District of Barriere

REPORT TO COUNCIL

Date: July 15, 2019	**File:** 530.20/Rpts
To: COUNCIL	**From:** C. Hannigan, CAO
Re: Wells Update	

Background: BC Groundwater has been working this past week on the three District wells that are in the process of being licenced as new wells under the new Water Act legislation. These are the two new wells at Bradford Park and the 4-year old well at Louis Creek Industrial Park that replaced the old Tolko well.

Discussion: Unfortunately due to an over pumping situation that resulted from a control malfunction, one or both of the Bradford wells started showing sediment being measured that was not in character with what the wells should be producing. The Bradford wells have now both undergone the Step Test procedure to see if the sediment is indicative of a more serious problem. The text of the Investigation and Response Plan prepared by BC Groundwater is attached to this report and Mr. Carriou will be present at this meeting with updates to this attached report as more work will be required on PW3.

The third well in the Louis Creek Industrial Park was scheduled for a pump test this week as part of the GARP/GUDI Study required for licencing and in advance of designing the final water system for the Industrial Park. Mr. Carriou will also provide an update on that pump test when he presents to Council at this meeting.

Recommendation: The recommendation will be provided through the reporting out provided by Thierry Carriou, from BC Groundwater at the meeting.

Prepared by: Colleen Hannigan, CAO

MEMORANDUM

DATE: July 2, 2019
FROM: Thierry M. Carriou, M.Sc., P.Eng
PROJECT: 09003.15 Professional Well Development Services:
Bradford Park Production Wells (Investigation and Response Plan)
SUBJECT: **BRADFORD PARK PRODUCTION WELLS PW1 AND PW3: REVIEW OF JULY 19TH - 22ND EVENTS AND THE ACTION PLAN TO EVALUATE AND REPAIR GLACIOLACUSTRINE SEDIMENT INVASION OF THE WELLS**

1.0 BACKGROUND

The District of Barriere (the "District") received *Short-Term Use* authorization from the *Ministry of Forests, Lands and Natural Resource Operations and Rural Development* on October 19, 2018 to operate the Bradford Park wells specifically for the purpose of evaluating long-term operating characteristics and interactions between the deep aquifers.

The District experienced a shortfall of water on February 8, 2019 resulting from a maintenance issue at Deep Well No. 2 ("DW2"). BC Groundwater Consulting Services Ltd. ("BCGW") provided verbal advice to D. Borrill on that day recommending Bradford Park PW1 operation at a rate of 300 - 400 USgpm, not exceeding 12 hours per day, to meet that shortfall.

PW1 was carefully monitored during emergency operation given that the rate of pumping exceeded the originally proposed schedule designed to "set" the filter pack around the screen prior to commencing production pumping. The District found that operation of Bradford Park PW3, in addition to PW1, was required at times to meet daily demands. BCGW Field Reports of February 18th / 20th and our March 30th memo document emergency well operation and aquifer performance during this period. DW2 returned to operation on May 31, 2019. The Bradford Park wells operated without incident during the 112 days (about 4 months) of emergency pumping. The two wells were operated only briefly for sampling purposes between May 31st to June 16th.

The Bradford Park wells were again brought on-line by District staff on Monday June 17th. D. Borrill contacted BCGW on Monday June 24, 2019 to report that the combined discharge of both wells exhibited a component of "clay" the day prior (Sunday June 23rd). The wells were shut down on Monday June 24th and have been off since that time. BCGW dispatched a field technician on June 27th to download production wells PW1, PW3, the nested monitoring wells, photograph the pumphouse log book and obtain the daily sand samples collected during this period. The District also provided daily operating reports per our request and reported that a lightning strike earlier that week may have lead to operational issues at Bradford Park.

2.0 ANALYSIS AND INTERPRETATIONS

A summary of operating data from May 11th to June 23rd is attached, during which time BCGW carried out weekly monitoring of the Bradford Park wells, including datalogger downloads and static water levels for calibration / verification purposes.

BCGW provides the following analysis and interpretations:

1. PW1 and PW3 were operated per the pumping schedule about half of the time from May 11th to May 30th. Operation exceeded the recommended maximum 12 hrs/day (1180 m^3/day) for the remainder of the time due to system demands. Please recall that DW2 was not operational during this time and the District had no choice but to operate the Bradford Park wells at these higher rates.

• BCGW verifies that District staff operated the wells within our standard production well operating guidelines of < 1 ntu (turbidity) and sand concentration < 1 mg/L at all times. Sand production reached 0.9 mg/L at PW3 for one day on May 19th associated with an increased operating rate. BCGW has no concerns with this given that it is well below the AWWA A100 specification of 5 mg/L (2 hour basis).

2. PW1 and PW3 were operated per the pumping schedule on June 17th and 18th when re-started. The wells were operated in a manner that exceeded the pumping schedule of 12 hours and 1180 m^3 per day from the Bradford Park wells from June 19th to 23rd. Operating hours exceeded 18 hrs/day at PW3 on June 19th, 21st and 22nd.

• Combined turbidity and sand concentrations were observed to start increasing on Friday June 21st. BCGW review of the samples verifies that production of very fine sand / silt was observed the following day June 22nd. These sediments are “glaciolacustrine” in origin, as deposited by historic glacial lakes that are widespread within the region’s aquifers. The wells were operated at 3.2 ntu on June 23rd. BCGW review of the samples verifies that glaciolacustrine sediments are also included in the sample from that day. Please refer to the attached photographs for details.

• Combined sand production reached a maximum of 0.4 mg/L based on the samples collected and provided to BCGW. The sediment concentration was likely greater than the recorded mass given that much of the silt will not settle in the collection bucket at the rate of sample collection (5 USgpm). Nevertheless, the sand concentration likely remained below the AWWA A100 specification of 5 mg/L (2 hour basis).

3. BCGW interprets that a piping condition likely commenced on June 19th corresponding to the very large drawdown caused in the aquifer by both PW1 and PW3 operating above the 12 hr/day pumping schedule. That large drawdown caused a steep hydraulic gradient to form towards one or both wells, providing the conditions required for sediment transport from the aquifer towards the well. It is likely that the rate of fine sediment production in the well(s) was low enough, so as to not break though the filter pack “set” over the past few months of pumping. However, prolonged pumping on June 21st and 22nd likely resulted in the filter pack becoming increasingly blinded by the glaciolacustrine sediments, causing the hydraulic gradient to increase with extended pumping, eventually resulting in break-through of the sediments.

4. BCGW does not currently know the PW1 and PW3 well screen filter pack conditions. We also do not know if cross-piping may have occurred between the wells. This event is similar to that experienced by the pump contractor during testing of PW3 in 2017 as documented in our memos dated July 28, 2017 and March 15, 2018.
• Review of the water levels, temperatures and electrical conductivity information in the production wells is not possible because drawdown exceeded 70 % of the water column (the recommended operating limit).
• Initial review of water levels in the two nested monitoring wells located between PW1 and PW3 suggests that a water level imbalance occurred between Deep Aquifer No. 1 and No. 2 due to the very high operating hours at PW3 compered to PW1. This is believed to be the same phenomenon that occurred during the 2017 PW3 puming test. It provides upward hydraulic gradient conditions that aid to mobilize deeper fine sediment into the wells.

3.0 PROGNOSIS
It is unfortunate that this event has occurred. However, District staff were vigilant and identified this issue early on (June 22nd). The only critique by BCGW is that the wells should not have been operated the following day (June 23rd).

At this time BCGW is of the opinion that piping failure, if it has occurred, is likely limited to PW1 and PW3 based on the monitoring well datalogger information. That data suggests that cross-piping has not occurred between PW1 and PW3, however, this will need to be carefully investigated.

4.0 ACTION PLAN

4.1 Overview

BCGW will carry out the following tests to identify if changes have occurred in specific capacity (well output), water quality and sand / turbidity as compared to previous A100 certifications carried out on April 19, 2017 (PW1) and August 3, 2017 (PW3):

1. A one-day step-discharge test of PW1.
2. A one-day step-discharge test of PW3.
3. Monitoring during the above tests to determine if any evidence exists that cross-piping between PW1 and PW3 has occurred. BCGW will prepare certified daily Field Reports summarizing testing results and presenting our interpretations. This test is also expected to provide data which can be analyzed to determine if any physical damage has occurred to the well screen (i.e. partial collapse due to slumped sediments at depth). Recommendations to carry-out physical inspection and water-jetting of one or both wells will be based on these results. It may be possible to extend the duration of the above tests to fully clear the filter packs and return the wells to operation, if piping has been minor.

4.2 Pumping Tests

BCGW will conduct a one (1) day step-discharge test of PW1 and one (1) day step-discharge test of PW3 as follows:

- The test will be carried out with the installed production pumps. BCGW does not suspect this poses an excessive risk to the production pumps given the fine texture of sand and the short duration of the test. If the District is concerned about using their production pumps for this purpose, you are welcome to specify that BCGW carry-out the testing using a temporary pump and 3-phase generator.
- Monitoring will be comprised of the following:
  - Pumping rate and drawdown monitoring (use pumphouse instrumentation if possible)
  - Groundwater level, temperature and electrical conductivity (use existing datalogger)
  - Field water chemistry monitoring (use BCGW portable meter)
  - Sediment collection and measurement (use BCGW equipment)
  - Water samples
  - WIPN 41752 (S) water level and temperature changes (use existing datalogger)
  - WIPN 29688 (D) water level and temperature changes (use existing datalogger)
- BCGW will request assistance from the District, and advice from TRUE Consulting, to discharge from the pumphouse. This has the benefit of using installed instrumentation and maintains adequate pump back-pressure to minimize the risk of production pump damage.

Discharge via the blow-off valve is also a possibility, but this may bypass pumphouse instrumentation. BCGW has ways of adapting to the conditions, as required.

- Discharge will be routed into a tip-tank (c/w cyclone) and break-tank provided by JR Drilling Central (“JRDC”). This tank will provide primary containment of sediment discharged from the well and the opportunity to independently verify pumping rates. Discharge will be pumped onto Bradford Park using the JRDC Cornell pump and BCGW lay-flat hose. The tank provides the opportunity to break and move sections of the hose to distribute water throughout the park and minimize the risk of flooding. Contraflex lay-flat discharge hose will be used.
- The pumping test may need to be carried out over two days if discharge exceeds the absorption capacity of soils within the park, or if the rate of discharge needs to be increased very slowly due to sand production. Note that the original shallow standpipes are still in service to monitor any rising

water-table condition due to infiltration, so as to protect neighbouring residences. Testing will only occur during daylight hours.

4.3 Well Screen Inspection and Filter-Pack Water Jetting

If the well specific capacity (output) has declined, or the well is found to no longer meet the original A100 specifications, the risk of more serious filter pack disturbance or physical screen damage is a possibility. In that case, BCGW will proceed with inspection of the production well screen and water-jetting of the filter pack.

A brief outline of the process is described below:

• The production pump will be removed from the well by a pump contractor under the direct supervision of BCGW. Observations of the drop pipe, wire, check valve, pump and motor will be carried out to determine if any signs of sand or fine glaciolacustrine sediments are obvious.

• BCGW will carry out a high-resolution camera inspection of the well and screen, recording the results to DVD. This will require water from a nearby hydrant to flush the well from the surface during the inspection.

• JRDC will mobilize to site with the drilling rig, air-lift pump and water jetting tool. Ideally, PW1 will be used to supply the water required to water jet the PW3 screens, if that filter pack has been compromised. However, PW3 may be used to supply water to jet the PW1 screens, if that filter pack has been compromised. Alternatively, water from a hydrant may be required if both well filter packs are compromised.

• Supply water will be directed into the DR12 drilling rig auxiliary connection and directed into the jetting tool rotating inside the screen(s). Discharge in excess of the supply will be discharged to a break tank and discharged to Bradford Park. An air-lift pump will be used the remove sediment which accumulates in the well. Use of this water is covered under the current FLNRORD STU.

• When the air-lift pump confirms that the specific capacity and sand / turbidity returns to the original value, or stabilizes at a new rate, the down-hole equipment will be demobilized and the pump(s) reinstalled.

5.0 CLOSURE

BCGW proposes to carry-out the step-discharge tests during the week of July 8th to 12th at standard hourly rates. We will request an estimate from JRDC to rent the tanks and pump required to execute these tests. An extra couple of days may be required if the pumping test demonstrates that it is a reliable method of clearing sand from the wells. We have scheduled BCGW staff to carry out this work per our recent emails.

I understand that the next Council meeting is July 15th. Please indicate if a special meeting is required for authorization to proceed. Rick and I will make ourselves available this week to attend via phone. For tracking purposes, BCGW will track costs on this assignment at File 09003.15 from this point forward and provide a Retainer Agreement by the end of day for signature prior to arrival on-site.

Sincerely,

BC Groundwater Consulting Services Ltd.
Thierry M. Carriou, M.Sc., P. Eng.
Hydrogeologist (1993)