

REGIONAL MUNICIPALITY OF NIAGARA

REGIONAL ROAD 20 REDEVELOPMENT POST-DEVELOPMENT MONITORING REPORT

December 11, 2018





11 December 2018

Frank Tassone
Regional Municipality of Niagara
1815 Sir Isaac Brock Way
P.O. Box 1042
Thorold, Ontario
Canada L2V 4T7

Dear Sir:

Subject: Regional Road 20 Redevelopment – Post-Development
Monitoring Report

Client ref.: O.01.06 77 020 0841

We are pleased to provide four copies of the Post-development Surface Water and Erosion Monitoring Report for the Regional Road 20 Redevelopment. Copies have been forwarded to the Niagara Peninsula Conservation Authority and the Town of Pelham on your behalf.

The report provides background information on the physical setting, details of the work program completed, and a presentation of the construction monitoring data for the Regional Road 20 Redevelopment. Conclusions and recommendations for future monitoring programs, as necessary, are included in the report. Relevant technical data is appended.

We trust that this report satisfies your requirements.

Yours sincerely,

A handwritten signature in blue ink that reads 'Bailey Walters'.

Bailey Walters, MSc, PGeo
Senior Geoscientist

Encl.

cc: Town of Pelham
Niagara Peninsula Conservation Authority

WSP ref.: 111-53018-00

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1 INTRODUCTION

The Regional Municipality of Niagara has redeveloped approximately three kilometres of Regional Road 20, between the Highway 406 junction and the Town of Pelham. The development area, shown on Figure 1, is located in the Town of Pelham and the City of Thorold, in the Regional Municipality of Niagara.

1.1 BACKGROUND

Jagger Hims Limited (now WSP Canada Limited) completed the 2007-2008 pre-construction surface water and erosion monitoring program, including the field investigation and reporting, which was finalized in April 2009.

Construction for the Redevelopment of Regional Road 20 began in May 2009 and was to be completed in a phased approach over the three years. Phase 1 construction was completed in May to October 2009. Phase 2 construction was completed in June to November 2010. Phase 3 construction, scheduled to be completed in 2011, was postponed and completed in April to October 2012.

Post-construction monitoring was initiated following completion of each construction phase. Phase 1 post-construction monitoring was undertaken from October 2009 to October 2014. Phase 2 post-construction monitoring was undertaken from November 2010 to November 2015. Phase 3 post-construction monitoring began in October 2012 and was completed October 2016. The construction and environmental monitoring phases are outlined in Table 1-1, below.

Environmental monitoring undertaken at the three phase locations after 2008 and prior to the actual start date of the construction is considered as pre-construction monitoring at that location.

Table 1-1 Regional Road 20 Redevelopment Construction and Monitoring Phases

CONSTRUCTION PHASE	LOCATION	CONSTRUCTION PHASE ENVIRONMENTAL MONITORING	POST-CONSTRUCTION ENVIRONMENTAL MONITORING
Phase 1	East of Rice Road to east of Cataract Road	May 2009 - October 2009	October 2009 – October 2014
Phase 2	East of Cataract Road to Hwy 406	June – November 2010	November 2010 - November 2015
Phase 3	West of Station Street to east of Rice Road	April – October 2012	October 2012 to October 2016

This report provides final summary of the monitoring completed between 2008 and 2016, which includes pre-construction, construction, and post-construction monitoring at the Regional Road 20 Redevelopment, located within the Twelve Mile Creek watershed. Phase 1 monitoring requirements were satisfied as of October 2014. The historical monitoring data for Phase 1 is included in the report for reference purposes. Monitoring locations at Cataract Road (SW4 and SW5) are within the area affected by Phase 1 construction, monitoring locations at Rice Road (SW1, SW2 and SW3) are within the area

affected by Phase 1 and Phase 3 construction, and the locations at the Merrittville Highway (SW6 and SW7) are affected by Phase 2 construction.

1.2 OBJECTIVE AND SCOPE

The principal objective of the construction monitoring program for the Regional Road 20 Redevelopment is to evaluate the impacts from development against the baseline information collected during the pre-construction phase of monitoring. If an unacceptable impact is identified, mitigation measures will be recommended.

The monitoring program included a data collection component, and an analysis and interpretation component. This report provides the results of the surface water and erosion monitoring program activities that occurred over the period of 2016 calendar year.

1.3 PHYSICAL SETTING

This section describes the local geology, hydrogeology, and hydrology. Within the Surface Water section, the monitoring locations are described in the physical context.

1.3.1 GEOLOGY AND HYDROGEOLOGY

The redeveloped area between Station Street and Highway 406 in Pelham and Thorold is located to the northeast of the Fonthill Kame Complex.

The site is located within the Haldimand Clay Plain physiographic region (Chapman and Putnam, 1984). The fine-grained glaciolacustrine overburden in the area, deposited by pro-glacial Lake Warren, varies in thickness between 23 and 35 metres.

Local overburden thickness is mapped as approximately 21 m at the eastern end of the project site to 38 m at the west (Vos, 1969). The bedrock contact is located at approximately 160 mASL at the eastern end of the project site to 145 mASL in the west (Feenstra, 1981). The underlying bedrock is a succession of Palaeozoic beds that dip slightly southward, toward Lake Erie.

Typical quaternary geology of the area (Fenco MacLaren, 1995) includes the following units:

Table 1-2 Quaternary Geology

GEOLOGIC UNIT	DESCRIPTION
QUATERNARY DEPOSITS	<p>Upper Glaciolacustrine Unit</p> <p>The surficial overburden in the area is mapped as an upper glaciolacustrine unit that is composed of a brown, reddish, and grey silty clay to clayey silt that is massive to thinly-stratified. This unit may be present from ground surface to approximately 10 metres below ground surface.</p>

GEOLOGIC UNIT	DESCRIPTION
	Halton Till Underlying the upper glaciolacustrine unit is the Halton Till, a brown to grey, massive to laminated clayey silt with a sand content of less than 20 percent. The till is approximately 10 metres thick.
	Lower Glaciolacustrine Unit Beneath the Halton Till is a lower glaciolacustrine unit of silty clay that is approximately 10 metres thick.
	Lower Till Unit The Lower Till unit consists of sandy silt with lenses of silt, sand, and gravel. The Lower Till unit is approximately 5 metres thick.
BEDROCK	Salina Formation The bedrock consists of inter-bedded dolostones and shales of the Salina Formation.

The upper glaciolacustrine unit, the Halton Till, and the lower glaciolacustrine unit are reportedly fairly uniform and predictable. The sand and gravel lenses within the lower till unit are considered non-uniform and unpredictable since they are laterally variable and discontinuous.

Generally, hydraulic conductivity in overburden soils is low due to the fine-grained nature of the material. Local topography (including existing ditches and swales) and seasonal precipitation strongly influence groundwater flow through fractures in the shallow, weathered overburden.

1.3.2 SURFACE WATER

The study area is located within the Twelve Mile Creek watershed, which drains to the north, ultimately to Lake Ontario.

1.3.2.1 CATARACT ROAD TRIBUTARY (SW4 & SW5)

In the vicinity of the intersection of Cataract Road and Regional Road 20, the area is drained to the north, via a roadside ditch and swale through agricultural fields, before joining the Twelve Mile Creek in the northeast of the study area.

Surface water station SW4 is located at the intersection of Cataract Road and Regional Road 20, at the evert of the culvert beneath Regional Road 20. The logger in the culvert was removed on 7 May 2009 to facilitate the replacement of the culvert. The logger was re-installed on 5 June 2009. The original circular corrugated steel pipe culvert was replaced with an elliptical concrete culvert (975 mm x 1535 mm) in May 2009.

From the culvert, the flow continues north in the roadside ditch on the west side of Cataract Road for approximately 460 m. North of the culvert, the roadside ditch collects additional road runoff from Cataract Road and McSherry Lane before flowing east through a culvert under Cataract Road and continuing northeast in a drainage swale.

Surface water station SW5 is located approximately 70 m east of Cataract Road, near the beginning of the agricultural drainage swales.

No natural channel was encountered in the vicinity of the intersection of Regional Road 20 and Cataract Road.

1.3.2.2 RICE ROAD TRIBUTARY (SW1, SW2 & SW3)

The southwestern area of the site drains to Twelve Mile Creek through the Rice Road Tributary of Twelve Mile Creek. A square, closed-bottom concrete culvert (approximately 1.22 m wide) beneath Regional Road 20 drains away water from the area surrounding the intersection with Rice Road.

There are three surface water stations established on the Rice Road Tributary. From 2009 to 2015, SW1 was located at the culvert invert on the south side of Regional Road 20. Runoff collected from the properties northeast, southeast and southwest of the Rice Road intersection flows into the culvert. Following construction of a storm-water management pond in 2015, the invert at the south side was reconfigured making it inaccessible for monitoring and surface water flow that formerly joined into the box culvert beneath RR20 was redirected into the SWM Pond; as a consequence, SW1 was relocated to near the evert (north end) of the box culvert. The result is that roadside drainage that previous discharged directly to the Rice Road Tributary (by-passing SW1) was now directed to the SWM Pond and the resultant (attenuated) discharge was now captured by SW1 monitoring.

SW2 is located approximately 3 m north of the box culvert evert.

Between SW1 and SW2, the tributary receives surface water runoff from Regional Road 20 storm drains and from the roadside ditch located on the north side of Regional Road 20. The storm drains collect road runoff from Regional Road 20, west of the Rice Road Tributary. The roadside ditch collects water from Regional Road 20 and Hurricane Road, west of the Rice Road Tributary and east as far as Rice Road. The collected runoff then flows north into the narrowly confined, densely wooded channel of the Rice Road Tributary.

SW3 is located approximately 40 metres north of the confluence of these inputs, in the natural channel.

1.3.2.3 MERRITTVILLE HIGHWAY TRIBUTARY (SW6 & SW7)

A watercourse, south of Regional Road 20 and east of the Merrittville Highway collects excess surface water and flows north through a concrete box culvert under Regional Road 20. Surface water station SW6 is located approximately 80 m east of the intersection of Merrittville Highway and Regional Road 20.

Surface water flowing from the box culvert joins water collected from the short roadside ditches on the north side of Regional Road 20. The runoff then enters a smaller underground culvert leading from Regional Road 20 on the east side of a restaurant, located at the corner property.

The runoff flows northwest via the buried concrete culvert, crossing beneath Merrittville Highway approximately 140 m north of the Regional Road 20 intersection. Approximately 15 m downstream of the culvert evert the roadside ditch transitions to a natural channel and continues to the north.

Surface water station SW7 is located approximately 50 m downstream of the Merrittville Highway culvert, in the natural watercourse.

2 MONITORING PROGRAM

The monitoring program for the Regional Road 20 Redevelopment included surface water flow monitoring, surface water quality sampling and erosion monitoring in accordance with the monitoring requirements detailed in Appendix A. The program has been approved by the Niagara Peninsula Conservation Authority (NPCA).

2.1 SURFACE WATER

Surface water flow monitoring stations are shown on Figure 1. Flow monitoring was conducted on a continuous basis at monitoring stations at SW1 at Rice Road and at SW6 at the Merrittville Highway. This monitoring included 10-minute interval measurements of water level, velocity and calculated discharge rate. In addition, water temperatures were recorded electronically by submerged temperature loggers at 10-minute intervals. The water level and temperature at the SW3 monitoring station on the Rice Road Tributary were recorded at hourly intervals by a Levelogger located in a stilling well in the watercourse. Manual flow measurements were made during each site inspection of the monitoring stations. Flows were measured manually generally following the USGS area-velocity method.

Annual surface water quality monitoring was completed to correspond with specific weather conditions that included spring runoff, twice during dry periods, and twice during precipitation. The locations of the surface water monitoring stations are shown on Figure 1, as required by the Terms of Reference (Appendix A). The surface water monitoring protocols are presented in Table 2-1.

Table 2-1 Monitoring Protocols and Procedures

SURFACE WATER SAMPLING

Attempts are made to schedule surface water monitoring events to correspond with intended freshet, dry, or wet event monitoring.

Surface water samples at each location are collected prior to flow measurement.

Surface water samples are collected directly into the laboratory provided bottles that do not have preservatives. For bottles with preservatives added, standard grab sampling methods are used and then the water is decanted into laboratory provided bottles with the appropriate preservatives. The sample container is pointed upstream and care is taken to avoid particulate and organic matter in the water.

Sample bottles are marked, labelled, and sealed in the field.

Samples are stored in ice packed coolers and delivered or couriered to the laboratory at the end of each day, under Chain of Custody procedures.

Field parameters (pH, conductivity, dissolved oxygen, and temperature) are measured from a separate beaker of water using calibrated instruments.

When the flows are present, stream flow discharge is calculated based on the cross-sectional area of the stream, and the water velocity.

A cross-sectional profile of the stream is determined by measuring the cross-sectional width and depth of the wetted stream at incremental sections. The velocity is measured using an electromagnetic velocity meter by measuring the average velocity of each section.

Field notes including date, weather, time, sampling data, staff, field parameters, visual observations, and number of bottles are marked on the Water Sampling Field Data sheets in the Project Field Book.

Surface water sampling was conducted during five occasions in 2015 (one spring freshet event, two dry events, and two wet events). Surface water stations SW1, SW2, SW3, SW6 and SW7 were sampled successfully on all five occasions.

Dissolved oxygen, temperature, pH, and conductivity were measured in the field during sampling collection.

Surface water samples were submitted to AGAT Laboratories of Mississauga for analysis of the following parameters, as set out in the Terms of Reference (Appendix A).

- Total Suspended Solids
- Chloride
- Nitrogen Species: Total Ammonia, Nitrate + Nitrite, and Total Kjeldahl Nitrogen
- BOD₅
- E. coli
- Total Phosphorus

2.2 EROSION

A section of the Rice Road Tributary, from Regional Road 20 northward for approximately 150 m, was surveyed by William A. Mascoe Surveying Limited annually in April from 2007 to 2016. The creek was surveyed at approximately one-metre intervals along the watercourse to obtain breaks in grade, including lowest points, defined stream banks, and the edges of the creek.

Field benchmarks were established relative to the Regional Niagara co-ordinate system in Universal Transverse Mercator (UTM) system co-ordinates in metres of easting and northing referenced to the North American Datum 1983 (NAD83).

3 MONITORING PROGRAM RESULTS

Section 3 provides a summary of the results of surface water and erosion monitoring.

3.1 SURFACE WATER

Section 3.1 provides a summary of the surface water flow monitoring, automated and manual, and the surface water quality, including temperature and chemical characteristics.

3.1.1 AUTOMATED MONITORING STATIONS

Automated surface water flow monitoring stations were installed on 31 March 2016 and removed on 9 December 2016. Stations were installed at stations SW1 (south side of Regional Road 20 near Rice Road), SW3 (north side of Regional Road 20 near Rice Road), and SW6 (Regional Road 20 and Merrittville Highway), as shown in Figure 1. These stations, except for SW3, consisted of data logging equipment to collect velocity and temperature at 10-minute intervals.

Three types of monitoring station equipment were used. Station SW1 was equipped with a Greyline Stingray™ Portable Level-Velocity logger with submerged depth/velocity sensor. Station SW6 was equipped with an American Sigma 910™ Portable Area-Velocity flow meter with submerged depth/velocity sensor. Surface water station SW6 was also equipped with an Onset StowAway™ Tidbit underwater temperature logger.

As the American Sigma flow meter was routinely found to silt up in the natural channel at SW3, it was replaced with a Solinst Levellogger™ installed within a stilling well in 2010. The stilling well was installed such that its screen transects the creek bed, ensuring that the creek stage is accurately measured. The logger is located in a well sump below the ground surface and is programmed to record water levels at hourly intervals.

The discharge rates were calculated from the direct measurements of velocity and depth using the fixed shape and dimension of the culvert/structure in which each was installed. Discharge rates are calculated using area-velocity method and the water level and velocity data from the American Sigma open channel flow meters. In instances where a positive, non-zero water level was recorded but the velocity was zero, calculated discharge is zero, and vice versa.

At SW3, where creek stage is monitored by the Levellogger located in the stilling well, the discharge rate was related to the recorded water levels through an empirical relationship between the manual discharge rate measurements and the water levels recorded by the logger at the time of the manual discharge rate reading.

The monitoring period was determined based on the occurrence of freezing weather. While the equipment can handle temperatures close to freezing, the pressure transducers use diaphragms that can rupture when frozen.

As noted above, the monitoring station equipment was installed in March or early April of each year, as this was the earliest the equipment could be installed due to freezing weather conditions. Similarly, the monitoring station equipment was removed in November or December of each year due to freezing conditions. While the equipment can handle some temperatures close to freezing, the pressure transducers use diaphragms that can be ruptured when frozen. The exception is the Levellogger, installed below ground surface at SW3, which can remain in situ year-round.

The monitoring equipment was inspected during each site visit. In a number of cases, debris (soil, twigs, worms, etc.) around the sensors was removed. Data from the monitoring equipment were downloaded to a portable laptop in the field. During inspections, spot manual measurements of flow and water depths were made and noted in the field book.

Stream flow was measured manually during each site inspection of the monitoring stations and the results are included in Table B-6, Appendix B. Flows were measured manually at all surface water stations using the USGS area velocity method whereby the depth of the station profile was measured at 10 cm intervals and the velocity measured at 60% of the depth.

The results of the automated flow monitoring are presented graphically on Figures B-1 through B-8, and a summary of the flow data is included in Tables B-1 through B-5, Appendix B.

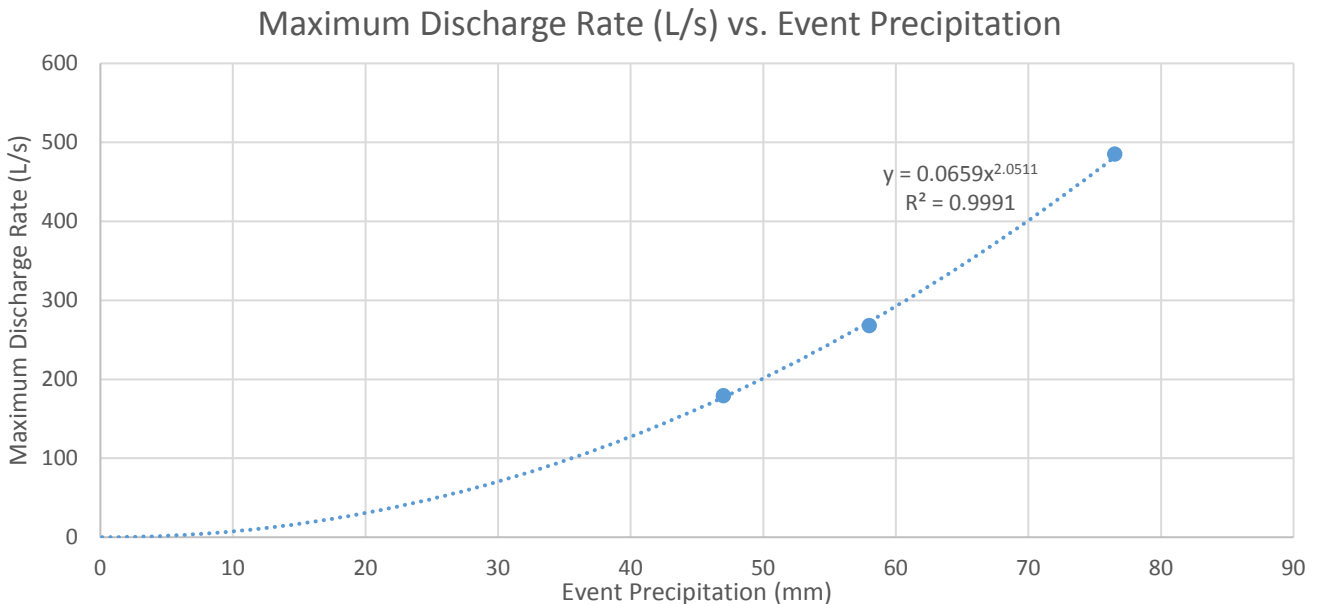
3.1.1.1 CATARACT ROAD TRIBUTARY (SW4)

At station SW4, the five-years of post-development monitoring period ended in 2014. The historical results of the automated flow data collection at SW4 are presented on Figure B-1 for reference purposes. Table B-1 presents a summary of the flow data from SW4.

The maximum discharge rates during each construction period are summarized in the following table and graph.

Table 3-1 Summary of Maximum Discharges – Cataract Road Tributary SW4

Period	Precipitation (mm)		Max 1-hour intensity (mm/h)	Maximum Discharge Rate (L/s)
	1-week Lead-up	Event		
Pre-Construction	29	47	5.5	179
Construction	9	58	39.5	268
Post-Construction	58	76.5	4.75	485



Pre-construction maximum discharge was calculated to be 179 L/s. (47 mm storm event with maximum 1-hour intensity of 5.5 mm/h). The maximum discharge calculated for the construction period (May through October 2009) was 268 L/s. The maximum post-construction discharge occurred in late October 2012 and was calculated to be 485 L/s. The discharge

3.1.1.2 RICE ROAD TRIBUTARY (SW1 & SW3)

The results of the automated flow and temperature data collection for SW1 and SW3 are presented on Figures B-2 through B-5 of Appendix B.

Automated flow and temperature measurement at SW1 was recorded with a Greyline Stingray™ Portable Level-Velocity logger installed in the 120-cm concrete box culvert that was constructed during the 2012 monitoring period. The box culvert was extended by approximately 10 m with a concrete pipe between June and September 2015. Table B-2 presents a summary of the 2016 and the historical flow data from SW1. The results of the automated flow and temperature data collection at SW1 are presented on Figures B-2 and B-3. During the 2016 monitoring season, surface water temperature at SW1 on the Rice Road tributary showed seasonal temperature fluctuations.

The precipitation events were determined based on regional climatic data provided in Appendix D.

The results of manual flow measurements, obtained using USGS method, are presented in Table B-6.

The monitoring station at SW3 is located in a natural channel and therefore required modification for automated flow monitoring. A 100 cm-diameter steel half-pipe was installed to house the submerged flow meter sensor, which allows for a uniform correlation between depth, velocity, and flow, in the irregularly shaped natural channel.

Automated flow data at SW3 may be unreliable for some periods during 2009 based on the following issues encountered during periodic site visits:

- Silt accumulation: during the 18 June inspection event, it was noted that silt had accumulated on the submerged flow meter sensor. The silt was removed and the flow meter repositioned to minimise further accumulations.
- Recalibration: during the 24 July inspection event, it was noted that although the sensor was submerged, the meter was recording no depth. The meter was recalibrated in the field, which seemed to correct the issue.
- Dislodgment of monitoring equipment: during the 26 August monitoring event, the half-pipe at this station had been dislodged and washed downstream. The data indicated that this had occurred on 9 August, following very high flows resulting from a substantial rain event.

Due to the issues with the flow meter installation at SW3, in spring 2010, the American Sigma open-channel flow meter and Onset StowAway™ Tidbit were replaced with a Solinst Levellogger™ installed within a stilling well in the stream channel. The Levellogger recorded water levels and temperature. As the logger is installed within the well sump, it is protected from temperature extremes and can remain in place throughout the year.

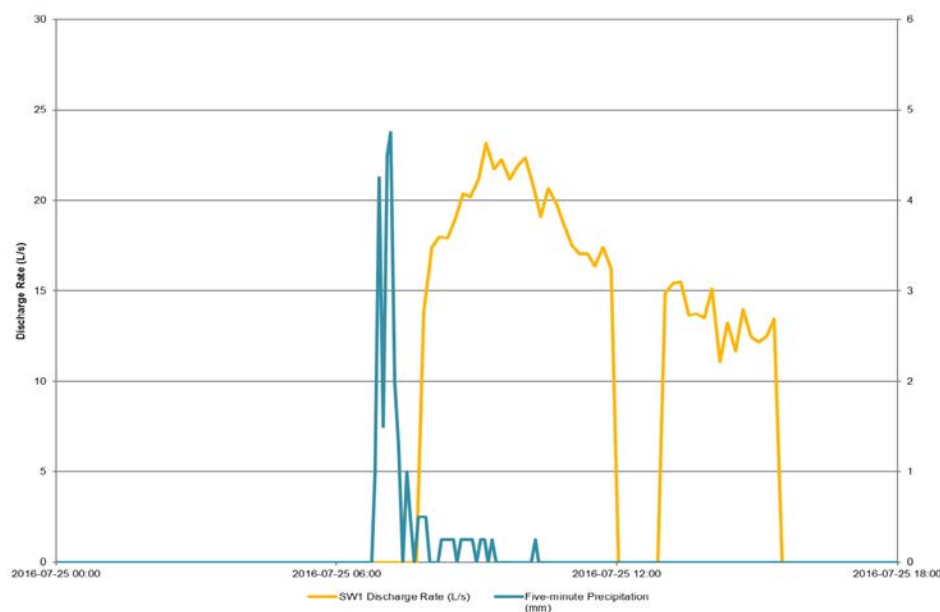
The SW3 flow data from the American Sigma flow meter and the water level data from the Levellogger are presented in Table B-3 and Table B-4, respectively. Water level and discharge rates at SW3 over the 2016 monitoring period in relation to precipitation events are presented graphically in Figures B-5 and B-6, respectively. During the 2016 monitoring season, surface water temperature at SW3 on the Rice Road tributary showed seasonal temperature fluctuations.

The highest discharge rate calculated from the automated flow velocities and depths for the 2016 monitoring period (31 March to 9 December) was approximately 39 L/s (188 L/s in 2015) at the SW1 monitoring station. The average discharge rate, based on the automated measurement rate of ten minutes, was 0.9 L/s (1.2 L/s in 2015). The calculated total discharge over the monitoring period is approximately 70 900 m³ (24800 m³ in 2015).

At downstream station SW3, the highest calculated discharge rate for the 2016 monitoring period (1 April through 9 December 2016) was approximately 39 L/s (134 L/s in 2015) and the average discharge rate was 0.9 L/s (3.6 L/s in 2015). The calculated total discharge during the monitoring period is approximately 7 390 m³ (12860 m³ in 2015).

The discharge rates recorded at SW1 in response to a storm event that occurred from 25 July 2016 are summarized on the following figure.

Figure 3-1 Rice Road Tributary Discharge Hydrograph – 25 July 2016 Storm Event



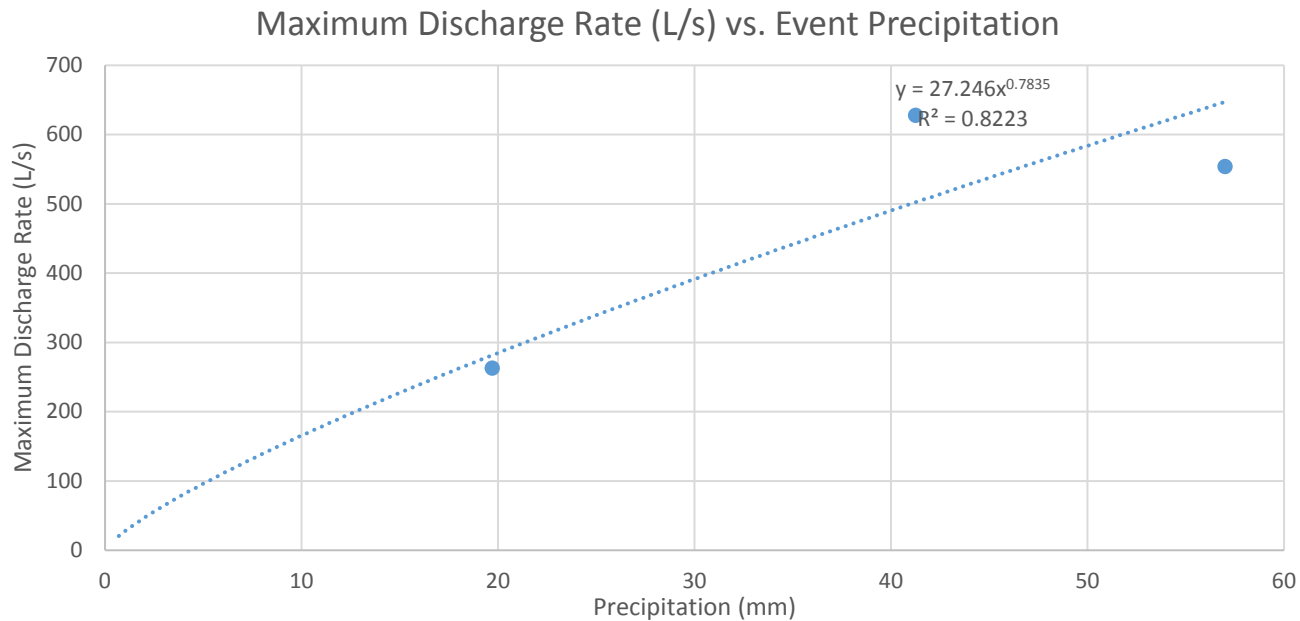
The maximum discharge rate during the storm event was approximately 23 L/s and the lag time (time between the peak precipitation and peak stream discharge) was about 2 hours (the Levellogger is programmed to take measurements every ten minutes).

The larger lag time reflects retention in the storm water management pond (installed in 2014-2015) prior to discharge; in the years prior to installation of the pond, lag times were short with the peaks generally about 10 minutes apart.

The maximum discharge rates during each construction period are summarized in the following table and graph.

Table 3-2 Summary of Maximum Discharges – Rice Road Tributary SWI

Period	Date	Precipitation (mm)		Max 1-hour intensity (mm/h)	Maximum Discharge Rate (L/s)
		1-week Lead-up	Event		
Pre-Construction	2008-07-24	32	19.7	17.5	263
Construction	2009-08-20	0.25	57	10.25	554
Post-Construction	2013-06-10	56	41.25	23.5	628



3.1.1.3 MERRITTVILLE HIGHWAY TRIBUTARY (SW6)

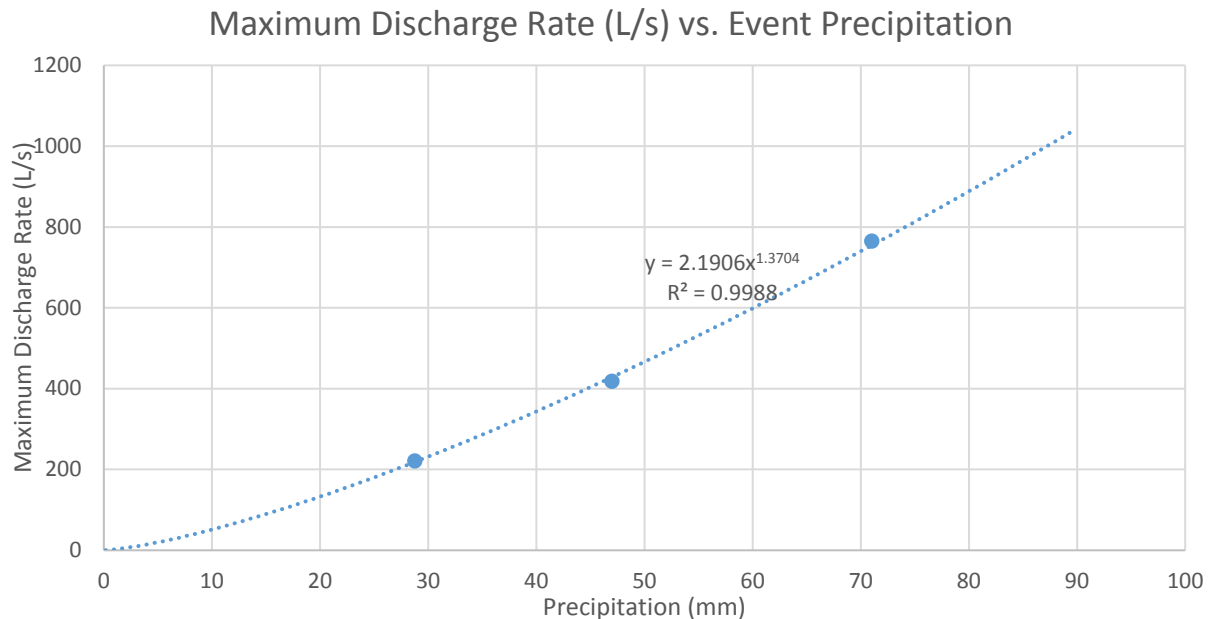
At station SW6, the five-years of post-development monitoring period ended in 2015. The historical results of the automated flow data collection at SW6 are presented on Figure B-6 of Appendix B for reference purposes.

Table B-5 presents a summary of the flow data from SW6 monitoring period in relation to precipitation events. The precipitation events were determined based on regional climatic data from Appendix D.

The results of manual flow measurements, obtained using USGS method, are presented in Table B-6. The discharge rates were calculated from direct measurements of velocity and depth and the fixed dimensions of the concrete storm sewer pipe (92 cm diameter).

Table 3-3 Summary of Maximum Discharge Rates

Period	Date	Precipitation (mm)		Max 1-hour intensity (mm/h)	Maximum Discharge Rate (L/s)
		1-week Lead-up	Event		
Pre-Construction	2009-04-04	26.75	47	5.5	418
Construction	2010-06-06	44.5	28.75	11.25	221
Post-Construction	2014-07-28	6	71	44.75	764.5



3.1.2 MANUAL SURFACE WATER FLOW

As shown on Table B-6, Appendix B, manual flow measurements were made during each site inspection of the monitoring stations. The results of the flow monitoring are used for calibration purposes, and to refine the empirical relationship between creek stage and discharge at surface water station, SW3.

3.1.3 SURFACE WATER TEMPERATURE

In 2016, the surface water temperature was recorded at SW1 and SW3. The results of 2016 temperature logging are shown graphically, on the figures in Appendix B.

In general, the measured temperatures reflect seasonal variations. Ambient temperatures in the pipes between flow events may be 2 to 5 degrees warmer than the recorded atmospheric temperatures but decrease during storm events, with the exception of temperatures recorded at SW3. Surface water temperatures at SW3 are moderated, as the logger is located within the sump of the stilling well, below the creek bed; thus, recorded temperatures at SW3 reflect seasonal surface water temperatures moderated by the temperature in the shallow sub-surface.

3.1.4 SURFACE WATER QUALITY

Collection of surface water quality samples was attempted five times during 2004, 2007, 2008, 2009, and 2011, 2013, 2014, 2015, and 2016, four times during 2005, 2006, and 2010, six times in 2012, to coincide with the spring freshet, two dry events and two wet events. Samples were obtained at the following specific weather events:

Table 3-4 Surface Water Sampling Dates

Year	Spring Freshet	Dry Events (with no precipitation)	Wet Events (with precipitation)
2007		2007-12-05	2007-10-19
2008	2008-03-27	2008-10-31	2008-08-06 2008-12-16
2009	2009-04-06	2009-02-13 2009-09-10	2009-06-18 2009-12-01
2010	2010-03-09	2010-09-03	2010-06-16 2010-10-05
2011	2011-06-06	2011-03-29 2011-09-30	2011-06-24 2011-11-29
2012	2012-04-25	2012-03-15 2012-07-27	2012-10-10 2012-12-05
2013	2013-03-27	2013-05-02 2013-10-10	2013-06-13 2013-12-10
2014	2014-03-18	2014-04-25 2014-09-24	2014-06-04 2014-12-01
2015	2015-03-12	2015-05-13 2015-09-30	2015-06-09 2015-10-29
2016	2016-03-22	2016-06-29 2016-09-01	2016-04-26 2016-10-21

Water quality results were compared to the Provincial Water Quality Objectives (PWQO) and are presented in Table C-1; Appendix C. Laboratory certificates of analysis for the current reporting period are included in Appendix C.

As presented in the pre-construction monitoring report, existing water quality was generally degraded with respect to concentrations of total phosphorus, *E. coli* bacteria, chloride, TSS, and nitrate. In general, the results of the 2016 analytical testing indicated that:

- Concentrations of total phosphorus generally exceed the PWQO at the sampled surface water monitoring stations.
- Concentrations of *E. coli* bacteria generally exceed the PWQO at the sampled surface water monitoring stations.
- Chloride and conductivity concentrations were periodically elevated at the sampled surface water monitoring stations, likely due to road runoff.
- Concentrations of TSS are periodically elevated in samples from each water course.
- Concentrations of nitrate are periodically elevated at the sampled surface water monitoring stations, likely due to local agricultural activities.

3.1.4.1 CATARACT ROAD TRIBUTARY (SW4 & SW5)

Stations SW4 and SW5 were not sampled in 2016 since the monitoring requirement for these stations ended in 2014. A summary of the historical pre-construction, construction and post-construction results of surface water field and laboratory analyses are included in Table C-1 for reference purposes. Time-concentration graphs of historical parameter concentrations at the Cataract Road Tributary surface monitoring stations are presented in Figure C-1 for reference purposes. Post-development, there has been an increasing trend in chloride, and associated conductivity; a road salt management plan should be established to reduce the road salt entering the stream to pre-development (i.e., pre-2010) concentrations.

3.1.4.2 RICE ROAD TRIBUTARY (SW1, SW2 & SW3)

A summary of the pre-construction, construction and post-construction results of surface water field and laboratory analyses are included in Table C-1. Time-concentration graphs of parameter concentrations at the Rice Road Tributary surface monitoring stations are presented in Figure C-2.

Comparing the post-construction phase water quality results from the surface water stations on the Rice Road Tributary to those of the pre-construction phase, the mean concentrations generally were similar; however as seen in Figure C-2, several parameter concentrations were somewhat variable during the construction phases relative to the pre-construction ranges.

Post-construction parameter concentrations in 2016 generally were similar to the pre-construction phase, with the exception of un-ionized ammonia, which has had increasing peak concentrations since 2014. This may be related to on-going construction project in the vicinity of the intersection and Regional Road 20, which includes construction of a storm water management pond that discharges to the Rice Road Tributary. Water quality in the discharge from the storm water management pond should include sampling for un-ionized ammonia; this should be addressed in the environmental compliance approval (ECA) for the pond.

3.1.4.3 MERRITTVILLE HIGHWAY TRIBUTARY (SW6 & SW7)

Stations SW6 and SW7 were not sampled in 2016 since the monitoring requirement for these stations ended in 2015. A summary of the pre-construction, construction, and post-construction results of surface water field and laboratory analyses are included in Table C-1 for reference purposes. Time-concentration graphs of parameter concentrations at the Merrittville Highway Tributary surface monitoring stations are presented in Figure C-3.

3.2 EROSION MONITORING RESULTS

Licensed Ontario Land Surveyors (William A. Mascoe Surveying Limited) surveyed the creek reach annually in April from 2007 to April 2016 following the snow melt/spring freshet, using Total Station survey equipment. The creek profile was surveyed at approximately one-metre intervals, including breaks in grade, lowest point, edge of creek, and top of bank. Field benchmarks were established, and the work was completed relative to the Regional Niagara UTM system for future monitoring purposes.

The survey points from 2007 and 2016 are presented on Figures 2 and 3, respectively, with interpreted topographic contours. The survey points have accuracies of three decimal places, but for presentation purposes the contours are presented at one-metre intervals in metres above sea level (mASL).

Figure 4 presents the difference between 2016 and 2007 surveys, identifying areas of either erosion or accretion relative to the original 2007 survey. The differences were interpolated using the ESRI's ArcGIS using the "Topo to Raster" tool which is a technique used to create a hydrologically correct surface. The algorithm used is based on that of ANUDEM (developed by Hutchinson et al at the Australian National University). Between April 2007 and April 2016, the erosion/accretion in the surveyed reach is generally less than 0.5 m, as seen in Figure 4, with small areas of greater erosion/accretion, which may be related to the removal (by others) of the tree canopy in the area or the natural advancement of the stream

meander. Figure 5 presents the difference between 2016 and 2015 survey; during this period, the erosion/accretion in the surveyed reach is generally less than 0.25 m.

3.3 CLIMATE DATA

The 5-minute interval climatic data was provided by Regional Niagara's station located at the Town of Pelham offices approximately one kilometre to the southwest. The climate data is included in Appendix D. Precipitation data from the nearest Environment Canada station was used whenever possible. The Regional Niagara Pelham climate station data and the Environment Canada Welland-Pelham data generally agree on total precipitation amounts for 2016.

Normal annual precipitation for the area is approximately 873 mm, based on the 1971-2000 30-Year Normals calculated from Environment Canada climatological station data located at St. Catharines Power Glen (approximately six kilometres north of the study area). St. Catharines Power Glen is the nearest Environment Canada Climatological Station with sufficient data to calculate 30-Year Normals.

There was 646 mm of precipitation received in 2016 in the area, based on the total precipitation measured at the Environment Canada Welland-Pelham climatological station, indicating that 2016 was a below average precipitation year.

4 DEVELOPMENT MONITORING PROGRAM

The post-construction monitoring program was initiated at Cataract Road Tributary in October 2009, when Phase 1 construction had been completed. Phase 2 construction was completed in November 2010, at which point post-construction monitoring at Merrittville Highway Tributary began. Phase 3 construction occurred between April and October 2012, therefore construction phase monitoring at the Rice Road Tributary was completed after October 2012; post-construction monitoring at the Rice Road Tributary was initiated in November 2012.

As of October 2014, the five-year post-construction monitoring period at Phase 1 (SW4 and SW5) had been satisfied. As of October 2015, the five-year post-construction monitoring period at Phase 2 (SW6 and SW7) had been satisfied. As of October 2016, five years of post-construction monitoring has been completed at Phase 3 (SW1 and SW3) locations. Thus 5 years of post-construction monitoring has been completed.

Long-term monitoring reports will be compiled and should be circulated to the NPCA, for review, on an annual basis. This is the final monitoring report.

A draft report will be made available to the client for comment, prior to submission to the regulatory agencies. Digital copy of final annual reports will be made available for download by Regional Niagara.

5 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of the monitoring program presented in this report, the following conclusions are provided:

- In the vicinity of the intersection of Cataract Road and Regional Road 20, surface water and run-off flow north from the culvert (SW4) in the roadside ditch on the west side of Cataract Road until it enters drainage swale (SW5) more than 350 m from the Regional Road 20 intersection and continues on through drainage swales in agricultural fields toward Twelve Mile Creek.
- In the vicinity of Rice Road, the site drains to Twelve Mile Creek through the Rice Road Tributary. A 1.2 m wide, square, concrete culvert (SW1 at invert, SW2 near evert) drains the area surrounding the intersection of Rice Road and Regional Road 20. The creek then flows into a narrow confined, densely wooded creek channel (SW3) converge with Twelve Mile Creek, downstream.
- Runoff from the area southeast of the intersection of Merrittville Highway and Regional Road 20 (SW6) flows through a 0.9 m-diameter concrete culvert, eventually crossing beneath Merrittville Highway. Flow enters a natural channel (SW7) soon after and continues toward Twelve Mile Creek.
- Surface water flow meters at surface water stations SW1, and SW6 collected flow data intermittently for the 2015 monitoring period. The Levellogger at SW3 collected creek stage data successfully for the entire monitoring period.
- Temperatures measured within the channel at SW1 on the Rice Road Tributary, and within the channel at SW6 on the Merrittville Highway reflected seasonal temperature fluctuations of surface water runoff during flow conditions and ambient temperatures when dry. Temperatures recorded at SW3 reflect shallow sub-surface temperatures beneath the streambed.
- Pre-construction water quality generally was degraded with respect to concentrations of total phosphorus, *E. coli* bacteria, chloride, TSS, and nitrate in each of the watercourses.
- Post-construction surface water quality results generally were consistent with the pre-construction results with the following exceptions:
 - At the Cataract Road Tributary:
 - There is an increasing trend in the concentrations of chloride and conductivity
 - Dissolved oxygen has decreased somewhat
 - Concentrations of *E. coli* have episodic peaks in summer greater than pre-development maxima.
 - Nitrates have decreased (improved)
 - Temperature (relative to ambient air temperature) has decreased somewhat (improved)
 - At the Rice Road Tributary:
 - Chloride and conductivity increased markedly post construction but has decreased since 2014; 2016 concentrations were within pre-construction range
 - Concentrations of un-ionized ammonia at the three sampling locations generally exceeded the pre-construction maxima; an increasing trend since 2014 is observed.
 - Concentrations of *E. coli* have episodic peaks in summer greater than pre-development maxima.
 - At the Merrittville Highway Tributary:
 - There is an increasing trend in the concentrations of chloride and conductivity

- Concentrations of *E. coli* have episodic peaks in summer greater than pre-development maxima.
- Increased conductivity and chloride concentrations relative to pre-construction ranges are generally attributed to an increased total mass of road salt used at the newly-widened roadway. Increased *E. coli* and un-ionized ammonia concentrations relative to pre-construction ranges are attributed to summer seasonal effects (i.e., low water levels and less flow having a concentrating effect).
- Annual erosion surveys of the Rice Road Tributary were conducted annually in April from 2007 to April 2016. Analysis of the annual change in survey points indicated that annual erosion and accretion at any one point is generally less than 0.5 m.

Based on the findings of the monitoring program, the following recommendations are provided for consideration:

- Post-development monitoring at RR20 may be discontinued.
- A road salt management plan should be established to reduce the road salt entering the streams to pre-development (i.e., pre-2010) concentrations.
- Water quality in the discharge from the storm water management pond at the intersection of RR 20 and Rice Road should include sampling for un-ionized ammonia; this should be addressed in the environmental compliance approval (ECA) for the pond.
- Future considerations:
 - Future monitoring programs designed to monitor the effects of development should consider increased pre-development monitoring to grow the base-line database over a greater range of climatic conditions to improve the comparison of development and post-development conditions. Post-development monitoring, could then be reduced.
 - In development areas where there are significant natural features, the features should have some level of continuous monitoring, rather than project-specific monitoring.

6 REFERENCES

- Chapman, L.J. and D.F. Putnam. 1984. The Physiography of Southern Ontario; Ontario Geological Survey, Special Volume 2, 270 p. Accompanied by Map P.2715 (coloured), scale 1:600 000.
- Feenstra, B.H. 1981. Quaternary Geology and Industrial Minerals of the Niagara-Welland Area, Southern Ontario. Ontario Geological Survey, OFR 5361, 260 p.
- Feenstra, B.H. 1981: Bedrock Topography of the Niagara and Niagara-on-the-Lake Area, Southern Ontario; Ontario Geological Survey Preliminary Map P.2400, Bedrock Topography Series. Scale 1:50 000
- Feenstra, B.H. 1984. Quaternary Geology of the Niagara-Welland Area, Southern Ontario. Ontario Geological Survey, Map 2496, Quaternary Geology Series, Scale 1:50 000.
- Fenco MacLaren Inc. 1995. Port Colborne/Fort Erie Waste Management Master Plan, Summary of EPA Activities – Geology/Hydrogeology.
- Telford, P.G., B.A. Liberty, and B.H. Feenstra. 1976. Palaeozoic Geology of the Niagara Area, Southern Ontario. Ontario Division of Mines, Map 2344.
- Waterloo Hydrogeologic Inc. 2005. Niagara Peninsula Conservation Authority Groundwater Study Final Report.
- Vos, M.A. 1969. Drift Thickness of Southern Ontario, Niagara Sheet. Ontario Geological Survey, Preliminary Map No. P.537, Drift Thickness Series, scale 1:50 000.
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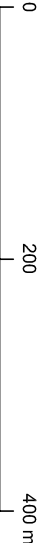
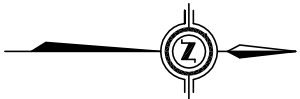
LEGEND

SW7 ▲ SURFACE WATER SAMPLING STATION AND DESIGNATION

SW1 ▲ SURFACE WATER SAMPLING AND CONTINUOUS FLOW MONITORING STATION

[] EROSION SURVEY AREA

[Hatched Box] REDEVELOPMENT AREA

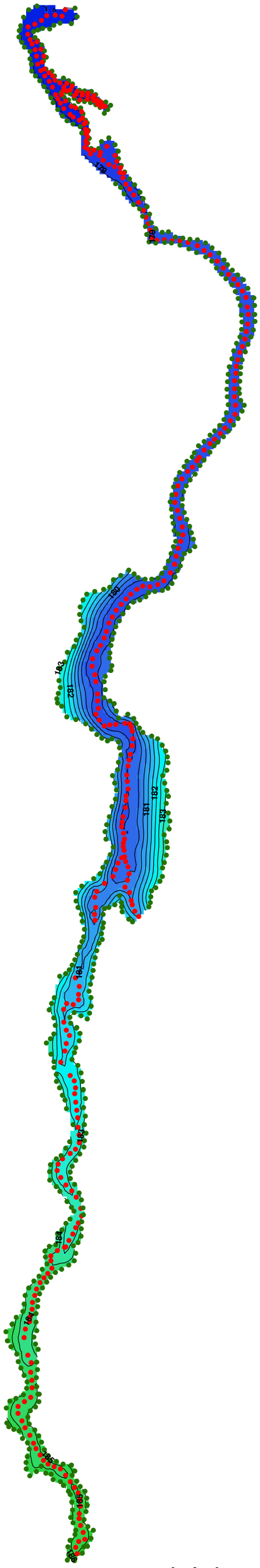


SOURCE: Aerial photograph taken from the Your Niagara, Public Navigator, Niagara Region, 2009.

SITE PLAN

Surface Water and Erosion
Monitoring Report
Regional Road 20 Redevelopment
Regional Municipality of Niagara

DATE: DECEMBER 2018	SCALE: 1:6000
PROJECT: 111-S3018-00	REF. NO.: 111-S3018-00 F1-SP
wsp	
FIGURE 1	



LEGEND

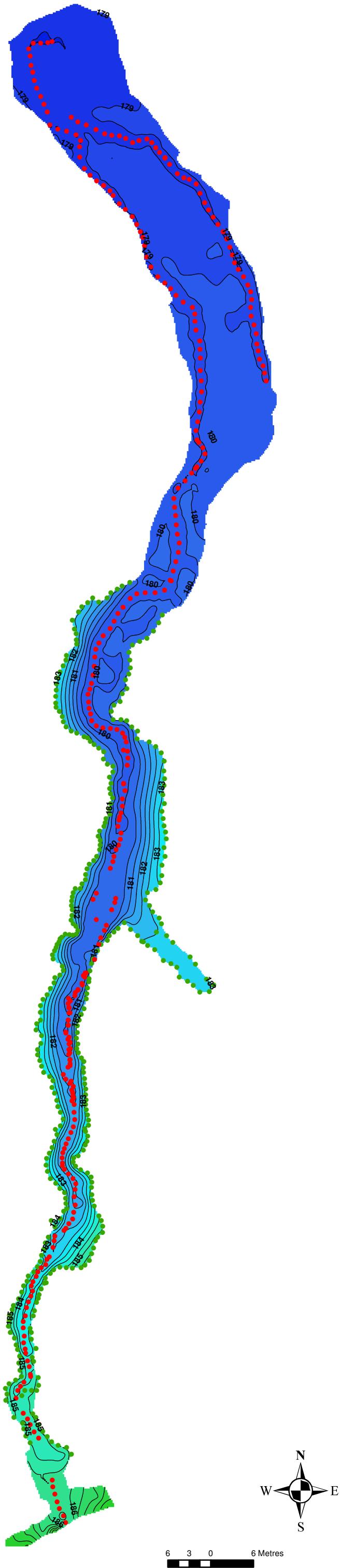
- CENTRE LINE WITH SURVEY POINTS (2007)
- TOP OF BANK WITH SURVEY POINTS (2007)
- ELEVATION CONTOURS (METRES)

ELEVATION COLOUR SCALE

	186 - 186.5
	185.5 - 186
	185 - 185.5
	184.5 - 185
	184 - 184.5
	183.5 - 184
	183 - 183.5
	182.5 - 183
	182 - 182.5
	181.5 - 182
	181 - 181.5
	180.5 - 181
	180 - 180.5
	179.5 - 180
	179 - 179.5
	178.5 - 179
	178 - 178.5



RICE ROAD TRIBUTARY EROSION SURVEY 2007		
SURFACE WATER AND EROSION 2016 MONITORING REPORT REGIONAL ROAD 20 REDEVELOPMENT REGIONAL MUNICIPALITY OF NIAGARA		
DATE: JUNE 2017	SCALE: 1:550	
PROJECT: 111-53018-00 100	FILE. NO.:111-53018-00 100 F2	
		FIGURE 2



LEGEND

•

CENTRE LINE WITH SURVEY POINTS (2016)

•

TOP OF BANK WITH SURVEY POINTS (2016)

—

ELEVATION CONTOURS (METRES)

ELEVATION COLOUR SCALE

188.5 - 189

188 - 188.5

187.5 - 188

187 - 187.5

186.5 - 187

186 - 186.5

185.5 - 186

185 - 185.5

184.5 - 185

184 - 184.5

183.5 - 184

183 - 183.5

182.5 - 183

182 - 182.5

181.5 - 182

181 - 181.5

180.5 - 181

180 - 180.5

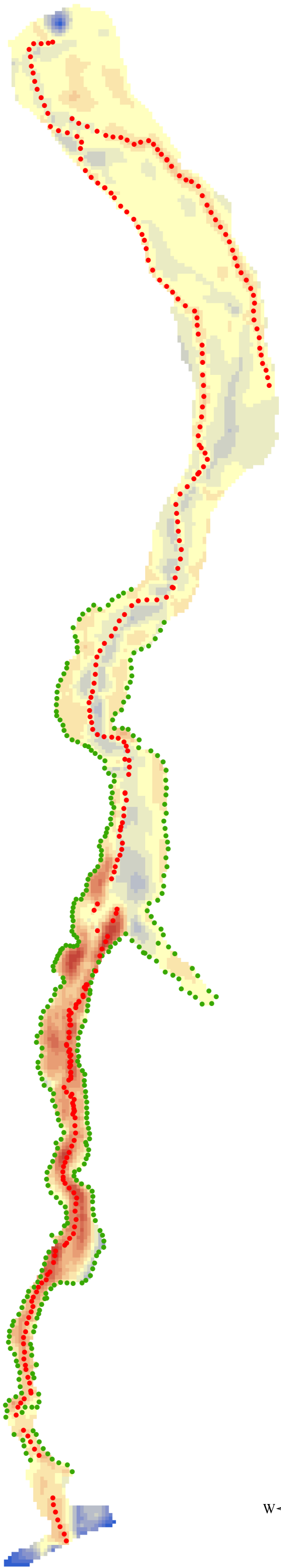
179.5 - 180

179 - 179.5

178.5 - 179

178 - 178.5

RICE ROAD TRIBUTARY EROSION SURVEY 2016		
SURFACE WATER AND EROSION 2016 MONITORING REPORT REGIONAL ROAD 20 REDEVELOPMENT REGIONAL MUNICIPALITY OF NIAGARA		
DATE: JUNE 2017	SCALE: 1:550	
PROJECT: 111-53018-00 100	FILE. NO.:111-53018-00 100 F3	
		FIGURE 3



LEGEND

- CENTRE LINE WITH SURVEY POINTS (2016)
- TOP OF BANK WITH SURVEY POINTS (2016)

EROSION/ACCRETION COLOUR SCALE

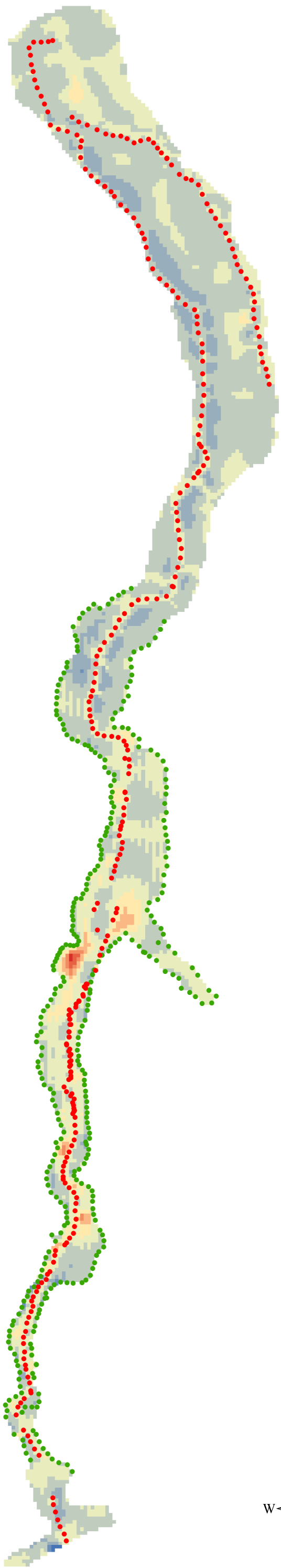
2 to 2.25
1.75 to 2
1.5 to 1.75
1.25 to 1.5
1 to 1.25
0.75 to 1
0.5 to 0.75
0.25 to 0.5
0 to 0.25
-0.25 to 0
-0.5 to -0.25
-0.75 to -0.5
-1 to -0.75
-1.25 to -1
-1.5 to -1.25
-1.75 to -1.5
-1.75 to -2

NEGATIVE NUMBERS REPRESENT
EROSION, POSITIVE NUMBERS
REPRESENT ACCRETION.

**RICE ROAD TRIBUTARY EROSION SURVEY
2016 MINUS 2007**

SURFACE WATER AND EROSION
2016 MONITORING REPORT
REGIONAL ROAD 20 REDEVELOPMENT
REGIONAL MUNICIPALITY OF NIAGARA

DATE: JUNE 2017	SCALE: 1:550
PROJECT: 111-53018-00 100	FILE. NO.:111-53018-00 100 F4



LEGEND

- CENTRE LINE WITH SURVEY POINTS (2016)
- TOP OF BANK WITH SURVEY POINTS (2016)

EROSION/ACCRETION COLOUR SCALE

0.75 to 1
0.5 to 0.75
0.25 to 0.5
0 to 0.25
-0.25 to 0
-0.5 to -0.25
-0.75 to -0.5
-1 to -0.75
-1.25 to -1
-1.5 to -1.25

NEGATIVE NUMBERS REPRESENT
EROSION, POSITIVE NUMBERS
REPRESENT ACCRETION.



6 3 0 6 Metres

RICE ROAD TRIBUTARY EROSION SURVEY 2016 MINUS 2015		
SURFACE WATER AND EROSION 2016 MONITORING REPORT REGIONAL ROAD 20 REDEVELOPMENT REGIONAL MUNICIPALITY OF NIAGARA		
DATE: JUNE 2017	SCALE: 1:550	
PROJECT: 111-53018-00 100	FILE. NO.:111-53018-00 100 F5	
		FIGURE 5

APPENDIX

A TERMS OF REFERENCE



9 August 2007

One St. Paul Street, Suite 601
St. Catharines, Ontario, L2R 7L2
Telephone 905-687-1771
Facsimile 905-687-1773
Toll Free 1-800-668-2598

David MacLeod, C.E.T.
Project Manager
Public Works Department -Transportation Division
Regional Municipality Niagara
2201 St. David's Road
P.O. Box 1042
Thorold, Ontario,
Canada
L2V 4T7

Dear Mr. MacLeod:

Re: Surface Water Work Program (Revised 9 August 2007)
Regional Municipality of Niagara
Regional Road 20 (Station Street to Highway 406) Redevelopment
File 1070359.00

The work program has been revised based on discussion with Mr. Steve Miller at Niagara Peninsula Conservation Authority on 9 August 2007 regarding clarification of erosion monitoring and surface water sampling locations.

1.0 PROJECT UNDERSTANDING

It is understood that Regional Road 20 will be redeveloped between Station Street and Highway 406 in Pelham and Thorold.

2.0 SCOPE OF WORK

This work program addresses the need for hydrologic monitoring with respect to storm water discharge to Twelve Mile Creek tributaries.

The Niagara Peninsula Conservation Authority (NPCA) staff have indicated that the monitoring requirements for this site will be the same as for the Chestnut Ridge Development, located on Regional Road 20, on the west side of Fonthill. NPCA's recent evaluation of the long-term monitoring program for the Chestnut Ridge Phase I site indicated that the monitoring undertaken was adequate. The program proposed here is based upon that program.

The Sub-watershed and Environmental Impact Statement prepared for Pelham Area 1 (TSH, 2003) outlined monitoring requirements to provide for the evaluation of conditions for pre-, during and



post-development periods. This letter is intended to outline the details for monitoring including location, frequency and timing.

The monitoring requirements are divided into three types:

- Water Quality
- Surface Water Flow
- Erosion

3.0 SURFACE WATER MONITORING PROGRAM

3.1 SURFACE WATER QUALITY MONITORING

Monitoring Stations

1. Regional Road 20, at Rice Road, south side of culvert
2. Regional Road 20, at Rice Road, north side of culvert
3. Rice Road Tributary to Twelve Mile Creek, approximately 30m downstream of Regional Road 20, within the natural channel
4. Regional Road 20, at Cataract Road, culvert outfall
5. Cataract Road tributary, approximately 30m downstream of Cataract Road, within the natural channel
6. Regional Road 20, at Merrittville Highway, culvert outfall
7. Regional Road 20, at Merrittville Highway, approximately 30m downstream of Regional Road 20

Frequency of Sampling

Annual Monitoring (spot sampling):

It is proposed that sampling be carried out annually and flow conditions noted for the sites chosen for the following:

- Spring runoff with melting snow. Obtain samples at all sites.
- Two dry period samples – samples are to be taken at all three sites. Because of a potential for lack of base flow, at least one sample should be taken in early spring.
- Two storm events, preferably thunderstorms or after significant rain in a frontal storm. Take samples at all three sites or record of lack of flow if no sample possible.

Flow should be measured whenever sample is taken at each site.

Parameters to Sample

General water quality parameters to include:

- Total suspended solids
- Total phosphorus
- Total Kjeldahl nitrogen, ammonia nitrogen, nitrite plus nitrate nitrogen
- BOD5
- Chloride
- E.coli.



- Temperature, pH, conductivity, DO (field parameters)

3.2 FLOW MONITORING (INCLUDING TEMPERATURE)

Monitoring Locations:

- Regional Road 20, at Rice Road, south side of culvert
- Rice Road Tributary to Twelve Mile Creek, approximately 30m downstream of Regional Road 20, within the natural channel
- Regional Road 20, culvert at Cataract Road
- Regional Road 20, culvert at Merrittville Highway

Frequency, Parameters

First year – continuous gauge at all locations (10 min interval) on a seasonal basis (including temperature probe). Duration - March to November (weather, specifically temperature, permitting).

Second year – Modify to reduce dry period monitoring, if encountered.

4.0 EROSION MONITORING PROGRAM

4.1 MONITORING SECTIONS

- Twelve Mile Creek, Rice Road tributary north from Regional Road 20 for approximately 150m downstream to the former railway.

4.2 EROSION SURVEY PARAMETERS

Annual Monitoring:

- Survey on cross-section at minimum 1m intervals, obtaining, as well, any break in grade including lowest point, edge of creek and top of bank.
- Profile at 1m intervals of lowest point (drainage/stream invert) for the reach length.
- Survey to be tied into UTM NAD83.
- Total station equipment to be used.

5.0 REPORTING

The results of the surface water monitoring program and the erosion monitoring program will be summarised in an annual report.



Pre-Construction

The intent of the Year 1 Tasks and Report is to provide baseline data with respect to existing surface water flows, surface water quality and erosion within the receiving watercourse prior to construction at the site. A full year of monitoring shall be completed prior to the initiation of construction. This information will be compared to post-development data in order to determine if the proposed stormwater management strategy is functioning as designed.

Monitoring During Construction

NPCA will require monthly sediment control inspection reports, circulated to NPCA and the Town of Pelham for review. The sediment control inspection reports will include:

- A description and photograph of all physical sediment control measures
- Commentary on the condition of all sediment control measures, including after all major storm events, including photographs.
- Commentary on all deficient controls, and the specified repair or replacement.
- Proposed measures to avoid the long-term exposure of soil.

Sediment control monitoring and reporting will be undertaken by on-site construction personnel. Therefore, costs for sediment control monitoring during construction have not been included in the estimate.

Post-Development Monitoring

Prior to construction, a post-development monitoring plan will be submitted to NPCA for review and approval. The long-term monitoring reports will be compiled and circulated to the NPCA for review and approval. A final post-construction monitoring report will be prepared after the completion of five full years of monitoring. This report will also be circulated to the NPCA for approval.

A 'draft' report will be made available to the client for comment, prior to submission to the regulatory agencies. Two copies of final annual reports will be provided to Regional Niagara.

6.0 PROJECT COSTS

Estimated costs for Year 1 and subsequent years (Year 2 & 3 shown) are provided in the following tables. Costs assume that this work is undertaken in conjunction with monitoring program underway at Rice Road tributary. All costs are exclusive of GST.

Year 1 Tasks	Professional Fees	Disbursements	Laboratory and Contractor Fees	Totals
SW Monitoring Program	18700	12900	2700	34300
Erosion Monitoring Program	4300	100	6400	10800
TOTALS	23000	13000	9100	45100



One-time costs included in this estimate include set-up of the surface water flow stations and equipment purchases. The equipment, which will continue to be utilised throughout the long-term monitoring program includes: two American Sigma AV910 flowmeters at \$5685 each; and two Tidbit temperature loggers at \$150 each. Purchase of the equipment is the best option as rental fees for the monitoring equipment equals the purchase price after approximately 3 months.

A contingency cost of approximately \$27000 per year for pre-construction monitoring should be included in order to continue the pre-construction monitoring program to the actual time that construction commences at the site, should construction not begin immediately after the Year 1 program.

Year 2 & 3 Tasks	Professional Fees	Disbursements	Laboratory and Contractor Fees	Total
Surface Water Monitoring Program	14800	900	2700	18400
Erosion Monitoring Program	3400	200	4600	8200
TOTALS	18200	1100	7300	26600

Included in the cost estimates for subsequent years is an annual calibration of the flow meters by Can-Am Instruments in their laboratory.

The costs to attend meetings at the request of the client/regulatory agency are not included in this cost estimate and shall be billed as extra at standard rates.

We trust this information is sufficient for your current purposes. If you have any questions or require further information, please call.

Yours truly
JAGGER HIMS LIMITED

C.W. Bailey Walters, M.Sc., P.Geo.
Project Hydrogeologist



7.0 REFERENCES

Niagara Peninsula Conservation Authority. 2005. Regional Groundwater Study.

Totten Sims Hubicki. 2003. Sub-Watershed and Environmental Impact Statement prepared for Pelham Area 1.

APPENDIX

B

SURFACE WATER FLOW DATA

Data tables are not included in this report. Data tables can be provided upon request.

Figure B-1 - Cataract Road Tributary Flow Monitoring and Precipitation

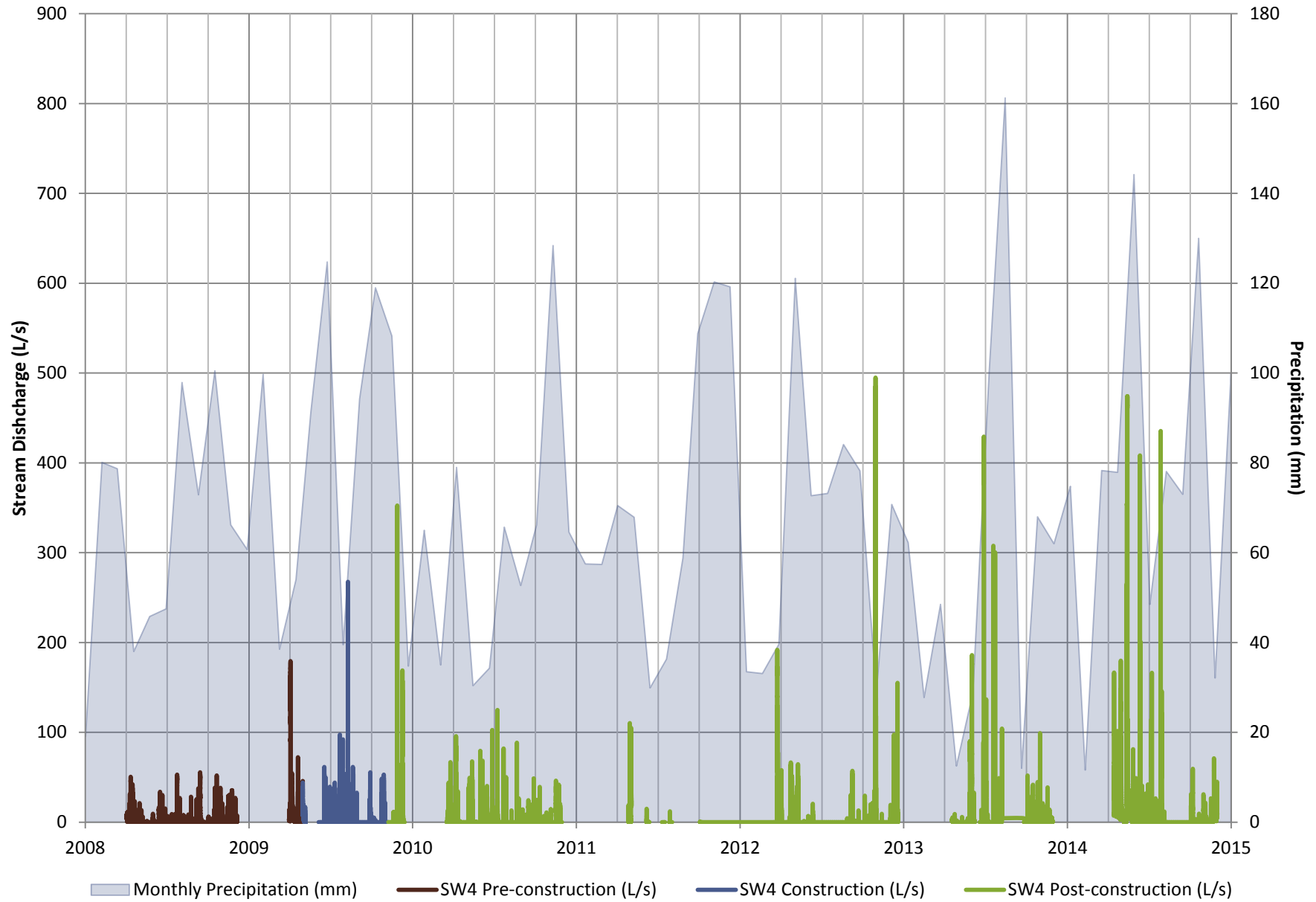


Figure B-2 - Rice Road Tributary Flow Monitoring and Precipitation

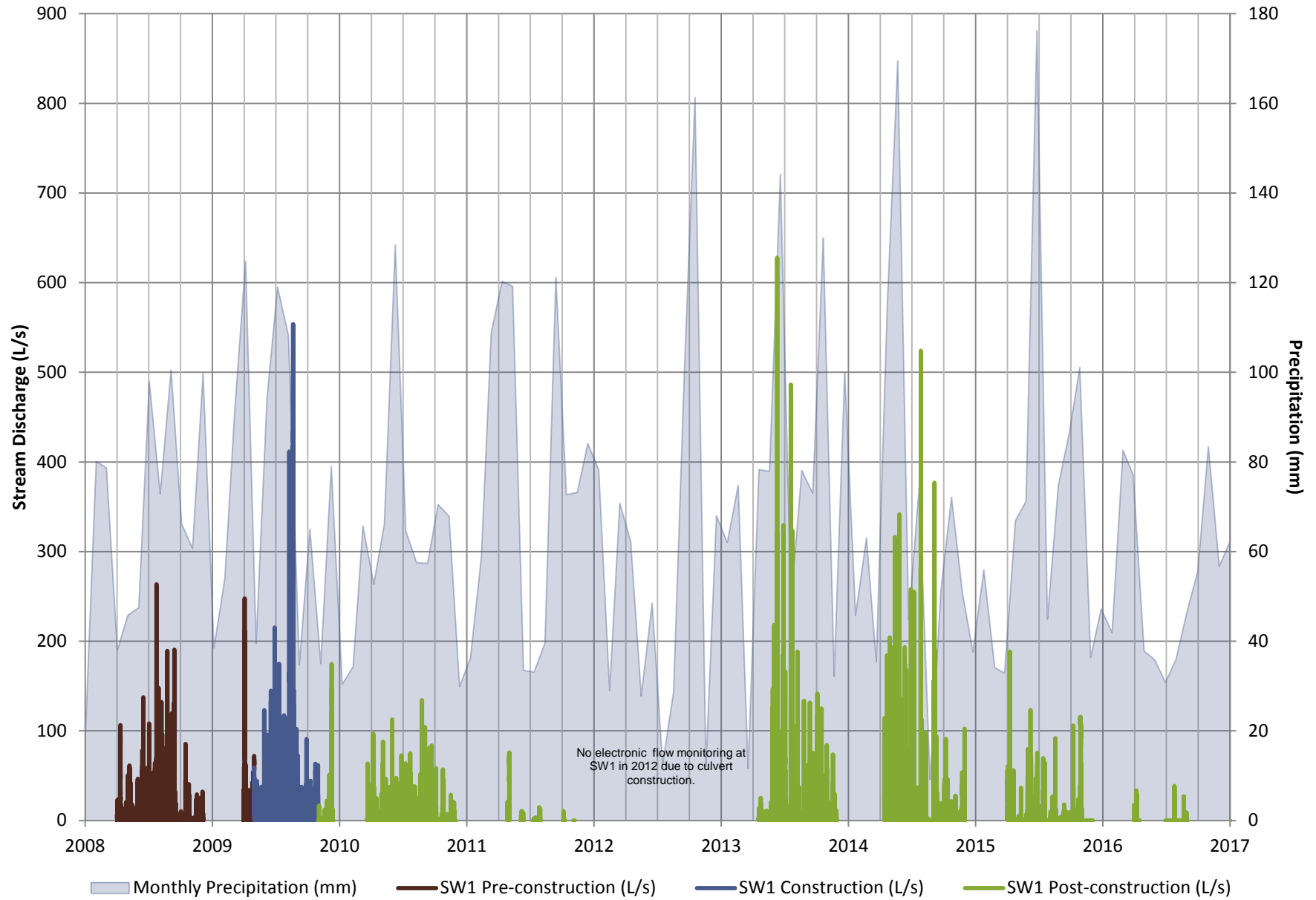


FIGURE B-3
SW1 AUTOMATED AND MANUAL FLOW MEASUREMENTS
REGIONAL ROAD 20 REDEVELOPMENT

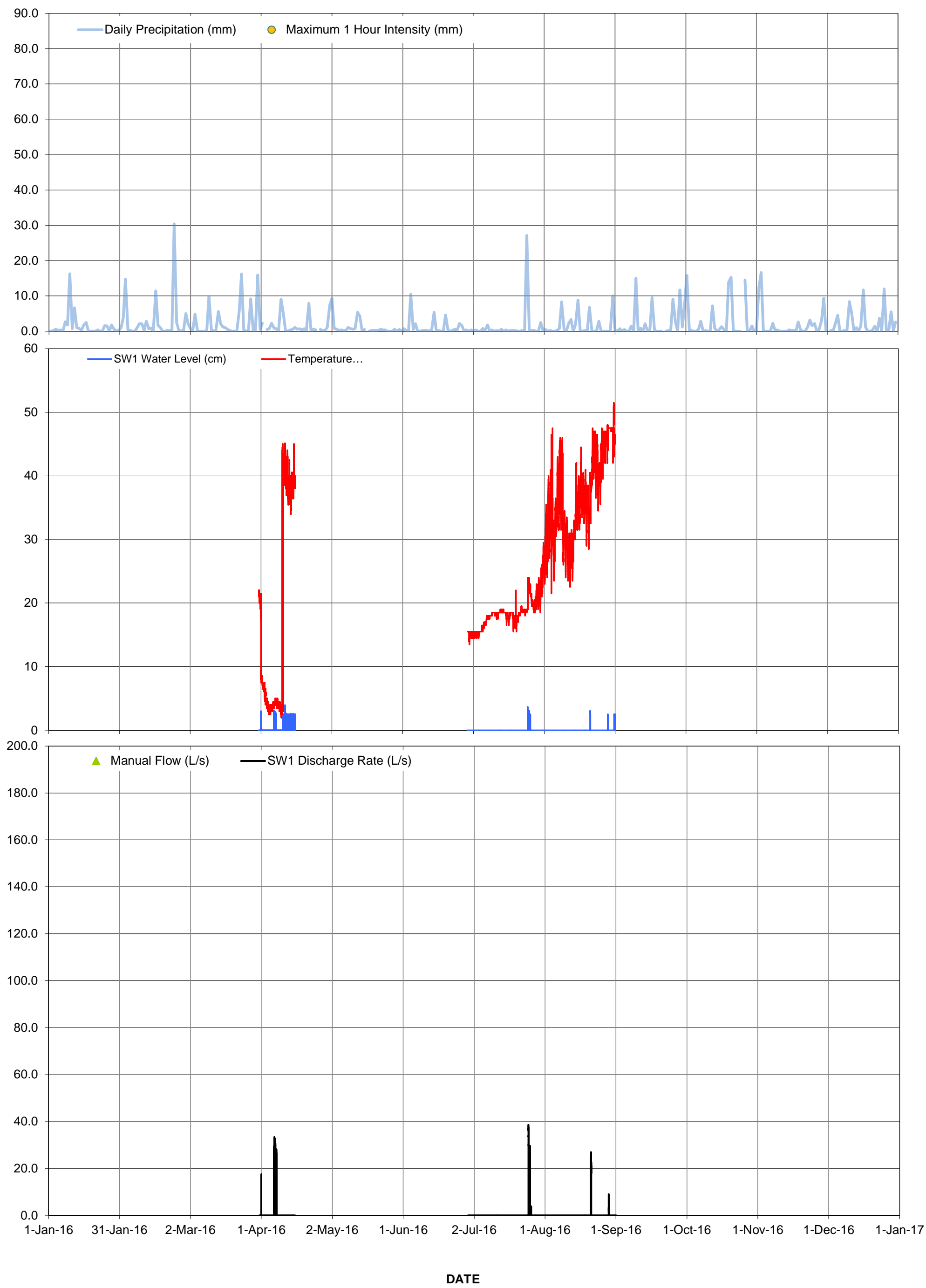


Figure B-4 - Rice Road Tributary Flow Monitoring and Precipitation

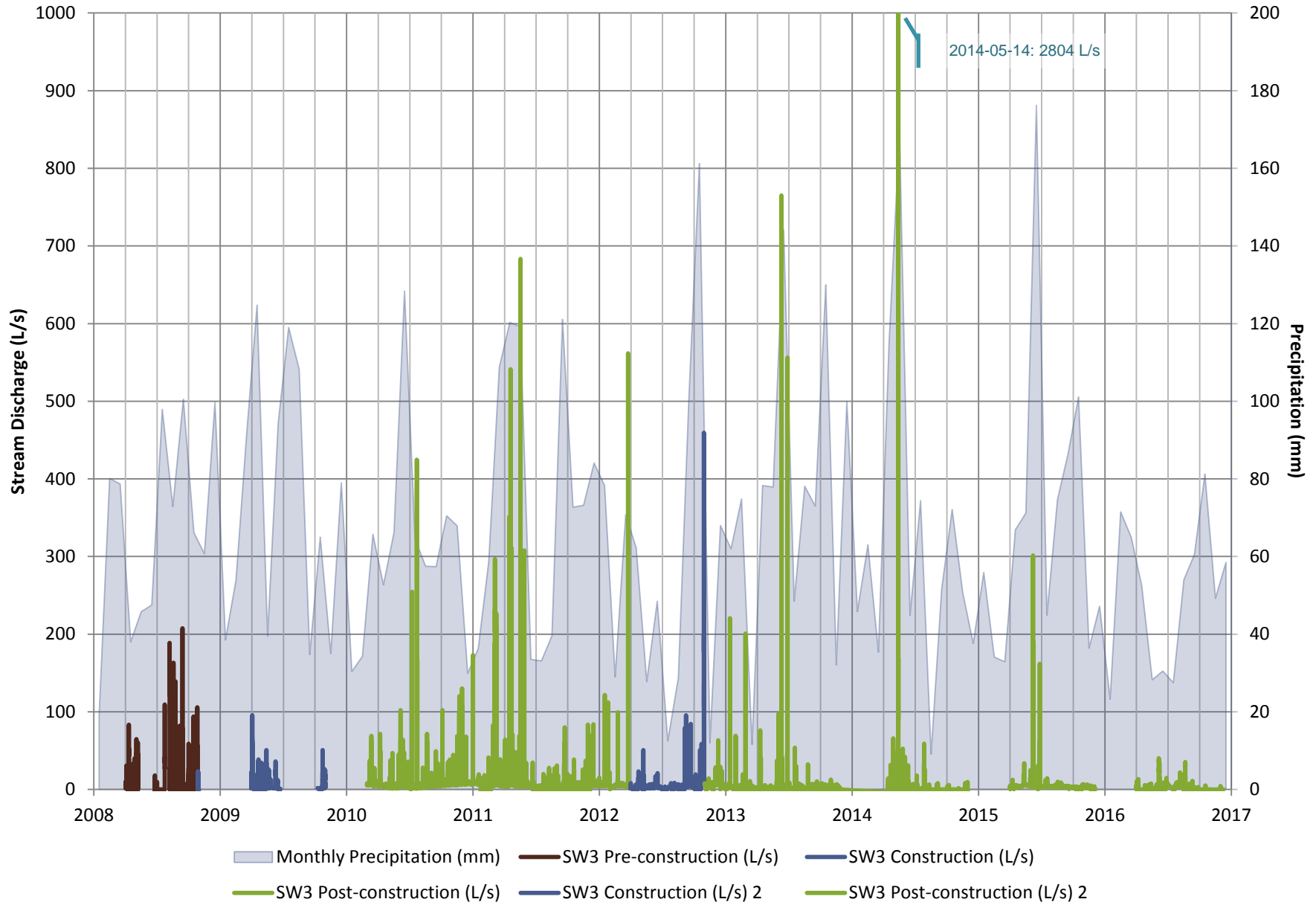


FIGURE B-5
SW3 AUTOMATED AND MANUAL FLOW MEASUREMENTS
REGIONAL ROAD 20 REDEVELOPMENT

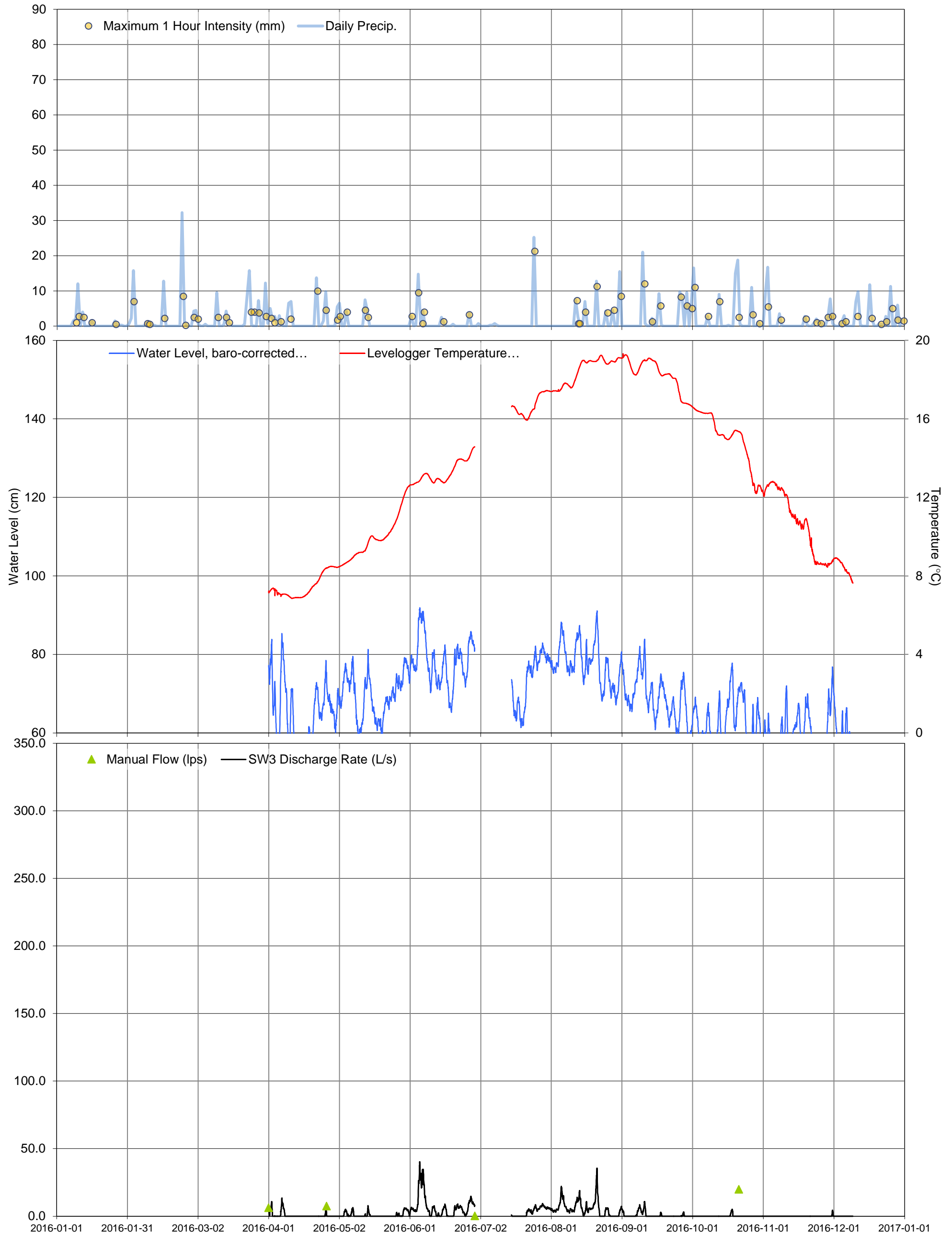
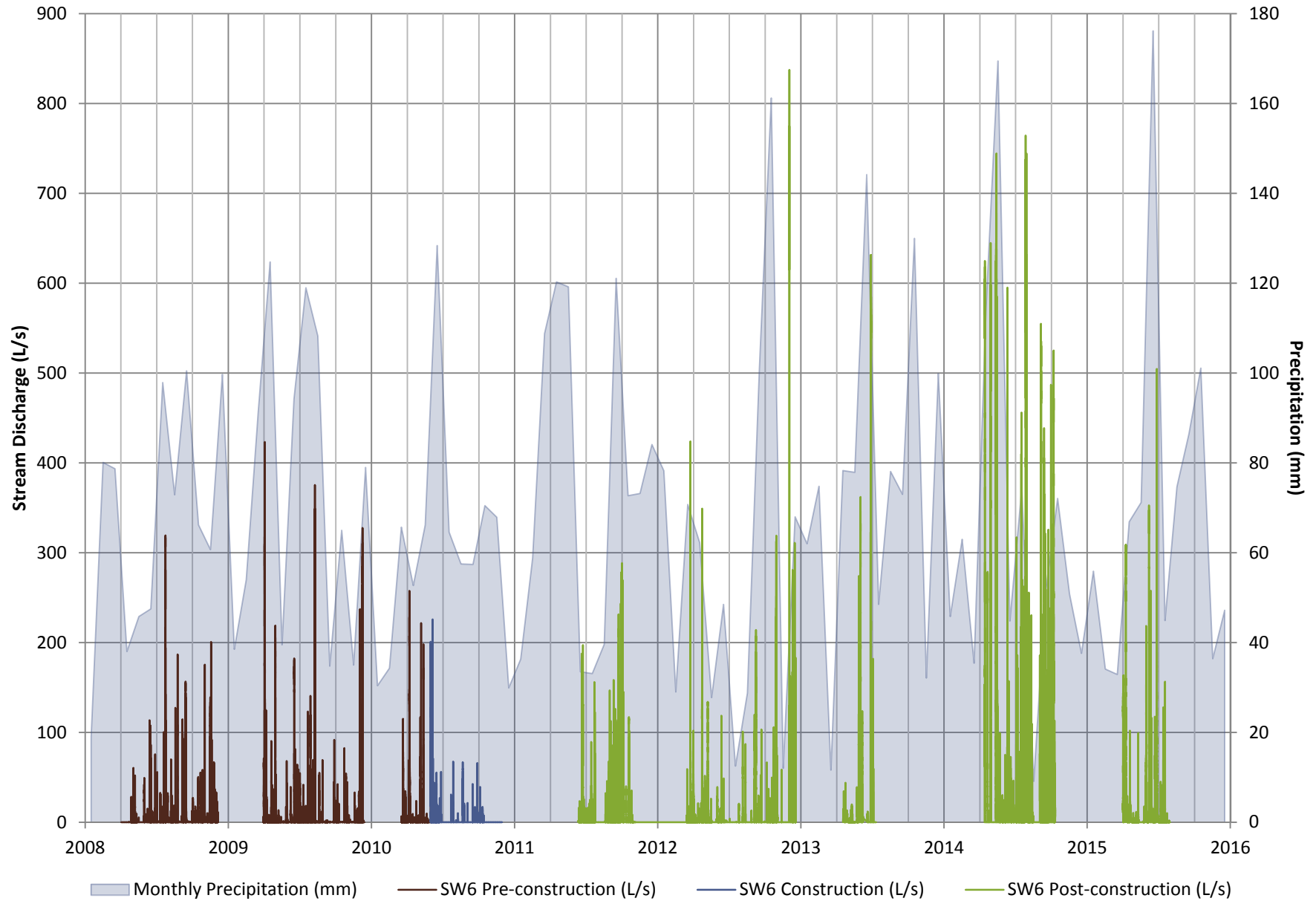


Figure B-6 - Merrittville Highway Tributary Flow Monitoring and Precipitation



APPENDIX

C SURFACE WATER QUALITY DATA



Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1
		Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.
		2007-10-19	2007-12-05	2008-03-27	2008-08-06	2008-10-31	2008-12-16	2008-12-16	2009-02-13	2009-04-06	2009-06-18
		Event Type	Wet	Dry	Freshet	Wet	Dry	Wet	DUP	Dry	Freshet
Event Phase		Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Construction
Field Analyses											
Air Temperature (K)		292.2	265.3	275.1	295.2	283.0	266.8	266.8	271.0	274.4	287.8
pH (unitless)	6.5 - 8.5	7.5	8.5	6.8	7.7	7.3	8.0	8.0	7.3	7.3	8.0
Conductivity (µS/cm)		920	2450	138	887	1166	1194	1194	1881	333	1934
Dissolved Oxygen (Cold Water Biota)	>5 to >8	12.5	16.7	14.4	5.5	8.5	13.0	13.0	12.1	11.6	7.0
Temperature (°C)		19.3	6.1	3.4	24.2	14.7	2.4	2.4	3.1	6.3	16.4
Temperature-based DO objective*	calculated	5.4	6.9	7.2	4.9	5.8	7.4	7.4	7.3	6.9	5.7
Appearance		slightly cloudy	clear	yellow-brown	clear	clear	yellow-brown	yellow-brown	clear	slightly cloudy	clear
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.7	7.7	7.7	7.9	8.0	8.0	8.0	7.9	7.9	7.8
Total Kjeldahl Nitrogen (TKN)		0.36	0.33	0.52	0.35	0.12	0.21	0.17	0.34	1.01	0.38
Total Ammonia (as N)		<0.02	<0.02	0.11	0.06	0.02	0.03	0.04	0.05	0.14	0.15
Un-ionized Ammonia (as N)	0.02	<0.0003	<0.001	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.004
Total Ammonia (as N, for calculations)		0.0100	0.01	0.11	0.06	0.02	0.03	0.04	0.05	0.14	0.15
Nitrate (as N)		<0.10	1.13	0.28	<0.10	0.26	0.79	0.78	1.27	0.30	2.35
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate		-	-	-	-	-	-	-	-	-	-
E.coli (5TMPN/100ml)	100	560		234	470	1650	82	63	4	180	740
Total BOD ₅		1	<1	3	2	1	<1	1	<1	3	1
Chloride		57	330	16	77	139	180	183	480	32	261
Total Phosphorus	0.03	0.07	<0.01	0.63	0.05	0.15	0.30	0.33	0.05	0.32	0.05
Total Suspended Solids		4	2	91	18	239	24	46	3	39	6

Notes:

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· PWQO - Provincial Water Quality Objectives (1999)

· Shading indicates parameters exceed PWQO

* - Twelve Mile Creek - Cold Water Biota Criteria relative to temperature ($y = 7.7259e^{-0.019x}$)

** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1
		Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.
		2009-09-10	2009-12-01	2010-03-09	2010-06-16	2010-09-03	2010-10-05	2011-03-29	2011-06-06	2011-06-24	2011-09-30
		Dry	Wet	Freshet	Wet	Dry	Wet	Dry	Freshet	Wet	Dry
Event Type		Construction	Construction	Construction	Construction	Construction	Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Event Phase											
Field Analyses											
Air Temperature (K)		291.6	278.1	277.1	293.0	294.8	282.2	271.4	292.2	292.4	286.2
pH (unitless)	6.5 - 8.5	8.5	8.8	7.4	8.0	8.9	7.6	8.9	8.0	7.9	8.0
Conductivity (µS/cm)		499	1133	178	860	800	414	1300	1500	1017	595
Dissolved Oxygen (Cold Water Biota)	>5 to >8	9.2	23.2		13.1	17.1	9.5	7.8	12.7	6.4	7.1
Temperature (°C)		23.9	9.1	2.7	25.8	27.6	14.3	7.6	22.6	18.7	16.2
Temperature-based DO objective*	calculated	4.9	6.5	7.3	4.7	4.6	5.9	6.7	5.0	5.4	5.7
Appearance		clear to cloudy	clear and colourless	clear yellowish	clear	Clear	light yellow	Clear yellowish	clear	clear	cloudy
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	8.1	8.5	7.5	8.1	8.4	7.8	8.2	8.2	7.8	7.0
Total Kjeldahl Nitrogen (TKN)		0.52	<0.10	0.61	0.57	1.77	0.38	0.32	0.21	0.59	0.48
Total Ammonia (as N)		0.02	<0.02	0.05	<0.02	<0.02	0.06	<0.02	<0.02	0.03	0.05
Un-ionized Ammonia (as N)	0.02	0.003	<0.002	0.000	<0.001	<0.007	0.001	0.002	0.001	0.001	0.001
Total Ammonia (as N, for calculations)		0.02	0.01	0.05	0.01	0.01	0.06	0.01	0.01	0.03	0.05
Nitrate (as N)		<0.10	0.33	0.22	0.24	<0.10	0.20	0.73	0.27	0.45	0.44
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate		-	-	-	-	-	-	-	-	-	-
E.coli (5TMPN/100ml)	100	24	1	10	140	180	12300	5	700	340	730
Total BOD ₅		<1	<1	3	2	11	1	<1	2	2	4
Chloride		56	138	25	172	128	58	221	301	177	86
Total Phosphorus	0.03	0.19	0.03	0.32	0.05	0.39	0.09	0.07	0.06	0.03	0.15
Total Suspended Solids		23	11	152	15	281	28	15	158	11	79

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** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1
		Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.
		2011-11-29	2012-03-15	2012-04-25	2012-07-27	2012-10-10	2012-12-05	2013-03-27	2013-05-02	2013-06-13	2013-10-10
		Wet	Dry	Freshet	Wet	Dry	Wet	Freshet	Dry	Wet	Dry
Event Type		Post-Construction	Post-Construction	Construction	Construction	Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Event Phase											
Field Analyses											
Air Temperature (K)		279.4	285.5	279.5	296.3	282.1	274.0	276.6	289.6	289.7	285.7
pH (unitless)	6.5 - 8.5	8.2	7.9	8.1	7.6	8.1	7.8	8.2	8.2	7.5	7.3
Conductivity (µS/cm)		171	1490	1147	1418	740	1538	1715	2060	452	1630
Dissolved Oxygen (Cold Water Biota)	>5 to >8	11.1	2.5	9.1	4.6	7.2	8.2	12.3	11.0	11.7	8.5
Temperature (°C)		7.1	5.9	14.1	23.7	12.9	6.3	7.0	11.0	17.0	13.9
Temperature-based DO objective*	calculated	6.8	6.9	5.9	4.9	6.0	6.9	6.8	6.3	5.6	5.9
Appearance		brownish	slightly cloudy	cloudy	slightly yellow	cloudy brown	Clear	Clear	Clear	Cloudy Brown	Clear
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.6	8.0	8.0	7.6	7.3	7.8	8.2	8.2	7.7	8.1
Total Kjeldahl Nitrogen (TKN)		1.12	0.29	1.02	0.8	0.98	0.58	0.18	0.21	1.9	0.28
Total Ammonia (as N)		0.05	<0.02	<0.02	0.07	0.23	<0.02	<0.02	0.04	0.59	<0.02
Un-ionized Ammonia (as N)	0.02	0.001	0.000	0.001	0.001	0.006	0.000	0.000	0.001	0.006	0.000
Total Ammonia (as N, for calculations)		0.05	0.01	0.01	0.07	0.23	0.01	0.01	0.04	0.59	0.01
Nitrate (as N)		0.28	0.20	0.64	0.46	0.66	0.68	0.81	1.26	17.00	1.10
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate		-	-	-	-	-	-				
E.coli (5TMPN/100ml)	100	217	54	90	92	690	50	910	0	1090	73
Total BOD ₅		4	2	3	4	5	5	1	<1	2	<1
Chloride		9	308	177	129	51	235	342	364	21	252
Total Phosphorus	0.03	0.32	0.04	0.17	0.11	0.27	0.07	<0.01	0.01	0.65	0.03
Total Suspended Solids		88	11	68	77	51	39	3	4	65	12

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** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter	Event Type Event Phase	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1
		Rice Rd. 2013-12-10	Rice Rd. 2014-03-18	Rice Rd. 2014-04-25	Rice Rd. 2014-06-04	Rice Rd. 2014-09-24	Rice Rd. 2014-12-01	Rice Rd. 2015-03-12	Rice Rd. 2015-05-13	Rice Rd. 2015-06-09	Rice Rd. 2015-09-30
		Wet	Freshet	Dry	Wet	Dry	Wet	Freshet	Dry	Wet	Dry
		Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Field Analyses											
Air Temperature (K)		267.9	273.0	283.1	288.5	288.7	273.9	272.2	273.2	289.7	285.9
pH (unitless)	6.5 - 8.5	7.7	7.6	8.3	7.4	7.6	7.7	7.4	7.7	8.4	7.7
Conductivity (µS/cm)		3340	4540	2860	2080	1571	2740	3120	1631	1626	376
Dissolved Oxygen (Cold Water Biota)	>5 to >8	7.8	11.8	11.0	9.7	9.3	8.6	11.0	10.4	8.2	3.4
Temperature (°C)		4.3	3.1	8.5	16.7	15.0	2.1	0.4	11.9	17.8	16.2
Temperature-based DO objective*	calculated	7.1	7.3	6.6	5.6	5.8	7.4	7.7	6.2	5.5	5.7
Appearance		Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Cloudy brown	Clear
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.9	7.7	8.1	7.9	7.7	7.8	7.5	7.6	7.7	8.1
Total Kjeldahl Nitrogen (TKN)		0.71	0.33	0.29	0.41	0.31	0.44	3.78	0.52	1.57	0.24
Total Ammonia (as N)		0.08	0.11	0.06	0.05	0.12	0.05	1.29	0.1	0.03	<0.02
Un-ionized Ammonia (as N)	0.02	0.000	0.001	0.002	0.000	0.001	0.000	0.003	0.001	0.002	0.000
Total Ammonia (as N, for calculations)		0.08	0.11	0.06	0.05	0.12	0.05	1.29	0.1	0.03	0.01
Nitrate (as N)		1.29	1.44	1.63	0.96	<0.10	0.56	1.50	0.50	0.26	0.17
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<1	<0.5	<0.05	<0.05
Dissolved Nitrite + Nitrate											
E.coli (5TMPN/100ml)	100	61	10	0	74	92	230	400	1100	10800	58
Total BOD ₅		3	1	<1	10	1	3	10	<5	<5	<5
Chloride		809	1260	639	398	205	715	1170	341	24	27
Total Phosphorus	0.03	0.01	0.07	0.03	0.07	0.02	0.12	0.78	0.05	0.55	0.04
Total Suspended Solids		8	17	4	4	3	36	20	<10	228	10

Notes:

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** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter	Event Type Event Phase	SW1	SW1	SW1	SW1	SW1	SW1
		Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.
		2015-10-29	2016-03-22	2016-04-26	2016-06-29	2016-09-01	2016-10-21
		Wet	Freshet	Wet	Dry	Dry	Wet
		Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Field Analyses							
Air Temperature (K)		283.0	275.5	273.2	292.1	291.5	282.2
pH (unitless)	6.5 - 8.5	7.9	8.8	8.3	8.3	7.6	8.2
Conductivity (µS/cm)		859	1929	1308	1530	1180	600
Dissolved Oxygen (Cold Water Biota)	>5 to >8	8.2	13.2	12.0	5.2	3.9	7.9
Temperature (°C)		11.9	6.7	8.0	23.8	24.4	16.0
Temperature-based DO objective*	calculated	6.2	6.8	6.6	4.9	4.9	5.7
Appearance		slightly cloudy	Cloudy	Light brown, cloudy	Clear, colourless	Light brown, cloudy	Slightly cloudy
LABORATORY ANALYSES							
pH (unitless)	6.5 - 8.5	7.3	8.1	8.0	7.7	8.2	7.7
Total Kjeldahl Nitrogen (TKN)		0.27	0.79	0.59	0.59	0.59	0.35
Total Ammonia (as N)		0.23	<0.02	0.11	0.13	<0.02	<0.02
Un-ionized Ammonia (as N)	0.02	0.004	0.002	0.004	0.012	0.000	0.001
Total Ammonia (as N, for calculations)		0.23	0.01	0.11	0.13	0.01	0.01
Nitrate (as N)		1.84	1.20	0.59	<0.25	<0.25	<0.05
Nitrite (as N)		<0.25	<0.5	<0.25	<0.25	<0.25	<0.05
Dissolved Nitrite + Nitrate							
<i>E.coli</i> (5TMPN/100ml)	100	84	0	90	16	400	186
Total BOD ₅		<5	6	<5	<5	<5	<5
Chloride		43	415	253	351	193	49
Total Phosphorus	0.03	0.05	0.02	0.08	0.06	0.06	0.05
Total Suspended Solids		103	14	60	36	34	15

Notes:

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** - *E.coli* results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter	Event Type Event Phase	SW2	SW2	SW2	SW2	SW2	SW2	SW2	SW2	SW2
		Rice Rd. 2007-10-19	Rice Rd. 2007-12-05	Rice Rd. 2008-03-27	Rice Rd. 2008-08-06	Rice Rd. 2008-10-31	Rice Rd. 2008-12-16	Rice Rd. 2009-02-13	Rice Rd. 2009-02-13	Rice Rd. 2009-04-06
		Wet	Dry	Freshet	Wet	Dry	Wet	Dry	DUP	Freshet
		Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction
Field Analyses										
Air Temperature (K)		292.2	265.3	275.1	295.2	283.0	266.8	271.0	271.0	274.4
pH (unitless)	6.5 - 8.5	7.9	8.5	6.9	8.0	7.1	8.0	7.4	7.4	7.3
Conductivity (µS/cm)		902	2800	214	1630	1795	1637	2297	2297	310
Dissolved Oxygen (Cold Water Biota)	>5 to >8	13.1	17.2	14.5	8.1	9.5	13.6			11.6
Temperature (°C)		18.2	4.9	4.1	21.7	12.7	2.9	3.2	3.2	6.3
Temperature-based DO objective*	calculated	5.5	7.0	7.1	5.1	6.1	7.3	7.3	7.3	6.9
Appearance		clear	clear	yellow-brown	clear	clear	clear	clear	clear	slightly cloudy brown
LABORATORY ANALYSES										
pH (unitless)	6.5 - 8.5	7.9	7.8	7.7	8.2	8.1	8.1	8.0	8.0	7.9
Total Kjeldahl Nitrogen (TKN)		0.52	0.2	0.58	0.16	<0.10	0.29	0.34	0.39	0.93
Total Ammonia (as N)		0.03	<0.02	0.11	0.03	<0.02	0.03	0.03	0.03	0.1
Un-ionized Ammonia (as N)	0.02	0.001	<0.001	0.000	0.001	<0.0001	0.000	0.000	0.000	0.000
Total Ammonia (as N, for calculations)		0.03	0.01	0.11	0.03	0.01	0.03	0.03	0.03	0.1
Nitrate (as N)		<0.10	1.28	0.34	0.25	0.87	1.45	1.59	1.59	0.34
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate										
<i>E.coli</i> (5TMPN/100ml)	100	4300		342	195	780	105	7	28	60
Total BOD ₅		2	<1	1	<1	<1	<1	<1	<1	3
Chloride		52	434	38	246	323	307	619	612	37
Total Phosphorus	0.03	0.11	<0.01	0.63	0.04	0.02	0.03	0.05	0.05	0.33
Total Suspended Solids		19	<2	111	<2	8	3	3	3	46
Notes:		1	2	3	4	5	6	7	8	9

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Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW2	SW2	SW2	SW2	SW2	SW2	SW2	SW2	SW2	SW2
		Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.
		2009-06-18	2009-09-10	2009-12-01	2010-03-09	2010-06-16	2010-09-03	2010-10-05	2011-03-29	2011-06-06	2011-06-24
		Event Type	Wet	Dry	Wet	Freshet	Wet	Dry	Wet	Dry	Freshet
Event Phase		Construction	Construction	Construction	Construction	Construction	Construction	Construction	Post-Construction	Post-Construction	Post-Construction
Field Analyses											
Air Temperature (K)		287.8	291.6	278.1	277.1	293.0	294.8	282.2	271.4	292.2	292.4
pH (unitless)	6.5 - 8.5	7.9	8.7	8.3	7.2	8.0	8.3	7.5	8.8	8.3	8.0
Conductivity (µS/cm)		1967	478	>4000	181	850	970	309	2140	1856	959
Dissolved Oxygen (Cold Water Biota)	>5 to >8	9.1	8.7	14.9	14.8	9.4	6.3	10.5	15.6	8.7	7.6
Temperature (°C)		16.7	22.1	10.1	3.0	23.4	23.2	14.2	5.7	17.7	18.4
Temperature-based DO objective*	calculated	5.6	5.1	6.4	7.3	5.0	5.0	5.9	6.9	5.5	5.4
Appearance		clear	clear	clear and colourless	clear yellowish	clear	clear	brown	clear	clear	cloudy
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.9	8.2	8.2	7.6	8.0	8.3	7.9	8.1	8.3	7.9
Total Kjeldahl Nitrogen (TKN)		0.36	0.53	0.31	0.54	0.57	<0.10	0.15	0.74	0.41	0.64
Total Ammonia (as N)		0.13	0.02	0.2	0.04	0.03	<0.02	0.06	<0.02	0.03	0.03
Un-ionized Ammonia (as N)	0.02	0.003	0.004	0.008	0.000	0.002	<0.002	0.001	0.000	0.002	0.001
Total Ammonia (as N, for calculations)		0.13	0.02	0.2	0.04	0.03	0.01	0.06	0.01	0.03	0.03
Nitrate (as N)		2.32	0.11	0.55	0.19	0.5	0.1	0.21	1.05	0.72	0.50
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate											
E.coli (5TMPN/100ml)	100	790	30	13	20	1720	80	11400	6	300	1120
Total BOD ₅		2	<1	<1	3	2	2	5	1	<1	2
Chloride		296	61	1670	29	212	183	34	403	430	205
Total Phosphorus	0.03	0.03	0.16	0.03	0.30	0.06	0.02	0.29	0.11	0.02	0.12
Total Suspended Solids		<2	14	6	158	13	18	268	80	<2	11
Notes:		10	11	12	13	14	15	16	17	18	19

· All parameters are mg/L unless otherwise indicated.

· PWQO - Provincial Water Quality Objectives (1999)

· Shading indicates parameters exceed PWQO

* - Twelve Mile Creek - Cold Water Biota Criteria relative to temperature ($y = 7.7259e^{-0.019x}$)

** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW2	SW2	SW2	SW2	SW2	SW2	SW2	SW2	SW2	SW2
		Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.
		2011-09-30	2011-11-29	2012-03-15	2012-04-25	2012-10-10	2012-12-05	2013-03-27	2013-05-02	2013-06-13	2013-10-10
		Dry	Wet	Dry	Freshet	Dry	Wet	Freshet	Dry	Wet	Dry
Event Type		Post-Construction	Post-Construction	Post-Construction	Construction	Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Event Phase											
Field Analyses											
Air Temperature (K)		286.2	279.4	285.5	279.5	282.1	274.0	276.6	289.6	289.7	285.7
pH (unitless)	6.5 - 8.5	8.1	8.3	8.0	8.1	7.8	8.0	8.2	8.2	7.5	7.4
Conductivity (µS/cm)		505	144	1950	1402	814	1492	1991	2250	456	1942
Dissolved Oxygen (Cold Water Biota)	>5 to >8	8.2	11.1	10.6	9.5	7.8	8.1	13.2	9.8	11.4	8.9
Temperature (°C)		16.3	7.1	6.2	12.8	13.2	7.1	5.5	10.9	12.1	14.8
Temperature-based DO objective*	calculated	5.7	6.8	6.9	6.1	6.0	6.8	7.0	6.3	6.1	5.8
Appearance		cloudy	brownish	clear and colourless	clear	cloudy grey		Clear	Clear	Cloudy brown	Clear
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.4	7.7	8.2	8.1	7.6	8.0	8.3	8.2	7.7	8.2
Total Kjeldahl Nitrogen (TKN)		0.33	0.82	0.51	0.64	0.95	0.35	0.22	0.21	1.61	0.33
Total Ammonia (as N)		0.1	0.05	0.02	<0.02	0.22	<0.02	<0.02	0.05	0.51	0.03
Un-ionized Ammonia (as N)	0.02	0.003	0.001	0.000	0.000	0.004	0.000	0.000	0.001	0.003	0.000
Total Ammonia (as N, for calculations)		0.1	0.05	0.02	0.01	0.22	0.01	0.01	0.05	0.51	0.03
Nitrate (as N)		0.58	0.26	1.01	0.80	0.70	0.56	1.02	1.42	13.60	1.10
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate											
E.coli (5TMPN/100ml)	100	850	235	18	150	940	20	690	0	1570	40
Total BOD ₅		2	3	<1	2	5	3	1	3	3	1
Chloride		58	13	397	271	75	223	414	386	27	292
Total Phosphorus	0.03	0.16	0.23	0.02	0.18	0.26	0.04	<0.01	0.02	0.57	0.04
Total Suspended Solids		72	105	3	30	117	21	<2	5	62	18
Notes:		20	21	22	23	24	25	26	27	28	29

· All parameters are mg/L unless otherwise indicated.

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· Shading indicates parameters exceed PWQO

* - Twelve Mile Creek - Cold Water Biota Criteria relative to temperature ($y = 7.7259e^{-0.019x}$)

** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter	Event Type Event Phase	SW2	SW2	SW2	SW2	SW2	SW2	SW2	SW2	SW2	SW2
		Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.
		2013-12-10	2014-03-18	2014-04-25	2014-06-04	2014-09-24	2014-12-01	2015-03-12	2015-05-13	2015-06-09	2015-09-30
		Wet	Freshet	Dry	Wet	Dry	Wet	Freshet	Dry	Wet	Dry
		Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Field Analyses											
Air Temperature (K)		267.9	273.0	283.1	288.5	288.7	273.9	272.2	273.2	289.7	285.9
pH (unitless)	6.5 - 8.5	7.7	7.8	8.3	7.6	7.8	7.7	7.3	7.7	8.4	8.0
Conductivity (µS/cm)		3800	5390	3120	2360	2040	2950	3820	1738	255	910
Dissolved Oxygen (Cold Water Biota)	>5 to >8	8.0	11.2	11.2	9.9	8.7	8.5	10.8	10.3	9.8	6.7
Temperature (°C)		2.9	2.9	7.9	16.3	13.4	2.1	0.5	12.1	17.4	17.5
Temperature-based DO objective*	calculated	7.3	7.3	6.6	5.7	6.0	7.4	7.7	6.1	5.6	5.5
Appearance		Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Cloudy brown	Clear
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	8.0	7.9	8.1	8.0	7.9	7.9	7.7	8.0	7.7	8.1
Total Kjeldahl Nitrogen (TKN)		0.42	0.36	0.29	0.44	0.2	0.38	3.42	0.41	1.28	0.24
Total Ammonia (as N)		0.05	0.1	0.05	0.04	0.06	0.04	1.2	0.04	0.04	0.06
Un-ionized Ammonia (as N)	0.02	0.000	0.001	0.002	0.000	0.001	0.000	0.002	0.000	0.003	0.002
Total Ammonia (as N, for calculations)		0.05	0.1	0.05	0.04	0.06	0.04	1.2	0.04	0.04	0.06
Nitrate (as N)		1.21	1.44	1.57	1.07	<0.10	0.55	<2	0.60	0.22	<0.25
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<2	<0.05	<0.05	<0.25
Dissolved Nitrite + Nitrate											
<i>E.coli</i> (5TMPN/100ml)	100	69	3	2	36	2200	460	380	1500	8700	180
Total BOD ₅		2	1	<1	11	1	3	10	<5	<5	<5
Chloride		764	1390	639	449	350	803	1370	381	29	107
Total Phosphorus	0.03	0.01	0.05	0.02	0.09	0.02	0.11	0.66	0.04	0.56	0.02
Total Suspended Solids		6	12	5	3	3	16	13	<10	272	<10
Notes:		30	31	32	33	34	35	36	37	38	39

· All parameters are mg/L unless otherwise indicated.

· PWQO - Provincial Water Quality Objectives (1999)

· Shading indicates parameters exceed PWQO

* - Twelve Mile Creek - Cold Water Biota Criteria relative to temperature ($y = 7.7259e^{-0.019x}$)

** - *E.coli* results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter	Event Type Event Phase	SW2	SW2	SW2	SW2	SW2	SW2
		Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.
		2015-10-29	2016-03-22	2016-04-26	2016-06-29	2016-09-01	2016-10-21
		Wet	Freshet	Wet	Dry	Dry	Wet
		Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Field Analyses							
Air Temperature (K)		283.0	275.5	273.2	292.1	291.5	282.2
pH (unitless)	6.5 - 8.5	7.9	7.8	8.5	8.3	7.6	7.9
Conductivity (µS/cm)		863	2600	2059	1519	1190	590
Dissolved Oxygen (Cold Water Biota)	>5 to >8	8.1	9.0	11.5	4.5	9.5	8.0
Temperature (°C)		11.8	6.4	10.2	16.8	23.4	15.7
Temperature-based DO objective*	calculated	6.2	6.8	6.4	5.6	5.0	5.7
Appearance		slightly cloudy	Clear	Light yellow, cloudy	Yellow brown, cloudy	Clear	Clear
LABORATORY ANALYSES							
pH (unitless)	6.5 - 8.5	7.2	8.1	8.0	8.0	8.1	7.9
Total Kjeldahl Nitrogen (TKN)		0.28	0.42	0.48	0.84	0.54	0.4
Total Ammonia (as N)		0.22	<0.02	0.03	0.19	<0.02	0.04
Un-ionized Ammonia (as N)	0.02	0.004	0.000	0.002	0.011	0.000	0.001
Total Ammonia (as N, for calculations)		0.22	0.01	0.03	0.19	0.01	0.04
Nitrate (as N)		1.83	1.30	1.17	<0.25	<0.25	<0.05
Nitrite (as N)		<0.25	<1.0	<0.25	<0.25	<0.25	<0.05
Dissolved Nitrite + Nitrate							
E.coli (5TMPN/100ml)	100	136	0	8	316	46	250
Total BOD ₅		<5	<5	5	<5	<5	<5
Chloride		59	625	456	305	193	50
Total Phosphorus	0.03	0.06	0.01	0.08	0.23	0.06	0.08
Total Suspended Solids		102	<10	92	506	17	11
Notes:		40	41	42	43	44	45

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· Shading indicates parameters exceed PWQO

* - Twelve Mile Creek - Cold Water Biota Criteria relative to temperature ($y = 7.7259e^{-0.019x}$)

** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3
		Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.
		2007-10-19	2007-12-05	2008-03-27	2008-08-06	2008-10-31	2008-12-16	2009-02-13	2009-04-06
		Wet	Dry	Freshet	Wet	Dry	Wet	Dry	Freshet
Event Type	Event Phase	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction
Field Analyses									
Air Temperature (K)		292.2	265.3	275.1	295.2	283.0	266.8	271.0	274.4
pH (unitless)	6.5 - 8.5	7.8	8.6	6.9	8.1	7.1	8.1	7.5	7.3
Conductivity (µS/cm)		890	2790	251	1556	1781	1760	2861	444
Dissolved Oxygen (Cold Water Biota)	>5 to >8	12.9	17.0	14.4	-	8.4	13.3		11.6
Temperature (°C)		18.9	4.3	5.5	22.1	12.5	2.7	3.1	6.2
Temperature-based DO objective*	calculated	5.4	7.1	7.0	5.1	6.1	7.3	7.3	6.9
Appearance		slightly cloudy	clear	yellow-brown	clear	clear	clear	clear	slightly cloudy light brown
LABORATORY ANALYSES									
pH (unitless)	6.5 - 8.5	7.8	7.9	7.8	8.0	8.0	8.1	8.0	7.9
Total Kjeldahl Nitrogen (TKN)		0.67	0.32	0.39	0.27	<0.10	0.18	0.34	0.93
Total Ammonia (as N)		0.02	0.02	0.11	0.04	0.02	<0.02	0.02	0.12
Un-ionized Ammonia (as N)	0.02	0.000	0.001	0.000	0.002	0.000	<0.0003	0.000	0.000
Total Ammonia (as N, for calculations)		0.02	0.02	0.11	0.04	0.02	0.01	0.02	0.12
Nitrate (as N)		0.16	1.39	0.37	0.23	0.78	1.64	2.04	0.54
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate		-	-	-	-	-	-	-	-
E.coli (5TMPN/100ml)	100	2480		103	156	580	85	12	100
Total BOD ₅		3	<1	1	<1	<1	<1	<1	3
Chloride		50	467	44	265	320	331	800	64
Total Phosphorus	0.03	0.15	0.03	0.67	0.04	0.02	0.09	0.05	0.33
Total Suspended Solids		20	11	111	<2	3	44	<2	44

Notes:

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· Shading indicates parameters exceed PWQO

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** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter	Event Type Event Phase	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3
		Rice Rd. 2009-06-18	Rice Rd. 2009-06-18	Rice Rd. 2009-09-10	Rice Rd. 2009-12-01	Rice Rd. 2010-03-09	Rice Rd. 2010-06-16	Rice Rd. 2010-09-03	Rice Rd. 2010-10-05	Rice Rd. 2011-03-29	Rice Rd. 2011-06-06
		Wet	DUP	Dry	Wet	Freshet	Wet	Dry	Wet	Dry	Freshet
		Construction	Construction	Construction	Construction	Construction	Construction	Construction	Construction	Post-Construction	Post-Construction
Field Analyses											
Air Temperature (K)		287.8	287.8	291.6	278.1	277.1	293.0	294.8	282.2	271.4	292.2
pH (unitless)	6.5 - 8.5	7.8	7.8	8.6	8.0	7.0	8.0	8.0	7.8	8.8	8.3
Conductivity (µS/cm)		1928	1928	423	>4000	385	860	1075	253	2210	1931
Dissolved Oxygen (Cold Water Biota)	>5 to >8	8.7	8.7	7.7	13.6	15.1	7.7	5.4	11.5	15.0	9.1
Temperature (°C)		15.5	15.5	22.2	10.1	4.5	22.7	22.9	13.3	6.0	18.0
Temperature-based DO objective*	calculated	5.8	5.8	5.1	6.4	7.1	5.0	5.0	6.0	6.9	5.5
Appearance		clear	clear	clear to cloudy	clear and colourless	murky yellow	clear	-	brown	clear	clear
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	8.0	8.0	8.1	8.1	7.8	7.9	8.2	7.9	8.2	8.4
Total Kjeldahl Nitrogen (TKN)		0.35	0.36	0.34	0.35	0.53	0.67	0.24	0.15	0.24	<0.10
Total Ammonia (as N)		0.12	0.12	0.02	0.17	0.05	0.03	<0.02	0.07	<0.02	<0.02
Un-ionized Ammonia (as N)	0.02	0.002	0.002	0.003	0.003	0.000	0.001	<0.001	0.001	0.002	0.001
Total Ammonia (as N, for calculations)		0.12	0.12	0.02	0.17	0.05	0.03	0.01	0.07	0.01	0.01
Nitrate (as N)		2.07	2.02	0.12	0.56	0.36	0.55	<0.10	0.17	1.07	0.78
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate		-	-	-	-	-	-	-	-	-	-
E.coli (5TMPN/100ml)	100	1300	1300	800	14	30	920	4500	9300	5	220
Total BOD ₅		1	<1	<1	<1	2	1	3	5	<1	1
Chloride		307	312	47	1750	84	195	212	25	257	443
Total Phosphorus	0.03	0.02	0.12	0.23	0.03	0.32	0.07	0.05	0.33	0.04	0.03
Total Suspended Solids		5	6	24	5	167	30	45	342	11	12

Notes:

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** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter	Event Type Event Phase	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3
		Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.
		2011-06-24	2011-09-30	2011-11-29	2012-03-15	2012-04-25	2012-07-04	2012-07-27	2012-10-10	2012-12-05	2013-03-27
		Wet	Dry	Wet	Dry	Freshet	Wet	Wet	Dry	Wet	Freshet
		Post-Construction	Post-Construction	Post-Construction	Post-Construction	Construction	Construction	Construction	Construction	Post-Construction	Post-Construction
Field Analyses											
Air Temperature (K)		292.4	286.2	279.4	285.5	279.5	273.2	296.3	282.1	274.0	276.6
pH (unitless)	6.5 - 8.5	8.0	8.4	8.4	8.0	8.2	7.9	7.9	7.9	7.9	8.1
Conductivity (µS/cm)		894	361	135	2110	1565	2300	1275	903	1565	2070
Dissolved Oxygen (Cold Water Biota)	>5 to >8	7.2	8.9	11.5	10.3	9.9	4.4	4.9	7.4	9.3	14.4
Temperature (°C)		18.4	15.9	7.1	6.2	12.5	22.4	22.0	13.3	7.1	5.8
Temperature-based DO objective*	calculated	5.4	5.7	6.8	6.9	6.1	5.0	5.1	6.0	6.8	6.9
Appearance		cloudy	cloudy	brownish	clear	cloudy	clear	clear	cloudy grey		Clear
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.9	7.6	7.7	8.2	8.2	7.9	7.8	7.7	8.0	8.3
Total Kjeldahl Nitrogen (TKN)		0.57	0.32	0.73	0.24	0.62	0.47	0.49	1.02	0.34	0.17
Total Ammonia (as N)		<0.02	0.04	0.03	0.03	<0.02	0.2	0.11	0.23	<0.02	<0.02
Un-ionized Ammonia (as N)	0.02	0.001	0.003	0.001	0.000	0.001	0.007	0.004	0.005	0.000	0.000
Total Ammonia (as N, for calculations)		0.01	0.04	0.03	0.03	0.01	0.2	0.11	0.23	0.01	0.01
Nitrate (as N)		0.47	0.40	0.18	1.04	0.80	0.50	0.36	0.65	0.46	1.01
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate		-	-	-	-	-	-	-	-	-	-
E.coli (5TMPN/100ml)	100	900	1130	203	18	60	490	244	610	10	670
Total BOD ₅		2	1	3	<1	2	1	3	7	2	1
Chloride		166	44	11	414	285	427	135	85	231	439
Total Phosphorus	0.03	0.12	0.14	0.21	0.02	0.19	0.06	0.06	0.24	0.03	0.01
Total Suspended Solids		42	42	124	4	58	73	187	107	19	3

Notes:

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** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3
		Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.
		2013-05-02	2013-06-13	2013-10-10	2013-12-10	2014-03-18	2014-04-25	2014-06-04	2014-09-24	2014-12-01	2015-03-12
		Dry	Wet	Dry	Wet	Freshet	Dry	Wet	Dry	Wet	Freshet
Event Type		Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Event Phase											
Field Analyses											
Air Temperature (K)		289.6	289.7	285.7	267.9	273.0	283.1	288.5	288.7	273.9	272.2
pH (unitless)	6.5 - 8.5	8.3	7.5	7.4	7.7	7.7	8.5	7.5	7.6	7.8	7.0
Conductivity (µS/cm)		2190	462	1991	3780	5610	3150	2370	2350	2890	3890
Dissolved Oxygen (Cold Water Biota)	>5 to >8	10.0	11.5	8.5	8.0	11.3	12.2	8.8	8.2	8.6	10.9
Temperature (°C)		10.8	17.0	14.7	2.8	3.1	8.0	16.3	14.3	2.0	0.5
Temperature-based DO objective*	calculated	6.3	5.6	5.8	7.3	7.3	6.6	5.7	5.9	7.4	7.7
Appearance		Clear	Cloudy Brown	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	8.2	7.6	8.2	8.0	7.9	8.2	8.0	7.9	7.9	7.7
Total Kjeldahl Nitrogen (TKN)		0.21	2.15	0.23	0.41	0.29	0.27	0.42	0.83	0.35	3.34
Total Ammonia (as N)		0.04	0.51	0.05	0.03	0.1	0.04	0.03	0.05	0.03	1.27
Un-ionized Ammonia (as N)	0.02	0.001	0.005	0.000	0.000	0.000	0.002	0.000	0.001	0.000	0.001
Total Ammonia (as N, for calculations)		0.04	0.51	0.05	0.03	0.1	0.04	0.03	0.05	0.03	1.27
Nitrate (as N)		1.39	13.60	0.96	1.15	1.45	1.54	0.98	<0.10	0.49	<2
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<2
Dissolved Nitrite + Nitrate											
E.coli (5TMPN/100ml)	100	1	1420	55	89	8	4	38	243	470	330
Total BOD ₅		1	2	<1	2	<1	<1	8	3	3	10
Chloride		398	27	297	838	1410	658	458	412	939	1410
Total Phosphorus	0.03	0.03	0.59	0.03	0.02	0.04	0.01	0.07	0.11	0.09	0.65
Total Suspended Solids		4	60	6	7	8	2	3	16	18	16

Notes:

· All parameters are mg/L unless otherwise indicated.

· PWQO - Provincial Water Quality Objectives (1999)

· Shading indicates parameters exceed PWQO

* - Twelve Mile Creek - Cold Water Biota Criteria relative to temperature ($y = 7.7259e^{-0.019x}$)

** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3	
		Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	Rice Rd.	
		2015-05-13	2015-06-09	2015-09-30	2015-10-29	2016-03-22	2016-04-26	2016-06-29	2016-09-01	2016-10-21	
		Event Type	Dry	Wet	Dry	Wet	Freshet	Wet	Dry	Dry	Wet
Event Phase		Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	
Field Analyses											
Air Temperature (K)		273.2	289.7	285.9	283.0	275.5	273.2	292.1	291.5	282.2	
pH (unitless)	6.5 - 8.5	7.7	8.0	7.9	8.1	8.0	8.5	8.7	7.6	7.8	
Conductivity (µS/cm)		1990	664	936	861	2670	2081	1565	1200	580	
Dissolved Oxygen (Cold Water Biota)	>5 to >8	10.3	13.8	7.2	8.2	9.3	12.0	6.6	5.9	8.4	
Temperature (°C)		12.3	17.1	17.2	11.6	6.4	10.5	17.0	23.0	15.7	
Temperature-based DO objective*	calculated	6.1	5.6	5.6	6.2	6.8	6.3	5.6	5.0	5.7	
Appearance		Clear	Cloudy brown grey	Clear	slightly cloudy	Clear	Light yellow, cloudy	Yellow-brown, cloudy	Cleat	Clear	
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	8.0	7.7	8.1	7.4	8.2	8.0	8.1	7.9	7.9	
Total Kjeldahl Nitrogen (TKN)		0.44	1.37	0.22	0.37	0.46	0.5	0.42	0.51	0.39	
Total Ammonia (as N)		0.04	0.21	0.04	0.22	<0.02	0.03	0.08	<0.02	<0.02	
Un-ionized Ammonia (as N)	0.02	0.000	0.007	0.001	0.005	0.000	0.002	0.010	0.000	0.000	
Total Ammonia (as N, for calculations)		0.04	0.21	0.04	0.22	0.01	0.03	0.08	0.01	0.01	
Nitrate (as N)		<0.5	0.61	<0.25	1.71	1.30	1.20	<0.25	<50	<0.05	
Nitrite (as N)		<0.5	<0.10	<0.25	<0.25	<1.0	<0.5	<0.25	<50	<0.05	
Dissolved Nitrite + Nitrate											
E.coli (5TMPN/100ml)	100	1200	5800	138	132	0	8	340	46	320	
Total BOD ₅		<5	<5	<5	<5	<5	<5	<5	<5	<5	
Chloride		480	124	119	60	640	461	307	203	50	
Total Phosphorus	0.03	0.05	0.45	0.02	0.05	0.02	0.07	0.08	0.07	0.06	
Total Suspended Solids		25	337	<10	83	<10	61	92	23	20	

Notes:

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• PWQO - Provincial Water Quality Objectives (1999)

• Shading indicates parameters exceed PWQO

* - Twelve Mile Creek - Cold Water Biota Criteria relative to temperature ($y = 7.7259e^{-0.019x}$)

** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter	Event Type Event Phase	SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4
		Cataract Rd. 2007-10-19	Cataract Rd. 2007-12-05	Cataract Rd. 2008-03-27	Cataract Rd. 2008-08-06	Cataract Rd. 2008-10-31	Cataract Rd. 2008-12-16	Cataract Rd. 2009-02-13	Cataract Rd. 2009-04-06	Cataract Rd. 2009-06-18
		Wet	Dry	Freshet	Wet	Dry	Wet	Dry	Freshet	Wet
		Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Construction
Field Analyses										
Air Temperature (K)		292.2	265.3	275.1	295.2	283.0	266.8	271.0	274.4	287.8
pH (unitless)	6.5 - 8.5	7.7	8.4	7.0	7.9	7.0	7.3	7.7	7.0	8.0
Conductivity (µS/cm)		2080	1510	309	2759	939	903	861	720	3092
Dissolved Oxygen (Cold Water Biota)	>5 to >8	11.3	18.2	10.6	18.0	9.8	12.5	11.3	11.3	8.2
Temperature (°C)		19.1	2.2	4.1	29.0	11.9	3.1	3.2	6.1	16.4
Temperature-based DO objective*	calculated	5.4	7.4	7.1	4.5	6.2	7.3	7.3	6.9	5.7
Appearance		cloudy grey-green	clear	clear-cloudy yellow		clear	clear	clear yellowish	slightly cloudy light brown	clear
LABORATORY ANALYSES										
pH (unitless)	6.5 - 8.5	7.8	7.9	7.6	8.2	8.1	7.8	7.6	7.6	7.7
Total Kjeldahl Nitrogen (TKN)		0.94	0.48	1.15	0.75	0.22	0.23	0.4	1.04	1.03
Total Ammonia (as N)		0.08	0.04	0.11	0.06	0.02	0.03	0.03	0.1	0.42
Un-ionized Ammonia (as N)	0.02	0.001	0.001	0.000	0.003	0.000	0.000	0.000	0.000	0.011
Total Ammonia (as N, for calculations)		0.08	0.04	0.11	0.06	0.02	0.03	0.03	0.1	0.42
Nitrate (as N)		1.20	3.67	0.90	<0.10	8.36	3.23	2.28	1.67	8.34
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.23
Dissolved Nitrite + Nitrate		-	-	-	-	-	-	-	-	-
<i>E.coli</i> (5TMPN/100ml)	100	18500		6000	26	1850	7200	9280	3940	1300
Total BOD ₅		3	1	2	3	<1	4	1	2	2
Chloride		534	334	34	719	87	107	192	119	464
Total Phosphorus	0.03	0.24	0.07	0.20	0.06	0.06	0.04	0.05	0.16	0.03
Total Suspended Solids		31	5	33	16	15	53	<2	22	15

Notes:

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· Shading indicates parameters exceed PWQO

* - Twelve Mile Creek - Cold Water Biota Criteria relative to temperature ($y = 7.7259e^{-0.019x}$)

** - *E.coli* results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4
		Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.
		2009-12-01	2010-03-09	2010-06-16	2010-09-03	2010-10-05	2011-03-29	2011-06-24	2011-09-30	2011-11-29	2012-03-15
		Wet	Freshet	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Event Type	Event Phase	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Field Analyses											
Air Temperature (K)		278.1	277.1	293.0	294.8	282.2	271.4	292.4	286.2	279.4	285.5
pH (unitless)	6.5 - 8.5	7.8	7.2	7.7	7.2	7.7	8.3	7.7	8.1	8.1	7.9
Conductivity (µS/cm)		1180	370	600	1080	306	1157	1124	549	300	1360
Dissolved Oxygen (Cold Water Biota)	>5 to >8	15.6	13.5	10.5	5.0	9.6	12.7	2.3	7.5	10.5	8.6
Temperature (°C)		9.9	5.4	19.8	25.6	13.3	3.5	18.7	16.3	7.8	5.7
Temperature-based DO objective*	calculated	6.4	7.0	5.3	4.8	6.0	7.2	5.4	5.7	6.7	6.9
Appearance		clear and colourless	clear yellowish	clear	Slightly Cloudy Brown	clear yellow	clear	clear	cloudy	yellowish	slightly cloudy
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.8	7.5	7.6	8.0	7.8	7.9	7.7	7.7	7.5	8.0
Total Kjeldahl Nitrogen (TKN)		0.37	0.76	0.63	0.39	0.37	1.20	0.62	0.53	1.14	0.23
Total Ammonia (as N)		0.02	0.10	0.05	<0.02	0.20	0.02	<0.02	0.05	0.06	0.03
Un-ionized Ammonia (as N)	0.02	0.000	0.000	0.001	<0.0002	0.003	0.000	0.000	0.002	0.001	0.000
Total Ammonia (as N, for calculations)		0.02	0.1	0.05	0.01	0.2	0.02	0.01	0.05	0.06	0.03
Nitrate (as N)		2.91	0.76	0.84	<0.10	0.26	1.58	0.49	1.39	0.99	1.66
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate		-	-	-	-	-	-	-	-	-	-
E.coli (5TMPN/100ml)	100	11200	460	420	100	1860	5900	76	1590	313	69
Total BOD ₅		<1	4	1	<1	2	<1	2	<1	4	<1
Chloride		150	58	75	112	28	281	197	57	22	189
Total Phosphorus	0.03	0.07	0.16	0.07	0.05	0.10	0.03	0.05	0.11	0.09	0.01
Total Suspended Solids		2	16	4	65	21	7	11	8	56	<2

Notes:

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** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4
		Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.
		2012-04-25	2012-07-27	2012-10-10	2013-03-27	2013-05-02	2013-06-13	2013-12-10	2014-03-18	2014-04-25	2014-12-01
		Event Type	Freshet	Wet	Dry	Freshet	Dry	Wet	Wet	Freshet	Dry
Event Phase		Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Field Analyses											
Air Temperature (K)		279.5	296.3	282.1	276.6	289.6	289.7	267.9	273.0	283.1	273.9
pH (unitless)	6.5 - 8.5	7.7	7.6	8.4	8.4	8.2	7.4	7.9	7.3	8.2	7.7
Conductivity (µS/cm)		828	1324	592	2190	2110	368	2690	2510	1119	2320
Dissolved Oxygen (Cold Water Biota)	>5 to >8	8.9	4.1	10.9	10.9	3.9	5.4	7.1	9.9	11.8	6.8
Temperature (°C)		8.3	23.3	13.6	4.2	10.1	16.6	5.3	2.1	7.5	2.2
Temperature-based DO objective*	calculated	6.6	5.0	6.0	7.1	6.4	5.6	7.0	7.4	6.7	7.4
Appearance		clear	dark brown	clear	Clear	Clear	Cloudy brown	Clear	Clear	Clear	Clear
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.9	7.6	7.9	8.1	7.8	7.6	7.9	7.5	7.9	7.8
Total Kjeldahl Nitrogen (TKN)		0.39	1.96	0.65	0.31	0.34	1.91	0.28	0.38	0.28	0.86
Total Ammonia (as N)		<0.02	0.04	<0.02	<0.02	0.03	0.09	<0.02	0.14	0.03	0.05
Un-ionized Ammonia (as N)	0.02	0.000	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.001	0.000
Total Ammonia (as N, for calculations)		0.01	0.04	0.01	0.01	0.03	0.09	0.01	0.14	0.03	0.05
Nitrate (as N)		3.68	0.63	0.68	1.71	1.90	0.70	2.05	1.43	2.43	2.72
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate		-	-	-							
E.coli (5TMPN/100ml)	100	2580	137	28	580	3	5400	313	1940	60	4520
Total BOD ₅		2	12	2	1	3	3	<1	<1	<1	2
Chloride		69	236	59	535	382	32	612	543	135	1020
Total Phosphorus	0.03	0.09	0.68	0.10	0.07	0.05	0.55	0.02	0.05	0.03	0.10
Total Suspended Solids		24	187	121	17	24	56	5	9	6	13

Notes:

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** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter	Event Type Event Phase	SW5	SW5	SW5	SW5	SW5	SW5	SW5	SW5	SW5	SW5
		Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.
		2007-10-19	2007-12-05	2008-03-27	2008-10-31	2008-12-16	2009-02-13	2009-04-06	2009-06-18	2009-09-10	2009-12-01
		Wet	Dry	Freshet	Dry	Wet	Dry	Freshet	Wet	Dry	Wet
		Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Construction	Construction	Post-Construction
Field Analyses											
Air Temperature (K)		292.2	265.3	275.1	283.0	266.8	271.0	274.4	287.8	291.6	278.1
pH (unitless)	6.5 - 8.5	7.3	8.7	6.9	7.1	7.8	7.7	7.1	8.0	8.7	8.6
Conductivity (µS/cm)		159	1200	1630	928	845	747	390	3143	1062	996
Dissolved Oxygen (Cold Water Biota)	>5 to >8	10.9	20.3	18.0	10.8	15.6	11.8	11.8	8.0	15.2	17.0
Temperature (°C)		19.5	0.3	29.0	11.4	0.0	4.0	6.4	16.7	28.7	10.1
Temperature-based DO objective*	calculated	5.3	7.7	4.5	6.2	7.7	7.2	6.8	5.6	4.5	6.4
Appearance		cloudy brown	slightly cloudy	clear	clear	clear	clear yellowish	slightly cloudy light brown	clear	cloudy, green (lots of algae)	clear yellowish
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.5	7.9	7.7	8.2	8.1	7.9	7.7	7.9	8.3	8.4
Total Kjeldahl Nitrogen (TKN)		4.72	1.07	1.64	0.35	0.63	0.57	1.48	1.45	1.5	0.55
Total Ammonia (as N)		2.75	0.23	0.08	0.02	0.24	0.04	0.27	1.10	0.04	0.07
Un-ionized Ammonia (as N)	0.02	0.021	0.008	0.000	0.000	0.001	0.000	0.000	0.032	0.010	0.005
Total Ammonia (as N, for calculations)		2.75	0.23	0.08	0.02	0.24	0.04	0.27	1.1	0.04	0.07
Nitrate (as N)		<0.10	3.86	0.87	5.79	2.80	1.94	1.19	14.10	<0.10	1.67
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.34	<0.10	<0.10
Dissolved Nitrite + Nitrate		-	-	-	-	-	-	-	-	-	-
E.coli (5TMPN/100ml)	100	12300		5030	31	2700	6130	2660	1720	10	205
Total BOD ₅		29	<1	1	<1	1	2	4	3	4	1
Chloride		207	192	20	87	99	117	48	322	202	126
Total Phosphorus	0.03	0.87	0.13	0.38	0.05	0.10	0.08	0.33	0.03	0.24	0.11
Total Suspended Solids		584	13	67	3	4	3	44	9	57	10

Notes:

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** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter	Event Type Event Phase	SW5	SW5	SW5	SW5	SW5	SW5	SW5	SW5	SW5	SW5
		Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.
		2010-03-09	2010-06-16	2010-10-05	2011-03-29	2011-06-06	2011-06-24	2011-09-30	2011-11-29	2012-03-15	2012-04-25
		Freshet	Wet	Wet	Dry	Freshet	Wet	Dry	Wet	Dry	Freshet
		Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Field Analyses											
Air Temperature (K)		277.1	293.0	282.2	271.4	292.2	292.4	286.2	279.4	285.5	279.5
pH (unitless)	6.5 - 8.5	7.3	8.2	7.6	9.6	8.4	8.3	8.3	8.2	7.9	8.3
Conductivity (µS/cm)		264	470	385	1440	809	964	401	205	1360	770
Dissolved Oxygen (Cold Water Biota)	>5 to >8	14.0	9.3	10.9	20.2	9.4	7.9	7.9	11.0	9.4	9.7
Temperature (°C)		4.1	27.6	12.6	10.2	26.0	21.4	16.0	6.8	5.8	17.6
Temperature-based DO objective*	calculated	7.1	4.6	6.1	6.4	4.7	5.1	5.7	6.8	6.9	5.5
Appearance		cloudy yellow	clear	cloudy yellow	clear yellowish	clear	clear yellowish	cloudy	brownish	clear	clear
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.6	8.4	7.9	8.7	8.3	8.1	7.8	7.5	8.1	8.2
Total Kjeldahl Nitrogen (TKN)		0.83	1.06	0.42	0.64	1	0.97	0.44	1.56	0.32	0.77
Total Ammonia (as N)		0.15	0.03	0.14	0.05	0.14	0.05	0.1	0.02	0.02	0.04
Un-ionized Ammonia (as N)	0.02	0.000	0.003	0.001	0.022	0.019	0.004	0.005	0.000	0.000	0.002
Total Ammonia (as N, for calculations)		0.15	0.03	0.14	0.05	0.14	0.05	0.1	0.02	0.02	0.04
Nitrate (as N)		0.61	<0.10	0.4	0.42	<0.10	0.15	1.32	0.28	0.85	3.65
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate		-	-	-	-	-	-	-	-	-	-
E.coli (5TMPN/100ml)	100	190	860	1220	31	52000	2800	1850	190	6	160
Total BOD ₅		5	2	1	<1	4	2	<1	5	<1	2
Chloride		39.0	54.0	43	457	93	150	32	15	191	69
Total Phosphorus	0.03	0.38	0.15	0.12	0.07	0.06	0.03	0.11	0.12	0.02	0.11
Total Suspended Solids		167	21	23	7	19	8	11	611	6	30

Notes:

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· PWQO - Provincial Water Quality Objectives (1999)

· Shading indicates parameters exceed PWQO

* - Twelve Mile Creek - Cold Water Biota Criteria relative to temperature ($y = 7.7259e^{-0.019x}$)

** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter	Event Type Event Phase	SW5	SW5	SW5	SW5	SW5	SW5	SW5	SW5	SW5	SW5
		Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.	Cataract Rd.
		2012-10-10	2012-12-05	2013-03-27	2013-05-02	2013-06-13	2013-10-10	2013-12-10	2014-03-18	2014-04-25	2014-06-04
		Dry	Wet	Freshet	Dry	Wet	Dry	Wet	Freshet	Dry	Wet
		Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Field Analyses											
Air Temperature (K)		282.1	274.0	276.6	289.6	289.7	285.7	267.9	273.0	283.1	288.5
pH (unitless)	6.5 - 8.5	8.4	8.3	8.2	8.3	7.1	7.6	7.9	7.8	8.2	8.3
Conductivity (µS/cm)		643	1038	2170	1939	238	1608	2990	1499	1105	1000
Dissolved Oxygen (Cold Water Biota)	>5 to >8	8.9	10.7	21.4	9.4	10.2	13.7	9.8	11.2	14.5	11.4
Temperature (°C)		12.8	4.3	3.4	14.1	16.8	15.5	0.1	0.7	6.5	20.2
Temperature-based DO objective*	calculated	6.1	7.1	7.2	5.9	5.6	5.8	7.7	7.6	6.8	5.3
Appearance		clear		Clear	Clear	Cloudy brown	Clear	Clear	Clear	Clear	Clear
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	8.1	8.1	8.4	8.1	7.6	8.4	8.1	7.9	8.3	8.3
Total Kjeldahl Nitrogen (TKN)		0.39	0.66	0.45	0.61	2.49	0.32	0.37	0.52	0.4	0.52
Total Ammonia (as N)		<0.02	0.05	<0.02	0.03	0.13	0.03	0.03	0.09	<0.02	0.04
Un-ionized Ammonia (as N)	0.02	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.003
Total Ammonia (as N, for calculations)		0.01	0.05	0.01	0.03	0.13	0.03	0.03	0.09	0.01	0.04
Nitrate (as N)		0.34	1.87	0.98	<0.10	0.60	<0.10	1.78	0.90	1.47	<0.10
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate		-	-								
E.coli (5TMPN/100ml)	100	1090	80	1	4	6100	95	72	260	27	280
Total BOD ₅		3	2	1	1	3	<1	3	2	<1	1
Chloride		48	146	534	353	16	313	649	297	141	118
Total Phosphorus	0.03	0.05	0.08	<0.01	0.03	0.91	0.05	0.03	0.08	<0.01	0.03
Total Suspended Solids		7	7	2	3	170	16	5	6	<2	6

Notes:

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· Shading indicates parameters exceed PWQO

* - Twelve Mile Creek - Cold Water Biota Criteria relative to temperature ($y = 7.7259e^{-0.019x}$)

** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW5	SW5	SW6	SW6	SW6	SW6	SW6	SW6	SW6	SW6
		Cataract Rd.	Cataract Rd.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.
		2014-09-24	2014-12-01	2007-10-19	2007-12-05	2008-03-27	2008-08-06	2008-10-31	2008-12-16	2009-02-13	2009-04-06
		Dry	Wet	Wet	Dry	Freshet	Wet	Dry	Wet	Dry	Freshet
Event Type		Post-Construction	Post-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction
Event Phase											
Field Analyses											
Air Temperature (K)		288.7	273.9	292.2	265.3	275.1	295.2	283.0	266.8	271.0	274.4
pH (unitless)	6.5 - 8.5	7.9	7.7	7.2	8.4	7.7	7.9	6.8	7.4	7.8	7.3
Conductivity (µS/cm)		1231	2770	1249	1260	360	2343	1310	998	1295	480
Dissolved Oxygen (Cold Water Biota)	>5 to >8	9.9	7.0	10.9	19.4	14.1	-	7.4	14.4	11.8	11.8
Temperature (°C)		13.7	2.0	19.6	0.5	4.5	29.7	10.5	0.8	2.4	6.4
Temperature-based DO objective*	calculated	6.0	7.4	5.3	7.7	7.1	4.4	6.3	7.6	7.4	6.8
Appearance		Clear	Clear	cloudy brown	clear	clear-light brownish	yellowish	clear	yellow-brownish	clear yellowish	slightly cloudy light brown
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.9	7.8	7.7	7.8	7.9	8.0	7.8	7.9	7.9	7.9
Total Kjeldahl Nitrogen (TKN)		0.49	1.55	2.43	0.91	0.81	2.49	0.43	0.82	0.96	1.8
Total Ammonia (as N)		0.08	0.24	0.13	0.019669	0.08	0.78	0.05	0.08	0.11	0.38
Un-ionized Ammonia (as N)	0.02	0.001	0.001	0.001	0.0004251	0.000	0.045	0.000	0.000	0.001	0.001
Total Ammonia (as N, for calculations)		0.08	0.24	0.13	0.019669	0.08	0.78	0.05	0.08	0.11	0.38
Nitrate (as N)		<0.10	3.57	0.45	4.68	0.34	<0.10	0.23	1.16	0.72	0.41
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate				-	-	-	-	-	-	-	-
E.coli (5TMPN/100ml)	100	29	3350	3600		1370	69	70	840	1910	80
Total BOD ₅		<1	3	9	2	1	9	2	2	<1	3
Chloride		145	557	254	225	75	465	238	176	331	64
Total Phosphorus	0.03	0.02	0.20	0.25	0.11	0.11	0.54	0.21	0.16	0.12	0.28
Total Suspended Solids		3	10	55	3	21	134	108	23	14	33

Notes:

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** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW6	SW6	SW6	SW6	SW6	SW6	SW6	SW6	SW6	SW6
		Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.
		2009-06-18	2009-09-10	2009-09-10	2009-12-01	2009-12-01	2010-03-09	2010-06-16	2010-09-03	2010-10-05	2011-03-29
		Wet	Dry	DUP	Wet	DUP	Freshet	Wet	Dry	Wet	Dry
Event Type	Event Phase	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Construction	Construction	Construction	Post-Construction
Field Analyses											
Air Temperature (K)		287.8	291.6	291.6	278.1	278.1	277.1	293.0	294.8	282.2	271.4
pH (unitless)	6.5 - 8.5	8.2	7.9	7.9	8.0	8.0	7.3	7.8	7.1	7.5	8.4
Conductivity (µS/cm)		1473	2343	2343	877	877	386	840	>4000	791	1221
Dissolved Oxygen (Cold Water Biota)	>5 to >8	6.7	3.2	3.2	13.7	13.7	13.1	4.3	2.2	10.8	13.3
Temperature (°C)		17.4	23.7	23.7	8.0	8.0	5.9	23.5	24.5	12.3	5.0
Temperature-based DO objective*	calculated	5.6	4.9	4.9	6.6	6.6	6.9	4.9	4.9	6.1	7.0
Appearance		yellowish	cloudy, sediment in sample		cloudy, sediment in sample		clear yellowish	slightly cloudy	slight cloudy brown	brown	clear yellowish
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.9	7.9	7.8	7.9	8.0	7.7	7.9	7.9	7.8	7.9
Total Kjeldahl Nitrogen (TKN)		0.54	0.89	0.92	0.87	0.72	0.77	0.79	1.74	1.71	1.73
Total Ammonia (as N)		0.07	0.07	0.07	0.14	0.14	0.36	0.2	0.83	0.73	0.7
Un-ionized Ammonia (as N)	0.02	0.004	0.002	0.002	0.002	0.002	0.001	0.007	0.005	0.005	0.023
Total Ammonia (as N, for calculations)		0.07	0.07	0.07	0.14	0.14	0.36	0.2	0.83	0.73	0.7
Nitrate (as N)		<1.0	<0.10	<0.10	0.55	0.51	0.29	0.14	7.62	1.20	0.24
Nitrite (as N)		<1.0	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<1.0	<0.10	<0.10
Dissolved Nitrite + Nitrate		-	-	-	-	-	-	-	-	-	-
E.coli (5TMPN/100ml)	100	3600	80	100	92	103	1450	870	420	970	8400
Total BOD ₅		3	2	3	1	<1	4	2	8	2	4
Chloride		301	725	715	130	132	62	181	978	137	584
Total Phosphorus	0.03	0.07	0.39	0.43	0.18	0.22	0.14	0.28	0.18	0.29	0.17
Total Suspended Solids		15	217	357	18	11	21	83	175	459	10

Notes:

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** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW6	SW6	SW6	SW6	SW6	SW6	SW6	SW6	SW6	SW6
		Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.
		2011-06-06	2011-06-24	2011-09-30	2011-11-29	2012-03-15	2012-04-25	2012-07-04	2012-07-27	2012-10-10	2012-12-05
		Freshet	Wet	Dry	Wet	Dry	Freshet	Wet	Wet	Dry	Wet
Event Type	Event Phase	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Field Analyses											
Air Temperature (K)		292.2	292.4	286.2	279.4	285.5	279.5	273.2	296.3	282.1	274.0
pH (unitless)	6.5 - 8.5	7.6	7.7	8.1	8.1	7.6	7.8	7.4	7.4	7.8	7.8
Conductivity (µS/cm)		3290	1826	633	202	2630	1163	2240	2000	745	1147
Dissolved Oxygen (Cold Water Biota)	>5 to >8	7.0	3.3	7.6	11.1	3.6	12.2	9.2	3.6	6.8	7.2
Temperature (°C)		19.9	20.1	16.0	6.8	6.9	7.4	23.0	22.9	13.6	6.3
Temperature-based DO objective*	calculated	5.3	5.3	5.7	6.8	6.8	6.7	5.0	5.0	6.0	6.9
Appearance		yellowish	grayish	cloudy	brownish	yellowish	yellowish	brown	yellowish	yellowish	
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	8.0	7.7	7.8	7.6	8.0	7.9	7.7	7.4	7.8	8.0
Total Kjeldahl Nitrogen (TKN)		1.68	3.63	0.75	1.04	0.67	1.25	6.73	2.96	1.14	0.73
Total Ammonia (as N)		0.88	0.98	0.24	0.02	0.14	0.05	0.57	0.39	0.13	0.02
Un-ionized Ammonia (as N)	0.02	0.014	0.020	0.008	0.000	0.001	0.000	0.008	0.004	0.002	0.000
Total Ammonia (as N, for calculations)		0.88	0.98	0.24	0.02	0.14	0.05	0.57	0.39	0.13	0.02
Nitrate (as N)		0.26	0.19	0.70	0.28	0.26	0.36	<0.10	0.30	0.72	0.30
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate		-	-	-	-	-	-	-	-	-	-
E.coli (5TMPN/100ml)	100	790	4200	1970	161	89	570	50	860	1320	260
Total BOD ₅		2	8	2	3	<1	2	59	6	4	2
Chloride		789	348	78	14	566	200	436	400	70	151
Total Phosphorus	0.03	0.21	0.44	0.14	0.05	0.06	0.14	0.83	0.28	0.14	0.11
Total Suspended Solids		12	104	35	62	7	36	6780	317	37	9

Notes:

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** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW6	SW6	SW6	SW6	SW6	SW6	SW6	SW6	SW6	SW6
		Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.
		2013-03-27	2013-05-02	2013-06-13	2013-10-10	2013-12-10	2014-03-18	2014-04-25	2014-06-04	2014-09-24	2014-12-01
		Freshet	Dry	Wet	Dry	Wet	Freshet	Dry	Wet	Dry	Wet
Event Type	Event Phase	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Field Analyses											
Air Temperature (K)		276.6	289.6	289.7	285.7	267.9	273.0	283.1	288.5	288.7	273.9
pH (unitless)	6.5 - 8.5	8.3	7.7	7.6	7.6	7.9	7.9	8.0	7.2	7.4	7.7
Conductivity (µS/cm)		2770	4110	362	1454	3520	4570	3360	2920	1899	3060
Dissolved Oxygen (Cold Water Biota)	>5 to >8	7.3	3.8	6.0	4.0	5.3	9.2	6.1	5.8	6.0	7.5
Temperature (°C)		2.5	9.8	17.2	15.9	3.4	0.7	7.9	16.9	13.8	2.1
Temperature-based DO objective*	calculated	7.4	6.4	5.6	5.7	7.2	7.6	6.6	5.6	5.9	7.4
Appearance		Clear	Clear	Cloudy brown	Clear	Clear	Clear	Clear	Clear	Clear	Clear
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	8.1	7.8	7.8	8.0	7.9	7.6	7.9	7.8	7.7	7.7
Total Kjeldahl Nitrogen (TKN)		1.22	0.71	1.14	0.58	0.66	0.82	0.81	0.74	0.54	1.06
Total Ammonia (as N)		0.34	0.19	0.09	0.1	0.18	0.22	0.13	0.18	0.15	0.03
Un-ionized Ammonia (as N)	0.02	0.007	0.002	0.001	0.001	0.001	0.002	0.002	0.001	0.001	0.000
Total Ammonia (as N, for calculations)		0.34	0.19	0.09	0.1	0.18	0.22	0.13	0.18	0.15	0.03
Nitrate (as N)		0.28	0.66	0.40	0.32	0.81	0.39	0.49	0.46	<0.10	0.39
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate											
E.coli (5TMPN/100ml)	100	680	5	5200	164	1330	1420	17	190	42	130
Total BOD ₅		2	1	2	<1	<1	2	<1	<1	3	2
Chloride		792	943	34	170	790	1240	764	647	297	196
Total Phosphorus	0.03	0.10	0.09	0.29	0.08	0.07	0.11	0.08	0.12	0.08	0.20
Total Suspended Solids		6	14	24	22	11	11	5	12	35	24

Notes:

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Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW6	SW6	SW6	SW6	SW6	SW7	SW7	SW7	SW7	SW7
		Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.
		2015-03-12	2015-05-13	2015-06-09	2015-09-30	2015-10-29	2007-10-19	2007-12-05	2008-03-27	2008-08-06	2008-10-31
		Event Type	Freshet	Dry	Wet	Dry	Wet	Wet	Dry	Freshet	Wet
Event Phase		Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction
Field Analyses											
Air Temperature (K)		272.2	273.2	289.7	285.9	283.0	292.2	265.3	275.1	295.2	283.0
pH (unitless)	6.5 - 8.5	6.7	7.8	7.5	8.0	7.9	7.1	8.4	8.3	7.8	6.9
Conductivity (µS/cm)		4380	6020	1145	1295	785	1281	1360	515	1654	1171
Dissolved Oxygen (Cold Water Biota)	>5 to >8	9.1	8.9	13.4	6.1	7.3	9.7	19.6	13.4	-	7.8
Temperature (°C)		0.2	12.3	17.3	17.6	11.0	19.6	0.4	3.8	24.3	11.0
Temperature-based DO objective*	calculated	7.7	6.1	5.6	5.5	6.3	5.3	7.7	7.2	4.9	6.3
Appearance		Clear	Clear	Slightly cloudy grey	Clear yellowish	slightly cloudy	cloudy brown	clear	clear yellow	clear yellowish	clear
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.6	7.7	7.9	8.1	7.7	7.5	7.8	7.9	7.8	7.9
Total Kjeldahl Nitrogen (TKN)		1.87	0.75	1.37	0.63	1.04	1.56	1.27	0.78	1.53	0.41
Total Ammonia (as N)		0.57	0.1	0.22	0.06	0.03	0.2	0.37	0.09	0.12	0.16
Un-ionized Ammonia (as N)	0.02	0.000	0.001	0.002	0.002	0.000	0.001	0.008	0.002	0.004	0.000
Total Ammonia (as N, for calculations)		0.57	0.1	0.22	0.06	0.03	0.2	0.37	0.09	0.12	0.16
Nitrate (as N)		<2	<5	0.35	0.29	2.96	0.52	4.30	0.49	<0.10	<0.10
Nitrite (as N)		<2	<5	<0.25	<0.25	<0.25	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate							-	-	-	-	-
E.coli (5TMPN/100ml)	100	1910	1300	7800	1250	1700	4300		417	162	90
Total BOD ₅		7	<5	<5	<5	<5	9	1	<1	6	1
Chloride		1640	3040	249	277	129	251	254	99	330	164
Total Phosphorus	0.03	0.20	0.06	0.18	0.06	0.12	0.39	0.10	0.10	0.24	0.10
Total Suspended Solids		11	<10	45	<10	14	96	4	16	11	12

Notes:

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Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter	Event Type Event Phase	SW7	SW7	SW7	SW7	SW7	SW7	SW7	SW7	SW7	SW7
		Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.
		2008-12-16	2009-02-13	2009-04-06	2009-06-18	2009-09-10	2009-12-01	2010-03-09	2010-06-16	2010-09-03	2010-10-05
		Wet	Dry	Freshet	Wet	Dry	Wet	Freshet	Wet	Dry	Wet
		Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Pre-Construction	Construction	Construction	Construction
Field Analyses											
Air Temperature (K)		266.8	271.0	274.4	287.8	291.6	278.1	277.1	293.0	294.8	282.2
pH (unitless)	6.5 - 8.5	7.5	7.8	7.2	8.2	7.9	7.9	7.5	7.9	7.3	7.6
Conductivity (µS/cm)		1070	1429	470	1422	1810	922	375	960	1755	944
Dissolved Oxygen (Cold Water Biota)	>5 to >8	14.2	11.5	12.0	6.8	1.8	14.4	12.8	6.1	2.0	10.5
Temperature (°C)		0.0	2.4	6.5	17.2	21.5	7.9	5.3	24.1	23.9	12.7
Temperature-based DO objective*	calculated	7.7	7.4	6.8	5.6	5.1	6.6	7.0	4.9	4.9	6.1
Appearance		clear yellowish	clear yellowish	slightly cloudy light brown	yellowish	cloudy greyish	clear yellowish	cloudy yellowish	clear	Cloudy Grey	cloudy brown
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.8	7.9	7.8	7.8	7.8	7.9	7.7	7.9	8.0	7.8
Total Kjeldahl Nitrogen (TKN)		0.91	0.85	1.65	0.66	1.34	0.81	0.7	1.21	3.83	1.19
Total Ammonia (as N)		0.08	0.14	0.1	0.14	0.67	0.18	0.17	0.2	1.18	0.19
Un-ionized Ammonia (as N)	0.02	0.000	0.001	0.000	0.007	0.021	0.002	0.001	0.008	0.012	0.002
Total Ammonia (as N, for calculations)		0.08	0.14	0.1	0.14	0.67	0.18	0.17	0.2	1.18	0.19
Nitrate (as N)		0.99	0.81	0.42	0.60	<0.10	0.50	0.30	0.27	<1.0	1.79
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<1.0	<0.10
Dissolved Nitrite + Nitrate		-	-	-	-	-	-	-	-	-	-
E.coli (5TMPN/100ml)	100	316	1200	360	4180	90	141	930	790	10	820
Total BOD ₅		2	1	2	2	2	<1	3	3	10	2
Chloride		194	376	70	276	482	142	65	223	321	184
Total Phosphorus	0.03	0.19	0.15	0.30	0.10	0.01	0.20	0.15	0.21	0.95	0.14
Total Suspended Solids		18	9	35	23	26	13	19	32	1980	185

Notes:

· All parameters are mg/L unless otherwise indicated.

· PWQO - Provincial Water Quality Objectives (1999)

· Shading indicates parameters exceed PWQO

* - Twelve Mile Creek - Cold Water Biota Criteria relative to temperature ($y = 7.7259e^{-0.019x}$)

** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW7	SW7	SW7	SW7	SW7	SW7	SW7	SW7	SW7	SW7
		Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.
		2011-03-29	2011-06-06	2011-06-24	2011-09-30	2011-11-29	2012-03-15	2012-04-25	2012-07-04	2012-07-27	2012-10-10
		Dry	Freshet	Wet	Dry	Wet	Dry	Freshet	Wet	Wet	Dry
Event Type	Event Phase	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Field Analyses											
Air Temperature (K)		271.4	292.2	292.4	286.2	279.4	285.5	279.5	273.2	296.3	282.1
pH (unitless)	6.5 - 8.5	8.4	8.0	7.7	8.1	8.1	7.3	7.9	7.8	7.7	7.8
Conductivity (µS/cm)		2710	2887	2093	622	215	2580	1200	2230	1536	740
Dissolved Oxygen (Cold Water Biota)	>5 to >8	14.2	17.5	2.0	7.4	11.1	8.1	8.9	6.1	5.6	7.7
Temperature (°C)		5.5	24.5	21.0	16.0	6.9	6.4	12.2	24.7	25.3	12.6
Temperature-based DO objective*	calculated	7.0	4.9	5.2	5.7	6.8	6.8	6.1	4.8	4.8	6.1
Appearance		clear yellowish		yellowish	cloudy	brownish	yellowish	clear	brownish	yellowish	cloudy brown
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	7.9	8.2	7.8	7.8	7.6	8.0	8.0	7.7	7.6	7.8
Total Kjeldahl Nitrogen (TKN)		1.32	1.13	3.1	0.82	1.08	0.91	1.05	1.95	2.33	1.04
Total Ammonia (as N)		0.3	0.49	0.83	0.03	0.02	0.14	0.12	0.22	0.42	0.16
Un-ionized Ammonia (as N)	0.02	0.009	0.025	0.017	0.001	0.000	0.000	0.002	0.007	0.011	0.002
Total Ammonia (as N, for calculations)		0.3	0.49	0.83	0.03	0.02	0.14	0.12	0.22	0.42	0.16
Nitrate (as N)		0.32	0.15	<0.10	0.64	0.29	0.23	0.43	0.11	0.14	0.65
Nitrite (as N)		<0.10	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate		-	-	-	-	-	-	-	-	-	-
E.coli (5TMPN/100ml)	100	5700	750	170	1760	184	136	1060	60	670	810
Total BOD ₅		2	3	4	1	3	2	2	7	5	5
Chloride		572	668	395	74	15	526	206	330	242	72
Total Phosphorus	0.03	0.13	0.20	0.23	0.12	0.08	0.07	0.11	0.21	0.09	0.11
Total Suspended Solids		14	11	34	24	78	24	19	96	72	52

Notes:

· All parameters are mg/L unless otherwise indicated.

· PWQO - Provincial Water Quality Objectives (1999)

· Shading indicates parameters exceed PWQO

* - Twelve Mile Creek - Cold Water Biota Criteria relative to temperature ($y = 7.7259e^{-0.019x}$)

** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW7	SW7	SW7	SW7	SW7	SW7	SW7	SW7	SW7	SW7
		Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.
		2012-12-05	2013-03-27	2013-05-02	2013-06-13	2013-10-10	2013-12-10	2014-03-18	2014-04-25	2014-06-04	2014-09-24
		Event Type	Wet	Freshet	Dry	Wet	Dry	Wet	Freshet	Dry	Wet
Event Phase		Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Field Analyses											
Air Temperature (K)		274.0	276.6	289.6	289.7	285.7	267.9	273.0	283.1	288.5	288.7
pH (unitless)	6.5 - 8.5	7.9	8.7	7.8	7.7	7.5	7.8	7.6	8.3	7.5	7.4
Conductivity (µS/cm)		1194	3150	3420	372	1452	3870	4660	2950	2540	2100
Dissolved Oxygen (Cold Water Biota)	>5 to >8	7.6	11.3	5.9	7.3	9.7	8.2	8.5	9.9	7.9	7.4
Temperature (°C)		5.3	3.3	12.9	12.4	15.6	0.9	1.2	8.1	19.8	15.8
Temperature-based DO objective*	calculated	7.0	7.3	6.0	6.1	5.7	7.6	7.6	6.6	5.3	5.7
Appearance			Clear	Clear	Cloudy brown	Clear	Clear	Clear	Clear	Clear	Clear
LABORATORY ANALYSES											
pH (unitless)	6.5 - 8.5	8.0	8.1	8.0	7.8	8.1	7.9	7.6	8.0	7.9	7.8
Total Kjeldahl Nitrogen (TKN)		0.75	1.07	1.07	1.48	0.6	0.81	0.76	0.78	0.74	0.49
Total Ammonia (as N)		0.02	0.26	0.1	0.11	0.07	0.22	0.18	0.08	0.12	0.07
Un-ionized Ammonia (as N)	0.02	0.000	0.013	0.002	0.001	0.001	0.001	0.001	0.002	0.001	0.000
Total Ammonia (as N, for calculations)		0.02	0.26	0.1	0.11	0.07	0.22	0.18	0.08	0.12	0.07
Nitrate (as N)		0.27	0.84	0.20	0.26	0.22	0.60	0.34	0.31	0.25	<0.10
Nitrite (as N)		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Dissolved Nitrite + Nitrate		-									
E.coli (5TMPN/100ml)	100	210	78	13	5300	36	1070	480	7	210	5
Total BOD ₅		3	2	2	3	<1	3	2	<1	<1	<1
Chloride		155	924	729	36	166	962	1140	673	525	266
Total Phosphorus	0.03	0.09	0.08	0.07	0.26	0.08	0.08	0.10	0.09	0.13	0.09
Total Suspended Solids		7	6	9	48	7	7	9	5	16	11

Notes:

· All parameters are mg/L unless otherwise indicated.

· PWQO - Provincial Water Quality Objectives (1999)

· Shading indicates parameters exceed PWQO

* - Twelve Mile Creek - Cold Water Biota Criteria relative to temperature ($y = 7.7259e^{-0.019x}$)

** - E.coli results may be elevated due to 1-day lab analysis delay

Table C-1

Surface Water Quality

Regional Road 20 Redevelopment



Parameter		SW7	SW7	SW7	SW7	SW7	SW7
		Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.	Merrittville Hwy.
		2014-12-01	2015-03-12	2015-05-13	2015-06-09	2015-09-30	2015-10-29
		Wet	Freshet	Dry	Wet	Dry	Wet
Event Type		Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction	Post-Construction
Event Phase							
Field Analyses							
Air Temperature (K)		273.9	272.2	273.2	289.7	285.9	283.0
pH (unitless)	6.5 - 8.5	7.7	6.5	7.9	7.3	8.1	8.1
Conductivity (µS/cm)		3110	5520	5360	1583	1253	821
Dissolved Oxygen (Cold Water Biota)	>5 to >8	7.7	9.2	8.8	16.4	5.1	7.0
Temperature (°C)		2.1	0.0	14.8	17.5	16.5	11.2
Temperature-based DO objective*	calculated	7.4	7.7	5.8	5.5	5.6	6.2
Appearance		Clear	Clear	Slightly cloudy	Slight cloudy grey brown	Clear yellowish	slightly cloudy
LABORATORY ANALYSES							
pH (unitless)	6.5 - 8.5	7.8	7.7	8.0	7.9	8.0	7.7
Total Kjeldahl Nitrogen (TKN)		1.13	1.78	1.04	1.65	0.64	0.89
Total Ammonia (as N)		0.03	0.55	0.04	0.23	0.02	0.03
Un-ionized Ammonia (as N)	0.02	0.000	0.000	0.001	0.001	0.001	0.001
Total Ammonia (as N, for calculations)		0.03	0.55	0.04	0.23	0.02	0.03
Nitrate (as N)		0.32	<2.5	<2.5	0.39	0.29	2.66
Nitrite (as N)		<0.10	<2.5	<2.5	<0.25	<0.25	<0.25
Dissolved Nitrite + Nitrate							
E.coli (5TMPN/100ml)	100	190	1850	1000	11300	770	1700
Total BOD ₅		2	7	<5	<5	<5	<5
Chloride		237	2080	1670	354	261	141
Total Phosphorus	0.03	0.20	0.19	0.14	0.23	0.08	0.10
Total Suspended Solids		12	<10	16	34	<10	13

Notes:

· All parameters are mg/L unless otherwise indicated.

· PWQO - Provincial Water Quality Objectives (1999)

· Shading indicates parameters exceed PWQO

* - Twelve Mile Creek - Cold Water Biota Criteria relative to temperature ($y = 7.7259e^{-0.019x}$)

** - *E.coli* results may be elevated due to 1-day lab analysis delay

Figure C-1 Surface Water Quality Cataract Road Tributary

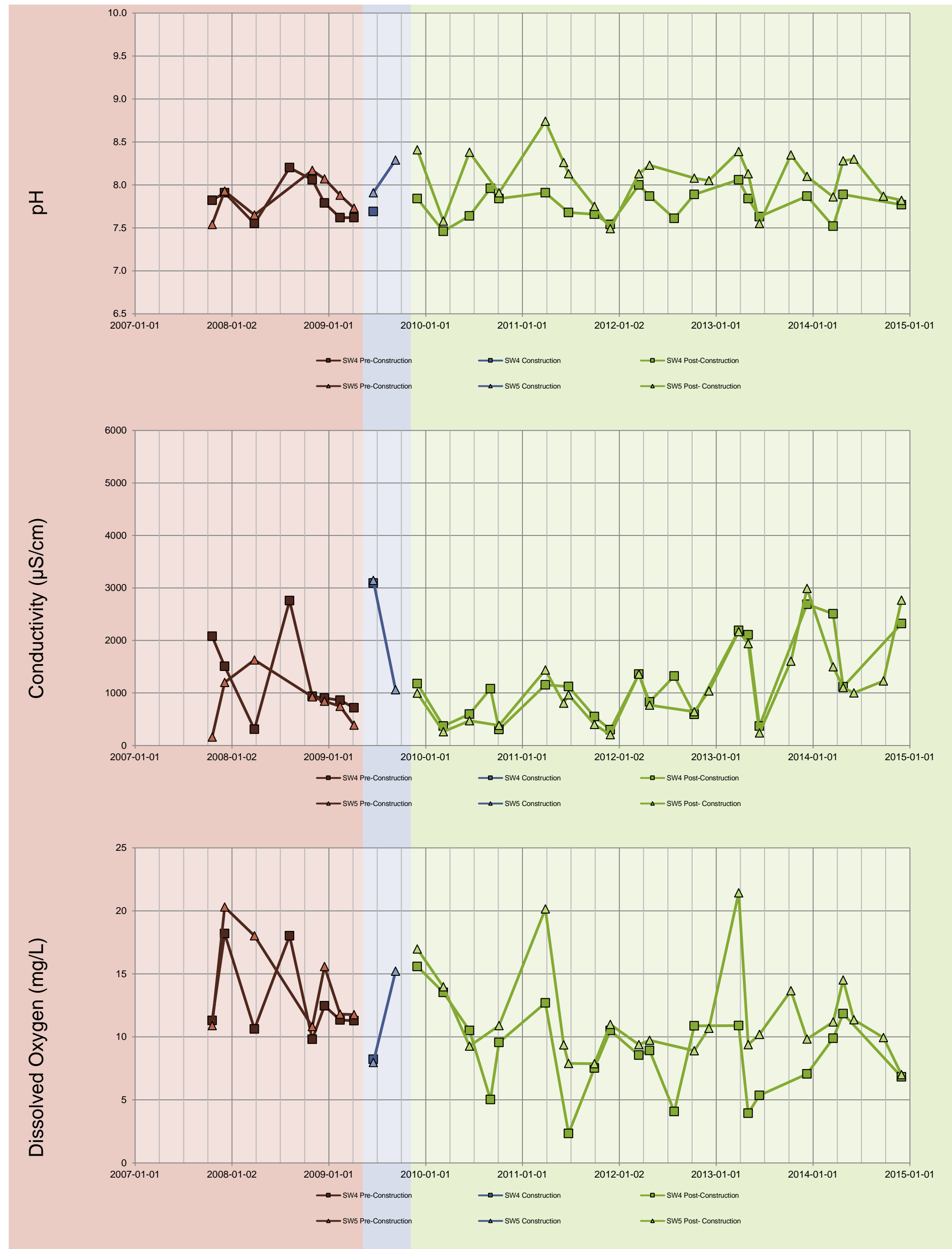


Figure C-1 Surface Water Quality Cataract Road Tributary

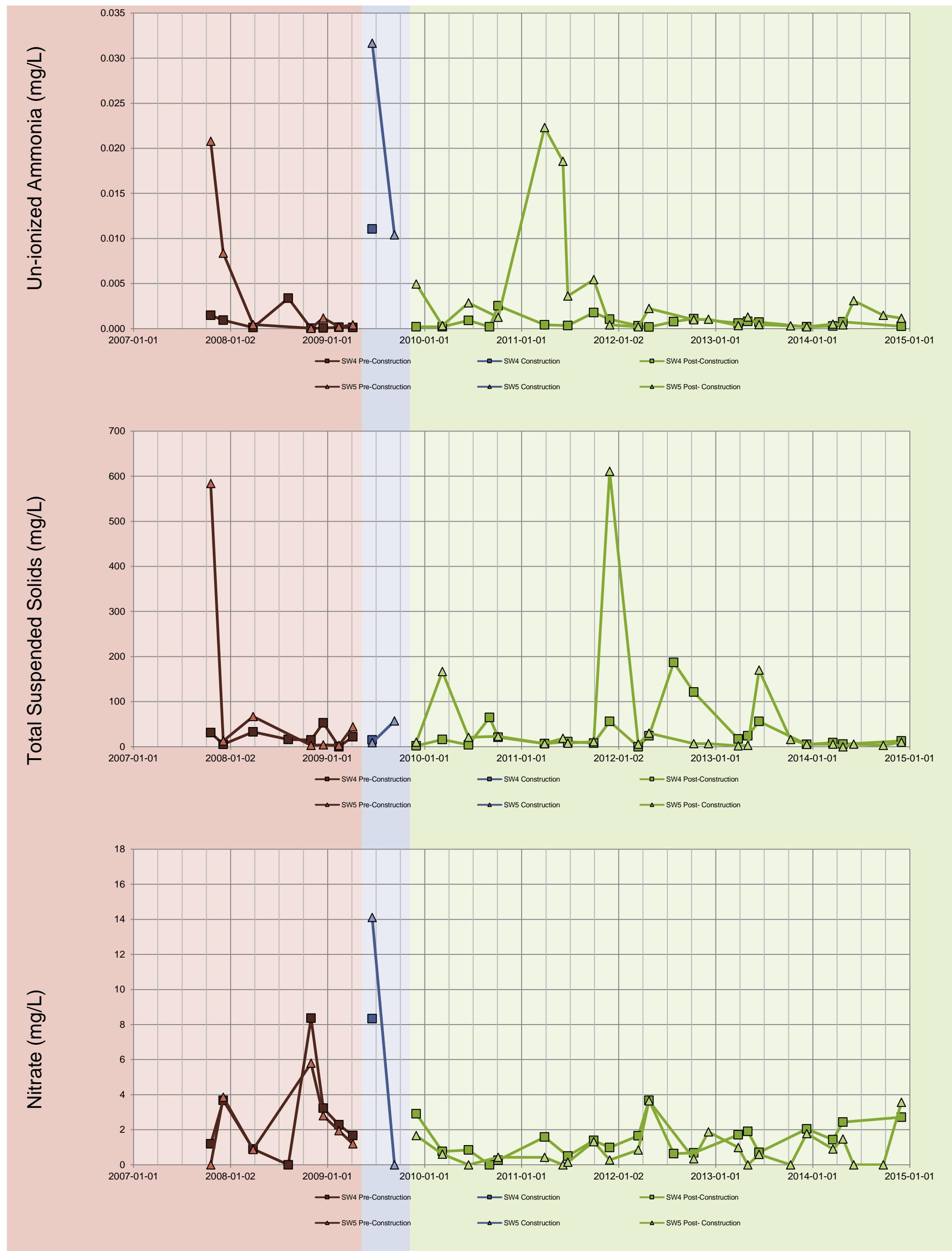


Figure C-1 Surface Water Quality Cataract Road Tributary

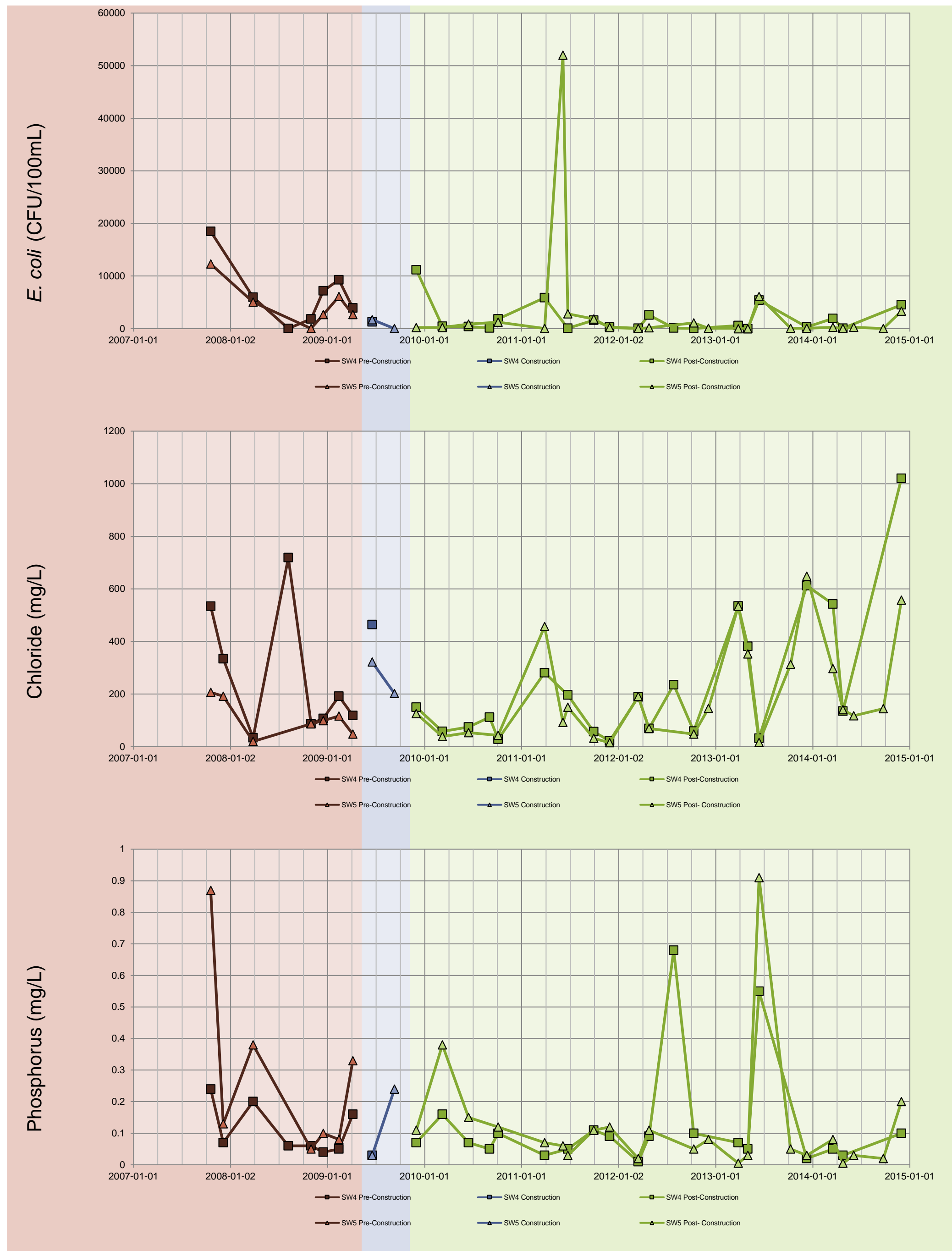


Figure C-1 Surface Water Quality Cataract Road Tributary

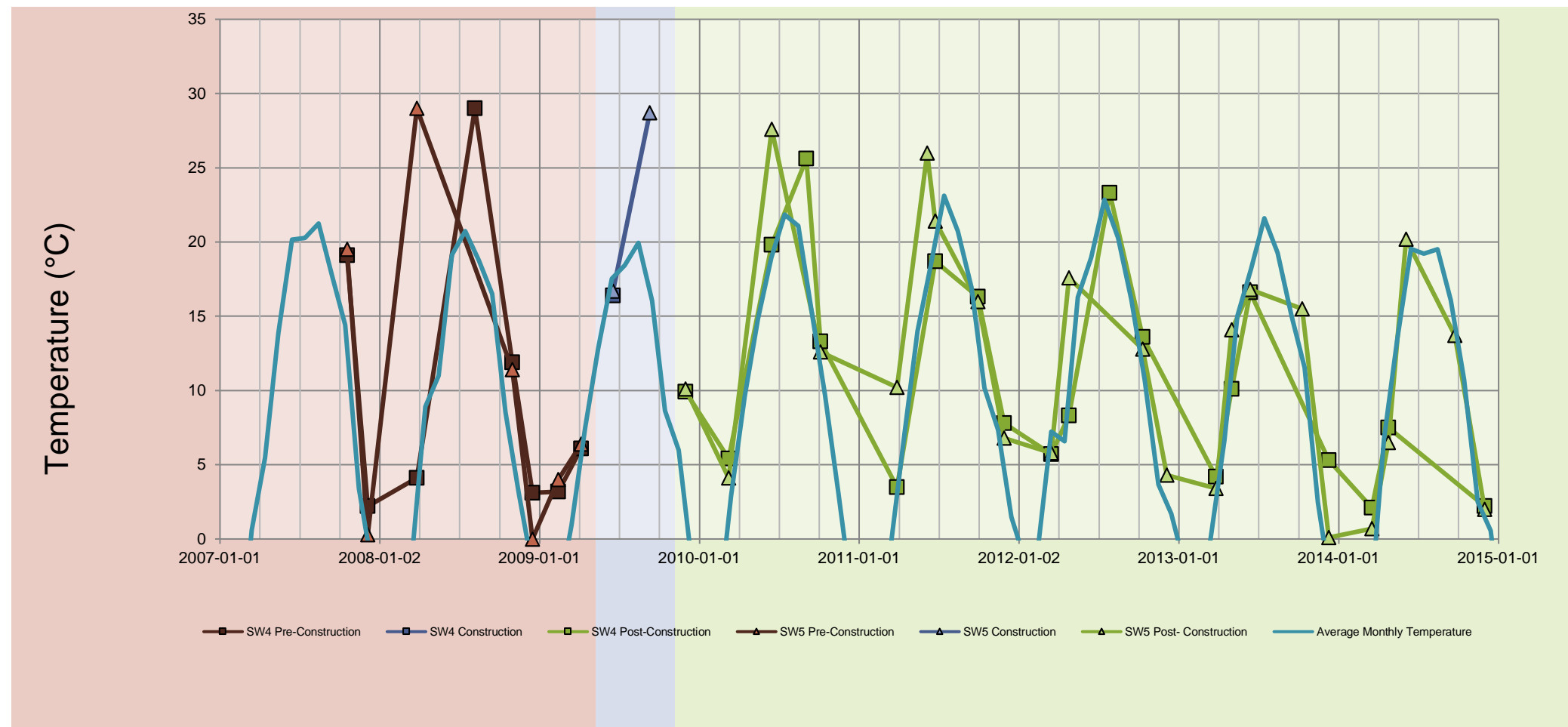


Figure C-2 Surface Water Quality Rice Road Tributary

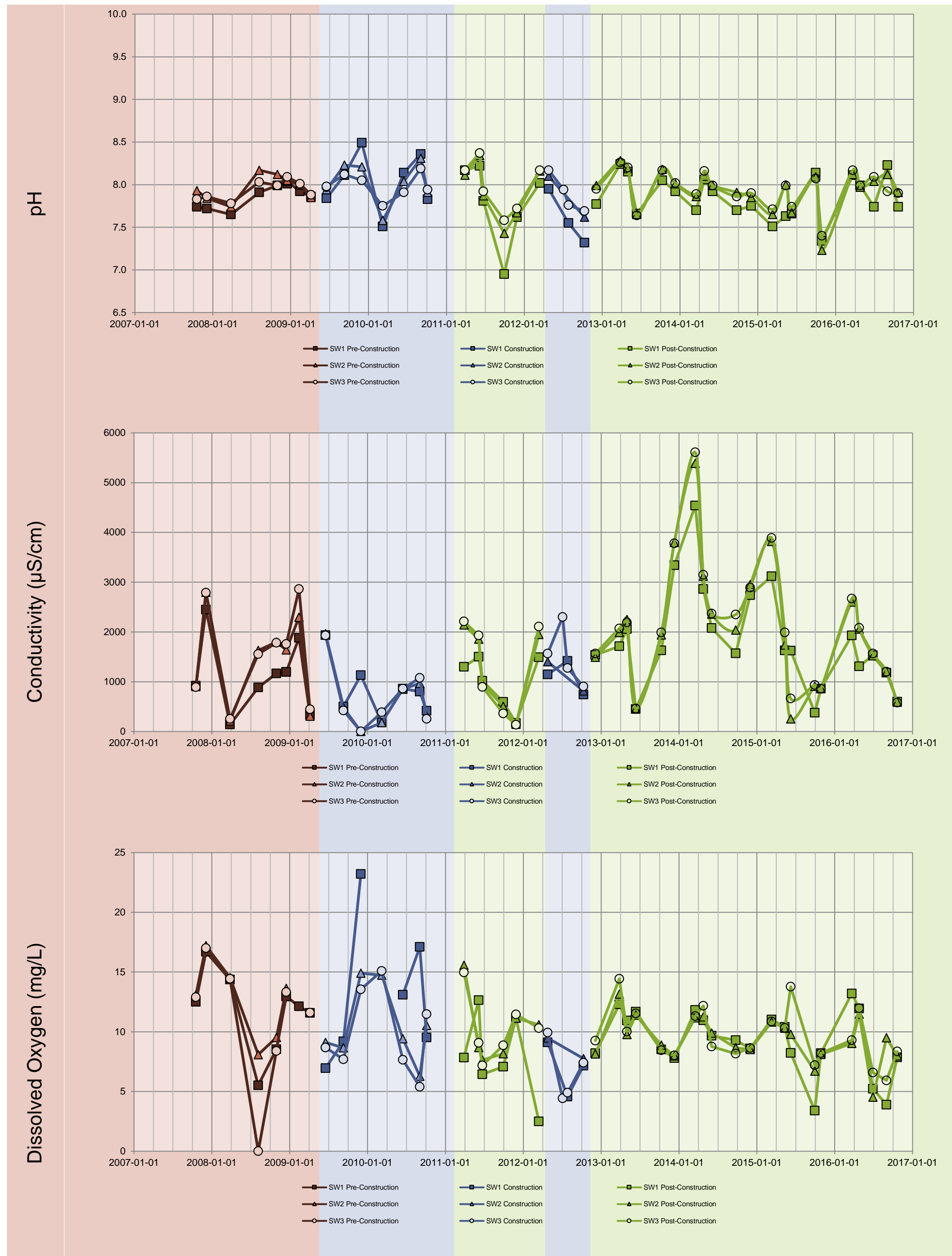


Figure C-2 Surface Water Quality Rice Road Tributary

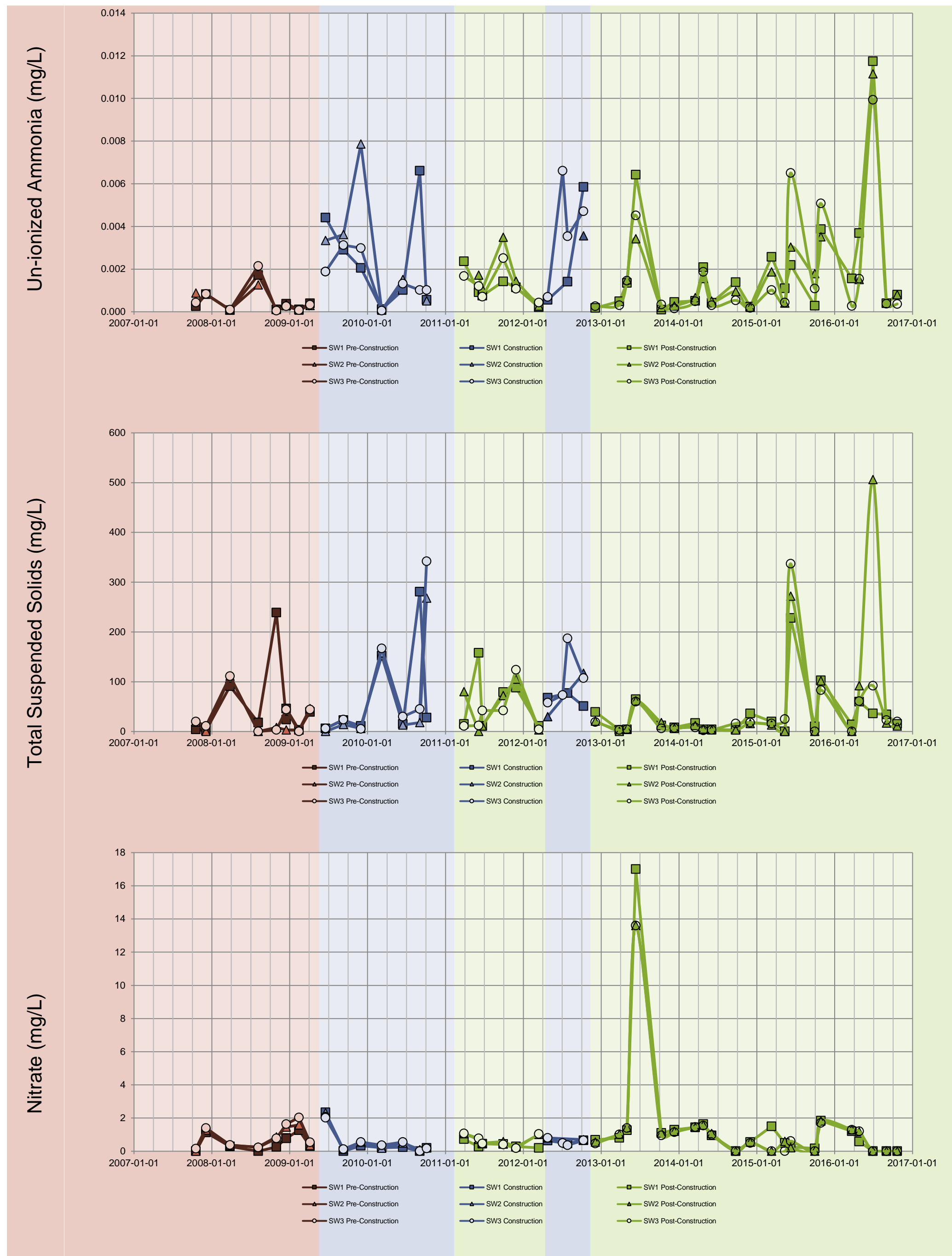


Figure C-2 Surface Water Quality Rice Road Tributary

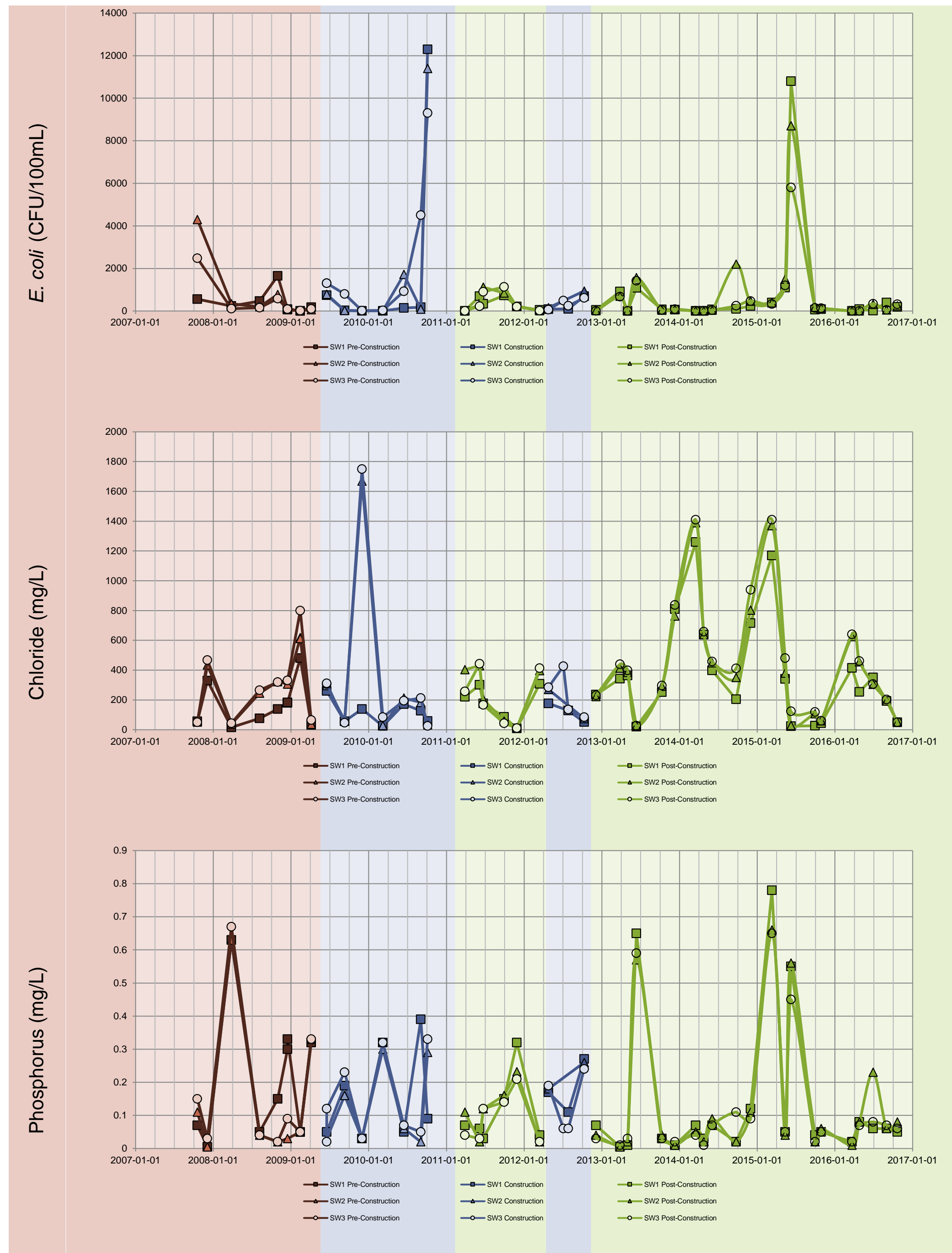


Figure C-2 Surface Water Quality Rice Road Tributary

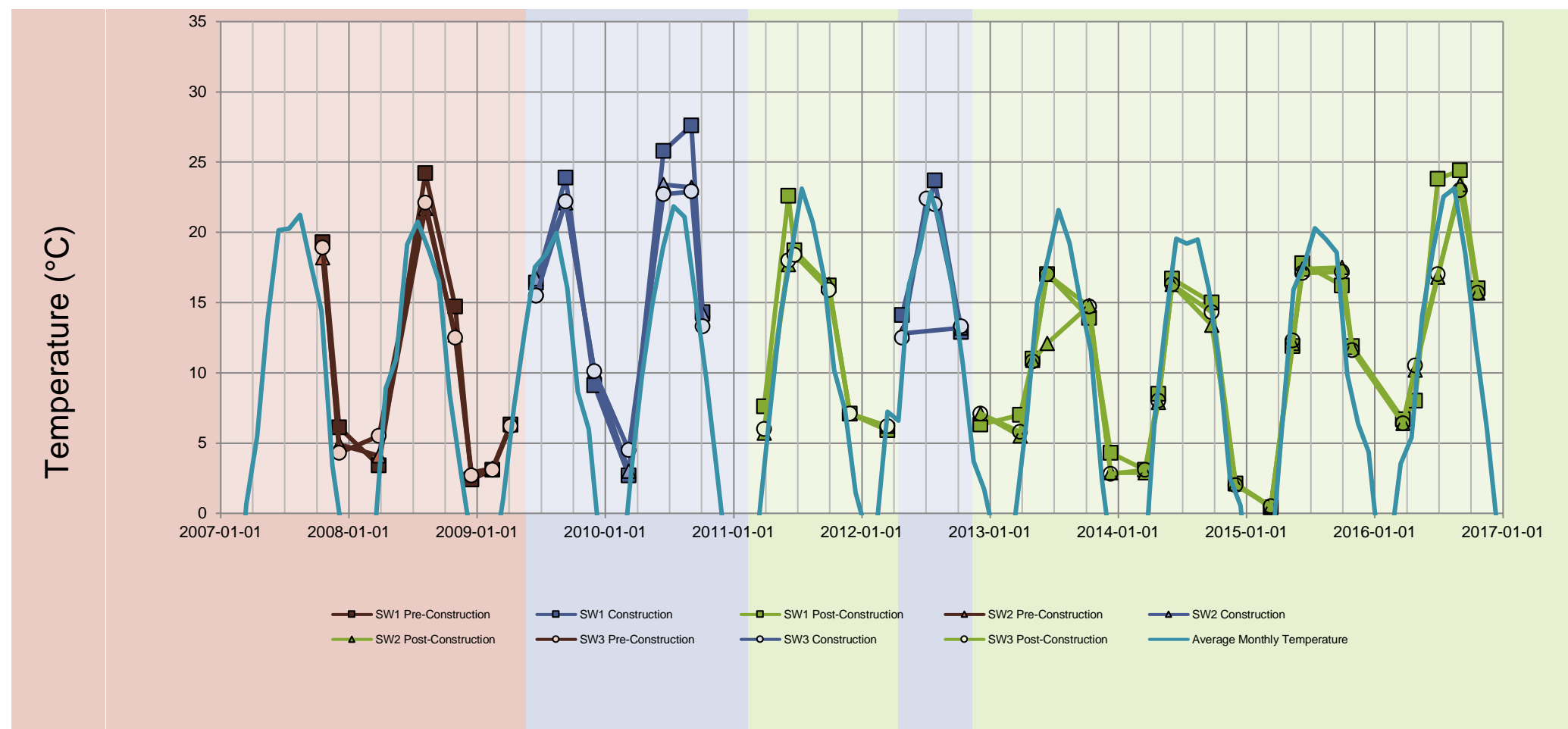


Figure C-3 Surface Water Quality Merrittville Highway Tributary

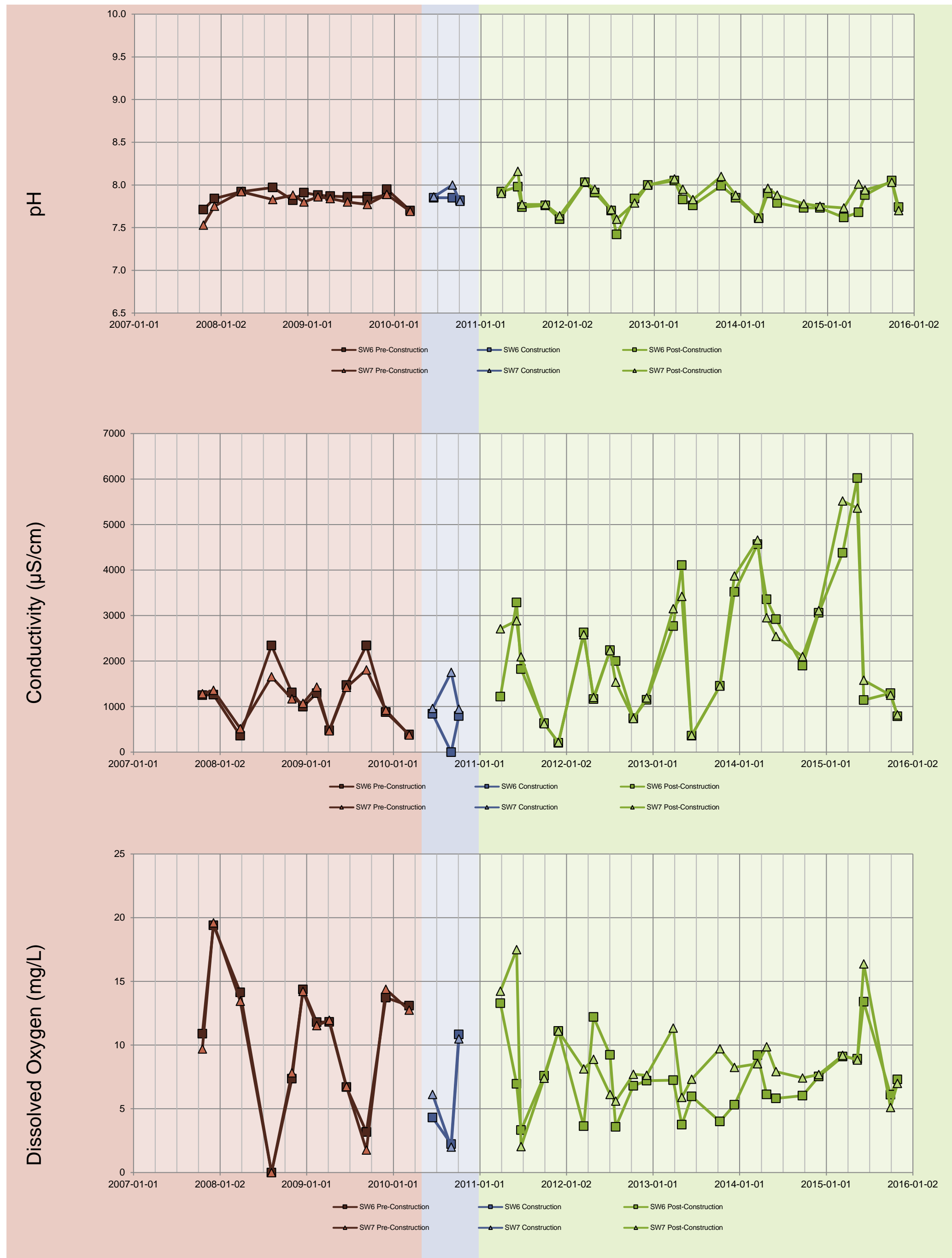


Figure C-3 Surface Water Quality Merrittville Highway Tributary

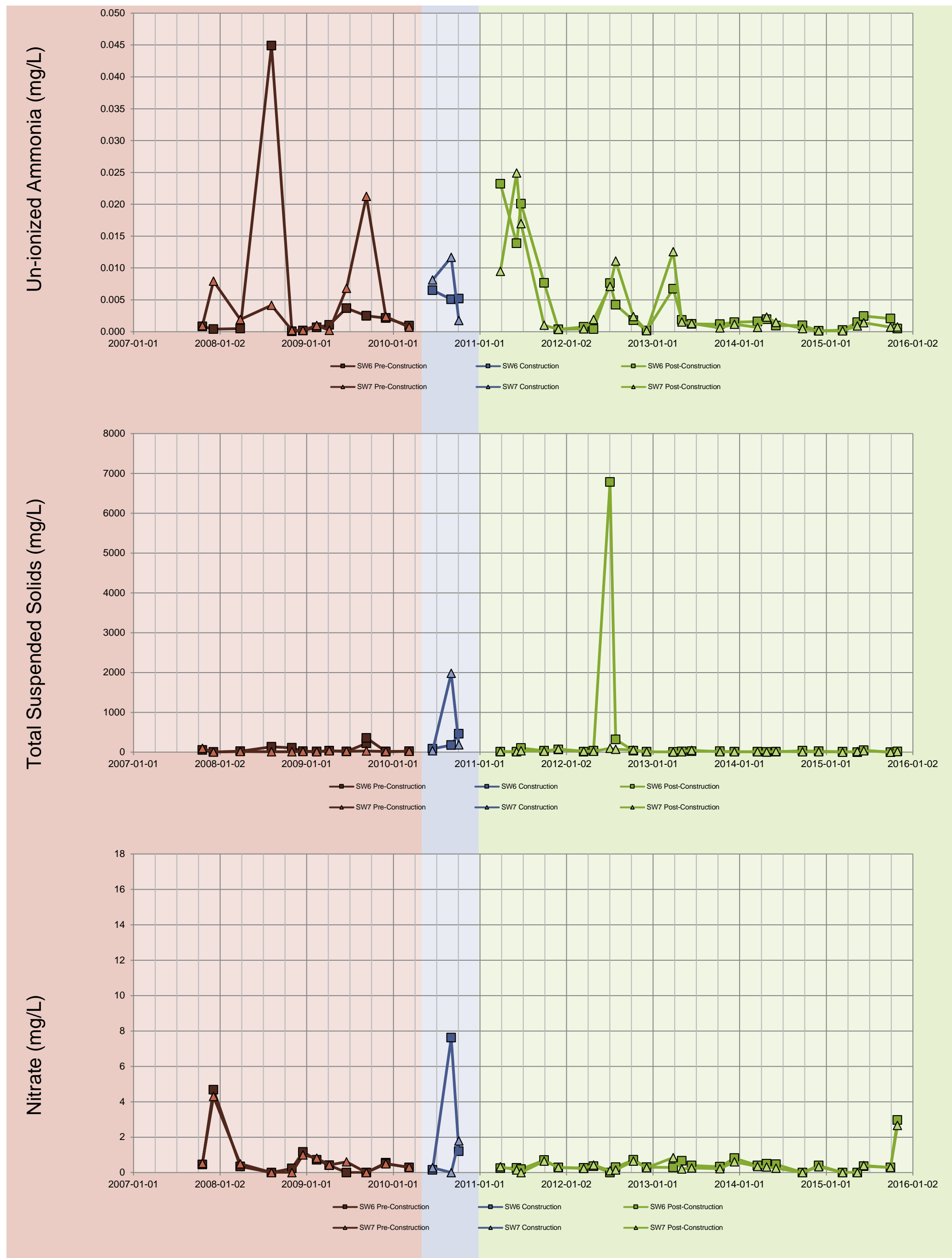


Figure C-3 Surface Water Quality Merrittville Highway Tributary

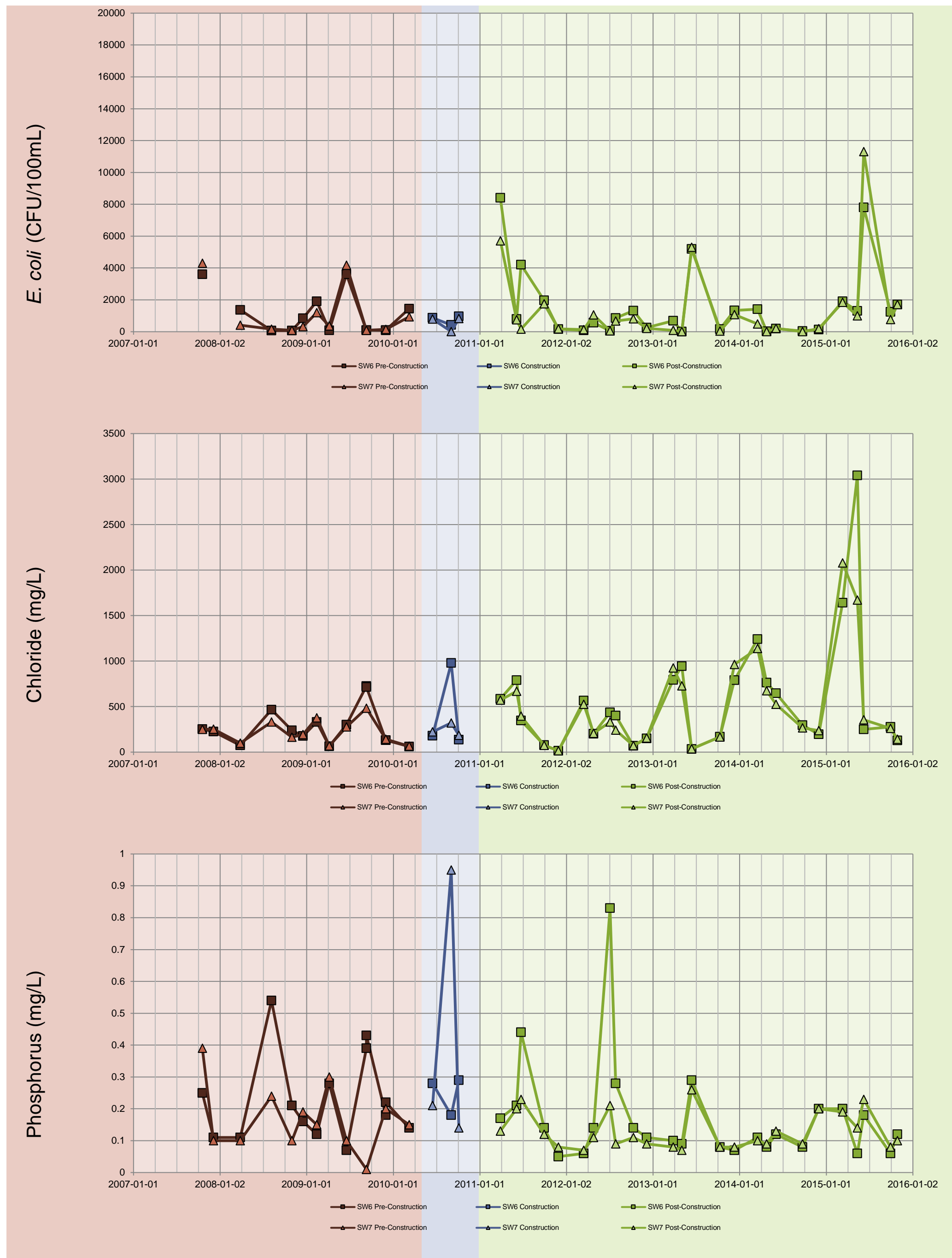
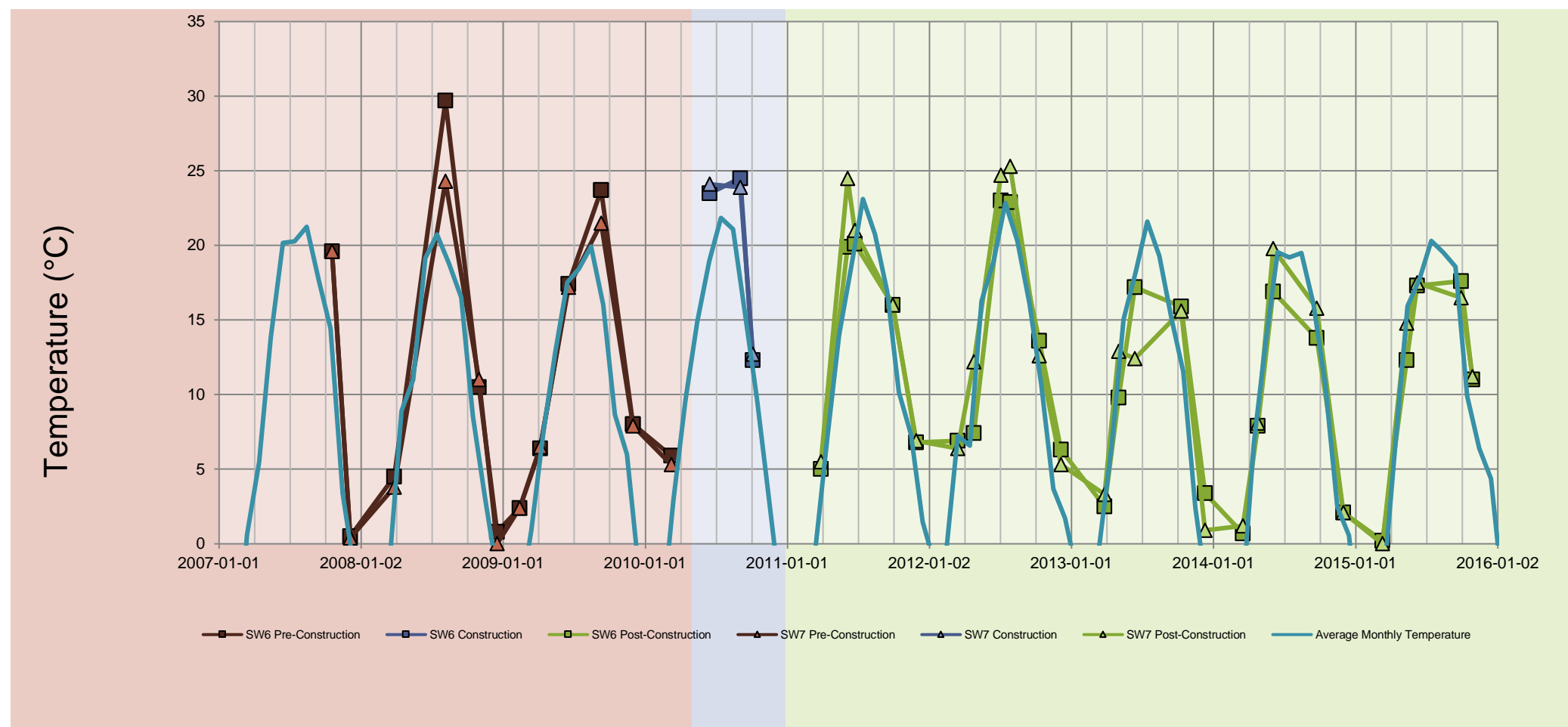


Figure C-3 Surface Water Quality Merrittville Highway Tributary



CLIENT NAME: WSP CANADA INC.
55 KING STREET, 7TH FLOOR
ST CATHARINES, ON L2R3H5
(905) 687-1771

ATTENTION TO: Craig Leger

PROJECT: 111-53018-00

AGAT WORK ORDER: 16T079620

MICROBIOLOGY ANALYSIS REVIEWED BY: Inesa Alizarchyk, Inorganic Lab Supervisor

WATER ANALYSIS REVIEWED BY: Sofka Pehlyova, Senior Analyst

DATE REPORTED: Mar 31, 2016

PAGES (INCLUDING COVER): 7

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 16T079620

PROJECT: 111-53018-00

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: WSP CANADA INC.

SAMPLING SITE: Fonthill - Regional Road 20

ATTENTION TO: Craig Leger

SAMPLED BY: Steve Kellerman

Microbiological Analysis (water)

DATE RECEIVED: 2016-03-23

DATE REPORTED: 2016-03-31

		SAMPLE DESCRIPTION:		SW1	SW2	SW3	SW100
		SAMPLE TYPE:		Water	Water	Water	Water
		DATE SAMPLED:		3/22/2016	3/22/2016	3/22/2016	3/22/2016
Parameter	Unit	G / S	RDL	7457566	7457567	7457572	7457582
Escherichia coli	CFU/100mL	2	ND	ND	ND	ND	ND

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

7457566-7457582 RDL >1 indicates dilutions of the sample.

ND - Not Detected.

Certified By:



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 16T079620

PROJECT: 111-53018-00

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: WSP CANADA INC.

SAMPLING SITE: Fonthill - Regional Road 20

ATTENTION TO: Craig Leger

SAMPLED BY: Steve Kellerman

Inorganic Chemistry (Water)

DATE RECEIVED: 2016-03-23

DATE REPORTED: 2016-03-31

		SAMPLE DESCRIPTION:		SW1		SW2		SW3		SW100	
		SAMPLE TYPE:		Water		Water		Water		Water	
		DATE SAMPLED:		3/22/2016		3/22/2016		3/22/2016		3/22/2016	
Parameter	Unit	G / S	RDL	7457566	RDL	7457567	7457572	RDL	7457582		
BOD (5)	mg/L		5	6	5	<5	<5	5	6		
pH	pH Units		NA	8.11	NA	8.12	8.17	NA	8.07		
Total Suspended Solids	mg/L		10	14	10	<10	<10	10	15		
Chloride	mg/L		1.0	415	2.0	625	640	1.0	409		
Nitrate as N	mg/L		0.5	1.2	1.0	1.3	1.3	0.5	1.1		
Nitrite as N	mg/L		0.5	<0.5	1.0	<1.0	<1.0	0.5	<0.5		
Ammonia as N	mg/L		0.02	<0.02	0.02	<0.02	<0.02	0.02	<0.02		
Total Phosphorus	mg/L		0.01	0.02	0.01	0.01	0.02	0.01	0.02		
Total Kjeldahl Nitrogen	mg/L		0.10	0.79	0.10	0.42	0.46	0.10	0.85		

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

7457566-7457582 Elevated RDLs for Anions indicate the degree of sample dilutions prior to analyses to keep analytes within the calibration range, reduce matrix interference and/or to avoid contaminating the instrument.

Certified By:

Sofia Pehlyova

Quality Assurance

CLIENT NAME: WSP CANADA INC.

PROJECT: 111-53018-00

SAMPLING SITE: Fonthill - Regional Road 20

AGAT WORK ORDER: 16T079620

ATTENTION TO: Craig Leger

SAMPLED BY: Steve Kellerman

Microbiology Analysis

RPT Date: Mar 31, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Microbiological Analysis (water)

Escherichia coli 7457566 7457566 ND ND NA < 1

Comments: ND - Not Detected, NA - % RPD Not Applicable

Certified By:



Quality Assurance

CLIENT NAME: WSP CANADA INC.

PROJECT: 111-53018-00

SAMPLING SITE: Fonthill - Regional Road 20

AGAT WORK ORDER: 16T079620

ATTENTION TO: Craig Leger

SAMPLED BY: Steve Kellerman

Water Analysis

RPT Date: Mar 31, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Inorganic Chemistry (Water)															
BOD (5)	7456577		449	470	4.6%	< 5	103%	75%	125%	NA			NA		
pH	7458510		8.05	8.11	0.7%	NA	99%	90%	110%	NA			NA		
Total Suspended Solids	7457577	7457577	90	95	5.4%	< 10	102%	80%	120%	NA			NA		
Chloride	7457487		71.0	67.0	5.8%	< 0.10	97%	90%	110%	101%	90%	110%	96%	80%	120%
Nitrate as N	7457487		<0.25	<0.25	NA	< 0.05	102%	90%	110%	107%	90%	110%	108%	80%	120%
Nitrite as N	7457487		<0.25	<0.25	NA	< 0.05	NA	90%	110%	95%	90%	110%	93%	80%	120%
Ammonia as N	7457572	7457572	<0.02	<0.02	NA	< 0.02	90%	90%	110%	97%	90%	110%	94%	80%	120%
Total Phosphorus	7460336		0.17	0.16	6.1%	< 0.01	106%	90%	110%	102%	90%	110%	104%	70%	130%
Total Kjeldahl Nitrogen	7455677		0.64	0.67	4.6%	< 0.10	102%	80%	120%	100%	80%	120%	95%	70%	130%

Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By:



Method Summary

CLIENT NAME: WSP CANADA INC.

AGAT WORK ORDER: 16T079620

PROJECT: 111-53018-00

ATTENTION TO: Craig Leger

SAMPLING SITE: Fonthill - Regional Road 20

SAMPLED BY: Steve Kellerman

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Microbiology Analysis			
Escherichia coli	MIC-93-7010	EPA 1604	Membrane Filtration
Water Analysis			
BOD (5)	INOR-93-6006	SM 5210 B	DO METER
pH	INOR-93-6000	SM 4500-H+ B	PC TITRATE
Total Suspended Solids	INOR-93-6028	SM 2540 D	BALANCE
Chloride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrate as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INOR-93-6059	QuikChem 10-107-06-1-J & SM 4500 NH3-F	LACHAT FIA
Total Phosphorus	INOR-93-6022	SM 4500-P B&E	SPECTROPHOTOMETER
Total Kjeldahl Nitrogen	INOR-93-6048	QuikChem 10-107-06-2-I & SM 4500-Norg D	LACHAT FIA



AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
web@agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water intended for human consumption)

Report Information:

Company: VSP
Contact: Craig Leger St. Catharines Office
Address: 905-687-1771 Fax: 905-687-1773
Phone: 905-687-1771
Reports to be sent to: Craig.Leger@vspgroup.com
1. Email: Craig.Leger@vspgroup.com
2. Email:

Project Information:

Project: Regional Road 20 11/53018-02
Site Location: East Hill
Sampled By: SA
AGAT Quote #: 18876 PO:

Invoice Information:

Company: Bill To Same: Yes ☒ No ☐
Contact:
Address:
Email:

Please note: If quotation number is not provided, client will be billed full price for analysis.

Regulatory Requirements:

(Please check all applicable boxes)
☐ Regulation 153/04
Table Indicate One
☐ Sewer Use
☐ Sanitary
☐ Ind/Com
☐ Res/Park
☐ Agriculture
☐ CCME
☒ Prov. Water Quality Objectives (PMOQ)
Soil Texture (Check One)
☐ Coarse
☐ Fine
Region Indicate One
☐ Other

Is this submission for a Record of Site Condition?

☐ Yes ☒ No

Report Guideline on Certificate of Analysis

☐ Yes ☒ No

Sample Matrix Legend

B Biota
GW Ground Water
O Oil
P Paint
S Soil
SD Sediment
SW Surface Water

Metals and Inorganics

Metal Scan

Hydride Forming Metals

Client Custom Metals

ORPs: ☐ B-HWS ☐ Cl ☐ CN
☐ Cr⁶⁺ ☐ EC ☐ FOC ☐ NO₃/NO₂
☐ Total N ☐ Hg ☐ pH ☐ SAR
Nutrients: ☐ TP ☐ NH₃ ☐ TKN
☐ NO₃ ☐ NO₂ ☐ NO₃/NO₂

Volatiles: ☐ VOC ☐ BTEX ☐ THM

CCME Fractions 1 to 4

ABNs

PAHs

Chlorophenols

PCBs

Organochlorine Pesticides

TCLP Metals/Inorganics

Sewer Use

(Check Applicable)

See on per grade

Laboratory Use Only

Work Order #: 161079620

Cooler Quantity: 4.7 4.9 4.9

Arrival Temperatures: 4.7 4.9 4.9

Custody Seal Intact: ☐ Yes ☐ No ☐ N/A

Notes:

Turnaround Time (TAT) Required:

Regular TAT

☒ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ 1 Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT

*TAT is exclusive of weekends and statutory holidays

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Metals	Metal	Hydrid	Client	ORPs: <input type="checkbox"/> Cr ⁶⁺ <input type="checkbox"/> Total	Nutrie <input type="checkbox"/> NO ₃	Volat	CCME	ABNs	PAHs	Chloro	PCBs	Organ	TCLP	Sewer
SV1	22/12/16		5	SV																
SV2																				
SV3																				
SV6																				
SV100																				

Samples Relinquished By (Print Name and Sign):

Date:

Time:

Samples Received By (Print Name and Sign):

Date:

Time:

Page

of

1

Samples Relinquished By (Print Name and Sign):

Date:

Time:

Samples Received By (Print Name and Sign):

Date:

Time:

No.

T

021428

CLIENT NAME: WSP CANADA INC.
55 KING STREET, 7TH FLOOR
ST CATHARINES, ON L2R3H5
(905) 687-1771

ATTENTION TO: Craig Leger

PROJECT: 111-53018-00

AGAT WORK ORDER: 16T089209

MICROBIOLOGY ANALYSIS REVIEWED BY: Elizabeth Polakowska, MSc (Animal Sci), PhD (Agri Sci), Inorganic Lab Supervisor

WATER ANALYSIS REVIEWED BY: Parvathi Malemath, Data Reviewer

DATE REPORTED: May 06, 2016

PAGES (INCLUDING COVER): 7

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 16T089209

PROJECT: 111-53018-00

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: WSP CANADA INC.

SAMPLING SITE:RR 20

ATTENTION TO: Craig Leger

SAMPLED BY:Sean Morris

Microbiological Analysis (water)

DATE RECEIVED: 2016-04-27

DATE REPORTED: 2016-05-06

		SAMPLE DESCRIPTION:		SW1	SW100	SW2	SW3
		SAMPLE TYPE:		Water	Water	Water	Water
		DATE SAMPLED:		4/26/2016	4/26/2016	4/26/2016	4/26/2016
Parameter	Unit	G / S	RDL	7516297	7516298	7516304	7516310
Escherichia coli	CFU/100mL	2	90	100	8	8	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

7516297-7516310 RDL >1 indicates dilutions of the sample.

Certified By:

Elizabeth Potokowska



Certificate of Analysis

AGAT WORK ORDER: 16T089209

PROJECT: 111-53018-00

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: WSP CANADA INC.

SAMPLING SITE: RR 20

ATTENTION TO: Craig Leger

SAMPLED BY: Sean Morris

Fonthill Sites - SW Parameters

DATE RECEIVED: 2016-04-27

DATE REPORTED: 2016-05-06

		SAMPLE DESCRIPTION:		SW1	SW100			SW2	SW3
		SAMPLE TYPE:		Water	Water			Water	Water
		DATE SAMPLED:		4/26/2016	4/26/2016			4/26/2016	4/26/2016
Parameter	Unit	G / S	RDL	7516297	7516298	RDL	7516304	RDL	7516310
BOD (5)	mg/L	5	<5	<5	5	5	5	5	<5
pH	pH Units	NA	7.99	8.05	NA	7.97	NA	7.99	7.99
Total Suspended Solids	mg/L	10	60	24	10	92	10	61	61
Chloride	mg/L	0.50	253	248	0.10	456	1.0	461	461
Nitrate as N	mg/L	0.25	0.59	0.58	0.25	1.17	0.5	1.2	1.2
Nitrite as N	mg/L	0.25	<0.25	<0.25	0.25	<0.25	0.5	<0.5	<0.5
Ammonia as N	mg/L	0.02	0.11	0.10	0.02	0.03	0.02	0.03	0.03
Total Phosphorus	mg/L	0.01	0.08	0.09	0.01	0.08	0.01	0.07	0.07
Total Kjeldahl Nitrogen	mg/L	0.10	0.59	0.64	0.10	0.48	0.10	0.50	0.50

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

7516297-7516310 The RDL's were increased for Anions to reflect a dilution of the sample in order to keep the analytes within a valid calibration range of the instruments.

Certified By:



Quality Assurance

CLIENT NAME: WSP CANADA INC.

PROJECT: 111-53018-00

SAMPLING SITE:RR 20

AGAT WORK ORDER: 16T089209

ATTENTION TO: Craig Leger

SAMPLED BY:Sean Morris

Microbiology Analysis

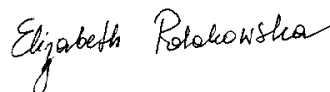
RPT Date: May 06, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE		MATRIX SPIKE	
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper

Microbiological Analysis (water)

Escherichia coli	7515297	ND	ND	NA	< 1
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Comments: ND - Not Detected, NA - % RPD Not Applicable

Certified By:



Quality Assurance

CLIENT NAME: WSP CANADA INC.

PROJECT: 111-53018-00

SAMPLING SITE: RR 20

AGAT WORK ORDER: 16T089209

ATTENTION TO: Craig Leger

SAMPLED BY: Sean Morris

Water Analysis

RPT Date: May 06, 2016

RPT Date: May 06, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Fonthill Sites - SW Parameters

BOD (5)	7516297	7516297	<5	<5	NA	< 5	101%	75%	125%	NA			NA		
pH	7521618		6.80	6.84	0.6%	NA	100%	90%	110%	NA			NA		
Total Suspended Solids	7516252		69	63	9.1%	< 10	98%	80%	120%	NA			NA		
Chloride	7517713		11.3	11.4	0.9%	< 0.10	96%	90%	110%	107%	90%	110%	103%	80%	120%
Nitrate as N	7517713		<0.25	<0.25	NA	< 0.05	98%	90%	110%	108%	90%	110%	109%	80%	120%
Nitrite as N	7517713		<0.25	<0.25	NA	< 0.05	NA	90%	110%	104%	90%	110%	104%	80%	120%
Ammonia as N	7526005		12.0	12.2	1.7%	< 0.02	90%	90%	110%	101%	90%	110%	90%	80%	120%
Total Phosphorus	7516297	7516297	0.08	0.08	0.0%	< 0.01	95%	90%	110%	92%	90%	110%	101%	70%	130%
Total Kjeldahl Nitrogen	7516297	7516297	0.59	0.64	8.1%	< 0.10	102%	80%	120%	101%	80%	120%	97%	70%	130%

Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the RL (Reporting Limit), the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By:



Method Summary

CLIENT NAME: WSP CANADA INC.

PROJECT: 111-53018-00

SAMPLING SITE:RR 20

AGAT WORK ORDER: 16T089209

ATTENTION TO: Craig Leger

SAMPLED BY:Sean Morris

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Microbiology Analysis			
Escherichia coli	MIC-93-7010	EPA 1604	Membrane Filtration
Water Analysis			
BOD (5)	INOR-93-6006	SM 5210 B	DO METER
pH	INOR-93-6000	SM 4500-H+ B	PC TITRATE
Total Suspended Solids	INOR-93-6028	SM 2540 D	BALANCE
Chloride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrate as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INOR-93-6059	QuikChem 10-107-06-1-J & SM 4500 NH3-F	LACHAT FIA
Total Phosphorus	INOR-93-6022	SM 4500-P B&E	SPECTROPHOTOMETER
Total Kjeldahl Nitrogen	INOR-93-6048	QuikChem 10-107-06-2-I & SM 4500-Norg D	LACHAT FIA

CLIENT NAME: WSP CANADA INC.
4 Hughson Street South, Suite 300
Hamilton, ON L8N3Z1
(905) 529-4414

ATTENTION TO: Bailey Walters

PROJECT: 111-53018-00

AGAT WORK ORDER: 16T111241

MICROBIOLOGY ANALYSIS REVIEWED BY: Scott Ross, Operations Manager

WATER ANALYSIS REVIEWED BY: Parvathi Malemath, Data Reviewer

DATE REPORTED: Jul 13, 2016

PAGES (INCLUDING COVER): 8

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 16T111241

PROJECT: 111-53018-00

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: WSP CANADA INC.

SAMPLING SITE:

ATTENTION TO: Bailey Walters

SAMPLED BY:

Microbiological Analysis (water)

DATE RECEIVED: 2016-06-30

DATE REPORTED: 2016-07-13

		SAMPLE DESCRIPTION:		SW1	SW2	SW100	SW3
		SAMPLE TYPE:		Water	Water	Water	Water
		DATE SAMPLED:		6/29/2016	6/29/2016	6/29/2016	6/29/2016
Parameter	Unit	G / S	RDL	7676589	7676595	7676600	7676605
Escherichia coli	CFU/100mL	2	16	316	52	340	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

7676589-7676605 RDL >1 indicates dilutions of the sample.

Certified By:



Certificate of Analysis

AGAT WORK ORDER: 16T111241

PROJECT: 111-53018-00

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: WSP CANADA INC.

ATTENTION TO: Bailey Walters

SAMPLING SITE:

SAMPLED BY:

Inorganic Chemistry (Water)

DATE RECEIVED: 2016-06-30

DATE REPORTED: 2016-07-13

		SAMPLE DESCRIPTION:		SW1	SW2	SW100	SW3
		SAMPLE TYPE:		Water	Water	Water	Water
		DATE SAMPLED:		6/29/2016	6/29/2016	6/29/2016	6/29/2016
Parameter	Unit	G / S	RDL	7676589	7676595	7676600	7676605
BOD (5)	mg/L		5	<5	<5	<5	<5
pH	pH Units	6.5-8.5	NA	7.74	8.04	7.81	8.09
Total Suspended Solids	mg/L		10	36	506	32	92
Chloride	mg/L		0.50	351	305	354	307
Nitrate as N	mg/L		0.25	<0.25	<0.25	<0.25	<0.25
Nitrite as N	mg/L		0.25	<0.25	<0.25	<0.25	<0.25
Total Phosphorus	mg/L	0.03	0.01	0.06	0.23	0.06	0.08
Total Kjeldahl Nitrogen	mg/L		0.10	0.59	0.84	0.53	0.42
Ammonia as N	mg/L		0.02	0.13	0.19	0.14	0.08

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PWQO (mg/L)

7676589-7676605 Samples required dilution prior to analysis for Anions in order to keep the analytes within the calibration range of the instruments and to minimize any matrix interferences; the RDLs were adjusted to reflect the dilution.

Certified By:





AGAT Laboratories

Guideline Violation

AGAT WORK ORDER: 16T111241

PROJECT: 111-53018-00

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: WSP CANADA INC.

ATTENTION TO: Bailey Walters

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	GUIDEVALUE	RESULT
7676589	SW1	PWQO (mg/L)	Inorganic Chemistry (Water)	Total Phosphorus	0.03	0.06
7676595	SW2	PWQO (mg/L)	Inorganic Chemistry (Water)	Total Phosphorus	0.03	0.23
7676600	SW100	PWQO (mg/L)	Inorganic Chemistry (Water)	Total Phosphorus	0.03	0.06
7676605	SW3	PWQO (mg/L)	Inorganic Chemistry (Water)	Total Phosphorus	0.03	0.08

Quality Assurance

CLIENT NAME: WSP CANADA INC.

PROJECT: 111-53018-00

SAMPLING SITE:

AGAT WORK ORDER: 16T111241

ATTENTION TO: Bailey Walters

SAMPLED BY:

Microbiology Analysis


RPT Date: Jul 13, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE		MATRIX SPIKE	
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper

Microbiological Analysis (water)

Escherichia coli	7675333	2	2	NA	< 1
------------------	---------	---	---	----	-----

Comments: NA - % RPD Not Reportable based on the number of colonies count acceptable for RPD calculation

Certified By:



Quality Assurance

CLIENT NAME: WSP CANADA INC.

PROJECT: 111-53018-00

SAMPLING SITE:

AGAT WORK ORDER: 16T111241

ATTENTION TO: Bailey Walters

SAMPLED BY:

Water Analysis

RPT Date: Jul 13, 2016

RPT Date: Jul 13, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Inorganic Chemistry (Water)															
BOD (5)	7675750		582	576	1.0%	< 5	101%	75%	125%	NA			NA		
pH	7676605	7676605	8.09	8.07	0.2%	NA	100%	90%	110%	NA			NA		
Total Suspended Solids	7677778		<10	<10	NA	< 10	94%	80%	120%	NA			NA		
Chloride	7676761		3.32	3.13	5.9%	< 0.10	91%	90%	110%	101%	90%	110%	108%	80%	120%
Nitrate as N	7676761		0.33	0.28	16.4%	< 0.05	102%	90%	110%	108%	90%	110%	116%	80%	120%
Nitrite as N	7676761		<0.25	<0.25	NA	< 0.05	NA	90%	110%	96%	90%	110%	96%	80%	120%
Total Phosphorus	7676589	7676589	0.06	0.06	0.0%	< 0.01	95%	90%	110%	102%	90%	110%	97%	70%	130%
Total Kjeldahl Nitrogen	7676595	7676595	0.84	0.89	5.8%	< 0.10	101%	80%	120%	103%	80%	120%	99%	70%	130%
Ammonia as N	7673421		<0.02	<0.02	NA	< 0.02	103%	90%	110%	99%	90%	110%	97%	80%	120%

Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the RL (Reporting Limit), the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By:



Method Summary

CLIENT NAME: WSP CANADA INC.

PROJECT: 111-53018-00

SAMPLING SITE:

AGAT WORK ORDER: 16T111241

ATTENTION TO: Bailey Walters

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Microbiology Analysis			
Escherichia coli	MIC-93-7010	EPA 1604	Membrane Filtration
Water Analysis			
BOD (5)	INOR-93-6006	SM 5210 B	DO METER
pH	INOR-93-6000	SM 4500-H+ B	PC TITRATE
Total Suspended Solids	INOR-93-6028	SM 2540 D	BALANCE
Chloride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrate as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Total Phosphorus	INOR-93-6022	SM 4500-P B&E	SPECTROPHOTOMETER
Total Kjeldahl Nitrogen	INOR-93-6048	QuikChem 10-107-06-2-I & SM 4500-Norg D	LACHAT FIA
Ammonia as N	INOR-93-6059	QuikChem 10-107-06-1-J & SM 4500 NH3-F	LACHAT FIA



Laboratory Use Only

Work Order #: 16T111241

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water intended for human consumption)

1. Email: Bailey_walters@wspgrrp.com

2. Email: Craig_Lepp@wspgrrp.com

Please note: If quotation number is not provided, client will be billed full price for analysis.

Bill To Same: Yes ☒ No ☐

Company:	
Contact:	
Address:	
E-mail:	

Report Guideline on Certificate of Analysis

☐ Yes ☒ No

☐ Other

☐ 3 Business Days ☐ 2 Business Days ☐ 1 Business Day

Please provide prior notification for rush TAT

*TAT is exclusive of weekends and statutory holidays

Please note: If quotation number is not provided, client will be billed full price for analysis.																																																																																																																							
PO: _____																																																																																																																							
Invoice Information:					Bill To Same: Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>																																																																																																																		
Company: _____																																																																																																																							
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Address: _____																																																																																																																							
Email: _____																																																																																																																							
<div>Sample matrix Legend</div> <div>B Biota GW Ground Water O Oil P Paint S Soil SD Sediment <u>SW Surface Water</u></div>																																																																																																																							
Field Filtered - Metals, Hg, CrVI (Please Circle)																																																																																																																							
<table><tr><th>Sample Identification</th><th>Date Sampled</th><th>Time Sampled</th><th># of Containers</th><th>Sample Matrix</th><th>Comments/ Special Instructions</th><th>Y / N</th><th>Metals and Inorganics</th><th>Metals Scan</th><th>Hydride Forming Metals</th><th>Client Custom Metals</th><th>ORPs: <input type="checkbox"/> B-HWS <input type="checkbox"/> Cl <input type="checkbox"/> CN <input type="checkbox"/> Cr6+ <input type="checkbox"/> EC <input type="checkbox"/> FOC <input type="checkbox"/> NO3/NO2 <input type="checkbox"/> Total N <input type="checkbox"/> Hg <input type="checkbox"/> pH <input type="checkbox"/> SAR</th><th>Nutrients: <input type="checkbox"/> TP <input type="checkbox"/> NH3 <input type="checkbox"/> TKN <input type="checkbox"/> NO3 <input type="checkbox"/> NO2 <input type="checkbox"/> NO3/NO2</th><th>Volatiles: <input type="checkbox"/> VOC <input type="checkbox"/> BTEX <input type="checkbox"/> THM</th><th>CCME Fractions 1 to 4</th><th>ABNs</th><th>PAHs</th><th>Chlorophenols</th><th>PCBs</th><th>Organochlorine Pesticides</th><th>TCLP Metals/Inorganics</th><th>Sewer Use</th></tr><tr><td>SW1</td><td>29/06/2016</td><td>10:00</td><td>5</td><td>SW</td><td></td><td>2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr><tr><td>SW2</td><td></td><td></td><td>5</td><td>SW</td><td></td><td>2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr><tr><td>SW100</td><td></td><td></td><td>5</td><td>SW</td><td></td><td>2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr><tr><td>SW3</td><td></td><td></td><td>5</td><td>SW</td><td></td><td>2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr></table>										Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Y / N	Metals and Inorganics	Metals Scan	Hydride Forming Metals	Client Custom Metals	ORPs: <input type="checkbox"/> B-HWS <input type="checkbox"/> Cl <input type="checkbox"/> CN <input type="checkbox"/> Cr6+ <input type="checkbox"/> EC <input type="checkbox"/> FOC <input type="checkbox"/> NO3/NO2 <input type="checkbox"/> Total N <input type="checkbox"/> Hg <input type="checkbox"/> pH <input type="checkbox"/> SAR	Nutrients: <input type="checkbox"/> TP <input type="checkbox"/> NH3 <input type="checkbox"/> TKN <input type="checkbox"/> NO3 <input type="checkbox"/> NO2 <input type="checkbox"/> NO3/NO2	Volatiles: <input type="checkbox"/> VOC <input type="checkbox"/> BTEX <input type="checkbox"/> THM	CCME Fractions 1 to 4	ABNs	PAHs	Chlorophenols	PCBs	Organochlorine Pesticides	TCLP Metals/Inorganics	Sewer Use	SW1	29/06/2016	10:00	5	SW		2															X	SW2			5	SW		2															X	SW100			5	SW		2															X	SW3			5	SW		2															X
Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Y / N	Metals and Inorganics	Metals Scan	Hydride Forming Metals	Client Custom Metals	ORPs: <input type="checkbox"/> B-HWS <input type="checkbox"/> Cl <input type="checkbox"/> CN <input type="checkbox"/> Cr6+ <input type="checkbox"/> EC <input type="checkbox"/> FOC <input type="checkbox"/> NO3/NO2 <input type="checkbox"/> Total N <input type="checkbox"/> Hg <input type="checkbox"/> pH <input type="checkbox"/> SAR	Nutrients: <input type="checkbox"/> TP <input type="checkbox"/> NH3 <input type="checkbox"/> TKN <input type="checkbox"/> NO3 <input type="checkbox"/> NO2 <input type="checkbox"/> NO3/NO2	Volatiles: <input type="checkbox"/> VOC <input type="checkbox"/> BTEX <input type="checkbox"/> THM	CCME Fractions 1 to 4	ABNs	PAHs	Chlorophenols	PCBs	Organochlorine Pesticides	TCLP Metals/Inorganics	Sewer Use																																																																																																		
SW1	29/06/2016	10:00	5	SW		2															X																																																																																																		
SW2			5	SW		2															X																																																																																																		
SW100			5	SW		2															X																																																																																																		
SW3			5	SW		2															X																																																																																																		
SW As per quote																																																																																																																							

BRENDAN KELLY Brendan Kelly

Example: Reinquished By (Print Name and Sign): _____

Samples Relinquished By (Print Name and Sign):

Date _____

29/06/2016

Private

Date _____

Examinee Recipient's Full Print Name and Sign:



Samples Received By (Print Name and Sign):

Samples Received By (Print Name and Sign):

Date / / Time

2.10

Date	Time
1-18	

Date	Time
------	------

[illegible]

10

[illegible]

CLIENT NAME: WSP CANADA INC.
4 Hughson Street South, Suite 300
Hamilton, ON L8N3Z1
(905) 529-4414

ATTENTION TO: Bailey Walters

PROJECT: 111-53018-00

AGAT WORK ORDER: 16T134110

MICROBIOLOGY ANALYSIS REVIEWED BY: Inesa Alizarchyk, Inorganic Lab Supervisor

WATER ANALYSIS REVIEWED BY: Parvathi Malemath, Data Reviewer

DATE REPORTED: Sep 12, 2016

PAGES (INCLUDING COVER): 8

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 16T134110

PROJECT: 111-53018-00

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: WSP CANADA INC.

SAMPLING SITE:

ATTENTION TO: Bailey Walters

SAMPLED BY: Hayden Bellows

Microbiological Analysis (water)

DATE RECEIVED: 2016-09-02

DATE REPORTED: 2016-09-12

		SAMPLE DESCRIPTION:		SW1	SW2	SW3	SW100
		SAMPLE TYPE:		Water	Water	Water	Water
		DATE SAMPLED:		9/1/2016	9/1/2016	9/1/2016	9/1/2016
Parameter	Unit	G / S	RDL	7823163	7823164	7823169	7823174
Escherichia coli	CFU/100mL	100	2	400	46	46	380

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PWQO

7823163-7823174 RDL >1 indicates dilutions of the sample.

Certified By:



Certificate of Analysis

AGAT WORK ORDER: 16T134110

PROJECT: 111-53018-00

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: WSP CANADA INC.

SAMPLING SITE:

ATTENTION TO: Bailey Walters

SAMPLED BY: Hayden Bellows

Inorganic Chemistry (Water)

DATE RECEIVED: 2016-09-02

DATE REPORTED: 2016-09-12

		SAMPLE DESCRIPTION:		SW1	SW2	SW3		SW100	
		SAMPLE TYPE:		Water	Water	Water		Water	
		DATE SAMPLED:		9/1/2016	9/1/2016	9/1/2016		9/1/2016	
Parameter	Unit	G / S	RDL	7823163	7823164	RDL	7823169	RDL	7823174
BOD (5)	mg/L		5	<5	<5	5	<5	5	<5
pH	pH Units	6.5-8.5	NA	8.23	8.12	NA	7.92	NA	7.95
Total Suspended Solids	mg/L		10	34	17	10	23	10	50
Chloride	mg/L		0.50	193	193	100	203	0.50	192
Nitrate as N	mg/L		0.25	<0.25	<0.25	50	<50	0.25	<0.25
Nitrite as N	mg/L		0.25	<0.25	<0.25	50	<50	0.25	<0.25
Ammonia as N	mg/L		0.02	<0.02	<0.02	0.02	<0.02	0.02	<0.02
Total Phosphorus	mg/L	0.03	0.01	0.06	0.06	0.01	0.07	0.01	0.07
Total Kjeldahl Nitrogen	mg/L		0.10	0.59	0.54	0.10	0.51	0.10	0.60

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PWQO (mg/L)

7823163-7823174 Elevated RDLs for Anions indicate the degree of dilution prior to analysis in order to keep analytes within the calibration range of the instruments and to reduce matrix interferences.

Certified By:





Guideline Violation

AGAT WORK ORDER: 16T134110

PROJECT: 111-53018-00

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: WSP CANADA INC.

ATTENTION TO: Bailey Walters

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	GUIDEVALUE	RESULT
7823163	SW1	PWQO	Microbiological Analysis (water)	Escherichia coli	100	400
7823163	SW1	PWQO (mg/L)	Inorganic Chemistry (Water)	Total Phosphorus	0.03	0.06
7823164	SW2	PWQO (mg/L)	Inorganic Chemistry (Water)	Total Phosphorus	0.03	0.06
7823169	SW3	PWQO (mg/L)	Inorganic Chemistry (Water)	Total Phosphorus	0.03	0.07
7823174	SW100	PWQO	Microbiological Analysis (water)	Escherichia coli	100	380
7823174	SW100	PWQO (mg/L)	Inorganic Chemistry (Water)	Total Phosphorus	0.03	0.07

Quality Assurance

CLIENT NAME: WSP CANADA INC.

PROJECT: 111-53018-00

SAMPLING SITE:

AGAT WORK ORDER: 16T134110

ATTENTION TO: Bailey Walters

SAMPLED BY: Hayden Bellows

Microbiology Analysis

RPT Date: Sep 12, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE		MATRIX SPIKE	
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper

Microbiological Analysis (water)

Escherichia coli 7823163 7823163 400 360 10.5% < 1

Certified By:



Quality Assurance

CLIENT NAME: WSP CANADA INC.

PROJECT: 111-53018-00

SAMPLING SITE:

AGAT WORK ORDER: 16T134110

ATTENTION TO: Bailey Walters

SAMPLED BY: Hayden Bellows

Water Analysis

RPT Date: Sep 12, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Inorganic Chemistry (Water)															
BOD (5)	7822593		124	122	1.6%	< 5	100%	75%	125%	NA				NA	
pH	7817858		8.23	8.12	1.3%	NA	100%	90%	110%	NA				NA	
Total Suspended Solids	7823163	7823163	34	34	NA	< 10	104%	80%	120%	NA				NA	
Chloride	7821138		1940	1960	1.3%	< 0.10	92%	90%	110%	108%	90%	110%	NA	80%	120%
Nitrate as N	7821138		<2.5	<2.5	NA	< 0.05	93%	90%	110%	104%	90%	110%	105%	80%	120%
Nitrite as N	7821138		<2.5	<2.5	NA	< 0.05	NA	90%	110%	94%	90%	110%	101%	80%	120%
Ammonia as N	7823163	7823163	<0.02	<0.02	NA	< 0.02	98%	90%	110%	99%	90%	110%	104%	80%	120%
Total Phosphorus	7823320		0.02	0.02	NA	< 0.01	91%	90%	110%	105%	90%	110%	96%	70%	130%
Total Kjeldahl Nitrogen	7820711		12.0	12.1	0.8%	< 0.10	106%	80%	120%	97%	80%	120%	99%	70%	130%

Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the RL (Reporting Limit), the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By:



Method Summary

CLIENT NAME: WSP CANADA INC.

PROJECT: 111-53018-00

SAMPLING SITE:

AGAT WORK ORDER: 16T134110

ATTENTION TO: Bailey Walters

SAMPLED BY: Hayden Bellows

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Microbiology Analysis			
Escherichia coli	MIC-93-7010	EPA 1604	Membrane Filtration
Water Analysis			
BOD (5)	INOR-93-6006	SM 5210 B	DO METER
pH	INOR-93-6000	SM 4500-H+ B	PC TITRATE
Total Suspended Solids	INOR-93-6028	SM 2540 D	BALANCE
Chloride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrate as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INOR-93-6059	QuikChem 10-107-06-1-J & SM 4500 NH3-F	LACHAT FIA
Total Phosphorus	INOR-93-6022	SM 4500-P B&E	SPECTROPHOTOMETER
Total Kjeldahl Nitrogen	INOR-93-6048	QuikChem 10-107-06-2-I & SM 4500-Norg D	LACHAT FIA

CLIENT NAME: WSP CANADA INC.
4 Hughson Street South, Suite 300
Hamilton, ON L8N3Z1
(905) 529-4414

ATTENTION TO: Bailey Walters

PROJECT: 111-53018-00 Regional Road 20

AGAT WORK ORDER: 16T151516

MICROBIOLOGY ANALYSIS REVIEWED BY: Inesa Alizarchyk, Inorganic Lab Supervisor

WATER ANALYSIS REVIEWED BY: Elizabeth Polakowska, MSc (Animal Sci), PhD (Agri Sci), Inorganic Lab Supervisor

DATE REPORTED: Nov 02, 2016

PAGES (INCLUDING COVER): 8

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

***NOTES**

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 16T151516

PROJECT: 111-53018-00 Regional Road 20

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: WSP CANADA INC.

SAMPLING SITE: Fonthill Sites

ATTENTION TO: Bailey Walters

SAMPLED BY: Craig Leger

Microbiological Analysis (water)

DATE RECEIVED: 2016-10-21

DATE REPORTED: 2016-11-02

		SAMPLE DESCRIPTION:		SW1	SW2	SW3	SW100
		SAMPLE TYPE:		Water	Water	Water	Water
		DATE SAMPLED:		2016-10-21	2016-10-21	2016-10-21	2016-10-21
Parameter	Unit	G / S	RDL	7946308	7946313	7946318	7946323
Escherichia coli	CFU/100mL	100	2	186	250	320	360

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PWQO

7946308-7946323 ND - Not Detected.

Certified By:



Certificate of Analysis

AGAT WORK ORDER: 16T151516

PROJECT: 111-53018-00 Regional Road 20

5835 COOPERS AVENUE
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<http://www.agatlabs.com>

CLIENT NAME: WSP CANADA INC.

SAMPLING SITE: Fonthill Sites

ATTENTION TO: Bailey Walters

SAMPLED BY: Craig Leger

Fonthill Sites - SW Package

DATE RECEIVED: 2016-10-21

DATE REPORTED: 2016-11-02

		SAMPLE DESCRIPTION:		SW1	SW2	SW3	SW100
		SAMPLE TYPE:		Water	Water	Water	Water
		DATE SAMPLED:		2016-10-21	2016-10-21	2016-10-21	2016-10-21
Parameter	Unit	G / S	RDL	7946308	7946313	7946318	7946323
BOD (5)	mg/L		5	<5	<5	<5	<5
pH	pH Units	6.5-8.5	NA	7.74	7.91	7.90	7.91
Total Suspended Solids	mg/L		10	15	11	20	17
Chloride	mg/L		0.10	49.3	49.6	49.5	49.4
Nitrate as N	mg/L		0.05	<0.05	<0.05	<0.05	<0.05
Nitrite as N	mg/L		0.05	<0.05	<0.05	<0.05	<0.05
Ammonia as N	mg/L		0.02	<0.02	0.04	<0.02	<0.02
Total Phosphorus	mg/L	0.03	0.01	0.05	0.08	0.06	0.06
Total Kjeldahl Nitrogen	mg/L		0.10	0.35	0.40	0.39	0.37

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to PWQO (mg/L)

Certified By:

Elizabeth Potokowska

Guideline Violation

AGAT WORK ORDER: 16T151516

PROJECT: 111-53018-00 Regional Road 20

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: WSP CANADA INC.

ATTENTION TO: Bailey Walters

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	GUIDEVALUE	RESULT
7946308	SW1	PWQO	Microbiological Analysis (water)	Escherichia coli	100	186
7946308	SW1	PWQO (mg/L)	Fonthill Sites - SW Package	Total Phosphorus	0.03	0.05
7946313	SW2	PWQO	Microbiological Analysis (water)	Escherichia coli	100	250
7946313	SW2	PWQO (mg/L)	Fonthill Sites - SW Package	Total Phosphorus	0.03	0.08
7946318	SW3	PWQO	Microbiological Analysis (water)	Escherichia coli	100	320
7946318	SW3	PWQO (mg/L)	Fonthill Sites - SW Package	Total Phosphorus	0.03	0.06
7946323	SW100	PWQO	Microbiological Analysis (water)	Escherichia coli	100	360
7946323	SW100	PWQO (mg/L)	Fonthill Sites - SW Package	Total Phosphorus	0.03	0.06

Quality Assurance

CLIENT NAME: WSP CANADA INC.

PROJECT: 111-53018-00 Regional Road 20

SAMPLING SITE: Fonthill Sites

AGAT WORK ORDER: 16T151516

ATTENTION TO: Bailey Walters

SAMPLED BY: Craig Leger

Microbiology Analysis

RPT Date: Nov 02, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE		MATRIX SPIKE	
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper

Microbiological Analysis (water)

Escherichia coli	7945342	ND	ND	NA	< 1
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Comments: ND - Not Detected, NA - % RPD Not Applicable

Certified By:



Quality Assurance

CLIENT NAME: WSP CANADA INC.

PROJECT: 111-53018-00 Regional Road 20

SAMPLING SITE: Fonthill Sites

AGAT WORK ORDER: 16T151516

ATTENTION TO: Bailey Walters

SAMPLED BY: Craig Leger

Water Analysis															
RPT Date: Nov 02, 2016			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Fonthill Sites - SW Package

BOD (5)	7946621		<5	<5	NA	< 5	101%	75%	125%	NA			NA		
pH	7939755		8.26	8.18	1.0%	NA	102%	90%	110%	NA			NA		
Total Suspended Solids	7949073		168	166	1.2%	< 10	98%	80%	120%	NA			NA		
Chloride	7947145		30.3	30.4	0.3%	< 0.10	94%	90%	110%	108%	90%	110%	101%	80%	120%
Nitrate as N	7947145		<0.25	<0.25	NA	< 0.05	102%	90%	110%	110%	90%	110%	107%	80%	120%
Nitrite as N	7947145		<0.25	<0.25	NA	< 0.05	NA	90%	110%	102%	90%	110%	105%	80%	120%
Ammonia as N	7945752		0.18	0.17	5.7%	< 0.02	95%	90%	110%	103%	90%	110%	94%	80%	120%
Total Phosphorus	7944419		0.04	0.04	NA	< 0.01	102%	90%	110%	105%	90%	110%	90%	70%	130%
Total Kjeldahl Nitrogen	7946318 7946318		0.39	0.38	NA	< 0.10	102%	80%	120%	100%	80%	120%	102%	70%	130%

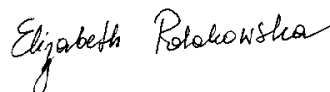
Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Fonthill Sites - SW Package

Total Kjeldahl Nitrogen	7946318 7946318		0.39	0.38	NA	< 0.10	100%	80%	120%	100%	80%	120%	NA	70%	130%
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Certified By:



Method Summary

CLIENT NAME: WSP CANADA INC.

AGAT WORK ORDER: 16T151516

PROJECT: 111-53018-00 Regional Road 20

ATTENTION TO: Bailey Walters

SAMPLING SITE: Fonthill Sites

SAMPLED BY: Craig Leger

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Microbiology Analysis			
Escherichia coli	MIC-93-7010	EPA 1604	Membrane Filtration
Water Analysis			
BOD (5)	INOR-93-6006	SM 5210 B	DO METER
pH	INOR-93-6000	SM 4500-H+ B	PC TITRATE
Total Suspended Solids	INOR-93-6028	SM 2540 D	BALANCE
Chloride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrate as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Nitrite as N	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Ammonia as N	INOR-93-6059	QuikChem 10-107-06-1-J & SM 4500 NH3-F	LACHAT FIA
Total Phosphorus	INOR-93-6022	SM 4500-P B&E	SPECTROPHOTOMETER
Total Kjeldahl Nitrogen	INOR-93-6048	QuikChem 10-107-06-2-I & SM 4500-Norg D	LACHAT FIA



AGAT

Laboratories

M.B.I.

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
web@earth.agatlabs.com

Chain-of-Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain-of-Custody Form (potable water intended for human consumption)

Report Information:

Company: WSP
Contact: Bailey Walters
Address: 4 Hughson St.
Hamilton, ON
Phone: _____ Fax: _____
Reports to be sent to: _____
1. Email: bailey.walters@wspgroup.com
2. Email: _____

Project Information:

Project: Fonthill Sites
Site Location: Reg Rd 20 111-53018-00
Sampled By: JCL
AGAT Quote #: 134907 PO: _____
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☒ No ☐
Company: _____
Contact: _____
Address: _____
Email: _____

Regulatory Requirements:

(Please check all applicable boxes)

☐ Regulation 153/04

Table Indicate One

☐ Ind/Com

☐ Res/Park

☐ Agriculture

Soil Texture (Check One)

☐ Coarse

☐ Fine

☐ Sewer Use

☐ Sanitary

☐ Storm

Region Indicate One

☐ Regulation 558

☐ CCME

☒ Prov. Water Quality
Objectives (PWQO)

☐ Other

Indicate One

Is this submission for a
Record of Site Condition?

☐ Yes ☒ No

Report Guideline on
Certificate of Analysis

☒ Yes ☐ No

Sample Matrix Legend

B Biota
GW Ground Water
O Oil
P Paint
S Soil
SD Sediment
SW Surface Water

Field Filtered - Metals, Hg, Cu
(Please Circle)

Metals and Inorganics

Metal Scan

Hydride Forming Metals

Client Custom Metals

(Check Applicable)
ORPs: ☐ B-HWS ☐ Cl- ☐ CN-
☐ Cr6+ ☐ EC ☐ FOC ☐ NO₂/NO₃
☐ Total N ☐ Hg ☐ pH ☐ SAR
Nutrients: ☐ TP ☐ NH₃ ☐ TKN
☐ NO₂ ☐ NO₃ ☐ NO₂/NO₃
Volatiles: ☐ VOC ☐ BTEX ☐ THM

CCME Fractions 1 to 4

ABNs

PAHs

Chlorophenols

PCBs

Organochlorine Pesticides

TCLP Metals/Inorganics

Sewer Use

SS As Per Quote

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Y/N	Metals and Inorganics	Metal Scan	Hydride Forming Metals	Client Custom Metals	ORPs:	Nutrients:	Volatiles:	CCME Fractions 1 to 4	ABNs	PAHs	Chlorophenols	PCBs	Organochlorine Pesticides	TCLP Metals/Inorganics	Sewer Use
SW1	21 Oct 16		5	SW		~															
SW2	↓		↓	↓		↓															
SW3																					
SW100																					

Samples Relinquished By (Print Name and Sign): <u>Creyer Chris</u>	Date: <u>21 Oct</u>	Time: <u>12:15</u>	Samples Received By (Print Name and Sign): <u>BAILEY WALTERS</u>	Date: <u>21 Oct</u>	Time: <u>5:30</u>
Samples Relinquished By (Print Name and Sign):	Date:	Time:	Samples Received By (Print Name and Sign):	Date:	Time:
Samples Relinquished By (Print Name and Sign):	Date:	Time:	Samples Received By (Print Name and Sign):	Date:	Time:

Page 1 of 1

No: **T 037078**

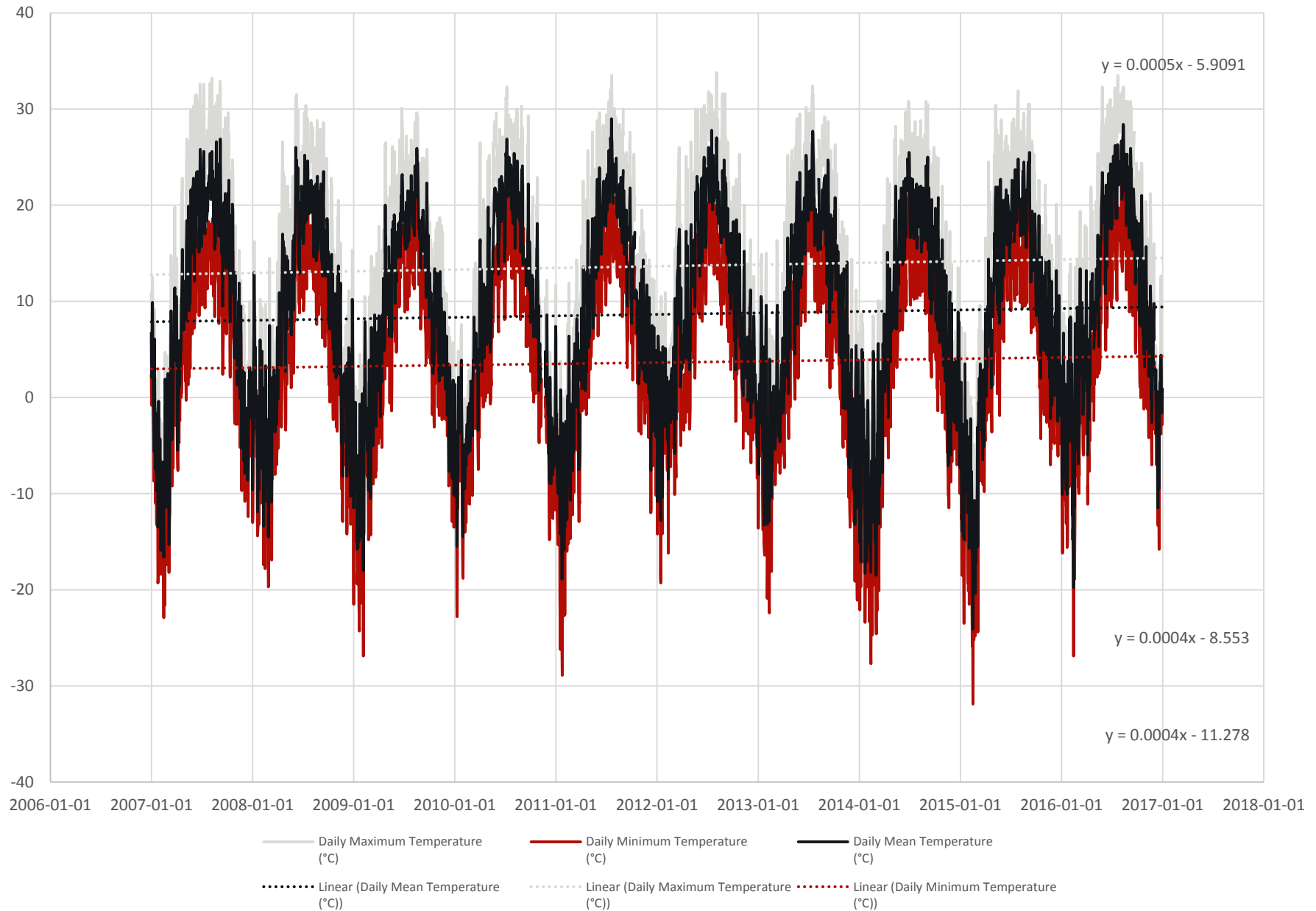
APPENDIX

D

CLIMATE DATA

Data tables are not included in this report. Data tables can be provided upon request.

Figure D-1
Daily Temperature vs Time
Environment Canada Climate Data



2017-06-06

Z:\Projects\2011\111-53018-00 - Regional Road 20\100\1634010 - 2016 SW Monitoring\Tech\App D - Climate Data\Env Can Welland-Pelham 2007-2016.xlsx

Figure D-2
Daily Precipitation vs Time
Environment Canada Climate Data

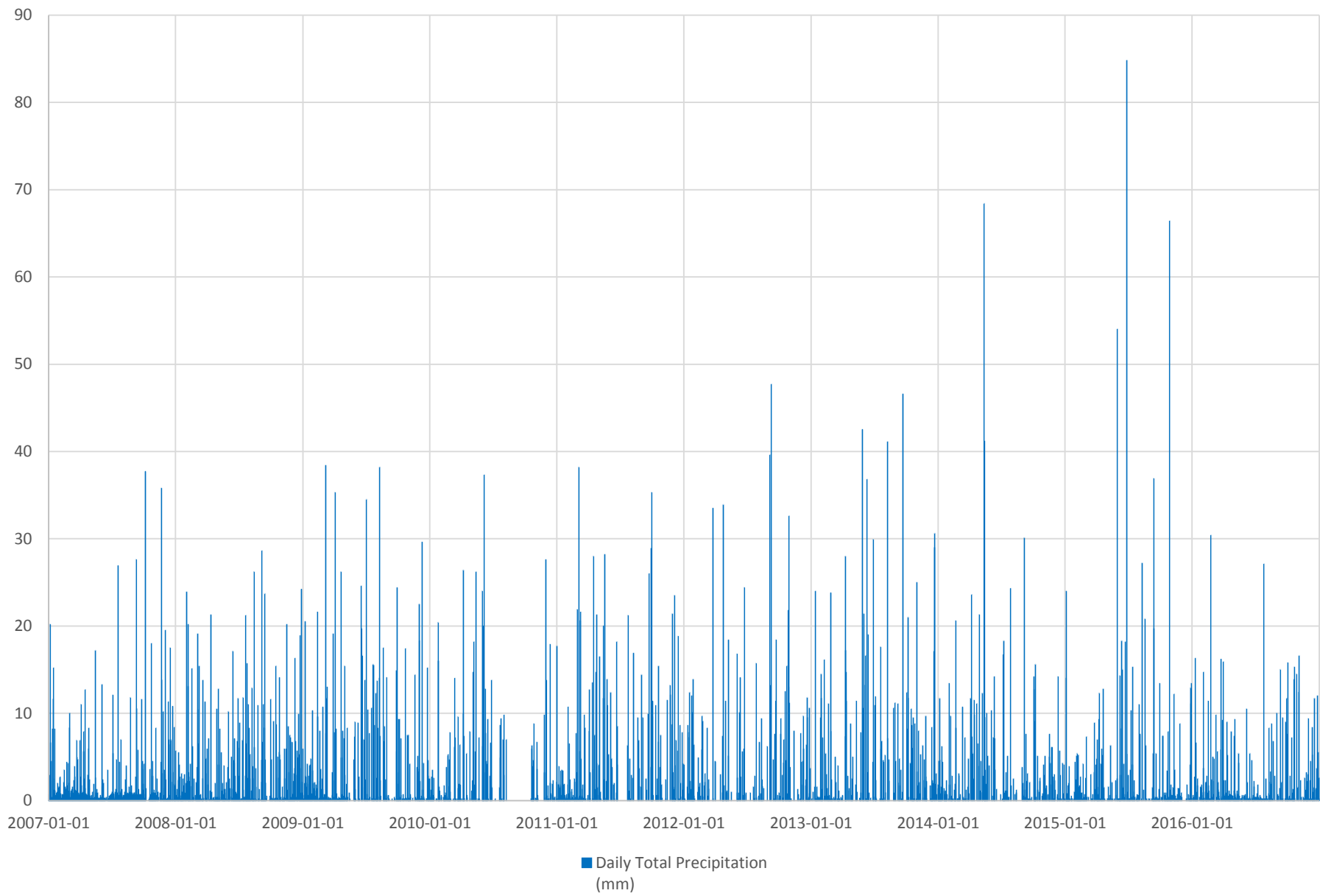


Figure D-3
Hourly Precipitation vs Time
Regional Municipality of Niagara Pelham Climate Station

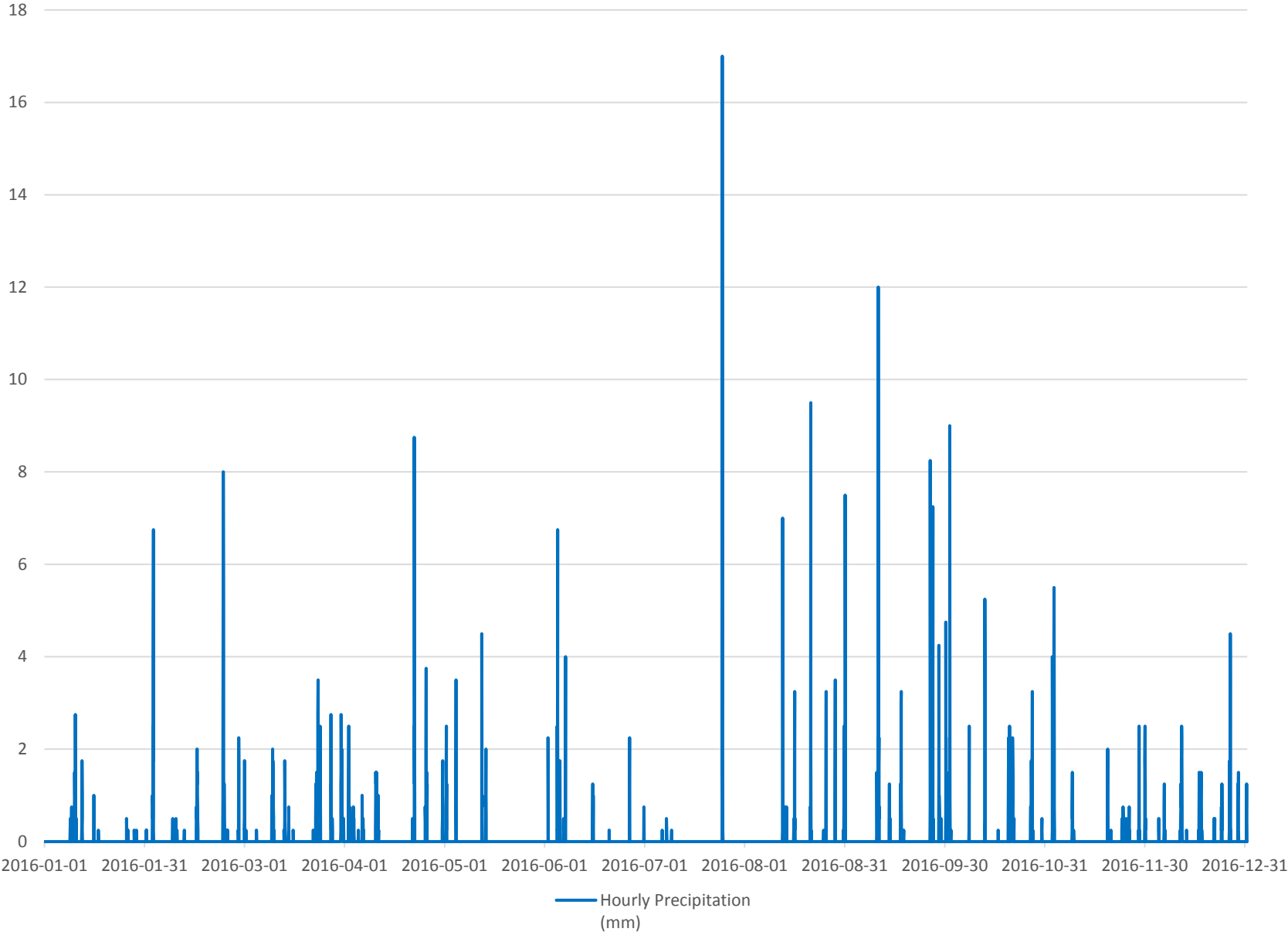


Figure D-4
Hourly Precip Intensity vs Time
Regional Municipality of Niagara Pelham Climate Station

