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CenterBeam Place, 14 King Street, Suite 420
PO Box 20040, Saint John, NB E2L 1G2
506-633-6650 | CBCL.ca | info@CBCL.ca

November 29, 2022

Shawn Hamilton
Environmental Impact Assessment Specialist, Environmental Assessment Branch
Environmental Science & Protection Division
NB Department of Environment and Local Government
P.O.Box 6000, Fredericton, NB, E3B 5H1

Dear Mr. Hamilton:

RE: ***Initial EIA and WSSA Application***
Feasibility Study for Alternative Groundwater Supply
Mactaquac Biodiversity Facility

Pursuant to the New Brunswick's *Environmental Impact Assessment Regulation* (Regulation 87-83) under the Clean Environment Act, development of a full-scale water supply would fall under item 's' of *Schedule A all waterworks with a capacity greater than fifty cubic metres of water daily* and therefore is subject to an EIA. The registration fee has been submitted through the website.

CBCL Limited has been retained by Public Works and Government Services Canada to investigate the feasibility of an alternative groundwater supply for the Mactaquac Biodiversity Facility. The following information is being submitted for review under initial registration for required elements of EIA and an associated Water Supply Source Assessment (WSSA).

Please note, at this time, the Proponent would like to understand the thickness and extent of gravel material present, and whether it constitutes an aquifer that could potentially support the targeted pumping rates. No water well drilling or pumping tests are proposed for this initial step. If the extent of the aquifer is not adequate, development of an alternative plan will be required, and substantive EIA work at the current site would not be of value. As such, the following documentation has been produced to support the Technical Review Committee's ability to provide approval for this initial phase of the project. Should the work indicate potential viability of a new water supply, additional information will be provided to satisfy the EIA Guidelines.

1 Project Description

Public Works and Government Services Canada is considering options to relocate the Mactaquac Biodiversity Facility, shown on Figure 1. Should the existing facility be relocated, it would require a new water source to replace the facility's existing network of 10 wells. Anecdotal reports suggest that these wells draw water from a system of unconfined and confined sand and gravel aquifers. Pumping records for five active wells showed an average water use of 2000 igpm between June and November 2021, peaking at over 3000 igpm in September 2021.

CBCL completed a desktop investigation of potential supply options and hatchery sites, provided as Appendix A. The two proposed hatchery locations are restricted to NB Power-owned parcels adjacent to the Mactaquac Dam. A source of cold, high-quality fresh water would be required, with a rate of production on the order of 2000 to 3000 igpm. The desktop study included a review of the area geology, topography, drainage patterns, and existing water wells. The review identified area aquifers that may be capable of supplying groundwater to the facility.

Potential exploration areas have been identified on the south bank of the Saint John River, directly adjacent to the Mactaquac Dam, 16 km to the west of Fredericton (Figure 1). The existing facility is located 2 km to the east and downstream of the dam. The exploration area is adjacent to the First Nations community of Kingsclear, which is serviced by groundwater. Table 1 provides a summary of information for the Initial Application.

Table 1. EIA and WSSA Initial Application

	Name of Proponent	Public Works and Government Services Canada
1	Property PID	75258699
2	Purpose of proposed water supply	Federal Fish Hatchery, Biodiversity
3	Required pumping rate	2000 igpm (average), 3000 igpm (peak)
4	Alternate water supply sources	Existing well field via pipeline or Saint John River (both infeasible due to water temperature and quality requirements)
5	Area Hydrogeology	Attached
6	Proposed testing and work schedule	ASAP; November 2022 - March 2023
7	Existing Contamination Hazards	No significant hazards. High Voltage Transmission lines in area. Community of Kingsclear sewage treatment lagoon is located on the river, 0.5 to 1 km to the east of the proposed drilling areas.

8	Groundwater Use Problems in the area	None known at this time.
9	Water courses within 60 metres of drilling site	Saint John River and one local drainage course. The investigation will consider the potential for riverbank filtration. The facility's existing wells likely draw a component of yield from the river (see Appendix A).
10	Supervisory Personnel	Public Services Canada: Matthew Walsh
		CBCL Site Supervisor: Ryan Threndyle
		CBCL Hydrogeologist: Colin Walker
		CBCL Project Manager: Peter Seheult
		Drilling Firms: Nova Drilling (Geotechnical)
		E.R. Steeves (water wells)
11	Mapping	Attached
12	Land use zoning map	The target properties are owned by NB power
13	Contingency Plan	N/A

2 Area Hydrogeology

The predominant surficial material in much of the study area is low permeability till (previous drilling logs show silt and sand with gravel, cobbles, and boulders). The underlying bedrock is mapped as fine-grained sedimentary rock (wacke and siltstone) at the study site and throughout much of the surrounding area. Previous geotechnical studies encountered the bedrock surface at 1 to 4 metres below ground at most locations, but also showed a section of deeper sand and gravel material that may form a buried outwash aquifer on the study site.

Drillers report the presence of two granular units in the area: a shallow unconfined sand and gravel aquifer, and a deeper confined unit of sand and gravel. These aquifers may be associated with modern alluvium and lag-deposits, or they may be part of a larger, more regional outwash valley associated with the Saint John River. The presence of the river in connection with unconfined sand and gravel suggests that the reported large yields of the existing facility wells could be associated with induced infiltration from the river. The production wells that service Kingsclear appear to draw from gravel aquifers that are likely to be connected to the regional deposit underlying the Saint John River.

The Saint John River is a regional groundwater discharge zone, and likely receives baseflow from both younger, shallow flow systems (i.e., sand and gravel) on the banks of the river, and older, deeper flow systems originating in the bedrock. Wells drilled in the study area are generally expected to benefit from favourable gradients. Higher hydraulic heads generated by the Mactaquac dam are likely to affect the shallow flow systems closest to the river (e.g., higher than

average gradients and/or an elevated water table). A more detailed description of the area physical setting, water wells, and hydrogeology is presented in Appendix A.

3 Potential Sources of Contamination

The Kingsclear sewage treatment lagoon is located on the adjacent parcel < 1 Km from the proposed well, posing a potential risk to groundwater quality in the area. Wells installed in an unconfined aquifer and close to surface water are at increased risk of drawing Groundwater Under the Direct Influence of surface water (GUDI) and are more likely than other wells to be affected by pathogens. Additional information and analysis of the impact of potential contamination will be provided with an updated reporting should development of groundwater supply wells commence.

The potential yield of wells in this area could be subject to limitations associated with:

- The shape and thickness of the aquifer.
- Existing water permitting rights associated with the Kingsclear municipal well(s).
- The Kingsclear sewage treatment lagoon, a potential source of pathogens.
- Unmapped areas of fill and/or dumping.
- The Saint John River and its interaction with shallow groundwater (a potential source of improved yield and/or temperature variations and/or pathogens).

The proposed work program will not introduce any new potential sources of contamination to the site or disturb existing environmentally sensitive features (if any are present). Geotechnical drilling will not require management of overflow water / silt entrainment. Operation of the rig will observe standard protocols to ensure that heavy equipment does not impact the site (e.g. hydraulic lines, refueling to be completed in the parking area only).

4 Proposed Work Program

As the full extent and thickness of shallow aquifers in the target area is currently unknown, initial work will focus on identification and delineation of this material. Figure 2 shows potential drilling locations, subject to site reconnaissance and considerations for siting of the facility. The following proposed work program is based on the requirements for a WSSA.

The proposed exploration program will include the following work:

- Site reconnaissance visit to observe site features in detail and determine rig access. Any potentially environmentally sensitive features will be identified during this visit.
- Advancement of several geotechnical boreholes to map the area stratigraphy and lithology, to determine whether there is an adequate thickness and extent of sand and gravel for development.

Several geotechnical boreholes will be drilled up to 30 m deep in the areas of highest potential as identified in the desktop report. Logging of the geologic material will show whether there is an adequate thickness of granular material to support a water well. Each borehole will be instrumented with a monitoring well which will provide early indications of the aquifer yield and allow for collection of a preliminary water quality sample. If geotechnical work shows that there is site access to a potentially viable aquifer, future EIA work would include test well drilling and aquifer testing.

5 Description of Existing Environment

The target property is an existing industrial site adjacent to the Mactaquac Power generating station, on previously disturbed land. Consequently, the potential for local environmentally sensitive features is minimal. Mapping shows a small stream that traverses the centre of the site and discharges immediately below the Mactaquac dam. Site reconnaissance will identify any other features that may be present as a result of regeneration of the area. It is recognized that more detailed work may be required if the work proceeds to full development of a large-scale water supply. For example, test well drilling and pumping tests may include hydrological monitoring of the stream.

6 Proposed Mitigation

Mobilization of the geotechnical rig will ensure that no existing features (vegetation, wet areas) are disturbed by the rig. Contamination was not encountered during previous geotechnical investigations. If contaminated soil or groundwater are observed, sampled material will be disposed of off-site, the borehole will be sealed with granulated bentonite, and exploration will be moved to another part of the site or discontinued entirely.

7 Public Consultation

As the stated work program is limited to drilling of 2” monitoring wells, public consultation has not been completed at this stage. If the stated work program leads to further development of groundwater supply wells, public consultation will be competed per EIA requirements.

Shawn Hamilton
November 29, 2022

If you have any questions regarding the information presented, please do not hesitate to contact us.

Yours very truly,

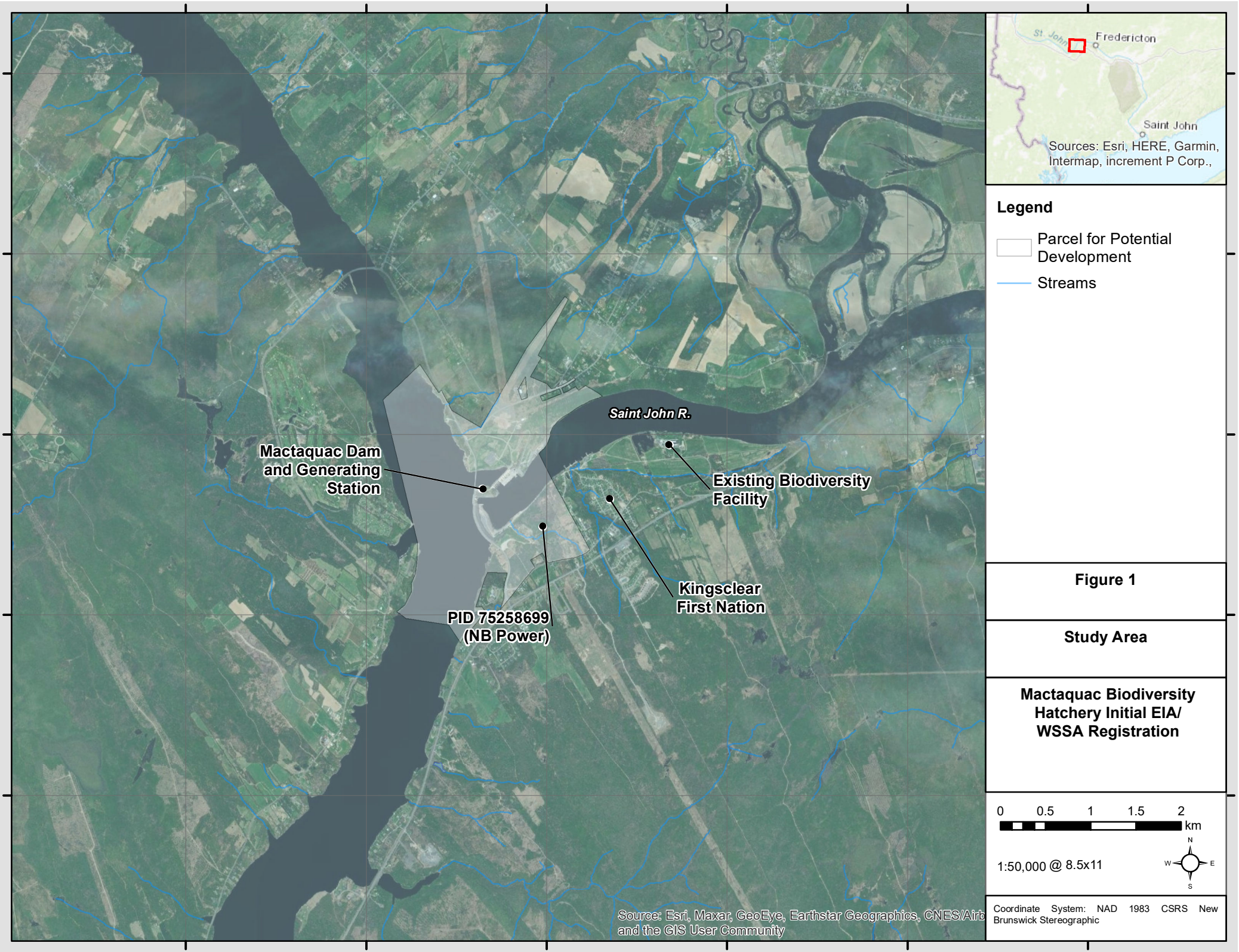
CBCL Limited

Prepared by:
Colin Walker, M.Sc., P.Geo, FGC
Senior Hydrogeologist
Direct: 902-478-8875
E-Mail: colinw@cbcl.ca

Reviewed by:
Peter Sehault, P.Eng.
Project Manager

Attachments:
Figure 1 Study Area
Figure 2 Potential Test Well Locations
Appendix A – Desktop Investigation

CBCL Project No: 213235.01


Saint John R.
Mactaquac Dam and Generating Station
Existing Biodiversity Facility
Kingsclear First Nation
PID 75258699 (NB Power)
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airb and the GIS User Community
St. John
Fredericton
Saint John
Sources: Esri, HERE, Garmin, Intermap, increment P Corp.,
Legend
Parcel for Potential Development
Streams
Figure 1
Study Area
Mactaquac Biodiversity Hatchery Initial EIA/ WSSA Registration
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km
1:50,000 @ 8.5x11
N
W
E
S
Coordinate System: NAD 1983 CSRS New Brunswick Stereographic

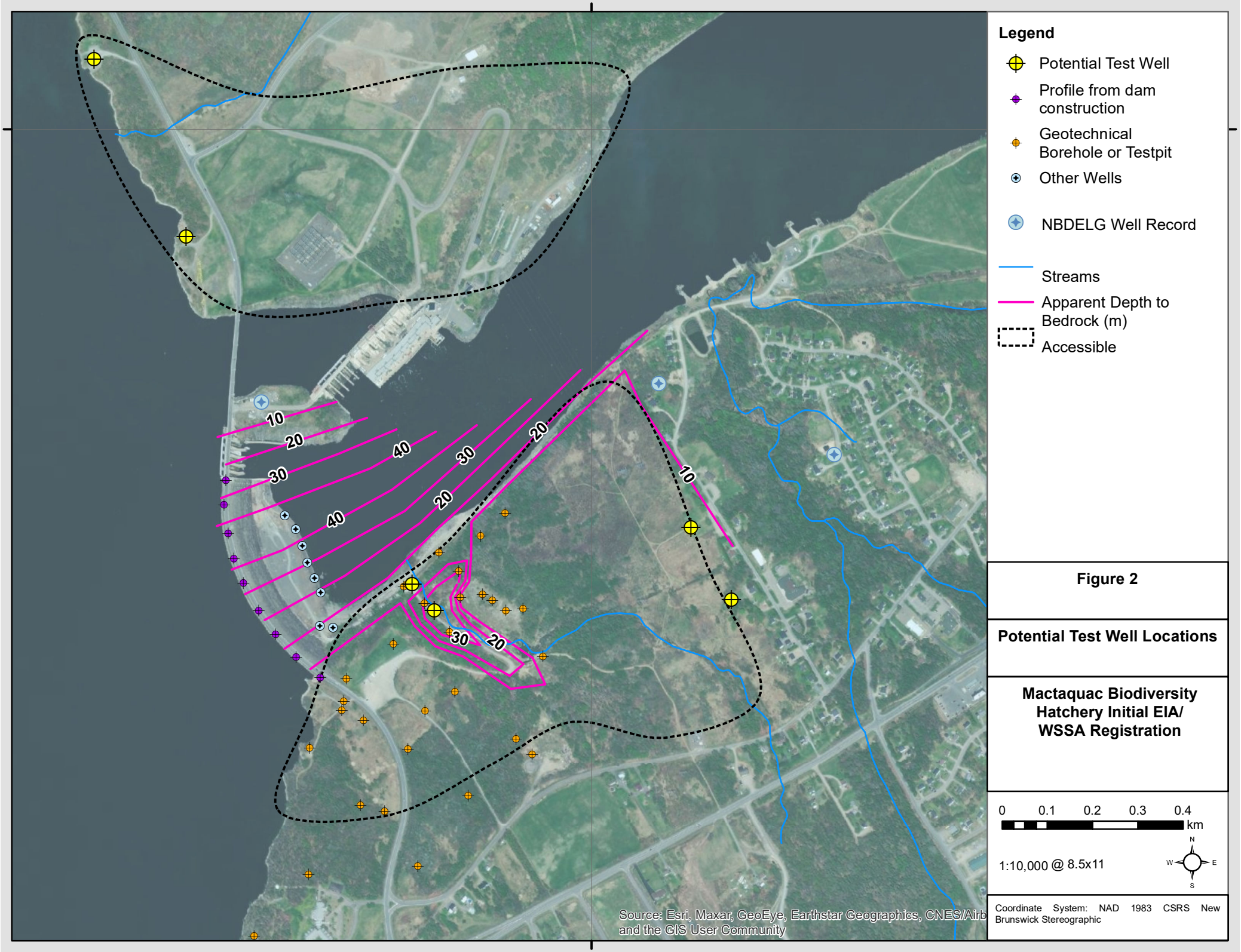

Figure 2

Potential Test Well Locations

Mactaquac Biodiversity Hatchery Initial EIA/ WSSA Registration

0 0.1 0.2 0.3 0.4 km

1:10,000 @ 8.5x11

N W E S

Coordinate System: NAD 1983 CSRS New Brunswick Stereographic

APPENDIX A

Desktop Investigation

5. GROUNDWATER

It was realized after RS.1 scope was underway that a critical element in determining the feasibility of alternative sites was to conduct a preliminary assessment of the sites potential to supply groundwater. The following study was added to the RS.1 scope through a change order to address this fundamental requirement. It was only studied at Site B as Site A was not recommended for development through the aforementioned Geotechnical Report.

CBCL Limited completed a desktop investigation of the potential to supply groundwater to alternative hatchery sites. The two proposed hatchery locations are restricted to NB Power-owned parcels adjacent to the Mactaquac Dam, shown on Figure 1A. A source of cold, high quality fresh water would be required, with a rate of production on the order of 1000 to 2000 igpm. This study included a review of the area geology, topography, drainage patterns, and existing water wells. The review identified area aquifers that may be capable of supplying groundwater to the facility.

Potential exploration areas have been identified on the north and south banks of the Saint John River, directly adjacent to the Mactaquac Dam, 16 km to the west of Fredericton (Figure 1A). The existing facility is located 2 km to the east and downstream of the dam. The exploration area to the south of the river is adjacent to the First Nations community of Kingsclear, which is serviced by groundwater.

5.1 Topography and Drainage

The Saint John River is incised into a rolling landscape, showing a relief of 100 metres between the river and adjacent hilltops (Figure 2A). The river to the west of the dam is maintained at an elevation approximately 35 metres above the downstream reach. Local flow systems draining the upland areas adjacent to the river flow predominantly southward or northward. The Keswick River joins the Saint John River approximately four kilometres to the east, forming a system of island deltas, flood plains, bars, and oxbow lakes.

Figure 2A shows areas within the targeted parcel that would permit access to the Saint John River and that would permit drill rig access. The topography in these areas generally slopes moderately toward the river, with steeper terrain associated with localized features. The zone to the south of the river includes a small watercourse and shows signs of sandy surface material and previous activity (potentially a small borrow-pit) . The eastern part of this area also includes high-voltage power transmission lines. The Kingsclear sewage treatment lagoon is located on the adjacent parcel.

5.2 Geology Mapping

Surficial geology mapping for the Mactaquac Area is shown on Figure 3A. Till predominates in much of the study area, typically composed of fine-grained material (silt and clay) mixed with varying

amounts of sand, gravel, and cobbles. The resulting matrix tends to exhibit low permeability. Units closer to the river include glaciofluvial material, alluvium, and lag-deposits, which all have the potential to include sand and gravel with higher permeabilities.

Figure 4A shows bedrock geology mapping. The Burtt's Corner Formation, shown in blue, predominates throughout most of the study area. The primary material type in this formation is wacke, a fine-grained sedimentary rock. Wells installed in finer-grained rock typically exhibit moderate to lower yields, depending wholly on fracture permeability. Other rock units in the area (Shin Formation, Minto Formation) are described as predominantly sandstone and conglomerate. Wells installed in this type of coarse-grained material tend to exhibit favourable yields.

5.3 Existing Water Wells

The provincial water well database contains records of 16 wells located within 5 km of the targeted area, summarized in Table 5.1. Most wells are installed in bedrock, with a thickness of overburden material of less than 4 metres. Drillers estimated well yields generally vary from 2 to 19 igpm.

Table 5.1. Well Summary

		Estimated Yield (m^3/d)	Estimated Yield (igpm)	Static Water Level (m)	Pumping Water Level (m)	Well Depth (m)	Depth to Bedrock (m)	Casing Length (m)
Quartile	25	11	2	2.3	5.7	45.4	1.4	6.8
	50	34	5	4.6	9.1	92.1	2.9	9.4
	75	121	19	6.7	51.1	118.5	3.9	12.2
Maximum		1638	250	22.3	134.1	137.8	12.8	21.3
Average		174	27	5.6	35.0	82.7	3.4	10.0
n		16	16	12	13	16	15	14

Quartile 25: 25% of wells in area at this level or lower

Quartile 50: 50% of wells in area at this level or lower

Quartile 75: 25% of wells in area at this level or higher

Wells closest to the areas of interest are shown on Figure 5A and listed in Table 2. Drillers' descriptions of the borehole lithology area generally consistent with area mapping, indicating fine-grained sedimentary rocks. Provincial records list one municipal well, located in Kingsclear First Nation, which is directly adjacent to the potential exploration area. This well has a reported yield of 250 igpm and draws water from a unit of sand and gravel that is 38 metres deep.

Table 5.2. Well Information

Well #	Type	Date of Completion	Estimated Yield (m^3/d)	Estimated Yield (igpm)	Well Depth (m)	Depth to Bedrock (m)	Primary Material	Fracture Zones (m)
1791	Domestic	07/17/2002	131	20	105.16	1.52	Shale	12; 98
14586	Domestic	11/05/2008	33	5	50.29	4.57	Shale	37; 46
14876	Domestic	06/18/2008	7	1	92.66	3.66	Shale	30; 79
38644	Other	09/14/2016	0.4	0.1	46.33	2.74	Wacke	10
41845	Exploratory	09/10/2018	3	1	106.68	7.32	Wacke	50; 107
41846	Domestic	09/13/2018	118	18	121.92	3.35	Wacke	22; 34; 59; 86
41847	Exploratory	09/14/2018	36	6	121.92	3.05	Wacke	27; 51; 61; 84
42485	Municipal	11/19/2019	1638	250	37.8	6.1	Sand and Gravel	36
90066300	Domestic	10/10/1994	13	2	15.24	3.05	Shale	76
90447400	Domestic	11/21/1995	393	60	38.1	12.8	Wacke	26; 35

The existing biodiversity facility is supplied by up to 10 active wells, shown on Figure 5A. Anecdotal reports suggest that these wells draw water from a system of unconfined and confined sand and gravel aquifers. Pumping records for five active wells showed an average water use of 2000 igpm between June and November 2021, peaking at over 3000 igpm in September 2021. The presence of the river in connection with unconfined sand and gravel suggests that the large, reported yields could be associated with induced infiltration from the river. Anecdotal reports of varying water temperatures from the shallowest wells support this likelihood.

Six pressure relief wells and two production wells were installed in the late 1960s as a part of testing and construction of the Mactaquac Dam, shown on Figure 6A. These wells were screened in a confined sand and gravel aquifer. One of the test wells was pumped at 1440 igpm for 8 days, producing 17 metres of drawdown. Sustainable pumping rates were estimated to meet or exceed the tested rate. NB Power will not permit these wells to be used as a water source for the new hatchery. There is concern that ground water removal at these well locations may destabilize the dam. However, a cross sectional drawing (Figure 7A) of two pressure relief wells and the dam (supplied by NB Power) indicates a significant fluvial sand and gravel over burden in the river course just below the dam and near the ravine below the proposed hatchery site. The two test wells proposed for the outwash aquifer from the ravine would be expected to produce significant amounts of water if this aquifer and the main river aquifer are contiguous as the apparent depth to bed rock contour lines suggest.

5.4 Hydrogeologic Setting

Shallow wells near the centre of the Saint John River valley coincide with mapping of granular material. Drillers report the presence of two granular units in the area: a shallow unconfined sand and gravel aquifer, and a deeper confined unit of sand and gravel. These aquifers may be associated with modern alluvium and lag-deposits, or they may be part of a larger, more regional outwash valley associated with the Saint John River. Wells installed in an unconfined aquifer and close to surface water are at increased risk of drawing Groundwater Under the Direct Influence of surface water (GUDI) and are more likely than other wells to be affected by pathogens.

Work on the Mactaquac Dam included mapping and testing of a 30-metre thick confined, artesian sand and gravel aquifer underlying the Saint John River (Tawil and Harriman, 2001). The aquifer is part of a buried outwash valley deposit that occupies the pre-glacial bedrock valley. The aquifer is overlain by two till units comprising a 15- to 20-metre-thick confining unit. The two till units are separated by a lens of sand and gravel. Artesian pressures in the aquifer were observed to generate a head of up to six metres above the surface of the river.

Previous geotechnical studies included excavation of test pits and boreholes at the study site, shown on Figure 6A. The bedrock surface was encountered between 1 and 4 metres below the ground surface at most locations. The shallowest material encountered at most locations was silt and sand with gravel, cobbles, and boulders (Hatch, 2011). A deeper deposit of sand and gravel was encountered adjacent to the stream that traverses the site from south to north (Hatch, 2011). Borehole data indicates that there is a localized, 15 to 20-metre thick, buried valley aquifer in this area, forming a smaller lobe of the channel underlying the Saint John River. The Kingsclear river valley also appears to be associated with a buried outwash aquifer. The westward limit of this aquifer has not been mapped but could extend onto the eastern-most part of the study site.

The Saint John River is a regional groundwater discharge zone, and likely receives baseflow from both younger, shallow flow systems (i.e., sand and gravel) on the banks of the river, and older, deeper flow systems originating in the bedrock. In some valley systems there is a component of flow parallel to and below the riverbed. Wells drilled in the study area are generally expected to benefit from favourable gradients. Wells installed in the unconfined aquifer may benefit from relatively rapid recharge rates but would also tend to be affected by low water table conditions during periods of drought. Higher hydraulic heads generated by the Mactaquac dam are likely to affect the shallow flow systems closest to the river (e.g., higher than average gradients and/or an elevated water table).

5.5 Recommended Approach

Successful development of a new groundwater supply would require the installation of several shallow, large-diameter, high-capacity wells in sand and gravel material. As the full extent and thickness shallow aquifers in the target areas is currently unknown, initial work would need to focus

on identification and delineation of this material. Figure 6A shows potential drilling locations, subject to site reconnaissance and considerations for siting of the facility.

The potential yield of wells in this area could be subject to limitations associated with:

- The shape and thickness of the aquifer.
- Existing water permitting rights associated with the Kingsclear municipal well(s).
- The Kingsclear sewage treatment lagoon, a potential source of pathogens.
- Unmapped areas of fill and/or dumping.
- The Saint John River and its interaction with shallow groundwater (a potential source of improved yield and/or temperature variations and/or pathogens).

Indications from the site setting and existing wells are that development of a new high-capacity supply may be feasible. As such, we recommend an exploration program as part of the R2 scope that would include the following work:

- Submission of an initial Water Supply Source Application (WSSA) and initial EIA registration to NBDELG, with accompanying background information.
- A site reconnaissance visit to observe site features in more detail, and to determine rig access to potential drilling sites.
- Advancement of several geotechnical boreholes to map the area stratigraphy and lithology, to determine whether there is an adequate thickness of sand and gravel for development.
- Installation of one or more test wells and preliminary aquifer testing.

CBCL will use the results of this work to provide recommendations and cost scoping for production well design and installation. CBCL can prepare a scope of work and costs for this work, at the client's request.

5.6 References

Amec Foster Wheeler. 2015. Mactaquac Engineering – Geotechnical Investigation – South Bank, Kingsclear, NB. Letter Report to Hatch Hydropower. 139 p.

Hatch. 2011. Mactaquac 2010 Geotechnical Program, Final Report H336233. Submitted to NB Power Generation. 148 p.

Tawil, H., and Harriman, G. 2001. Aquifer Performance Under the Mactaquac Dam. Canadian Dam Association 2001 Annual Conference, Fredericton, NB. 12 p.

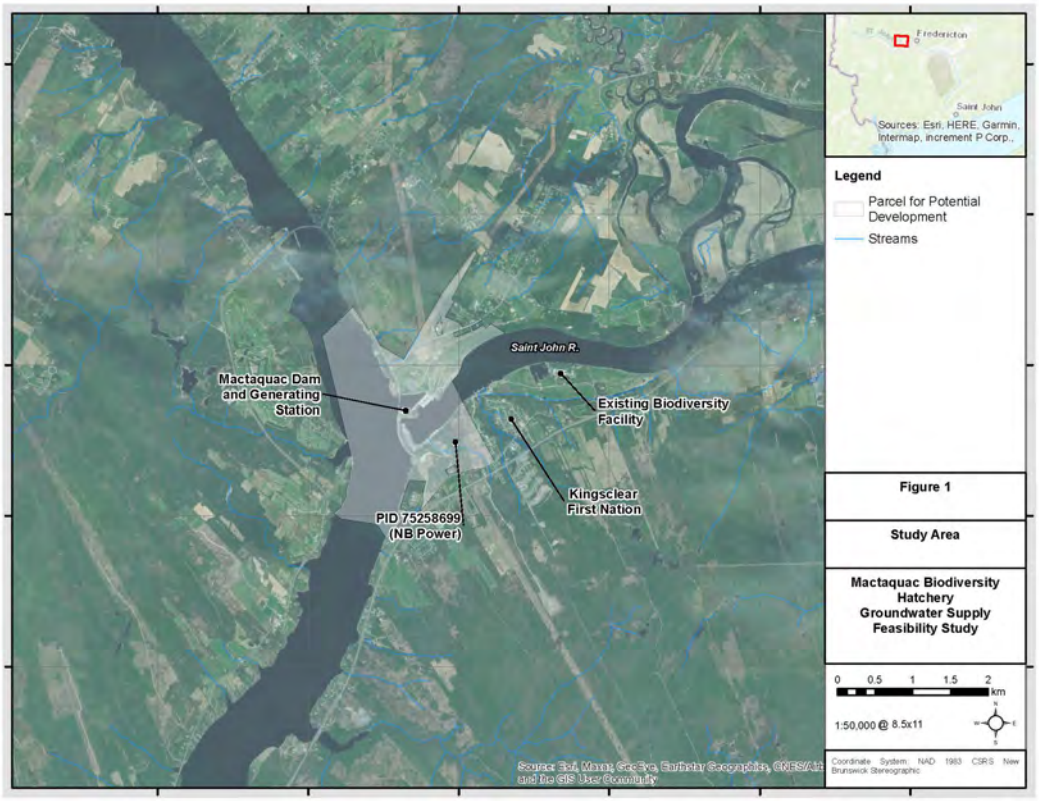

Figure 1A

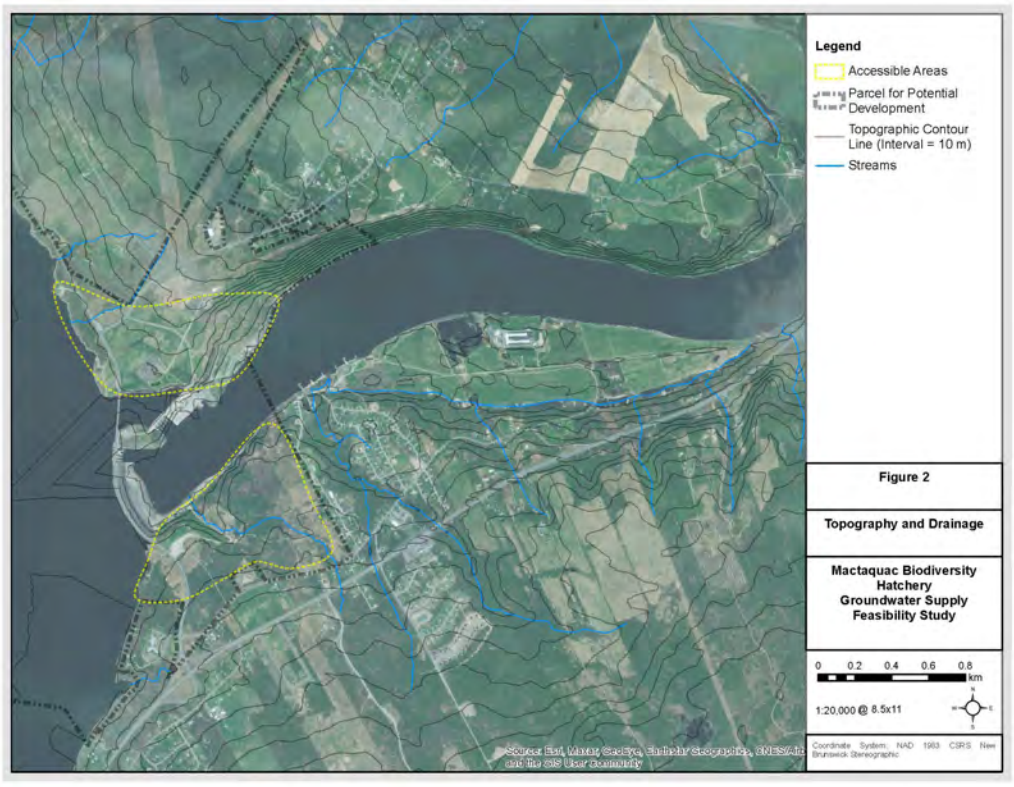

Figure 2A

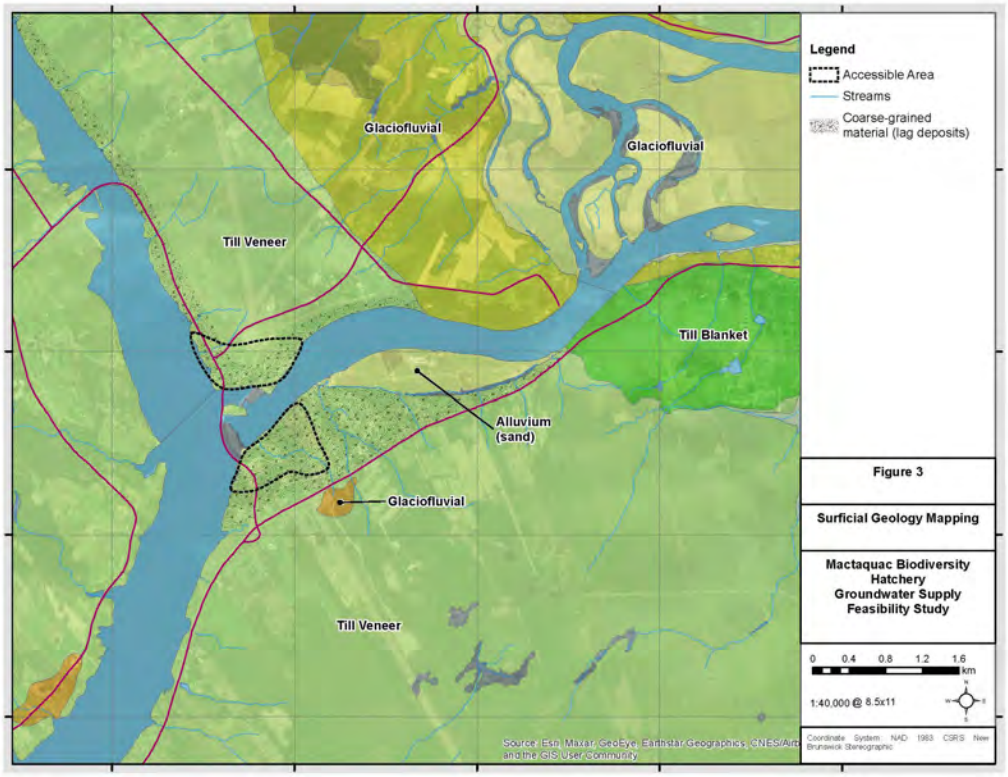

Figure 3A

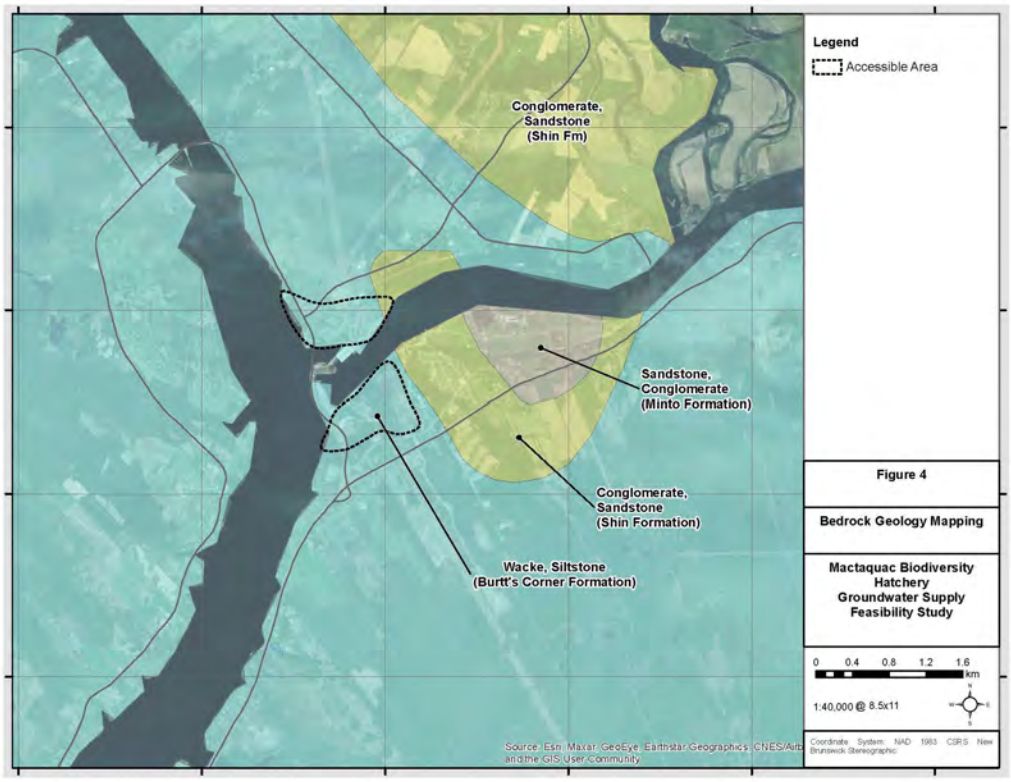

Figure 4A

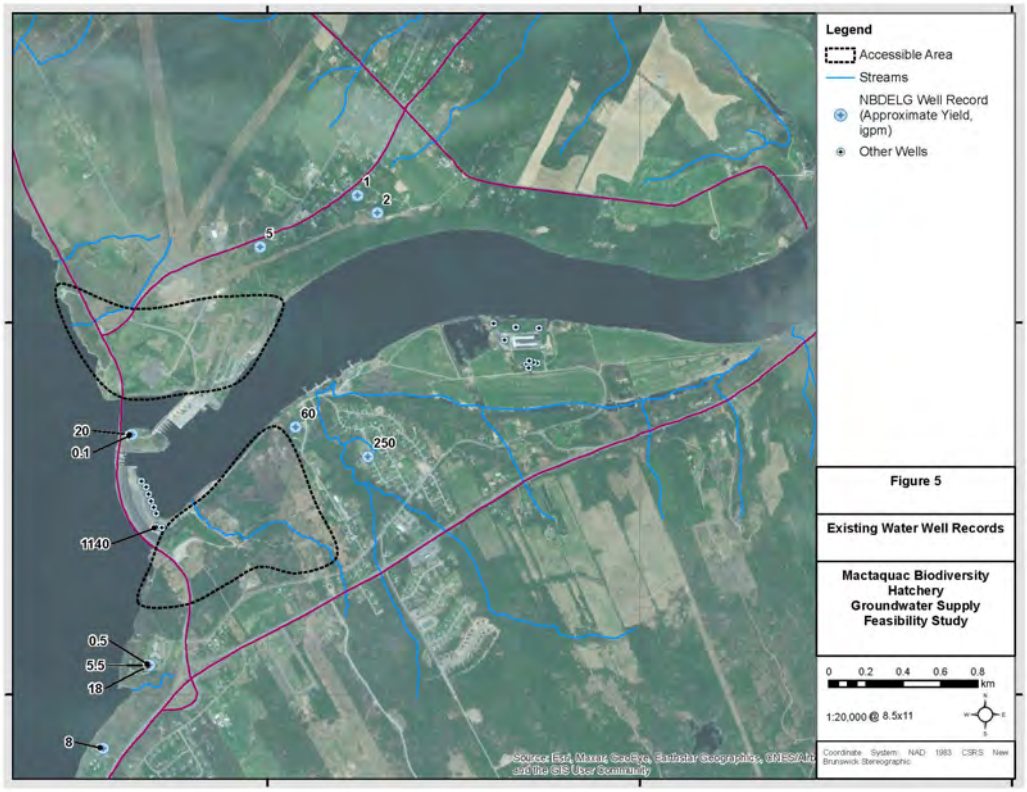

Figure 5A

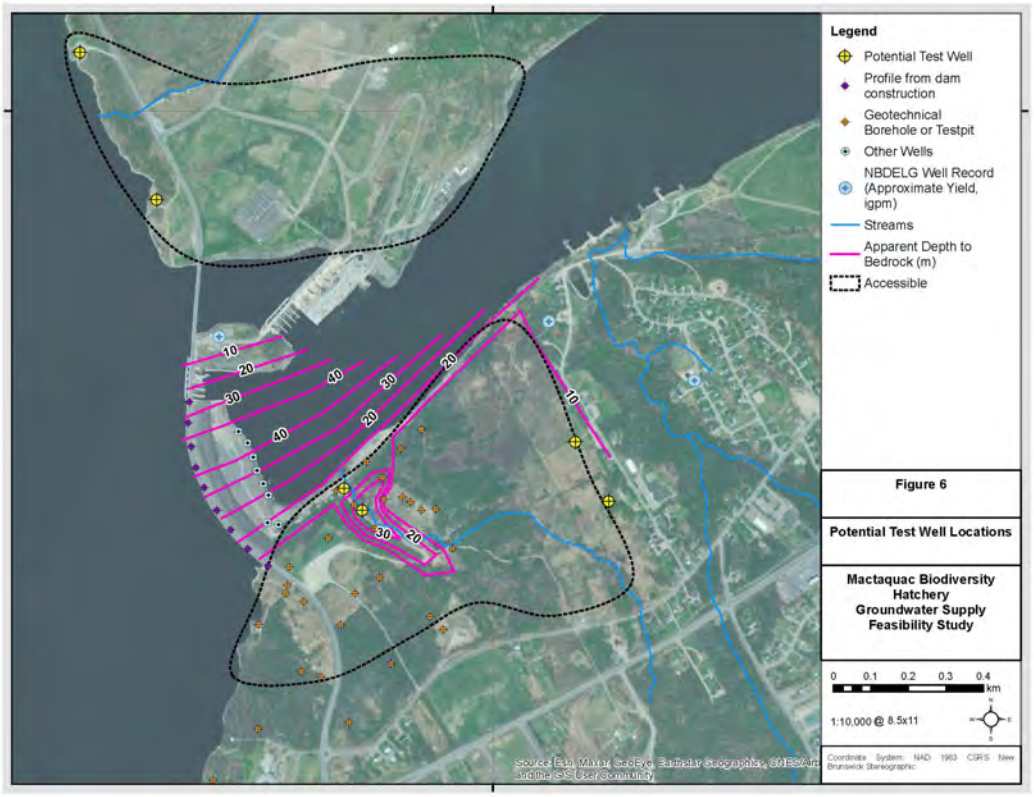

Figure 6A

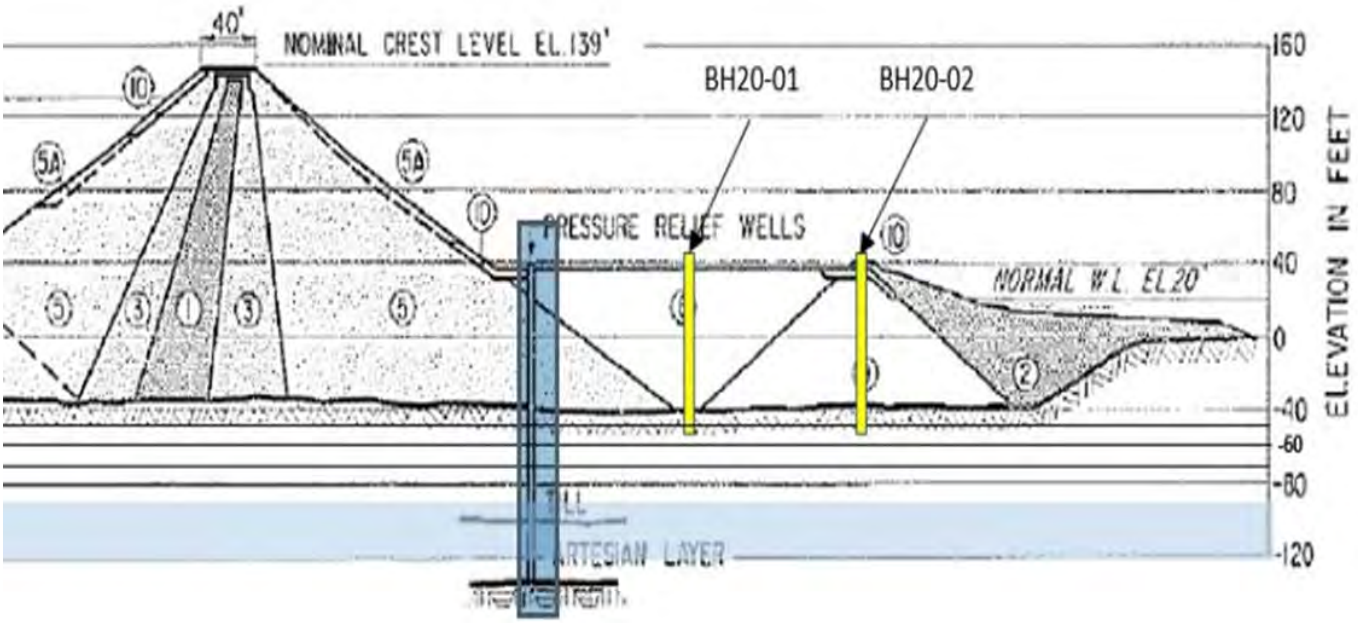
40'
NOMINAL CREST LEVEL EL.139'
BH20-01
BH20-02
PRESSURE RELIEF WELLS
NORMAL W.L. EL.20'
ARTESIAN LAYER
160
120
80
40
0
-40
-60
-80
-120
ELEVATION IN FEET

Figure 7A