approximately 800 m3/d.
9. Ground elevation obtained from WSP Survey.

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

Client: Village of New Maryland

Print Date: 3/28/2021

All noted depths are in metres along hole.

DRILL HOLE # OW20-01

Project: Village of New Maryland Water Supply
Location: New Maryland, NB
Project No.: 2231-001

Survey Method: WSP Survey
Coordinates (m): 2,485,530.E, 7,430,560.N
Assumed Ground Elevation (m): 69.4
Datum: NAD83
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation: Drilltech
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary Hammer
Core:
Fluid: Water
Casing: 152 mm **Cased To (m):** 30.48

Start Date: 17 Dec 20
Finish Date: 18 Dec 20
Final Depth of Hole (m): 152.40
Logged by: CO
Reviewed by: WT / KW

Depth (m)	Lithological Description	Estimated Water Return (m3/d) (0 / 500 / 1000)	Installation Details	Comments	Elevation (m)
0 – ~9.5	SILT and CLAY Some sand, trace gravel, low plasticity, light brown. [TILL]		Casing		69 – ~60
~9.5 – ~13	SHALE Grey, fine grained. [BEDROCK]		Casing		
~13 – ~27	SANDSTONE Light grey, medium grained. [BEDROCK] At 25.3 m - Fracture		Casing		
~27 – 50	SANDSTONE Reddish brown and grey, medium grained. [BEDROCK] At 28.3 m - Fracture		Casing to ~30.5		– 20

(Continued on next page)

Project: Village of New Maryland Water Supply

DRILL HOLE # OW20-01

Location: New Maryland, NB

Project No.: 2231-001

Survey Method: WSP Survey
Coordinates (m): 2,485,530.E, 7,430,560.N
Assumed Ground Elevation (m): 69.4
Datum: NAD83
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation: Drilltech
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary Hammer
Core:
Fluid: Water
Casing: 152 mm **Cased To (m):** 30.48

Start Date: 17 Dec 20
Finish Date: 18 Dec 20
Final Depth of Hole (m): 152.40
Logged by: CO
Reviewed by: WT / KW

Depth (m)	Symbol	Lithological Description	Estimated Water Return (m3/d) 0 500 1000	Installation Details	Comments	Elevation (m)
50–66						19–3
66.7		SANDSTONE Grey, medium grained, trace lignite. [BEDROCK]				
		At 79.3 m - Fracture with estimated yield of 15 m3/d.				
		At 82.3 m - Fracture				
100						-30

Depth scale: 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100

Elevation scale: 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0, -1, -2, -3, -4, -5, -6, -7, -8, -9, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -20, -21, -22, -23, -24, -25, -26, -27, -28, -29, -30

(Continued on next page)

DRILL HOLE # OW20-01

Project: Village of New Maryland Water Supply
Location: New Maryland, NB
Project No.: 2231-001

Survey Method: WSP Survey
Coordinates (m): 2,485,530.E, 7,430,560.N
Assumed Ground Elevation (m): 69.4
Datum: NAD83
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation: Drilltech
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary Hammer
Core:
Fluid: Water
Casing: 152 mm ***Cased To (m):*** 30.48

Start Date: 17 Dec 20
Finish Date: 18 Dec 20
Final Depth of Hole (m): 152.40
Logged by: CO
Reviewed by: WT / KW

Depth (m)	Lithological Description	Estimated Water Return (m3/d) (0 / 500 / 1000)	Installation Details	Comments	Elevation (m)
100 – 108					-31 to -39
108 – 112	SHALE Dark grey, fine grained. [BEDROCK]				
112 – 140	SANDSTONE Dark grey, medium grained, trace lignite. [BEDROCK] At 126.5 m - Fracture with estimated yield of 65 m3/d.				
140 – 144	SANDSTONE Dark grey with black streaks.				
144 – 150	SANDSTONE Dark grey and reddish brown, medium grained. [BEDROCK]				to -80

Depth scale: 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150

Elevation scale: -31, -32, -33, -34, -35, -36, -37, -38, -39, -40, -41, -42, -43, -44, -45, -46, -47, -48, -49, -50, -51, -52, -53, -54, -55, -56, -57, -58, -59, -60, -61, -62, -63, -64, -65, -66, -67, -68, -69, -70, -71, -72, -73, -74, -75, -76, -77, -78, -79, -80

(Continued on next page)

Project: Village of New Maryland Water Supply

DRILL HOLE # OW20-01

Location: New Maryland, NB

Project No.: 2231-001

Survey Method: WSP Survey
Coordinates (m): 2,485,530.E, 7,430,560.N
Assumed Ground Elevation (m): 69.4
Datum: NAD83
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation: Drilltech
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary Hammer
Core:
Fluid: Water
Casing: 152 mm **Cased To (m):** 30.48

Start Date: 17 Dec 20
Finish Date: 18 Dec 20
Final Depth of Hole (m): 152.40
Logged by: CO
Reviewed by: WT / KW

Depth (m)	Symbol	Lithological Description	Estimated Water Return (m3/d) (0 / 500 / 1000)	Installation Details	Comments	Elevation (m)
150						-81
152		SHALE Dark grey and reddish brown shale, fine grained. [BEDROCK]				-82 -83

END OF HOLE AT 152.4 m

NOTES:
1. Borehole was drilled at a diameter of 152 mm.
2. The soil and bedrock structure was not visible in recovered drill cuttings due to disturbance of the drilling method.
3. Steel casing installed to 30.5 m below ground surface.
4. The well stick-up height was 0.82 m above ground surface.
5. The well was developed (air-lifting) for approximately 1 hour.
6. Initial water level was 9.68 m below top of casing on January 14, 2021.
7. The estimated yield of the well after development was approximately 80 m3/d.
8. Ground elevation obtained from WSP Survey.

Project: Village of New Maryland Water Supply

DRILL HOLE # OW20-02

Location: New Maryland, NB

Project No.: 2231-001

Survey Method: WSP Survey
Coordinates (m): 2,485,532.E, 7,430,559.N
Assumed Ground Elevation (m): 69.4
Datum: NAD83
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation: Drilltech
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary Hammer
Core:
Fluid: Water
Casing: 152 mm **Cased To (m):** 17.68

Start Date: 18 Dec 20
Finish Date: 18 Dec 20
Final Depth of Hole (m): 30.48
Logged by: CO
Reviewed by: WT / KW

Depth (m)	Symbol	Lithological Description	Estimated Water Return (m3/d) (0 / 500 / 1000)	Installation Details	Comments	Elevation (m)
0–9.4		SILT and CLAY Some sand, trace gravel, low plasticity, light brown. [TILL]				69–60
9.4–13		SHALE Grey, fine grained. [BEDROCK]				
13–27		SANDSTONE Light grey, medium grained. [BEDROCK] At 14.3 m - Fracture At 25.3 m - Fracture with estimated yield of 15 m3/d.				
27–30.48		SANDSTONE Reddish brown and grey, medium grained. [BEDROCK] At 28.4 m - Fracture with estimated yield of 5 m3/d.				39

END OF HOLE AT 30.48 m

NOTES:
1. Borehole was drilled at a diameter of 152 mm.
2. The soil and bedrock structure was not visible in recovered drill cuttings due to disturbance of the drilling method.
3. Steel casing installed to 17.7 m below ground surface.
4. The well stick-up height was 0.52 m above ground surface.
5. The well was developed (air-lifting) for approximately 1 hour.
6. Initial water level was 7.35 m below top of casing on January 14, 2021.
7. The estimated yield of the well after development was approximately 20 m3/d.
8. Ground elevation obtained from WSP Survey.

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

Client: Village of New Maryland

Print Date: 3/28/2021

All noted depths are in metres along hole.

Project: Village of New Maryland Water Supply

DRILL HOLE # OW20-03

Location: New Maryland, NB

Project No.: 2231-001

Survey Method: WSP Survey
Coordinates (m): 2,485,855.E, 7,430,258.N
Assumed Ground Elevation (m): 59.7
Datum: NAD83
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation: Drilltech
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary Hammer
Core:
Fluid: Water
Casing: 152 mm **Cased To (m):** 30.15

Start Date: 21 Dec 20
Finish Date: 22 Dec 20
Final Depth of Hole (m): 102.11
Logged by: WT
Reviewed by: KW

Depth (m)	Symbol	Lithological Description	Estimated Water Return (m3/d) (0 / 500 / 1000)	Installation Details	Comments	Elevation (m)
0		SILT and CLAY Some sand, trace gravel, low plasticity, light brown. [TILL]		Casing 0–30.15		59
6.7		SHALE Dark grey, fine grained. [BEDROCK]				
11.3		SANDSTONE Light grey, medium grained. [BEDROCK]				
18		MUDSTONE Reddish brown. [BEDROCK]				
23.2		SANDSTONE Grey, medium grained. [BEDROCK]				
33.6		MUDSTONE Reddish brown. [BEDROCK]				
45.8		SANDSTONE Light grey, medium grained, trace lignite. [BEDROCK]				
50						10

Depth scale (m): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50

Elevation scale (m): 59, 58, 57, 56, 55, 54, 53, 52, 51, 50, 49, 48, 47, 46, 45, 44, 43, 42, 41, 40, 39, 38, 37, 36, 35, 34, 33, 32, 31, 30, 29, 28, 27, 26, 25, 24, 23, 22, 21, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10

(Continued on next page)

Project: Village of New Maryland Water Supply

DRILL HOLE # OW20-03

Location: New Maryland, NB

Project No.: 2231-001

Survey Method: WSP Survey
Coordinates (m): 2,485,855.E, 7,430,258.N
Assumed Ground Elevation (m): 59.7
Datum: NAD83
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation: Drilltech
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary Hammer
Core:
Fluid: Water
Casing: 152 mm **Cased To (m):** 30.15

Start Date: 21 Dec 20
Finish Date: 22 Dec 20
Final Depth of Hole (m): 102.11
Logged by: WT
Reviewed by: KW

Depth (m)	Symbol	Lithological Description	Estimated Water Return (m3/d) (0 / 500 / 1000)	Installation Details	Comments	Elevation (m)
50–89.9						9 to -30
89.9		At 89.9 m - Fracture with estimated yield of 10 m3/d.				-30
96.9		At 96.9 m - Fracture with estimated yield of 40 m3/d.				-37
100						-40

(Continued on next page)

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

Client: Village of New Maryland

Print Date: 3/28/2021

All noted depths are in metres along hole.

Project: Village of New Maryland Water Supply

DRILL HOLE # OW20-03

Location: New Maryland, NB

Project No.: 2231-001

Survey Method: WSP Survey
Coordinates (m): 2,485,855.E, 7,430,258.N
Assumed Ground Elevation (m): 59.7
Datum: NAD83
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation: Drilltech
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary Hammer
Core:
Fluid: Water
Casing: 152 mm **Cased To (m):** 30.15

Start Date: 21 Dec 20
Finish Date: 22 Dec 20
Final Depth of Hole (m): 102.11
Logged by: WT
Reviewed by: KW

Depth (m)	Symbol	Lithological Description	Estimated Water Return (m3/d) (0 – 500 – 1000)	Installation Details	Comments	Elevation (m)
100 – 102		At 100.9 m - Fracture with estimated yield of 500 m3/d.				-41 – -42

END OF HOLE at 102.11 m

NOTES:
1. Borehole was drilled at a diameter of 152 mm.
2. The soil and bedrock structure was not visible in recovered drill cuttings due to disturbance of the drilling method.
3. Steel casing installed to 30.1 m below ground surface.
4. The well stick-up height was 0.41 m above ground surface.
5. The well was developed (air-lifting) for approximately 1 hour.
6. Initial water level was 1.47 m below top of casing on January 14, 2021.
7. The estimated yield of the well after development was approximately 550 m3/d.
8. Ground elevation obtained from WSP Survey.

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

Client: Village of New Maryland

Print Date: 3/28/2021

All noted depths are in metres along hole.

Project: Village of New Maryland Water Supply

DRILL HOLE # OW20-04

Location: New Maryland, NB

Project No.: 2231-001

Survey Method: WSP Survey
Coordinates (m): 2,485,857.E, 7,430,256.N
Assumed Ground Elevation (m): 59.7
Datum: NAD83
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation: Drilltech
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary Hammer
Core:
Fluid: Water
Casing: 152 mm **Cased To (m):** 11.73

Start Date: 22 Dec 20
Finish Date: 22 Dec 20
Final Depth of Hole (m): 60.96
Logged by: WT
Reviewed by: KW

Depth (m)	Lithological Description	Estimated Water Return (m3/d) (0 / 500 / 1000)	Installation Details	Comments	Elevation (m)
0 – 6.7	SILT and CLAY Some sand, trace gravel, low plasticity, light brown. [TILL]				59.7 – 53
6.7 – 11.3	SHALE Dark grey, fine grained. [BEDROCK]				53 – 48.4
11.3 – 18.0	SANDSTONE Light grey, medium grained. [BEDROCK] At 13.7 m - Fracture with estimated yield of 15 m3/d.				48.4 – 41.7
18.0 – 23.2	MUDSTONE Reddish brown. [BEDROCK]				41.7 – 36.5
23.2 – 33.6	SANDSTONE Grey, medium grained. [BEDROCK]				36.5 – 26.1
33.6 – 45.8	MUDSTONE Reddish brown. [BEDROCK] At 34.8 m - Fracture with estimated yield of 15 m3/d.				26.1 – 13.9
45.8 – 50	SANDSTONE Light grey, medium grained. [BEDROCK]				13.9 – 9.7

(Continued on next page)

Project: Village of New Maryland Water Supply

DRILL HOLE # OW20-04

Location: New Maryland, NB

Project No.: 2231-001

Survey Method: WSP Survey
Coordinates (m): 2,485,857.E, 7,430,256.N
Assumed Ground Elevation (m): 59.7
Datum: NAD83
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation: Drilltech
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary Hammer
Core:
Fluid: Water
Casing: 152 mm **Cased To (m):** 11.73

Start Date: 22 Dec 20
Finish Date: 22 Dec 20
Final Depth of Hole (m): 60.96
Logged by: WT
Reviewed by: KW

Depth (m)	Symbol	Lithological Description	Estimated Water Return (m3/d) 0 / 500 / 1000	Installation Details	Comments	Elevation (m)
50						9
52						8
54						7
56						6
58						5
60						4
						3
						2
						1
						0
						-1

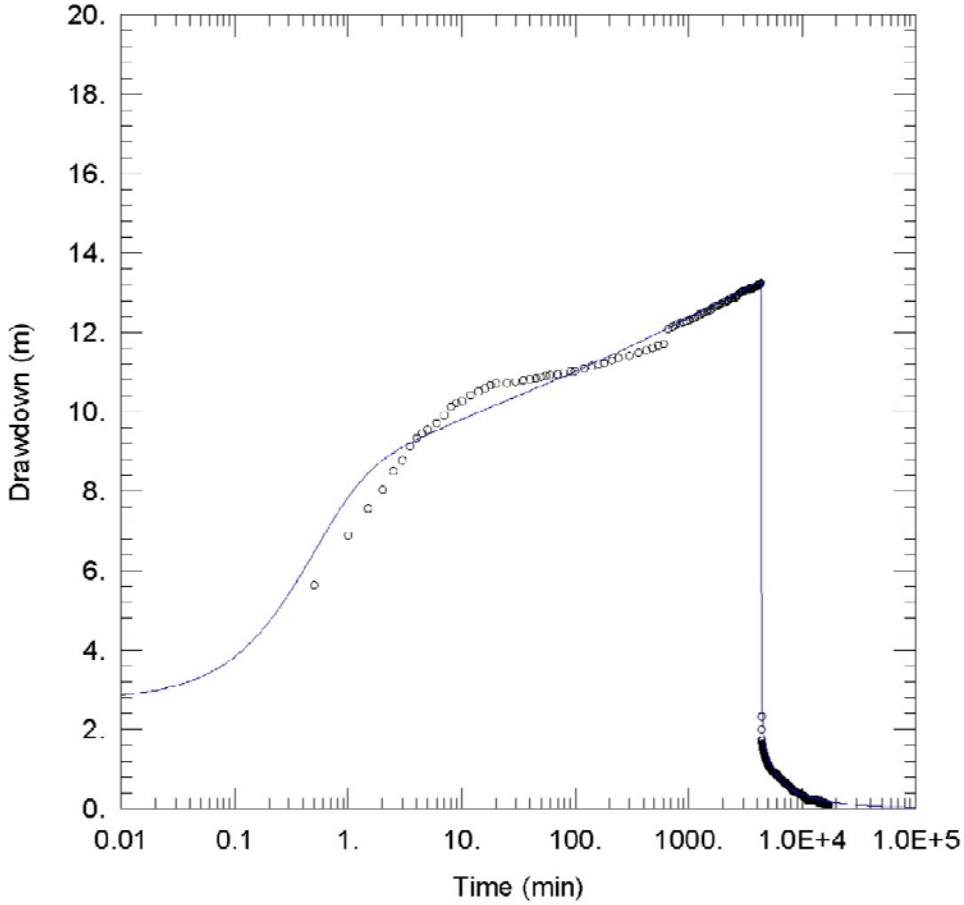
END OF HOLE AT 60.96 m

NOTES:
1. Borehole was drilled at a diameter of 152 mm.
2. The soil and bedrock structure was not visible in recovered drill cuttings due to disturbance of the drilling method.
3. Steel casing installed to 11.8 m below ground surface.
4. The well stick-up height was 0.48 m above ground surface.
5. The well was developed (air-lifting) for approximately 1 hour.
6. Initial water level was 4.47 m below top of casing on January 14, 2021.
7. The estimated yield of the well after development was approximately 30 m3/d.
8. Ground elevation obtained from WSP Survey.

APPENDIX B
PUMPING TEST ANALYSES

DRAFT

03-2021



AQUIFER DATA

Saturated Thickness: 106.7 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW21-01	2485537.43	7430011.595

Observation Wells

Well Name	X (m)	Y (m)
○ TW21-01	2485537.43	7430011.595

SOLUTION

Aquifer Model: Confined

Solution Method: Papadopulos-Cooper

T = 406.3 m^2/day

S = 5.917E-9

r(w) = 0.15 m

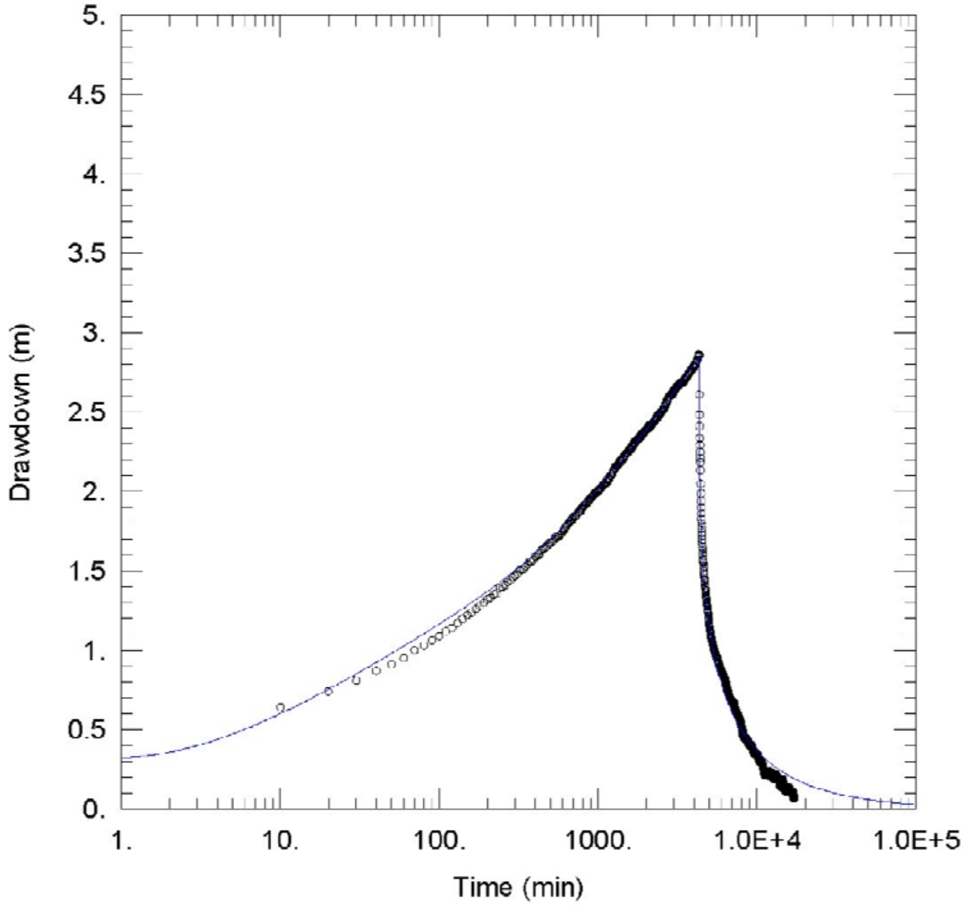
r(c) = 0.15 m

NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.

PREPARED BY:	FIGURETITLE:		
WT	TW21-01 PUMPING TEST - TW21-01 AQTESOLV OUTPUT		
CHECKED BY: CO	CLIENT: VILLAGE OF NEW MARYLAND		
APPROVED BY: KW	SCALE: AS SHOWN	PROJECT NO: 2231001	FIGURE NO: B-1

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.



WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW21-01	2485537.43	7430011.595

Observation Wells

Well Name	X (m)	Y (m)
○ TW17-01	2485674.41	7429862.11

SOLUTION

Aquifer Model: Confined

T = 392. m^2/day
Kz/Kr = 1.

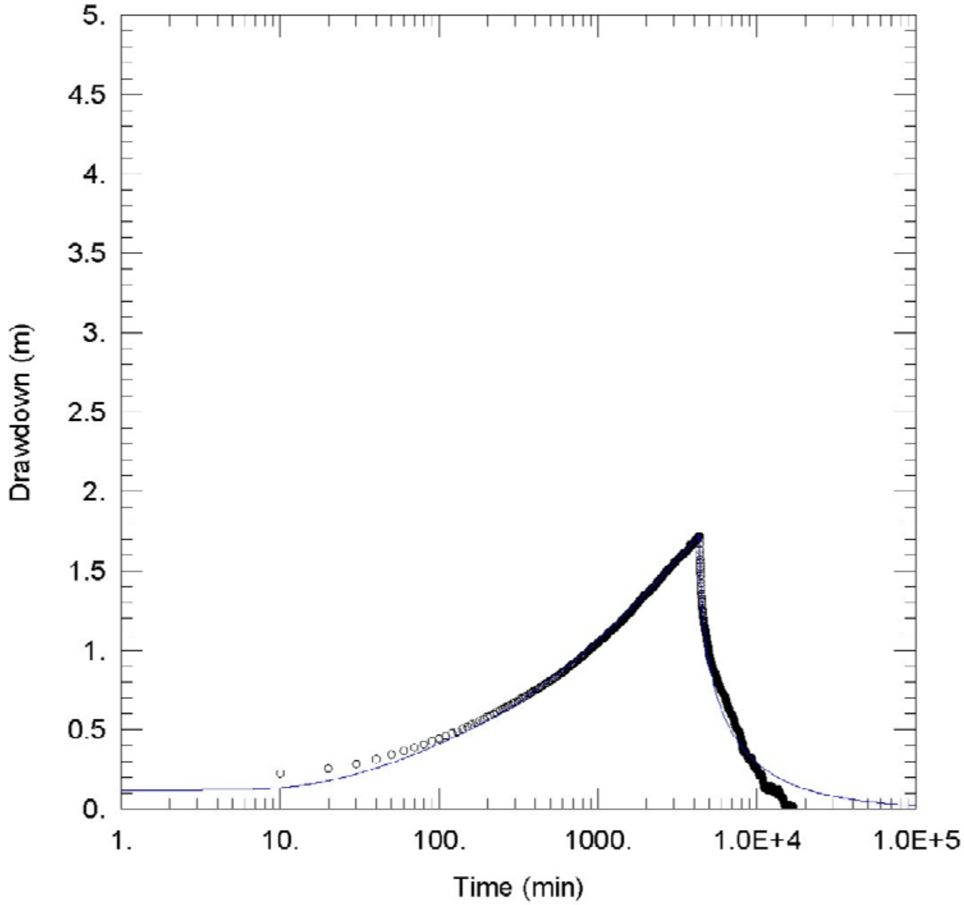
Solution Method: Theis

S = 5.89E-5
b = 106.7 m

NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.

PREPARED BY: WT	FIGURETITLE: TW21-01 PUMPING TEST - TW17-01 AQTESOLV OUTPUT			
CHECKED BY: CO	CLIENT: VILLAGE OF NEW MARYLAND			
APPROVED BY: KW	SCALE: AS SHOWN	PROJECT NO: 2231001	FIGURE NO: B-2	

0 5 10 mm in ANSI A sized paper



WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW21-01	2485537.43	7430011.595

Observation Wells

Well Name	X (m)	Y (m)
TW05-01	2485192.24	7430335

SOLUTION

Aquifer Model: Confined

T = 497.3 m^2/day

Kz/Kr = 1.

Solution Method: Theis

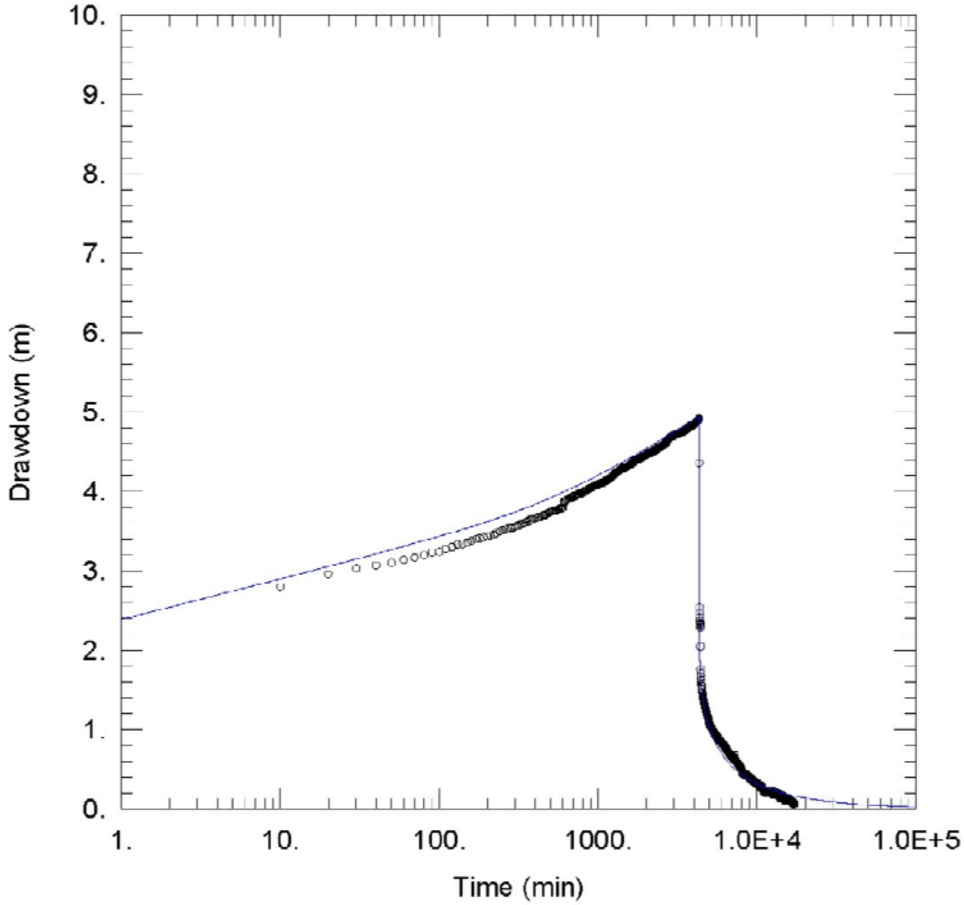
S = 0.0001086

b = 106.7 m

NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.

PREPARED BY:	FIGURETITLE:		
WT	TW21-01 PUMPING TEST - TW05-01 AQTESOLV OUTPUT		
CHECKED BY:	CLIENT:		
CO	VILLAGE OF NEW MARYLAND		
APPROVED BY:	SCALE:	PROJECT NO:	FIGURE NO:
KW	AS SHOWN	2231001	B-3

0 5 10 mm in ANSI A sized paper



WELL DATA

Pumping Wells		
Well Name	X (m)	Y (m)
TW21-01	2485537.43	7430011.595

Observation Wells		
Well Name	X (m)	Y (m)
TW05-02	2485539.8	7430009.49

SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 447. m^2/day

S = 6.758E-5

Kz/Kr = 1.

b = 106.7 m

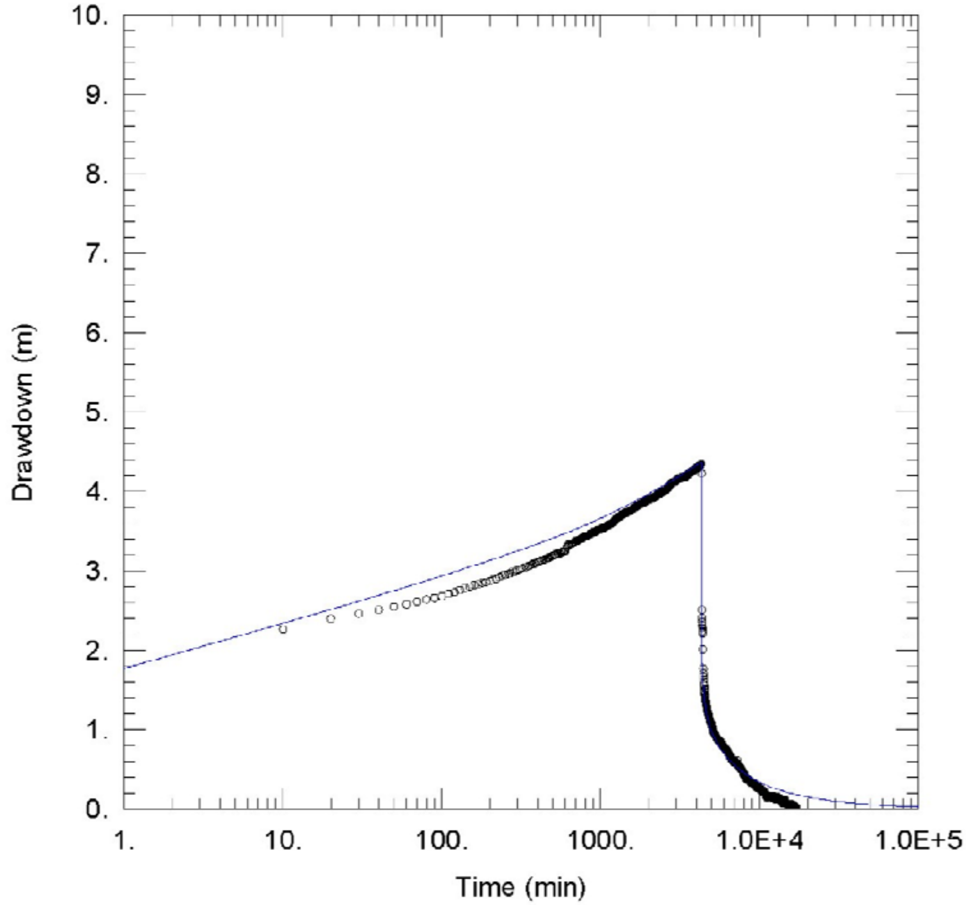
NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.

PREPARED BY:	FIGURETITLE:		
WT	TW21-01 PUMPING TEST - TW05-02 AQTESOLV OUTPUT		
CHECKED BY:	CLIENT:		
CO	VILLAGE OF NEW MARYLAND		
APPROVED BY:	SCALE:	PROJECT NO:	FIGURE NO:
KW	AS SHOWN	2231001	B-4

0 5 10 mm in ANSI A sized paper

DRAFT

03-2021



WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW21-01	2485537.43	7430011.595

Observation Wells

Well Name	X (m)	Y (m)
○ TW05-03	2485543.8	7430007.04

SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 400. m^2/day

S = 0.0001569

Kz/Kr = 1.

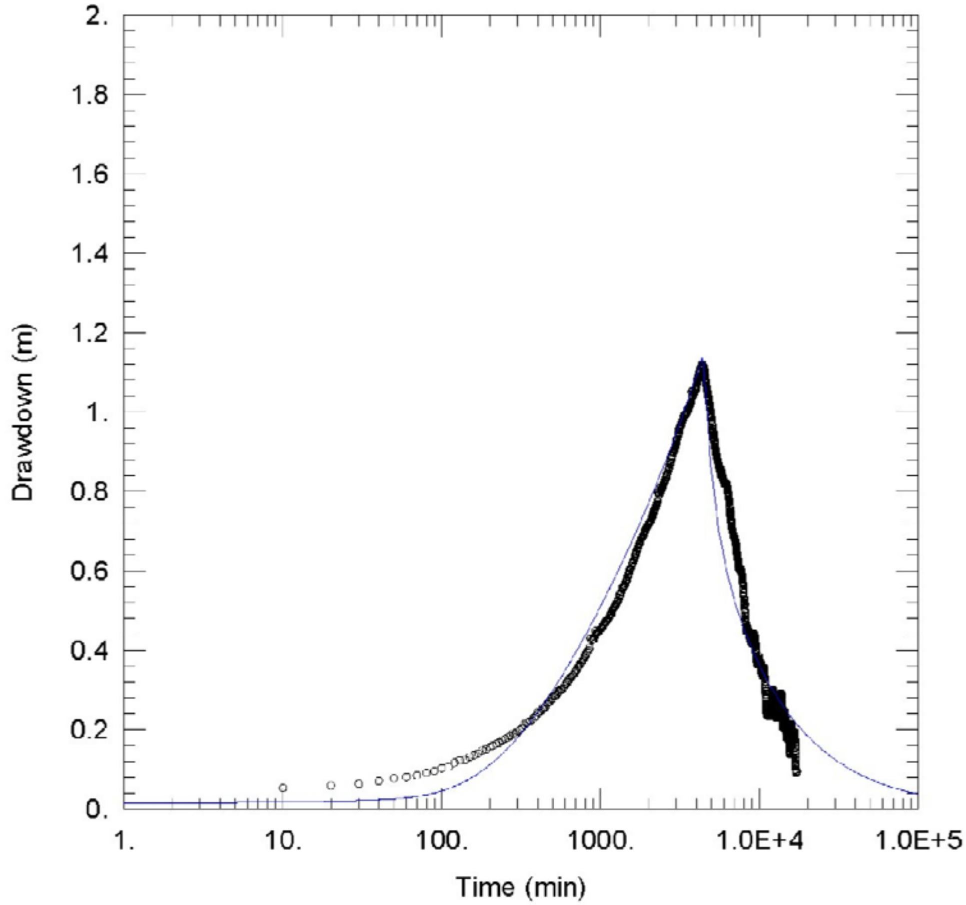
b = 106.7 m

NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.

PREPARED BY:	FIGURETITLE:		
WT	TW21-01 PUMPING TEST - TW05-03 AQTESOLV OUTPUT		
CHECKED BY: CO	CLIENT: VILLAGE OF NEW MARYLAND		
APPROVED BY: KW	SCALE: AS SHOWN	PROJECT NO: 2231001	FIGURE NO: B-5

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.



WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW21-01	2485537.43	7430011.595

Observation Wells

Well Name	X (m)	Y (m)
○ OW20-01	2485530.33	7430560.46

SOLUTION

Aquifer Model: Confined

T = 299.8 m^2/day
Kz/Kr = 1.

Solution Method: Theis

S = 0.0006108
b = 106.7 m

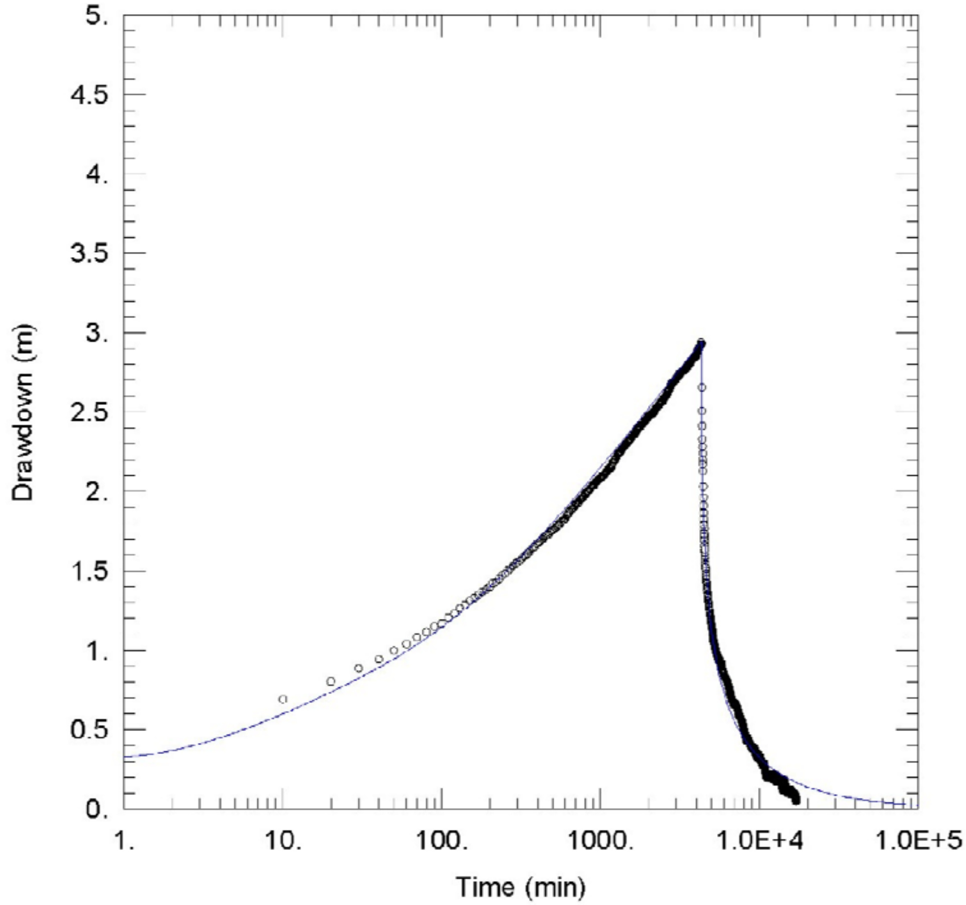
NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.

PREPARED BY:	FIGURETITLE:		
WT	TW21-01 PUMPING TEST - OW20-01 AQTESOLV OUTPUT		
CHECKED BY: CO	CLIENT: VILLAGE OF NEW MARYLAND		
APPROVED BY: KW	SCALE: AS SHOWN	PROJECT NO: 2231001	FIGURE NO: B-6

0 5 10 mm in ANSI A sized paper

DRAFT

03-2021



WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW21-01	2485537.43	7430011.595

Observation Wells

Well Name	X (m)	Y (m)
○ OW20-03	2485854.68	7430257.7

SOLUTION

Aquifer Model: Confined

T = 456.4 m^2/day
Kz/Kr = 1.

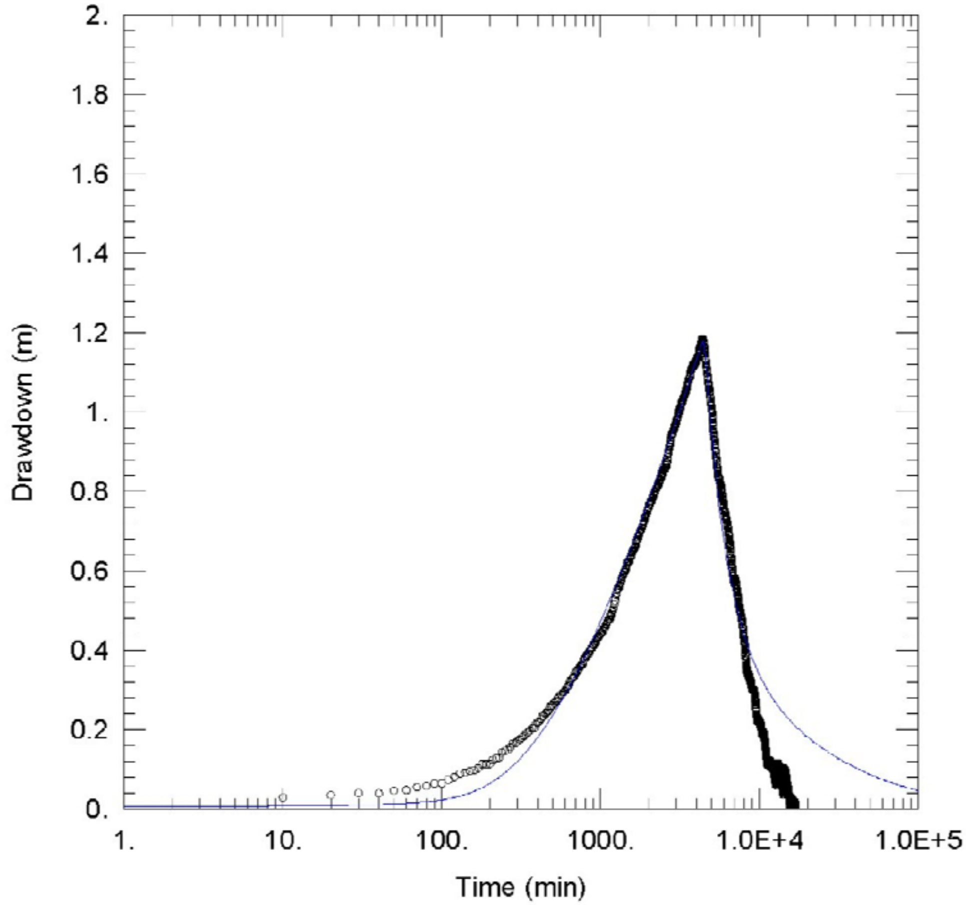
Solution Method: Theis

S = 1.418E-5
b = 106.7 m

NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.

PREPARED BY: WT	FIGURETITLE: TW21-01 PUMPING TEST - OW20-03 AQTESOLV OUTPUT			
CHECKED BY: CO	CLIENT: VILLAGE OF NEW MARYLAND			
APPROVED BY: KW	SCALE: AS SHOWN	PROJECT NO: 2231001	FIGURE NO: B-7	

0 5 10 mm in ANSI A sized paper



WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW21-01	2485537.43	7430011.595

Observation Wells

Well Name	X (m)	Y (m)
○ OW20-04	2485856.57	7430255.62

SOLUTION

Aquifer Model: Confined

T = 223. m^2/day
Kz/Kr = 1.

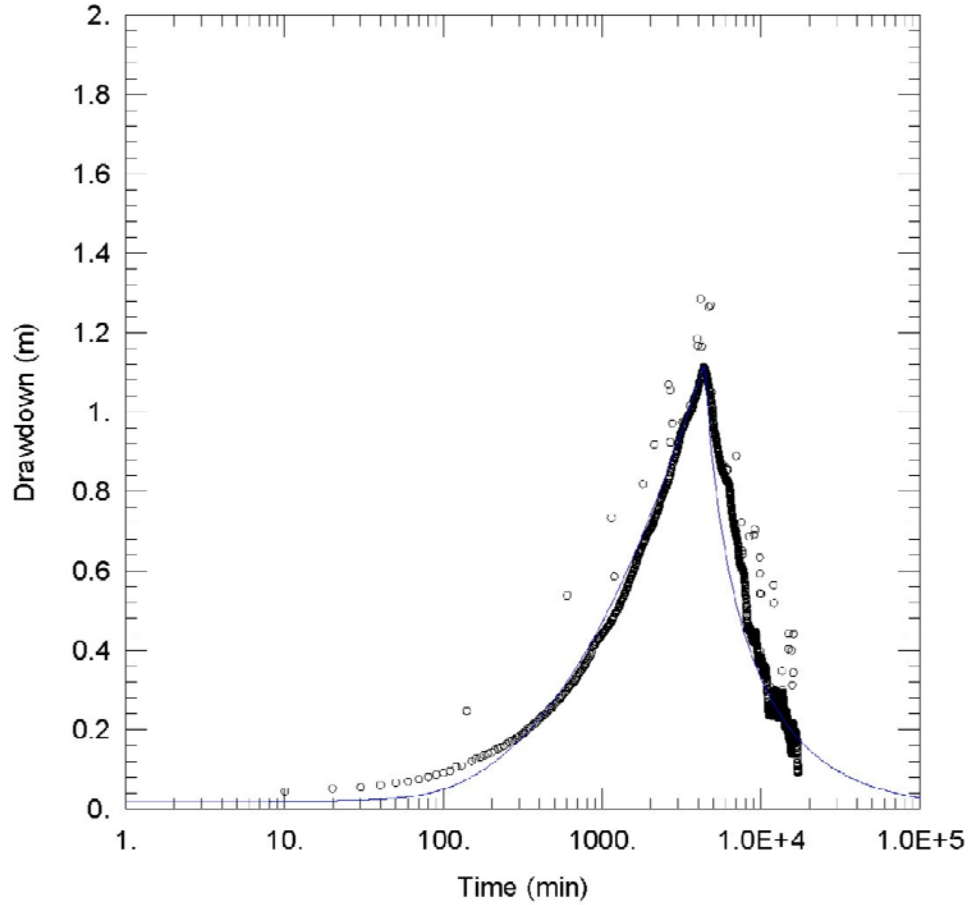
Solution Method: Theis

S = 0.001369
b = 106.7 m

NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.

PREPARED BY:	FIGURETITLE:		
WT	TW21-01 PUMPING TEST - OW20-04 AQTESOLV OUTPUT		
CHECKED BY: CO	CLIENT: VILLAGE OF NEW MARYLAND		
APPROVED BY: KW	SCALE: AS SHOWN	PROJECT NO: 2231001	FIGURE NO: B-8

0 5 10 mm in ANSI A sized paper



WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW21-01	2485537.43	7430011.595

Observation Wells

Well Name	X (m)	Y (m)
○ OW-01	2485367.51	7430832.61

SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 409.8 m^2/day

S = 0.000284

Kz/Kr = 1.

b = 106.7 m

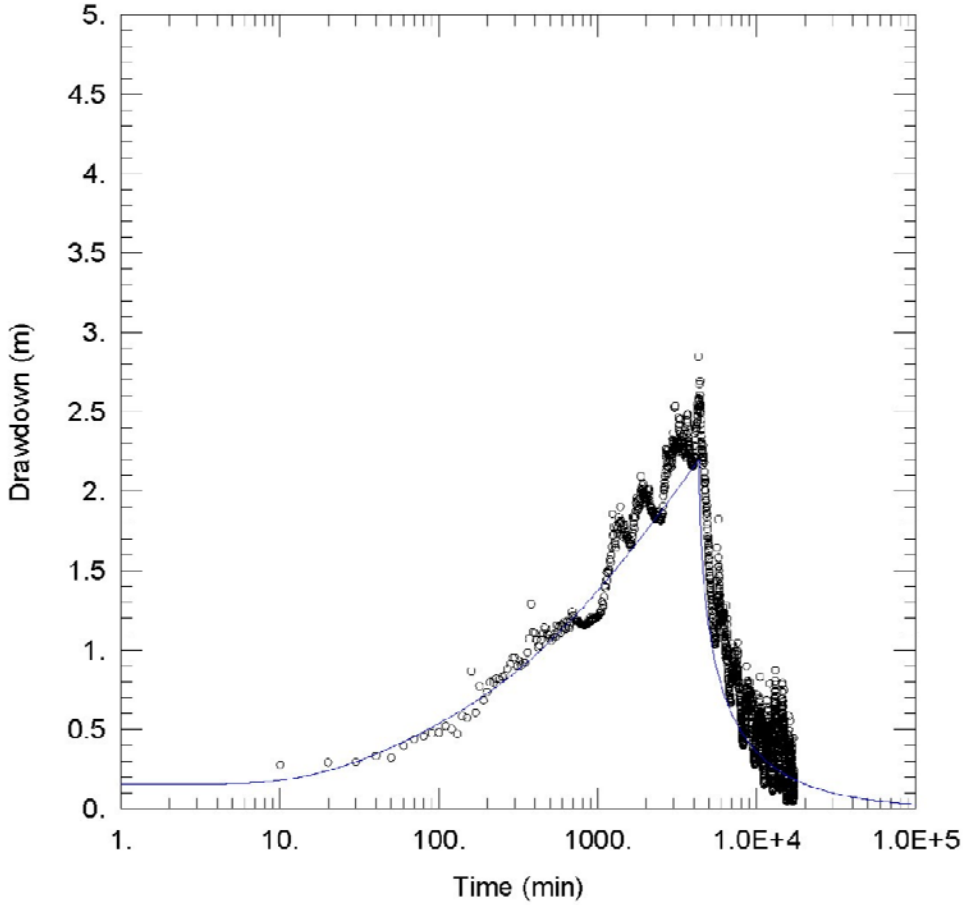
NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.

PREPARED BY:	FIGURETITLE:		
WT	TW21-01 PUMPING TEST - OW-01 AQTESOLV OUTPUT		
CHECKED BY:	CLIENT:		
CO	VILLAGE OF NEW MARYLAND		
APPROVED BY:	SCALE:	PROJECT NO:	FIGURE NO:
KW	AS SHOWN	2231001	B-9

0 5 10 mm in ANSI A sized paper

DRAFT

03-2021



WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
TW21-01	2485537.43	7430011.595

Observation Wells

Well Name	X (m)	Y (m)
OW-09	2486064.42	7430325.23

SOLUTION

Aquifer Model: Confined

T = 405.2 m^2/day
Kz/Kr = 1.

Solution Method: Theis

S = 4.712E-5
b = 106.7 m

NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.

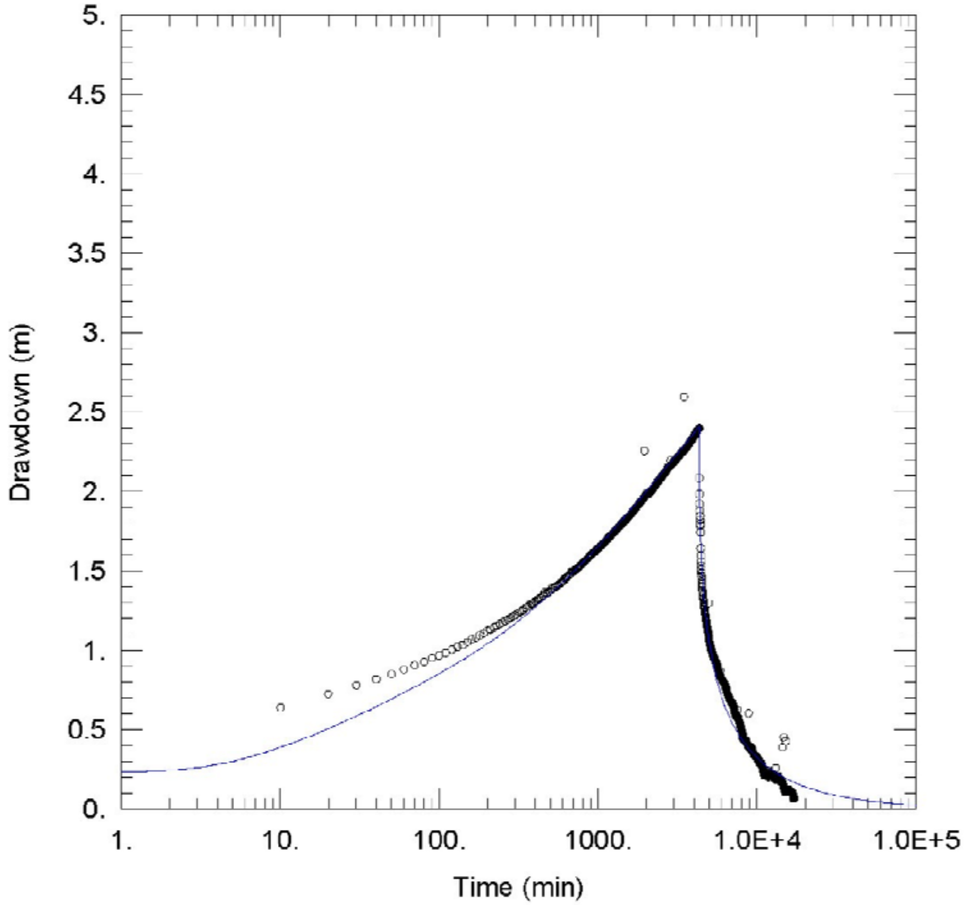
PREPARED BY:	FIGURETITLE:		
WT	TW21-01 PUMPING TEST - OW-09 AQTESOLV OUTPUT		
CHECKED BY:	CLIENT:		
CO	VILLAGE OF NEW MARYLAND		
APPROVED BY:	SCALE:	PROJECT NO:	FIGURE NO:
KW	AS SHOWN	2231001	B-10

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

DRAFT

03-2021



WELL DATA

Pumping Wells			Observation Wells		
Well Name	X (m)	Y (m)	Well Name	X (m)	Y (m)
TW21-01	2485537.43	7430011.595	OW-15	2485311.38	7429794.98

SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 449.8 m^2/day

S = 5.138E-5

Kz/Kr = 1.

b = 106.7 m

NOTES:
1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH BGC'S REPORT TITLED 'GROUNWATER SUPPLY IN THE SUNRISE WELLFIELD', AND DATED MARCH 2021.

PREPARED BY:	FIGURETITLE:		
WT	TW21-01 PUMPING TEST - OW-15 AQTESOLV OUTPUT		
CHECKED BY:	CLIENT:		
CO	VILLAGE OF NEW MARYLAND		
APPROVED BY:	SCALE:	PROJECT NO:	FIGURE NO:
KW	AS SHOWN	2231001	B-11

0 5 10 mm in ANSI A sized paper

BGC ENGINEERING INC.

APPENDIX C
WATER QUALITY RESULTS

Table C-1. General Chemistry Results.

PARAMETER	UNITS	RL	GCDWQ		TW21-01		
			MAC	AO	18-2-21	19-2-21	20-2-21
Sodium	mg/L	0.05	-	200	33.7	32.6	32.6
Potassium	mg/L	0.02	-	-	0.4	0.45	0.45
Calcium	mg/L	0.05	-	-	36.1	37.3	36.6
Magnesium	mg/L	0.01	-	-	2.42	2.43	2.39
Iron	mg/L	0.02	-	0.3	< 0.02	< 0.02	< 0.02
Manganese	mg/L	0.001	0.12	0.02	0.347	0.365	0.358
Copper	mg/L	0.001	2	1	< 0.001	< 0.001	< 0.001
Zinc	mg/L	0.001		5	0.001	< 0.001	0.002
Ammonia (as N)	mg/L	0.05	-	-	< 0.05	< 0.05	< 0.05
pH	units	-	-	7.0 - 10.5	7.8	8.000	7.00
Alkalinity (as CaCo3)	mg/L	2	-	-	100	104	110
Chloride	mg/L	1.5	-	250	44.5	41.6	43.7
Fluoride	mg/L	0.05	1.5	-	0.32	0.34	0.33
Sulfate	mg/L	1	-	500	18	19	19
Sulfide	mg/L	0.05	-	0.05	< 0.05	< 0.05	< 0.05
Nitrate (as N)	mg/L	0.05	10.00	-	< 0.05	< 0.05	< 0.05
Nitrite (as N)			1	-			
ortho-Phosphate (as P)	mg/L	0.01	-	-	0.02	0.03	0.02
r-Silica (as SiO2)	mg/L	0.1	-	-	14.9	14.1	14.1
Carbon - Total Organic	mg/L	0.5	-	-	0.6	0.8	0.8
Turbidity	NTU	0.1	0.1	-	0.1	0.3	0.3
Conductivity	uS/cm	1	-	-	365	365	368
Bicarbonate (as CaCO3)	mg/L	-	-	-	99.4	103	110
Carbonate (as CaCo3)	mg/L	-	-	-	0.59	0.968	0.103
Hydroxide (as CaCO3)	mg/L	-	-	-	0.032	0.05	0.005
Cation Sum	meq/L	-	-	-	3.49	3.5	3.47
Anion Sum	meq/L	-	-	-	3.63	3.65	3.83
Percent Difference	%	-	-	-	-1.98	-2.03	-4.96
Theoretical Conductivity	uS/cm	-	-	-	352	352	358
Hardness (as CaCO3)	mg/L	0.2	-	-	100	103	101
Ion Sum	mg/L	-	-	-	211	211	216
Saturation pH (5 degs C)	units	-	-	-	8.1	8	8
Langelier Index (5 degs C)	-	-	-	-	-0.26	-0.03	-1.01

Note: Exceedances of the CDWQG are **highlighted**.

Table C-2. Dissolved Metals Results.

PARAMETER	UNITS	RL	GCDWQ		TW21-01		
			MAC	AO	18-2-21	19-2-21	20-2-21
Aluminum	ug/L	1	-	100	1	1	< 1
Antimony	ug/L	0.1	6	-	< 0.1	< 0.1	< 0.1
Arsenic	ug/L	1	10	-	< 1	< 1	< 1
Barium	ug/L	1	2000	-	135	144	145
Beryllium	ug/L	0.1	-	-	< 0.1	< 0.1	< 0.1
Bismuth	ug/L	1	-	-	< 1	< 1	< 1
Boron	ug/L	1	5000	-	23	22	23
Cadmium	ug/L	0.01	7	-	< 0.01	< 0.01	< 0.01
Calcium	ug/L	50	-	-	36100	37300	36600
Chromium	ug/L	1	50	-	< 1	< 1	< 1
Cobalt	ug/L	0.1	-	-	< 0.1	< 0.1	< 0.1
Copper	ug/L	1	2000	1000	< 1	< 1	< 1
Iron	ug/L	20	-	300	< 20	< 20	< 20
Lead	ug/L	0.1	5	-	< 0.1	< 0.1	< 0.1
Lithium	ug/L	0.1	-	-	33.5	34.6	35.5
Magnesium	ug/L	10	-	-	2420	2430	2390
Manganese	ug/L	1	120	20	347	365	358
Mercury	ug/L	0.025	1	-	< 0.025	< 0.025	< 0.025
Molybdenum	ug/L	0.1	-	-	0.4	0.4	0.4
Nickel	ug/L	1	-	-	< 1	< 1	< 1
Potassium	ug/L	20	-	-	400	450	450
Rubidium	ug/L	0.1	-	-	0.5	0.6	0.6
Selenium	ug/L	1	50	-	< 1	< 1	< 1
Silver	ug/L	0.1	-	-	< 0.1	< 0.1	< 0.1
Sodium	ug/L	50	-	200000	33700	32600	32600
Strontium	ug/L	1	7000	-	679	712	710
Tellurium	ug/L	0.1	-	-	< 0.1	< 0.1	< 0.1
Thallium	ug/L	0.1	-	-	< 0.1	< 0.1	< 0.1
Tin	ug/L	0.1	-	-	< 0.1	< 0.1	< 0.1
Uranium	ug/L	0.1	20	-	< 0.1	< 0.1	< 0.1
Vanadium	ug/L	1	-	-	< 1	< 1	< 1
Zinc	ug/L	1	-	5000	1	< 1	2

Note: Exceedances of the CDWQG are **highlighted**.

Table C-3. Microbiology and Volatile Organic Compound Results.

PARAMETER	UNITS	RL	GCDWQ		TW21-01		
			MAC	AO	18-2-21	19-2-21	20-2-21
Total Coliforms	MPN/100mL	-	0	-	0	64	0
E. coli	MPN/100mL	-	0	-	0	0	0
Faecal Coliforms	MPN/100mL	-	0	-	0	0	0
Chloromethane	µg/L	5.0	-	-	< 5.0	-	< 5.0
Vinyl Chloride	µg/L	0.5	2	-	< 0.5	-	< 0.5
Bromomethane	µg/L	5.0	-	-	< 5.0	-	< 5.0
Chloroethane	µg/L	5.0	-	-	< 5.0	-	< 5.0
Trichlorofluoromethane	µg/L	5.0	-	-	< 5.0	-	< 5.0
1,1-Dichloroethylene	µg/L	0.5	14	-	< 0.5	-	< 0.5
Methylene Chloride	µg/L	5.0	-	-	< 5.0	-	< 5.0
1,2-Dichloroethylene (trans)	µg/L	0.5	-	-	< 0.5	-	< 0.5
1,1-Dichloroethane	µg/L	0.5	-	-	< 0.5	-	< 0.5
1,2-Dichloroethylene (cis)	µg/L	0.5	-	-	< 0.5	-	< 0.5
Bromochloromethane	µg/L	0.5	-	-	< 0.5	-	< 0.5
Chloroform	µg/L	0.5	10		< 0.5	-	< 0.5
1,1,1-Trichloroethane	µg/L	0.5	-	-	< 0.5	-	< 0.5
Carbon Tetrachloride	µg/L	0.5	2	-	< 0.5	-	< 0.5
Benzene	µg/L	0.5	5	-	< 0.5	-	< 0.5
1,2-Dichloroethane	µg/L	0.5	5	-	< 0.5	-	< 0.5
Trichloroethylene	µg/L	0.5	5	-	< 0.5	-	< 0.5
1,2-Dichloropropane	µg/L	0.5	-	-	< 0.5	-	< 0.5
Bromodichloromethane	µg/L	0.5	-	-	< 0.5	-	< 0.5
1,3-Dichloropropylene (trans)	µg/L	0.5	-	-	< 0.5	-	< 0.5
Toluene	µg/L	0.5	60	24	< 0.5	-	< 0.5
1,3-Dichloropropylene (cis)	µg/L	0.5	-	-	< 0.5	-	< 0.5
1,1,2-Trichloroethane	µg/L	0.5	-	-	< 0.5	-	< 0.5
Tetrachloroethylene	µg/L	0.5	10	-	< 0.5	-	< 0.5
Dibromochloromethane	µg/L	0.5	-	-	< 0.5	-	< 0.5
1,2-Dibromoethane	µg/L	0.5	-	-	< 0.5	-	< 0.5
Chlorobenzene	µg/L	0.5	5	-	< 0.5	-	< 0.5
Ethylbenzene	µg/L	0.5	140	16	< 0.5	-	< 0.5
m,p-Xylenes	µg/L	0.5	90	20	< 0.5	-	< 0.5
o-Xylene	µg/L	0.5			< 0.5	-	< 0.5
Styrene	µg/L	0.5	-	-	< 0.5	-	< 0.5
Bromoform	µg/L	0.5	-	-	< 0.5	-	< 0.5
1,1,1,2-Tetrachloroethane	µg/L	0.5	-	-	< 0.5	-	< 0.5
1,1,2,2-Tetrachloroethane	µg/L	0.5	-	-	< 0.5	-	< 0.5
1,3-Dichlorobenzene	µg/L	0.5	-	-	< 0.5	-	< 0.5
1,4-Dichlorobenzene	µg/L	0.5	5	1	< 0.5	-	< 0.5
1,2-Dichlorobenzene	µg/L	0.5	200	3	< 0.5	-	< 0.5
1,2-Dichloroethane-d4	%				112	-	116
Toluene-d8	%				91	-	94
4-Bromofluorobenzene	%				105	-	103

Note: Exceedances of the CDWQG are **highlighted**.

APPENDIX D
LABORATORY CERTIFICATES

Report ID: 385334-IAS
Report Date: 01-Mar-21
Date Received: 18-Feb-21

CERTIFICATE OF ANALYSIS
for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Kent Wiezel
Project #: 2231.001
Location: VoNM

Analysis of Water

RPC Sample ID:			385334-1
Client Sample ID:			TW21-01 24-hr
Date Sampled:			18-Feb-21
Analytes	**Units**	**RL**	
Sodium	mg/L	0.05	33.7
Potassium	mg/L	0.02	0.40
Calcium	mg/L	0.05	36.1
Magnesium	mg/L	0.01	2.42
Iron	mg/L	0.02	< 0.02
Manganese	mg/L	0.001	0.347
Copper	mg/L	0.001	< 0.001
Zinc	mg/L	0.001	0.001
Ammonia (as N)	mg/L	0.05	< 0.05
pH	units	-	7.8
Alkalinity (as $CaCO_3$)	mg/L	2	100
Chloride	mg/L	0.5	44.5
Sulfate	mg/L	1	18
Sulfide	mg/L	0.05	< 0.05
Nitrate + Nitrite (as N)	mg/L	0.05	< 0.05
o-Phosphate (as P)	mg/L	0.01	0.02
r-Silica (as SiO_2)	mg/L	0.1	14.9
Carbon - Total Organic	mg/L	0.5	0.6
Turbidity	NTU	0.1	0.1
Conductivity	µS/cm	1	365
Calculated Parameters			
Bicarbonate (as $CaCO_3$)	mg/L	-	99.4
Carbonate (as $CaCO_3$)	mg/L	-	0.590
Hydroxide (as $CaCO_3$)	mg/L	-	0.032
Cation Sum	meq/L	-	3.49
Anion Sum	meq/L	-	3.63
Percent Difference	%	-	-1.98
Theoretical Conductivity	µS/cm	-	352
Hardness (as $CaCO_3$)	mg/L	0.2	100
Ion Sum	mg/L	-	211
Saturation pH (5°C)	units	-	8.1
Langelier Index (5°C)	-	-	-0.26

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; Organic Carbon and ion chemistries for turbid samples are determined on filtered aliquots.

Matthew Norman
Senior Chemist
Inorganic Analytical Chemistry

Brannen Burhoe
Supervisor
Inorganic Analytical Services

Report ID: 385334-IAS
Report Date: 01-Mar-21
Date Received: 18-Feb-21

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Kent Wiezel
Project #: 2231.001
Location: VoNM

Analysis of Metals in Water

RPC Sample ID:			385334-1
Client Sample ID:			TW21-01 24-hr
Date Sampled:			18-Feb-21
Analytes	**Units**	**RL**	
Aluminum	µg/L	1	1
Antimony	µg/L	0.1	< 0.1
Arsenic	µg/L	1	< 1
Barium	µg/L	1	135
Beryllium	µg/L	0.1	< 0.1
Bismuth	µg/L	1	< 1
Boron	µg/L	1	23
Cadmium	µg/L	0.01	< 0.01
Calcium	µg/L	50	36100
Chromium	µg/L	1	< 1
Cobalt	µg/L	0.1	< 0.1
Copper	µg/L	1	< 1
Iron	µg/L	20	< 20
Lead	µg/L	0.1	< 0.1
Lithium	µg/L	0.1	33.5
Magnesium	µg/L	10	2420
Manganese	µg/L	1	347
Mercury	µg/L	0.025	< 0.025
Molybdenum	µg/L	0.1	0.4
Nickel	µg/L	1	< 1
Potassium	µg/L	20	400
Rubidium	µg/L	0.1	0.5
Selenium	µg/L	1	< 1
Silver	µg/L	0.1	< 0.1
Sodium	µg/L	50	33700
Strontium	µg/L	1	679
Tellurium	µg/L	0.1	< 0.1
Thallium	µg/L	0.1	< 0.1
Tin	µg/L	0.1	< 0.1
Uranium	µg/L	0.1	< 0.1
Vanadium	µg/L	1	< 1
Zinc	µg/L	1	1

Report ID: 385334-IAS
Report Date: 01-Mar-21
Date Received: 18-Feb-21

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	4.M47	APHA 4500-NH_3 G	Phenate Colourimetry
pH	4.M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Sulfate	4.M45	APHA 4500-SO_4 E	Turbidimetry
Sulfide	-	APHA 4500-S2- D	Methylene Blue Colourimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
o-Phosphate (as P)	4.M50	APHA 4500-P F	Molybdate/Ascorbic Acid Colourimetry
r-Silica (as SiO_2)	4.M46	APHA 4500-SI F	Heteropoly Blue Colourimetry
Carbon - Total Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter - Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES
Mercury	4.M52	EPA 245.1	Cold Vapor AAS

Report ID: 385334-OAS
Report Date: 26-Feb-21
Date Received: 18-Feb-21

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Kent Wiezel
Project #: 2231.001
Location: VoNM

Volatile Organic Compounds in Water

RPC Sample ID:			385334-1
Client Sample ID:			TW21-01 24-hr
Date Sampled:			18-Feb-21
Matrix:			water
Analytes	Units	RL	
Chloromethane	µg/L	5.0	< 5.0
Vinyl Chloride	µg/L	0.5	< 0.5
Bromomethane	µg/L	5.0	< 5.0
Chloroethane	µg/L	5.0	< 5.0
Trichlorofluoromethane	µg/L	5.0	< 5.0
1,1-Dichloroethylene	µg/L	0.5	< 0.5
Methylene Chloride	µg/L	5.0	< 5.0
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5
1,1-Dichloroethane	µg/L	0.5	< 0.5
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5
Bromochloromethane	µg/L	0.5	< 0.5
Chloroform	µg/L	0.5	< 0.5
1,1,1-Trichloroethane	µg/L	0.5	< 0.5
Carbon Tetrachloride	µg/L	0.5	< 0.5
Benzene	µg/L	0.5	< 0.5
1,2-Dichloroethane	µg/L	0.5	< 0.5
Trichloroethylene	µg/L	0.5	< 0.5
1,2-Dichloropropane	µg/L	0.5	< 0.5
Bromodichloromethane	µg/L	0.5	< 0.5
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5

This report relates only to the sample(s) and information provided to the laboratory.
RL = Reporting Limit

Angela Colford
Lab Supervisor
Organic Analytical Services

Steven Davenport
Senior Technician
Organic Analytical Services

Report ID: 385334-OAS
Report Date: 26-Feb-21
Date Received: 18-Feb-21

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Kent Wiezel
Project #: 2231.001
Location: VoNM

Volatile Organic Compounds in Water

RPC Sample ID:			385334-1
Client Sample ID: Date Sampled: Matrix:			TW21-01 24-hr 18-Feb-21 water
Analytes	Units	RL	
Toluene	µg/L	0.5	< 0.5
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5
1,1,2-Trichloroethane	µg/L	0.5	< 0.5
Tetrachloroethylene	µg/L	0.5	< 0.5
Dibromochloromethane	µg/L	0.5	< 0.5
1,2-Dibromoethane	µg/L	0.5	< 0.5
Chlorobenzene	µg/L	0.5	< 0.5
Ethylbenzene	µg/L	0.5	< 0.5
m,p-Xylenes	µg/L	0.5	< 0.5
o-Xylene	µg/L	0.5	< 0.5
Styrene	µg/L	0.5	< 0.5
Bromoform	µg/L	0.5	< 0.5
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,3-Dichlorobenzene	µg/L	0.5	< 0.5
1,4-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichloroethane-d4	%		112
Toluene-d8	%		91
4-Bromofluorobenzene	%		105

CERTIFICATE OF ANALYSIS
for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Method Summary

OAS-HC02: Determination of Volatile Organic Compounds in Water.

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Project #: 2231.001
Location: VoNM
QA/QC Report

RPC Sample ID:			BLANKD0065	SPIKED0065
Matrix:			water	water
Analytes	Units	RL		% Recovery
Chloromethane	µg/L	5.0	< 5.0	121%
Vinyl Chloride	µg/L	0.5	< 0.5	112%
Bromomethane	µg/L	5.0	< 5.0	125%
Chloroethane	µg/L	5.0	< 5.0	112%
Trichlorofluoromethane	µg/L	5.0	< 5.0	109%
1,1-Dichloroethylene	µg/L	0.5	< 0.5	115%
Methylene Chloride	µg/L	5.0	< 5.0	113%
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5	101%
1,1-Dichloroethane	µg/L	0.5	< 0.5	102%
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5	95%
Bromochloromethane	µg/L	0.5	< 0.5	97%
Chloroform	µg/L	0.5	< 0.5	103%
1,1,1-Trichloroethane	µg/L	0.5	< 0.5	98%
Carbon Tetrachloride	µg/L	0.5	< 0.5	102%
Benzene	µg/L	0.5	< 0.5	101%
1,2-Dichloroethane	µg/L	0.5	< 0.5	100%
Trichloroethylene	µg/L	0.5	< 0.5	89%
1,2-Dichloropropane	µg/L	0.5	< 0.5	92%
Bromodichloromethane	µg/L	0.5	< 0.5	101%
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5	88%

RL = Reporting Limit

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Project #: 2231.001
Location: VoNM
QA/QC Report

RPC Sample ID:			BLANKD0065	SPIKED0065
Matrix:			water	water
Analytes	Units	RL		% Recovery
Toluene	µg/L	0.5	< 0.5	100%
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5	81%
1,1,2-Trichloroethane	µg/L	0.5	< 0.5	101%
Tetrachloroethylene	µg/L	0.5	< 0.5	99%
Dibromochloromethane	µg/L	0.5	< 0.5	97%
1,2-Dibromoethane	µg/L	0.5	< 0.5	91%
Chlorobenzene	µg/L	0.5	< 0.5	101%
Ethylbenzene	µg/L	0.5	< 0.5	98%
m,p-Xylenes	µg/L	0.5	< 0.5	105%
o-Xylene	µg/L	0.5	< 0.5	98%
Styrene	µg/L	0.5	< 0.5	97%
Bromoform	µg/L	0.5	< 0.5	96%
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5	100%
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5	97%
1,3-Dichlorobenzene	µg/L	0.5	< 0.5	104%
1,4-Dichlorobenzene	µg/L	0.5	< 0.5	96%
1,2-Dichlorobenzene	µg/L	0.5	< 0.5	94%

RL = Reporting Limit

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Project #: 2231.001

Summary of Date Analyzed

	VOC	
RPC Sample ID	**Extracted**	**Analyzed**
385334-1	19-Feb-21	19-Feb-21

Report/Rapport: 385334-ML-W1
Date: 19-Feb-21
Date Received/Reçu: 18-Feb-21

CERTIFICATE OF ANALYSIS / CERTIFICAT D'ANALYSE

for/pour
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1368
Fax: 506.452.1395
www.rpc.ca

Attention: Kent Wiezel

Project/Job #: 2231.001

Client Location: VoNM

Microbiological Examination of Water/Qualité microbiologique de l'eau potable

RPC Sample ID/No. d'échantillon de RPC:				385334-1
Client Sample ID/ID d'échantillon du client:				TW21-01 24-hr
Date collected/Date du prélèvement				18-Feb-21
Time sampled/Heure du prélèvement				12:30:00 PM
Analytes/Paramètre(s)	**Method/Méthode**	**Date Analyzed Date Analysé**	**Units Unités**	
Total Coliforms/Coliformes totaux	FFA01	18-Feb-21	MPN/100mL	0
E. coli	FFA01	18-Feb-21	MPN/100mL	0
Faecal Coliforms/Coliformes fécaux	FFA01	18-Feb-21	MPN/100mL	0

This report relates only to the sample(s) and information provided to the laboratory.

Le présent rapport ne s'applique qu'aux échantillons et à l'information transmis au laboratoire.

Cathy Hay
Microbiology Supervisor
Food, Fisheries & Aquaculture

Bethany Marston
Micro Technician
Food, Fisheries & Aquaculture

Report ID: 385515-IAS
Report Date: 01-Mar-21
Date Received: 19-Feb-21

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Kent Wiezel
Project #: 2231.001
Location: VoNM

Analysis of Water

RPC Sample ID:			385515-1
Client Sample ID:			TW21-01 -48 hr
Date Sampled:			19-Feb-21
Analytes	**Units**	**RL**	
Sodium	mg/L	0.05	32.6
Potassium	mg/L	0.02	0.45
Calcium	mg/L	0.05	37.3
Magnesium	mg/L	0.01	2.43
Iron	mg/L	0.02	< 0.02
Manganese	mg/L	0.001	0.365
Copper	mg/L	0.001	< 0.001
Zinc	mg/L	0.001	< 0.001
Ammonia (as N)	mg/L	0.05	< 0.05
pH	units	-	8.0
Alkalinity (as $CaCO_3$)	mg/L	2	104
Chloride	mg/L	0.5	41.6
Sulfate	mg/L	1	19
Sulfide	mg/L	0.05	< 0.05
Nitrate + Nitrite (as N)	mg/L	0.05	< 0.05
o-Phosphate (as P)	mg/L	0.01	0.03
r-Silica (as SiO_2)	mg/L	0.1	14.1
Carbon - Total Organic	mg/L	0.5	0.8
Turbidity	NTU	0.1	0.3
Conductivity	µS/cm	1	365
Calculated Parameters			
Bicarbonate (as $CaCO_3$)	mg/L	-	103.
Carbonate (as $CaCO_3$)	mg/L	-	0.968
Hydroxide (as $CaCO_3$)	mg/L	-	0.050
Cation Sum	meq/L	-	3.50
Anion Sum	meq/L	-	3.65
Percent Difference	%	-	-2.03
Theoretical Conductivity	µS/cm	-	352
Hardness (as $CaCO_3$)	mg/L	0.2	103
Ion Sum	mg/L	-	211
Saturation pH (5°C)	units	-	8.0
Langelier Index (5°C)	-	-	-0.03

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; Organic Carbon and ion chemistries for turbid samples are determined on filtered aliquots.

Matthew Norman
Senior Chemist
Inorganic Analytical Chemistry

Brannen Burhoe
Supervisor
Inorganic Analytical Services

Report ID: 385515-IAS
Report Date: 01-Mar-21
Date Received: 19-Feb-21

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Kent Wiezel
Project #: 2231.001
Location: VoNM

Analysis of Metals in Water

RPC Sample ID:			385515-1
Client Sample ID:			TW21-01 -48 hr
Date Sampled:			19-Feb-21
Analytes	**Units**	**RL**	
Aluminum	µg/L	1	1
Antimony	µg/L	0.1	< 0.1
Arsenic	µg/L	1	< 1
Barium	µg/L	1	144
Beryllium	µg/L	0.1	< 0.1
Bismuth	µg/L	1	< 1
Boron	µg/L	1	22
Cadmium	µg/L	0.01	< 0.01
Calcium	µg/L	50	37300
Chromium	µg/L	1	< 1
Cobalt	µg/L	0.1	< 0.1
Copper	µg/L	1	< 1
Iron	µg/L	20	< 20
Lead	µg/L	0.1	< 0.1
Lithium	µg/L	0.1	34.6
Magnesium	µg/L	10	2430
Manganese	µg/L	1	365
Mercury	µg/L	0.025	< 0.025
Molybdenum	µg/L	0.1	0.4
Nickel	µg/L	1	< 1
Potassium	µg/L	20	450
Rubidium	µg/L	0.1	0.6
Selenium	µg/L	1	< 1
Silver	µg/L	0.1	< 0.1
Sodium	µg/L	50	32600
Strontium	µg/L	1	712
Tellurium	µg/L	0.1	< 0.1
Thallium	µg/L	0.1	< 0.1
Tin	µg/L	0.1	< 0.1
Uranium	µg/L	0.1	< 0.1
Vanadium	µg/L	1	< 1
Zinc	µg/L	1	< 1

CERTIFICATE OF ANALYSIS
for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	4.M47	APHA 4500-NH_3 G	Phenate Colourimetry
pH	4.M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Sulfate	4.M45	APHA 4500-SO_4 E	Turbidimetry
Sulfide	-	APHA 4500-S2- D	Methylene Blue Colourimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
o-Phosphate (as P)	4.M50	APHA 4500-P F	Molybdate/Ascorbic Acid Colourimetry
r-Silica (as SiO_2)	4.M46	APHA 4500-SI F	Heteropoly Blue Colourimetry
Carbon - Total Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter - Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES
Mercury	4.M52	EPA 245.1	Cold Vapor AAS

Report/Rapport: 385515-ML-W1
Date: 22-Feb-21
Date Received/Reçu: 19-Feb-21

CERTIFICATE OF ANALYSIS / CERTIFICAT D'ANALYSE

for/pour
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1368
Fax: 506.452.1395
www.rpc.ca

Attention: Kent Wiezel

Project/Job #: 2231.001

Client Location: VoNM

Microbiological Examination of Water/Qualité microbiologique de l'eau potable

RPC Sample ID/No. d'échantillon de RPC:				385515-1
Client Sample ID/ID d'échantillon du client:				TW21-01 -48 hr
Date collected/Date du prélèvement				19-Feb-21
Time sampled/Heure du prélèvement				12:40:00 PM
Analytes/Paramètre(s)	**Method/Méthode**	**Date Analyzed Date Analysé**	**Units Unités**	
Total Coliforms/Coliformes totaux	FFA01	19-Feb-21	MPN/100mL	64
E. coli	FFA01	19-Feb-21	MPN/100mL	0
Faecal Coliforms/Coliformes fécaux	FFA01	19-Feb-21	MPN/100mL	0

This report relates only to the sample(s) and information provided to the laboratory.

Le présent rapport ne s'applique qu'aux échantillons et à l'information transmis au laboratoire.

Corrie Maston
Acting Microbiology Supervisor
Food, Fisheries & Aquaculture

Bethany Marston
Micro Technician
Food, Fisheries & Aquaculture

Report ID: 385646-IAS
Report Date: 03-Mar-21
Date Received: 22-Feb-21

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Kent Wiezel
Project #: 2231.001
Location: VoNM

Analysis of Water

RPC Sample ID:			385646-1
Client Sample ID:			TW21-01 72-hr
Date Sampled:			20-Feb-21
Analytes	**Units**	**RL**	
Sodium	mg/L	0.05	32.6
Potassium	mg/L	0.02	0.45
Calcium	mg/L	0.05	36.6
Magnesium	mg/L	0.01	2.39
Iron	mg/L	0.02	< 0.02
Manganese	mg/L	0.001	0.358
Copper	mg/L	0.001	< 0.001
Zinc	mg/L	0.001	0.002
Ammonia (as N)	mg/L	0.05	< 0.05
pH	units	-	7.0
Alkalinity (as $CaCO_3$)	mg/L	2	110
Chloride	mg/L	0.5	43.7
Sulfate	mg/L	1	19
Nitrate + Nitrite (as N)	mg/L	0.05	< 0.05
o-Phosphate (as P)	mg/L	0.01	0.02
r-Silica (as SiO_2)	mg/L	0.1	14.1
Carbon - Total Organic	mg/L	0.5	0.8
Turbidity	NTU	0.1	0.3
Conductivity	µS/cm	1	368
Calculated Parameters			
Bicarbonate (as $CaCO_3$)	mg/L	-	110.
Carbonate (as $CaCO_3$)	mg/L	-	0.103
Hydroxide (as $CaCO_3$)	mg/L	-	0.005
Cation Sum	meq/L	-	3.47
Anion Sum	meq/L	-	3.83
Percent Difference	%	-	-4.96
Theoretical Conductivity	µS/cm	-	358
Hardness (as $CaCO_3$)	mg/L	0.2	101
Ion Sum	mg/L	-	216
Saturation pH (5°C)	units	-	8.0
Langelier Index (5°C)	-	-	-1.01

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; Organic Carbon and ion chemistries for turbid samples are determined on filtered aliquots.

Peter Crowhurst, B.Sc., C.Chem.
Director
Inorganic Analytical Chemistry

Brannen Burhoe
Supervisor
Inorganic Analytical Services

Report ID: 385646-IAS
Report Date: 03-Mar-21
Date Received: 22-Feb-21

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Kent Wiezel
Project #: 2231.001
Location: VoNM

Analysis of Water

RPC Sample ID:			385646-1
Client Sample ID:			TW21-01 72-hr
Date Sampled:			20-Feb-21
Analytes	**Units**	**RL**	
Fluoride	mg/L	0.05	0.33
Sulfide	mg/L	0.05	< 0.05

Report ID: 385646-IAS
Report Date: 03-Mar-21
Date Received: 22-Feb-21

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Kent Wiezel
Project #: 2231.001
Location: VoNM

Analysis of Metals in Water

RPC Sample ID:			385646-1
Client Sample ID:			TW21-01 72-hr
Date Sampled:			20-Feb-21
Analytes	**Units**	**RL**	
Aluminum	µg/L	1	< 1
Antimony	µg/L	0.1	< 0.1
Arsenic	µg/L	1	< 1
Barium	µg/L	1	145
Beryllium	µg/L	0.1	< 0.1
Bismuth	µg/L	1	< 1
Boron	µg/L	1	23
Cadmium	µg/L	0.01	< 0.01
Calcium	µg/L	50	36600
Chromium	µg/L	1	< 1
Cobalt	µg/L	0.1	< 0.1
Copper	µg/L	1	< 1
Iron	µg/L	20	< 20
Lead	µg/L	0.1	< 0.1
Lithium	µg/L	0.1	35.5
Magnesium	µg/L	10	2390
Manganese	µg/L	1	358
Mercury	µg/L	0.025	< 0.025
Molybdenum	µg/L	0.1	0.4
Nickel	µg/L	1	< 1
Potassium	µg/L	20	450
Rubidium	µg/L	0.1	0.6
Selenium	µg/L	1	< 1
Silver	µg/L	0.1	< 0.1
Sodium	µg/L	50	32600
Strontium	µg/L	1	710
Tellurium	µg/L	0.1	< 0.1
Thallium	µg/L	0.1	< 0.1
Tin	µg/L	0.1	< 0.1
Uranium	µg/L	0.1	< 0.1
Vanadium	µg/L	1	< 1
Zinc	µg/L	1	2

Report ID: 385646-IAS
Report Date: 03-Mar-21
Date Received: 22-Feb-21

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	4.M47	APHA 4500-NH_3 G	Phenate Colourimetry
pH	4.M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Fluoride	4.M30	APHA 4500-F- D	SPADNS Colourimetry
Sulfate	4.M45	APHA 4500-SO_4 E	Turbidimetry
Sulfide	-	APHA 4500-S2- D	Methylene Blue Colourimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
o-Phosphate (as P)	4.M50	APHA 4500-P F	Molybdate/Ascorbic Acid Colourimetry
r-Silica (as SiO_2)	4.M46	APHA 4500-SI F	Heteropoly Blue Colourimetry
Carbon - Total Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter - Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES
Mercury	4.M52	EPA 245.1	Cold Vapor AAS

Report ID: 385646-OAS
Report Date: 26-Feb-21
Date Received: 22-Feb-21

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Kent Wiezel
Project #: 2231.001
Location: VoNM

Volatile Organic Compounds in Water

RPC Sample ID:			385646-1
Client Sample ID:			TW21-01 72-hr
Date Sampled:			20-Feb-21
Matrix:			water
Analytes	Units	RL	
Chloromethane	µg/L	5.0	< 5.0
Vinyl Chloride	µg/L	0.5	< 0.5
Bromomethane	µg/L	5.0	< 5.0
Chloroethane	µg/L	5.0	< 5.0
Trichlorofluoromethane	µg/L	5.0	< 5.0
1,1-Dichloroethylene	µg/L	0.5	< 0.5
Methylene Chloride	µg/L	5.0	< 5.0
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5
1,1-Dichloroethane	µg/L	0.5	< 0.5
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5
Bromochloromethane	µg/L	0.5	< 0.5
Chloroform	µg/L	0.5	< 0.5
1,1,1-Trichloroethane	µg/L	0.5	< 0.5
Carbon Tetrachloride	µg/L	0.5	< 0.5
Benzene	µg/L	0.5	< 0.5
1,2-Dichloroethane	µg/L	0.5	< 0.5
Trichloroethylene	µg/L	0.5	< 0.5
1,2-Dichloropropane	µg/L	0.5	< 0.5
Bromodichloromethane	µg/L	0.5	< 0.5
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5

This report relates only to the sample(s) and information provided to the laboratory.
RL = Reporting Limit

Angela Colford
Lab Supervisor
Organic Analytical Services

Steven Davenport
Senior Technician
Organic Analytical Services

Report ID: 385646-OAS
Report Date: 26-Feb-21
Date Received: 22-Feb-21

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Kent Wiezel
Project #: 2231.001
Location: VoNM

Volatile Organic Compounds in Water

RPC Sample ID:			385646-1
Client Sample ID:			TW21-01 72-hr
Date Sampled:			20-Feb-21
Matrix:			water
Analytes	Units	RL	
Toluene	µg/L	0.5	< 0.5
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5
1,1,2-Trichloroethane	µg/L	0.5	< 0.5
Tetrachloroethylene	µg/L	0.5	< 0.5
Dibromochloromethane	µg/L	0.5	< 0.5
1,2-Dibromoethane	µg/L	0.5	< 0.5
Chlorobenzene	µg/L	0.5	< 0.5
Ethylbenzene	µg/L	0.5	< 0.5
m,p-Xylenes	µg/L	0.5	< 0.5
o-Xylene	µg/L	0.5	< 0.5
Styrene	µg/L	0.5	< 0.5
Bromoform	µg/L	0.5	< 0.5
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,3-Dichlorobenzene	µg/L	0.5	< 0.5
1,4-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichloroethane-d4	%		116
Toluene-d8	%		94
4-Bromofluorobenzene	%		103

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Method Summary

OAS-HC02: Determination of Volatile Organic Compounds in Water.

Report ID: 385646-OAS
Report Date: 26-Feb-21
Date Received: 22-Feb-21

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Project #: 2231.001
Location: VoNM
QA/QC Report

RPC Sample ID:			BLANKD0066	SPIKED0066
Matrix:			water	water
Analytes	Units	RL		% Recovery
Chloromethane	µg/L	5.0	< 5.0	104%
Vinyl Chloride	µg/L	0.5	< 0.5	99%
Bromomethane	µg/L	5.0	< 5.0	112%
Chloroethane	µg/L	5.0	< 5.0	107%
Trichlorofluoromethane	µg/L	5.0	< 5.0	106%
1,1-Dichloroethylene	µg/L	0.5	< 0.5	109%
Methylene Chloride	µg/L	5.0	< 5.0	113%
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5	102%
1,1-Dichloroethane	µg/L	0.5	< 0.5	104%
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5	97%
Bromochloromethane	µg/L	0.5	< 0.5	99%
Chloroform	µg/L	0.5	< 0.5	106%
1,1,1-Trichloroethane	µg/L	0.5	< 0.5	102%
Carbon Tetrachloride	µg/L	0.5	< 0.5	104%
Benzene	µg/L	0.5	< 0.5	101%
1,2-Dichloroethane	µg/L	0.5	< 0.5	101%
Trichloroethylene	µg/L	0.5	< 0.5	91%
1,2-Dichloropropane	µg/L	0.5	< 0.5	98%
Bromodichloromethane	µg/L	0.5	< 0.5	108%
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5	91%

RL = Reporting Limit

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Project #: 2231.001
Location: VoNM
QA/QC Report

RPC Sample ID:			BLANKD0066	SPIKED0066
Matrix:			water	water
Analytes	Units	RL		% Recovery
Toluene	µg/L	0.5	< 0.5	102%
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5	84%
1,1,2-Trichloroethane	µg/L	0.5	< 0.5	102%
Tetrachloroethylene	µg/L	0.5	< 0.5	104%
Dibromochloromethane	µg/L	0.5	< 0.5	104%
1,2-Dibromoethane	µg/L	0.5	< 0.5	95%
Chlorobenzene	µg/L	0.5	< 0.5	104%
Ethylbenzene	µg/L	0.5	< 0.5	100%
m,p-Xylenes	µg/L	0.5	< 0.5	107%
o-Xylene	µg/L	0.5	< 0.5	100%
Styrene	µg/L	0.5	< 0.5	106%
Bromoform	µg/L	0.5	< 0.5	99%
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5	101%
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5	99%
1,3-Dichlorobenzene	µg/L	0.5	< 0.5	110%
1,4-Dichlorobenzene	µg/L	0.5	< 0.5	102%
1,2-Dichlorobenzene	µg/L	0.5	< 0.5	98%

RL = Reporting Limit

Report ID: 385646-OAS
Report Date: 26-Feb-21
Date Received: 22-Feb-21

CERTIFICATE OF ANALYSIS
for
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Project #: 2231.001

Summary of Date Analyzed

	VOC	
RPC Sample ID	**Extracted**	**Analyzed**
385646-1	22-Feb-21	22-Feb-21

Report/Rapport: 385646-ML-W1
Date: 23-Feb-21
Date Received/Reçu: 22-Feb-21

CERTIFICATE OF ANALYSIS / CERTIFICAT D'ANALYSE

for/pour
BGC Engineering Inc.
330 Alison Boulevard
Fredericton, NB E3C 0A9

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1368
Fax: 506.452.1395
www.rpc.ca

Attention: Kent Wiezel

Project/Job #: 2231.001

Client Location: VoNM

Microbiological Examination of Water/Qualité microbiologique de l'eau potable

RPC Sample ID/No. d'échantillon de RPC:				385646-2
Client Sample ID/ID d'échantillon du client:				TW21-01 72-hr
Date collected/Date du prélèvement				22-Feb-21
Time sampled/Heure du prélèvement				12:50:00 PM
Analytes/Paramètre(s)	**Method/Méthode**	**Date Analyzed Date Analysé**	**Units Unités**	
Total Coliforms/Coliformes totaux	FFA01	22-Feb-21	MPN/100mL	0
E. coli	FFA01	22-Feb-21	MPN/100mL	0
Faecal Coliforms/Coliformes fécaux	FFA01	22-Feb-21	MPN/100mL	0

This report relates only to the sample(s) and information provided to the laboratory.

Le présent rapport ne s'applique qu'aux échantillons et à l'information transmis au laboratoire.

Cathy Hay
Microbiology Supervisor
Food, Fisheries & Aquaculture

Julia Khoury
Micro Technician
Food, Fisheries & Aquaculture