Appendix A – Amended Environmental Compliance Approval Number 0963-A4ZMVA

Ontario

Ministry of the Environment and Climate Change
Ministère de l'Environnement et de l'Action en matière de changement climatique

AMENDED ENVIRONMENTAL COMPLIANCE APPROVAL
NUMBER 0963-A4ZMVA
Issue Date: January 22, 2016

The Corporation of the Township of Mapleton
7275 Sideroad 16
Post Office Box, No. 160
Mapleton, Ontario
N0G 1P0

Site Location: Drayton Wastewater Treatment Plant
7101 Sideroad 15
Mapleton Township, County of Wellington
N0G 1P0

You have applied under section 20.2 of Part II.1 of the Environmental Protection Act, R.S.O. 1990, c. E. 19 (Environmental Protection Act) for approval of:

the existing municipal sewage treatment works in Drayton for the collection, transmission, treatment and disposal of domestic sewage with a Rated Capacity of 750 cubic metres per day, and consisting of the following:

Proposed Works

- one (1) 200 mm dia magnetic flowmeter and associated pipework in the effluent discharge system;

Previous Works

Moorefield

Low-Pressure Sanitary Sewage Collection System (Off-site)

- approximately 160 individual packaged grinder pump stations outside of the properties to be serviced including service laterals;
- low-pressure collection sewers on Robb Street, Carson Street, Adam Brown Street, Maudsley Street, Ball Avenue, McGivern Street, Hillwood Drive, Booth Street West and Eighth Concession Road;

Booth Street Sanitary Sewage Pumping Station (Off-site)

- a 2.4 m diameter by 4.5 m deep wet well equipped with two (2) submersible sewage pumps (one

standby) each rated at 14.14 L/s at 47 m T.D.H., and an emergency overflow outlet;
- a 150 mm diameter forcemain along Booth Street East, Eighth Concession Road and Drayton WWTP Access Road discharging to the influent structure of the sewage treatment plant;
- a 50 kW outdoor diesel generator set;

Drayton

Sanitary Sewers (Off-site)
- sanitary sewers on Mill Street, High Street, Smith Drive, Spring Street, Main Street, Wood Street, Robin Drive, John Street, Union Street, Edward Street, Elm Street, Wellington Street, Easement West of Wellington Street, King Street, Queen Street and Wortley Street, Conestoga Drive, Hillview Drive, Pine Street, Maple Street, Green Street, Andrews Drive, Dales Drive, Parkside Street, Andrews Drive West, Faith Drive, River Run Road, Riverview Drive, Bedell Drive Pioneer Drive;

Sewage Pumping Station and Forcemain (Off-site)

- a sewage pumping station located on the north side of Mill Street approximately 110 m west of the west limit of Wellington Street with a wet well with two (2) sewage pumps (one standby) each rated at 34.0 L/s at a T.D.H. of 42.0 m;
- forcemain to the waste stabilization ponds, emergency bypass connection on the discharge forcemain;
- a 60 kW standby diesel generator and emergency station overflow;

Drayton Wastewater Treatment Plant

Stabilization Ponds

- a 21.2 ha waste stabilization pond system with two (2) treatment cells operated in series and three (3) effluent treatment/storage cells operated in parallel or series with individual operating depths (exclusive of sludge storage bottom zones and freeboard), areas and volumes as listed below:

Parameters	Function	Operating Depth (m)	Surface Area (ha)	Operating Volume (m^3)
Cell 2	Treatment - Primary Cell	1.825	3.1	60,500
Cell 1	Treatment - Secondary Cell	1.825	3.2	62,100
Cell 3	Storage/treatment	2.425	5.5	131,700
Cell 4A	Storage/treatment	2.600	3.4	77,600
Cell 4B	Storage/treatment	2.600	6.0	140,700
Total			**21.2**	**472,600**

- influent works to Cell No.2, interconnecting structures between lagoon cells;
- a primary gravity flow control structure (flow control structure A) with adjustable weir control, receiving influent from Cell No.1 and with valved inlet/outlet pipes to Cells No.3, 4A and 4B, and outlet pipe to Manhole 2;
- a secondary gravity flow control structure (flow control structure B) with valved inlet/outlet pipes to Cells No.4A and 4B and the primary flow control chamber;

- a fine bubble aeration system for Cell No. 2 comprising two high speed blowers (one standby) each rated at of 680 m^3/h at 45 kPa, air header, feeder lines and diffuser tubes at the bottom of the cell perpendicular to the direction of sewage flow;
- a compressed air distribution system in Cell No.3 comprising a 25 hp compressor/blower, air header and distribution laterals for minimizing ice formation and to improve alum mixing;
- effluent works and 600 mm diameter sewer to the stabilization pond effluent pumping station;

Stabilization Pond Effluent Pumping Station

- a 3.4 m by 3.3 m by 6.0 m deep wet well, including a bypass/overflow chamber with a bottom sluice gate and an overflow weir, equipped with three (3) submersible pumps (two duty and one shelf spare) with variable speed 3 hp motors, each rated at 23.1 L/second at 4.0 m TDH, with a 150 mm diameter pipe discharging stabilization pond effluent to a common trough at the top of the wet well;
- one (1) 200 mm diameter gravity flow pipe conveying stabilization pond effluent from the trough to the filtration building;
- a 600 mm diameter emergency bypass/overflow sewer from the pumping station to the final effluent manhole;

Alum Building

- a 4.3 m x 6.1 m alum building with a 15,500 L alum storage tank and two (2) 7.1 L/h capacity metering pumps to dose alum to flow control structure A;

Effluent Filtration Building

- one (1) metering chamber complete with 200 mm diameter inlet pipe from the Stabilization Pond Effluent Pumping Station, a 200 mm diameter magnetic flowmeter and a 200 mm outlet pipe discharging to the filter influent channel described below;
- one (1) filter influent channel 690 mm wide by 2.5 m deep equipped with a stainless steel screen and guide, five (5) 200 mm diameter filter inlet pipes with gate valves and one (1) 200 mm diameter overflow pipe discharging to the filter effluent channel;
- five (5) continuous backwash upflow sand filters, each having a 4.65 m^2 filtration area, 2.0 m depth coarse media, with design filtering capacity of 800 m^3/day, complete with headloss gauges, air-lift pumps for rejection/backwashing of filters to the reject wet well and effluent weirs;
- a 250 mm diameter filtered effluent pipe and a 500 mm wide by 1.6 m deep effluent channel for the disinfection system described below;
- two (2) air compressors with 7.5 hp motors, each having an output capacity of 46 m3/h at 690 kPa pressure discharging to a common air reservoir to provide air to the air lift pumps;
- a 2.16 m by 1.7 m, 4.7 m deep reject/backwash wastewater wet well equipped with two (2) submersible pumps with 3 hp integral motors (one standby), each having a capacity of 13.5 L/s, to pump filter reject/backwash wastewater to Cell No.2 of the stabilization pond system via an approximately 37.0 m long 100 mm diameter forcemain;

Effluent Disinfection System

- two (2) ultraviolet radiation units installed in series in the effluent channel of the filtration building, with a Peak Flow Rate of 4,000 m^3/d;

Effluent Aeration and Discharge System

- a reinforced concrete cascade aerator including a 100 mm diameter drain/bypass pipe to provide adequate aeration to the filtered effluent prior to discharging to the Conestogo River,
- one (1) 300 mm diameter effluent discharge pipe from the cascade aerator to the final effluent manhole;
- one (1) 600 mm diameter final effluent pipe to the outfall structure at the Conestogo River.

Cell No.3 Alum Addition System (Back Up System)

- one (1) 5 hp pump to draw water from an intake located in Cell No. 3 and to discharge back to Cell No. 3 through three (3) 100 mm dia. distribution pipe at the cell bottom weighted with saddlebag ballast system;
- two (2) 1,000 L capacity alum storage tanks and one (1) 3.9 L/min capacity chemical pump to feed liquid alum into the water pump suction pipe;

including all other controls, electrical equipment, instrumentation, piping, pumps, valves and appurtenances essential for the proper operation of the aforementioned sewage Works;

all in accordance with supporting documents listed in Schedule A.

For the purpose of this environmental compliance approval, the following definitions apply:

"Approval" means this entire document and any schedules attached to it, and the application;

"Average Daily Flow" means the cumulative total sewage flow to the sewage works during a calendar year divided by the number of days during which sewage was flowing to the sewage works that year;

"BOD5" (also known as $TBOD_5$) means five day biochemical oxygen demand measured in an unfiltered sample and includes carbonaceous and nitrogenous oxygen demand;

"By-pass" means diversion of sewage around one or more unit processes within the Sewage Treatment Plant with the diverted sewage flows being returned to the Sewage Treatment Plant treatment train upstream of the Final Effluent sampling location, and discharging to the environment through the Sewage Treatment Plant outfall;

"CBOD5" means five day carbonaceous (nitrification inhibited) biochemical oxygen demand measured in an unfiltered sample;

"Daily Concentration" means the concentration of a contaminant in the effluent discharged over any

single day, as measured by a composite or grab sample, whichever is required;

"Director" means a person appointed by the Minister pursuant to section 5 of the EPA for the purposes of Part II.1 of the EPA;

"Emergency Situation" means a structural, mechanical or electrical failure that causes a temporary reduction in the capacity of the Sewage Treatment Plant or an unforeseen flow condition that may result in:

a) danger to the health or safety of any person; or,
b) injury or damage to any property, or serious risk of injury or damage to any property; or
c) treatment process biomass washout.

"EPA" means the *Environmental Protection Act* , R.S.O. 1990, c.E.19, as amended;

"Equivalent Equipment" means a substituted equipment or like-for-like equipment that meets the required quality and performance standards of a named equipment;

"Event" means an action or occurrence, at a given location within the Sewage Treatment Plant that causes a Plant Bypass or Plant Overflow. An Event ends when there is no recurrence of a Bypass or Overflow in the 12-hour period following the last Bypass or Overflow. Two Events are separated by at least 12 hours during which there has been no recurrence of a Bypass or Overflow;

"Final Effluent" means sewage discharge via the Sewage Treatment Plant outfall after undergoing the full train of unit processes as listed in the Approval;

"Geometric Mean Density" is the nth root of the product of multiplication of the results of n number of samples over the period specified;

"Limited Operational Flexibility" (LOF) means any modifications that the Owner is permitted to make to the Works under this Approval;

"Ministry" means the ministry of the government of Ontario responsible for the EPA and OWRA and includes all officials, employees or other persons acting on its behalf;

"Monthly Average Concentration" means the arithmetic mean of all Daily Concentrations of a contaminant in the effluent sampled or measured, or both, during a calendar month;

"Notice of Modifications" means the form entitled "Notice of Modifications to Sewage Works";

"Owner" means The Corporation of the Township of Mapleton and its successors and assignees;

"OWRA" means the *Ontario Water Resources Act* , R.S.O. 1990, c. O.40, as amended;

"Peak Flow Rate" means the maximum rate of sewage flow for which the plant or process unit was designed;

"Plant Overflow" means a discharge to the environment from the Sewage Treatment Plant at a location other than the plant outfall or into the plant outfall downstream of the Final Effluent sampling location;

"Previous Works" means those portions of the sewage works previously constructed and approved under an Approval;

"Rated Capacity" means the Average Daily Flow for which the Works are approved to handle;

"Regional Director" means the Regional Director of the West-Central Region of the Ministry;

"Regional Water Compliance Manager" means the Regional Water Compliance Manager of the West-Central Region of the Ministry;

"Sewage Treatment Plant" means the entire sewage treatment and effluent discharge facility;

"Water Supervisor" means the Water Supervisor for the Guelph, Hamilton, and Niagara offices of the Ministry; and

"Works" means the sewage works described in the Owner's application, and this Approval, and includes Proposed Works, Previous Works, and modifications made under Limited Operational Flexibility.

You are hereby notified that this environmental compliance approval is issued to you subject to the terms and conditions outlined below:

TERMS AND CONDITIONS

1. GENERAL PROVISIONS

(1) The Owner shall ensure that any person authorized to carry out work on or operate any aspect of the Works is notified of this Approval and the conditions herein and shall take all reasonable measures to ensure any such person complies with the same.

(2) Except as otherwise provided by these conditions, the Owner shall design, build, install, operate and maintain the Works in accordance with the description given in this Approval, and the application for approval of the Works.

(3) Where there is a conflict between a provision of any document in the schedule referred to in this Approval and the conditions of this Approval, the Conditions in this Approval shall take precedence, and where there is a conflict between the documents in the schedule, the document bearing the most recent date shall prevail.

(4) Where there is a conflict between the documents listed in the Schedule A, and the application, the application shall take precedence unless it is clear that the purpose of the document was to amend the application.

(5) The Conditions of this Approval are severable. If any Condition of this Approval, or the application of any requirement of this Approval to any circumstance, is held invalid or unenforceable, the application of such condition to other circumstances and the remainder of this Approval shall not be affected thereby.

2. EXPIRY OF APPROVAL

This Approval will cease to apply to those parts of the Works which have not been constructed within five (5) years of the date of this Approval.

3. CHANGE OF OWNER

(1) The Owner shall notify the Water Supervisor and the Director, in writing, of any of the following changes within thirty (30) days of the change occurring:

(a) change of Owner;

(b) change of address of the Owner;

(c) change of partners where the Owner is or at any time becomes a partnership, and a copy of the most recent declaration filed under the *Business Names Act* , R.S.O. 1990, c.B17 shall be included in the notification to the Water Supervisor;

(d) change of name of the corporation where the Owner is or at any time becomes a corporation, and a copy of the most current information filed under the *Corporations Information Act* , R.S.O. 1990, c. C39 shall be included in the notification to the Water Supervisor;

(2) In the event of any change in ownership of the Works, other than a change to a successor municipality, the Owner shall notify in writing the succeeding owner of the existence of this Approval, and a copy of such notice shall be forwarded to the Water Supervisor and the Director.

4. UPON THE SUBSTANTIAL COMPLETION OF THE WORKS

(1) Upon the Substantial Completion of the Works,the Owner shall prepare a statement, certified by a Professional Engineer, that the works are constructed in accordance with this Approval, and upon request, shall make the written statement available for inspection by Ministry personnel.

(2) Within six (6) months of the Substantial Completion of the Sewage Works, a set of as-built drawings showing the works "as constructed" shall be prepared. These drawings shall be kept up to date through revisions undertaken from time to time and a copy shall be retained at the Works for the operational life of the Works.

5. BY-PASSES

(1) Any By-pass or Plant Overflow is prohibited, except:

(a) in an Emergency Situation;

(b) where the By-pass / Plant Overflow is a direct and unavoidable result of a planned maintenance procedure, the Owner notified the Water Supervisor 15 days prior to the By-pass and the Water Supervisor has given written consent of the By-pass; and

(c) where the By-pass / Plant Overflow is planned for research or training purposes, the discharger notified the Water Supervisor 15 days prior to the By-pass / Plant Overflow and the Water Supervisor has given written consent of the By-pass / Plant Overflow.

(2) The Owner shall forthwith notify the Spills Action Centre (SAC) and the Medical Officer of Health of all By-pass and Plant Overflow Events. This notice shall include, at a minimum, the following information:

(a) the date, time, and duration of the Event;

(b) the location of the Event;

(c) the measured or estimated volume of the Event (unless the Event is ongoing);

(d) the reason for the Event; and

(e) the level of treatment the By-pass(es) and/or Plant Overflow(s) received and disinfection status of same.

(3) The Owner shall submit By-pass and Plant Overflow Event Reports to the Ministry's local office on a quarterly basis, no later than each of the following dates for each calendar year: February 14, May 15, August 14, and November 15. Event Reports shall be in an electronic format specified by the Ministry. In each Event Report the Owner shall include, at a minimum, the following information on any Events that occurred during the preceding quarter:

(a) the date of the Event(s);

(b) the measured or estimated volume of the Event(s);

(c) the duration of the Event(s);

(d) the location of the Event(s);

(e) the reason for the Event(s); and

(f) the level of treatment the By-pass(es) and/or Plant Overflow(s) received and disinfection status of same.

(4) The Owner shall use best efforts to collect a representative sample consisting of a minimum of two (2) grab samples of the By-pass / Plant Overflow and have it analyzed for parameters outlined in Condition 7 using the protocols specified in Condition 10, one at the beginning of the Event and the second approximately near the end of the Event, to best reflect the effluent quality of such By-pass or Plant Overflow.

(5) The Owner shall maintain a logbook of all Plant By-passes and Plant Overflows, which shall contain, at a minimum, the types of information set out in subsection 2 (a) to 2(e) in respect of each By-pass and Plant Overflow.

6. EFFLUENT OBJECTIVES

(1) The Owner shall use best efforts to design, construct and operate the Works with the objective that the concentrations of the materials named below as effluent parameters are not exceeded in the effluent from the Works.

Table 1 - Effluent Objectives

Effluent Parameter	Concentration Objective (milligrams per litre unless otherwise indicated)
CBOD5	5.0
Total Ammonia Nitrogen	3.0
Total Phosphorus	0.3
E.coli	100 organisms/ 100mL Monthly Geometric Mean Density

(2) The Owner shall use best efforts to:

(a) maintain the pH of the effluent from the Works within the range of 6.5 to 8.5, inclusive, at all times;

(b) operate the works within the Rated Capacity of the Works;

(c) ensure that the effluent from the Works is essentially free of floating and settleable solids and does not contain oil or any other substance in amounts sufficient to create a visible film or sheen or foam or discolouration on the receiving waters.

(3) The Owner shall include in all reports submitted in accordance with Conditions 11 a summary of the efforts made and results achieved under this Condition.

7. EFFLUENT LIMITS

(1) The Owner shall operate and maintain the Works such that the concentrations of the materials named

below as effluent parameters are not exceeded in the effluent from the Works.

Table 2 - Effluent Limits	
Effluent Parameter	**Average Concentration** (milligrams per litre unless otherwise indicated)
Column 1	Column 2
CBOD5	7.5 (Apr. & Oct.) 10.0 (Mar., Nov. & Dec.)
Total Ammonia Nitrogen	5.0
Total Phosphorus	0.5

(2) For the purposes of determining compliance with and enforcing subsection (1):

(a) The Monthly Average Concentration of a parameter named in Column 1 of subsection (1) shall not exceed the corresponding maximum concentration set out in Column 2 of subsection (1).

(3) Notwithstanding subsection (1), the Owner shall operate and maintain the Works such that the pH of the effluent shall be maintained within the range of 6.0 - 9.5, inclusive, at all times.

(4) Notwithstanding subsection (1), the Owner shall operate and maintain the Works such that the effluent is continuously disinfected so that the monthly Geometric Mean Density of *E. coli* does not exceed 200 organisms per 100 millilitres of effluent discharged from the Works.

(5) Subsections (1), (3) and (4) shall apply upon the issuance of this Approval.

8. OPERATION AND MAINTENANCE

(1) The Owner shall exercise due diligence in ensuring that, at all times, the Works and the related equipment and appurtenances used to achieve compliance with this Approval are properly operated and maintained. Proper operation and maintenance shall include effective performance, adequate funding, adequate operator staffing and training, including training in all procedures and other requirements of this Approval and the OWRA and regulations, adequate laboratory facilities, process controls and alarms and the use of process chemicals and other substances used in the Works.

(2) The Owner shall prepare an operations manual prior to the commencement of operation of the sewage works, that includes, but not necessarily limited to, the following information:

(a) operating procedures for routine operation of the Works;

(b) inspection programs, including frequency of inspection, for the Works and the methods or tests employed to detect when maintenance is necessary;

(c) repair and maintenance programs, including the frequency of repair and maintenance for the Works;

(d) procedures for the inspection and calibration of monitoring equipment;

(e) a spill prevention control and countermeasures plan, consisting of contingency plans and procedures for dealing with equipment breakdowns, potential spills and any other abnormal situations, including notification of the Water Supervisor; and

(f) procedures for receiving, responding and recording public complaints, including recording any followup actions taken.

(3) The Owner shall maintain the operations manual current and retain a copy at the location of the Works for the operational life of the Works. Upon request, the Owner shall make the manual available to Ministry staff.

(4) The Owner shall provide for the overall operation of the Works with an operator who holds a licence that is applicable to that type of facility and that is of the same class as or higher than the class of the facility in accordance with Ontario Regulation 129/04.

9. SEASONAL DISCHARGE

(1) The Owner shall operate the Works such that discharge of Final Effluent from the Works is conducted on a seasonal discharge basis with the effluent being discharged only during the months at the rates as specified below. However, discharges in excess of these daily discharges is allowed if the minimum 10:1 of the streamflow to daily discharge rate for the applicable period of that design streamflow occurs, based on actual measurements of flow rate in the Conestogo River.

Month	Maximum Final Effluent Discharge Rate (m^3/d)
March	1,581
April	3,154
October	233
November	1,754
December	4,000

(a) The streamflow is defined as the streamflow of the Conestogo River at the closest upstream Water Survey of Canada station, Conestogo River above Drayton (UTM coordinates 529057E 4847811N; WSC Station ID #2GA39);

(b) The Owner shall, during the discharge of Final Effluent, make reference to the streamflow data of the Conestogo River from the Grand River Conservation Authority Website. The Owner shall take responsibility for interpreting the hydrometric data for that day and make the appropriate operational changes. The streamflow provided shall be the basis of proportional discharge for that day and the next six days for the purposes of determining the final effluent discharge rate.

(2) The Maximum Final Effluent Discharge Rate shall not exceed the maximum design capacity of the

sand filtration and the UV disinfection rate of 4,000 m^3/d.

(3) In the event that the streamflow is unreliable or unavailable, the Owner shall follow the specified seasonal discharge during the months at the rates stipulated in Subsection (1).

10. MONITORING AND RECORDING

The Owner shall, upon commencement of operation of the Works, carry out the following monitoring program:

(1) All samples and measurements taken for the purposes of this Approval are to be taken at a time and in a location characteristic of the quality and quantity of the effluent stream over the time period being monitored.

(2) For the purposes of this condition, the following definitions apply:

(a) Weekly means once each week;
(b) Bi-weekly means once every two weeks;

(3) Samples shall be collected at the following sampling points, at the frequency specified, by means of the specified sample type and analyzed for each parameter listed and all results recorded:

Table 3 - Influent Monitoring - Influent Splitter Box at the entrance of Stabilization Ponds	
Frequency	Bi-weekly
Sample Type	Grab
Parameters	BOD5, Total Suspended Solids, Total Phosphorus, Total Kjeldahl Nitrogen

Table 4 - Lagoon Content Monitoring - one sample from each cell	
Frequency	Once at least seven (7) days prior to scheduled seasonal discharge
Sample Type	Grab
Parameters	CBOD5, Total Suspended Solids, Total Phosphorus, pH

Table 5 - Effluent Monitoring - Effluent from Disinfection System		
Parameters	**Sample Type**	**Frequency**
CBOD5	Composite	Weekly
Total Suspended Solids	Composite	Weekly
Total Phosphorus	Composite	Weekly
Total Ammonia Nitrogen	Composite	Weekly
E. coli	Grab	Weekly
pH	Grab	Weekly
Temperature	Grab	Weekly
Unionized Ammonia	Calculated	Weekly

Table 6 - Conestogo River Monitoring *		
Parameters	**Sample Type**	**Frequency****
BOD5	Grab	Weekly
Total Suspended Solids	Grab	Weekly
Total Phosphorus	Grab	Weekly
Total Ammonia Nitrogen	Grab	Weekly
E. coli	Grab	Weekly
pH	Grab	Weekly
Temperature	Grab	Weekly

*The Owner shall collect from the Conestogo River at the north side of the bridge crossing in Drayton. The sample shall be collected mid-channel only for open flowing water according to protocols acceptable to the Grand River Conservation Authority. Sampling is only required if there is open water in the middle of the river.

**The river sample shall be taken on the same day as the discharge sample from the Final Effluent specified in Condition 7.

(4) The methods and protocols for sampling, analysis and recording shall conform, in order of precedence, to the methods and protocols specified in the following:

(a) the Ministry's Procedure F-10-1, "Procedures for Sampling and Analysis Requirements for Municipal and Private Sewage Treatment Works (Liquid Waste Streams Only), as amended from time to time by more recently published editions;

(b) the Ministry's publication "Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater" (January 1999), ISBN 0-7778-1880-9, as amended from time to time by more recently published editions;

(c) the publication "Standard Methods for the Examination of Water and Wastewater" (21st edition), as amended from time to time by more recently published editions;

(5) The temperature and pH of the effluent from the Works shall be determined in the field at the time of sampling for Total Ammonia Nitrogen. The concentration of un-ionized ammonia shall be calculated using the total ammonia concentration, pH and temperature using the methodology stipulated in "Ontario's Provincial Water Quality Objectives" dated July 1994, as amended, for ammonia (un-ionized).

(6) The measurement frequencies specified in **Table 6 - Conestogo River Monitoring** in respect to any parameter are minimum requirements which may, after twelve (12) months of monitoring in accordance with this Condition, be modified by the Regional Director in writing from time to time.

(7) The Owner shall install and maintain continuous flow measuring devices, to measure the flowrate of the influent to and effluent from the Works with an accuracy to within plus or minus 15 per cent (+/- 15%) of the actual flowrate for the entire design range of the flow measuring device, and record the flowrate at a daily frequency.

(8) The Owner shall retain for a minimum of five (5) years from the date of their creation, all records and

information related to or resulting from the monitoring activities required by this Approval.

11. REPORTING

(1) One (1) week prior to the start up of the operation of the Proposed Works, the Owner shall notify the Water Supervisor (in writing) of the pending start up date.

(2) Fifteen (15) days prior to the date of a planned By-pass being conducted pursuant to Condition 5 and as soon as possible for an unplanned By-pass,the Owner shall notify the Water Supervisor (in writing) of the pending start date, in addition to an assessment of the potential adverse effects on the environment and the duration of the By-pass.

(3) The Owner shall report to the Water Supervisor or designate, any exceedence of any parameter specified in Condition 7 orally, as soon as reasonably possible, and in writing within seven (7) days of the exceedence.

(4) In addition to the obligations under Part X of the *Environmental Protection Act* , the Owner shall, within ten (10) working days of the occurrence of any reportable spill as defined in Ontario Regulation 675/98, bypass or loss of any product, by-product, intermediate product, oil, solvent, waste material or any other polluting substance into the environment, submit a full written report of the occurrence to the Water Supervisor describing the cause and discovery of the spill or loss, clean-up and recovery measures taken, preventative measures to be taken and schedule of implementation.

(5) The Owner shall, upon request, make all manuals, plans, records, data, procedures and supporting documentation available to Ministry staff.

(6) The Owner shall prepare and submit a performance report to the Water Supervisor on an annual basis, within ninety (90) days following the end of the period being reported upon. The first such report shall cover the first annual period following the commencement of operation of the Works and subsequent reports shall be submitted to cover successive annual periods following thereafter. The reports shall contain, but shall not be limited to, the following information:

(a) a summary and interpretation of all monitoring data and a comparison to the effluent limits outlined in Condition 7, including an overview of the success and adequacy of the Works;

(b) a description of any operating problems encountered and corrective actions taken;

(c) a summary of all maintenance carried out on any major structure, equipment, apparatus, mechanism or thing forming part of the Works;

(d) a summary of any effluent quality assurance or control measures undertaken in the reporting period;

(e) a summary of the calibration and maintenance carried out on all effluent monitoring equipment; and

(f) a description of efforts made and results achieved in meeting the Effluent Objectives of Condition 6;

(g) a tabulation of the volume of sludge generated in the reporting period, an outline of anticipated volumes to be generated in the next reporting period and a summary of the locations to where the sludge was disposed;

(h) a summary of any complaints received during the reporting period and any steps taken to address the complaints;

(i) a summary of all By-pass, spill or abnormal discharge events;

(j) a copy of all Notice of Modifications submitted to the Water Supervisor as a result of Schedule B, Section 1, with a status report on the implementation of each modification;

(k) a report summarizing all modifications completed as a result of Schedule B, Section 3; and

(l) any other information the Water Supervisor requires from time to time.

(7) The Owner shall, within thirty (30) calendar days of issuance of this Approval, submit a Municipal and Local Services Board Wastewater System Profile Information Form, and shall resubmit the updated document every time a notification is provided to the Water Supervisor in compliance with requirements of change of ownership under this Approval.

12. LIMITED OPERATIONAL FLEXIBILITY

(1) The Owner may make modifications to the Works in accordance with the Terms and Conditions of this Approval and subject to the Ministry's "Limited Operational Flexibility Criteria for Modifications to Sewage Works ", included under Schedule B of this Approval, as amended.

(2) Sewage works proposed under Limited Operational Flexibility shall adhere to the design guidelines contained within the Ministry's publication "Design Guidelines for Sewage Works 2008", as amended.

(3) The Owner shall ensure at all times, that the Works, related equipment and appurtenances which are installed or used to achieve compliance are operated in accordance with all Terms and Conditions of this Approval.

(4) For greater certainty, the following are not permitted as part of Limited Operational Flexibility:

(a) Modifications to the Works that result in an increase of the Rated Capacity of the Works;

(b) Modifications to the Works that may adversely affect the approved effluent quality criteria or the location of the discharge/outfall;

(c) Modifications to the treatment process technology of the Works, or modifications that involve construction of new reactors (tanks) or alter the treatment train process design;

(d) Modifications to the Works approved under s.9 of the EPA, and

(e) Modifications to the Works pursuant to an order issued by the Ministry.

(5) Implementation of Limited Operational Flexibility is not intended to be used for piecemeal measures that result in major alterations or expansions.

(6) If the implementation of Limited Operational Flexibility requires changes to be made to the Emergency Response, Spill Reporting and Contingency Plan, the Owner shall, as deemed necessary in consultation with the Water Supervisor, provide a revised copy of this plan for approval to the local fire services authority prior to implementing Limited Operational Flexibility.

(7) For greater certainty, any modification made under the Limited Operational Flexibility may only be carried out after other legal obligations have been complied with, including those arising from the *Environmental Protection Act, Niagara Escarpment Planning and Development Act, Oak Ridges Moraine Conservation Act, Lake Simcoe Protection Act* and *Greenbelt Act.*

(8) Prior to implementing Limited Operational Flexibility, the Owner shall complete a Notice of Modifications describing any proposed modifications to the Works and submit it to the Water Supervisor.

The reasons for the imposition of these terms and conditions are as follows:

1. Condition 1 is imposed to ensure that the Works are built and operated in the manner in which they were described for review and upon which approval was granted. This condition is also included to emphasize the precedence of Conditions in the Approval and the practice that the Approval is based on the most current document, if several conflicting documents are submitted for review. The condition also advises the Owners their responsibility to notify any person they authorized to carry out work pursuant to this Approval the existence of this Approval.

2. Condition 2 is included to ensure that the Works are constructed in a timely manner so that standards applicable at the time of Approval of the Works are still applicable at the time of construction, to ensure the ongoing protection of the environment.

3. Condition 3 is included to ensure that the Ministry records are kept accurate and current with respect to the approved works and to ensure that subsequent owners of the Works are made aware of the Approval and continue to operate the Works in compliance with it.

4. Condition 4 is included to ensure that the Works are constructed in accordance with the approval and that record drawings of the Works "as constructed" are maintained for future references.

5. Condition 5 is included to indicate that By-pass / Plant Overflows of untreated or partially treated

sewage to the receiving watercourse is prohibited, save in certain limited circumstances where the failure to By-pass / Plant Overflow could result in greater injury to the public interest than the Bypass itself where a By-pass / Plant Overflow will not violate the approved effluent requirements, or where the By-pass / Plant Overflow can be limited or otherwise mitigated by handling it in accordance with an approved contingency plan. The notification and documentation requirements allow the Ministry to take action in an informed manner and will ensure the Owner is aware of the extent and frequency of By-pass / Plant Overflow events.

6. Condition 6 is imposed to establish non-enforceable effluent quality objectives which the Owner is obligated to use best efforts to strive towards on an ongoing basis. These objectives are to be used as a mechanism to trigger corrective action proactively and voluntarily before environmental impairment occurs and before the compliance limits of Condition 7 are exceeded.

7. Condition 7 is imposed to ensure that the effluent discharged from the Works to the Conestogo River meets the Ministry's effluent quality requirements thus minimizing environmental impact on the receiver and to protect water quality, fish and other aquatic life in the receiving water body.

8. Condition 8 is included to require that the Works be properly operated, maintained, funded, staffed and equipped such that the environment is protected and deterioration, loss, injury or damage to any person or property is prevented. As well, the inclusion of a comprehensive operations manual governing all significant areas of operation, maintenance and repair is prepared, implemented and kept up-to-date by the Owner and made available to the Ministry. Such a manual is an integral part of the operation of the Works. Its compilation and use should assist the Owner in staff training, in proper plant operation and in identifying and planning for contingencies during possible abnormal conditions. The manual will also act as a benchmark for Ministry staff when reviewing the Owner's operation of the Works.

9. Condition 9 is included to ensure that the treated effluent is discharged to the receiver during periods and at rates that minimizes the environmental impact on the receiver.

10. Condition 10 is included to enable the Owner to evaluate and demonstrate the performance of the Works, on a continual basis, so that the Works are properly operated and maintained at a level which is consistent with the design objectives and effluent limits specified in the Approval and that the Works does not cause any impairment to the receiving watercourse.

11. Condition 11 is included to provide a performance record for future references, to ensure that the Ministry is made aware of problems as they arise, and to provide a compliance record for all the terms and conditions outlined in this Approval, so that the Ministry can work with the Owner in resolving any problems in a timely manner.

12. Condition 12 is included to ensure that the Works are operated in accordance with the application and supporting documentation submitted by the Owner, and not in a manner which the Director has not been asked to consider. These Conditions are also included to ensure that a Professional Engineer has reviewed the proposed modifications and attests that the modifications are in line with that of Limited Operational Flexibility, and provide assurance that the proposed modifications comply with the Ministry's requirements stipulated in the Terms and Conditions of this Approval, MOE policies, guidelines, and industry engineering standards and best management practices.

Schedule 'A' forms part of this Approval and contains a list of supporting documentation / information received, reviewed and relied upon in the issuance of this Approval.

SCHEDULE 'A'

1. Application for approval dated November 26, 2002 for Phase 1A Expansion and Upgrading and accompanying reports, drawings, specifications and addendum provided by R.J.Burnside and Associates Limited, Consulting Engineers and Environmental Study Report dated September 1996 and pre-design report dated October 1999 prepared by CH2M Gore & Storrie Limited, Consulting Engineers;
2. Application for Approval of Municipal and Private Sewage Works submitted by Dave Arsenault of R.J. Burnside & Associates Limited dated December 4, 2002 and accompanying reports, drawings, specifications and addendum provided by R.J.Burnside and Associates Limited, Consulting Engineers;
3. Additional information submitted by Bob Mayberry of R.J. Burnside on January 23 and 27, 2003;
4. Application for Approval of Municipal and Private Sewage Works submitted by R.J. Burnside & Associates Limited dated July 13, 2005 for alternative aeration system and alum addition system;
5. Additional information on the alternative aeration system and alum addition system submitted by R.J. Burnside on August 23, 2005;
6. Application for Approval of Municipal and Private Sewage Works submitted by R.J. Burnside & Associates Limited dated August 21, 2008, including Technical Design Brief - Raise Cell No. 3 Berm Crest Elevation and engineering plans and specifications;
7. Application for Approval of Municipal and Private Sewage Works submitted by R.J. Burnside & Associates Limited received July 6, 2010 including Technical Design Brief for the proposed additional lagoon cells together with ESR and final engineering plans received August 24, 2011.
8. Application for Environmental Compliance Approval submitted by Robert H Mayberry of R.J. Burnside & Associates Limited received February 1, 2013 for incorporation of minor design changes during construction of the proposed works approved in 2011.
9. Application for Environmental Compliance Approval dated June 16, 2015 submitted by Jeff Paznar of R.J. Burnside & Associates Limited received June 18, 2015 for the over capacity issues and the spring discharge requirements including application letter, Provincial Officer's Order, Response to comments, engineering drawings and all other supporting documents.

Schedule B

Limited Operational Flexibility Criteria for Modifications to Municipal Sewage Works

1. The modifications to sewage works approved under an Environmental Compliance Approval (Approval) that are permitted under the Limited Operational Flexibility (LOF), are outlined below and are subject to the LOF conditions in the Approval, and require the submission of the Notice of Modifications. If there is a conflict between the sewage works listed below and the Terms and Conditions in the Approval, the Terms and Conditions in the Approval shall take precedence.

1.1 Sewage Pumping Stations

a. Alter pumping capacity by adding or replacing equipment where new equipment is located within an existing sewage treatment plant site or an existing sewage pumping station site, provided that the modifications do not result in an increase of the sewage treatment plant Rated Capacity and the existing flow process and/or treatment train are maintained, as applicable.

b. Forcemain relining and replacement with similar pipe size where the nominal diameter is not greater than 1,200mm

1.2 Sewage Treatment Process

a. Installing additional chemical dosage equipment including replacing with alternative chemicals for pH adjustment or coagulants (non-toxic polymers) provided that there are no modifications of treatment processes or other modifications that may alter the intent of operations and may have negative impacts on the effluent quantity and quality.

b. Expanding the buffer zone between a sanitary sewage lagoon facility or land treatment area and adjacent uses provided that the buffer zone is entirely on the proponent's land.

c. Optimizing existing sanitary sewage lagoons with the purpose to increase efficiency of treatment operations provided that existing sewage treatment plant rated capacity is not exceeded and where no land acquisition is required.

d. Optimizing existing sewage treatment plant equipment with the purpose to increase the efficiency of the existing treatment operations, provided that there are no modifications to the works that result in an increase of the approved Rated Capacity, and may have adverse effects to the effluent quality or location of the discharge.

e. Replacement, refurbishment of previously approved equipment in whole or in part with Equivalent Equipment, like-for-like of different make and model, provided that the firm capacity, reliability, performance standard, level of quality and redundancy of the group of equipment is kept the same or exceeded. For clarity purposes, the following equipment can

be considered under this provision: pumps, screens, grit separators, blowers, aeration equipment, sludge thickeners, dewatering equipment, UV systems, chlorine contact equipment, bio-disks, and sludge digester systems.

1.3 Sewage Treatment Plant Outfall

a. Replacement of discharge pipe with similar pipe size or diffusers provided that the outfall location is not changed.

1.4 Sanitary Sewers

a. Pipe relining and replacement with similar pipe size within the Sewage Treatment Plant site, where the nominal diameter is not greater than 1,200mm.

1.5 Pilot Systems

a. Installation of pilot systems for new or existing technologies provided that:

i. any effluent from the pilot system is discharged to the inlet of the sewage treatment plant or hauled off-site for proper disposal,
ii. any effluent from the pilot system discharged to the inlet of the sewage treatment plant or sewage conveyance system does not significantly alter the composition/concentration of the influent sewage to be treated in the downstream process; and that it does not add any inhibiting substances to the downstream process, and
iii. the pilot system's duration does not exceed a maximum of two years; and a report with results is submitted to the Director and Water Supervisor three months after completion of the pilot project.

2. Sewage works that are exempt from section 53 of the OWRA by O. Reg. 525/98 continue to be exempt and are not required to follow the notification process under this Limited Operational Flexibility.

3. Normal or emergency operational modifications, such as repairs, reconstructions, or other improvements that are part of maintenance activities, including cleaning, renovations to existing approved sewage works equipment, provided that the modification is made with Equivalent Equipment, are considered pre-approved.

4. The modifications noted in section (3) above are <u>not</u> required to follow the notification protocols under Limited Operational Flexibility, provided that the number of pieces and description of the equipment as described in the Approval does not change.

Ontario
Ministry of
the Environment

Notice of Modification to Sewage Works

RETAIN COPY OF COMPLETED FORM AS PART OF THE ECA AND SEND A COPY TO THE WATER SUPERVISOR (FOR MUNICIPAL) OR DISTRICT MANAGER (FOR NON-MUNICIPAL SYSTEMS)

Part 1 – Environmental Compliance Approval (ECA) with Limited Operational Flexibility

(Insert the ECA's owner, number and issuance date and notice number, which should start with "01" and consecutive numbers thereafter)

ECA Number	Issuance Date (mm/dd/yy)	Notice number (if applicable)

ECA Owner	Municipality

Part 2: Description of the modifications as part of the Limited Operational Flexibility

(Attach a detailed description of the sewage works)

Description shall include:
1. A detail description of the modifications and/or operations to the sewage works (e.g. sewage work component, location, size, equipment type/model, material, process name, etc.)
2. Confirmation that the anticipated environmental effects are negligible.
3. List of updated versions of, or amendments to, all relevant technical documents that are affected by the modifications as applicable, i.e. submission of documentation is not required, but the listing of updated documents is (design brief, drawings, emergency plan, etc.)

Part 3 – Declaration by Professional Engineer

I hereby declare that I have verified the scope and technical aspects of this modification and confirm that the design:
1. Has been prepared or reviewed by a Professional Engineer who is licensed to practice in the Province of Ontario;
2. Has been designed in accordance with the Limited Operational Flexibility as described in the ECA;
3. Has been designed consistent with Ministry's Design Guidelines, adhering to engineering standards, industry's best management practices, and demonstrating ongoing compliance with s.53 of the Ontario Water Resources Act; and other appropriate regulations.

I hereby declare that to the best of my knowledge, information and belief the information contained in this form is complete and accurate

Name (Print)	PEO License Number

Signature	Date (mm/dd/yy)

Name of Employer

Part 4 – Declaration by Owner

I hereby declare that:
1. I am authorized by the Owner to complete this Declaration;
2. The Owner consents to the modification; and
3. The modifications to the sewage works are proposed in accordance with the Limited Operational Flexibility as described in the ECA.
4. The Owner has fulfilled all applicable requirements of the *Environmental Assessment Act*.

I hereby declare that to the best of my knowledge, information and belief the information contained in this form is complete and accurate

Name of Owner Representative (Print)	Owner representative's title (Print)

Owner Representative's Signature	Date (mm/dd/yy)

EAB Form December 2, 2013

Upon issuance of the environmental compliance approval, I hereby revoke Approval No(s). 7875-95DQSC, 1440-5JFU5R issued on April 3, 2013, February 6, 2003.

In accordance with Section 139 of the Environmental Protection Act, you may by written Notice served upon me and the Environmental Review Tribunal within 15 days after receipt of this Notice, require a hearing by the Tribunal. Section 142 of the Environmental Protection Act provides that the Notice requiring the hearing shall state:

1. The portions of the environmental compliance approval or each term or condition in the environmental compliance approval in respect of which the hearing is required, and;
2. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

Pursuant to subsection 139(3) of the Environmental Protection Act, a hearing may not be required with respect to any terms and conditions in this environmental compliance approval, if the terms and conditions are substantially the same as those contained in an approval that is amended or revoked by this environmental compliance approval.

The Notice should also include:

3. The name of the appellant;
4. The address of the appellant;
5. The environmental compliance approval number;
6. The date of the environmental compliance approval;
7. The name of the Director, and;
8. The municipality or municipalities within which the project is to be engaged in.

And the Notice should be signed and dated by the appellant.

This Notice must be served upon:

The Secretary*
Environmental Review Tribunal
655 Bay Street, Suite 1500
Toronto, Ontario
M5G 1E5

AND

The Director appointed for the purposes of Part II.1 of the Environmental Protection Act
Ministry of the Environment and Climate Change
135 St. Clair Avenue West, 1st Floor
Toronto, Ontario
M4V 1P5

*** Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal at: Tel: (416) 212-6349, Fax: (416) 326-5370 or www.ert.gov.on.ca**

The above noted activity is approved under s.20.3 of Part II.1 of the Environmental Protection Act.

DATED AT TORONTO this 22nd day of January, 2016

Fariha Pannu.

Fariha Pannu, P.Eng.
Director
appointed for the purposes of Part II.1 of the
Environmental Protection Act

SW/

c: DWMD Supervisor, MOECC Guelph
Rekha Chetlur, Registration and Compliance Section, MOECC Drinking Water Programs Bramch - IMBS
Jeff Paznar, P. Eng., EP, R.J. Burnside & Associates Limited

Appendix B – Receiving Water Impact Assessment Update

EXP Services Inc.
1595 Clark Blvd.
Brampton, Ontario, L6T 4V1
T: 905.793.9800 • www.exp.com

Memorandum

To:	Brad McRoberts, P.Eng.	**From:**	EXP Services Inc.
Date:	October 13, 2017		
Project Name	Mapleton WPCP Class EA	**Project No.:**	BRM-00605325-A0
Subject	Receiving Water Impact Assessment (Final)		
Prepared By:	Hui Wang, P.Eng; Arun Jain, P.Eng., Jesse Newton, EIT, Jean-Louis Gaudet		
Distribution:			

1 Summary

The Township of Mapleton is undertaking a Schedule C Class Environmental Assessment (EA) to expand the Mapleton Wastewater Pollution Control Plant (WPCP) to cater to 2031 demands. It is expected that plant will need to be expanded from the current 750 m^3/day capacity to a future capacity of 1,300 m^3 /day.

In this context, the previous Receiving Water Impact Assessment – Mapleton WPCP, Conestogo River at Drayton (2008) was reviewed. The previous work recommended a discharge of 4000 m^3/day through months of January – April and from October – December. This approach was not deemed to be entirely correct due to lack of correlation between proposed discharge and monthly $7Q_{20}$ flows in the river.

The approach taken in this Receiving Water Impact Assessment (RWIA) update relies on new calculation of $7Q_{20}$ flows based on 38 year of data from 1973-2013. The maximum potential discharge flow was established by maintaining the river water concentration of un-ionized ammonia in line with the Ontario Provincial Water Quality Objectives (PWQO). This should serve as the theoretical maximum allowable discharge flow for current and future expansions of the plant.

The proposed discharge flow, however, has been developed based on the following:

- Adjusting dilution in way as to not go below current minimum dilution achieved in December discharges;
- Allowing for discharge of accumulated rainfall volume of 158 m^3.

Since the river waters are deemed to be Policy 2 with respect to total phosphorus (TP), the new TP limit is based on no increased loading to the river in future, compared to the WPCP's existing (2016) amended Environmental Compliance Approval (included in Appendix A).

2 Introduction

The Mapleton WPCP discharges treated effluent to the Conestogo River. The discharge point is about 1.2 km upstream from the inlet of Conestogo Reservoir (also known as Conestogo Lake). Of this distance, approximately 280 m is through wetland and 950 m through the Conestogo River. Figure 1 depicts a map of the Conestogo Lake, and Figure 2 depicts the distance between the effluent discharge point and the lake.

In this memo, we provide analysis and discussion on the impact of the proposed WPCP upgrade on the receiving water body. Based on the analysis, the discharge limits for the upgraded WPCP are proposed.

The analysis use as a guideline Procedure B-1-5: Deriving Receiving Water Based, Point-Source Effluent Requirements for Ontario Waters, and Water Management – Policies, Guidelines and Provincial Water Quality Objectives (MOEE. 1994). The analyses use the following data sources and references:

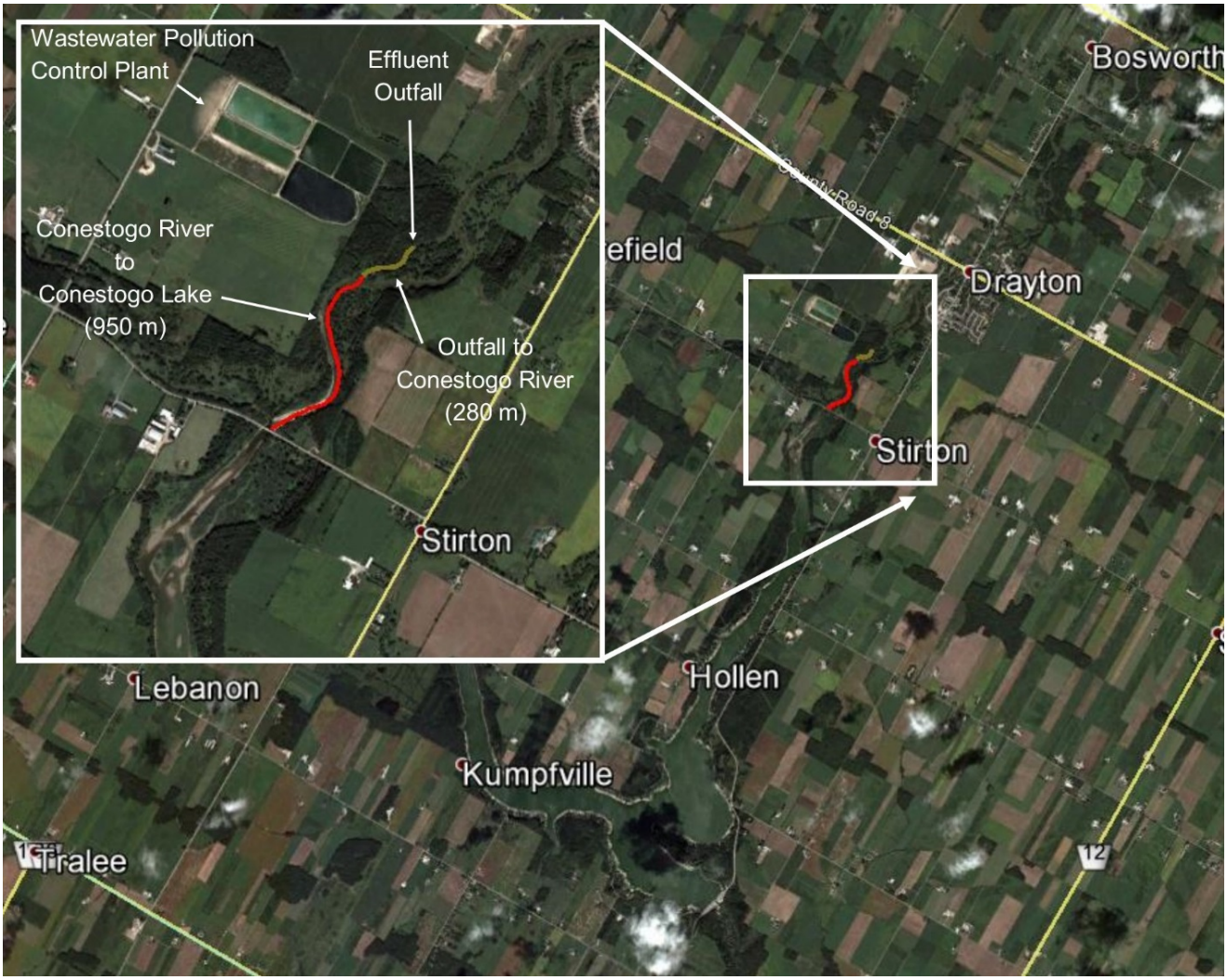
- Water quality data from the website of Provincial (Stream) Water Quality Monitoring Network (PWQMN);
- Conestogo River flow data from the website of Canada Water Office (Station 02GA039, Conestogo River above Drayton);
- Receiving Water Impact Assessment (Revised), Mapleton WPCP, Conestogo River at Drayton, Township of Mapleton. J. Burnside & Associates Limited. January 2008 (RWIA 2008).

On May 7, 2015, EXP organised a consultation meeting with representatives from the Ontario Ministry of the Environment and Climate Change (MOECC), the Grand River Conservation Authority (GRCA), and the Township of Mapleton. Comments from this meeting have been taken into account in the assessment. Subsequent to the May 7 meeting, the GRCA and MOECC provided comments on subsequent draft versions of this memorandum, which have since been updated to address those comments.

Figure 1: Conestogo Lake

Image source: Natural Resources Canada. Canadian Geographical Names – Conestoga Lake. http://www4.rncan.gc.ca/search-place-names/unique/FASNU.

Figure 2: Mapleton WPCP outfall relative to Conestogo Lake



Background image source: Google Earth.

3 Receiving Water Impact Assessment Approach

With reference of background water quality, the MOECC applies two policies to the receiving water:

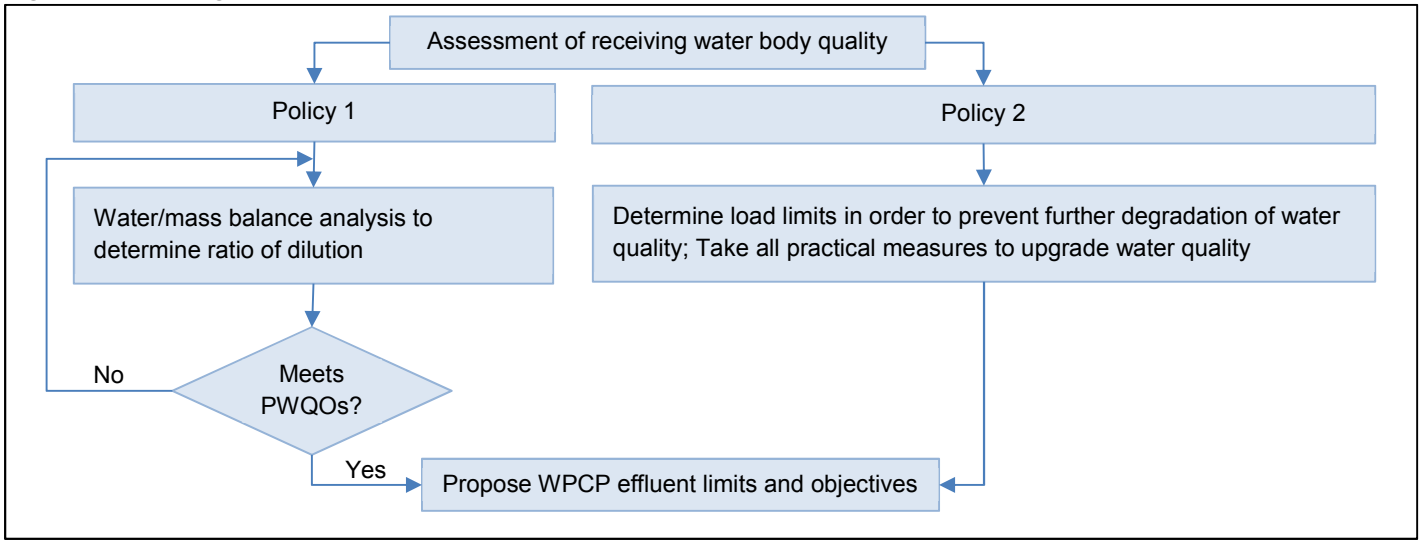
- Policy 1: In areas which have water quality better than the Provincial Water Quality Objectives, water quality shall be maintained at or above the objective; and
- Policy 2: Water quality which presently does not meet the Provincial Water Quality Objectives shall not be degraded further and all practical measures shall be taken to upgrade the water quality to the Objectives.

With respect to Policy 2, the MOECC recognizes that, under certain circumstances, it may not be technically feasible, physically possible or socially desirable to improve water quality toward the PWQOs. The Policy notes that:

> where it is clearly demonstrated that all reasonable and practical measures to attain the Provincial Water Quality Objectives have been undertaken but where:
>
> 1) The Provincial Water Quality Objectives are not attainable because of natural background water quality; or
> 2) The Provincial Water Quality Objectives are not attainable because of irreversible human-induced conditions; or
> 3) To attain or maintain the Provincial Water Quality Objectives would result in substantial and widespread adverse economic or social impact; or
> 4) Suitable treatment techniques are not available;
>
> then deviations from this policy may be allowed, subject to the approval of the Ministry of Environment and Energy.[1]

This RWIA-update will reflect the MOECC's water management policies; see Figure 3 for the approach.

Figure 3: Receiving Water Impact Assessment Approach



[1] Ministry of Environment and Energy. *Water Management Policies, Guidelines, Provincial Water Quality Objectives*. July 1994.

4 Conestogo River $7Q_{20}$ Flows

The MOECC's Procedure B-1-5 (Deriving Receiving-water Based, Point-Source Effluent Requirements for Ontario Waters, July 1994) notes that the low flow statistic $7Q_{20}$ is to be used as the basic design flow for the receiving stream for continuous point source discharges (where $7Q_{20}$ is the minimum 7-day flow equalled or exceeded on average 95% of the time, over a 20-year period). The $7Q_{20}$ provides a conservative approach to ensuring there is sufficient streamflow for the assimilation or dilution of point source discharges. This section presents the approach taken to calculate the $7Q_{20}$, the resulting $7Q_{20}$ values, and a comparison to $7Q_{20}$ calculated in the previous studies.

4.1 Estimation of $7Q_{20}$ Flows

Flow frequency analysis was used to estimate monthly $7Q_{20}$ low flows of the Conestogo River at Drayton. The technique applied uses observed flow discharge data to calculate statistical information such as mean values, standard deviations, skewness, and recurrence intervals. The statistical data were then fitted to a Log-Pearson Type III distribution. The technique used is discussed below.

Historical flow discharge data from hydrometric Station 02GA039 on the Conestogo River above Drayton was obtained from the Government of Canada's Wateroffice website (https://wateroffice.ec.gc.ca/). For this station a database of 38 years of daily flow data from 1973 to 2013 (missing April 1998 to March 2001) was available and used.

Calculation of the $7Q_{20}$ involved the following steps:

1. Calculating the 7-day moving window average of daily flows;
2. Determining the monthly minimum of the 7-day moving window average of daily flows of each year; and
3. Fitting the monthly data series to a Log-Pearson Type III distribution.

The Log-Pearson Type III distribution is fitted to the monthly 7-day low flow data series by the method of moments:

$$\mu = \gamma + \alpha\beta$$
$$\sigma = \alpha\beta^2$$
$$\gamma_1 = 2\alpha^{-0.5}$$

where μ, σ, and γ_1 are the mean, standard deviation, and skewness of the log data series, respectively, and α, β and γ are the parameters of the Log-Pearson Type III distribution. The Cunnane plotting position equation was used to calculate the exceedance probability of the ranked data.

Table 1 presents the calculated $7Q_{20}$ flows, as well as the estimation error (coefficient of determination). The graphs of the curve fitting are provided in Appendix E. Appendices B to E include the raw and processed data tables related to these steps. These include:

- Appendix B: Daily discharge as reported by Station 02GA039 and the 7-day moving window average.
- Appendix C: Monthly minimums of the 7-day moving window average for each month;
- Appendix D: Summary of $7Q_{20}$ values; and
- Appendix E: $7Q_{20}$ calculation tables and graphs.

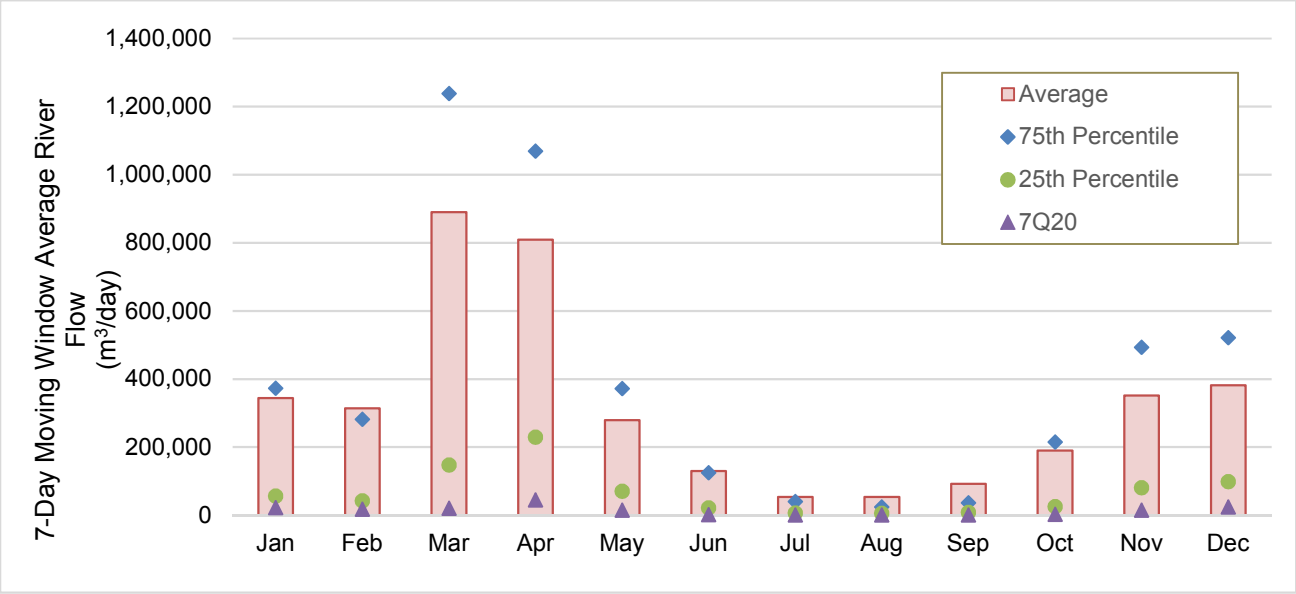
Table 1: Summary of estimation of $7Q_{20}$ by Log Pearson-III distribution (based on daily flow data observed at station 02GA039, 1973-2013)

Month	$7Q_{20}$ (m^3/s)	$7Q_{20}$ (m^3/d)	# of samples	Coefficient of determination, R^2
Jan	0.265	22,918	38	0.92
Feb	0.205	17,740	38	0.94
Mar	0.245	21,129	38	0.97
April	0.526	45,407	38	0.99
May	0.171	14,738	38	0.98
Jun	0.019	1,643	38	0.97
Jul	0.007	639	38	0.90
Aug	0.015	1,312	38	0.86
Sept*	0.008	712	38	0.74*
Oct	0.035	3,057	38	0.93
Nov	0.175	15,085	38	0.94
Dec	0.282	24,402	38	0.99

*While the curve fit for September is a little poor, it is irrelevant for the purpose of this memo since no discharge is proposed for this month.

To appreciate the annual flow characteristics of the Conestogo River, Figure 4 is provided for context, which compares the $7Q_{20}$ flows against other 7-day moving window average flows for each month.

Figure 4: Comparison of average, $7Q_{20}$, and 75th and 25th percentile river flows for the Conestogo River (7-day moving average)



Data source: Environment Canada. Daily Discharge at Station 02GA039 Conestogo River above Drayton. 1973 - 2013 (missing April 1998 to March 2001).

4.2 1996 and 2008 Assimilative Capacity $7Q_{20}$ Values

Estimated $7Q_{20}$ values for the Conestogo River near Drayton were calculated for the 1996 Assimilative Capacity Study and the 2008 RWIA, which were conducted to support proposed WPCP expansions. The 1996 report examined 20 years of river flow data (1973 to 1993) and the 2008 study examined 31 years of river flow data

(1973 to 2004). Table 2 compares the $7Q_{20}$ values calculated for this RWIA (i.e. 2016 values) to the 1996 and 2008 studies ($7Q_{20}$ values for some months are not available from the 1996 study). The 2016 $7Q_{20}$ values were somewhat higher than the 2008 $7Q_{20}$ values for January, February, March, May and August. However, for the remaining months (which include four of the WPCP's five available months for discharge), the $7Q_{20}$ values were slightly lower.

Table 2: Comparison of 2016-calculated $7Q_{20}$ values with previous RWIAs dated 1996 and 2008

Month	1996 $7Q_{20}$ (L/s) (1)	2008 $7Q_{20}$ (L/s) (1)	2016 $7Q_{20}$ (L/s) (2)
January	-	201	265
February	-	164	205
March	200	238	245
April	800	659	526
May	100	169	171
June	-	32	19
July	-	23	7
August	-	13	15
September	-	14	8
October	20	48	35
November	120	256	175
December	280	292	282

(1) R.J. Burnside & Associates Limited. Receiving Water Impact Assessment (Revised), Mapleton WPCP, Conestogo River at Drayton, Township of Mapleton. January 2008.
(2) Calculated for this report, per the details in this section.

5 Conestogo River Water Quality at Drayton

For this RWIA, data from two stations in Ontario‘s Provincial (Stream) Water Quality Monitoring Network (PWQMN) were used to assess the water quality in the Conestogo River near Drayton:

- Station ID: 16018407502 (data from 2007 to 2014), located at Wellington Street North in Drayton, approximately 2.4 km upstream from the Mapleton WPCP discharge point.
- Station ID: 16018410002 (data from 1990 to 2006), located near Wellington County Road 7 and about 5.3 km further upstream from Station 16018407502 .

These stations were used to provide data for total phosphorus (TP), total ammonia nitrogen (TAN), pH and water temperature. The un-ionized ammonia (NH_3) concentrations were calculated using Emerson equation and based on water, pH and temperature. Other water quality parameters were obtained from the Station data. Data for $CBOD_5$ and *Escherichia coli* (*E. coli)* was obtained from R.J. Burnside’s 2008 RWIA. The water quality data from these sources is summarized in Table 3, with provincial water quality objective exceedances shown in red. The raw data used in this analysis is provided in Appendix F, with some datasets presented graphically. The calculation table for NH_3 are provided in Appendix G.

From the data presented in Table 3, it was determined that, with reference to the parameters concerning the WPCP’s effluent, the applicable water management policies are as follow:

- Policy 2: Total phosphorus (TP), and fecal coliform;
- Policy 1: Un-ionized ammonia (NH_3), and dissolved oxygen (DO).

Table 3: Summary of monthly water quality data upstream of the Mapleton WPCP effluent discharge point

MONTH	$CBOD_5$[1]	Fecal coliform[1]	TSS[2] (RESIDUE, PARTICULATE; RSP)	Total ammonia nitrogen[2] (AMMONIUM, TOTAL UNFIL.REAC (1995-2013); NNHTUR)	Water temperature[2] (TEMPERATURE, WATER; FWTEMP)	pH[2] (PH FIELD; FWPH)	Un-ionised ammonia (NH_3)[3]	Total phosphorus[2] (PHOSPHORUS, UNFILTERED TOTAL; PPUT)	Nitrate[2] (NITRATES TOTAL, UNFIL.REAC; NNOTUR)	Nitrite[2] (NITRITE, UNFILTERED REACTIVE; NNO2UR)	Nitrate (NNOTUR - NNO2UR)	Total Kjeldahl nitrogen[2] (NITROGEN, TOT, KJELDAHL/ UNF.REA; NNTKUR)	Dissolved oxygen [4] (DO)
	(mg/L)	(#/100 ml)	(mg/L)	(mg/L as N)	(°C)		(mg/L as N)	(mg/L)	(mg/L)	(mg/L as N)	(mg/L as N)	(mg/L)	(mg/L)
PWQO Guideline	-	100	-	-		6.5 - 8.5	0.0165	0.03					> 5 to > 8 (cold water biota)* > 4 to > 7 (warm water biota)*
CCME Guideline						6.5 - 9	0.0156			0.06 mg/L as N	13 mg/L as NO_3^- 2.94 mg/L as N		> 6.5 to > 9.5 (cold water biota)* > 5.5 to > 6.5 (warm water biota)*
Jan	-	-	166.8	0.126	1.0	8.04	0.0010	0.087	3.200	0.035	3.158	0.800	≥ 12.2
(n)			*4*	*4*	*9*	*9*	*9*	*9*	*4*	*4*	*4*	*9*	*9 (all passing)*
Feb	-	-	24.5	0.084	0.7	8.15	0.0011	0.052	4.940	0.022	*4.921*	0.800	≥ 10.48
(n)			*5*	*5*	*10*	*10.00*	*10*	*10*	*5*	*5*	*5*	*10*	*10 (all passing)*
Mar	0.6	350	100.7	0.162	3.9	7.94	0.0014	0.204	4.693	0.024	*4.672*	1.160	≥ 10.37
(n)			*10*	*10*	*15*	*13*	*13*	*15*	*10*	*10*	*10*	*14*	*15 (all passing)*
Apr	0.55	11.5	31.7	0.060	11.5	8.34	0.0011	0.097	4.245	0.021	*4.232*	0.780	≥ 9.9
(n)			*16*	*16*	*19*	*19*	*19*	*20*	*16*	*16*	*16*	*20*	*19 (all passing)*
May	-	-	7.9	0.038	18.8	8.45	0.0017	0.032	4.280	0.045	*4.106*	0.840	≥ 9.1
(n)			*19*	*18*	*23*	*23*	*22*	*23*	*17*	*18*	*18*	*23*	*23 (all passing)*
Jun	-	-	14.1	0.066	23.8	8.21	0.0039	0.036	4.290	0.049	*4.254*	0.898	≥ 7.09
(n)			*18*	*19*	*24*	*24*	*24*	*24*	*19*	*19*	*19*	*24*	*24 (all passing)*
Jul	-	-	18.7	0.054	25.9	8.32	0.0045	0.049	1.338	0.029	1.299	0.930	≥ 5.92**
(n)			*18*	*18*	*23*	*23*	*23*	*23*	*18*	*18*	*18*	*23*	*23 (1 sample not passing for cold water biota only)***
Aug	-	-	17.7	0.046	23.9	8.29	0.0030	0.043	0.740	0.012	0.728	0.795	≥ 5.9
(n)			*22*	*21*	*26*	*26*	*25*	*27*	*21*	*21*	*21*	*27*	*26 (all passing)*
Sep	-	-	15.4	0.029	20.0	8.40	0.0016	0.032	0.099	0.006	0.093	0.703	≥ 5.83
(n)			*21*	*20*	*25*	*25*	*24*	*24*	*19*	*20*	*19*	*24*	*24 (all passing)*
Oct	0.95	1,517	13.0	0.030	11.2	8.40	0.0010	0.033	3.600	0.020	*3.668*	0.770	≥ 9.05
(n)			*15*	*14*	*19*	*18*	*17*	*19*	*13*	*13*	*12*	*19*	*19 (all passing)*
Nov	1.33	1,133	14.3	0.036	5.5	8.33	0.0008	0.040	6.515	0.031	*6.485*	0.830	≥ 10.9
(n)			*11*	*11*	*15*	*14*	*14*	*14*	*11*	*11*	*11*	*15*	*15 (all passing)*
Dec	< 0.5	80	7.6	0.021	2.6	8.39	0.0004	0.039	9.165	0.035	*9.101*	0.800	≥ 12.49
(n)			*4*	*4*	*8*	*8*	*7*	*7*	*4*	*4*	*4*	*7*	*8 (all passing)*
Total n			*163*	*160*	*216*	*212*	*207*	*215*	*157*	*159*	*157*	*215*	*215 (1 not passing for cold water biota only)*

Note: Exceedances of PWQO Guidelines are shown in (red), and that of CCME Guidelines in (*blue italics*).
(1) Average monthly results of field-monitoring program in Conestoga River upstream of WPCP outfall. Data from: R.J. Burnside & Associates Limited. Receiving Water Impact Assessment (Revised), Mapleton WPCP, Conestogo River at Drayton, Township of Mapleton (Table 6.) January 2008.
(2) 75th percentile of parameter values of samples taken at Station ID 16018410002 (1990 – 2006) and Station ID 16018407502 (2007 – 2014).
(3) 75th Percentile values calculated from total ammonia, temperature and pH measured at stations 16018407502 and 16018410002.
(4) Minimum of parameter values of samples taken at Station ID 16018410002 (1990 – 2006) and Station ID 16018407502 (2007 – 2014).
*Minimum acceptable dissolved oxygen values depend on the type of biota (as indicated) as well as on the water temperature. Colder waters require higher minimum DO levels compared to warmer waters. For example, for warm water biota, minimum DO level at 0 °C is 7 mg/L, while at 20 °C it is 4 mg/L. See MOEE (1994) for details, and Appendix F (Table F-2) for field sample water temperatures corresponding to each DO measurement. It is noted that all measured DO levels were above the minimum DO level specified (PWQO) for the measured water temperature for both cold and warm water biota.
**See note in Appendix F (Table F-2) for details. Note also that no WPCP discharge is proposed for July.

6 Existing Effluent Discharge Regime

6.1 Effluent Criteria and Current Discharge Window

The influent rated capacity (approved) of the existing WPCP is 750 m^3/d. The discharge of effluent is seasonal. The WPCP's amended Environmental Compliance Approval (Number 0963-A4ZMVA, issue date January 22, 2016) describes Mapleton WPCP discharge limits in terms of pollutant concentration as well as the allowable monthly discharge volumes.

In addition to the approved seasonal discharge limits, Section 9(1) of the Environmental Compliance Approval (ECA) also includes a provision that allows the facility to discharge more than the approved discharge limit if the streamflow to effluent discharge flow is greater than 10:1 (maximum discharge is the maximum design capacity of the sand filtration and ultra-violet (UV) disinfection unit, of 4,000 m^3/day).

Table 4 presents the WPCP's existing effluent objectives and limits as per the existing ECA (amended 2016) which is available in Appendix A.

Table 4: Existing effluent objectives and limits for Mapleton WPCP

Parameter	Unit	Objective	Limit
Carbonaceous biochemical oxygen demand, five day ($CBOD_5$)	(mg/L) (monthly average concentration)	5.0	7.5 (Apr and Oct) 10 (Mar., Nov. and Dec)
Total phosphorous (TP)	(mg/L) (monthly average concentration)	0.3	0.5
Total ammonia nitrogen (TAN) (NH4 + NH3)	(mg/L) (monthly average concentration)	3.0	5.0
E. coli.	(organisms/100 mL)	100	200
pH		6.5 to 8.5	6.0 to 9.5

Source: Amended Environmental Compliance Approval (Number 0963-A4ZMVA, issue date January 22, 2016).

Table 5 presents the existing seasonal discharge rates as per the existing ECA (amended 2016) which is available in Appendix A.

Table 5: Current permitted effluent discharge for Mapleton WPCP

Month	Maximum final effluent discharge rate (m^3/day)
March	1,581
April	3,154
October	233
November	1,754
December	4,000

Source: Amended Environmental Compliance Approval (Number 0963-A4ZMVA, issue date January 22, 2016).

When the $7Q_{20}$ values calculated for this RWIA-update study are applied to the approved discharge rates, the ratio of $7Q_{20}$ stream flow to effluent rate varies significantly between the months, with the greatest dilution factor calculated for April (14.1) and the smallest for December (6.1). Based on the measured daily discharge at Station 02GA039, the periods when the streamflow will be less than 10:1 to effluent are found to be rare. For example, the minimum flow rate needed in March to maintain the 10:1 dilution rate is 15,811 m^3/day. Of the 372 measurements taken for daily stream flow rate in March between 1973 and 2013, only 0.4% were less than that amount. For all but one of the months where discharge occurs, 1.5% or less of the measurements for streamflow were below what is required for 10:1 dilution. The only exception for this was December, where 7.1% of the measurements were below the required flow rate.

For context and comparison, when average daily flow rates are considered, the dilution factor is much greater than 10:1; see Table 6. These average values are provided for comparison only; it is noted that the design flow criterion is $7Q_{20}$.

Table 6: Observed effluent discharge rates and streamflow ratios (1973 to 2013)

	Dilution factor based on current approved discharge rates and $7Q_{20}$ stream flow			Statistics based on 10:1 dilution factor		Dilution factor based on average stream flow*	
Month	Approved discharge rate (m^3/d)	$7Q_{20}$ (m^3/d)	Dilution factor	Stream flow needed for 10:1 dilution (m^3/d)	Percentage of stream flow measurements with less than 10:1 dilution (1973-2013)(1)	Average stream flow** (m^3/d)	Dilution factor based on average stream flow
March	1,581	21,129	13.4	15,811	0.4%	890,051	562.9
April	3,154	45,407	14.4	31,540	1.0%	809,146	256.5
October	233	3,057	13.1	2,333	1.5%	190,139	815.0
November	1,754	15,085	8.6	17,540	0.6%	351,541	200.4
December	4,000	24,402	6.1	40,000	7.1%	381,638	95.4

(1) Daily discharge data missing for April 1998 to March 2001, inclusive. Number of days with data for each month include: March, 372; April, 360; October, 372; November, 360; December, 372.
*Provided for context and comparison purposes only. **Seven-day moving average.
NOTE: contributing volumes due to inflow and infiltration (I&I) are included in the effluent volumes reported. The existing effluent volume from the WPCP to the river is measured downstream of the lagoon cells and upstream of the sand filters. Thus, infiltration volumes and precipitation inflow volumes are included both in the current maximum permitted daily effluent discharge rates as stated in the existing ECA (amended 2016, see Table 5) and in the observed effluent discharge rates reported in Table 6 above.

6.2 After-mixing Concentrations of Existing WPCP Effluent Limits

The after-mixing concentration of concerned pollutants based on existing WPCP effluent limits were calculated to use as a baseline against which the proposed future effluent discharge window could be compared. The parameters discussed include un-ionized ammonia and TP.

6.2.1 Un-ionized ammonia (NH_3) – Existing after-mixing conditions

The un-ionized ammonia concentrations in the Conestogo River based on current effluent limits were calculated using observed total ammonia, pH and temperature data. The potential impact of the WPCP effluent discharge on the level of un-ionized ammonia (NH_3) in the Conestoga River relative to the Ontario PWQO was calculated using a mass-balance approach based on (i) NH_3-N concentration in the river, (ii) the existing WPCP effluent limit for total ammonia nitrogen (TAN) and approved discharge flow rates, and (iii) the $7Q_{20}$ values calculated for this report. The analysis uses the following equation:

- $C_{final} = (\%Q_{River} \times C_{75th}) + (\%Q_{WPCP} \times C_{WPCP})$
- $\%Q_{River} + \%Q_{WPCP} = 100\%$

where,

- C_{final} : Concentration of pollutant in the river downstream of WPCP discharge point;
- $\%Q_{River}$: Percentage of 20-yr return period, 7-day average low flow of the river;
- C_{75th}: 75th percentile of pollutant concentration in Conestogo River upstream of Drayton;
- Q_{WPCP}: Percentage discharge flow from the WPCP; and
- C_{WPCP}: Pollutant concentration of the WPCP discharge.

Table 8 (following page) presents the estimated after-mixing un-ionized ammonia (NH_3) concentrations in the Conestogo River during $7Q_{20}$ conditions under the existing TAN limit (5 mg/L) and flow regime (per the plant's ECA, amended 2016). The resulting concentrations for NH_3 are within the PWQO with the exception of December, where the PWQO is marginally exceeded at ~101% of the PWQO limit (October approaches the PWQO limit at 99%). Note that actual TAN concentration of the WPCP's effluent is generally lower than the 5mg/L discharge limit permitted under the plant's ECA. Note also that the $7Q_{20}$ values calculated for this study are slightly lower than in the 2008 RWIA study, which increases the after-mixing concentration of NH_3 compared to the 2008 $7Q_{20}$ values.

6.2.2 Total phosphorus – Existing after-mixing conditions

Table 7 and Table 8 show the total annual TP loading and after-mixing river based on the existing TP effluent limit of 0.5 mg/L and discharge regime. As summarized in Table 7, the total annual loading for phosphorus based on the existing effluent limit and discharge regime is 163.7 kg. The monthly loading is highest during the month of December, as that is when the WPCP has its highest approved discharge daily flow rate.

Table 7: Existing total phosphorus annual loading (current effluent limit maximum)

Month	Number of discharge days	Approved daily flow (m^3/day)	Monthly discharge (m^3/month)	Loading by effluent limit (TP = 0.5 mg/L)	
				Daily TP loading (kg/day)	Monthly TP loading (kg/month)
Mar	31	1,581	49,011	0.791	24.5
Apr	30	3,154	94,620	1.577	47.3
Oct	31	233	7,223	0.117	3.6
Nov	30	1,754	52,620	0.877	26.3
Dec	31	4,000	124,000	2.000	62.0
Annual (kg/year)					**163.7**

Approved daily WPCP flow rates and TP effluent limits in this table are based on Mapleton WPCP's current ECA (amended 2016).

Table 8: Existing after-mixing concentrations and loads of NH_3 and TP (based on Mapleton WPCP's ECA, Amended 2016)

Description	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
7Q20 low flow	m³/d	22,918	17,740	21,129	45,407	14,738	1,643	639	1,312	712	3,057	15,085	24,402	-
Effluent flow (existing approved maximum)	m³/d	**0**	**0**	**1,581**	**3,154**	**0**	**0**	**0**	**0**	**0**	**233**	**1,754**	**4,000**	**-**
Dilution ratio		-	-	13.4	14.4	-	-	-	-	-	13.1	8.6	6.1	-
Existing TAN effluent limit	mg/L as N	-	-	5	5	-	-	-	-	-	5	5	5	-
NH3 concentrations and PWQO criteria														
Un-ionized ammonia - Upstream (75°) *	mg/L as N	0.0010	0.0011	0.0014	0.0011	0.0017	0.0039	0.0045	0.0030	0.0016	0.0010	0.0008	0.0004	-
Un-ionized ammonia - Effluent End-of-Pipe **	mg/L as N	-	-	0.1026	0.0353	-	-	-	-	-	0.1444	0.0332	0.0535	-
Un-ionized ammonia - After mixing	mg/L as N	**-**	**-**	**0.0085**	**0.0034**	**-**	**-**	**-**	**-**	**-**	**0.0111**	**0.0042**	**0.0079**	**-**
PWQO criteria for un-ionized ammonia ***	mg/L as N	**0.0165**	**0.0165**	**0.0165**	**0.0165**	**0.0165**	**0.0165**	**0.0165**	**0.0165**	**0.0165**	**0.0165**	**0.0165**	**0.0165**	**-**
% of PWQO reached for NH3-N - Upstream		6%	7%	9%	7%	10%	24%	27%	18%	10%	6%	5%	2%	-
% of PWQO reached for NH3-N - After mixing		-	-	51%	20%	-	-	-	-	-	68%	25%	48%	-
NH3 loads														
Monthly NH3-N load - Upstream	kg as N	0.7	0.5	0.9	1.5	0.8	0.2	0.1	0.1	0.0	0.1	0.4	0.3	5.7
Monthly NH3-N load - Effluent	kg as N	-	-	5.0	3.3	-	-	-	-	-	1.0	1.7	6.6	17.8
Monthly NH3-N load - After mixing	kg as N	0.7	0.5	6.0	4.9	0.8	0.2	0.1	0.1	0.0	1.1	2.1	6.9	23.5
TP concentrations and PWQO criteria														
Total phosphorus - Upstream (75°)	mg/L	0.087	0.052	0.204	0.097	0.032	0.036	0.049	0.043	0.032	0.033	0.040	0.039	-
Total phosphorus - Effluent (existing TP limit)	mg/L	-	-	0.500	0.500	-	-	-	-	-	0.500	0.500	0.500	-
Total phosphorus - After mixing (75°)	mg/L	**0.087**	**0.052**	**0.225**	**0.123**	**0.032**	**0.036**	**0.049**	**0.043**	**0.032**	**0.066**	**0.088**	**0.104**	**-**
PWQO criteria for TP	mg/L	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**-**
% of PWQO reached for TP - Upstream		290%	173%	680%	323%	107%	120%	163%	143%	107%	110%	133%	130%	-
% of PWQO reached for TP - After mixing		-	-	749%	411%	-	-	-	-	-	220%	293%	346%	-
TP loads														
Monthly TP load - Upstream	kg	62	26	134	132	15	2	1	2	1	3	18	30	424
Monthly TP load - Effluent	kg	-	-	25	47	-	-	-	-	-	4	26	62	164
Monthly TP load - After mixing	kg	62	26	158	179	15	2	1	2	1	7	44	92	588

* 75th percentile (75°) values of individual NH3 concentrations were calculated using observed field conditions (pH and temperature) using the formulae below. See Appendix G.
** Calculated using maximum monthly observed effluent pH and temperature from 2012-2015. See Table 9.
*** Concentration of NH3 = (14.01+3)/14.01 * concentration of NH3-N.
Formulae (per MOEE, 1994):

Un-ionized ammonia [NH3] = fNH3 x [TAN]
fNH3 = 1 / (10^(pKa - pH) + 1)
pKa = 0.09018 + 2729.92 / (273.16 + Temperature [°C])

6.3 WPCP Effluent Quality (Sept 2012 to Apr 2016)

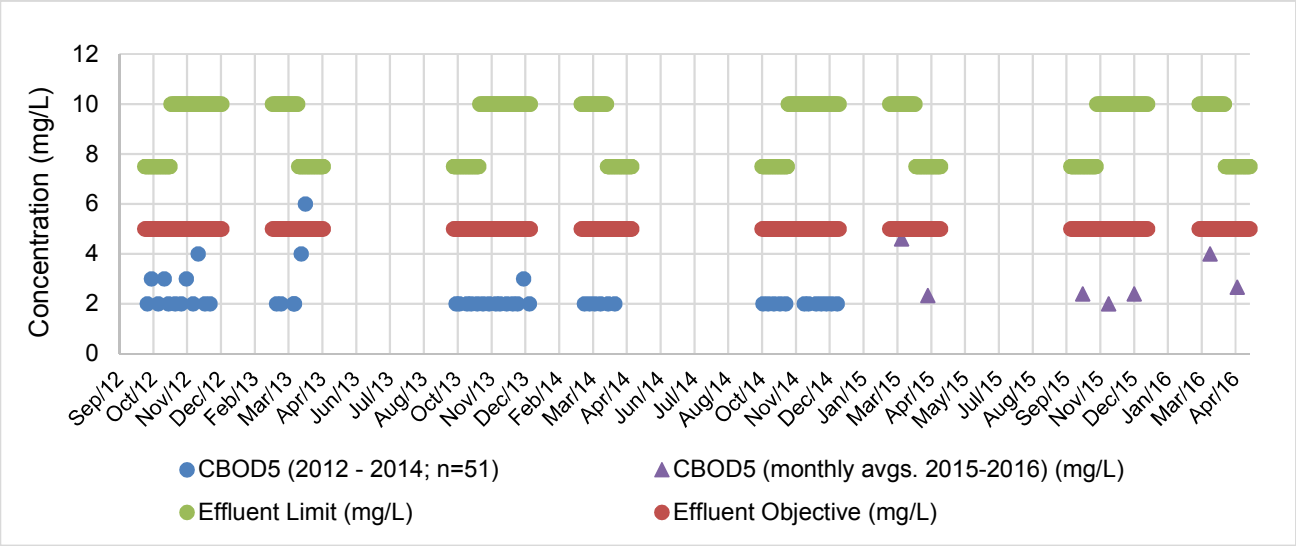
This section describes the quality of the WPCP's effluent from September 2012 to April 2016, as the data available was limited to this period. The parameters discussed include:

- Carbonaceous biochemical oxygen demand, five-day ($CBOD_5$);
- Total phosphorus (TP);
- Total ammonia nitrogen (TAN);
- E. coli;
- Total suspended solids (TSS);
- pH; and
- Temperature.

6.3.1 $CBOD_5$ – Effluent quality (Sept 2012 to Apr 2016)

Figure 5 presents the concentration of $CBOD_5$ measured in the WPCP's final effluent from September 2012 to April 2016. The data from September 2012 to December 2014 consisted of individual samples (n=51), while the data from 2015 and 2016 consisted of monthly averages. There was one exceedance of the effluent objective (in April 2013), but no exceedances of the effluent limit.

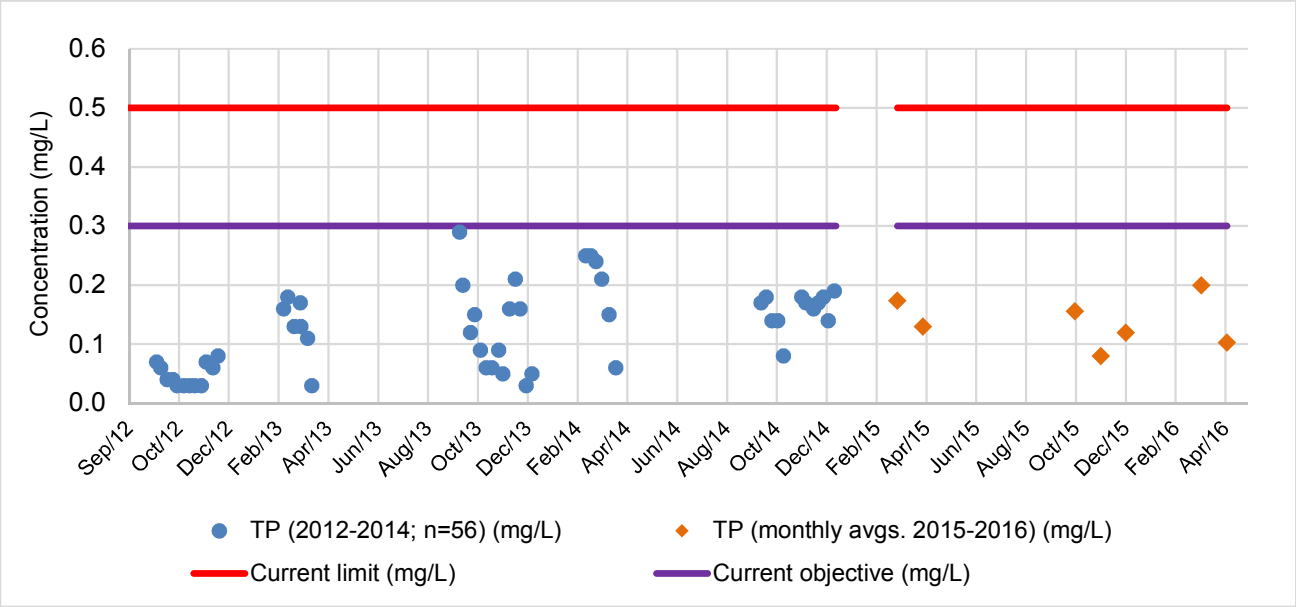
Figure 5: CBOD5 in Final Effluent (2012 - 2016)



6.3.2 Total phosphorus – Effluent quality (Sept 2012 to Apr 2016)

Figure 6 presents the concentration of TP measured in the WPCP's final effluent from September 2012 to April 2016. The data from September 2012 to December 2014 consisted of individual samples (n=51), while the data from 2015 and 2016 consisted of monthly averages. Of the sample set, there were no exceedances of the effluent objective.

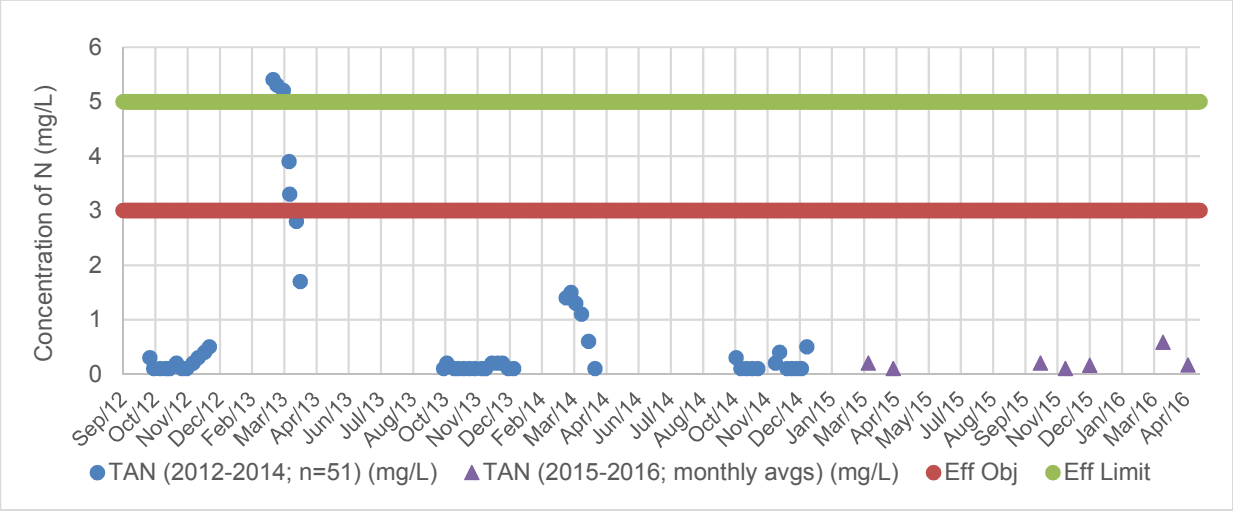
Figure 6: Total Phosphorus in Final Effluent (2012 - 2016)



6.3.3 Total Ammonia Nitrogen – Effluent Quality (Sept 2012 to Apr 2016)

Figure 7 presents the concentration of total ammonia nitrogen (TAN) measured in the WPCP's final effluent from September 2012 to April 2016. The data from September 2012 to December 2014 consisted of individual samples (n=51), while the data from 2015 and 2016 consisted of monthly averages. Of the sample set, there were five samples that exceeded the effluent objective, all occurring in March 2013. Within these, there were three exceedances of the effluent limit. This occurred shortly after the construction of the new storage lagoons. It is understood by the project team that the March exceedances were due to temporary challenges at that time due to the "learning curve" of operating the new system, and they have long since been resolved. Furthermore, it is noted that the post-lagoon nitrification unit as proposed in the Class EA would provide further assurance of consistently meeting effluent objectives in the future.

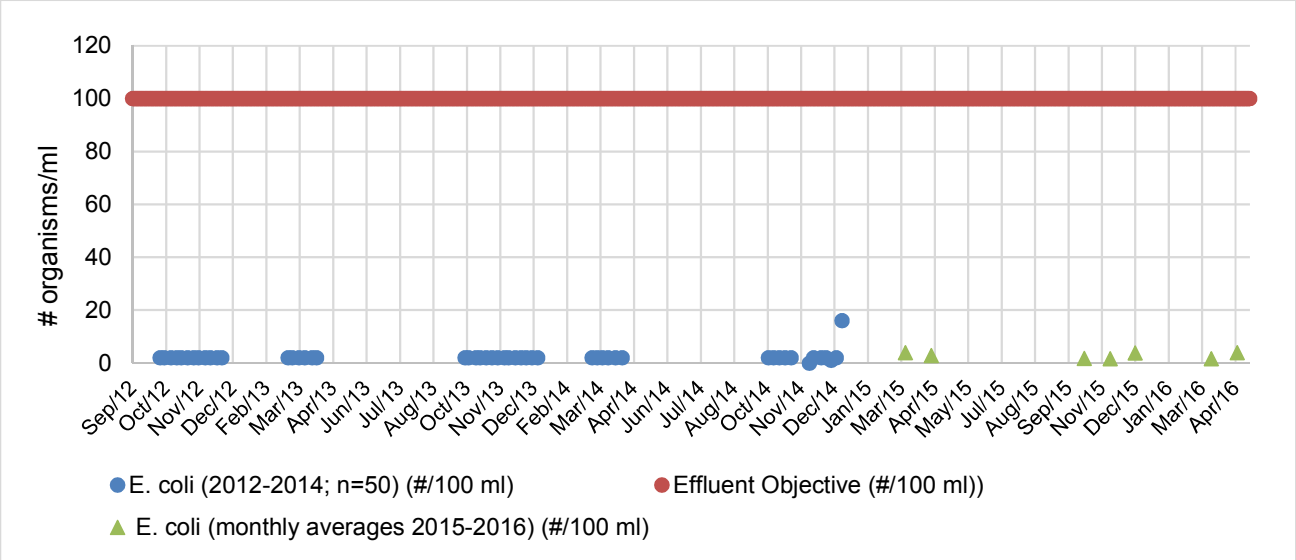
Figure 7: Total Ammonia (NH3 + NH4) as N in Final Effluent (2012 - 2016)



6.3.4 E. coli – Effluent Quality (Sept 2012 to Apr 2016)

Figure 8 presents the counts of *E. coli* measured in the WPCP's final effluent from September 2012 to April 2016. The data from September 2012 to December 2014 consisted of individual samples (n=50), while the data from 2015 and 2016 consisted of monthly averages. Of the sample set, there were no exceedances of the effluent objective.

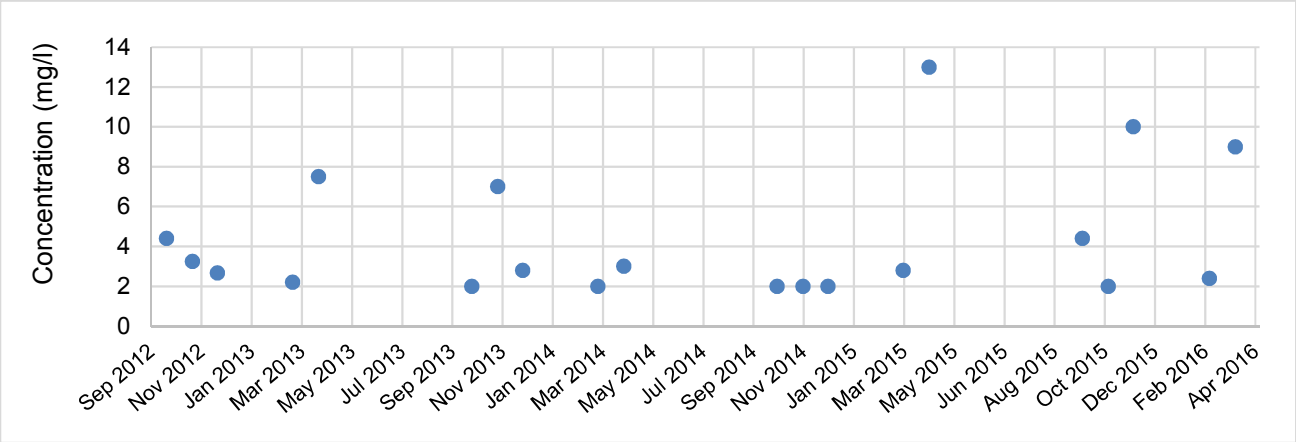
Figure 8: E. coli in Final Effluent (2012 - 2016)



6.3.5 Total Suspended Solids - Effluent Quality

Figure 9 presents the monthly average Total Suspended Solids (TSS) measured in the final effluent between September 2012 and April 2016. About 75% of the monthly averages were 5 mg/l or less, while 25% ranged between 5 and 13 mg/l. While the Mapleton WPCP ECA does not include effluent limits for TSS, these values nonetheless are relatively low compared to the 75th percentile values of TSS concentrations for the Conestogo River (see Table 3).

Figure 9: Total Suspended Solids in Final Effluent (2012 - 2016)



6.3.6 pH and Temperature - Effluent Quality

Table 9 summarizes the monthly average pH and temperature as observed/measured via grab samples between 2012-2015.

Table 9: Temperature and pH (grab) in final effluent (monthly average of given year)

	Temperature (°C)				pH			
Month	**2012**	**2013**	**2014**	**2015**	**2012**	**2013**	**2014**	**2015**
Mar	8.6	8	4.9	4.9	8.1	7.1	7	8.1
Apr	9.5	6.1	6.6	8.5	7.3	7.6	7.4	7.3
Oct	12.4	12.4	13.1	12.3	6.6	8.1	7.9	6.6
Nov	5.7	6.3	5.7	8.7	7.1	7.4	7.6	7.1
Dec	4.3	5.8	5.2	6.1	7.3	7.2	7.9	7.3

Maximum monthly values are highlighted.

Figure 10 depicts the monthly average pH measured in the final effluent between September 2012 and December 2015. The measurements fall within the minimum and maximum pH compliance range of 6.0 to 9.5. Figure 11 presents the monthly average temperature measured in the final effluent from 2012 to 2015.

Figure 10: pH in Final Effluent (2012 - 2015)

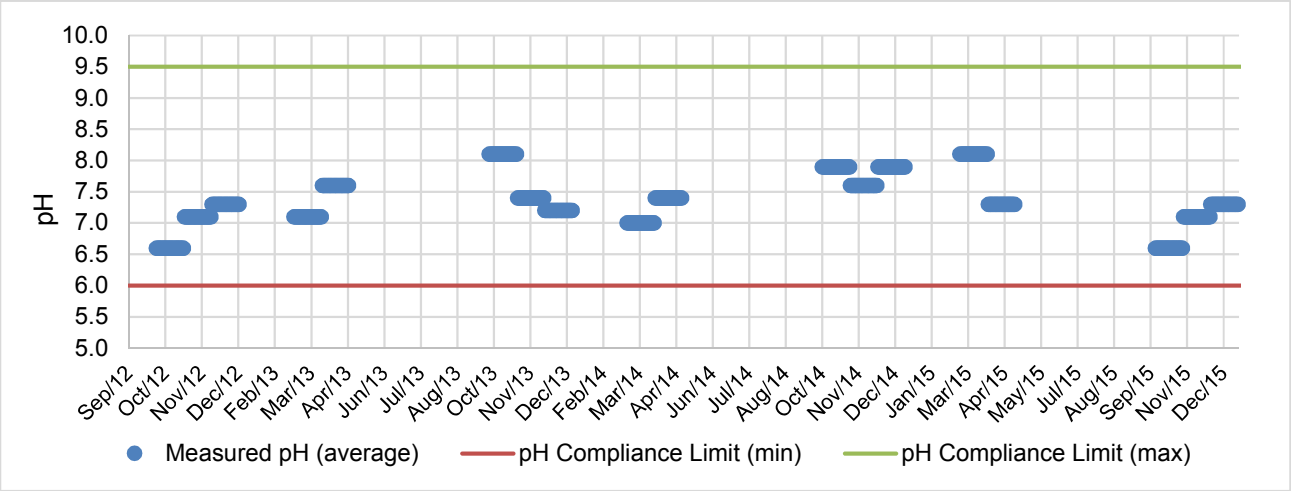
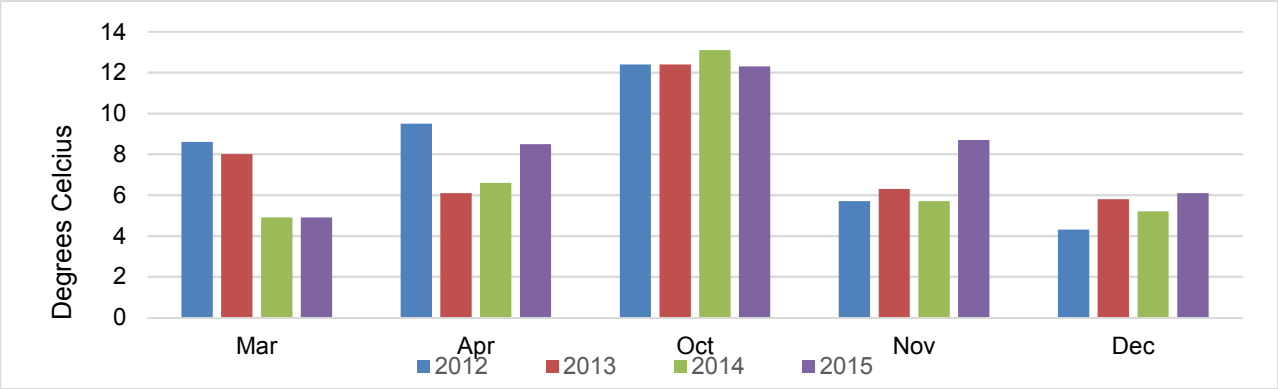


Figure 11: Temperature (grab) in Final Effluent (2012 - 2015)



6.3.7 Hydrogen Sulphide

The 2008 RWIA notes that hydrogen sulphide (H_2S) had in the past been an issue due to anaerobic conditions in the lagoons caused by ice coverage. However, the report also notes that then-recent upgrades to the WPCP and operational changes had significantly reduced those concerns. More specifically, there is a reinforced concrete cascade aerator (installed 2010 as per Town staff) that provides adequate aeration to the filtered effluent prior to discharge to Conestogo River.

A review of monthly process and compliance reports from 2012 to 2014, the WPCP's comprehensive performance evaluation report, the facility's annual reports from 2012-2015, and the MOECC's WPCP inspection report for February 26, 2015 (Inspection Number 1-BH00D) did not indicate any concerns with hydrogen sulphide. Therefore, the project team concludes that hydrogen sulphide is no longer an issue with this facility.

It should be noted that the effluent quality will be greatly improved after the proposed upgrades to install a Submerged Attached Growth Reactor (SAGR®) which provides a high level of aeration, further reducing the likelihood H_2S generation.

7 Identification of a Proposed Discharge Regime

The RWIA process was used to help identify a proposed discharge regime that would allow adequate discharge for the expanded WPCP with an acceptable impact on the receiving waters. The process included:

- Consultation with MOECC and GRCA on the WPCP and on river water quality concerns to be considered;
- Calculation of theoretical maximum allowable effluent discharge rates, based on PWQO for NH_3;
- Adjust maximum allowable discharge to improve upon or maintain the minimum dilution ratio, to ensure existing effluent mixing zones are not negatively impacted upon;
- Propose a discharge regime that is adequate to discharge the proposed future treated influent plus the accumulated precipitation; and
- Comparison of after-mixing concentrations and annual loadings for NH_3 and TP for the existing and proposed discharge regime.

These steps are discussed below.

NOTE: contributing volumes due to inflow and infiltration (I&I) are included in the proposed effluent volumes. Precipitation inflow volumes are included in the storage capacity and proposed discharge limits (158 m^3/day, see Section 7.3 below).

7.1 Consultations with MOECC and GRCA

Consultation with the MOECC and GRCA included in-person meetings, telephone conversations, and reviews of drafts of the RWIA. While the full documentation of this consultation will be included in the Mapleton Wastewater Class EA Environmental Study Report, key take-aways for EXP in preparing a proposed effluent discharge regime included:

- Un-ionized ammonia (NH_3) and TP are the key parameters of concern; Conestoga River is a Policy 2 receiver with respect to TP.
- Given the Conestogo River's traditionally low flows in the summer months and the concern over feeding phosphorus to Conestogo Lake in the summer (due to the potential for algal blooms), both the MOECC and the GRCA agreed that there should not be any effluent discharge during the summer months.
- Given the improvements in recent years to the WPCP, and the proposed reduction to the total ammonia effluent limit, the MOECC and GRCA agreed that they would be open to effluent discharge from the WPCP in the winter months.

Based on these key considerations, the proposed expanded discharge window was designed to include January and February, with no discharge proposed from May to September.

7.2 Calculation of Theoretical Maximum Potential Discharge Flows

Theoretical maximum potential discharge flows were determined based on the Conestogo River's ability to assimilate un-ionized ammonia up to the PWQO. This exercise was done only to determine what the maximum WPCP effluent rate would be if the un-ionized ammonia PWQO limit was maximized. The theoretical maximum discharge flows were estimated using the following parameters:

- The updated $7Q_{20}$ values prepared for this study;
- The previously discussed river water quality data for ammonia, water temperature and pH (Section 6);
- The proposed future effluent limit for total ammonia of 3 mg/L;
- An expanded discharge regime that includes January and February; and

- The upset limit of 4,000 m^3/day for the WPCP's effluent filtration/disinfection unit.

The analysis showed that the maximum possible flow rate of 4,000 m^3/day could potentially be achieved without increasing after-mixing un-ionized ammonia levels above the PWQO for the months of January, February, March, April, November and December. The maximum flow rate for October was lower, at 414 m^3/day. These maximum values, presented in Table 10, form the upper limits to discharge flow rates to be used when considering the proposed future discharge regime.

Table 10: Theoretical maximum after-mixing concentrations of NH_3 (based on theoretical maximum effluent rate and proposed TAN effluent limit)

Description	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
7Q20 low flow	m³/d	22,918	17,740	21,129	45,407	14,738	1,643	639	1,312	712	3,057	15,085	24,402
Theoretical maximum effluent discharge flow	m³/d	**4,000**	**4,000**	**4,000**	**4,000**	**0**	**0**	**0**	**0**	**0**	**414**	**4,000**	**4,000**
Dilution ratio		5.7	4.4	5.3	11.4	-	-	-	-	-	7.4	3.8	6.1
Proposed TAN effluent limit	mg/L as N	3	3	3	3	-	-	-	-	-	3	3	3
Un-ionized ammonia - Upstream (75°) *	mg/L as N	0.0010	0.0011	0.0014	0.0011	0.0017	0.0039	0.0045	0.0030	0.0016	0.0010	0.0008	0.0004
Un-ionized ammonia - Effluent end-of-pipe **	mg/L as N	0.0321	0.0321	0.0615	0.0212	-	-	-	-	-	0.0866	0.0199	0.0321
Un-ionized ammonia - After mixing	mg/L as N	0.0056	0.0068	0.0110	0.0028	-	-	-	-	-	0.0112	0.0048	0.0049
PWQO criteria for un-ionized ammonia ***	mg/L as N	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165
% of PWQO reached for for NH3-N - Upstream		6.0%	6.5%	8.6%	6.9%	10.5%	23.8%	27.3%	18.4%	9.6%	5.9%	5.0%	2.5%
% of PWQO reached for for NH3-N - After mixing		34.1%	41.2%	66.7%	16.8%	-	-	-	-	-	67.9%	29.3%	29.6%

* 75th percentile (75°) values of individual NH3 concentrations were calculated using observed field conditions (pH and temperature) using the formulae below. See Appendix G.
** Calculated using maximum monthly observed effluent pH and temperature from 2012-2015. See Table 9.
*** Concentration of NH3 = (14.01+3)/14.01 * concentration of NH3-N.
Formulae (per MOEE, 1994):

Un-ionized ammonia [NH3] = fNH3 x [TAN]
fNH3 = 1 / (10^(pKa - pH) + 1)
pKa = 0.09018 + 2729.92 / (273.16 + Temperature [°C])

7.3 Water Balance Accountability

A key issue facing the WPCP is how to manage water entering the lagoon system through precipitation. Prior to the WPCP's 2016 amended ECA, the facility's approved discharge volume was ultimately equal to that of its inflow rating. For example, the facility is currently rated to receive 750 m^3/day of influent, which amounts to 273,750 m^3 of influent per year. The previous (2013) ECA provided monthly upper limits, which added up to an annual total of 273,872 m^3. The consequence of this was twofold:

1. First, since the facility was required to discharge any accumulated rainfall within its approved volume, this in effect reduced the upper limit of influent the Township was able to receive, as it need to create a buffer to allow for incoming precipitation. As the level of precipitation varies year to year and month to month, this provided additional challenges for facility operations and growth planning.
2. Second, the facility on occasion would reach or exceed the safe storage limits of its storage lagoons. This most recently occurred in the spring of 2015. Given volume of treated effluent and rainwater/melted snow stored in its lagoons, it was determined that the allowed spring discharge volumes would not be sufficient to prevent the lagoons from exceeding their storage capacity prior to the fall discharge. To address this, a Provincial Order (I-BXVN3) was signed on March 11, 2015 allowing the facility to extend its discharge until April 30 and increase its discharge flowrate to the minimum 10:1 of the streamflow (up to the sand filtration and UV disinfection limits of 4,000 m^3/day). This Provincial Order allowed the facility to safely discharge its excess stored water and avoid a potential overflow of the lagoons.

For the purpose of this assessment, the value of 158 m^3/day (annual daily average) was used for the precipitation allowance added to the daily WPCP influent flow. When compared to precipitation data for the Glen Allan weather station (Climate Identifier # 6142803) for 1999 to 2013 and an assumed pan evaporation rate of 700 mm/year,[2] the value of 158 m^3/day corresponded to an amount of rainfall that fell within a 2-year to 5-year return period, which should be sufficient when setting discharge flow rates in $7Q_{20}$ conditions.

7.4 Developing the Proposed Effluent Discharge Regime

The next stage in identifying a proposed effluent discharge regime involved maintaining (or improving) existing dilution rates while balancing the need to ensure adequate flow to discharge the WPCP's annual influent plus precipitation.

In setting a proposed discharge flow rate, several factors were considered in finding the most suitable balance of flow rates and dilution rates throughout the discharge period. Key among these included:

- Constraint to maintain the minimum dilution rate of 6.1, which is experienced in December; and
- Requirement to be conservative with respect to discharge rates in January and February, as per MOECC.

Based on these considerations, and assuming a daily influent rate of 1,300 m^3/day and an average daily accumulation of 158 m^3/day of precipitation, the proposed future effluent discharge flow rate is presented in Table 11, followed by a comparison of the proposed discharge regime and dilution ratios to the existing in Table 12. A comparison of after-mixing concentrations of the existing and proposed discharge regime in the Conestoga River for un-ionized ammonia and TP is discussed in the following section (Section 8).

The nominal capacity of the storage lagoons should be designed based on average influent flow and average precipitation. Since the precipitation value of 158 m^3/day is the daily average of the total annual accumulation, it is recognized that actual monthly accumulation may be higher or lower depending on the time of year. Therefore, during detailed design any potential adjustments to the storage lagoon capacity should be confirmed to ensure adequate storage capacity based the minimum effluent holdover volumes after future facility

[2] Pan evaporation rate based on low range of the Class A Pan Evaporation Rate as per the *Hydrological Atlas of Canada Plate 17. Mean Annual Lake Evaporation*, prepared by G. den Hartog and H.L. Ferguson (1978). The Township of Mapleton falls within band of 700 to 900 mm per year for Class A Pan Evaporation.

optimization. If the detailed design concludes that some increase of lagoon storage capacity is required, then this would be considered a Schedule A: Pre-Approved Activity, according to the Municipal Class EA process.

Table 11: Proposed effluent discharge flow regime

Month	Daily discharge (m^3/day)
Jan	3,000
Feb	2,660
Mar	2,110
Apr	3,773
May	0
Jun	0
Jul	0
Aug	0
Sep	0
Oct	300
Nov	1,760
Dec	4,000

Table 12: Comparison of existing and proposed discharge regime and dilution factors

Month	$7Q_{20}$ (m^3/day)	Existing		Proposed	
		Existing approved daily discharge (m^3/day)	Dilution Factor ($7Q_{20}$ river flow: effluent discharge flow rate)	Proposed daily discharge (m^3/day)	Dilution factor ($7Q_{20}$ river flow: proposed effluent discharge flow rate)
Jan	22,918	n/a	n/a	3,000	7.6:1
Feb	17,740	n/a	n/a	2,660	6.7:1
Mar	21,129	1,581	13.4:1	2,110	10.0:1
Apr	45,407	3,154	14.4:1	3,773	12.0:1
Oct	3,057	233	13.1:1	300	10.2:1
Nov	15,085	1,754	8.6:1	1,760	8.6:1
Dec	24,402	4,000	6.1:1	4,000	6.1:1

In Table 12 above, it can be seen that the dilution factors for the proposed effluent discharge rates in January and February (for $7Q_{20}$ conditions) are 7.6 and 6.7, respectively. This is greater than the existing minimum dilution factor of 6.1 for December, which is at its currently approved level. The proposed daily discharge rates for the months of March, April and October have been slightly increased to allow for discharge of seasonal precipitation. However, for each of those months, the dilution factor does not fall below 10.0. The dilution factors for November and December remain essentially unchanged. During average river flow conditions, the dilution ratios will be much higher.

8 Effluent Water Quality Objectives under the Proposed Discharge Regime

Section 7 of this report described the process to identify an effluent discharge regime that would be able to manage the influent at the new proposed capacity plus an allowance for precipitation under $7Q_{20}$ river flow conditions. In this section, the loading and/or after mixing parameter concentrations in the Conestogo River for existing and proposed discharge regimes are compared. The existing and proposed effluent objectives and limits for the proposed expansion are presented in Table 12.

Table 13: Proposed effluent objectives and limits

Parameter	Objective		Limit	
	Existing	Proposed	Existing	Proposed
$CBOD_5$	5 mg/L	5 mg/L	7.5 (Apr. & Oct.) 10.0 (Mar., Nov. & Dec.)	7.5 (Apr. & Oct.) 10.0 (Jan., Feb., Mar., Nov. & Dec.)
Total suspended solids	N/A	10 mg/L (best available treatment technology-based effluent)	N/A	15 mg/L
Total ammonia nitrogen	3.0 mg/L	1 mg/L (best available treatment technology-based effluent)	5.0 mg/L	3.0 mg/L
Total phosphorus	0.3 mg/L	0.17 mg/L	0.5 mg/L	0.3 mg/L
E. coli	100 org./100 mL	100 org./100 mL	200 org./100 mL	200 org./100 mL

8.1 Total Phosphorus

As noted previously in this report, the proposed WPCP expansion involves an increase of influent flow from 750 m^3/d to 1,300 m^3/d. To account for this increase in influent and the estimated levels of precipitation, it is proposed to increase the total annual discharge for the WPCP. The proposed effluent limit for TP is determined on the basis that the TP load will not be increased after WPCP expansion. This would be through proposed upgrades that are to be described in the Class EA's Environmental Study Report (ESR), but include:

- Increased aeration to improve biological treatment;
- Installation of a Submerged Attached Growth Reactor (SAGR®) system for ammonia removal; and
- Improvements to the alum dosing system to improve removal of phosphorus, among other things.

The proposed effluent limit for TP is 0.3 mg/L and the proposed effluent objective is 0.17 mg/L. Table 14 and Table 15 compare the monthly and total annual loading based on the proposed effluent discharge regime and

proposed effluent limit/objective with that of the existing effluent limit/objective, respectively. It shows that the annual loading for TP is less under the proposed regime and effluent limits/objectives than under the existing ECA.

Table 14: Total phosphorus loading (based on proposed discharge regime and proposed TP effluent limit)

Month	No. of discharge days	Proposed daily flow (m^3/day)	Monthly discharge (m^3/month)	Future TP loading based on proposed effluent limit (0.3 mg/L)		Current TP loading based on existing discharge regime and effluent limit (0.5 mg/L) (2016 ECA)	
				Daily (kg/day)	Monthly (kg/month)	Daily (kg/day)	Monthly (kg/month)
Jan	31	3,000	93,000	0.90	27.9	-	-
Feb	28	2,660	74,480	0.80	22.3	-	-
Mar	31	2,110	65,410	0.63	19.6	0.79	24.5
Apr	30	3,773	113,190	1.13	34.0	1.58	47.3
Oct	31	300	9,300	0.09	2.8	0.12	3.6
Nov	30	1,760	52,800	0.53	15.8	0.88	26.3
Dec	31	4,000	124,000	1.20	37.2	2.00	62.0
Annual (kg/year)					**159.7**		**163.7**

Table 15: Total phosphorus loading (based on proposed discharge regime and proposed TP effluent objective)

Month	No. of discharge days	Proposed daily flow (m^3/day)	Monthly discharge (m^3/month)	Future TP loading based on proposed effluent objective (0.17 mg/L)		Current TP loading based on existing discharge regime and effluent objective 0.3 mg/L) (2016 ECA)	
				Daily (kg/day)	Monthly (kg/month)	Daily (kg/day)	Monthly (kg/month)
Jan	31	3,000	93,000	0.51	15.8	-	-
Feb	28	2,660	74,480	0.45	12.7	-	-
Mar	31	2,110	65,410	0.36	11.1	0.47	14.7
Apr	30	3,773	113,190	0.64	19.2	0.95	28.4
Oct	31	300	9,300	0.05	1.6	0.07	2.2
Nov	30	1,760	52,800	0.30	9.0	0.53	15.8
Dec	31	4,000	124,000	0.68	21.1	0.53	37.2
Annual (kg/year)					**90.5**		**98.0**

Table 17 presents the proposed TP limit/objective loading information in Table 14 and Table 15 in the context of the entire year with after-mixing concentrations, as well as in the context of un-ionized ammonia.

8.2 Ammonia

In order to maintain Policy 1 quality for un-ionized ammonia (NH_3) in the river downstream of WWTP discharge, a TAN effluent limit of 3.0 mg/L is proposed for the WPCP upgrade, with a proposed objective of 1.0 mg/L. This would be achieved primarily through the installation of a SAGR unit at the WPCP (this is discussed in more detail in the Environmental Study Report).

Table 17 shows the assimilative capacity of the Conestoga River under $7Q_{20}$ conditions with respect to the proposed discharge regime and proposed TAN effluent limit. The table shows that the proposed effluent discharge regime and proposed effluent limit would not cause the Conestoga River to exceed the PWQO for un-ionized ammonia under $7Q_{20}$ conditions.

Table 16 compares the NH_3 after-mixing concentrations for the existing and proposed scenarios as a percentage of the PWQO, under $7Q_{20}$ conditions. As one might expect, the NH_3 concentrations as a percentage of PWQO increase for January and February under the proposed scenario compared to under the existing ECA. However, in each of those two months, the after-mixing concentrations are still well below PWQO limit. For each month that already has an existing discharge, the after-mixing concentration as a percentage of PWQO decreases between approximately 4 and 18 percentage points under the proposed scenario in comparison to the existing regime as per the ECA (amended 2016) using the worst case scenario of the proposed NH_3 limit.

Regarding NH_3 (maximum) loadings based on the proposed TAN effluent limit of 3 mg/L, with the exception of the proposal to discharge during new months (January and February), NH_3 loads decrease for all months. Annual (maximum) NH_3 loadings marginally decrease from 23.5 kg/year to 23.4 kg/year.[3]

Table 16: Comparison of NH_3 after-mixing loads and concentrations as a percentage of the PWQO

	After-mixing concentrations, NH_3			After-mixing loads NH_3		
Month	**% of PWQO (existing ECA)**	**% of PWQO (proposed)**	**Change (percentage points)**	**Monthly, existing ECA (kg as N)**	**Monthly, proposed (kg as N)**	**Change (kg as N)**
Jan	6% (1)	28%	22	0.7	3.7	3.0
Feb	7% (1)	31%	25	0.5	2.9	2.4
Mar	51%	42%	(10)	6.0	5.0	(1.0)
Apr	20%	16%	(4)	4.9	3.9	(0.9)
May(2)	10%	10%	-	0.8	0.8	-
Jun(2)	24%	24%	-	0.2	0.2	-
Jul(2)	27%	27%	-	0.1	0.1	-
Aug(2)	18%	18%	-	0.1	0.1	-
Sep(2)	10%	10%	-	0.0	0.0	-
Oct	68%	52%	(15)	1.1	0.9	(0.2)
Nov	25%	17%	(8)	2.1	1.4	(0.7)
Dec	48%	30%	(18)	6.9	4.3	(2.7)
Total				**23.5**	**23.4**	**(0.2)**

(1) January and February do not have discharge flow under the current ECA.
(2) May, June, July, August, and September have neither existing nor proposed discharge flow.
*Product of existing NH3 effluent limit (5 mg/L), existing approved daily discharge limit, and # of days in month.
**Product of proposed NH3 effluent limit (3 mg/L), proposed daily discharge limit, and # of days in month.
Note: Values

[3] Note: Previous drafts reported NH_3 loading decreases from 50.0 kg/year to 40.9 kg/year under the proposed regime. The un-ionized ammonia calculations have since been updated using effluent pH and temperature (as opposed to river pH and temperature, previously used to represent mixed conditions).

Table 17: Proposed maximum after-mixing NH_3 and TP concentrations and loads in Conestoga River

Description	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
7Q20 low flow	m³/d	22,918	17,740	21,129	45,407	14,738	1,643	639	1,312	712	3,057	15,085	24,402	-
Proposed maximum discharge flow	m³/d	**3,000**	**2,660**	**2,110**	**3,773**	**0**	**0**	**0**	**0**	**0**	**300**	**1,760**	**4,000**	**-**
Dilution ratio		7.6	6.7	10.0	12.0	-	-	-	-	-	10.2	8.6	6.1	-
Proposed TAN effluent limit	mg/L N	3	3	3	3	-	-	-	-	-	3	3	3	-
NH3 mixing zone criteria														
Un-ionized ammonia - End-of-pipe max. allowable (†)	mg/L NH3	0.10	0.10	0.10	0.10	-	-	-	-	-	0.10	0.10	0.10	-
Un-ionized ammonia - End-of-pipe effluent	mg/L NH3	0.04	0.04	0.07	0.03	-	-	-	-	-	0.10	0.02	0.04	-
NH3 concentrations and PWQO criteria														
Un-ionized ammonia - Upstream (75°) *	mg/L N	0.0010	0.0011	0.0014	0.0011	0.0017	0.0039	0.0045	0.0030	0.0016	0.0010	0.0008	0.0004	-
Un-ionized ammonia - Effluent End-of-Pipe**	mg/L N	0.0321	0.0321	0.0615	0.0212	-	-	-	-	-	0.0866	0.0199	0.0321	-
Un-ionized ammonia - After mixing	mg/L N	0.0046	0.0051	0.0069	0.0027	-	-	-	-	-	0.0086	0.0028	0.0049	-
PWQO criteria for un-ionized ammonia ***	mg/L N	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	-
% of PWQO reached for NH3-N - Upstream		6.0%	6.5%	8.6%	6.9%	10.5%	23.8%	27.3%	18.4%	9.6%	5.9%	5.0%	2.5%	-
% of PWQO reached for NH3-N - After mixing		27.9%	31.1%	41.7%	16.2%	-	-	-	-	-	52.4%	17.1%	29.6%	-
NH3 loads														
Monthly NH3-N load - Upstream	kg as N	0.7	0.5	0.9	1.5	0.8	0.2	0.1	0.1	0.0	0.1	0.4	0.3	5.7
Monthly NH3-N load - Effluent	kg as N	3.0	2.4	4.0	2.4	-	-	-	-	-	0.8	1.1	4.0	17.6
Monthly NH3-N load - After mixing	kg as N	3.7	2.9	5.0	3.9	0.8	0.2	0.1	0.1	0.0	0.9	1.4	4.3	23.4
TP concentrations and PWQO criteria														
Total phosphorus - Upstream (75°)	mg/L	0.087	0.052	0.204	0.097	0.032	0.036	0.049	0.043	0.032	0.033	0.040	0.039	-
Total phosphorus - Effluent (proposed limit)	mg/L	0.300	0.300	0.300	0.300	-	-	-	-	-	0.300	0.300	0.300	-
Total phosphorus - After mixing	mg/L	**0.112**	**0.084**	**0.213**	**0.113**	**-**	**-**	**-**	**-**	**-**	**0.057**	**0.067**	**0.076**	**-**
PWQO criteria for TP	mg/L	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**0.030**	**-**
% of PWQO reached for TP - Upstream		290%	173%	680%	323%	107%	120%	163%	143%	107%	110%	133%	130%	-
% of PWQO reached for TP - After mixing		372%	281%	709%	375%	-	-	-	-	-	190%	224%	253%	-
TP loads - Using proposed limit of 0.3 mg/L														
Monthly TP load - Upstream	kg	62	26	134	132	15	2	1	2	1	3	18	30	424
Monthly TP load - Effluent	kg	28	22	20	34	-	-	-	-	-	3	16	37	160
Monthly TP load - After mixing	kg	90	48	153	166	15	2	1	2	1	6	34	67	584
TP loads - Using proposed objective of 0.17 mg/L														
Total phosphorus - Effluent (proposed objective)	mg/L	0.17	0.17	0.17	0.17	-	-	-	-	-	0.17	0.17	0.17	-
Total phosphorus - After mixing concentration	mg/L	**0.097**	**0.067**	**0.201**	**0.103**	**-**	**-**	**-**	**-**	**-**	**0.045**	**0.054**	**0.057**	**-**
Monthly TP load - Effluent	kg	16	13	11	19	-	-	-	-	-	2	9	21	90
Monthly TP load - After mixing	kg	78	38	145	151	15	2	1	2	1	5	27	51	514

(†) Procedural limit used by MOECC to ensure non-toxic mixing conditions. Noted for comparison purposes.
* 75th percentile (75°) values of individual NH3 concentrations were calculated using observed field conditions (pH and temperature) using the formulae below. See Appendix G.
** Calculated using maximum monthly observed effluent pH and temperature from 2012-2015. See Table 9.
*** Concentration of NH3 = (14.01+3)/14.01 * concentration of NH3-N.
Formulae (per MOEE, 1994):

Un-ionized ammonia [NH3] = fNH3 x [TAN]
fNH3 = 1 / (10^(pKa - pH) + 1)
pKa = 0.09018 + 2729.92 / (273.16 + Temperature [°C])

8.3 Hydrogen Sulphide

Further to the discussion regarding hydrogen sulphide (H_2S) in Section 6.3.6; it may be noted that, with the proposed upgrades, two additional steps would mitigate any (H_2S) related concerns, namely:

1. The influent treatment would involve a high degree of aeration in the proposed SAGR system prior to the effluent's flow into the storage cells, as opposed to the facultative lagoon in the current system.
2. Secondly, it may be noted that there would be ongoing discharge through the winter months from the storage, and as such, the potential for H_2S generation would be further diminished.

8.4 Dissolved Oxygen, $CBOD_5$, and NOD

In order to maintain Policy 1 for dissolved oxygen (DO), the receiving water has to have sufficient DO in order to manage the total oxygen demand (TOD) of the effluent while remaining above the specified PWQO temperature- and biota- based DO minimum. For this plant, the TOD will be comprised of carbonaceous biochemical oxygen demand (CBOD) and nitrogenous oxygen demand (NOD). Evaluating the impact of TOD on DO in flowing river systems often requires the use of computer models such as the Grand River Simulation Model (GRSM). However, the use of a complicated modeling approach for DO is not necessary in this case for several reasons including:

- The proposed discharge regime occurs during cold weather months (e.g. October to April) when photosynthetic activity in the river is low which means diurnal variations in DO are expected to be small;
- DO levels are elevated during this period of the year as summarized in Table 3 and lower temperatures allow more oxygen dissolve in the water, i.e. oxygen saturation is higher during this period; and,
- The oxygen demand exerted by BOD decay and nitrification is low due to cold water conditions and slower biochemical reaction rates.

For ambient conditions, the Greenbook[4] indicates that the 75th percentile (75°) is normally used to determine background water quality, including DO. Accordingly, the after-mixing conditions were evaluated under the proposed effluent discharge regime to determine the remaining, after-mixing dissolved oxygen content (see Table 16). The values in Table 16 were calculated using the 75th percentile of ambient DO, $CBOD_5$ limits, proposed TAN effluent limit of 3 mg/L (to estimate the nitrogenous oxygen demand), and $7Q_{20}$ flows. Based on these conditions, the DO content passes the minimum DO temperature- and biota- based PWQO requirements for all months

This simple mass balance type of approach demonstrates that DO impacts will be minimal even with highly conservative assumptions, e.g. assuming all BOD is biodegradable, complete nitrification, no loss of TAN to the atmosphere, and no reaeration of DO.

[4] See Section 4.5 in Ontario Ministry of Environment and Energy. July 1994. *Deriving receiving-water based, point-source effluent requirements for Ontario waters (Procedure B-1-5)*. PIBS# 3302.

Table 18 Summary of total oxygen demand for the proposed discharge regime

Description	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Oxygen demand calculations (proposed regime)													
NOD effluent maximum load (1)	kg/month DO	1275	1021	897	1552	0	0	0	0	0	128	724	1700
CBOD5 effluent limit*	mg/L	10.0	10.0	10.0	7.5	0.0	0.0	0.0	0.0	0.0	7.5	10.0	10.0
CBOD5 effluent maximum load (2)	kg/month DO	930	745	654	849	0	0	0	0	0	70	528	1240
Total oxygen demand (TOD = NOD + CBOD5)	kg/month DO	2205	1766	1551	2401	0	0	0	0	0	197	1252	2940
Oxygen consumption based on 75th percentile [DO] and proposed discharge regime													
Observed DO (75°), upstream (3)	mg/L DO	13.6	13.2	13.6	13.5	11.7	10.1	9.0	9.1	10.9	11.9	13.8	14.0
Available DO based on 7Q20, upstream (4)	kg/month DO	9691	6564	8888	18349	5350	499	178	371	234	1126	6259	10568
Remaining mass of DO, after mixing (5)	kg/month DO	7486	4798	7338	15948	5350	499	178	371	234	929	5007	7628
Remaining [DO], after mixing (6)	**mg/L DO**	**9.3**	**8.4**	**10.2**	**10.8**	**11.7**	**10.1**	**9.0**	**9.1**	**10.9**	**8.9**	**9.9**	**8.7**
Temperature (75th percentile), upstream (7)	°C	1.0	0.7	3.9	11.5	18.8	23.8	25.9	23.9	20.3	11.2	5.5	2.6
Minimum DO requirement per PWQO (8)	**mg/L DO**	**8**	**8**	**8**	**6**	**6**	**5**	**5**	**5**	**5**	**6**	**7**	**8**
PASS / FAIL	**-**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**

*Proposed $CBOD_5$ limit of 10 mg/L for new discharging months January and February. Other limits are as per existing ECA, amended 2016.
(1) NOD effluent maximum load = Proposed TAN limit of 3 mg/L * Proposed max. effluent limit (see Table 11 and Table 17) * 4.57 mg/L-O / mg-N * no. days in month
(2) CBOD5 effluent maximum load = CBOD5 effluent limit * Proposed max. effluent limit (see Table 11 and Table 17) * no. days in month
(3) 75th percentile of observed ambient dissolved oxygen content (Table F-2).
(4) Available DO based on 7Q20, upstream = Observed DO * 7Q20 flow * no. days/month
(5) Remaining mass of DO = Available DO – TOD
(6) Remaining concentration of DO after mixing = Remaining mass of DO / (7Q20 + Max effluent flow limit) / # days in month
(7) See Appendix F, Table F-2, for ambient temperature calculations for 75th percentile.
(8) Based on upstream, ambient river temperature (75th percentile) and cold water biota (stricter than warm water biota) – see footnote to Table F-2 for complete details.

8.5 Total Suspended Solids

Effluent total suspended solids (TSS) are not expected to have an impact on the quality of the Conestogo River. The current and proposed effluent limits for cBOD and TP necessitate a high degree of TSS removal which is achieved using tertiary filtration. It is expected that effluent TSS will be less than 15 mg/L on a monthly average basis. When compared to background conditions in the Conestogo River (see Table 3), the 75th percentile of TSS concentrations in most months is approximately equal to or greater than 15 mg/L and therefore the effluent is likely to have lower TSS than the Conestogo River. The maximum impact of the effluent on TSS may occur in December, which has the lowest background concentration of TSS. A simple mass balance calculation suggests that the effluent may cause an increase in TSS during December of approximately 1 mg/L under 7Q20 conditions.

8.6 Impacts on Conestogo Reservoir

8.6.1 Background and Operation

The Conestogo Reservoir was built in 1958 as part of a network of dams that provide flood control and low flow augmentation on the Conestogo River[5]. It provides low flow augmentation by releasing water stored in the reservoir during times when the river flow is low (i.e., summer periods). From a wastewater management perspective, this provides WPCP downstream of the reservoir with a river flow in which to release their discharge. This dam has additional purposes for electricity production and recreation; however, these are auxiliary uses that result from its primary functions of flood control and low flow augmentation[6].

The Conestogo dam operates within upper and lower rule curves, or water level limits. Water levels are maintained between these limits, which shift over the course of the year. The Conestogo Dam rule curves are presented in Figure 12. The reservoir's fill and drawdown phases include:

- Early January to Mid-February - winter drawdown phase;
- Mid-February to Late May - spring reservoir filling phase;
- Early June to Late October - summer drawdown phase; and
- Late October to Late December - fall drawdown phase.

[5] Grand River Conservation Authority. (2014). *Background Briefing Reservoir operations.* Cambridge: Grand River Conservation Authority.
[6] Shifflett, S. (2011). *Conestogo Dam Operations.* Cambridge: Grand River Conservation Authority.

Figure 12: Conestogo Dam Rule Curve

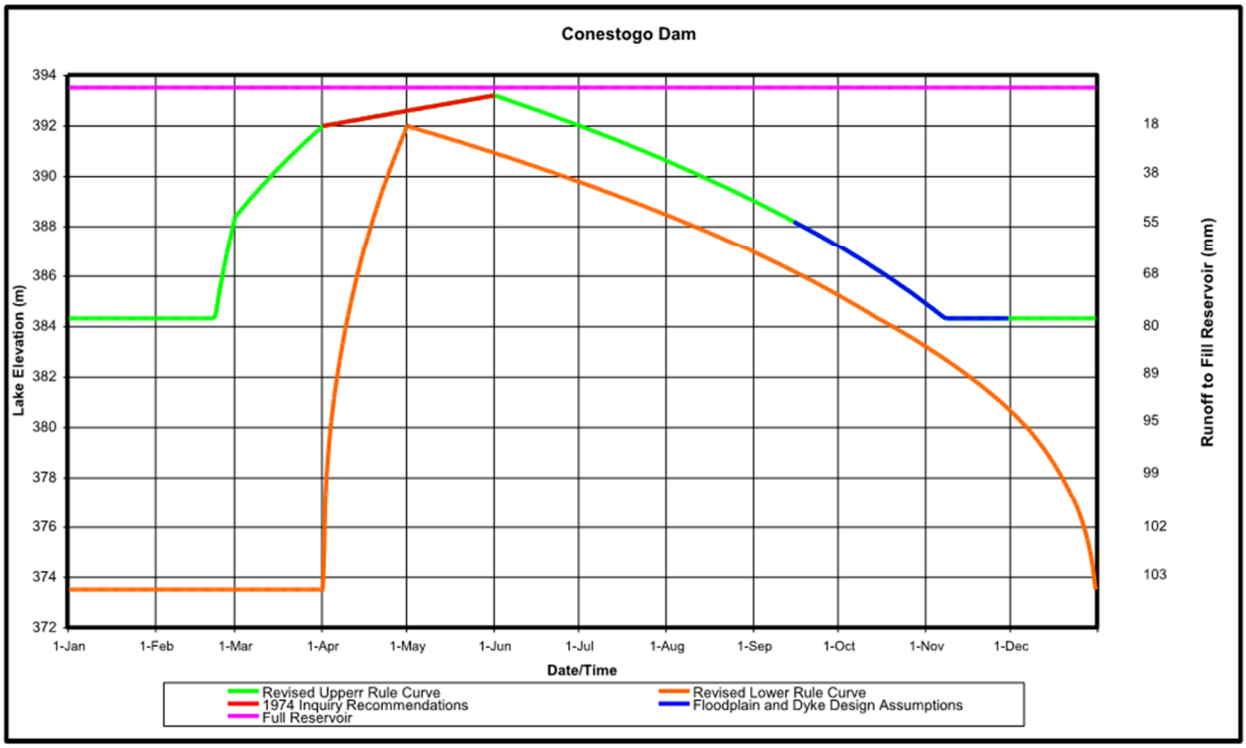


Image source: Boyd, D. (2004). Reservoir Operating Policy. Cambridge: Grand River Conservation Authority.

8.6.2 Impact of Total Phosphorus Loading

To assess the impact of the Mapleton WPCP's on total phosphorus (TP) loading in the Conestogo reservoir, the WPCP's TP loading rate was compared with the estimated total annual TP loading rate as provide by the Conestogo River and Moorefield Creek. Based on data and analysis provide by the GRCA, the estimated annual TP loading rate in the Conestogo reservoir is 24,978 kg/year (based on monitoring stations located on Moorefield Creek and on the Conestogo River near Drayton, upstream of the WPCP). As seen in Table 12, the estimated annual loading from the Mapleton WPCP is 163.7 kg/year based on the present effluent limit and 159.7 kg/year based on the proposed effluent limit, or approximately 0.6%. Based on this analysis, the contribution of TP from the WPCP to the Conestogo reservoir appears to be minimal compared to that of the Upper Conestogo subbasin drainage system.

8.7 Mixing zone considerations

During the review process for this RWIA update, the MOECC identified a concern with respect to the effluent mixing zone with respect to the calculated maximum possible discharge.

To ensure that the mixing zone will not be impacted negatively during $7Q_{20}$ conditions, the proposed discharge regime is now structured such that there was no new dilution factor below the minimum of what has been currently approved (i.e. 6.1, dilution factor for December). The following may also be noted in this context:

1. While it is proposed to extend the allowable discharge window, the maximum discharge flowrate (4,000 m^3/day) and minimum dilution factor (6.1) remain the same.
2. As noted above, the discharge flow has been structured such that it does not fall below the minimum permitted dilution factor of 6.1 during $7Q_{20}$ conditions (while it is further noted that dilution under average conditions will be much greater, see Table 6).
3. The dilution factors for additional discharge months (i.e. January and February) are greater than 6.1; therefore, it is reasonable to assume that the mixing zone boundary during these two months should be smaller than that of December.
4. The effluent concentration *and* total loading of un-ionized ammonia (NH_3) in the proposed discharge regime is less than that of the existing discharge regime. Our ecologist has noted that with the proposed stricter effluent discharge limits, conditions within the mixing zone are likely to improve.
5. Impacts from the potential aquatic toxicity of the effluent discharge plume in the proposed January and February discharge period are likely to be small, due to the following reasons:
    - Ammonia is less toxic to aquatic life at lower temperature and pH values[7]. During the months of January and February, the water temperature will be very low, thereby reducing its potential aquatic toxicity.
    - The concentrations of ammonia that cause toxicity to fish depend on the length of exposure[8]. In January and February, the level of biological activity in the river would be lower compared to other parts of the year; therefore, exposure of aquatic life to ammonia in the river water likely would be minimal.

We also that with the installation of the proposed SAGR® system, while a significant reduction to the TAN effluent limit (from 5 to 3 mg/L) is proposed, note that the SAGR® system is expected to produce levels below 1 mg/L.

Therefore, in consideration of these factors, conditions within the mixing zone will improve under the proposed discharge regime in comparison to the same of the existing discharge regime.

In November 2016, Hutchinson Environmental Sciences Limited (HESL), on behalf of the Township, completed a dye tracer study to verify the mixing zone of the WPCP discharge (available in Appendix H). The purpose of the dye tracer study was to delineate the extent of the mixing zone in the Conestoga River and to measure the dilution of the effluent in the mixing zone. The study report noted the following conclusions:

- By about 480 m downstream, Rhodamine WT dye concentrations were approximately equal across the width of the river indicating that the effluent was homogenously mixed with Conestoga River at this point (at a river flow of 153 L/s and effluent discharge of 26 L/s).
- At the confluence between the effluent-receiving channel and the Conestoga River, the WPCP effluent from the receiving channel was contained to the northern side (left bank) due to the presence of an island in the Conestoga River located at the receiving channel discharge location, which splits the river flows at this point.
- The island in the Conestoga River located at the confluence between the effluent-receiving channel and the river was effective in isolating the effluent to the north side of the island while providing an area for safe fish passage along the south side of the island.
- Downstream of this island (approximately 75 m downstream of the confluence with the effluent receiving channel) the effluent plume mixed across the entire width of the river, such that at cross-section 4 (114 m downstream), the Rhodamine WT dye tracer was detected at all points across the width of the river. At

[7] Levit, Stuart M. Center for Science in Public Participation. *A Literature Review of Effects of Ammonia on Fish*. Prepared for The Nature Conservancy. November 2010.
[8] Ibid.

this location, there was approximately 40% of the river width available for fish passage where the effluent made up less than 10% of the river volume (at effluent flows of 26 L/s and river flows of 153 L/s).

- The highest dye concentrations were measured near the left bank between 28 and 287 m downstream of the confluence with the effluent-receiving channel.
- Based on the Rhodamine WT dye tracer and water quality results, there was safe fish passage alongside the Mapleton WPCP effluent plume on the day of the dye tracer study. At higher river flows, there would be even greater river width available, as increased Conestoga River flows would tend to keep the WPCP plume toward the left bank for a greater downstream distance[9].

8.8 Water Quality Summary

The Class EA process for the Mapleton WPCP upgrade includes the identification of a preferred effluent discharge regime that is able to discharge 1,300 m^3/day of treated influent plus an allowance for precipitation while at the same time protecting the sensitive environmental conditions within the Conestogo River. To do this, stricter effluent limits for TAN and TP were proposed, which would be achieved through improvements to the WPCP's treatment process.

An effluent discharge regime was identified that would allow the WPCP to achieve its discharge volume requirements while producing an effluent that would reduce the overall impact of on the Conestogo River under $7Q_{20}$ conditions. The proposed discharge allowance had been established by maintaining the Conestogo River's water quality in its actual Policy designation (i.e., Policy 1 for NH_3, and Policy 2 for TP) and by considering the storage capacity limit at the WPCP.

Further, the proposed discharge should not cause negative impacts to the wetland, since the new effluent quality will be much improved as compared to the existing effluent discharge.

While the available background river data for the new proposed discharge period of January and February is limited, the GRCA is continuing with its river quality monitoring program, which will provide additional data for verification of the analysis in this report. To allow adequate time for the collection of this data, an interim phasing of the proposed WPCP capacity is proposed and introduced in Section 9.

[9] Tara Roumeliotis and Deborah Sinclair. *Mapleton WWTF – Dye Tracer Study in Conestoga River*. Draft Memorandum to Brad McRoberts (Township of Mapleton). January 20, 2017.

9 Interim Phasing

One of the primary concerns raised by the MOECC regarding adding discharge in January and February is the lack of available river water quality data during cold winter months. While the assimilative capacity assessment calculations discussed in Sections 8 show that river water quality for ammonia will remain below the PWQO, the limited dataset for background river water quality and its age insert uncertainty into the accuracy of the results.

To resolve this uncertainty, it is proposed that the Township phase in the implementation of the expansion in two phases:

- Phase 1 - Interim Rating: The first phase of the expansion would have the influent capacity of the WPCP raised to an interim-capacity of about 900 m^3/day (exact rating to be confirmed during approvals process). It be achieved by rerating the existing WPCP through optimization, which will allow the Township to increase the WPCP's capacity without a large capital investment, thereby relieving the Township's immediate growth pressures while providing time for additional winter river water quality monitoring.

  As discussed previously, the GRCA has implemented a monitoring program for the Conestogo River, which would act as a source for the additional data.

- Phase 2 - Full Rating: The second phase of the phasing process would increase the facility's influent rating to 1,300 m^3/day, to be achieved through implementation of the EA's preferred design. It would occur once sufficient data has been generated adequately calculate the potential impact of adding a January and February discharge period to the WPCP's existing discharge regime.

10 Conclusion

Based on the analysis discussed in the previous sections, the proposed discharge regime and proposed effluent objectives / limits are expected to result in a net improvement to the after-mixing river water quality, while providing the Township with additional influent capacity that considers an allocation for net precipitation. Uncertainties related to the limited available river water quality background data for January and February can be addressed through:

- A two-phase approach to implementation; and
- Incorporation of additional river water quality monitoring data from the GRCA's monitoring program.

The phased approach will allow the Township to increase the WPCP's capacity to an interim rating through facility rerating under the current effluent objectives/limits and provide the time required for the additional data from GRCA's monitoring program to help verify this document's analysis.

Appendix A: Amended Environmental Compliance Approval

Ontario

Ministry of the Environment and Climate Change
Ministère de l'Environnement et de l'Action en matière de changement climatique

AMENDED ENVIRONMENTAL COMPLIANCE APPROVAL
NUMBER 0963-A4ZMVA
Issue Date: January 22, 2016

The Corporation of the Township of Mapleton
7275 Sideroad 16
Post Office Box, No. 160
Mapleton, Ontario
N0G 1P0

Site Location: Drayton Wastewater Treatment Plant
7101 Sideroad 15
Mapleton Township, County of Wellington
N0G 1P0

You have applied under section 20.2 of Part II.1 of the Environmental Protection Act, R.S.O. 1990, c. E. 19 (Environmental Protection Act) for approval of:

the existing municipal sewage treatment works in Drayton for the collection, transmission, treatment and disposal of domestic sewage with a Rated Capacity of 750 cubic metres per day, and consisting of the following:

Proposed Works

- one (1) 200 mm dia magnetic flowmeter and associated pipework in the effluent discharge system;

Previous Works

Moorefield

Low-Pressure Sanitary Sewage Collection System (Off-site)

- approximately 160 individual packaged grinder pump stations outside of the properties to be serviced including service laterals;
- low-pressure collection sewers on Robb Street, Carson Street, Adam Brown Street, Maudsley Street, Ball Avenue, McGivern Street, Hillwood Drive, Booth Street West and Eighth Concession Road;

Booth Street Sanitary Sewage Pumping Station (Off-site)

- a 2.4 m diameter by 4.5 m deep wet well equipped with two (2) submersible sewage pumps (one

standby) each rated at 14.14 L/s at 47 m T.D.H., and an emergency overflow outlet;
- a 150 mm diameter forcemain along Booth Street East, Eighth Concession Road and Drayton WWTP Access Road discharging to the influent structure of the sewage treatment plant;
- a 50 kW outdoor diesel generator set;

Drayton

Sanitary Sewers (Off-site)
- sanitary sewers on Mill Street, High Street, Smith Drive, Spring Street, Main Street, Wood Street, Robin Drive, John Street, Union Street, Edward Street, Elm Street, Wellington Street, Easement West of Wellington Street, King Street, Queen Street and Wortley Street, Conestoga Drive, Hillview Drive, Pine Street, Maple Street, Green Street, Andrews Drive, Dales Drive, Parkside Street, Andrews Drive West, Faith Drive, River Run Road, Riverview Drive, Bedell Drive Pioneer Drive;

Sewage Pumping Station and Forcemain (Off-site)

- a sewage pumping station located on the north side of Mill Street approximately 110 m west of the west limit of Wellington Street with a wet well with two (2) sewage pumps (one standby) each rated at 34.0 L/s at a T.D.H. of 42.0 m;
- forcemain to the waste stabilization ponds, emergency bypass connection on the discharge forcemain;
- a 60 kW standby diesel generator and emergency station overflow;

Drayton Wastewater Treatment Plant

Stabilization Ponds

- a 21.2 ha waste stabilization pond system with two (2) treatment cells operated in series and three (3) effluent treatment/storage cells operated in parallel or series with individual operating depths (exclusive of sludge storage bottom zones and freeboard), areas and volumes as listed below:

Parameters	Function	Operating Depth (m)	Surface Area (ha)	Operating Volume (m^3)
Cell 2	Treatment - Primary Cell	1.825	3.1	60,500
Cell 1	Treatment - Secondary Cell	1.825	3.2	62,100
Cell 3	Storage/treatment	2.425	5.5	131,700
Cell 4A	Storage/treatment	2.600	3.4	77,600
Cell 4B	Storage/treatment	2.600	6.0	140,700
Total			**21.2**	**472,600**

- influent works to Cell No.2, interconnecting structures between lagoon cells;
- a primary gravity flow control structure (flow control structure A) with adjustable weir control, receiving influent from Cell No.1 and with valved inlet/outlet pipes to Cells No.3, 4A and 4B, and outlet pipe to Manhole 2;
- a secondary gravity flow control structure (flow control structure B) with valved inlet/outlet pipes to Cells No.4A and 4B and the primary flow control chamber;

- a fine bubble aeration system for Cell No. 2 comprising two high speed blowers (one standby) each rated at of 680 m³/h at 45 kPa, air header, feeder lines and diffuser tubes at the bottom of the cell perpendicular to the direction of sewage flow;
- a compressed air distribution system in Cell No.3 comprising a 25 hp compressor/blower, air header and distribution laterals for minimizing ice formation and to improve alum mixing;
- effluent works and 600 mm diameter sewer to the stabilization pond effluent pumping station;

Stabilization Pond Effluent Pumping Station

- a 3.4 m by 3.3 m by 6.0 m deep wet well, including a bypass/overflow chamber with a bottom sluice gate and an overflow weir, equipped with three (3) submersible pumps (two duty and one shelf spare) with variable speed 3 hp motors, each rated at 23.1 L/second at 4.0 m TDH, with a 150 mm diameter pipe discharging stabilization pond effluent to a common trough at the top of the wet well;
- one (1) 200 mm diameter gravity flow pipe conveying stabilization pond effluent from the trough to the filtration building;
- a 600 mm diameter emergency bypass/overflow sewer from the pumping station to the final effluent manhole;

Alum Building

- a 4.3 m x 6.1 m alum building with a 15,500 L alum storage tank and two (2) 7.1 L/h capacity metering pumps to dose alum to flow control structure A;

Effluent Filtration Building

- one (1) metering chamber complete with 200 mm diameter inlet pipe from the Stabilization Pond Effluent Pumping Station, a 200 mm diameter magnetic flowmeter and a 200 mm outlet pipe discharging to the filter influent channel described below;
- one (1) filter influent channel 690 mm wide by 2.5 m deep equipped with a stainless steel screen and guide, five (5) 200 mm diameter filter inlet pipes with gate valves and one (1) 200 mm diameter overflow pipe discharging to the filter effluent channel;
- five (5) continuous backwash upflow sand filters, each having a 4.65 m^2 filtration area, 2.0 m depth coarse media, with design filtering capacity of 800 m^3/day, complete with headloss gauges, air-lift pumps for rejection/backwashing of filters to the reject wet well and effluent weirs;
- a 250 mm diameter filtered effluent pipe and a 500 mm wide by 1.6 m deep effluent channel for the disinfection system described below;
- two (2) air compressors with 7.5 hp motors, each having an output capacity of 46 m3/h at 690 kPa pressure discharging to a common air reservoir to provide air to the air lift pumps;
- a 2.16 m by 1.7 m, 4.7 m deep reject/backwash wastewater wet well equipped with two (2) submersible pumps with 3 hp integral motors (one standby), each having a capacity of 13.5 L/s, to pump filter reject/backwash wastewater to Cell No.2 of the stabilization pond system via an approximately 37.0 m long 100 mm diameter forcemain;

Effluent Disinfection System

- two (2) ultraviolet radiation units installed in series in the effluent channel of the filtration building, with a Peak Flow Rate of 4,000 m^3/d;

Effluent Aeration and Discharge System

- a reinforced concrete cascade aerator including a 100 mm diameter drain/bypass pipe to provide adequate aeration to the filtered effluent prior to discharging to the Conestogo River,
- one (1) 300 mm diameter effluent discharge pipe from the cascade aerator to the final effluent manhole;
- one (1) 600 mm diameter final effluent pipe to the outfall structure at the Conestogo River.

Cell No.3 Alum Addition System (Back Up System)

- one (1) 5 hp pump to draw water from an intake located in Cell No. 3 and to discharge back to Cell No. 3 through three (3) 100 mm dia. distribution pipe at the cell bottom weighted with saddlebag ballast system;
- two (2) 1,000 L capacity alum storage tanks and one (1) 3.9 L/min capacity chemical pump to feed liquid alum into the water pump suction pipe;

including all other controls, electrical equipment, instrumentation, piping, pumps, valves and appurtenances essential for the proper operation of the aforementioned sewage Works;

all in accordance with supporting documents listed in Schedule A.

For the purpose of this environmental compliance approval, the following definitions apply:

"Approval" means this entire document and any schedules attached to it, and the application;

"Average Daily Flow" means the cumulative total sewage flow to the sewage works during a calendar year divided by the number of days during which sewage was flowing to the sewage works that year;

"BOD5" (also known as $TBOD_5$) means five day biochemical oxygen demand measured in an unfiltered sample and includes carbonaceous and nitrogenous oxygen demand;

"By-pass" means diversion of sewage around one or more unit processes within the Sewage Treatment Plant with the diverted sewage flows being returned to the Sewage Treatment Plant treatment train upstream of the Final Effluent sampling location, and discharging to the environment through the Sewage Treatment Plant outfall;

"CBOD5" means five day carbonaceous (nitrification inhibited) biochemical oxygen demand measured in an unfiltered sample;

"Daily Concentration" means the concentration of a contaminant in the effluent discharged over any

single day, as measured by a composite or grab sample, whichever is required;

"Director" means a person appointed by the Minister pursuant to section 5 of the EPA for the purposes of Part II.1 of the EPA;

"Emergency Situation" means a structural, mechanical or electrical failure that causes a temporary reduction in the capacity of the Sewage Treatment Plant or an unforeseen flow condition that may result in:

a) danger to the health or safety of any person; or,
b) injury or damage to any property, or serious risk of injury or damage to any property; or
c) treatment process biomass washout.

"EPA" means the *Environmental Protection Act* , R.S.O. 1990, c.E.19, as amended;

"Equivalent Equipment" means a substituted equipment or like-for-like equipment that meets the required quality and performance standards of a named equipment;

"Event" means an action or occurrence, at a given location within the Sewage Treatment Plant that causes a Plant Bypass or Plant Overflow. An Event ends when there is no recurrence of a Bypass or Overflow in the 12-hour period following the last Bypass or Overflow. Two Events are separated by at least 12 hours during which there has been no recurrence of a Bypass or Overflow;

"Final Effluent" means sewage discharge via the Sewage Treatment Plant outfall after undergoing the full train of unit processes as listed in the Approval;

"Geometric Mean Density" is the nth root of the product of multiplication of the results of n number of samples over the period specified;

"Limited Operational Flexibility" (LOF) means any modifications that the Owner is permitted to make to the Works under this Approval;

"Ministry" means the ministry of the government of Ontario responsible for the EPA and OWRA and includes all officials, employees or other persons acting on its behalf;

"Monthly Average Concentration" means the arithmetic mean of all Daily Concentrations of a contaminant in the effluent sampled or measured, or both, during a calendar month;

"Notice of Modifications" means the form entitled "Notice of Modifications to Sewage Works";

"Owner" means The Corporation of the Township of Mapleton and its successors and assignees;

"OWRA" means the *Ontario Water Resources Act* , R.S.O. 1990, c. O.40, as amended;

"Peak Flow Rate" means the maximum rate of sewage flow for which the plant or process unit was designed;

"Plant Overflow" means a discharge to the environment from the Sewage Treatment Plant at a location other than the plant outfall or into the plant outfall downstream of the Final Effluent sampling location;

"Previous Works" means those portions of the sewage works previously constructed and approved under an Approval;

"Rated Capacity" means the Average Daily Flow for which the Works are approved to handle;

"Regional Director" means the Regional Director of the West-Central Region of the Ministry;

"Regional Water Compliance Manager" means the Regional Water Compliance Manager of the West-Central Region of the Ministry;

"Sewage Treatment Plant" means the entire sewage treatment and effluent discharge facility;

"Water Supervisor" means the Water Supervisor for the Guelph, Hamilton, and Niagara offices of the Ministry; and

"Works" means the sewage works described in the Owner's application, and this Approval, and includes Proposed Works, Previous Works, and modifications made under Limited Operational Flexibility.

You are hereby notified that this environmental compliance approval is issued to you subject to the terms and conditions outlined below:

TERMS AND CONDITIONS

1. GENERAL PROVISIONS

(1) The Owner shall ensure that any person authorized to carry out work on or operate any aspect of the Works is notified of this Approval and the conditions herein and shall take all reasonable measures to ensure any such person complies with the same.

(2) Except as otherwise provided by these conditions, the Owner shall design, build, install, operate and maintain the Works in accordance with the description given in this Approval, and the application for approval of the Works.

(3) Where there is a conflict between a provision of any document in the schedule referred to in this Approval and the conditions of this Approval, the Conditions in this Approval shall take precedence, and where there is a conflict between the documents in the schedule, the document bearing the most recent date shall prevail.

(4) Where there is a conflict between the documents listed in the Schedule A, and the application, the application shall take precedence unless it is clear that the purpose of the document was to amend the application.

(5) The Conditions of this Approval are severable. If any Condition of this Approval, or the application of any requirement of this Approval to any circumstance, is held invalid or unenforceable, the application of such condition to other circumstances and the remainder of this Approval shall not be affected thereby.

2. EXPIRY OF APPROVAL

This Approval will cease to apply to those parts of the Works which have not been constructed within five (5) years of the date of this Approval.

3. CHANGE OF OWNER

(1) The Owner shall notify the Water Supervisor and the Director, in writing, of any of the following changes within thirty (30) days of the change occurring:

(a) change of Owner;

(b) change of address of the Owner;

(c) change of partners where the Owner is or at any time becomes a partnership, and a copy of the most recent declaration filed under the *Business Names Act* , R.S.O. 1990, c.B17 shall be included in the notification to the Water Supervisor;

(d) change of name of the corporation where the Owner is or at any time becomes a corporation, and a copy of the most current information filed under the *Corporations Information Act* , R.S.O. 1990, c. C39 shall be included in the notification to the Water Supervisor;

(2) In the event of any change in ownership of the Works, other than a change to a successor municipality, the Owner shall notify in writing the succeeding owner of the existence of this Approval, and a copy of such notice shall be forwarded to the Water Supervisor and the Director.

4. UPON THE SUBSTANTIAL COMPLETION OF THE WORKS

(1) Upon the Substantial Completion of the Works,the Owner shall prepare a statement, certified by a Professional Engineer, that the works are constructed in accordance with this Approval, and upon request, shall make the written statement available for inspection by Ministry personnel.

(2) Within six (6) months of the Substantial Completion of the Sewage Works, a set of as-built drawings showing the works "as constructed" shall be prepared. These drawings shall be kept up to date through revisions undertaken from time to time and a copy shall be retained at the Works for the operational life of the Works.

5. BY-PASSES

(1) Any By-pass or Plant Overflow is prohibited, except:

(a) in an Emergency Situation;

(b) where the By-pass / Plant Overflow is a direct and unavoidable result of a planned maintenance procedure, the Owner notified the Water Supervisor 15 days prior to the By-pass and the Water Supervisor has given written consent of the By-pass; and

(c) where the By-pass / Plant Overflow is planned for research or training purposes, the discharger notified the Water Supervisor 15 days prior to the By-pass / Plant Overflow and the Water Supervisor has given written consent of the By-pass / Plant Overflow.

(2) The Owner shall forthwith notify the Spills Action Centre (SAC) and the Medical Officer of Health of all By-pass and Plant Overflow Events. This notice shall include, at a minimum, the following information:

(a) the date, time, and duration of the Event;

(b) the location of the Event;

(c) the measured or estimated volume of the Event (unless the Event is ongoing);

(d) the reason for the Event; and

(e) the level of treatment the By-pass(es) and/or Plant Overflow(s) received and disinfection status of same.

(3) The Owner shall submit By-pass and Plant Overflow Event Reports to the Ministry's local office on a quarterly basis, no later than each of the following dates for each calendar year: February 14, May 15, August 14, and November 15. Event Reports shall be in an electronic format specified by the Ministry. In each Event Report the Owner shall include, at a minimum, the following information on any Events that occurred during the preceding quarter:

(a) the date of the Event(s);

(b) the measured or estimated volume of the Event(s);

(c) the duration of the Event(s);

(d) the location of the Event(s);

(e) the reason for the Event(s); and

(f) the level of treatment the By-pass(es) and/or Plant Overflow(s) received and disinfection status of same.

(4) The Owner shall use best efforts to collect a representative sample consisting of a minimum of two (2) grab samples of the By-pass / Plant Overflow and have it analyzed for parameters outlined in Condition 7 using the protocols specified in Condition 10, one at the beginning of the Event and the second approximately near the end of the Event, to best reflect the effluent quality of such By-pass or Plant Overflow.

(5) The Owner shall maintain a logbook of all Plant By-passes and Plant Overflows, which shall contain, at a minimum, the types of information set out in subsection 2 (a) to 2(e) in respect of each By-pass and Plant Overflow.

6. EFFLUENT OBJECTIVES

(1) The Owner shall use best efforts to design, construct and operate the Works with the objective that the concentrations of the materials named below as effluent parameters are not exceeded in the effluent from the Works.

Table 1 - Effluent Objectives

Effluent Parameter	**Concentration Objective** (milligrams per litre unless otherwise indicated)
CBOD5	5.0
Total Ammonia Nitrogen	3.0
Total Phosphorus	0.3
E.coli	100 organisms/ 100mL Monthly Geometric Mean Density

(2) The Owner shall use best efforts to:

(a) maintain the pH of the effluent from the Works within the range of 6.5 to 8.5, inclusive, at all times;

(b) operate the works within the Rated Capacity of the Works;

(c) ensure that the effluent from the Works is essentially free of floating and settleable solids and does not contain oil or any other substance in amounts sufficient to create a visible film or sheen or foam or discolouration on the receiving waters.

(3) The Owner shall include in all reports submitted in accordance with Conditions 11 a summary of the efforts made and results achieved under this Condition.

7. EFFLUENT LIMITS

(1) The Owner shall operate and maintain the Works such that the concentrations of the materials named

below as effluent parameters are not exceeded in the effluent from the Works.

Table 2 - Effluent Limits	
Effluent Parameter	**Average Concentration** (milligrams per litre unless otherwise indicated)
Column 1	Column 2
CBOD5	7.5 (Apr. & Oct.) 10.0 (Mar., Nov. & Dec.)
Total Ammonia Nitrogen	5.0
Total Phosphorus	0.5

(2) For the purposes of determining compliance with and enforcing subsection (1):

(a) The Monthly Average Concentration of a parameter named in Column 1 of subsection (1) shall not exceed the corresponding maximum concentration set out in Column 2 of subsection (1).

(3) Notwithstanding subsection (1), the Owner shall operate and maintain the Works such that the pH of the effluent shall be maintained within the range of 6.0 - 9.5, inclusive, at all times.

(4) Notwithstanding subsection (1), the Owner shall operate and maintain the Works such that the effluent is continuously disinfected so that the monthly Geometric Mean Density of *E. coli* does not exceed 200 organisms per 100 millilitres of effluent discharged from the Works.

(5) Subsections (1), (3) and (4) shall apply upon the issuance of this Approval.

8. OPERATION AND MAINTENANCE

(1) The Owner shall exercise due diligence in ensuring that, at all times, the Works and the related equipment and appurtenances used to achieve compliance with this Approval are properly operated and maintained. Proper operation and maintenance shall include effective performance, adequate funding, adequate operator staffing and training, including training in all procedures and other requirements of this Approval and the OWRA and regulations, adequate laboratory facilities, process controls and alarms and the use of process chemicals and other substances used in the Works.

(2) The Owner shall prepare an operations manual prior to the commencement of operation of the sewage works, that includes, but not necessarily limited to, the following information:

(a) operating procedures for routine operation of the Works;

(b) inspection programs, including frequency of inspection, for the Works and the methods or tests employed to detect when maintenance is necessary;

(c) repair and maintenance programs, including the frequency of repair and maintenance for the Works;

(d) procedures for the inspection and calibration of monitoring equipment;

(e) a spill prevention control and countermeasures plan, consisting of contingency plans and procedures for dealing with equipment breakdowns, potential spills and any other abnormal situations, including notification of the Water Supervisor; and

(f) procedures for receiving, responding and recording public complaints, including recording any followup actions taken.

(3) The Owner shall maintain the operations manual current and retain a copy at the location of the Works for the operational life of the Works. Upon request, the Owner shall make the manual available to Ministry staff.

(4) The Owner shall provide for the overall operation of the Works with an operator who holds a licence that is applicable to that type of facility and that is of the same class as or higher than the class of the facility in accordance with Ontario Regulation 129/04.

9. SEASONAL DISCHARGE

(1) The Owner shall operate the Works such that discharge of Final Effluent from the Works is conducted on a seasonal discharge basis with the effluent being discharged only during the months at the rates as specified below. However, discharges in excess of these daily discharges is allowed if the minimum 10:1 of the streamflow to daily discharge rate for the applicable period of that design streamflow occurs, based on actual measurements of flow rate in the Conestogo River.

Month	Maximum Final Effluent Discharge Rate (m^3/d)
March	1,581
April	3,154
October	233
November	1,754
December	4,000

(a) The streamflow is defined as the streamflow of the Conestogo River at the closest upstream Water Survey of Canada station, Conestogo River above Drayton (UTM coordinates 529057E 4847811N; WSC Station ID #2GA39);

(b) The Owner shall, during the discharge of Final Effluent, make reference to the streamflow data of the Conestogo River from the Grand River Conservation Authority Website. The Owner shall take responsibility for interpreting the hydrometric data for that day and make the appropriate operational changes. The streamflow provided shall be the basis of proportional discharge for that day and the next six days for the purposes of determining the final effluent discharge rate.

(2) The Maximum Final Effluent Discharge Rate shall not exceed the maximum design capacity of the

sand filtration and the UV disinfection rate of 4,000 m^3/d.

(3) In the event that the streamflow is unreliable or unavailable, the Owner shall follow the specified seasonal discharge during the months at the rates stipulated in Subsection (1).

10. MONITORING AND RECORDING

The Owner shall, upon commencement of operation of the Works, carry out the following monitoring program:

(1) All samples and measurements taken for the purposes of this Approval are to be taken at a time and in a location characteristic of the quality and quantity of the effluent stream over the time period being monitored.

(2) For the purposes of this condition, the following definitions apply:

(a) Weekly means once each week;
(b) Bi-weekly means once every two weeks;

(3) Samples shall be collected at the following sampling points, at the frequency specified, by means of the specified sample type and analyzed for each parameter listed and all results recorded:

Table 3 - Influent Monitoring - Influent Splitter Box at the entrance of Stabilization Ponds	
Frequency	Bi-weekly
Sample Type	Grab
Parameters	BOD5, Total Suspended Solids, Total Phosphorus, Total Kjeldahl Nitrogen

Table 4 - Lagoon Content Monitoring - one sample from each cell	
Frequency	Once at least seven (7) days prior to scheduled seasonal discharge
Sample Type	Grab
Parameters	CBOD5, Total Suspended Solids, Total Phosphorus, pH

Table 5 - Effluent Monitoring - Effluent from Disinfection System		
Parameters	**Sample Type**	**Frequency**
CBOD5	Composite	Weekly
Total Suspended Solids	Composite	Weekly
Total Phosphorus	Composite	Weekly
Total Ammonia Nitrogen	Composite	Weekly
E. coli	Grab	Weekly
pH	Grab	Weekly
Temperature	Grab	Weekly
Unionized Ammonia	Calculated	Weekly

Table 6 - Conestogo River Monitoring *		
Parameters	**Sample Type**	**Frequency****
BOD5	Grab	Weekly
Total Suspended Solids	Grab	Weekly
Total Phosphorus	Grab	Weekly
Total Ammonia Nitrogen	Grab	Weekly
E. coli	Grab	Weekly
pH	Grab	Weekly
Temperature	Grab	Weekly

*The Owner shall collect from the Conestogo River at the north side of the bridge crossing in Drayton. The sample shall be collected mid-channel only for open flowing water according to protocols acceptable to the Grand River Conservation Authority. Sampling is only required if there is open water in the middle of the river.

**The river sample shall be taken on the same day as the discharge sample from the Final Effluent specified in Condition 7.

(4) The methods and protocols for sampling, analysis and recording shall conform, in order of precedence, to the methods and protocols specified in the following:

(a) the Ministry's Procedure F-10-1, "Procedures for Sampling and Analysis Requirements for Municipal and Private Sewage Treatment Works (Liquid Waste Streams Only), as amended from time to time by more recently published editions;

(b) the Ministry's publication "Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater" (January 1999), ISBN 0-7778-1880-9, as amended from time to time by more recently published editions;

(c) the publication "Standard Methods for the Examination of Water and Wastewater" (21st edition), as amended from time to time by more recently published editions;

(5) The temperature and pH of the effluent from the Works shall be determined in the field at the time of sampling for Total Ammonia Nitrogen. The concentration of un-ionized ammonia shall be calculated using the total ammonia concentration, pH and temperature using the methodology stipulated in "Ontario's Provincial Water Quality Objectives" dated July 1994, as amended, for ammonia (un-ionized).

(6) The measurement frequencies specified in **Table 6 - Conestogo River Monitoring** in respect to any parameter are minimum requirements which may, after twelve (12) months of monitoring in accordance with this Condition, be modified by the Regional Director in writing from time to time.

(7) The Owner shall install and maintain continuous flow measuring devices, to measure the flowrate of the influent to and effluent from the Works with an accuracy to within plus or minus 15 per cent (+/- 15%) of the actual flowrate for the entire design range of the flow measuring device, and record the flowrate at a daily frequency.

(8) The Owner shall retain for a minimum of five (5) years from the date of their creation, all records and

information related to or resulting from the monitoring activities required by this Approval.

11. REPORTING

(1) One (1) week prior to the start up of the operation of the Proposed Works, the Owner shall notify the Water Supervisor (in writing) of the pending start up date.

(2) Fifteen (15) days prior to the date of a planned By-pass being conducted pursuant to Condition 5 and as soon as possible for an unplanned By-pass,the Owner shall notify the Water Supervisor (in writing) of the pending start date, in addition to an assessment of the potential adverse effects on the environment and the duration of the By-pass.

(3) The Owner shall report to the Water Supervisor or designate, any exceedence of any parameter specified in Condition 7 orally, as soon as reasonably possible, and in writing within seven (7) days of the exceedence.

(4) In addition to the obligations under Part X of the *Environmental Protection Act* , the Owner shall, within ten (10) working days of the occurrence of any reportable spill as defined in Ontario Regulation 675/98, bypass or loss of any product, by-product, intermediate product, oil, solvent, waste material or any other polluting substance into the environment, submit a full written report of the occurrence to the Water Supervisor describing the cause and discovery of the spill or loss, clean-up and recovery measures taken, preventative measures to be taken and schedule of implementation.

(5) The Owner shall, upon request, make all manuals, plans, records, data, procedures and supporting documentation available to Ministry staff.

(6) The Owner shall prepare and submit a performance report to the Water Supervisor on an annual basis, within ninety (90) days following the end of the period being reported upon. The first such report shall cover the first annual period following the commencement of operation of the Works and subsequent reports shall be submitted to cover successive annual periods following thereafter. The reports shall contain, but shall not be limited to, the following information:

(a) a summary and interpretation of all monitoring data and a comparison to the effluent limits outlined in Condition 7, including an overview of the success and adequacy of the Works;

(b) a description of any operating problems encountered and corrective actions taken;

(c) a summary of all maintenance carried out on any major structure, equipment, apparatus, mechanism or thing forming part of the Works;

(d) a summary of any effluent quality assurance or control measures undertaken in the reporting period;

(e) a summary of the calibration and maintenance carried out on all effluent monitoring equipment; and

(f) a description of efforts made and results achieved in meeting the Effluent Objectives of Condition 6;

(g) a tabulation of the volume of sludge generated in the reporting period, an outline of anticipated volumes to be generated in the next reporting period and a summary of the locations to where the sludge was disposed;

(h) a summary of any complaints received during the reporting period and any steps taken to address the complaints;

(i) a summary of all By-pass, spill or abnormal discharge events;

(j) a copy of all Notice of Modifications submitted to the Water Supervisor as a result of Schedule B, Section 1, with a status report on the implementation of each modification;

(k) a report summarizing all modifications completed as a result of Schedule B, Section 3; and

(l) any other information the Water Supervisor requires from time to time.

(7) The Owner shall, within thirty (30) calendar days of issuance of this Approval, submit a Municipal and Local Services Board Wastewater System Profile Information Form, and shall resubmit the updated document every time a notification is provided to the Water Supervisor in compliance with requirements of change of ownership under this Approval.

12. LIMITED OPERATIONAL FLEXIBILITY

(1) The Owner may make modifications to the Works in accordance with the Terms and Conditions of this Approval and subject to the Ministry's "Limited Operational Flexibility Criteria for Modifications to Sewage Works ", included under Schedule B of this Approval, as amended.

(2) Sewage works proposed under Limited Operational Flexibility shall adhere to the design guidelines contained within the Ministry's publication "Design Guidelines for Sewage Works 2008", as amended.

(3) The Owner shall ensure at all times, that the Works, related equipment and appurtenances which are installed or used to achieve compliance are operated in accordance with all Terms and Conditions of this Approval.

(4) For greater certainty, the following are not permitted as part of Limited Operational Flexibility:

(a) Modifications to the Works that result in an increase of the Rated Capacity of the Works;

(b) Modifications to the Works that may adversely affect the approved effluent quality criteria or the location of the discharge/outfall;

(c) Modifications to the treatment process technology of the Works, or modifications that involve construction of new reactors (tanks) or alter the treatment train process design;

(d) Modifications to the Works approved under s.9 of the EPA, and

(e) Modifications to the Works pursuant to an order issued by the Ministry.

(5) Implementation of Limited Operational Flexibility is not intended to be used for piecemeal measures that result in major alterations or expansions.

(6) If the implementation of Limited Operational Flexibility requires changes to be made to the Emergency Response, Spill Reporting and Contingency Plan, the Owner shall, as deemed necessary in consultation with the Water Supervisor, provide a revised copy of this plan for approval to the local fire services authority prior to implementing Limited Operational Flexibility.

(7) For greater certainty, any modification made under the Limited Operational Flexibility may only be carried out after other legal obligations have been complied with, including those arising from the *Environmental Protection Act, Niagara Escarpment Planning and Development Act, Oak Ridges Moraine Conservation Act, Lake Simcoe Protection Act* and *Greenbelt Act.*

(8) Prior to implementing Limited Operational Flexibility, the Owner shall complete a Notice of Modifications describing any proposed modifications to the Works and submit it to the Water Supervisor.

The reasons for the imposition of these terms and conditions are as follows:

1. Condition 1 is imposed to ensure that the Works are built and operated in the manner in which they were described for review and upon which approval was granted. This condition is also included to emphasize the precedence of Conditions in the Approval and the practice that the Approval is based on the most current document, if several conflicting documents are submitted for review. The condition also advises the Owners their responsibility to notify any person they authorized to carry out work pursuant to this Approval the existence of this Approval.

2. Condition 2 is included to ensure that the Works are constructed in a timely manner so that standards applicable at the time of Approval of the Works are still applicable at the time of construction, to ensure the ongoing protection of the environment.

3. Condition 3 is included to ensure that the Ministry records are kept accurate and current with respect to the approved works and to ensure that subsequent owners of the Works are made aware of the Approval and continue to operate the Works in compliance with it.

4. Condition 4 is included to ensure that the Works are constructed in accordance with the approval and that record drawings of the Works "as constructed" are maintained for future references.

5. Condition 5 is included to indicate that By-pass / Plant Overflows of untreated or partially treated

sewage to the receiving watercourse is prohibited, save in certain limited circumstances where the failure to By-pass / Plant Overflow could result in greater injury to the public interest than the Bypass itself where a By-pass / Plant Overflow will not violate the approved effluent requirements, or where the By-pass / Plant Overflow can be limited or otherwise mitigated by handling it in accordance with an approved contingency plan. The notification and documentation requirements allow the Ministry to take action in an informed manner and will ensure the Owner is aware of the extent and frequency of By-pass / Plant Overflow events.

6. Condition 6 is imposed to establish non-enforceable effluent quality objectives which the Owner is obligated to use best efforts to strive towards on an ongoing basis. These objectives are to be used as a mechanism to trigger corrective action proactively and voluntarily before environmental impairment occurs and before the compliance limits of Condition 7 are exceeded.

7. Condition 7 is imposed to ensure that the effluent discharged from the Works to the Conestogo River meets the Ministry's effluent quality requirements thus minimizing environmental impact on the receiver and to protect water quality, fish and other aquatic life in the receiving water body.

8. Condition 8 is included to require that the Works be properly operated, maintained, funded, staffed and equipped such that the environment is protected and deterioration, loss, injury or damage to any person or property is prevented. As well, the inclusion of a comprehensive operations manual governing all significant areas of operation, maintenance and repair is prepared, implemented and kept up-to-date by the Owner and made available to the Ministry. Such a manual is an integral part of the operation of the Works. Its compilation and use should assist the Owner in staff training, in proper plant operation and in identifying and planning for contingencies during possible abnormal conditions. The manual will also act as a benchmark for Ministry staff when reviewing the Owner's operation of the Works.

9. Condition 9 is included to ensure that the treated effluent is discharged to the receiver during periods and at rates that minimizes the environmental impact on the receiver.

10. Condition 10 is included to enable the Owner to evaluate and demonstrate the performance of the Works, on a continual basis, so that the Works are properly operated and maintained at a level which is consistent with the design objectives and effluent limits specified in the Approval and that the Works does not cause any impairment to the receiving watercourse.

11. Condition 11 is included to provide a performance record for future references, to ensure that the Ministry is made aware of problems as they arise, and to provide a compliance record for all the terms and conditions outlined in this Approval, so that the Ministry can work with the Owner in resolving any problems in a timely manner.

12. Condition 12 is included to ensure that the Works are operated in accordance with the application and supporting documentation submitted by the Owner, and not in a manner which the Director has not been asked to consider. These Conditions are also included to ensure that a Professional Engineer has reviewed the proposed modifications and attests that the modifications are in line with that of Limited Operational Flexibility, and provide assurance that the proposed modifications comply with the Ministry's requirements stipulated in the Terms and Conditions of this Approval, MOE policies, guidelines, and industry engineering standards and best management practices.

Schedule 'A' forms part of this Approval and contains a list of supporting documentation / information received, reviewed and relied upon in the issuance of this Approval.

SCHEDULE 'A'

1. Application for approval dated November 26, 2002 for Phase 1A Expansion and Upgrading and accompanying reports, drawings, specifications and addendum provided by R.J.Burnside and Associates Limited, Consulting Engineers and Environmental Study Report dated September 1996 and pre-design report dated October 1999 prepared by CH2M Gore & Storrie Limited, Consulting Engineers;
2. Application for Approval of Municipal and Private Sewage Works submitted by Dave Arsenault of R.J. Burnside & Associates Limited dated December 4, 2002 and accompanying reports, drawings, specifications and addendum provided by R.J.Burnside and Associates Limited, Consulting Engineers;
3. Additional information submitted by Bob Mayberry of R.J. Burnside on January 23 and 27, 2003;
4. Application for Approval of Municipal and Private Sewage Works submitted by R.J. Burnside & Associates Limited dated July 13, 2005 for alternative aeration system and alum addition system;
5. Additional information on the alternative aeration system and alum addition system submitted by R.J. Burnside on August 23, 2005;
6. Application for Approval of Municipal and Private Sewage Works submitted by R.J. Burnside & Associates Limited dated August 21, 2008, including Technical Design Brief - Raise Cell No. 3 Berm Crest Elevation and engineering plans and specifications;
7. Application for Approval of Municipal and Private Sewage Works submitted by R.J. Burnside & Associates Limited received July 6, 2010 including Technical Design Brief for the proposed additional lagoon cells together with ESR and final engineering plans received August 24, 2011.
8. Application for Environmental Compliance Approval submitted by Robert H Mayberry of R.J. Burnside & Associates Limited received February 1, 2013 for incorporation of minor design changes during construction of the proposed works approved in 2011.
9. Application for Environmental Compliance Approval dated June 16, 2015 submitted by Jeff Paznar of R.J. Burnside & Associates Limited received June 18, 2015 for the over capacity issues and the spring discharge requirements including application letter, Provincial Officer's Order, Response to comments, engineering drawings and all other supporting documents.

Schedule B

Limited Operational Flexibility Criteria for Modifications to Municipal Sewage Works

1. The modifications to sewage works approved under an Environmental Compliance Approval (Approval) that are permitted under the Limited Operational Flexibility (LOF), are outlined below and are subject to the LOF conditions in the Approval, and require the submission of the Notice of Modifications. If there is a conflict between the sewage works listed below and the Terms and Conditions in the Approval, the Terms and Conditions in the Approval shall take precedence.

1.1 Sewage Pumping Stations

a. Alter pumping capacity by adding or replacing equipment where new equipment is located within an existing sewage treatment plant site or an existing sewage pumping station site, provided that the modifications do not result in an increase of the sewage treatment plant Rated Capacity and the existing flow process and/or treatment train are maintained, as applicable.

b. Forcemain relining and replacement with similar pipe size where the nominal diameter is not greater than 1,200mm

1.2 Sewage Treatment Process

a. Installing additional chemical dosage equipment including replacing with altemative chemicals for pH adjustment or coagulants (non-toxic polymers) provided that there are no modifications of treatment processes or other modifications that may alter the intent of operations and may have negative impacts on the effluent quantity and quality.

b. Expanding the buffer zone between a sanitary sewage lagoon facility or land treatment area and adjacent uses provided that the buffer zone is entirely on the proponent's land.

c. Optimizing existing sanitary sewage lagoons with the purpose to increase efficiency of treatment operations provided that existing sewage treatment plant rated capacity is not exceeded and where no land acquisition is required.

d. Optimizing existing sewage treatment plant equipment with the purpose to increase the efficiency of the existing treatment operations, provided that there are no modifications to the works that result in an increase of the approved Rated Capacity, and may have adverse effects to the effluent quality or location of the discharge.

e. Replacement, refurbishment of previously approved equipment in whole or in part with Equivalent Equipment, like-for-like of different make and model, provided that the firm capacity, reliability, performance standard, level of quality and redundancy of the group of equipment is kept the same or exceeded. For clarity purposes, the following equipment can

be considered under this provision: pumps, screens, grit separators, blowers, aeration equipment, sludge thickeners, dewatering equipment, UV systems, chlorine contact equipment, bio-disks, and sludge digester systems.

1.3 Sewage Treatment Plant Outfall

a. Replacement of discharge pipe with similar pipe size or diffusers provided that the outfall location is not changed.

1.4 Sanitary Sewers

a. Pipe relining and replacement with similar pipe size within the Sewage Treatment Plant site, where the nominal diameter is not greater than 1,200mm.

1.5 Pilot Systems

a. Installation of pilot systems for new or existing technologies provided that:

i. any effluent from the pilot system is discharged to the inlet of the sewage treatment plant or hauled off-site for proper disposal,
ii. any effluent from the pilot system discharged to the inlet of the sewage treatment plant or sewage conveyance system does not significantly alter the composition/concentration of the influent sewage to be treated in the downstream process; and that it does not add any inhibiting substances to the downstream process, and
iii. the pilot system's duration does not exceed a maximum of two years; and a report with results is submitted to the Director and Water Supervisor three months after completion of the pilot project.

2. Sewage works that are exempt from section 53 of the OWRA by O. Reg. 525/98 continue to be exempt and are not required to follow the notification process under this Limited Operational Flexibility.

3. Normal or emergency operational modifications, such as repairs, reconstructions, or other improvements that are part of maintenance activities, including cleaning, renovations to existing approved sewage works equipment, provided that the modification is made with Equivalent Equipment, are considered pre-approved.

4. The modifications noted in section (3) above are <u>not</u> required to follow the notification protocols under Limited Operational Flexibility, provided that the number of pieces and description of the equipment as described in the Approval does not change.

Ontario
Ministry of the Environment

Notice of Modification to Sewage Works

RETAIN COPY OF COMPLETED FORM AS PART OF THE ECA AND SEND A COPY TO THE WATER SUPERVISOR (FOR MUNICIPAL) OR DISTRICT MANAGER (FOR NON-MUNICIPAL SYSTEMS)

Part 1 – Environmental Compliance Approval (ECA) with Limited Operational Flexibility

(Insert the ECA's owner, number and issuance date and notice number, which should start with "01" and consecutive numbers thereafter)

ECA Number	Issuance Date (mm/dd/yy)	Notice number (if applicable)

ECA Owner	Municipality

Part 2: Description of the modifications as part of the Limited Operational Flexibility

(Attach a detailed description of the sewage works)

Description shall include:

1. A detail description of the modifications and/or operations to the sewage works (e.g. sewage work component, location, size, equipment type/model, material, process name, etc.)
2. Confirmation that the anticipated environmental effects are negligible.
3. List of updated versions of, or amendments to, all relevant technical documents that are affected by the modifications as applicable, i.e. submission of documentation is not required, but the listing of updated documents is (design brief, drawings, emergency plan, etc.)

Part 3 – Declaration by Professional Engineer

I hereby declare that I have verified the scope and technical aspects of this modification and confirm that the design:

1. Has been prepared or reviewed by a Professional Engineer who is licensed to practice in the Province of Ontario;
2. Has been designed in accordance with the Limited Operational Flexibility as described in the ECA;
3. Has been designed consistent with Ministry's Design Guidelines, adhering to engineering standards, industry's best management practices, and demonstrating ongoing compliance with s.53 of the Ontario Water Resources Act and other appropriate regulations.

I hereby declare that to the best of my knowledge, information and belief the information contained in this form is complete and accurate

Name (Print)	PEO License Number
Signature	Date (mm/dd/yy)
Name of Employer	

Part 4 – Declaration by Owner

I hereby declare that:

1. I am authorized by the Owner to complete this Declaration;
2. The Owner consents to the modification; and
3. The modifications to the sewage works are proposed in accordance with the Limited Operational Flexibility as described in the ECA;
4. The Owner has fulfilled all applicable requirements of the *Environmental Assessment Act*.

I hereby declare that to the best of my knowledge, information and belief the information contained in this form is complete and accurate

Name of Owner Representative 1 (Print)	Owner representative 1 Title (Print)
Owner Representative 1 Signature	Date (mm/dd/yy)

MM Form December 2, 2013

Upon issuance of the environmental compliance approval, I hereby revoke Approval No(s). 7875-95DQSC, 1440-5JFU5R issued on April 3, 2013, February 6, 2003.

In accordance with Section 139 of the Environmental Protection Act, you may by written Notice served upon me and the Environmental Review Tribunal within 15 days after receipt of this Notice, require a hearing by the Tribunal. Section 142 of the Environmental Protection Act provides that the Notice requiring the hearing shall state:

1. The portions of the environmental compliance approval or each term or condition in the environmental compliance approval in respect of which the hearing is required, and;
2. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

Pursuant to subsection 139(3) of the Environmental Protection Act, a hearing may not be required with respect to any terms and conditions in this environmental compliance approval, if the terms and conditions are substantially the same as those contained in an approval that is amended or revoked by this environmental compliance approval.

The Notice should also include:

3. The name of the appellant;
4. The address of the appellant;
5. The environmental compliance approval number;
6. The date of the environmental compliance approval;
7. The name of the Director, and;
8. The municipality or municipalities within which the project is to be engaged in.

And the Notice should be signed and dated by the appellant.

This Notice must be served upon:

The Secretary*
Environmental Review Tribunal
655 Bay Street, Suite 1500
Toronto, Ontario
M5G 1E5

AND

The Director appointed for the purposes of Part II.1 of the Environmental Protection Act
Ministry of the Environment and Climate Change
135 St. Clair Avenue West, 1st Floor
Toronto, Ontario
M4V 1P5

*** Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal at: Tel: (416) 212-6349, Fax: (416) 326-5370 or www.ert.gov.on.ca**

The above noted activity is approved under s.20.3 of Part II.1 of the Environmental Protection Act.

DATED AT TORONTO this 22nd day of January, 2016

Fariha Pannu.

Fariha Pannu, P.Eng.
Director
appointed for the purposes of Part II.1 of the
Environmental Protection Act

SW/

c: DWMD Supervisor, MOECC Guelph
Rekha Chetlur, Registration and Compliance Section, MOECC Drinking Water Programs Bramch - IMBS
Jeff Paznar, P. Eng., EP, R.J. Burnside & Associates Limited

Appendix B: Station 02GA039 data and 7-day Moving Window Average

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg.		4.157	3.839	11.442	8.494	3.057	1.401	0.553	0.761	1.380	2.326	4.772	4.685
Max.		136	126	214	238	122	62	45	51	80	47	91	225
Min.		0.194	0.180	0.165	0.097	0.056	0.000	0.000	0.000	0.000	0.011	0.093	0.219
95th centile		17.575	17.240	47.015	29.900	10.915	6.215	1.792	2.517	5.044	9.987	18.400	16.645
5th centile		0.326	0.241	0.340	0.743	0.260	0.062	0.025	0.027	0.024	0.082	0.346	0.394

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

1973	1	28.300	1.420	0.538	24.500	1.690	5.780	1.310	0.054	0.008	0.011	0.507	6.400
1973	2	25.500	3.960	0.521	17.000	3.370	4.810	0.810	0.187	0.008	0.014	0.733	3.540
1973	3	18.100	11.300	1.270	14.900	13.600	2.820	0.544	0.530	0.008	0.021	0.985	2.660
1973	4	13.000	7.080	4.250	11.000	7.670	2.090	0.385	0.382	0.007	0.025	0.892	2.890
1973	5	8.500	4.810	19.800	6.800	4.980	1.630	0.399	0.195	0.007	0.023	0.648	6.770
1973	6	6.090	3.110	28.300	4.930	2.940	1.320	0.303	0.116	0.007	0.019	0.467	6.200
1973	7	4.250	2.410	88.100	3.910	1.850	1.180	0.221	0.062	0.006	0.017	0.362	3.480
1973	8	3.000	1.980	49.000	2.860	1.770	1.260	0.159	0.042	0.006	0.017	0.320	2.460
1973	9	1.980	1.560	22.500	2.060	4.700	1.250	0.108	0.028	0.005	0.016	0.280	1.780
1973	10	1.420	1.270	14.000	1.720	13.000	0.923	0.076	0.051	0.005	0.014	0.227	1.530
1973	11	1.220	1.050	61.700	1.700	11.000	0.660	0.059	0.105	0.005	0.015	0.249	1.300
1973	12	0.991	0.949	58.900	1.510	6.970	0.510	0.045	0.062	0.005	0.018	0.215	1.170
1973	13	0.920	0.878	20.400	1.180	4.530	0.411	0.048	0.045	0.005	0.028	0.210	0.878
1973	14	0.850	0.765	37.700	0.994	3.170	0.320	0.045	0.031	0.005	0.057	0.221	0.680
1973	15	0.793	0.694	26.400	0.892	2.340	0.261	0.034	0.023	0.005	0.040	0.547	0.510
1973	16	0.779	0.665	14.400	0.790	1.830	0.294	0.026	0.020	0.005	0.040	3.170	0.340
1973	17	0.708	0.637	9.000	0.750	1.810	0.377	0.024	0.016	0.007	0.062	2.320	0.255
1973	18	0.708	0.617	1.700	0.694	1.630	0.473	0.022	0.016	0.012	0.076	1.310	0.227
1973	19	8.500	0.600	2.550	0.643	1.360	0.416	0.017	0.013	0.010	0.068	1.190	0.227
1973	20	7.650	0.595	4.250	0.578	1.120	0.354	0.016	0.017	0.008	0.071	1.220	0.241
1973	21	6.370	0.580	3.820	0.532	0.980	0.280	0.016	0.026	0.008	0.062	1.170	0.255
1973	22	5.660	0.575	3.400	0.793	1.020	0.224	0.015	0.037	0.017	0.051	1.830	0.241
1973	23	8.500	0.572	3.680	1.610	0.833	0.320	0.013	0.028	0.028	0.040	1.970	0.227
1973	24	7.650	0.566	5.660	1.270	0.711	0.360	0.011	0.022	0.031	0.037	1.890	0.227
1973	25	6.510	0.561	14.200	0.963	0.648	0.549	0.022	0.018	0.025	0.031	6.570	0.227
1973	26	5.520	0.558	32.600	0.745	0.799	0.643	0.031	0.016	0.022	0.026	4.620	0.850
1973	27	4.250	0.555	25.200	0.631	2.140	3.680	0.027	0.014	0.023	0.025	2.970	5.520
1973	28	3.400	0.552	14.200	2.020	7.990	3.110	0.042	0.012	0.020	0.025	10.200	4.330
1973	29	2.690		28.300	3.280	15.400	3.000	0.074	0.010	0.016	0.034	18.600	3.110
1973	30	2.460		35.400	1.890	8.670	2.200	0.048	0.009	0.013	0.062	9.430	2.210
1973	31	1.850		18.700		5.100		0.040	0.008		0.178		1.950
1974	1	1.780	9.630	1.470	2.860	3.000	0.869	0.130	0.034	0.042	0.093	0.108	0.309
1974	2	1.590	4.810	1.390	47.600	2.060	0.688	0.119	0.048	0.034	0.074	0.093	0.294
1974	3	1.440	2.550	9.060	35.100	1.380	0.524	0.116	0.065	0.031	0.065	0.108	0.278
1974	4	1.300	1.420	46.400	82.400	1.170	0.419	0.127	0.062	0.031	0.068	0.142	0.261
1974	5	1.190	1.130	83.300	23.700	1.070	0.343	0.133	0.057	0.027	0.062	0.176	0.249
1974	6	1.100	0.963	72.500	9.800	3.060	0.266	0.113	0.048	0.023	0.059	0.371	0.249

	3.084	0.557	25.557	1.603	6.554	2.070	0.045	0.011	0.019	0.122	8.399
	2.861	0.550	23.329	1.947	7.127	2.108	0.067	0.010	0.017	0.223	7.966
	3.869	0.651	21.857	3.783	7.224	2.093	0.139	0.009	0.017	0.361	7.686
	4.394	1.178	21.400	4.789	6.381	1.623	0.188	0.008	0.017	0.484	7.674
	4.697	3.927	18.329	5.211	4.414	1.235	0.205	0.008	0.018	0.572	7.184
	4.790	7.890	13.976	5.163	3.364	0.850	0.215	0.008	0.018	0.630	5.413
14.820	4.870	20.397	11.863	5.157	2.804	0.567	0.218	0.007	0.019	0.656	4.563
11.206	4.950	27.320	8.771	5.169	2.159	0.403	0.216	0.007	0.019	0.630	4.000
7.846	4.607	30.460	6.637	5.359	1.650	0.303	0.194	0.007	0.020	0.565	3.749
5.463	3.174	32.279	4.754	5.273	1.379	0.236	0.125	0.006	0.019	0.457	3.587
3.780	2.313	40.486	3.426	5.749	1.175	0.189	0.086	0.006	0.017	0.365	3.360
2.707	1.761	46.071	2.670	6.033	1.015	0.139	0.067	0.006	0.017	0.303	2.560
1.969	1.442	44.943	2.134	6.260	0.885	0.102	0.056	0.005	0.018	0.266	1.800
1.483	1.207	37.743	1.718	6.449	0.762	0.077	0.052	0.005	0.024	0.246	1.400
1.168	1.024	34.514	1.437	6.530	0.619	0.059	0.049	0.005	0.027	0.278	1.121
0.996	0.896	33.357	1.255	6.120	0.483	0.048	0.048	0.005	0.030	0.691	0.915
0.894	0.805	32.643	1.117	4.521	0.405	0.040	0.043	0.005	0.037	0.990	0.733
0.821	0.744	24.071	0.973	3.183	0.378	0.035	0.030	0.006	0.046	1.142	0.580
1.894	0.694	16.021	0.849	2.381	0.365	0.031	0.023	0.007	0.053	1.281	0.445
2.855	0.653	13.714	0.763	1.894	0.356	0.026	0.019	0.007	0.059	1.425	0.354
3.644	0.627	8.874	0.697	1.581	0.351	0.022	0.019	0.008	0.060	1.561	0.294
4.339	0.610	5.589	0.683	1.393	0.345	0.019	0.021	0.010	0.061	1.744	0.255
5.442	0.597	4.057	0.800	1.250	0.349	0.018	0.022	0.013	0.061	1.573	0.239
6.434	0.586	3.580	0.874	1.093	0.347	0.016	0.023	0.016	0.058	1.511	0.235
7.263	0.578	5.366	0.913	0.953	0.358	0.016	0.023	0.018	0.051	2.263	0.235
6.837	0.572	9.659	0.927	0.873	0.390	0.018	0.023	0.020	0.045	2.753	0.324
6.351	0.567	12.651	0.935	1.019	0.865	0.019	0.023	0.022	0.039	3.003	1.078
5.927	0.563	14.134	1.147	2.020	1.269	0.023	0.021	0.024	0.034	4.293	1.660
5.503		17.691	1.503	4.074	1.666	0.031	0.017	0.024	0.031	6.689	2.070
4.640		22.223	1.543	5.194	1.935	0.036	0.014	0.021	0.034	7.754	2.353
3.811		24.086		5.821		0.041	0.012		0.054		2.600
2.821	18.420	1.926	0.931	2.801	1.007	0.150	0.030	0.045	0.055	0.106	1.189
2.927	18.420	1.914	7.640	2.473	0.962	0.135	0.032	0.048	0.061	0.103	0.641
2.344	13.970	2.853	12.567	2.250	0.908	0.125	0.037	0.049	0.065	0.104	0.447
1.911	9.930	9.150	24.256	2.119	0.856	0.123	0.042	0.050	0.069	0.110	0.360
1.637	7.391	20.750	27.566	2.046	0.755	0.124	0.046	0.045	0.073	0.121	0.311
1.479	5.029	30.836	28.891	2.150	0.598	0.124	0.049	0.036	0.072	0.159	0.283

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1974	7	1.020	0.850	91.500	9.150	3.820	0.238	0.091	0.042	0.022	0.076	0.439	0.252
1974	8	0.934	0.736	24.900	7.590	2.560	0.258	0.076	0.045	0.022	0.076	0.323	0.283
1974	9	0.878	0.651	11.000	4.280	8.690	0.229	0.062	0.037	0.022	0.088	0.227	0.311
1974	10	0.793	0.580	7.820	3.260	7.390	0.207	0.051	0.034	0.020	0.074	0.181	0.343
1974	11	0.750	0.547	7.420	3.140	3.880	0.212	0.037	0.031	0.019	0.065	0.167	0.340
1974	12	0.708	0.481	6.430	7.220	18.500	0.207	0.031	0.028	0.022	0.062	0.278	0.340
1974	13	0.680	0.453	4.250	13.600	14.500	0.195	0.031	0.027	0.024	0.057	0.343	0.340
1974	14	0.651	0.425	3.400	12.800	7.500	0.184	0.027	0.026	0.021	0.096	0.425	0.340
1974	15	0.623	0.396	1.980	18.300	31.400	0.218	0.026	0.024	0.020	0.241	0.374	0.340
1974	16	0.595	0.374	1.700	8.210	40.800	0.351	0.025	0.021	0.020	0.161	0.309	0.340
1974	17	0.580	0.360	1.560	5.210	122.000	0.340	0.024	0.020	0.024	0.130	0.323	0.340
1974	18	0.572	0.345	1.420	3.600	15.300	0.362	0.027	0.019	0.028	0.110	0.368	0.340
1974	19	0.561	0.340	1.300	2.680	6.740	0.507	0.027	0.016	0.028	0.088	0.490	0.345
1974	20	0.538	0.337	1.130	2.030	3.960	0.586	0.027	0.014	0.028	0.085	0.699	0.348
1974	21	1.130	0.337	1.050	1.620	2.700	0.629	0.026	0.014	0.034	0.085	4.450	0.362
1974	22	1.620	0.850	0.963	6.060	2.010	0.552	0.068	0.013	0.031	0.074	3.740	0.368
1974	23	2.890	1.470	0.878	17.800	1.750	0.470	0.054	0.014	0.031	0.068	1.870	0.388
1974	24	4.250	2.490	0.765	8.440	1.420	0.311	0.034	0.015	0.026	0.076	4.280	0.394
1974	25	4.530	2.320	0.708	4.360	1.170	0.221	0.028	0.016	0.031	0.102	4.130	0.396
1974	26	4.810	2.100	0.637	2.940	1.000	0.184	0.031	0.016	0.040	0.108	1.640	0.382
1974	27	33.700	1.900	0.609	2.090	0.900	0.144	0.031	0.021	0.037	0.102	0.867	0.368
1974	28	29.700	1.730	0.578	1.580	0.787	0.122	0.025	0.023	0.037	0.102	0.595	0.362
1974	29	18.900		0.530	2.330	1.050	0.119	0.027	0.062	0.065	0.096	0.442	0.357
1974	30	17.500		0.524	3.310	1.360	0.127	0.028	0.091	0.082	0.110	0.343	0.345
1974	31	14.700		0.779		1.080		0.031	0.062		0.113		0.343
1975	1	0.326	1.470	4.110	5.240	2.240	0.283	0.110	0.102	1.120	0.445	0.428	8.640
1975	2	0.249	1.300	3.540	4.530	1.910	0.241	0.108	0.093	0.909	0.433	0.821	3.260
1975	3	0.278	1.130	3.110	4.110	1.540	0.221	0.082	0.116	0.651	0.396	1.230	1.980
1975	4	0.294	1.050	2.890	3.820	1.620	0.221	0.065	0.150	0.473	0.348	2.270	1.870
1975	5	0.360	0.934	2.630	3.540	2.150	0.255	0.054	0.136	0.343	0.320	1.750	2.040
1975	6	0.360	0.821	2.410	3.260	5.920	0.258	0.045	0.108	0.328	0.289	1.230	32.800
1975	7	0.377	0.765	2.210	3.060	6.990	0.278	0.088	0.096	0.317	0.272	1.010	8.070
1975	8	0.391	0.708	2.040	2.920	3.400	0.263	0.096	0.091	0.283	0.255	1.050	2.270
1975	9	0.934	0.651	1.930	3.110	2.100	0.232	0.068	0.088	0.252	0.249	1.140	1.640
1975	10	1.980	0.595	1.810	3.400	1.460	0.193	0.071	0.074	0.235	0.269	3.620	1.330
1975	11	18.700	0.566	1.760	4.670	1.070	0.167	0.085	0.088	0.278	0.255	4.640	1.080
1975	12	22.100	0.467	1.700	5.660	0.968	0.229	0.099	0.099	1.910	0.258	2.440	0.934
1975	13	10.300	0.396	2.100	7.650	0.949	0.283	0.099	0.127	1.540	0.934	1.680	0.850
1975	14	4.640	0.326	1.980	8.780	0.745	0.303	0.105	0.108	1.440	1.430	1.250	7.760
1975	15	3.680	0.227	1.930	15.200	0.603	0.326	0.116	0.093	1.200	0.966	0.963	47.600
1975	16	3.110	0.283	1.840	25.200	0.564	0.405	0.105	0.091	0.858	0.716	0.932	8.210
1975	17	2.660	0.340	1.980	43.600	0.515	0.331	0.079	0.105	0.660	0.566	0.821	3.430
1975	18	2.270	0.396	3.680	86.100	0.447	0.320	0.065	0.091	0.597	0.479	0.753	1.670
1975	19	1.950	0.453	9.910	238.000	0.402	4.450	0.147	0.076	3.060	0.430	0.682	1.360

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.346	3.050	43.660	30.087	2.223	0.478	0.118	0.051	0.030	0.071	0.205	0.270
1.225	1.780	47.007	30.763	2.160	0.391	0.111	0.052	0.027	0.069	0.236	0.267
1.123	1.186	48.380	24.574	3.107	0.325	0.103	0.051	0.025	0.071	0.255	0.269
1.031	0.904	48.203	20.026	3.966	0.280	0.093	0.046	0.024	0.072	0.266	0.278
0.952	0.780	42.634	8.703	4.353	0.250	0.080	0.042	0.022	0.071	0.269	0.290
0.883	0.687	31.653	6.349	6.843	0.231	0.066	0.038	0.021	0.071	0.284	0.303
0.823	0.614	21.903	6.891	8.477	0.221	0.054	0.035	0.022	0.071	0.280	0.316
0.771	0.553	9.317	7.413	9.003	0.213	0.045	0.033	0.021	0.074	0.278	0.328
0.726	0.505	6.043	8.943	13.123	0.207	0.038	0.030	0.021	0.098	0.285	0.336
0.686	0.465	4.714	9.504	17.710	0.225	0.033	0.027	0.021	0.108	0.297	0.340
0.655	0.434	3.820	9.783	34.083	0.244	0.029	0.025	0.021	0.116	0.317	0.340
0.630	0.405	2.963	9.849	35.714	0.265	0.027	0.024	0.023	0.122	0.346	0.340
0.609	0.385	2.230	9.200	34.034	0.308	0.027	0.022	0.024	0.126	0.376	0.341
0.589	0.368	1.784	7.547	32.529	0.364	0.026	0.020	0.024	0.130	0.427	0.342
0.657	0.356	1.449	5.950	31.843	0.428	0.026	0.018	0.026	0.129	1.002	0.345
0.799	0.420	1.303	4.201	27.644	0.475	0.032	0.017	0.028	0.105	1.483	0.349
1.127	0.577	1.186	5.571	22.066	0.492	0.036	0.016	0.029	0.091	1.706	0.356
1.652	0.881	1.072	6.033	4.840	0.488	0.038	0.015	0.029	0.084	2.271	0.364
2.217	1.163	0.971	6.141	2.821	0.468	0.038	0.015	0.030	0.083	2.808	0.372
2.824	1.415	0.876	6.179	2.001	0.422	0.038	0.015	0.032	0.085	2.973	0.377
7.561	1.638	0.801	6.187	1.564	0.359	0.039	0.016	0.033	0.088	2.997	0.380
11.643	1.837	0.734	6.181	1.291	0.286	0.039	0.017	0.033	0.090	2.446	0.380
14.111		0.672	5.649	1.154	0.224	0.033	0.024	0.038	0.093	1.975	0.378
16.199		0.622	3.579	1.098	0.175	0.029	0.035	0.045	0.099	1.757	0.372
17.691		0.624		1.050		0.029	0.042		0.105		0.365
0.355	1.380	4.725	7.449	4.771	0.259	0.168	0.145	1.173	0.676	0.466	3.115
0.336	1.409	5.130	6.553	3.416	0.252	0.146	0.134	1.174	0.596	0.497	3.483
0.323	1.400	5.280	5.886	2.750	0.240	0.126	0.127	1.173	0.528	0.594	3.678
0.313	1.364	4.560	5.299	2.334	0.235	0.110	0.124	1.185	0.468	0.847	3.854
0.314	1.295	3.944	4.793	2.127	0.239	0.095	0.122	1.161	0.423	1.033	4.052
0.316	1.196	3.419	4.329	2.553	0.246	0.082	0.118	0.791	0.387	1.152	8.634
0.321	1.067	2.986	3.937	3.196	0.251	0.079	0.114	0.592	0.358	1.248	8.380
0.330	0.958	2.690	3.606	3.361	0.248	0.077	0.113	0.472	0.330	1.337	7.470
0.428	0.866	2.460	3.403	3.389	0.247	0.071	0.112	0.378	0.304	1.383	7.239
0.671	0.789	2.274	3.301	3.377	0.243	0.070	0.106	0.319	0.286	1.724	7.146
3.300	0.720	2.113	3.423	3.299	0.235	0.072	0.097	0.291	0.273	2.063	7.033
6.406	0.653	1.980	3.726	3.130	0.231	0.079	0.092	0.515	0.264	2.161	6.875
7.826	0.593	1.936	4.353	2.420	0.235	0.087	0.095	0.688	0.356	2.226	2.311
8.435	0.530	1.903	5.170	1.527	0.239	0.089	0.096	0.848	0.521	2.260	2.266
8.905	0.461	1.887	6.924	1.128	0.248	0.092	0.097	0.979	0.623	2.248	8.742
9.216	0.409	1.874	10.080	0.908	0.272	0.097	0.097	1.066	0.690	2.218	9.681
9.313	0.372	1.899	15.823	0.773	0.292	0.098	0.102	1.127	0.732	1.818	9.981
6.966	0.348	2.173	27.456	0.684	0.314	0.095	0.102	1.172	0.764	1.263	10.065
4.087	0.346	3.346	60.647	0.604	0.917	0.102	0.099	1.336	0.789	1.012	10.126

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1975	20	1.670	0.396	25.500	46.200	0.357	2.590	0.852	0.068	5.780	0.699	0.640	1.100
1975	21	1.420	0.294	24.900	18.700	0.306	1.290	0.804	0.076	4.730	1.100	0.782	0.963
1975	22	1.190	0.510	23.800	14.600	0.275	0.753	0.464	0.099	2.720	0.943	0.951	0.850
1975	23	1.050	0.708	21.800	14.900	0.252	0.487	0.300	0.110	1.960	0.799	0.852	0.793
1975	24	0.963	2.060	18.700	24.700	0.241	0.340	0.241	2.260	1.400	0.663	0.733	0.765
1975	25	1.020	7.930	13.600	11.400	0.292	0.266	0.207	1.270	0.997	0.603	0.688	0.736
1975	26	1.100	6.940	10.800	6.200	0.294	0.218	0.173	0.900	0.867	0.609	0.609	0.708
1975	27	1.190	6.090	8.780	4.530	0.306	0.178	0.167	0.660	0.767	0.549	0.643	0.680
1975	28	1.300	5.240	7.930	3.600	0.252	0.159	0.170	0.388	0.640	0.498	0.651	0.665
1975	29	1.420		7.080	2.940	0.227	0.133	0.150	0.513	0.538	0.450	0.725	0.651
1975	30	1.510		6.510	2.490	0.207	0.113	0.133	2.920	0.479	0.394	9.850	0.708
1975	31	1.670		5.800		0.246		0.122	1.710		0.337		0.793
1976	1	0.906	0.779	18.100	25.400	2.920	1.720	44.700	1.090	0.156	0.626	5.180	1.980
1976	2	0.850	0.750	10.800	13.500	2.920	1.140	10.600	0.677	0.221	0.496	3.340	1.590
1976	3	0.793	0.708	6.800	6.600	5.550	0.745	5.720	0.445	0.167	0.399	2.890	1.300
1976	4	0.736	0.685	4.760	4.810	3.790	0.527	5.100	0.311	0.139	0.334	2.970	1.100
1976	5	0.708	0.665	15.600	3.450	2.590	0.377	2.890	0.252	0.125	0.297	2.340	0.991
1976	6	0.680	0.651	34.000	2.890	6.480	0.300	1.650	0.229	0.116	0.411	2.290	0.934
1976	7	0.637	0.629	17.000	2.380	38.500	0.252	1.100	0.204	0.110	1.960	2.040	0.821
1976	8	0.603	0.609	11.000	1.960	11.400	0.227	2.890	0.184	0.105	1.510	1.580	0.765
1976	9	0.572	0.600	7.080	1.590	5.010	0.201	1.660	0.178	0.099	1.020	1.220	0.736
1976	10	0.538	0.589	5.100	1.440	3.200	0.184	1.040	0.170	0.130	0.816	1.120	0.680
1976	11	0.481	0.609	4.110	1.470	2.700	0.159	1.230	0.159	0.244	0.663	1.030	0.651
1976	12	0.453	0.623	3.740	1.200	2.650	0.136	0.929	0.150	0.306	0.532	0.934	0.623
1976	13	0.425	0.651	4.250	1.050	1.970	0.127	0.617	0.340	0.190	0.462	0.977	0.595
1976	14	0.396	0.680	4.960	0.960	1.570	0.139	0.453	0.294	0.156	2.200	0.917	0.566
1976	15	0.368	0.694	4.110	2.190	1.440	0.130	0.374	1.010	0.142	3.170	0.861	0.504
1976	16	0.425	1.950	3.680	5.860	1.410	0.130	0.320	0.660	0.133	1.740	0.705	0.453
1976	17	0.510	4.590	3.310	3.650	1.780	0.144	0.269	0.357	0.156	1.100	0.665	0.425
1976	18	0.572	6.650	3.030	2.300	1.870	0.139	0.229	0.261	1.680	0.841	0.733	0.402
1976	19	0.609	11.900	4.670	1.580	1.440	0.139	0.201	0.207	2.020	0.711	0.731	0.391
1976	20	0.538	8.780	62.600	1.170	1.120	0.147	0.204	0.176	2.450	0.940	0.833	0.510
1976	21	0.498	7.080	188.000	0.957	0.900	0.144	3.430	0.156	3.510	5.180	0.719	0.680
1976	22	0.467	7.930	34.300	1.210	0.776	0.127	1.720	0.139	5.040	5.070	0.660	0.651
1976	23	0.453	9.060	23.700	1.310	0.668	0.113	0.782	0.127	6.170	5.970	0.521	0.623
1976	24	0.439	7.220	45.600	1.070	0.580	0.116	0.504	0.119	4.050	9.230	0.555	0.609
1976	25	0.425	5.950	86.700	16.700	0.549	0.130	0.343	0.125	2.200	19.300	0.634	0.595
1976	26	0.538	8.780	29.700	16.200	0.595	0.130	0.261	0.102	1.450	13.600	12.200	0.566
1976	27	0.623	16.400	36.800	16.300	0.527	0.303	0.212	0.099	1.650	6.090	41.900	0.552
1976	28	0.736	17.000	22.100	16.000	0.422	0.275	0.190	0.110	1.510	4.050	16.700	0.538
1976	29	0.963	17.600	11.800	6.710	0.362	0.224	1.700	0.153	1.030	3.910	4.810	0.510
1976	30	0.878		8.410	3.960	0.351	7.050	3.140	0.133	0.787	6.310	2.550	0.481
1976	31	0.821		13.600		0.731		1.650	0.110		6.850		0.453
1977	1	0.453	0.255	0.481	5.950	0.456	0.275	0.351	0.388	0.473	39.400	0.603	22.100

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.854	0.346	6.689	66.154	0.519	1.246	0.210	0.090	1.942	0.755	0.863	10.161
2.394	0.341	9.963	67.571	0.456	1.387	0.310	0.086	2.412	0.708	0.796	9.190
2.039	0.382	13.087	67.486	0.409	1.448	0.359	0.087	2.629	0.705	0.794	2.512
1.744	0.442	15.939	66.014	0.365	1.460	0.387	0.089	2.787	0.717	0.783	1.452
1.502	0.688	18.327	63.314	0.326	1.461	0.410	0.397	2.892	0.730	0.770	1.072
1.323	1.764	19.744	52.643	0.304	1.454	0.431	0.566	2.950	0.748	0.761	0.938
1.202	2.691	19.871	19.529	0.288	0.849	0.434	0.683	2.636	0.774	0.751	0.845
1.133	3.505	17.483	13.576	0.281	0.505	0.337	0.768	1.920	0.752	0.751	0.785
1.116	4.211	15.059	11.419	0.273	0.343	0.246	0.812	1.336	0.666	0.732	0.742
1.149		12.670	9.753	0.266	0.254	0.201	0.872	1.024	0.596	0.700	0.714
1.215		10.486	7.980	0.260	0.201	0.177	1.273	0.813	0.538	1.986	0.702
1.316		8.643		0.261		0.160	1.194		0.491		0.706
0.730	0.763	13.007	21.116	11.256	0.673	7.545	1.178	0.123	1.322	6.570	11.539
0.750	0.793	13.519	18.801	9.287	0.750	9.040	1.237	0.140	1.078	5.104	11.676
0.767	0.805	13.640	14.487	7.766	0.782	9.839	1.270	0.150	0.928	4.647	10.119
0.777	0.798	13.066	12.017	5.979	0.797	10.524	1.288	0.154	0.740	4.493	4.290
0.785	0.755	12.951	10.824	4.063	0.799	10.898	1.081	0.150	0.567	4.269	2.046
0.781	0.723	15.380	10.036	4.030	0.791	11.101	0.665	0.148	0.479	3.694	1.492
0.759	0.695	15.294	8.433	8.964	0.723	10.251	0.458	0.148	0.646	3.007	1.245
0.715	0.671	14.280	5.084	10.176	0.510	4.279	0.329	0.140	0.772	2.493	1.072
0.676	0.650	13.749	3.383	10.474	0.376	3.001	0.258	0.123	0.847	2.190	0.950
0.639	0.633	13.506	2.646	10.139	0.295	2.333	0.218	0.118	0.907	1.937	0.861
0.603	0.622	13.413	2.169	9.983	0.243	1.780	0.197	0.133	0.954	1.660	0.797
0.566	0.616	11.719	1.847	9.991	0.208	1.500	0.182	0.159	0.987	1.459	0.744
0.530	0.616	7.469	1.584	9.347	0.184	1.352	0.198	0.169	0.995	1.272	0.696
0.495	0.623	5.749	1.381	4.071	0.168	1.260	0.211	0.176	1.029	1.111	0.659
0.462	0.635	4.764	1.414	2.649	0.154	0.900	0.329	0.181	1.266	1.008	0.622
0.441	0.828	4.279	2.024	2.134	0.144	0.709	0.398	0.186	1.369	0.935	0.582
0.437	1.400	4.023	2.340	1.931	0.138	0.599	0.424	0.190	1.410	0.870	0.545
0.450	2.263	3.869	2.459	1.813	0.135	0.456	0.439	0.395	1.435	0.827	0.510
0.472	3.874	4.001	2.513	1.640	0.135	0.352	0.447	0.640	1.461	0.798	0.477
0.488	5.035	12.337	2.530	1.519	0.138	0.293	0.424	0.962	1.529	0.778	0.464
0.503	5.949	38.486	2.530	1.423	0.139	0.718	0.404	1.442	1.955	0.750	0.481
0.517	6.983	42.799	2.390	1.328	0.139	0.910	0.279	2.141	2.226	0.721	0.502
0.521	7.999	45.659	1.740	1.222	0.136	0.976	0.203	3.004	2.830	0.695	0.526
0.511	8.374	51.700	1.371	1.051	0.132	1.010	0.169	3.560	3.992	0.679	0.552
0.490	8.274	63.653	3.428	0.862	0.131	1.026	0.150	3.634	6.629	0.665	0.580
0.480	7.829	67.229	5.517	0.741	0.130	1.035	0.135	3.553	8.470	2.303	0.605
0.492	8.917	63.543	7.678	0.656	0.152	1.036	0.124	3.439	9.206	8.170	0.611
0.526	10.334	39.843	9.827	0.588	0.171	0.573	0.117	3.153	9.044	10.453	0.591
0.597	11.716	36.629	10.613	0.529	0.184	0.570	0.119	2.580	8.879	11.046	0.570
0.657		34.444	10.991	0.484	1.175	0.907	0.120	1.811	8.927	11.336	0.550
0.712		29.873		0.505		1.071	0.119		8.587		0.528
0.508	0.269	0.444	14.859	0.749	0.109	0.284	0.110	0.745	20.811	0.768	5.456

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	2	0.439	0.249	0.453	5.300	0.481	0.210	0.201	0.221	1.350	34.000	0.586	19.600
1977	3	0.425	0.241	0.425	17.100	0.547	0.142	0.139	0.122	1.730	10.900	0.589	6.230
1977	4	0.411	0.235	0.623	5.970	0.569	0.116	0.102	0.099	0.886	5.350	0.682	2.970
1977	5	0.396	0.227	0.765	19.200	0.544	0.096	0.096	0.127	0.592	3.710	0.648	1.630
1977	6	0.396	0.221	0.750	8.780	0.501	0.110	1.530	0.597	0.442	2.920	0.597	0.991
1977	7	0.388	0.215	0.736	4.700	0.433	0.130	3.650	0.824	0.357	2.390	0.589	0.934
1977	8	0.379	0.204	0.722	3.140	0.374	0.119	2.520	2.000	0.314	5.350	0.816	0.878
1977	9	0.368	0.195	3.400	3.110	0.345	0.093	1.250	2.570	0.286	14.200	0.926	0.850
1977	10	0.368	0.201	18.400	3.990	0.317	0.079	0.595	1.180	0.258	8.300	6.060	0.821
1977	11	0.360	0.255	33.400	4.330	0.368	0.076	0.348	5.380	0.227	5.180	10.400	0.807
1977	12	0.354	0.311	71.400	3.540	0.280	0.071	0.241	2.570	0.198	6.460	5.040	0.793
1977	13	0.345	0.425	214.000	2.770	0.249	0.071	0.181	1.110	0.232	6.140	3.200	0.793
1977	14	0.340	0.411	69.100	2.240	0.227	0.062	0.139	0.694	0.362	4.220	2.380	1.700
1977	15	0.331	0.382	43.300	1.690	0.193	0.079	0.108	0.521	0.328	3.340	2.270	4.530
1977	16	0.326	0.354	34.000	1.270	0.173	0.071	0.096	36.800	0.382	6.740	7.730	4.960
1977	17	0.317	0.340	9.170	1.030	0.150	0.091	0.088	51.000	1.130	4.900	12.500	3.960
1977	18	0.311	0.326	5.690	0.954	0.212	0.091	0.122	8.690	2.000	3.510	6.630	3.110
1977	19	0.303	0.311	4.530	0.934	0.272	0.088	0.142	4.020	2.940	2.770	6.800	2.550
1977	20	0.297	0.297	3.960	0.869	0.210	0.074	0.130	2.390	4.900	2.180	6.540	2.290
1977	21	0.294	0.283	3.710	0.830	0.161	0.096	0.105	1.590	5.010	1.780	21.800	2.210
1977	22	0.292	0.275	2.920	0.980	0.133	0.074	0.082	2.080	2.970	1.570	9.090	2.120
1977	23	0.289	0.269	2.510	1.540	0.110	0.040	0.071	1.870	1.980	1.320	4.760	2.070
1977	24	0.286	0.382	1.770	1.570	0.102	0.045	0.059	3.400	4.450	1.100	7.310	2.010
1977	25	0.283	0.510	1.700	1.190	0.096	0.074	0.059	3.060	34.800	1.060	5.580	2.550
1977	26	0.280	0.481	2.140	0.966	0.088	0.062	0.054	1.590	28.200	0.937	3.110	3.400
1977	27	0.278	0.467	4.220	0.835	0.082	0.059	0.051	0.968	19.700	0.923	2.100	2.830
1977	28	0.275	0.515	20.000	0.688	0.076	0.057	0.048	0.716	12.200	0.833	1.840	2.000
1977	29	0.269		40.200	0.589	0.076	0.716	0.048	0.561	6.820	0.739	1.760	1.530
1977	30	0.263		20.200	0.521	0.076	0.668	0.048	0.504	4.560	0.699	1.700	1.250
1977	31	0.261		11.300		0.091		0.130	0.405		0.643		1.090
1978	1	1.020	0.665	0.340	14.000	1.220	0.450	0.085	0.051	0.051	0.394	0.484	0.779
1978	2	0.934	0.623	0.340	28.600	1.290	0.462	0.079	0.045	0.042	0.377	0.425	0.759
1978	3	0.850	0.595	0.340	24.600	1.150	0.428	0.074	0.048	0.054	0.345	0.399	0.739
1978	4	1.010	0.566	0.340	19.600	1.030	0.368	0.074	0.042	0.034	3.450	0.362	3.000
1978	5	1.010	0.538	0.340	30.600	1.010	0.391	0.074	0.040	0.034	2.890	0.357	4.190
1978	6	0.991	0.481	0.340	34.500	1.160	0.391	0.071	0.040	0.031	3.060	0.368	3.310
1978	7	0.963	0.453	0.340	45.600	1.110	0.348	0.065	0.042	0.031	4.810	0.379	3.090
1978	8	0.906	0.442	0.334	50.100	0.957	0.343	0.062	0.040	0.034	2.940	0.337	2.890
1978	9	1.770	0.430	0.337	37.100	1.960	0.326	0.062	0.040	0.034	1.820	0.317	3.060
1978	10	2.380	0.411	0.340	34.300	2.780	0.283	0.054	0.057	0.037	1.360	0.306	2.300
1978	11	1.980	0.391	0.345	99.100	2.080	0.232	0.051	0.102	0.042	1.090	0.306	2.000
1978	12	1.610	0.374	0.354	75.000	2.530	0.261	0.048	0.068	0.062	0.850	0.300	1.600
1978	13	1.360	0.362	0.368	62.300	10.300	1.180	0.045	0.054	0.116	0.716	0.300	1.550
1978	14	1.130	0.354	0.396	22.100	16.000	0.770	0.045	0.045	0.127	0.597	0.934	1.000

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.489	0.264	0.470	15.310	0.648	0.127	0.302	0.133	0.711	20.697	0.718	7.459
0.471	0.259	0.476	17.150	0.588	0.135	0.313	0.144	0.820	18.226	0.670	7.904
0.453	0.253	0.492	15.146	0.550	0.141	0.319	0.151	0.844	16.176	0.649	8.029
0.437	0.247	0.533	12.146	0.530	0.144	0.325	0.162	0.849	14.963	0.636	7.999
0.425	0.241	0.573	10.514	0.517	0.149	0.441	0.241	0.840	14.406	0.621	7.889
0.415	0.235	0.605	9.571	0.504	0.154	0.867	0.340	0.833	14.096	0.613	7.779
0.405	0.227	0.639	9.170	0.493	0.132	1.177	0.570	0.810	9.231	0.644	4.748
0.395	0.220	1.060	8.857	0.473	0.115	1.327	0.906	0.658	6.403	0.692	2.069
0.387	0.214	3.628	6.984	0.440	0.106	1.392	1.057	0.448	6.031	1.474	1.296
0.379	0.217	8.310	6.750	0.412	0.100	1.427	1.811	0.354	6.007	2.862	0.987
0.373	0.229	18.401	4.513	0.374	0.097	1.448	2.160	0.297	6.400	3.490	0.868
0.366	0.258	48.865	3.654	0.338	0.091	1.255	2.233	0.267	6.860	3.862	0.839
0.359	0.286	58.632	3.303	0.309	0.082	0.753	2.215	0.268	7.121	4.117	0.949
0.352	0.311	64.714	3.096	0.283	0.076	0.409	2.004	0.270	6.834	4.325	1.471
0.346	0.334	69.086	2.833	0.258	0.073	0.244	6.894	0.284	5.769	5.297	2.058
0.339	0.354	67.767	2.410	0.234	0.074	0.172	14.011	0.408	5.283	6.217	2.506
0.332	0.364	63.809	1.928	0.212	0.077	0.139	14.484	0.662	5.044	5.679	2.835
0.325	0.364	54.256	1.555	0.211	0.079	0.125	14.691	1.053	4.517	5.930	3.086
0.318	0.346	24.250	1.284	0.205	0.079	0.118	14.874	1.720	3.951	6.407	3.300
0.311	0.328	14.909	1.082	0.196	0.084	0.113	15.002	2.384	3.603	9.181	3.373
0.306	0.312	9.140	0.981	0.187	0.084	0.109	15.224	2.762	3.350	10.156	3.029
0.300	0.300	4.641	1.020	0.178	0.079	0.106	10.234	2.990	2.576	9.731	2.616
0.296	0.306	3.584	1.097	0.171	0.073	0.102	3.434	3.464	2.033	8.990	2.337
0.292	0.332	3.014	1.130	0.155	0.070	0.093	2.630	8.150	1.683	8.840	2.257
0.289	0.357	2.673	1.135	0.129	0.066	0.080	2.283	11.759	1.421	8.313	2.379
0.286	0.381	2.710	1.130	0.110	0.064	0.069	2.080	13.873	1.241	7.679	2.456
0.283	0.414	5.037	1.110	0.098	0.059	0.061	1.955	14.900	1.106	4.827	2.426
0.280		10.363	1.054	0.090	0.150	0.056	1.738	15.450	0.987	3.780	2.341
0.276		12.890	0.908	0.085	0.240	0.052	1.543	15.819	0.899	3.343	2.224
0.273		14.251		0.084		0.063	1.115		0.833		2.093
1.874	0.686	0.340	6.644	2.367	0.688	0.129	0.052	0.063	0.367	0.671	1.793
1.522	0.698	0.340	9.719	1.993	0.599	0.114	0.050	0.059	0.337	0.659	1.141
1.239	0.694	0.340	12.343	1.689	0.539	0.101	0.049	0.057	0.326	0.582	0.890
1.098	0.674	0.340	14.374	1.453	0.488	0.091	0.048	0.052	0.772	0.504	1.147
1.023	0.637	0.340	18.066	1.287	0.453	0.084	0.047	0.048	1.142	0.451	1.602
0.986	0.597	0.340	22.347	1.191	0.428	0.079	0.045	0.044	1.541	0.417	1.944
0.968	0.560	0.340	28.214	1.139	0.405	0.075	0.044	0.040	2.189	0.396	2.267
0.952	0.528	0.339	33.371	1.101	0.390	0.071	0.042	0.037	2.553	0.375	2.568
1.071	0.501	0.339	34.586	1.197	0.371	0.069	0.042	0.036	2.759	0.360	2.897
1.290	0.474	0.339	35.971	1.430	0.350	0.066	0.043	0.034	2.904	0.347	3.120
1.429	0.449	0.339	47.329	1.580	0.331	0.063	0.052	0.035	2.567	0.339	2.977
1.514	0.426	0.341	53.671	1.797	0.312	0.059	0.056	0.039	2.276	0.330	2.607
1.567	0.409	0.345	57.643	3.102	0.425	0.055	0.058	0.051	1.941	0.321	2.356
1.591	0.395	0.353	54.286	5.230	0.485	0.052	0.058	0.065	1.339	0.400	2.057

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1978	15	0.991	0.345	0.623	10.500	7.840	0.507	0.045	0.040	0.176	0.515	1.360	0.900
1978	16	0.878	0.340	1.080	8.010	4.700	0.402	0.045	0.048	0.215	0.445	0.934	0.850
1978	17	0.765	0.340	1.330	9.600	3.340	0.343	0.040	0.062	0.229	0.385	0.997	0.810
1978	18	0.665	0.340	1.250	11.400	2.620	0.467	0.037	0.059	0.637	0.362	5.240	0.770
1978	19	0.603	0.340	1.160	20.800	2.080	0.643	0.034	0.068	3.230	0.348	3.310	0.739
1978	20	0.609	0.340	1.130	19.600	3.450	0.524	0.034	0.076	1.420	0.360	2.100	0.830
1978	21	0.637	0.340	2.830	18.300	13.000	0.436	0.048	0.068	2.180	0.345	1.400	0.900
1978	22	0.580	0.340	5.660	10.500	4.280	0.377	0.074	0.065	3.310	0.323	1.050	0.889
1978	23	0.552	0.340	8.500	6.030	2.610	0.294	0.068	0.051	1.560	0.317	1.230	0.881
1978	24	0.538	0.340	9.340	4.730	1.880	0.221	0.062	0.054	0.869	0.294	5.180	0.869
1978	25	0.510	0.340	9.910	3.910	1.410	0.187	0.051	0.062	0.583	0.294	5.320	0.850
1978	26	0.538	0.340	7.080	3.280	1.080	0.161	0.057	0.071	0.422	0.510	2.500	0.821
1978	27	0.623	0.340	6.230	2.680	0.852	0.144	0.054	0.068	0.331	0.932	1.200	0.801
1978	28	0.708	0.340	5.380	2.170	0.722	0.125	0.048	0.068	0.303	0.909	1.000	0.759
1978	29	0.793		4.760	1.830	0.637	0.108	0.051	0.065	0.266	0.733	0.920	0.731
1978	30	0.765		4.530	1.480	0.569	0.093	0.051	0.059	0.269	0.606	0.830	0.699
1978	31	0.708		4.530		0.504		0.051	0.059		0.521		0.759
1979	1	3.200	0.300	0.480	11.200	3.000	0.798	0.203	0.056	0.028	0.027	0.530	3.010
1979	2	7.000	0.290	0.480	16.200	2.450	0.601	0.206	0.080	0.027	0.033	1.890	2.090
1979	3	6.000	0.280	0.500	15.700	3.020	0.468	0.205	0.103	0.027	0.042	1.370	1.520
1979	4	4.800	0.270	5.200	6.320	5.490	0.390	0.162	0.087	0.038	0.067	0.795	1.650
1979	5	3.870	0.260	28.000	3.400	3.310	0.353	0.133	0.060	0.040	0.091	0.616	2.020
1979	6	3.200	0.250	25.000	1.600	3.420	0.320	0.103	0.045	0.034	0.085	0.501	5.420
1979	7	2.200	0.240	21.000	1.100	4.980	0.282	0.092	0.032	0.030	0.127	0.518	5.470
1979	8	1.600	0.240	24.000	1.000	2.940	0.284	0.079	0.037	0.027	0.144	0.615	4.710
1979	9	1.160	0.240	20.000	1.000	1.920	0.371	0.070	0.032	0.024	0.214	0.653	3.910
1979	10	0.800	0.230	16.000	2.000	1.700	0.328	0.068	0.037	0.028	0.196	0.890	3.020
1979	11	0.580	0.230	13.000	3.000	2.580	0.383	0.070	0.039	0.030	0.163	1.460	4.860
1979	12	0.540	0.230	10.500	4.160	1.550	0.356	0.076	0.038	0.034	0.168	1.050	29.900
1979	13	0.560	0.220	9.000	22.400	3.890	0.294	0.070	0.039	0.035	0.238	0.792	9.110
1979	14	0.580	0.220	25.000	153.000	2.660	0.230	0.062	0.037	0.090	0.242	0.715	4.170
1979	15	0.530	0.220	21.000	42.200	3.290	0.184	0.049	0.034	0.163	0.227	0.672	3.020
1979	16	0.500	0.220	15.000	17.800	4.950	0.151	0.042	0.031	0.125	0.169	0.587	1.750
1979	17	0.470	0.220	11.200	11.800	2.730	0.123	0.038	0.030	0.076	0.160	0.566	1.100
1979	18	0.460	0.220	20.000	7.740	1.690	0.103	0.033	0.033	0.053	0.152	0.606	1.520
1979	19	0.450	0.220	36.300	5.210	1.200	0.093	0.029	0.035	0.042	0.206	0.788	1.240
1979	20	0.440	0.210	41.000	3.920	0.968	0.080	0.026	0.032	0.036	0.285	0.955	1.080
1979	21	0.430	0.220	48.000	3.160	0.896	0.069	0.024	0.030	0.033	0.462	0.922	0.992
1979	22	0.420	0.230	48.100	3.000	0.814	0.102	0.022	0.028	0.031	0.430	1.780	1.210
1979	23	0.420	0.244	49.700	2.600	0.682	0.241	0.020	0.027	0.031	0.344	13.300	9.710
1979	24	0.450	0.300	55.700	1.980	0.604	0.171	0.020	0.028	0.030	0.309	32.100	42.100
1979	25	0.460	0.400	40.900	1.720	0.583	0.130	0.024	0.041	0.027	0.279	11.500	70.300
1979	26	0.450	0.510	11.100	1.670	0.859	0.106	0.034	0.048	0.026	0.240	19.900	13.000
1979	27	0.440	0.520	5.870	3.320	0.923	0.088	0.036	0.040	0.026	0.206	10.500	5.860

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.603	0.381	0.395	48.629	6.213	0.508	0.050	0.058	0.085	0.993	0.546	1.773
1.476	0.368	0.501	44.473	6.604	0.519	0.048	0.059	0.111	0.796	0.634	1.457
1.245	0.358	0.642	40.944	6.684	0.528	0.046	0.060	0.138	0.657	0.733	1.244
1.057	0.351	0.772	28.416	6.761	0.561	0.044	0.054	0.223	0.553	1.438	1.069
0.913	0.346	0.887	20.673	6.697	0.616	0.042	0.054	0.676	0.481	1.868	0.946
0.806	0.343	0.996	14.573	5.719	0.522	0.040	0.057	0.862	0.430	2.125	0.843
0.735	0.341	1.343	14.030	5.290	0.475	0.040	0.060	1.155	0.394	2.192	0.828
0.677	0.340	2.063	14.030	4.781	0.456	0.045	0.064	1.603	0.367	2.147	0.827
0.630	0.340	3.123	13.747	4.483	0.441	0.048	0.064	1.795	0.349	2.190	0.831
0.598	0.340	4.267	13.051	4.274	0.423	0.051	0.063	1.887	0.336	2.787	0.840
0.576	0.340	5.504	11.981	4.101	0.383	0.053	0.063	1.879	0.326	2.799	0.851
0.566	0.340	6.350	9.479	3.959	0.314	0.056	0.064	1.478	0.349	2.683	0.863
0.568	0.340	7.079	7.061	3.587	0.260	0.059	0.063	1.322	0.431	2.554	0.859
0.578	0.340	7.443	4.757	1.833	0.216	0.059	0.063	1.054	0.511	2.497	0.839
0.609		7.314	3.519	1.313	0.177	0.056	0.063	0.619	0.570	2.479	0.816
0.639		6.747	2.869	1.021	0.148	0.053	0.064	0.435	0.611	2.421	0.790
0.664		6.060		0.825		0.052	0.065		0.644		0.774
1.110	0.370	0.422	16.156	2.476	0.971	0.123	0.042	0.037	0.026	0.408	8.753
1.993	0.347	0.456	16.884	2.580	0.934	0.134	0.049	0.034	0.027	0.644	7.409
2.735	0.324	0.484	18.289	2.773	0.869	0.148	0.058	0.033	0.029	0.810	4.783
3.313	0.309	1.170	18.531	3.083	0.813	0.158	0.064	0.032	0.035	0.872	3.519
3.761	0.294	5.097	17.517	3.123	0.741	0.163	0.066	0.033	0.045	0.893	2.884
4.118	0.281	8.594	12.289	3.263	0.580	0.163	0.067	0.032	0.053	0.886	2.846
4.324	0.270	11.523	7.931	3.667	0.459	0.158	0.066	0.032	0.067	0.889	3.026
4.096	0.261	14.883	6.474	3.659	0.385	0.140	0.063	0.032	0.084	0.901	3.269
3.261	0.254	17.671	4.303	3.583	0.353	0.121	0.057	0.031	0.110	0.724	3.529
2.519	0.247	19.886	2.346	3.394	0.333	0.101	0.047	0.032	0.132	0.655	3.743
1.916	0.241	21.000	1.871	2.979	0.332	0.088	0.040	0.030	0.146	0.750	4.201
1.440	0.237	18.500	1.980	2.727	0.332	0.080	0.037	0.030	0.157	0.812	8.184
1.063	0.233	16.214	4.951	2.794	0.328	0.075	0.036	0.030	0.179	0.854	8.711
0.831	0.230	16.786	26.651	2.463	0.321	0.071	0.037	0.038	0.195	0.882	8.526
0.679	0.227	16.357	32.537	2.513	0.307	0.066	0.037	0.058	0.207	0.890	8.284
0.584	0.224	15.643	34.937	2.946	0.275	0.062	0.036	0.072	0.200	0.881	7.976
0.537	0.223	14.957	36.337	3.093	0.246	0.058	0.035	0.079	0.195	0.835	7.701
0.520	0.221	15.957	37.014	2.966	0.206	0.053	0.035	0.082	0.194	0.713	7.224
0.507	0.220	19.643	37.164	2.916	0.168	0.046	0.034	0.083	0.199	0.675	3.130
0.490	0.219	24.214	34.524	2.498	0.138	0.040	0.033	0.084	0.206	0.698	1.983
0.469	0.219	27.500	13.119	2.246	0.115	0.034	0.032	0.075	0.237	0.728	1.529
0.453	0.220	31.371	7.519	1.893	0.103	0.031	0.031	0.057	0.266	0.886	1.270
0.441	0.223	36.329	5.347	1.283	0.116	0.027	0.031	0.043	0.291	2.702	2.407
0.439	0.235	42.686	3.944	0.979	0.123	0.025	0.030	0.037	0.313	7.207	8.265
0.439	0.261	45.671	3.084	0.821	0.127	0.024	0.032	0.033	0.331	8.764	18.090
0.439	0.302	42.071	2.579	0.772	0.128	0.024	0.033	0.031	0.336	11.494	19.770
0.439	0.346	37.053	2.493	0.766	0.130	0.026	0.035	0.029	0.324	12.857	20.453

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1979	28	0.380	0.500	4.620	3.030	0.780	0.099	0.049	0.039	0.026	0.365	6.460	3.780
1979	29	0.360		10.500	2.440	0.857	0.102	0.043	0.039	0.026	0.469	5.690	2.960
1979	30	0.340		38.200	2.150	1.450	0.131	0.036	0.036	0.026	0.549	4.210	2.710
1979	31	0.320		31.600		1.130		0.040	0.032		0.499		2.440
1980	1	2.010	0.480	0.210	9.640	2.680	0.366	0.749	0.193	0.143	0.190	1.140	0.743
1980	2	1.690	0.460	0.185	11.700	2.350	1.050	0.443	0.138	0.212	0.658	1.010	6.030
1980	3	1.250	0.440	0.175	8.860	3.560	1.140	0.287	0.121	0.224	1.540	0.882	11.000
1980	4	1.050	0.420	0.165	25.300	2.310	1.010	0.215	0.093	0.208	1.240	0.958	5.800
1980	5	0.840	0.395	0.170	13.600	1.560	0.673	0.174	0.076	0.157	1.300	2.080	3.250
1980	6	0.620	0.380	0.173	8.390	1.130	0.608	0.121	0.223	0.121	1.130	2.010	2.480
1980	7	0.500	0.345	0.176	6.740	0.970	1.000	0.101	0.438	0.102	0.863	2.450	2.400
1980	8	0.510	0.320	0.180	10.200	0.886	1.070	0.083	0.300	0.083	0.709	4.300	17.900
1980	9	0.513	0.290	0.190	15.900	0.774	0.866	0.094	0.257	0.076	0.566	4.370	20.200
1980	10	0.490	0.270	0.193	15.800	0.679	0.697	0.101	0.187	0.069	0.424	5.250	7.250
1980	11	17.200	0.260	0.195	11.100	0.643	0.537	0.079	0.151	0.061	0.390	3.170	3.800
1980	12	6.840	0.255	0.198	9.760	0.598	0.407	0.061	0.162	0.056	0.407	2.040	3.100
1980	13	5.000	0.245	0.199	7.780	0.630	0.332	0.047	0.168	0.060	0.542	1.680	2.300
1980	14	3.500	0.240	0.200	12.900	1.150	0.298	0.042	0.145	0.081	0.557	2.990	1.750
1980	15	2.200	0.240	0.202	27.500	1.170	0.300	0.047	0.118	0.087	0.481	3.650	1.620
1980	16	1.800	0.240	0.205	8.900	0.924	0.308	0.060	0.099	0.084	0.436	2.360	1.480
1980	17	1.620	0.240	0.570	4.910	0.770	0.262	0.080	0.089	0.095	0.536	1.590	1.360
1980	18	2.500	0.240	6.500	4.090	1.780	0.227	0.096	0.094	0.112	2.700	1.250	1.200
1980	19	1.850	0.239	9.400	3.260	3.030	0.195	0.118	0.080	0.100	3.150	1.010	1.060
1980	20	1.350	0.238	42.000	2.760	2.110	0.235	0.073	0.076	0.101	2.950	0.917	0.998
1980	21	1.050	0.224	112.000	2.350	1.490	0.254	0.066	0.065	0.094	3.720	0.909	0.920
1980	22	0.820	0.232	18.100	1.790	1.180	0.235	0.065	0.050	0.113	4.210	0.948	0.870
1980	23	0.750	0.252	13.700	1.510	0.897	0.196	0.107	0.045	0.394	2.610	0.951	0.830
1980	24	0.690	0.253	7.480	1.190	0.780	0.142	0.087	0.046	0.584	1.740	1.010	0.800
1980	25	0.640	0.254	5.730	1.110	0.710	0.125	0.059	0.048	0.419	1.820	1.120	0.770
1980	26	0.620	0.252	7.160	1.290	0.574	0.109	0.049	0.043	0.399	6.310	0.913	0.750
1980	27	0.590	0.250	18.000	1.190	0.510	0.106	0.058	0.038	0.379	5.010	0.798	0.730
1980	28	0.560	0.240	21.800	1.480	0.423	0.104	0.129	0.046	0.346	3.280	0.836	0.700
1980	29	0.540	0.232	18.500	3.300	0.401	0.256	0.310	0.042	0.266	2.310	0.805	0.670
1980	30	0.510		16.200	3.440	0.363	1.040	0.475	0.044	0.216	1.680	0.730	0.635
1980	31	0.490		13.200		0.367		0.282	0.071		1.400		0.620
1981	1	0.570	0.420	8.240	8.600	0.920	0.295	0.144	0.067	3.110	1.820	2.710	3.330
1981	2	0.550	0.410	3.500	5.280	0.755	0.235	0.121	0.043	5.190	3.600	2.300	11.600
1981	3	0.535	0.390	2.800	3.590	0.639	0.306	0.118	0.053	2.750	2.980	1.900	9.110
1981	4	0.515	0.380	2.400	3.170	0.569	1.330	0.133	0.086	24.200	2.130	1.670	5.020
1981	5	0.500	0.375	2.100	3.020	0.546	1.060	2.690	0.088	12.500	1.720	1.500	3.430
1981	6	0.485	0.370	1.820	2.280	0.622	0.648	1.530	0.074	5.040	22.400	1.470	2.600
1981	7	0.470	0.367	1.740	1.730	0.609	0.405	0.793	0.056	3.020	21.700	1.430	2.190
1981	8	0.455	0.365	1.670	1.460	0.550	0.365	0.429	0.046	2.070	10.500	1.280	1.600
1981	9	0.445	0.360	1.720	1.330	0.524	0.280	0.268	0.033	1.570	5.350	1.150	1.350

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.431	0.386	30.856	2.474	0.749	0.134	0.029	0.036	0.028	0.310	13.649	20.851
0.423		25.484	2.394	0.755	0.134	0.032	0.037	0.027	0.316	14.207	21.101
0.411		23.841	2.330	0.865	0.118	0.035	0.039	0.027	0.345	12.909	20.101
0.393		20.399		0.940		0.037	0.039		0.372		14.436
4.680	0.541	0.242	14.929	2.070	0.429	0.356	0.214	0.061	0.316	3.019	0.849
3.064	0.519	0.232	15.577	2.247	0.497	0.401	0.226	0.085	0.351	2.261	1.551
2.406	0.497	0.221	14.271	2.571	0.587	0.426	0.235	0.112	0.514	1.672	2.992
2.016	0.477	0.208	14.771	2.731	0.671	0.442	0.230	0.135	0.637	1.340	3.706
1.713	0.456	0.197	14.071	2.743	0.710	0.452	0.197	0.151	0.773	1.307	4.051
1.414	0.438	0.187	12.956	2.433	0.745	0.433	0.161	0.162	0.896	1.354	4.290
1.137	0.417	0.179	12.033	2.080	0.835	0.299	0.183	0.167	0.989	1.504	4.529
0.923	0.394	0.175	12.113	1.824	0.936	0.203	0.198	0.158	1.063	1.956	6.980
0.755	0.370	0.176	12.713	1.599	0.910	0.154	0.215	0.139	1.050	2.436	9.004
0.646	0.346	0.178	13.704	1.187	0.846	0.127	0.225	0.117	0.890	3.060	8.469
2.953	0.323	0.182	11.676	0.949	0.779	0.108	0.233	0.096	0.769	3.376	8.183
3.810	0.303	0.186	11.127	0.811	0.741	0.091	0.245	0.081	0.641	3.370	8.161
4.436	0.284	0.190	11.040	0.740	0.701	0.081	0.238	0.072	0.557	3.323	8.136
4.865	0.269	0.194	11.920	0.766	0.601	0.072	0.196	0.069	0.514	3.400	8.043
5.106	0.257	0.197	14.391	0.806	0.491	0.067	0.170	0.070	0.481	3.307	5.717
5.290	0.250	0.199	13.391	0.828	0.411	0.062	0.147	0.071	0.462	3.020	3.043
5.451	0.246	0.253	11.836	0.841	0.349	0.059	0.133	0.075	0.478	2.497	2.201
3.351	0.243	1.153	10.834	1.003	0.305	0.062	0.125	0.082	0.808	2.223	1.830
2.639	0.241	2.468	9.906	1.351	0.275	0.070	0.113	0.088	1.200	2.076	1.539
2.117	0.240	8.440	9.189	1.562	0.261	0.074	0.100	0.094	1.544	1.967	1.353
1.767	0.237	24.411	7.681	1.611	0.254	0.077	0.089	0.096	1.996	1.669	1.234
1.570	0.236	26.968	4.009	1.612	0.245	0.080	0.079	0.100	2.529	1.283	1.127
1.420	0.238	28.896	2.953	1.608	0.229	0.086	0.071	0.144	2.839	1.082	1.034
1.287	0.240	29.883	2.421	1.610	0.212	0.087	0.065	0.214	3.011	0.999	0.954
1.021	0.242	29.773	1.996	1.457	0.197	0.082	0.059	0.258	2.886	0.981	0.893
0.846	0.244	29.453	1.714	1.106	0.185	0.072	0.053	0.301	3.337	0.967	0.848
0.737	0.245	26.024	1.490	0.877	0.167	0.070	0.048	0.340	3.631	0.950	0.810
0.667	0.248	13.139	1.366	0.725	0.145	0.079	0.045	0.376	3.569	0.939	0.779
0.627	0.248	13.196	1.581	0.614	0.148	0.114	0.044	0.398	3.297	0.919	0.750
0.593		13.553	1.857	0.537	0.269	0.167	0.044	0.373	3.164	0.887	0.722
0.564		14.370		0.478		0.195	0.047		3.116		0.696
0.668	0.369	25.337	9.056	1.097	0.501	0.368	0.117	1.914	2.599	4.863	9.667
0.639	0.375	11.837	9.367	1.002	0.440	0.248	0.118	2.637	3.009	4.277	10.996
0.611	0.376	7.094	9.299	0.926	0.404	0.185	0.121	3.009	3.326	3.764	12.014
0.585	0.377	5.680	9.051	0.868	0.515	0.153	0.121	6.424	2.766	2.940	7.289
0.561	0.380	4.867	8.723	0.814	0.587	0.505	0.097	8.050	2.374	2.414	6.007
0.539	0.384	4.281	6.549	0.743	0.609	0.699	0.077	8.029	5.203	2.086	5.576
0.518	0.387	3.229	3.953	0.666	0.611	0.790	0.067	7.973	8.050	1.854	5.326
0.501	0.380	2.290	2.933	0.613	0.621	0.831	0.064	7.824	9.290	1.650	5.079
0.486	0.372	2.036	2.369	0.580	0.628	0.852	0.062	7.307	9.540	1.486	3.614

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	10	0.435	0.430	1.860	1.130	0.779	0.289	0.189	0.026	1.230	3.610	0.984	1.120
1981	11	0.425	0.650	1.810	1.030	8.680	0.404	0.148	0.032	0.987	2.790	0.992	1.000
1981	12	0.415	0.900	1.660	0.955	7.570	0.377	0.129	0.085	0.816	2.230	1.180	0.850
1981	13	0.410	1.240	1.340	0.835	4.260	0.281	0.109	0.127	0.679	1.780	1.100	0.770
1981	14	0.400	1.120	1.150	4.680	2.890	0.236	0.088	0.108	0.587	1.530	0.995	0.740
1981	15	0.391	1.090	1.230	4.890	2.930	0.237	0.076	0.165	0.523	1.890	0.921	0.690
1981	16	0.385	1.350	0.960	2.980	3.760	0.248	0.070	0.318	0.493	2.630	0.952	0.640
1981	17	0.380	2.100	0.820	2.500	2.760	0.250	0.056	0.341	0.510	2.110	1.510	0.610
1981	18	0.375	11.900	0.740	2.520	1.880	0.196	0.050	0.259	0.575	9.380	1.840	0.570
1981	19	0.370	46.000	0.640	1.930	1.420	0.164	0.050	0.194	0.587	11.300	1.660	0.540
1981	20	0.365	62.000	0.590	1.800	1.080	0.148	0.050	0.161	0.551	6.740	8.110	0.510
1981	21	0.363	56.000	0.611	1.480	0.875	0.146	0.051	0.129	0.570	4.810	9.870	0.490
1981	22	0.360	50.000	0.742	1.280	0.783	0.912	0.050	0.134	0.901	6.810	5.200	0.500
1981	23	0.358	98.000	1.280	1.150	0.785	3.580	0.043	0.132	0.989	12.600	3.670	0.520
1981	24	0.353	36.000	1.840	1.430	0.667	1.810	0.033	0.108	0.822	12.700	2.920	0.490
1981	25	0.350	12.300	2.480	1.420	0.658	0.960	0.033	0.114	0.726	7.190	2.300	0.465
1981	26	0.370	7.790	3.100	1.170	0.665	0.560	0.034	0.128	0.766	6.400	1.980	0.460
1981	27	0.385	5.920	4.070	0.976	0.559	0.352	0.032	0.145	6.050	5.490	38.100	0.458
1981	28	0.370	9.110	4.900	0.925	0.552	0.228	0.089	0.292	4.460	7.440	12.400	0.457
1981	29	0.355		5.320	1.120	0.557	0.173	0.256	1.120	2.600	5.180	5.620	0.454
1981	30	0.345		17.500	1.150	0.493	0.156	0.213	5.190	1.770	3.770	3.940	0.450
1981	31	0.340		19.900		0.388		0.127	3.410		3.050		0.440
1982	1	0.450	0.307	0.256	83.400	1.520	0.865	0.425	0.151	0.282	1.070	2.120	12.600
1982	2	0.445	0.296	0.255	31.500	1.340	1.020	0.329	0.158	0.267	0.818	17.600	7.790
1982	3	0.440	0.289	0.254	43.200	1.160	0.720	0.256	0.140	0.294	0.687	17.600	7.960
1982	4	0.440	0.284	0.252	13.000	1.030	0.505	0.228	0.195	0.296	0.589	11.200	20.700
1982	5	0.810	0.278	0.251	8.800	0.920	0.489	0.197	0.214	0.254	0.534	10.400	14.600
1982	6	1.580	0.275	0.250	8.300	0.935	1.040	0.162	0.209	0.236	0.498	6.870	36.700
1982	7	1.650	0.271	0.250	7.500	0.824	1.140	0.143	0.167	0.233	0.499	5.790	11.600
1982	8	1.530	0.269	0.250	7.200	0.754	0.871	0.116	0.153	0.230	0.711	7.510	6.100
1982	9	1.210	0.266	0.250	8.200	0.648	0.679	0.095	0.154	0.194	0.747	5.330	4.130
1982	10	1.040	0.262	0.260	12.000	0.555	0.506	0.104	0.140	0.159	0.660	4.000	3.030
1982	11	0.870	0.260	0.280	8.770	0.486	0.395	0.123	0.123	0.150	0.627	3.610	2.750
1982	12	0.770	0.259	0.305	10.400	0.412	0.306	0.145	0.111	0.147	0.598	17.500	1.950
1982	13	0.680	0.257	0.333	24.100	0.385	0.245	0.139	0.112	0.126	0.581	17.500	1.480
1982	14	0.620	0.255	1.800	19.900	0.352	0.229	0.126	0.124	0.125	0.543	7.800	1.270
1982	15	0.700	0.267	3.210	21.200	0.293	0.248	0.112	0.094	0.137	0.948	5.140	1.340
1982	16	0.595	0.280	2.900	24.400	0.263	0.600	0.092	0.076	0.165	1.790	4.090	9.520
1982	17	0.515	0.274	3.100	51.600	0.279	0.715	0.108	0.059	0.182	1.570	3.790	7.620
1982	18	0.460	0.269	3.500	20.200	0.264	0.571	0.411	0.065	0.316	1.130	3.810	5.370
1982	19	0.410	0.261	3.950	8.390	0.277	2.930	1.500	0.059	0.448	0.947	4.860	4.290
1982	20	0.388	0.258	4.420	14.600	0.565	6.040	0.797	0.053	0.380	0.830	6.800	3.280
1982	21	0.372	0.255	5.190	13.900	0.481	13.600	0.390	0.184	0.338	0.935	38.100	2.610
1982	22	0.350	0.274	5.900	5.780	0.354	7.440	0.256	0.218	0.304	0.916	19.600	2.100

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.472	0.378	1.901	2.017	0.600	0.625	0.862	0.058	7.090	9.630	1.355	2.473
0.459	0.417	1.817	1.711	1.759	0.493	0.864	0.051	3.774	9.724	1.258	1.899
0.447	0.492	1.754	1.416	2.762	0.395	0.498	0.050	2.105	9.797	1.212	1.530
0.436	0.616	1.686	1.210	3.282	0.343	0.295	0.058	1.482	6.851	1.159	1.269
0.426	0.724	1.601	1.631	3.608	0.319	0.194	0.065	1.134	3.970	1.097	1.061
0.417	0.827	1.539	2.121	3.948	0.301	0.144	0.082	0.913	2.740	1.046	0.931
0.409	0.969	1.430	2.357	4.410	0.296	0.116	0.123	0.759	2.351	1.018	0.830
0.401	1.207	1.281	2.553	4.693	0.290	0.097	0.168	0.656	2.137	1.093	0.757
0.394	2.814	1.129	2.766	3.721	0.261	0.083	0.200	0.598	3.079	1.214	0.696
0.387	9.257	0.983	2.905	2.843	0.230	0.071	0.216	0.565	4.374	1.283	0.651
0.381	17.937	0.876	3.043	2.389	0.211	0.063	0.221	0.547	5.083	2.284	0.614
0.376	25.777	0.799	2.586	2.101	0.198	0.058	0.224	0.544	5.551	3.552	0.579
0.371	32.764	0.729	2.070	1.794	0.295	0.054	0.219	0.598	6.254	4.163	0.551
0.367	46.571	0.775	1.809	1.369	0.771	0.050	0.193	0.669	7.679	4.551	0.534
0.363	51.414	0.920	1.656	1.070	0.994	0.047	0.160	0.714	9.191	4.753	0.517
0.360	51.471	1.169	1.499	0.895	1.103	0.044	0.139	0.735	8.879	4.819	0.502
0.360	46.013	1.520	1.390	0.788	1.159	0.042	0.129	0.761	8.179	4.864	0.491
0.363	38.001	2.018	1.272	0.713	1.189	0.039	0.127	1.546	8.000	9.149	0.483
0.364	31.303	2.630	1.193	0.667	1.200	0.045	0.150	2.102	8.376	9.510	0.479
0.363		3.284	1.170	0.635	1.095	0.074	0.291	2.345	8.143	9.570	0.472
0.361		5.601	1.170	0.593	0.606	0.099	1.014	2.456	6.881	9.609	0.462
0.359		8.181		0.553		0.112	1.486		5.503		0.455
0.453	0.325	0.262	35.243	2.584	0.928	1.110	0.189	0.503	2.410	0.894	12.179
0.451	0.322	0.260	38.114	2.340	1.026	0.935	0.197	0.390	2.427	3.294	12.039
0.448	0.318	0.258	42.814	2.113	1.085	0.730	0.203	0.336	2.329	5.701	12.387
0.446	0.308	0.257	43.300	1.724	0.990	0.537	0.195	0.311	2.126	7.201	14.749
0.496	0.300	0.255	43.243	1.437	0.804	0.405	0.180	0.294	1.243	8.581	16.336
0.658	0.292	0.254	42.600	1.245	0.789	0.313	0.178	0.277	0.837	9.478	18.121
0.831	0.286	0.253	27.957	1.104	0.826	0.249	0.176	0.266	0.671	10.226	15.993
0.985	0.280	0.252	17.071	0.995	0.826	0.204	0.177	0.259	0.619	10.996	15.064
1.094	0.276	0.251	13.743	0.896	0.778	0.171	0.176	0.248	0.609	9.243	14.541
1.180	0.272	0.252	9.286	0.809	0.747	0.149	0.176	0.229	0.605	7.300	13.837
1.241	0.269	0.256	8.681	0.732	0.731	0.134	0.166	0.208	0.611	6.216	11.273
1.236	0.266	0.264	8.910	0.659	0.705	0.127	0.151	0.193	0.620	7.230	9.466
1.107	0.263	0.275	11.167	0.581	0.592	0.124	0.137	0.177	0.632	8.749	4.434
0.960	0.261	0.497	12.939	0.513	0.462	0.121	0.131	0.162	0.638	9.036	2.959
0.841	0.261	0.920	14.939	0.447	0.373	0.121	0.123	0.148	0.672	8.697	2.279
0.754	0.263	1.298	17.253	0.392	0.361	0.120	0.111	0.144	0.821	8.520	3.049
0.679	0.265	1.704	22.910	0.353	0.391	0.121	0.100	0.147	0.951	8.490	3.704
0.620	0.266	2.164	24.543	0.321	0.416	0.162	0.092	0.171	1.023	8.519	4.079
0.569	0.266	2.685	24.256	0.302	0.791	0.355	0.084	0.214	1.073	6.713	4.413
0.527	0.266	3.269	22.899	0.328	1.619	0.449	0.076	0.250	1.108	5.184	4.670
0.491	0.266	3.753	22.041	0.346	3.529	0.487	0.084	0.281	1.164	9.513	4.861
0.441	0.267	4.137	19.839	0.355	4.557	0.508	0.102	0.305	1.160	11.579	4.970

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1982	23	0.361	0.270	7.440	4.390	0.322	3.900	0.192	0.197	0.371	0.794	10.100	2.230
1982	24	0.380	0.266	10.500	3.680	0.324	2.360	0.140	0.193	0.497	0.700	20.900	25.100
1982	25	0.344	0.263	13.000	3.050	0.332	1.560	0.120	0.553	0.703	0.795	8.770	60.100
1982	26	0.322	0.261	11.400	2.750	0.332	1.690	0.099	1.060	1.370	0.802	5.520	28.700
1982	27	0.315	0.260	10.300	3.750	0.305	1.580	0.101	0.674	2.010	0.753	4.170	9.680
1982	28	0.350	0.259	9.600	2.930	1.170	1.120	0.250	0.465	6.720	0.697	3.490	12.300
1982	29	0.340		9.200	2.280	1.790	0.807	0.319	0.379	3.340	0.742	24.200	9.390
1982	30	0.326		12.800	1.810	1.150	0.591	0.223	0.349	1.660	0.589	26.500	4.570
1982	31	0.317		110.000		0.881		0.179	0.313		0.557		3.730
1983	1	2.280	0.550	3.730	4.430	12.200	4.540	0.000	0.225	0.554	0.528	0.889	3.310
1983	2	1.700	1.220	4.790	5.020	24.000	3.010	0.000	0.250	0.457	0.511	0.891	2.980
1983	3	1.170	11.800	4.640	4.520	16.300	1.900	0.001	0.243	0.353	0.495	1.590	2.500
1983	4	0.948	7.840	7.520	9.260	10.100	1.440	0.054	0.260	0.291	0.628	1.990	2.400
1983	5	0.858	4.860	4.640	6.430	8.870	1.220	0.460	0.283	0.253	1.410	1.450	2.250
1983	6	0.778	3.260	3.260	4.970	5.110	1.300	0.297	0.283	0.233	1.370	1.270	2.100
1983	7	0.758	2.010	13.700	6.190	3.690	1.520	0.108	0.225	0.203	1.040	1.180	1.250
1983	8	0.701	1.300	17.900	6.540	9.690	1.090	0.044	0.206	0.207	1.040	1.250	1.840
1983	9	0.639	1.010	15.800	4.190	6.250	0.791	0.019	0.437	0.196	1.980	1.140	2.370
1983	10	1.290	0.781	10.400	28.200	3.610	0.708	0.017	0.350	0.267	1.310	1.050	2.480
1983	11	14.600	0.622	5.910	11.000	2.220	0.667	0.026	0.399	0.245	0.985	3.150	2.160
1983	12	4.590	0.576	3.580	5.760	1.530	0.516	0.041	0.473	0.179	1.010	5.610	5.680
1983	13	4.500	0.566	2.690	3.930	1.150	0.426	0.055	0.368	1.260	3.010	2.820	19.400
1983	14	2.920	0.575	2.300	11.500	1.010	0.364	0.065	0.305	1.290	7.530	1.800	14.400
1983	15	1.730	0.594	2.410	24.300	3.400	0.328	0.058	0.264	1.280	4.190	1.710	10.900
1983	16	1.300	0.600	2.050	7.840	2.810	0.295	0.050	0.223	1.500	2.430	2.110	8.300
1983	17	1.000	0.733	1.860	4.860	1.580	0.227	0.041	0.208	1.810	1.590	2.560	5.750
1983	18	0.800	0.942	1.860	3.460	1.140	0.189	0.057	0.192	1.640	1.190	1.870	3.700
1983	19	0.660	1.230	7.150	2.660	3.600	0.150	0.063	0.142	1.690	1.010	1.840	3.100
1983	20	0.625	3.310	13.300	1.960	35.300	0.133	0.091	0.137	1.370	0.878	7.580	2.500
1983	21	0.600	12.600	4.280	1.560	11.300	0.102	0.091	0.117	3.550	0.800	16.800	1.890
1983	22	0.580	11.000	3.080	1.240	6.560	0.063	0.076	0.401	2.570	0.761	7.850	1.700
1983	23	0.560	7.340	2.430	1.080	14.500	0.074	0.103	0.686	1.280	2.420	4.760	1.460
1983	24	0.621	8.380	1.830	0.983	7.920	0.024	0.136	0.534	1.150	5.700	5.310	1.300
1983	25	0.600	4.000	1.550	0.779	4.740	0.003	0.128	0.417	0.938	3.340	4.490	1.180
1983	26	0.560	2.640	1.400	0.683	5.140	0.000	0.094	0.325	0.813	2.450	3.000	1.050
1983	27	0.530	1.630	1.600	0.634	3.710	0.001	0.034	0.244	0.725	1.990	2.300	0.960
1983	28	0.500	1.690	2.890	0.743	2.490	0.061	0.018	0.194	0.661	1.520	2.070	0.870
1983	29	0.460		5.940	2.010	2.570	0.044	0.010	0.173	0.614	1.240	7.280	0.800
1983	30	0.480		3.850	5.590	5.380	0.016	0.007	0.216	0.563	1.060	4.920	0.750
1983	31	0.510		3.280		3.840		0.049	0.257		0.952		0.710
1984	1	0.600	0.185	1.370	13.500	0.739	2.820	0.279	0.060	0.169	0.199	0.386	1.790
1984	2	0.535	0.180	1.280	12.700	0.645	1.850	0.236	0.050	0.208	0.196	0.597	1.750
1984	3	0.538	0.215	1.180	10.600	0.584	2.480	0.192	0.044	0.321	0.167	0.665	1.680
1984	4	0.570	0.270	1.100	9.330	0.571	2.050	0.169	0.035	0.289	0.154	1.450	1.280

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.408	0.266	4.786	16.980	0.363	5.028	0.522	0.119	0.334	1.017	12.437	3.929
0.389	0.265	5.843	10.134	0.370	5.263	0.527	0.138	0.379	0.893	14.881	6.426
0.372	0.264	7.200	7.684	0.379	5.404	0.485	0.208	0.434	0.845	15.590	14.244
0.360	0.264	8.264	6.879	0.387	5.227	0.285	0.351	0.566	0.825	15.684	17.731
0.349	0.264	9.104	5.329	0.350	4.590	0.185	0.440	0.799	0.814	15.309	18.646
0.346	0.265	9.734	3.761	0.448	2.807	0.165	0.480	1.711	0.780	10.364	20.030
0.345		10.206	3.261	0.654	1.860	0.174	0.503	2.144	0.755	11.021	21.071
0.340		10.971	2.893	0.772	1.387	0.179	0.525	2.329	0.725	13.364	21.406
0.331		25.186		0.851		0.184	0.542		0.705		18.353
10.093	0.513	4.201	3.341	3.234	3.953	0.018	0.062	0.280	0.692	1.443	3.910
6.236	0.607	3.837	3.859	6.551	3.649	0.017	0.085	0.299	0.631	1.220	3.694
5.020	2.217	3.303	4.276	8.782	3.390	0.018	0.115	0.315	0.585	1.163	3.623
3.398	3.266	3.806	5.186	10.135	3.240	0.025	0.149	0.329	0.571	1.230	3.637
2.179	3.894	4.091	5.256	11.296	3.047	0.082	0.188	0.340	0.678	1.260	3.663
1.638	4.291	4.324	5.416	11.739	2.464	0.118	0.228	0.343	0.786	1.290	2.923
1.213	4.506	6.040	5.831	11.467	2.133	0.131	0.253	0.335	0.855	1.323	2.399
0.988	4.613	8.064	6.133	11.109	1.640	0.138	0.250	0.285	0.928	1.374	2.189
0.836	4.583	9.637	6.014	8.573	1.323	0.140	0.277	0.248	1.138	1.410	2.101
0.853	3.009	10.460	9.397	6.760	1.153	0.143	0.292	0.236	1.254	1.333	2.099
2.803	1.978	10.230	9.646	5.634	1.042	0.139	0.312	0.229	1.305	1.499	2.064
3.337	1.366	10.079	9.550	4.586	0.942	0.079	0.339	0.219	1.248	2.093	2.554
3.868	0.981	9.997	9.401	4.020	0.817	0.044	0.351	0.365	1.482	2.314	5.026
4.177	0.776	8.369	10.160	3.637	0.652	0.038	0.363	0.521	2.409	2.403	6.904
4.324	0.675	6.156	12.697	2.739	0.543	0.040	0.371	0.674	2.859	2.469	8.199
4.419	0.616	4.191	13.219	2.247	0.472	0.045	0.340	0.860	2.924	2.607	9.046
4.377	0.609	2.971	9.884	1.957	0.403	0.048	0.320	1.081	2.964	2.823	9.513
2.406	0.655	2.393	8.807	1.803	0.335	0.052	0.290	1.280	2.993	2.640	9.733
1.844	0.749	2.903	8.364	2.099	0.283	0.056	0.243	1.496	2.993	2.101	9.364
1.291	1.141	4.419	8.083	6.977	0.241	0.061	0.210	1.511	2.688	2.781	6.950
0.959	2.858	4.701	6.663	8.447	0.203	0.064	0.183	1.834	1.727	4.924	5.163
0.795	4.345	4.797	3.369	8.899	0.166	0.067	0.203	2.019	1.237	5.801	3.849
0.689	5.308	4.851	2.403	10.569	0.134	0.075	0.269	1.987	1.236	6.180	2.871
0.635	6.400	4.847	1.849	11.474	0.105	0.088	0.316	1.893	1.823	6.573	2.236
0.607	6.837	4.803	1.466	11.989	0.078	0.098	0.348	1.793	2.130	6.947	1.876
0.592	7.039	3.981	1.184	12.209	0.057	0.103	0.374	1.667	2.336	7.113	1.583
0.579	6.799	2.310	0.994	7.696	0.038	0.095	0.389	1.575	2.494	6.359	1.363
0.564	5.240	2.111	0.877	6.437	0.032	0.084	0.400	1.162	2.597	4.254	1.217
0.547		2.520	0.987	5.867	0.030	0.075	0.368	0.883	2.666	4.173	1.089
0.536		2.723	1.632	4.564	0.021	0.061	0.300	0.781	2.471	4.196	0.987
0.520		2.930		3.981		0.049	0.261		1.793		0.903
0.820	0.209	7.611	12.666	1.244	3.756	0.386	0.053	0.147	0.272	0.501	1.575
0.746	0.201	4.366	12.580	1.038	3.796	0.351	0.052	0.170	0.269	0.511	1.689
0.686	0.200	2.991	12.123	0.879	3.869	0.319	0.049	0.210	0.240	0.519	1.791
0.643	0.207	2.180	11.313	0.762	3.957	0.290	0.046	0.245	0.213	0.638	1.819

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1984	5	0.609	0.289	1.030	23.000	0.535	1.260	0.165	0.038	0.219	0.151	4.850	1.190
1984	6	0.580	0.264	0.980	15.600	0.498	0.885	0.319	0.037	0.166	0.133	2.890	1.040
1984	7	0.540	0.247	0.930	9.370	0.460	0.698	0.479	0.042	0.132	0.143	1.770	0.784
1984	8	0.505	0.235	0.890	6.160	0.630	0.549	0.384	0.046	0.113	0.147	1.230	0.777
1984	9	0.470	0.229	0.860	5.080	0.972	0.463	0.296	0.055	0.128	0.192	1.170	0.722
1984	10	0.445	0.241	0.820	4.260	0.876	0.422	0.267	0.058	0.206	0.254	4.430	0.742
1984	11	0.420	0.264	0.790	3.610	0.778	0.427	0.402	0.050	0.340	0.241	23.200	0.828
1984	12	0.398	0.620	0.760	3.210	0.840	0.352	0.406	0.042	0.290	0.233	12.100	2.060
1984	13	0.379	2.500	0.750	3.170	0.798	0.310	0.312	0.041	0.323	0.229	5.520	30.200
1984	14	0.360	63.200	0.740	3.240	0.810	0.273	0.261	0.031	0.804	0.203	3.670	9.890
1984	15	0.340	59.800	0.725	5.200	0.728	0.246	0.227	0.022	1.470	0.162	3.640	5.490
1984	16	0.323	43.200	12.200	5.820	0.637	0.220	0.212	0.048	1.350	0.134	6.810	4.990
1984	17	0.305	34.800	41.500	6.520	0.574	0.335	0.210	0.040	1.250	0.136	4.290	9.650
1984	18	0.291	34.400	41.000	6.180	0.566	17.900	0.239	0.037	1.190	0.219	3.080	5.870
1984	19	0.288	40.400	23.100	5.900	0.569	8.970	0.187	0.031	0.726	0.467	2.420	4.040
1984	20	0.265	38.700	12.400	4.480	0.511	3.480	0.148	0.026	0.274	0.428	1.750	2.840
1984	21	0.254	16.800	33.300	3.280	0.469	1.700	0.118	0.021	0.185	0.533	1.310	2.400
1984	22	0.246	11.700	25.000	2.410	0.474	0.938	0.108	0.025	0.141	0.591	1.060	10.800
1984	23	0.237	20.600	11.500	2.130	0.926	0.632	0.098	0.036	0.135	0.539	0.970	8.200
1984	24	0.260	24.000	8.100	2.100	1.190	0.526	0.075	0.053	0.135	0.472	1.020	4.650
1984	25	0.248	10.800	9.640	2.090	0.881	0.486	0.055	0.045	0.219	0.416	0.953	2.520
1984	26	0.235	6.780	13.300	1.700	1.570	0.414	0.052	0.049	0.365	0.529	0.964	2.350
1984	27	0.226	5.900	13.800	1.390	1.970	0.371	0.067	0.045	0.348	0.613	1.090	2.090
1984	28	0.217	2.930	15.000	1.120	1.430	0.431	0.054	0.039	0.297	0.613	1.550	17.600
1984	29	0.208	1.500	12.700	0.878	7.370	0.398	0.044	0.206	0.254	0.555	2.600	107.000
1984	30	0.200		9.060	0.794	6.730	0.325	0.044	0.281	0.221	0.447	2.080	27.500
1984	31	0.194		11.300		4.400		0.048	0.243		0.367		8.950
1985	1	5.850	0.460	12.000	21.400	1.110	14.400	0.000	0.537	0.778	0.106	0.804	4.670
1985	2	5.000	0.450	10.000	11.400	0.999	5.040	0.000	1.050	0.568	0.102	0.760	28.900
1985	3	3.600	0.440	8.800	8.170	0.930	2.220	0.000	1.030	0.447	0.059	0.975	8.500
1985	4	2.700	0.430	7.400	8.790	0.763	1.240	0.000	1.010	0.320	0.047	6.340	5.410
1985	5	2.100	0.420	6.600	110.000	0.896	0.943	0.000	1.000	0.319	0.110	16.200	3.910
1985	6	1.700	0.410	5.600	73.600	1.180	0.776	0.000	0.538	1.970	0.261	8.150	2.840
1985	7	1.400	0.400	5.000	24.500	1.270	0.622	0.062	0.130	2.400	0.271	5.760	2.300
1985	8	1.200	0.390	4.600	18.600	1.030	0.539	0.259	0.852	1.300	0.216	5.300	2.010
1985	9	1.100	0.385	4.800	9.620	0.862	0.430	0.074	0.851	1.170	0.317	4.880	1.690
1985	10	1.040	0.380	5.200	6.610	0.725	0.318	0.011	0.745	8.890	0.469	23.700	1.570
1985	11	0.980	0.370	6.000	13.100	0.619	0.237	0.000	0.172	6.070	0.617	10.400	1.790
1985	12	0.930	0.460	9.000	16.800	0.541	0.233	0.000	0.000	2.610	0.861	5.610	1.980
1985	13	0.890	0.540	15.000	16.000	0.465	0.201	0.000	0.000	1.270	4.820	19.700	1.700
1985	14	0.850	0.487	13.500	14.800	0.365	0.143	0.444	0.000	0.892	3.030	25.500	1.230
1985	15	0.810	0.450	11.800	15.900	0.306	0.083	0.925	0.072	0.689	1.920	21.100	1.150
1985	16	0.780	0.440	9.600	10.300	0.302	0.177	0.505	0.251	0.555	2.370	9.090	1.080
1985	17	0.750	0.430	8.200	6.240	0.278	0.381	0.202	0.019	0.423	1.790	10.100	1.090

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.616	0.219	1.484	12.784	0.678	3.084	0.252	0.046	0.247	0.192	1.252	1.767
0.592	0.228	1.206	13.719	0.624	2.249	0.241	0.045	0.231	0.174	1.601	1.544
0.567	0.236	1.124	13.443	0.576	1.720	0.263	0.044	0.215	0.163	1.801	1.359
0.554	0.243	1.056	12.394	0.560	1.396	0.278	0.042	0.207	0.156	1.922	1.214
0.545	0.250	0.996	11.306	0.607	1.198	0.286	0.042	0.195	0.155	2.004	1.068
0.531	0.254	0.944	10.400	0.649	0.904	0.297	0.044	0.179	0.168	2.541	0.934
0.510	0.253	0.900	9.583	0.678	0.672	0.330	0.047	0.186	0.180	5.649	0.869
0.480	0.300	0.861	6.756	0.722	0.542	0.365	0.047	0.196	0.192	6.684	0.993
0.451	0.619	0.829	4.980	0.765	0.460	0.364	0.048	0.219	0.206	7.060	5.159
0.425	9.613	0.801	4.104	0.815	0.399	0.333	0.046	0.315	0.214	7.331	6.460
0.402	18.122	0.778	3.967	0.829	0.356	0.310	0.043	0.509	0.216	7.676	7.133
0.381	24.261	2.398	4.073	0.781	0.321	0.298	0.042	0.683	0.208	8.481	7.743
0.361	29.198	8.209	4.396	0.738	0.309	0.290	0.039	0.832	0.191	8.461	9.015
0.342	34.074	13.954	4.763	0.708	2.805	0.267	0.037	0.954	0.188	5.587	9.736
0.327	39.757	17.145	5.147	0.669	4.036	0.235	0.036	1.016	0.221	4.204	10.019
0.310	44.929	18.809	5.334	0.628	4.489	0.212	0.034	1.009	0.250	3.666	6.110
0.295	38.300	23.461	5.340	0.579	4.693	0.192	0.032	0.921	0.297	3.329	5.040
0.282	31.429	26.929	4.941	0.543	4.792	0.175	0.033	0.731	0.358	2.960	5.799
0.269	28.200	26.829	4.414	0.584	4.851	0.158	0.031	0.557	0.416	2.126	6.257
0.263	26.657	22.057	3.783	0.672	4.878	0.139	0.033	0.398	0.464	1.659	5.543
0.257	23.286	17.577	3.199	0.717	2.390	0.113	0.034	0.259	0.492	1.355	5.064
0.249	18.483	16.177	2.599	0.860	1.168	0.093	0.036	0.208	0.501	1.147	4.823
0.244	13.797	16.377	2.157	1.069	0.724	0.082	0.039	0.218	0.528	1.052	4.716
0.238	11.816	13.763	1.849	1.206	0.543	0.073	0.042	0.234	0.539	1.087	6.887
0.233	10.359	12.006	1.630	2.191	0.465	0.064	0.068	0.250	0.534	1.307	20.630
0.228		11.657	1.439	3.020	0.422	0.056	0.103	0.263	0.521	1.465	23.387
0.218		12.114		3.479		0.052	0.130		0.506		24.001
24.477	0.504	29.657	43.900	1.416	6.212	0.050	0.077	0.931	0.231	1.248	2.264
24.856	0.491	29.557	44.471	1.283	6.911	0.014	0.227	0.794	0.181	0.986	6.051
25.071	0.479	22.557	41.981	1.154	5.814	0.001	0.374	0.692	0.140	0.913	6.979
22.943	0.466	16.386	26.809	1.055	4.813	0.000	0.518	0.639	0.107	1.660	7.477
7.957	0.453	12.057	31.694	1.004	4.429	0.000	0.661	0.623	0.092	3.844	7.784
4.271	0.441	9.486	36.609	1.010	4.308	0.000	0.738	0.793	0.110	4.877	7.967
3.193	0.430	7.914	36.837	1.021	3.606	0.009	0.756	0.972	0.137	5.570	8.076
2.529	0.420	6.857	36.437	1.010	1.626	0.046	0.801	1.046	0.152	6.212	7.696
1.971	0.411	6.114	36.183	0.990	0.967	0.056	0.773	1.132	0.183	6.801	3.809
1.606	0.402	5.600	35.960	0.961	0.695	0.058	0.732	2.338	0.242	10.047	2.819
1.360	0.394	5.400	36.576	0.940	0.552	0.058	0.613	3.160	0.323	10.627	2.301
1.193	0.399	5.743	23.261	0.890	0.451	0.058	0.470	3.487	0.430	9.114	2.026
1.077	0.418	7.086	15.033	0.787	0.369	0.058	0.393	3.387	1.082	10.764	1.863
0.999	0.430	8.300	13.647	0.658	0.300	0.113	0.374	3.172	1.476	13.584	1.710
0.943	0.439	9.329	13.261	0.555	0.235	0.208	0.263	3.084	1.719	15.841	1.587
0.897	0.447	10.014	13.359	0.475	0.199	0.269	0.177	2.997	2.012	16.443	1.500
0.856	0.454	10.443	13.306	0.411	0.208	0.297	0.073	1.787	2.201	14.500	1.431

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1985	18	0.730	0.420	7.000	4.770	0.229	0.391	0.047	0.000	0.326	1.260	8.850	1.000
1985	19	0.710	0.410	6.200	4.630	0.206	0.350	0.000	0.067	0.253	4.640	15.300	1.000
1985	20	0.670	0.405	7.000	4.260	0.222	0.239	0.000	0.073	0.172	5.940	15.600	0.960
1985	21	0.650	0.400	7.400	3.390	0.375	0.123	0.000	0.000	0.111	3.000	7.920	0.930
1985	22	0.630	0.800	8.000	2.420	0.330	0.142	0.000	0.000	0.079	1.750	5.060	0.910
1985	23	0.600	10.700	11.000	1.920	0.195	0.588	0.000	0.000	0.052	1.320	3.880	0.880
1985	24	0.590	57.800	9.500	1.580	0.107	0.484	0.000	0.000	0.285	1.990	3.190	0.870
1985	25	0.560	50.600	7.450	1.930	0.056	0.251	0.000	0.065	0.449	4.780	2.390	0.850
1985	26	0.540	36.900	7.400	1.830	0.141	0.091	0.000	1.530	0.348	2.590	2.010	0.840
1985	27	0.530	23.600	25.600	1.460	9.900	0.008	0.000	1.160	0.279	1.490	1.920	0.820
1985	28	0.520	16.000	115.000	1.250	8.250	0.000	0.000	0.689	0.212	1.110	1.760	0.800
1985	29	0.510		75.800	1.140	3.630	0.000	0.000	0.430	0.133	0.913	1.560	0.780
1985	30	0.490		39.200	1.190	1.620	0.000	0.000	0.782	0.088	0.919	1.540	0.770
1985	31	0.480		22.900		5.540		0.000	1.150		0.909		0.760
1986	1	0.780	0.880	0.610	5.660	1.080	0.618	0.308	0.260	0.950	22.200	3.050	1.970
1986	2	0.778	0.840	0.570	5.040	1.010	0.547	0.276	0.215	0.718	16.600	3.090	1.530
1986	3	0.750	0.800	0.560	3.460	0.834	0.456	0.220	0.179	0.570	14.300	3.040	2.130
1986	4	0.740	0.820	0.580	2.590	0.736	0.387	0.165	0.124	0.670	20.900	2.760	1.990
1986	5	0.730	0.860	0.600	2.360	0.700	0.356	0.149	0.105	2.090	19.300	2.440	1.910
1986	6	0.720	0.840	0.640	3.410	0.666	0.347	0.141	0.101	1.250	18.200	1.640	1.630
1986	7	0.700	0.800	0.650	3.030	0.601	0.323	0.113	0.102	0.862	9.470	1.420	1.600
1986	8	0.689	0.770	0.630	2.890	0.517	0.556	0.089	0.111	0.634	6.090	1.370	1.520
1986	9	0.670	0.740	0.610	2.670	0.464	0.432	0.073	0.141	0.487	4.230	1.460	1.590
1986	10	0.660	0.720	0.650	2.200	0.428	0.307	0.060	0.126	6.180	3.090	1.250	2.440
1986	11	0.645	0.700	12.000	2.020	0.401	0.875	0.082	0.122	79.600	2.540	1.140	2.610
1986	12	0.640	0.690	13.000	2.190	0.364	7.310	0.067	0.095	64.400	2.210	1.080	2.440
1986	13	0.635	0.670	14.000	3.590	0.332	6.670	0.056	0.090	18.000	2.780	0.941	1.890
1986	14	0.625	0.650	15.000	2.430	0.298	3.040	0.356	0.070	8.420	26.500	0.904	1.610
1986	15	0.620	0.640	18.800	2.020	0.321	1.610	0.229	1.760	8.070	15.000	0.896	1.510
1986	16	0.610	0.630	19.800	4.530	0.393	1.180	0.120	3.630	22.900	9.000	0.907	1.440
1986	17	0.700	0.625	17.000	6.730	0.559	1.010	0.125	1.210	9.260	6.320	1.020	1.430
1986	18	0.900	0.640	14.000	3.320	0.592	0.806	1.510	0.675	5.120	4.420	1.070	1.500
1986	19	5.000	0.700	40.000	2.240	1.940	0.634	2.280	0.413	3.290	3.110	0.818	1.600
1986	20	10.000	0.780	25.000	1.760	17.800	0.527	1.390	0.288	22.000	2.630	0.718	1.780
1986	21	8.000	0.820	15.000	12.400	21.700	0.432	0.802	0.210	14.900	2.300	0.821	1.820
1986	22	5.400	0.840	10.700	7.120	8.820	0.360	0.500	0.164	9.850	2.180	0.894	1.700
1986	23	4.000	0.820	16.600	3.440	23.900	1.180	0.332	0.205	41.900	2.170	0.923	1.500
1986	24	3.000	0.790	21.800	2.390	10.600	1.340	0.234	0.423	17.800	2.160	2.150	1.520
1986	25	2.300	0.750	23.400	1.870	5.130	0.989	0.228	0.423	8.200	2.120	3.070	1.800
1986	26	1.800	0.720	47.100	1.650	2.740	0.714	5.030	1.830	8.660	2.040	4.050	2.000
1986	27	1.450	0.690	26.400	1.460	1.800	0.618	1.910	26.100	12.400	3.250	9.760	2.700
1986	28	1.250	0.660	12.200	1.320	1.390	0.612	0.948	7.680	7.060	6.690	6.200	2.900
1986	29	1.050		14.900	1.160	1.080	0.474	0.622	3.310	23.500	4.900	4.340	2.890
1986	30	1.000		13.600	1.090	0.843	0.387	0.433	1.910	56.900	4.060	3.120	2.850

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.820	0.461	10.586	12.116	0.355	0.230	0.303	0.049	0.966	2.293	14.279	1.319
0.789	0.454	10.186	10.377	0.307	0.247	0.303	0.058	0.630	2.833	15.663	1.179
0.757	0.435	9.043	8.700	0.273	0.252	0.303	0.069	0.473	2.993	15.077	1.073
0.729	0.422	8.171	7.070	0.274	0.249	0.240	0.069	0.361	2.989	12.566	1.030
0.703	0.472	7.629	5.144	0.277	0.258	0.108	0.059	0.274	2.964	10.274	0.996
0.677	1.938	7.829	3.947	0.262	0.316	0.036	0.023	0.202	2.814	9.530	0.967
0.654	10.134	8.014	3.281	0.238	0.331	0.007	0.020	0.183	2.843	8.543	0.936
0.630	17.302	8.079	2.876	0.213	0.311	0.000	0.029	0.200	3.346	7.620	0.914
0.606	22.515	8.250	2.476	0.204	0.274	0.000	0.238	0.214	3.053	5.721	0.891
0.586	25.829	10.907	2.076	1.586	0.241	0.000	0.394	0.229	2.417	3.767	0.871
0.567	28.057	26.279	1.770	2.711	0.223	0.000	0.492	0.243	2.147	2.887	0.853
0.550		35.964	1.587	3.183	0.203	0.000	0.553	0.251	2.028	2.387	0.834
0.534		39.993	1.483	3.386	0.119	0.000	0.665	0.256	1.970	2.053	0.819
0.519		41.907		4.162		0.000	0.829		1.816		0.803
0.793	1.196	0.720	18.311	1.376	1.308	0.586	1.363	6.151	19.846	3.921	4.644
0.784	1.059	0.684	12.303	1.253	0.995	0.484	0.675	5.993	21.046	4.071	4.424
0.774	0.966	0.651	9.026	1.136	0.803	0.414	0.428	2.345	21.851	4.041	4.150
0.765	0.904	0.627	7.653	1.033	0.659	0.349	0.310	1.344	23.066	3.480	3.040
0.758	0.877	0.610	5.861	0.944	0.556	0.283	0.236	1.170	24.814	3.129	2.427
0.751	0.854	0.603	4.406	0.874	0.485	0.235	0.189	1.075	24.057	2.783	2.040
0.743	0.834	0.601	3.650	0.804	0.433	0.196	0.155	1.016	17.281	2.491	1.823
0.730	0.819	0.604	3.254	0.723	0.425	0.165	0.134	0.971	14.980	2.251	1.759
0.714	0.804	0.610	2.916	0.645	0.408	0.136	0.123	0.938	13.213	2.019	1.767
0.701	0.793	0.623	2.736	0.587	0.387	0.113	0.116	1.739	11.611	1.763	1.811
0.688	0.776	2.254	2.654	0.540	0.457	0.101	0.115	13.015	8.989	1.531	1.900
0.675	0.751	4.026	2.630	0.492	1.450	0.089	0.114	21.916	6.547	1.337	1.976
0.663	0.727	5.934	2.656	0.444	2.353	0.077	0.112	24.309	4.344	1.237	2.013
0.652	0.706	7.984	2.570	0.401	2.741	0.112	0.108	25.389	6.777	1.164	2.014
0.642	0.687	10.580	2.446	0.373	2.892	0.132	0.343	26.451	8.050	1.096	2.013
0.634	0.671	13.321	2.711	0.362	2.999	0.139	0.842	29.653	8.731	1.017	1.991
0.639	0.658	15.657	3.359	0.381	3.099	0.148	0.997	30.093	9.193	0.984	1.847
0.676	0.649	15.943	3.544	0.408	3.089	0.352	1.076	19.453	9.461	0.974	1.689
1.299	0.651	19.800	3.551	0.634	2.136	0.668	1.121	10.723	9.590	0.937	1.569
2.636	0.666	21.371	3.290	3.129	1.258	0.859	1.149	11.294	9.569	0.905	1.553
3.690	0.691	21.371	4.714	6.186	0.886	0.922	1.169	12.220	6.111	0.893	1.583
4.373	0.719	20.214	5.443	7.401	0.707	0.961	0.941	12.474	4.280	0.893	1.610
4.857	0.746	19.757	5.287	10.759	0.707	0.991	0.452	15.189	3.304	0.895	1.619
5.186	0.770	20.443	4.667	12.193	0.754	1.007	0.340	16.409	2.710	1.056	1.631
5.386	0.786	21.786	4.460	12.841	0.780	0.824	0.304	16.849	2.381	1.342	1.674
4.929	0.789	22.800	4.376	12.956	0.792	1.217	0.506	17.616	2.229	1.804	1.731
3.707	0.776	23.000	4.333	10.670	0.805	1.291	4.194	16.244	2.317	3.095	1.863
2.743	0.753	22.600	2.750	7.769	0.830	1.312	5.261	15.124	2.944	3.864	2.017
2.121		23.200	1.899	6.663	0.847	1.329	5.710	17.074	3.333	4.356	2.187
1.693		22.771	1.563	3.369	0.733	1.344	5.954	19.217	3.603	4.670	2.380

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1986	31	0.940		8.320		0.685		0.338	1.280		3.460		2.700
1987	1	2.520	0.720	1.000	9.180	0.536	0.094	0.039	0.106	0.083	0.135	0.904	13.800
1987	2	2.490	0.710	1.300	7.560	0.439	0.095	0.027	0.173	0.101	0.110	0.794	7.320
1987	3	2.210	0.730	1.330	6.320	0.398	0.099	0.017	0.363	0.066	0.096	0.871	4.210
1987	4	2.030	0.720	1.370	6.460	0.376	0.105	0.001	0.213	0.039	0.082	1.140	2.910
1987	5	1.860	0.690	1.420	50.100	0.403	0.109	0.001	0.148	0.009	0.066	1.100	2.210
1987	6	1.710	0.660	1.500	30.300	0.339	0.088	0.010	0.104	0.000	0.054	1.060	1.600
1987	7	1.690	0.640	5.500	11.700	0.298	0.113	0.720	0.089	0.000	0.084	1.180	1.350
1987	8	1.590	0.625	16.000	6.200	0.284	0.111	2.560	0.080	0.000	0.223	10.400	1.420
1987	9	1.550	0.612	18.000	3.710	0.256	0.068	2.310	0.366	0.000	0.370	13.600	6.220
1987	10	1.500	0.600	14.000	2.680	0.230	0.052	0.661	0.754	0.000	0.487	5.960	12.000
1987	11	1.460	0.595	9.500	2.130	0.211	0.047	0.346	0.446	0.000	0.478	2.910	6.430
1987	12	1.450	0.590	6.600	2.020	0.198	0.044	0.254	0.281	0.008	0.465	2.070	5.360
1987	13	1.440	0.585	4.600	2.310	0.168	0.028	0.145	0.204	0.010	0.443	1.680	4.610
1987	14	1.440	0.580	4.100	1.930	0.193	0.022	0.757	0.141	0.013	0.413	1.500	3.270
1987	15	2.010	0.575	3.800	2.190	0.421	0.016	0.757	0.103	0.000	0.403	1.300	2.200
1987	16	2.420	0.570	3.560	1.990	0.405	0.000	0.415	0.091	0.000	0.363	1.140	1.850
1987	17	2.000	0.565	3.600	1.600	0.283	0.000	0.254	0.290	0.010	0.189	1.130	1.800
1987	18	1.700	0.560	3.900	1.460	0.230	0.000	0.166	0.192	0.105	0.239	1.330	1.750
1987	19	1.420	0.560	6.400	1.310	0.221	0.000	0.140	0.115	0.139	0.208	1.790	1.700
1987	20	1.230	0.560	12.500	1.160	0.240	0.000	21.800	0.082	0.132	0.177	1.710	5.120
1987	21	1.090	0.560	21.000	1.040	0.273	0.000	5.670	0.063	0.178	0.184	1.220	13.800
1987	22	1.000	0.560	33.500	0.828	0.384	0.390	1.760	0.044	0.212	0.198	1.120	9.500
1987	23	0.950	0.560	45.600	0.754	0.442	1.390	0.903	0.027	0.187	0.387	1.140	6.230
1987	24	0.910	0.562	49.000	0.733	0.325	0.481	0.559	0.015	0.173	0.824	2.050	4.360
1987	25	0.870	0.563	39.900	0.720	0.262	0.243	0.660	0.005	0.103	2.340	4.270	19.100
1987	26	0.840	0.563	33.400	0.653	0.258	0.133	0.448	0.000	0.070	1.470	13.400	15.000
1987	27	0.810	0.564	16.300	0.632	0.288	0.092	0.304	0.000	0.059	3.120	8.880	7.000
1987	28	0.790	0.565	10.500	0.863	0.259	0.049	0.240	0.004	0.038	4.310	5.920	3.800
1987	29	0.770		8.030	0.886	0.180	0.033	0.192	0.010	0.049	2.120	31.900	2.900
1987	30	0.750		28.300	0.716	0.118	0.020	0.155	0.022	0.091	1.480	27.800	2.000
1987	31	0.730		12.100		0.111		0.121	0.050		1.130		1.400
1988	1	1.150	42.300	1.110	6.830	1.830	0.264	0.068	0.154	0.050	0.057	1.300	2.180
1988	2	1.000	6.900	1.050	6.190	1.390	0.228	0.064	0.114	0.048	0.201	1.270	1.870
1988	3	0.900	3.800	1.010	20.600	1.190	0.208	0.069	0.093	0.056	0.458	1.170	1.660
1988	4	0.820	2.400	0.980	31.100	1.030	0.183	0.055	0.150	0.131	0.308	1.140	1.660
1988	5	0.750	1.900	0.960	15.900	0.914	0.161	0.049	0.205	0.254	0.212	2.150	1.430
1988	6	0.690	1.600	0.940	9.690	0.807	0.152	0.051	0.132	0.258	0.170	8.650	1.240
1988	7	0.660	1.400	1.200	6.830	0.684	0.135	0.048	0.092	0.156	0.146	6.030	1.350
1988	8	0.640	1.300	2.900	5.080	0.610	0.146	0.045	0.065	0.106	0.126	5.820	1.250
1988	9	0.620	1.220	6.000	3.330	0.635	0.157	0.041	0.057	0.102	0.122	9.120	0.950
1988	10	0.600	1.150	11.000	2.550	1.030	0.137	0.037	0.058	0.071	0.137	18.400	0.820
1988	11	0.585	1.110	12.000	2.050	0.913	0.114	0.036	0.066	0.062	0.530	14.900	0.660
1988	12	0.575	1.070	11.700	1.640	0.712	0.099	0.035	0.098	0.065	0.656	7.850	0.570

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.399		20.846		1.953		1.358	6.076		3.789		2.549
2.651	0.773	0.625	16.830	0.715	0.187	0.087	0.224	0.024	0.078	2.076	15.139
2.721	0.754	0.731	13.139	0.675	0.164	0.056	0.184	0.039	0.079	1.980	15.574
2.651	0.743	0.841	11.713	0.639	0.137	0.040	0.193	0.048	0.083	1.658	14.261
2.527	0.733	0.956	11.136	0.602	0.115	0.027	0.189	0.053	0.086	1.206	13.409
2.380	0.721	1.078	17.146	0.536	0.104	0.020	0.183	0.053	0.090	1.060	12.879
2.217	0.709	1.212	17.431	0.458	0.100	0.016	0.175	0.050	0.091	1.000	8.550
2.073	0.696	1.917	17.374	0.398	0.100	0.116	0.171	0.043	0.090	1.007	4.771
1.940	0.682	4.060	16.949	0.362	0.103	0.477	0.167	0.031	0.102	2.364	3.003
1.806	0.668	6.446	16.399	0.336	0.099	0.803	0.195	0.016	0.139	4.193	2.846
1.704	0.650	8.256	15.879	0.312	0.092	0.895	0.251	0.007	0.195	4.920	3.959
1.623	0.632	9.417	15.260	0.289	0.084	0.944	0.284	0.001	0.252	5.173	4.461
1.564	0.617	10.157	8.391	0.259	0.075	0.980	0.303	0.001	0.309	5.311	4.911
1.526	0.607	10.600	4.393	0.235	0.066	0.999	0.317	0.003	0.364	5.400	5.341
1.490	0.598	10.400	2.997	0.220	0.053	1.005	0.325	0.004	0.411	5.446	5.616
1.550	0.591	8.657	2.424	0.240	0.040	0.747	0.328	0.004	0.437	4.146	5.727
1.674	0.585	6.594	2.179	0.261	0.030	0.476	0.289	0.004	0.436	2.366	5.103
1.746	0.580	5.109	2.024	0.268	0.022	0.418	0.222	0.006	0.393	1.676	3.646
1.780	0.575	4.309	1.929	0.271	0.016	0.393	0.186	0.021	0.359	1.450	2.977
1.776	0.571	4.280	1.827	0.274	0.009	0.376	0.162	0.040	0.323	1.410	2.454
1.746	0.567	5.409	1.663	0.285	0.005	3.470	0.145	0.057	0.285	1.414	2.527
1.696	0.564	7.823	1.536	0.296	0.002	4.172	0.134	0.081	0.252	1.374	4.031
1.551	0.562	12.066	1.341	0.291	0.056	4.315	0.125	0.111	0.223	1.349	5.074
1.341	0.561	18.071	1.165	0.296	0.254	4.385	0.116	0.138	0.226	1.349	5.700
1.186	0.560	24.557	1.041	0.302	0.323	4.428	0.077	0.161	0.317	1.480	6.066
1.067	0.561	29.700	0.935	0.307	0.358	4.499	0.050	0.161	0.617	1.900	8.544
0.984	0.561	33.557	0.841	0.312	0.377	4.543	0.034	0.151	0.797	3.559	10.444
0.924	0.562	34.100	0.766	0.319	0.390	1.472	0.022	0.140	1.218	4.583	10.713
0.881	0.562	32.600	0.740	0.317	0.397	0.696	0.014	0.120	1.807	5.254	9.284
0.849		28.961	0.749	0.288	0.346	0.472	0.009	0.097	2.082	9.651	8.341
0.820		26.490	0.743	0.241	0.150	0.365	0.008	0.083	2.238	13.460	7.737
0.794		21.219		0.211		0.303	0.013		2.281		7.314
4.750	11.469	1.471	17.034	1.976	0.455	0.073	0.118	0.073	0.096	4.640	2.359
2.750	12.231	1.331	11.404	1.819	0.380	0.069	0.117	0.068	0.103	3.400	2.247
1.879	12.584	1.219	11.361	1.707	0.323	0.068	0.117	0.062	0.151	2.620	2.160
1.453	12.770	1.137	14.541	1.601	0.277	0.066	0.127	0.068	0.181	1.936	2.039
1.146	12.901	1.074	15.070	1.482	0.242	0.064	0.148	0.094	0.197	1.569	1.873
0.959	12.843	1.033	14.126	1.360	0.213	0.061	0.154	0.122	0.210	2.461	1.733
0.853	8.614	1.036	13.877	1.121	0.190	0.058	0.134	0.136	0.222	3.101	1.627
0.780	2.757	1.291	13.627	0.946	0.173	0.054	0.122	0.144	0.232	3.747	1.494
0.726	1.946	1.999	13.219	0.839	0.163	0.051	0.113	0.152	0.220	4.869	1.363
0.683	1.567	3.426	10.640	0.816	0.153	0.047	0.108	0.154	0.174	7.330	1.243
0.649	1.383	5.000	6.490	0.799	0.143	0.044	0.096	0.144	0.206	9.296	1.100
0.624	1.264	6.534	4.453	0.770	0.134	0.042	0.081	0.117	0.270	10.110	0.977

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1988	13	0.600	1.050	5.200	1.520	0.650	0.090	0.041	0.122	0.086	0.492	15.800	0.550
1988	14	0.565	1.010	4.000	1.660	0.619	0.074	0.041	0.101	0.069	0.361	13.900	0.550
1988	15	0.560	1.300	2.650	2.020	0.608	0.067	0.038	0.072	0.063	0.288	7.230	0.540
1988	16	0.555	2.000	2.150	1.540	5.910	0.063	0.073	0.053	0.059	0.220	5.260	0.470
1988	17	0.600	3.500	1.800	1.410	10.200	0.059	0.089	0.155	0.139	0.199	6.360	0.430
1988	18	2.500	2.800	1.600	1.750	3.110	0.056	0.068	0.104	0.183	1.360	4.060	0.410
1988	19	5.000	2.450	1.450	1.590	1.660	0.067	0.055	0.084	0.139	1.680	2.790	0.400
1988	20	7.000	2.150	1.330	1.520	3.790	0.074	0.050	0.062	0.159	0.941	3.050	1.300
1988	21	10.900	2.000	1.240	2.490	10.400	0.062	0.053	0.050	0.165	0.641	13.400	6.500
1988	22	5.000	1.900	1.160	1.900	4.190	0.073	0.122	0.041	0.170	0.588	7.810	2.400
1988	23	3.500	2.000	3.500	1.920	2.080	0.107	0.251	0.040	0.205	0.567	4.650	2.330
1988	24	2.620	2.030	14.000	3.040	1.300	0.112	0.211	0.046	0.180	0.737	3.380	2.810
1988	25	1.960	1.800	50.500	2.490	0.956	0.096	0.168	0.065	0.150	5.210	2.650	1.820
1988	26	1.560	1.550	45.600	1.970	0.751	0.076	0.118	0.081	0.124	9.950	2.270	1.100
1988	27	1.330	1.400	20.900	1.770	0.609	0.068	0.093	0.096	0.098	6.630	2.510	1.300
1988	28	1.100	1.230	8.840	1.750	0.505	0.063	0.078	0.095	0.095	5.930	2.590	7.000
1988	29	0.980	1.180	12.200	1.660	0.408	0.070	0.060	0.071	0.080	4.720	2.220	5.000
1988	30	2.010		16.300	2.360	0.352	0.072	0.088	0.062	0.065	2.400	2.090	3.500
1988	31	31.000		8.570		0.295		0.232	0.055		1.550		2.300
1989	1	1.500	25.600	0.320	4.670	0.939	1.870	0.306	0.024	0.095	0.140	0.493	4.000
1989	2	1.220	8.600	0.320	3.700	0.843	1.440	0.240	0.024	0.171	0.216	0.465	2.200
1989	3	1.050	5.200	0.322	11.800	0.830	1.050	0.195	0.024	0.173	0.550	0.459	1.800
1989	4	0.990	2.500	0.325	18.500	0.731	1.740	0.163	0.360	0.105	0.530	0.385	1.580
1989	5	0.910	1.500	0.330	12.100	0.764	1.640	0.140	0.911	0.078	0.476	0.325	1.450
1989	6	0.850	1.100	0.338	13.100	1.240	1.000	0.118	0.373	0.075	0.387	0.738	1.320
1989	7	0.790	0.850	0.350	10.800	1.090	0.696	0.099	0.168	0.076	0.389	2.660	1.260
1989	8	13.000	0.700	0.380	6.750	1.100	0.531	0.084	0.108	0.075	0.382	3.230	1.030
1989	9	9.000	0.600	0.420	5.270	1.120	0.437	0.073	0.079	0.232	0.362	4.850	0.927
1989	10	6.000	0.550	0.468	3.860	0.928	0.737	0.066	0.065	0.260	0.263	4.530	0.880
1989	11	3.510	0.540	0.581	3.000	0.771	0.719	0.057	0.055	0.234	1.500	2.730	0.800
1989	12	3.350	0.535	2.400	4.050	1.920	0.562	0.053	0.049	0.150	1.270	2.460	0.740
1989	13	3.200	0.505	2.900	3.590	5.630	0.440	0.052	0.042	0.082	0.701	1.790	0.690
1989	14	3.000	0.490	6.000	5.610	2.880	0.372	0.049	0.039	0.074	0.569	2.850	0.650
1989	15	2.240	0.475	65.000	23.600	7.530	0.336	0.042	0.077	0.077	0.801	23.000	0.620
1989	16	1.570	0.455	12.000	14.000	3.880	0.331	0.040	0.087	0.074	0.880	44.000	0.600
1989	17	1.280	0.435	6.000	9.010	2.230	0.333	0.037	0.086	0.114	0.742	14.000	0.580
1989	18	1.110	0.415	3.800	8.190	1.480	0.372	0.033	0.075	0.170	1.120	7.910	0.555
1989	19	1.040	0.400	2.300	5.010	1.130	0.359	0.033	0.058	0.130	1.340	5.310	0.535
1989	20	0.953	0.390	1.300	3.350	1.000	2.810	0.034	0.047	0.099	1.240	12.600	0.520
1989	21	0.838	0.380	1.100	2.580	3.790	3.210	0.034	0.045	0.086	2.060	12.700	0.500
1989	22	0.761	0.370	1.000	1.960	2.620	28.100	0.034	0.082	0.998	1.870	11.700	0.490
1989	23	0.744	0.360	0.900	1.500	1.430	17.000	0.035	0.081	2.150	1.460	7.600	0.480
1989	24	0.879	0.350	1.200	1.290	1.060	6.930	0.034	0.073	0.835	1.040	4.500	0.465
1989	25	0.929	0.342	15.800	1.160	0.827	3.230	0.032	0.067	0.475	0.805	2.500	0.455

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.611	1.186	7.143	3.286	0.748	0.125	0.040	0.080	0.093	0.316	11.131	0.879
0.598	1.130	7.543	2.547	0.738	0.117	0.039	0.081	0.080	0.346	12.256	0.764
0.586	1.130	7.507	2.110	0.738	0.105	0.038	0.082	0.074	0.369	12.457	0.663
0.577	1.241	6.957	1.854	1.492	0.092	0.043	0.081	0.068	0.383	11.906	0.594
0.577	1.577	5.643	1.691	2.802	0.081	0.050	0.095	0.078	0.392	10.186	0.539
0.851	1.819	4.157	1.649	3.116	0.073	0.055	0.101	0.095	0.511	8.637	0.503
1.483	2.016	2.693	1.641	3.251	0.068	0.058	0.099	0.105	0.657	7.914	0.479
2.397	2.173	2.140	1.641	3.700	0.066	0.059	0.090	0.116	0.721	6.093	0.586
3.874	2.314	1.746	1.760	5.097	0.064	0.061	0.083	0.130	0.761	6.021	1.436
4.508	2.400	1.533	1.743	5.609	0.065	0.073	0.078	0.145	0.804	6.104	1.701
4.929	2.400	1.726	1.797	5.061	0.071	0.098	0.077	0.166	0.854	6.017	1.967
5.217	2.190	3.469	2.030	3.790	0.079	0.116	0.061	0.172	0.931	5.591	2.307
5.140	2.047	10.454	2.136	3.482	0.084	0.130	0.055	0.167	1.481	5.390	2.509
4.649	1.919	16.761	2.190	3.352	0.086	0.139	0.055	0.165	2.662	5.316	2.609
3.839	1.811	19.557	2.226	2.898	0.085	0.145	0.060	0.156	3.475	5.239	2.609
2.439	1.701	20.643	2.120	1.484	0.085	0.149	0.066	0.146	4.230	3.694	2.680
1.864	1.599	22.220	2.086	0.944	0.085	0.140	0.071	0.133	4.821	2.896	3.051
1.651		24.049	2.149	0.697	0.080	0.117	0.074	0.113	5.082	2.530	3.219
5.706		23.273		0.554		0.120	0.075		5.199		3.146
3.100	9.541	0.338	25.446	1.040	1.333	1.126	0.031	0.068	0.249	0.581	15.673
3.117	10.441	0.332	21.146	0.995	1.330	0.699	0.030	0.084	0.212	0.557	15.630
3.081	10.703	0.328	17.403	0.944	1.228	0.481	0.028	0.100	0.243	0.544	15.684
2.223	10.654	0.325	13.231	0.887	1.325	0.362	0.074	0.106	0.283	0.507	15.640
1.639	10.129	0.325	9.831	0.847	1.448	0.281	0.199	0.108	0.320	0.462	7.261
1.260	8.386	0.326	10.189	0.899	1.450	0.221	0.249	0.109	0.350	0.483	3.164
1.044	6.479	0.329	10.667	0.920	1.348	0.180	0.269	0.110	0.384	0.789	1.944
2.687	2.921	0.338	10.964	0.943	1.157	0.148	0.281	0.108	0.419	1.180	1.520
3.799	1.779	0.352	11.189	0.982	1.013	0.125	0.289	0.116	0.439	1.807	1.338
4.506	1.114	0.373	10.054	0.996	0.969	0.106	0.295	0.129	0.398	2.388	1.207
4.866	0.834	0.410	7.840	1.002	0.823	0.091	0.251	0.147	0.537	2.723	1.095
5.214	0.696	0.705	6.690	1.167	0.669	0.079	0.128	0.157	0.650	3.028	0.994
5.550	0.611	1.071	5.331	1.794	0.589	0.069	0.081	0.158	0.695	3.179	0.904
5.866	0.560	1.878	4.590	2.050	0.543	0.062	0.062	0.158	0.721	3.206	0.817
4.329	0.528	11.110	6.997	2.968	0.515	0.056	0.058	0.158	0.781	6.030	0.758
3.267	0.507	12.764	8.244	3.363	0.500	0.051	0.059	0.136	0.855	11.623	0.711
2.593	0.491	13.554	8.980	3.549	0.442	0.047	0.062	0.115	0.923	12.976	0.669
2.250	0.473	14.014	9.721	3.650	0.392	0.044	0.065	0.106	0.869	13.716	0.634
1.920	0.454	14.000	9.859	3.537	0.363	0.041	0.066	0.103	0.879	14.123	0.604
1.599	0.437	13.771	9.824	2.876	0.702	0.038	0.067	0.105	0.956	15.667	0.580
1.290	0.421	13.071	9.391	3.006	1.107	0.036	0.068	0.107	1.169	17.074	0.559
1.079	0.406	3.929	6.300	2.304	5.074	0.035	0.069	0.239	1.322	15.460	0.540
0.961	0.393	2.343	4.514	1.954	7.455	0.034	0.068	0.535	1.405	10.260	0.523
0.904	0.381	1.657	3.411	1.787	8.397	0.034	0.066	0.638	1.447	8.903	0.506
0.878	0.370	3.371	2.407	1.694	8.806	0.034	0.065	0.682	1.402	8.130	0.492

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1989	26	2.300	0.336	33.800	1.190	1.460	1.720	0.029	0.063	0.333	0.637	1.420	0.445
1989	27	3.370	0.330	38.000	1.130	1.760	0.997	0.035	0.061	0.256	0.548	1.890	0.440
1989	28	2.840	0.325	47.700	1.040	1.060	0.707	0.041	0.059	0.214	0.641	60.100	0.435
1989	29	5.180		35.900	0.875	0.781	0.533	0.032	0.064	0.176	0.645	30.000	0.430
1989	30	13.300		10.600	0.948	0.987	0.387	0.027	0.068	0.152	0.589	9.800	0.430
1989	31	14.200		7.450		1.410		0.026	0.067		0.516		0.460
1990	1	0.600	3.000	1.300	6.170	0.618	0.420	1.230	0.135	0.128	2.030	0.997	4.220
1990	2	0.860	3.600	1.200	8.280	0.538	0.549	0.774	0.116	0.115	1.250	0.919	3.220
1990	3	0.750	3.300	1.000	9.590	0.473	0.656	0.503	0.107	0.111	0.745	0.860	2.360
1990	4	1.100	2.200	0.950	5.990	0.442	0.760	0.349	0.099	0.117	1.140	0.849	3.440
1990	5	2.500	1.700	0.780	3.820	1.190	0.673	0.249	0.098	0.147	4.330	7.120	3.530
1990	6	4.200	1.550	0.680	2.950	1.410	0.550	0.192	0.112	0.172	2.590	48.300	3.480
1990	7	3.500	1.770	0.640	2.380	0.992	0.459	0.153	0.110	0.161	1.470	15.400	2.890
1990	8	3.000	2.220	0.610	1.920	0.836	0.424	0.140	0.107	0.140	0.993	8.790	2.540
1990	9	2.600	18.600	1.220	1.760	0.706	0.547	0.261	0.104	0.135	21.500	5.920	2.370
1990	10	2.300	21.500	4.000	2.130	0.716	0.476	0.216	0.099	0.137	26.900	6.000	2.710
1990	11	1.950	9.000	22.000	5.550	0.842	0.388	0.149	0.097	0.130	16.500	5.060	2.560
1990	12	1.750	5.600	88.900	3.330	0.766	0.310	0.130	0.102	0.125	9.750	3.560	2.260
1990	13	1.620	3.800	79.800	2.370	0.799	0.255	0.129	0.165	0.121	11.700	3.050	14.800
1990	14	1.500	6.300	36.000	2.260	0.737	0.251	0.128	0.216	0.142	6.130	3.130	8.210
1990	15	1.420	4.200	21.800	4.710	0.646	0.381	0.141	0.147	0.327	4.090	9.500	4.240
1990	16	1.340	2.700	17.400	4.420	0.666	0.373	0.149	0.125	0.239	3.160	14.300	3.160
1990	17	4.000	1.950	13.800	4.700	3.180	0.263	0.138	0.125	0.168	12.300	8.190	2.530
1990	18	25.000	1.400	7.200	4.030	6.150	0.220	0.129	0.116	0.286	18.300	4.260	4.940
1990	19	18.000	1.200	4.220	2.760	3.410	0.206	0.117	0.119	0.324	15.100	3.120	7.840
1990	20	11.000	1.050	3.200	2.440	16.100	0.170	0.139	0.125	0.350	7.310	2.520	4.180
1990	21	7.600	0.980	3.110	4.400	15.300	0.158	0.153	0.113	0.323	4.410	2.240	3.470
1990	22	5.780	2.660	9.000	3.270	5.810	0.167	0.142	0.112	0.339	3.200	21.400	24.100
1990	23	3.900	19.800	27.600	2.410	3.170	0.755	0.144	0.111	0.363	2.480	17.500	18.500
1990	24	3.400	12.000	7.800	1.900	2.200	5.310	0.149	0.109	0.350	2.030	11.800	8.290
1990	25	3.700	4.800	4.490	1.540	1.710	2.570	0.150	0.101	0.315	1.700	7.940	4.800
1990	26	5.600	2.600	4.000	1.280	1.310	1.370	0.123	0.100	0.329	1.410	5.740	4.450
1990	27	8.500	1.700	2.850	1.090	1.060	0.832	0.111	0.104	0.367	1.200	24.200	4.300
1990	28	11.000	1.400	2.370	0.926	0.986	0.602	0.100	0.161	0.353	1.190	28.700	5.140
1990	29	6.600		2.150	0.808	0.845	0.966	0.095	0.175	0.453	1.310	13.300	34.800
1990	30	4.700		2.270	0.772	0.654	2.070	0.104	0.131	1.670	1.130	6.310	57.800
1990	31	3.400		4.060		0.557		0.125	0.116		1.090		15.200
1991	1	7.570	0.800	2.800	4.130	1.300	0.859	0.071	0.304	0.092	0.109	0.684	13.200
1991	2	4.680	0.795	49.000	3.980	1.350	0.590	0.079	0.162	0.093	0.117	0.586	5.090
1991	3	2.750	0.790	46.400	3.120	1.320	0.425	0.082	5.800	0.097	0.496	0.478	2.400
1991	4	1.970	0.920	20.300	2.820	1.140	0.315	0.097	2.870	0.102	0.647	0.395	1.800
1991	5	1.750	1.100	12.200	3.560	1.000	0.250	0.171	1.210	0.100	0.616	0.339	1.380
1991	6	1.530	1.300	11.400	3.970	1.000	0.191	0.144	0.676	0.097	0.560	0.317	1.270
1991	7	1.340	1.720	24.900	3.670	1.060	0.162	2.130	0.390	0.097	0.844	0.278	1.690

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.058	0.361	7.871	1.861	1.741	9.000	0.033	0.065	0.711	1.302	7.574	0.479
1.403	0.353	13.114	1.544	1.850	8.741	0.033	0.067	0.733	1.203	6.044	0.468
1.689	0.345	19.771	1.324	1.460	8.383	0.034	0.069	0.752	1.000	12.816	0.459
2.320		24.757	1.169	1.197	4.445	0.034	0.067	0.634	0.825	15.430	0.450
4.114		26.143	1.090	1.134	2.072	0.033	0.065	0.349	0.701	15.744	0.443
6.017		27.036		1.184		0.032	0.064		0.626		0.442
0.463	6.114	6.229	3.410	1.005	0.833	1.377	0.113	0.131	0.788	1.190	12.916
0.522	5.829	3.571	4.021	0.862	0.724	1.121	0.112	0.133	0.922	1.119	12.241
0.566	5.086	2.000	4.984	0.746	0.667	0.997	0.112	0.134	0.981	1.071	11.759
0.661	3.829	1.450	5.501	0.654	0.634	0.928	0.112	0.128	1.092	1.022	8.793
0.957	3.129	1.190	5.740	0.692	0.610	0.877	0.112	0.124	1.660	1.852	5.197
1.496	2.679	1.044	5.837	0.778	0.595	0.767	0.113	0.129	1.965	8.591	3.794
1.930	2.446	0.936	5.597	0.809	0.581	0.493	0.111	0.136	1.936	10.635	3.306
2.273	2.334	0.837	4.990	0.840	0.582	0.337	0.107	0.138	1.788	11.748	3.066
2.521	4.477	0.840	4.059	0.864	0.581	0.264	0.105	0.140	4.681	12.463	2.944
2.743	7.077	1.269	2.993	0.899	0.556	0.223	0.104	0.144	8.418	13.197	2.994
2.864	8.049	4.276	2.930	0.956	0.502	0.194	0.104	0.146	10.612	13.799	2.869
2.757	8.606	16.864	2.860	0.895	0.451	0.177	0.104	0.143	11.386	13.290	2.687
2.389	8.927	28.167	2.777	0.808	0.408	0.168	0.112	0.136	12.688	6.826	4.304
2.103	9.574	33.219	2.760	0.772	0.379	0.165	0.127	0.133	13.353	5.073	5.064
1.877	9.857	36.246	3.159	0.745	0.373	0.165	0.133	0.160	13.796	5.174	5.307
1.697	7.586	38.557	3.539	0.739	0.348	0.149	0.136	0.174	11.176	6.371	5.420
1.940	4.793	39.957	3.906	1.091	0.317	0.138	0.140	0.179	9.090	6.684	5.394
5.233	3.707	37.843	3.689	1.849	0.293	0.135	0.142	0.201	9.347	6.570	5.734
7.554	3.079	25.746	3.607	2.227	0.278	0.133	0.145	0.230	10.111	6.507	6.531
8.894	2.686	14.803	3.617	4.413	0.266	0.134	0.139	0.262	9.484	6.431	5.014
9.766	1.926	10.104	3.923	6.493	0.253	0.138	0.124	0.288	9.239	6.304	4.337
10.389	1.706	8.276	3.717	7.231	0.222	0.138	0.119	0.290	9.111	8.004	7.174
10.754	4.149	9.733	3.430	7.589	0.277	0.137	0.117	0.308	9.014	8.461	9.366
10.669	5.584	8.876	3.030	7.449	0.998	0.139	0.115	0.334	7.547	8.977	10.189
7.626	6.070	8.489	2.674	6.814	1.334	0.142	0.113	0.338	5.176	9.503	10.169
5.854	6.270	8.457	2.463	6.514	1.500	0.143	0.110	0.338	3.220	9.877	9.684
5.497	6.363	8.407	2.270	4.366	1.595	0.139	0.107	0.341	2.347	12.974	9.701
5.983	6.423	8.301	1.774	2.321	1.658	0.131	0.114	0.345	1.887	16.754	9.940
6.100		7.323	1.422	1.612	1.772	0.125	0.123	0.361	1.617	15.597	11.469
6.214		3.704	1.188	1.252	1.960	0.119	0.126	0.548	1.424	13.999	17.083
6.214		3.170		1.017		0.115	0.127		1.290		18.070
18.466	0.844	5.379	21.686	2.094	2.173	0.081	0.371	0.104	0.112	1.994	5.859
18.499	0.827	10.850	21.080	1.791	2.011	0.078	0.386	0.101	0.112	1.628	6.395
18.277	0.816	16.210	13.897	1.601	1.633	0.077	1.206	0.099	0.167	1.159	6.587
17.824	0.825	18.329	5.600	1.453	1.130	0.079	1.608	0.098	0.244	0.816	6.716
13.103	0.862	19.500	4.066	1.329	0.820	0.092	1.770	0.098	0.315	0.625	6.781
5.064	0.931	20.686	3.697	1.229	0.553	0.102	1.693	0.097	0.379	0.518	6.763
3.084	1.061	23.857	3.607	1.167	0.399	0.396	1.630	0.097	0.484	0.440	3.833

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991	8	1.200	2.450	12.300	10.300	1.020	0.143	1.640	0.247	0.100	0.732	0.256	10.100
1991	9	1.100	3.400	6.730	59.400	0.991	0.125	0.786	0.187	0.097	0.459	0.219	24.100
1991	10	1.060	4.000	3.400	56.900	1.090	0.113	0.388	0.156	0.105	0.347	0.226	9.030
1991	11	1.030	3.550	2.700	10.800	0.939	0.313	0.216	0.144	0.105	0.307	0.221	4.850
1991	12	1.000	3.000	2.250	5.220	0.803	0.719	0.157	0.129	0.101	0.255	0.234	3.520
1991	13	1.030	2.450	1.980	3.620	0.721	0.473	0.136	0.119	0.103	0.214	0.267	12.100
1991	14	1.060	2.150	1.900	2.990	0.843	0.297	0.127	0.106	0.103	0.180	0.265	7.050
1991	15	1.100	1.930	3.000	9.690	0.834	0.209	0.112	0.098	0.115	0.186	0.398	3.170
1991	16	1.140	1.770	5.600	17.800	0.696	0.441	0.095	0.100	0.282	0.190	0.750	2.280
1991	17	1.310	1.670	9.000	6.120	0.644	0.527	0.085	0.117	0.185	0.179	0.748	1.730
1991	18	1.300	1.510	20.900	3.850	0.668	0.322	0.083	0.194	0.121	0.164	0.615	1.490
1991	19	1.240	3.600	19.300	3.010	0.578	0.210	0.076	0.159	0.105	0.161	0.621	1.380
1991	20	1.200	15.100	16.300	15.400	0.475	0.160	0.072	0.124	0.091	0.163	3.290	1.290
1991	21	1.150	14.200	13.800	19.700	0.402	0.134	0.067	0.115	0.080	0.159	4.990	1.240
1991	22	1.110	13.000	9.500	11.400	0.351	0.119	0.073	0.103	0.077	0.151	2.560	1.180
1991	23	1.020	10.700	13.100	6.700	0.282	0.110	0.080	0.096	0.099	0.144	1.760	1.150
1991	24	0.980	8.880	26.400	4.480	0.276	0.109	0.072	0.091	0.116	0.233	1.570	1.120
1991	25	0.940	5.470	13.400	3.470	0.821	0.100	0.064	0.097	0.113	1.510	1.340	1.090
1991	26	0.910	4.000	8.220	2.650	1.720	0.089	0.059	0.113	0.109	3.150	1.060	1.040
1991	27	0.870	3.100	53.400	2.180	3.070	0.087	0.058	0.110	0.111	3.760	0.892	1.020
1991	28	0.855	2.700	60.900	1.870	3.840	0.077	0.058	0.108	0.117	2.800	0.924	1.000
1991	29	0.840		14.300	1.700	2.420	0.073	0.077	0.104	0.113	1.670	1.400	1.270
1991	30	0.820		6.550	1.490	2.060	0.072	1.210	0.103	0.109	1.070	22.200	2.270
1991	31	0.810		4.300		1.240		0.832	0.097		0.826		2.400
1992	1	2.000	1.540	1.800	4.470	2.160	0.867	0.139	1.830	2.260	1.580	0.908	2.730
1992	2	1.720	1.470	1.660	3.440	23.300	0.670	0.135	3.700	1.550	1.420	2.820	2.480
1992	3	1.620	1.370	1.530	2.610	32.300	0.489	0.148	21.700	1.770	1.330	23.700	2.310
1992	4	5.000	1.340	1.510	2.620	7.940	0.371	0.221	7.840	1.960	1.240	18.000	2.010
1992	5	13.300	1.250	1.720	2.680	4.220	0.333	0.189	3.120	1.380	1.100	12.300	1.820
1992	6	8.000	1.200	3.990	2.750	3.170	0.323	0.158	1.640	1.680	0.894	8.500	1.700
1992	7	5.990	1.200	16.000	3.710	2.550	0.309	0.145	1.060	2.840	0.535	5.600	1.650
1992	8	3.730	1.120	27.000	4.410	2.040	0.299	0.147	7.620	2.500	0.472	3.800	1.490
1992	9	2.980	0.996	42.000	3.590	1.760	0.254	0.169	21.100	5.810	0.578	2.360	1.340
1992	10	2.670	0.965	111.000	3.040	1.960	0.199	0.174	13.900	5.380	0.685	2.410	1.280
1992	11	2.290	1.020	37.600	28.800	1.510	0.169	0.297	24.300	6.480	0.639	7.860	1.380
1992	12	1.940	0.983	12.100	25.200	1.230	0.175	0.298	8.200	2.750	0.697	31.900	1.300
1992	13	1.880	1.010	6.410	7.080	1.070	0.172	0.720	3.750	1.740	0.734	90.500	1.220
1992	14	1.210	1.040	4.030	4.390	0.969	0.191	0.896	2.510	1.240	0.725	16.600	1.220
1992	15	1.070	1.040	2.340	3.340	0.838	0.147	1.280	1.760	0.978	0.854	7.550	1.270
1992	16	1.830	1.220	1.790	25.200	0.760	0.132	0.951	1.660	0.870	6.370	4.650	8.010
1992	17	2.310	1.240	1.390	41.300	0.730	0.135	0.799	1.850	1.010	11.100	3.780	14.600
1992	18	2.280	1.190	2.150	11.200	0.901	0.193	1.690	1.410	8.190	5.760	3.360	7.360
1992	19	2.030	1.490	2.270	6.490	0.867	0.343	1.860	1.140	22.000	4.200	3.000	4.510
1992	20	1.880	2.520	2.330	4.940	0.696	0.253	1.020	0.947	7.670	3.190	2.600	7.470

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.174	1.296	25.214	4.489	1.127	0.297	0.620	1.622	0.098	0.573	0.378	3.390
1.663	1.669	19.176	12.406	1.076	0.230	0.721	1.626	0.099	0.622	0.326	6.106
1.421	2.127	13.033	20.089	1.043	0.186	0.765	0.819	0.100	0.601	0.290	7.053
1.287	2.503	10.519	21.229	1.014	0.185	0.782	0.430	0.100	0.552	0.265	7.489
1.180	2.774	9.097	21.466	0.986	0.252	0.780	0.276	0.100	0.501	0.250	7.794
1.109	2.939	7.751	21.416	0.946	0.293	0.779	0.196	0.101	0.451	0.243	9.341
1.069	3.000	4.466	21.319	0.915	0.312	0.493	0.155	0.102	0.356	0.241	10.107
1.054	2.926	3.137	21.231	0.889	0.321	0.275	0.134	0.104	0.278	0.261	9.117
1.060	2.693	2.976	15.289	0.847	0.366	0.176	0.122	0.131	0.240	0.337	6.000
1.096	2.360	3.776	8.034	0.783	0.426	0.133	0.116	0.142	0.216	0.412	4.957
1.134	2.069	6.376	7.041	0.744	0.427	0.114	0.123	0.144	0.195	0.468	4.477
1.169	2.154	8.811	6.726	0.712	0.354	0.102	0.128	0.145	0.182	0.523	4.171
1.193	3.961	10.857	8.409	0.677	0.309	0.093	0.128	0.143	0.175	0.955	2.627
1.206	5.683	12.557	10.796	0.614	0.286	0.084	0.130	0.140	0.172	1.630	1.797
1.207	7.264	13.486	11.040	0.545	0.273	0.079	0.130	0.134	0.167	1.939	1.513
1.190	8.540	14.557	9.454	0.486	0.226	0.077	0.130	0.108	0.160	2.083	1.351
1.143	9.570	17.043	9.220	0.433	0.166	0.075	0.126	0.098	0.168	2.201	1.264
1.091	10.136	15.971	9.166	0.455	0.135	0.072	0.112	0.097	0.360	2.304	1.207
1.044	10.193	14.389	9.114	0.618	0.117	0.070	0.106	0.098	0.787	2.367	1.159
0.997	8.479	19.689	7.226	0.989	0.107	0.068	0.104	0.101	1.301	2.025	1.120
0.955	6.836	26.417	4.679	1.480	0.099	0.066	0.103	0.106	1.678	1.444	1.086
0.916		27.103	3.293	1.776	0.092	0.067	0.103	0.111	1.895	1.278	1.099
0.888		26.167	2.549	2.030	0.087	0.228	0.104	0.113	2.028	4.198	1.259
0.864		23.010		2.167		0.337	0.105		2.112		1.441
1.571	2.143	2.151	6.141	4.583	0.469	0.168	0.685	7.695	2.256	1.257	5.749
1.669	1.909	2.029	5.484	6.411	0.505	0.158	1.173	7.851	1.927	1.405	4.417
1.754	1.739	1.910	4.371	9.967	0.521	0.153	4.224	7.987	1.767	4.575	3.611
2.326	1.603	1.801	3.920	10.480	0.522	0.159	5.300	5.781	1.621	6.959	3.044
4.044	1.494	1.736	3.689	10.650	0.517	0.162	5.673	3.050	1.476	8.545	2.627
4.863	1.409	2.014	3.383	10.769	0.512	0.162	5.843	2.064	1.332	9.604	2.314
5.376	1.339	4.030	3.183	10.806	0.480	0.162	5.841	1.920	1.157	10.261	2.100
5.623	1.279	7.630	3.174	10.789	0.399	0.163	6.669	1.954	0.999	10.674	1.923
5.803	1.211	13.393	3.196	7.711	0.340	0.168	9.154	2.563	0.878	10.609	1.760
5.953	1.153	29.031	3.257	3.377	0.298	0.172	8.040	3.079	0.786	7.567	1.613
5.566	1.107	34.187	6.997	2.459	0.269	0.183	10.391	3.724	0.700	6.119	1.523
3.943	1.069	35.670	10.214	2.031	0.247	0.198	11.117	3.920	0.643	8.919	1.449
3.069	1.042	36.016	10.833	1.731	0.225	0.279	11.419	3.929	0.620	20.633	1.380
2.386	1.019	34.306	10.930	1.506	0.208	0.386	11.626	3.700	0.647	22.204	1.319
2.006	1.008	30.783	10.777	1.334	0.187	0.548	10.789	3.483	0.702	22.740	1.287
1.841	1.040	25.039	13.864	1.191	0.169	0.659	8.011	2.777	1.529	23.067	2.240
1.790	1.079	9.380	19.330	1.015	0.160	0.749	6.290	2.153	3.017	23.263	4.143
1.789	1.103	4.316	16.816	0.928	0.164	0.948	3.020	2.397	3.749	22.620	4.997
1.801	1.176	2.911	14.143	0.876	0.188	1.171	2.011	5.147	4.249	18.491	5.456
1.801	1.391	2.329	13.837	0.823	0.199	1.214	1.611	5.994	4.600	5.934	6.349

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1992	21	1.740	2.790	2.000	5.460	0.602	0.215	0.645	0.785	3.750	3.600	9.200	4.350
1992	22	1.640	2.860	1.540	9.200	0.499	0.232	0.444	0.659	33.400	4.440	16.000	2.930
1992	23	1.690	2.830	1.440	5.890	0.467	0.200	0.370	0.629	17.000	3.300	47.700	2.220
1992	24	2.620	2.520	1.100	13.000	0.509	0.202	0.352	0.579	7.160	2.750	25.200	1.180
1992	25	3.300	2.360	1.600	10.500	0.485	0.204	0.275	0.510	3.720	2.230	11.800	1.080
1992	26	3.110	2.270	8.040	7.410	0.423	0.183	0.284	0.454	2.450	1.780	7.950	1.030
1992	27	2.560	2.180	10.400	4.350	0.375	0.182	0.340	0.820	2.260	1.510	5.980	1.000
1992	28	2.290	2.040	5.780	3.030	0.365	0.168	0.310	17.400	2.120	1.310	4.740	0.998
1992	29	2.010	1.890	4.300	2.340	0.363	0.156	0.512	20.500	1.900	1.200	3.890	1.320
1992	30	1.800		4.890	2.290	0.360	0.143	0.448	8.580	1.760	1.090	3.150	3.970
1992	31	1.690		5.110		0.532		1.070	3.850		0.998		24.000
1993	1	10.000	0.900	0.470	34.000	1.870	1.000	0.767	0.146	0.158	0.563	0.347	2.200
1993	2	4.800	0.874	0.465	16.800	1.470	0.806	0.584	0.133	0.149	0.828	0.316	2.100
1993	3	4.000	0.830	0.460	9.470	1.240	0.602	0.631	0.131	0.215	1.010	0.328	8.050
1993	4	70.000	0.790	0.456	7.960	1.150	0.449	0.532	0.139	0.235	0.757	0.354	7.310
1993	5	58.800	0.760	0.453	17.600	1.480	0.398	0.378	0.156	0.224	0.589	0.472	6.290
1993	6	14.200	0.730	0.450	29.900	1.490	0.422	0.294	0.146	0.202	0.460	0.659	4.250
1993	7	6.830	0.700	0.446	32.400	1.120	0.383	0.262	0.136	0.183	0.398	0.706	3.780
1993	8	3.800	0.680	0.443	29.900	0.995	0.629	0.243	0.130	0.165	0.373	0.594	3.070
1993	9	2.400	0.660	0.440	28.000	0.872	3.490	0.239	0.131	0.141	0.375	0.526	2.380
1993	10	1.700	0.640	0.438	38.500	0.706	5.920	0.301	0.124	0.171	0.418	0.447	2.520
1993	11	1.500	0.620	0.436	14.100	0.694	2.870	0.249	0.201	0.236	0.392	0.434	2.200
1993	12	1.300	0.600	0.434	8.540	0.502	1.500	0.418	0.681	0.254	0.385	0.417	1.900
1993	13	1.200	0.590	0.432	5.690	0.432	0.972	0.458	0.336	0.238	0.356	0.412	1.600
1993	14	1.100	0.580	0.430	4.420	0.402	0.712	0.279	0.230	0.219	0.277	0.424	1.400
1993	15	1.000	0.570	0.429	3.880	0.543	0.672	0.262	0.178	0.523	0.236	0.640	1.250
1993	16	0.940	0.560	0.428	4.390	0.497	0.540	0.231	0.179	0.682	0.247	0.642	1.000
1993	17	0.890	0.550	0.427	3.930	0.375	0.391	0.188	0.206	0.520	0.622	0.669	0.800
1993	18	0.860	0.540	0.426	3.180	0.338	0.320	0.159	0.167	0.361	2.380	0.633	0.973
1993	19	0.830	0.530	0.425	2.900	0.349	0.396	0.300	0.204	0.298	1.630	0.629	0.905
1993	20	0.800	0.520	0.424	29.200	0.379	4.160	0.437	0.132	0.258	1.110	0.860	0.892
1993	21	0.850	0.510	0.423	12.000	0.629	38.200	0.284	0.115	0.250	1.390	0.920	0.909
1993	22	1.000	0.505	0.422	5.260	0.594	21.100	0.218	0.129	0.246	1.870	1.200	0.750
1993	23	1.200	0.500	0.421	3.440	0.454	6.950	0.178	0.099	0.234	1.190	1.400	0.620
1993	24	1.180	0.495	0.420	3.030	0.629	3.000	0.144	0.098	0.230	0.910	1.210	0.570
1993	25	1.160	0.490	0.500	10.600	1.160	1.770	0.124	0.099	0.225	0.769	0.790	0.530
1993	26	1.120	0.485	0.700	8.010	0.897	9.680	0.139	0.090	0.248	0.651	0.800	0.510
1993	27	1.080	0.480	1.200	4.250	0.701	5.130	0.174	0.087	0.288	0.571	2.920	0.490
1993	28	1.040	0.475	2.770	3.140	0.656	2.380	0.180	0.155	0.416	0.512	10.500	0.470
1993	29	1.000		22.000	2.500	0.642	1.380	0.152	0.143	0.706	0.460	5.570	0.450
1993	30	0.970		45.000	2.230	0.491	0.992	0.191	0.128	0.710	0.410	3.210	0.440
1993	31	0.940		62.900		0.676		0.173	0.140		0.372		0.430
1994	1	0.430	0.900	1.820	14.700	8.930	2.340	0.338	0.147	0.084	0.240	0.177	1.700
1994	2	0.420	0.800	1.700	28.300	6.260	1.500	0.240	0.134	0.100	0.270	0.215	1.480

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.877	1.641	2.039	13.990	0.771	0.203	1.178	1.365	6.353	5.011	4.877	6.796
1.959	1.901	1.924	14.827	0.722	0.215	1.058	1.207	10.984	5.523	6.084	7.033
1.939	2.131	1.874	12.069	0.680	0.224	0.975	1.060	13.289	5.084	12.234	6.206
1.983	2.314	1.833	8.026	0.649	0.234	0.912	0.878	14.167	3.891	15.294	4.289
2.129	2.481	1.754	7.926	0.589	0.236	0.709	0.750	13.529	3.387	16.500	3.391
2.283	2.593	2.579	8.057	0.526	0.213	0.484	0.652	10.736	3.041	17.207	2.894
2.380	2.544	3.731	7.973	0.480	0.203	0.387	0.634	9.963	2.801	17.690	1.970
2.459	2.437	4.271	7.626	0.446	0.196	0.339	3.007	9.730	2.474	17.053	1.491
2.511	2.299	4.666	6.646	0.427	0.185	0.349	5.842	5.230	2.011	15.323	1.261
2.527		5.159	6.131	0.411	0.177	0.360	6.978	3.053	1.696	8.959	1.511
2.394		5.731		0.415		0.463	7.445		1.445		4.771
6.045	1.007	0.485	24.081	4.657	0.723	3.157	0.165	0.129	0.451	0.475	3.713
6.584	0.972	0.480	26.381	3.353	0.710	2.988	0.164	0.137	0.537	0.427	3.900
7.013	0.936	0.475	27.563	2.386	0.696	1.695	0.158	0.155	0.646	0.392	4.936
16.870	0.901	0.470	28.304	1.943	0.667	1.038	0.152	0.167	0.713	0.370	5.563
25.081	0.866	0.466	27.676	1.706	0.632	0.752	0.153	0.178	0.738	0.371	4.961
26.543	0.832	0.461	25.519	1.561	0.622	0.597	0.146	0.189	0.702	0.407	4.773
24.090	0.798	0.457	21.161	1.403	0.580	0.493	0.141	0.195	0.658	0.455	4.854
23.204	0.766	0.453	20.576	1.278	0.527	0.418	0.139	0.196	0.631	0.490	4.979
22.861	0.736	0.450	22.176	1.192	0.910	0.368	0.138	0.195	0.566	0.520	5.019
22.533	0.709	0.447	26.323	1.116	1.670	0.321	0.137	0.189	0.481	0.537	4.229
12.747	0.684	0.444	27.200	1.051	2.016	0.281	0.146	0.189	0.429	0.548	3.499
4.533	0.661	0.441	25.906	0.911	2.173	0.287	0.221	0.193	0.400	0.540	2.871
2.676	0.641	0.438	22.447	0.760	2.252	0.310	0.248	0.198	0.385	0.505	2.493
1.857	0.624	0.436	18.450	0.658	2.299	0.312	0.262	0.203	0.368	0.465	2.153
1.457	0.609	0.434	14.733	0.593	2.305	0.315	0.269	0.255	0.348	0.471	1.893
1.249	0.594	0.432	11.360	0.539	1.884	0.314	0.276	0.332	0.330	0.488	1.696
1.133	0.581	0.431	6.421	0.492	1.094	0.298	0.287	0.382	0.359	0.520	1.450
1.041	0.570	0.429	4.861	0.441	0.730	0.285	0.282	0.400	0.643	0.548	1.275
0.974	0.560	0.428	4.056	0.419	0.572	0.268	0.214	0.406	0.821	0.578	1.133
0.917	0.550	0.427	7.414	0.412	1.027	0.265	0.185	0.409	0.929	0.642	1.031
0.881	0.540	0.426	8.497	0.444	6.383	0.266	0.169	0.413	1.088	0.713	0.961
0.881	0.531	0.425	8.694	0.452	9.301	0.260	0.162	0.374	1.321	0.793	0.890
0.919	0.522	0.424	8.559	0.445	10.217	0.252	0.150	0.310	1.456	0.902	0.836
0.960	0.514	0.423	8.430	0.482	10.589	0.246	0.135	0.268	1.497	0.979	0.803
1.003	0.507	0.434	9.490	0.599	10.797	0.241	0.125	0.249	1.267	1.001	0.739
1.044	0.501	0.473	10.220	0.677	12.123	0.218	0.109	0.242	1.127	1.026	0.683
1.084	0.495	0.584	6.656	0.723	12.261	0.180	0.102	0.246	1.050	1.320	0.626
1.111	0.490	0.919	5.390	0.727	7.144	0.165	0.108	0.270	0.925	2.689	0.563
1.111		4.002	4.996	0.734	4.327	0.156	0.110	0.335	0.723	3.313	0.520
1.079		10.370	4.823	0.739	3.476	0.158	0.114	0.403	0.612	3.571	0.494
1.044		19.296		0.746		0.162	0.120		0.535		0.474
0.460	0.792	3.289	12.291	7.119	7.506	0.248	0.396	0.066	0.213	0.208	1.339
0.447	0.863	2.674	14.191	7.574	5.506	0.251	0.291	0.072	0.232	0.202	1.492

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	3	0.410	0.700	1.550	31.100	3.660	1.090	0.181	0.120	0.089	0.251	0.212	2.270
1994	4	0.400	0.600	1.570	13.900	2.620	0.869	0.145	0.132	0.069	0.200	0.546	6.830
1994	5	0.390	0.540	1.600	13.500	2.040	0.738	0.130	0.173	0.074	0.160	1.590	9.150
1994	6	0.380	0.500	1.800	8.270	2.240	0.626	0.163	0.148	0.089	0.210	3.640	10.700
1994	7	0.376	0.480	2.000	5.250	2.250	0.599	0.682	0.120	0.096	0.200	5.300	5.000
1994	8	0.371	0.460	2.200	4.560	2.040	0.515	0.637	0.104	0.099	0.180	3.000	3.000
1994	9	0.368	0.440	2.000	5.410	1.750	0.414	0.307	0.096	0.097	0.160	2.000	1.800
1994	10	0.365	0.430	1.900	7.420	1.670	0.376	0.219	0.091	0.104	0.148	1.500	1.500
1994	11	0.360	0.420	1.500	4.800	1.740	0.305	0.168	0.086	0.103	0.134	1.130	0.950
1994	12	0.355	0.410	1.200	4.580	13.100	0.323	0.132	0.083	0.104	0.112	0.914	0.920
1994	13	0.350	0.400	1.050	20.100	5.410	0.312	0.109	0.087	0.111	0.104	0.803	0.880
1994	14	0.346	0.390	0.900	14.300	3.000	0.271	0.097	0.100	0.377	0.096	0.721	0.860
1994	15	0.342	0.385	1.000	7.920	3.400	0.245	0.091	0.092	0.386	0.090	0.668	0.857
1994	16	0.337	0.382	0.950	7.850	4.920	0.204	0.086	0.084	0.294	0.085	0.575	0.881
1994	17	0.333	0.380	0.900	7.340	3.810	0.168	0.076	0.071	0.262	0.080	0.480	1.240
1994	18	0.327	0.380	0.860	4.560	2.630	0.145	0.071	0.061	0.320	0.180	0.437	2.120
1994	19	0.321	0.500	0.820	3.340	1.910	0.123	0.064	0.058	0.400	0.395	0.389	2.550
1994	20	0.316	3.000	0.800	2.510	1.410	0.101	0.079	0.066	0.300	0.337	0.346	2.350
1994	21	0.312	7.500	1.200	1.910	1.150	0.105	0.100	0.093	0.240	0.260	0.344	2.010
1994	22	0.309	6.800	8.000	1.470	0.989	0.091	0.407	0.112	0.200	0.222	0.448	1.840
1994	23	0.306	6.000	20.000	1.240	0.861	0.088	1.520	0.086	0.170	0.201	0.435	1.670
1994	24	0.303	4.500	35.000	1.150	0.768	0.123	0.658	0.069	0.150	0.190	0.394	1.690
1994	25	0.300	3.200	25.000	3.070	0.763	0.218	0.346	0.060	0.140	0.224	0.404	1.940
1994	26	0.305	2.800	15.000	7.870	15.500	0.234	0.866	0.062	0.174	0.253	0.361	1.850
1994	27	0.340	2.500	13.000	14.300	19.400	0.189	0.712	0.061	0.230	0.248	0.326	1.630
1994	28	0.600	2.200	12.300	7.290	6.840	0.157	0.410	0.063	0.260	0.226	1.240	1.580
1994	29	1.000		14.100	4.630	3.820	0.200	0.260	0.062	0.230	0.208	3.110	1.300
1994	30	1.300		8.780	3.740	2.560	0.402	0.205	0.061	0.220	0.180	2.230	1.050
1994	31	1.100		8.160		2.080		0.169	0.072		0.162		0.940
1995	1	0.900	1.000	0.470	1.380	2.940	0.961	0.138	0.082	0.151	0.024	0.716	3.800
1995	2	0.800	0.930	0.467	1.240	2.320	0.744	0.113	0.074	0.148	0.022	5.960	4.400
1995	3	0.629	0.860	0.463	1.250	1.910	17.600	0.094	0.098	0.158	0.024	11.400	4.670
1995	4	0.617	0.800	0.460	1.660	1.510	11.500	0.086	0.196	0.149	0.037	5.350	6.670
1995	5	0.617	0.720	0.480	1.320	1.240	4.550	0.081	0.197	0.143	0.058	2.860	4.500
1995	6	0.532	0.700	0.510	1.320	1.050	2.350	0.088	0.147	0.143	0.207	2.170	3.200
1995	7	0.555	0.670	1.000	1.370	0.875	1.480	0.156	0.134	0.154	0.227	2.810	2.400
1995	8	0.546	0.650	14.000	1.460	0.766	1.160	0.152	0.123	0.120	0.229	4.040	1.700
1995	9	0.552	0.630	11.000	2.270	0.685	0.896	0.122	0.109	0.067	0.188	2.640	1.300
1995	10	0.545	0.610	8.500	2.130	0.894	0.656	0.104	0.093	0.051	0.142	2.370	1.150
1995	11	0.572	0.600	7.000	1.810	4.050	0.508	0.093	0.139	0.040	0.116	47.500	1.100
1995	12	0.716	0.590	22.000	1.740	3.630	0.407	0.083	0.199	0.032	0.098	42.800	1.070
1995	13	6.000	0.580	44.000	1.730	2.400	0.331	0.116	0.191	0.026	0.087	12.800	1.050
1995	14	30.000	0.570	39.500	1.690	1.720	0.263	2.100	0.188	0.024	0.082	7.210	1.100
1995	15	69.500	0.560	31.800	1.430	1.320	0.221	1.260	0.182	0.023	0.116	5.540	1.150

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.436	0.914	2.253	16.777	6.973	2.890	0.244	0.206	0.076	0.243	0.197	1.765
0.426	0.914	2.020	17.006	5.304	2.037	0.238	0.167	0.077	0.239	0.243	2.694
0.417	0.849	1.849	16.920	4.554	1.597	0.234	0.154	0.078	0.224	0.440	3.824
0.409	0.734	1.749	16.847	4.213	1.320	0.228	0.146	0.082	0.222	0.935	4.909
0.401	0.646	1.720	16.431	4.000	1.109	0.268	0.139	0.086	0.219	1.669	5.304
0.392	0.583	1.774	14.983	3.016	0.848	0.311	0.133	0.088	0.210	2.072	5.490
0.385	0.531	1.817	11.713	2.371	0.693	0.321	0.128	0.088	0.194	2.327	5.536
0.379	0.493	1.867	8.330	2.087	0.591	0.326	0.123	0.090	0.180	2.511	5.426
0.373	0.467	1.857	7.030	1.961	0.510	0.329	0.117	0.095	0.170	2.594	4.586
0.368	0.449	1.800	5.756	3.541	0.451	0.330	0.104	0.099	0.163	2.498	3.410
0.364	0.434	1.693	7.446	3.994	0.406	0.322	0.095	0.102	0.148	2.092	2.007
0.359	0.421	1.536	8.739	4.101	0.359	0.238	0.092	0.142	0.133	1.438	1.416
0.355	0.411	1.364	9.219	4.296	0.321	0.160	0.091	0.183	0.121	1.105	1.110
0.351	0.402	1.214	9.567	4.749	0.291	0.129	0.089	0.211	0.110	0.902	0.978
0.346	0.395	1.071	9.556	5.054	0.261	0.108	0.086	0.234	0.100	0.756	0.941
0.341	0.390	0.980	9.521	5.181	0.238	0.095	0.083	0.265	0.107	0.657	1.108
0.337	0.402	0.926	9.344	3.583	0.210	0.085	0.079	0.307	0.147	0.582	1.341
0.332	0.774	0.890	6.831	3.011	0.180	0.081	0.076	0.334	0.180	0.517	1.551
0.327	1.790	0.933	5.061	2.747	0.156	0.081	0.075	0.315	0.204	0.463	1.715
0.322	2.706	1.933	4.140	2.403	0.134	0.126	0.078	0.288	0.223	0.431	1.856
0.318	3.509	4.654	3.196	1.823	0.117	0.331	0.078	0.270	0.239	0.411	1.969
0.313	4.097	9.526	2.311	1.388	0.111	0.414	0.078	0.254	0.255	0.399	2.033
0.310	4.500	12.974	2.099	1.122	0.121	0.453	0.078	0.229	0.261	0.394	2.007
0.307	4.829	15.000	2.746	3.063	0.137	0.568	0.078	0.196	0.241	0.390	1.907
0.311	4.757	16.743	4.430	5.633	0.150	0.658	0.078	0.186	0.228	0.387	1.804
0.352	4.000	18.329	5.199	6.446	0.157	0.703	0.073	0.189	0.223	0.515	1.743
0.451		19.200	5.650	6.850	0.173	0.682	0.066	0.193	0.221	0.896	1.666
0.593		17.597	6.007	7.093	0.218	0.494	0.063	0.201	0.218	1.152	1.577
0.706		13.763		7.280		0.424	0.063		0.214		1.470
1.321	1.957	0.501	1.907	7.369	1.213	0.156	0.175	0.151	0.030	0.471	4.556
1.171	1.619	0.491	1.699	7.203	1.208	0.157	0.133	0.151	0.027	1.301	4.827
1.028	1.356	0.483	1.546	7.001	3.632	0.127	0.119	0.152	0.026	2.905	5.151
0.891	1.127	0.476	1.493	4.089	5.188	0.117	0.125	0.151	0.027	3.597	5.720
0.793	0.973	0.473	1.430	2.737	5.562	0.109	0.126	0.150	0.031	3.897	5.006
0.719	0.873	0.476	1.386	2.110	5.586	0.103	0.128	0.149	0.057	4.127	4.463
0.664	0.811	0.550	1.363	1.692	5.598	0.108	0.133	0.149	0.086	4.467	4.234
0.614	0.761	2.483	1.374	1.382	5.626	0.110	0.138	0.145	0.115	4.941	3.934
0.578	0.719	3.988	1.521	1.148	5.648	0.111	0.143	0.133	0.139	4.467	3.491
0.566	0.683	5.136	1.647	1.003	3.227	0.113	0.143	0.118	0.155	3.177	2.989
0.560	0.654	6.070	1.669	1.366	1.657	0.114	0.135	0.103	0.167	9.199	2.193
0.574	0.636	9.144	1.729	1.707	1.065	0.114	0.135	0.087	0.172	14.904	1.703
1.355	0.619	15.357	1.787	1.900	0.777	0.118	0.141	0.070	0.155	16.423	1.396
5.562	0.604	20.857	1.833	2.021	0.603	0.396	0.149	0.051	0.135	17.051	1.210
15.412	0.591	23.400	1.829	2.100	0.469	0.554	0.157	0.038	0.118	17.266	1.131

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1995	16	38.800	0.580	25.600	1.150	1.030	0.184	0.477	0.210	0.021	0.160	4.220	1.400
1995	17	16.300	0.600	14.100	0.962	1.480	0.160	0.280	0.187	0.039	0.161	3.880	1.320
1995	18	10.000	0.610	7.430	0.895	2.120	0.138	0.234	0.152	0.044	0.158	3.660	1.250
1995	19	9.120	0.620	7.230	1.150	1.480	0.119	0.245	0.126	0.048	0.138	3.450	1.150
1995	20	15.000	0.600	10.700	1.390	1.130	0.105	0.184	0.157	0.040	0.147	3.710	1.080
1995	21	22.900	0.580	16.000	32.300	1.090	0.095	0.175	0.175	0.037	0.247	5.130	1.000
1995	22	12.900	0.560	8.880	26.500	0.955	0.084	0.137	0.171	0.041	0.261	4.820	0.900
1995	23	7.290	0.540	6.600	8.710	0.759	0.077	0.125	0.167	0.040	0.234	3.940	0.850
1995	24	5.090	0.520	4.380	4.740	0.910	0.073	0.129	0.167	0.043	0.197	2.800	0.780
1995	25	4.050	0.510	3.210	3.480	0.897	0.105	0.242	0.156	0.039	0.171	2.500	0.750
1995	26	3.300	0.500	2.700	3.320	0.782	0.305	0.367	0.150	0.034	0.148	2.400	0.730
1995	27	2.700	0.490	2.320	21.900	0.632	0.156	0.197	0.153	0.031	0.172	2.690	0.690
1995	28	2.400	0.480	2.030	10.700	0.606	0.142	0.150	0.153	0.028	0.508	9.500	0.670
1995	29	1.800		1.760	5.440	1.930	0.127	0.188	0.150	0.026	0.760	7.000	0.660
1995	30	1.400		1.630	3.800	2.180	0.121	0.137	0.148	0.025	0.564	4.000	0.650
1995	31	1.100		1.530		1.400		0.101	0.153		0.430		0.640
1996	1	0.640	2.400	6.200	15.000	11.100	0.635	0.871	1.290	0.104	3.270	4.290	6.680
1996	2	0.630	2.200	4.800	10.200	9.160	0.570	0.625	0.735	0.092	2.230	3.170	13.700
1996	3	0.610	1.800	3.000	7.870	5.380	0.666	0.557	0.476	0.083	1.560	2.580	6.060
1996	4	0.598	1.400	2.200	4.200	4.230	0.705	0.443	0.337	0.077	1.190	2.460	4.150
1996	5	0.590	1.200	1.800	3.800	3.580	0.755	0.315	0.256	0.067	0.963	2.770	3.600
1996	6	0.580	1.100	1.500	3.200	2.950	0.672	0.256	0.211	0.067	0.826	3.050	3.390
1996	7	0.560	1.000	1.200	3.510	2.300	1.360	0.245	0.180	0.086	0.717	6.100	3.290
1996	8	0.540	1.300	1.000	4.180	1.900	2.020	0.247	0.171	0.165	0.649	28.200	3.270
1996	9	0.520	4.000	0.800	5.140	1.910	1.580	0.446	0.143	0.189	0.632	12.000	3.160
1996	10	0.500	6.000	0.700	10.600	7.150	1.370	0.356	0.120	0.141	0.714	6.410	2.940
1996	11	0.480	5.000	0.650	16.800	12.200	1.210	0.272	0.114	0.128	0.701	4.320	2.940
1996	12	0.460	3.000	0.600	23.500	7.900	3.100	0.208	0.106	0.310	0.636	3.440	2.850
1996	13	0.440	2.500	0.800	74.700	4.540	9.290	0.287	0.101	0.307	0.588	3.070	12.300
1996	14	0.420	2.000	4.000	37.800	3.170	3.960	0.391	0.093	0.534	0.551	2.870	11.000
1996	15	0.400	1.500	15.000	16.900	2.350	2.100	1.050	0.090	0.937	0.494	2.200	7.530
1996	16	0.390	1.300	12.000	25.100	1.890	1.300	1.140	0.091	1.280	0.464	2.100	7.580
1996	17	2.200	1.100	9.000	13.300	1.600	0.939	0.758	0.093	1.220	0.740	2.490	34.100
1996	18	30.000	1.000	9.500	9.580	1.660	1.220	0.441	0.086	0.911	0.834	6.230	29.500
1996	19	131.000	0.950	18.000	9.490	1.250	2.220	3.370	0.080	0.596	5.170	5.300	9.000
1996	20	28.900	0.900	16.000	22.200	4.760	8.010	3.310	0.078	0.368	4.440	3.820	4.500
1996	21	15.400	10.000	9.000	18.100	66.400	9.040	1.420	0.083	0.269	2.980	3.040	3.000
1996	22	9.000	20.000	5.000	20.200	14.700	9.330	0.866	0.084	0.256	2.390	2.490	3.080
1996	23	4.600	30.000	4.000	23.600	6.870	8.630	0.586	0.080	0.331	2.210	2.150	2.810
1996	24	4.000	60.000	2.800	15.200	4.900	9.530	0.413	0.076	0.329	3.680	1.700	30.800
1996	25	3.200	25.000	17.300	9.310	3.410	9.960	0.291	0.066	0.782	3.860	1.600	11.000
1996	26	3.000	23.000	27.000	10.200	2.420	4.050	0.244	0.060	0.906	2.890	1.450	7.000
1996	27	4.000	20.000	12.000	9.230	1.800	2.210	0.215	0.395	0.855	2.350	1.180	5.000
1996	28	6.000	13.000	8.000	5.620	1.380	1.360	0.176	0.405	15.900	2.020	1.160	4.050

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20.876	0.584	25.486	1.669	2.149	0.367	0.605	0.172	0.031	0.114	17.491	1.146
23.127	0.583	26.286	1.502	2.233	0.296	0.630	0.185	0.029	0.117	17.707	1.170
24.474	0.584	26.347	1.371	1.957	0.243	0.650	0.187	0.030	0.123	11.444	1.191
25.674	0.589	24.237	1.287	1.650	0.202	0.673	0.177	0.032	0.129	5.823	1.203
26.960	0.591	19.480	1.238	1.469	0.170	0.683	0.172	0.034	0.137	4.524	1.207
25.946	0.593	16.123	5.611	1.379	0.146	0.408	0.170	0.036	0.161	4.227	1.193
17.860	0.593	12.849	9.192	1.326	0.126	0.247	0.168	0.039	0.182	4.124	1.157
13.359	0.587	10.134	10.272	1.288	0.111	0.197	0.162	0.041	0.192	4.084	1.079
11.757	0.576	8.746	10.812	1.206	0.099	0.176	0.159	0.042	0.197	3.930	1.001
10.907	0.561	8.143	11.181	1.032	0.094	0.177	0.160	0.041	0.199	3.764	0.930
10.076	0.544	7.496	11.491	0.932	0.121	0.194	0.163	0.039	0.201	3.614	0.870
8.319	0.529	6.299	14.421	0.861	0.128	0.196	0.163	0.038	0.204	3.469	0.814
5.390	0.514	4.303	11.336	0.792	0.135	0.192	0.160	0.037	0.242	4.093	0.767
3.804		3.286	8.327	0.931	0.141	0.200	0.157	0.034	0.313	4.404	0.733
2.963		2.576	7.626	1.134	0.147	0.201	0.154	0.032	0.360	4.413	0.704
2.393		2.169		1.204		0.197	0.152		0.393		0.684
0.669	3.743	22.243	14.519	8.740	1.287	2.939	0.904	0.208	5.696	4.023	2.070
0.654	3.629	14.357	12.119	8.719	1.023	1.605	0.974	0.213	5.903	4.063	3.799
0.643	3.314	11.214	11.529	8.030	0.861	1.106	1.012	0.168	5.996	4.096	4.457
0.633	2.657	8.243	10.986	7.316	0.764	0.854	1.035	0.121	6.044	4.159	4.881
0.623	2.114	5.643	10.110	7.024	0.715	0.704	1.049	0.100	3.910	4.316	5.230
0.613	1.814	4.000	8.539	6.843	0.679	0.594	0.822	0.087	2.228	3.803	5.549
0.601	1.586	2.957	6.826	5.529	0.766	0.473	0.498	0.082	1.537	3.489	5.839
0.587	1.429	2.214	5.280	4.214	0.964	0.384	0.338	0.091	1.162	6.904	5.351
0.571	1.686	1.643	4.557	3.179	1.108	0.358	0.253	0.105	0.934	8.166	3.846
0.555	2.286	1.314	4.947	3.431	1.209	0.330	0.203	0.113	0.813	8.713	3.400
0.539	2.800	1.093	6.747	4.570	1.281	0.305	0.171	0.120	0.743	8.979	3.227
0.520	3.057	0.921	9.561	5.187	1.616	0.290	0.149	0.155	0.696	9.074	3.120
0.500	3.257	0.821	19.776	5.414	2.847	0.294	0.134	0.189	0.662	9.077	4.393
0.480	3.400	1.221	24.674	5.539	3.219	0.315	0.121	0.253	0.639	8.616	5.494
0.460	3.429	3.221	26.491	5.603	3.230	0.430	0.110	0.364	0.617	4.901	6.103
0.441	3.043	4.821	29.343	5.600	3.190	0.529	0.102	0.520	0.593	3.487	6.734
0.684	2.343	6.007	29.729	4.807	3.128	0.587	0.098	0.674	0.596	2.927	11.186
4.901	1.771	7.271	28.697	3.301	3.130	0.611	0.094	0.786	0.615	3.200	14.980
23.550	1.479	9.757	26.696	2.351	3.004	1.062	0.091	0.826	1.263	3.466	15.859
27.616	1.250	11.929	19.196	2.383	2.821	1.494	0.087	0.835	1.813	3.573	14.744
29.756	2.393	12.643	16.381	11.416	3.547	1.641	0.086	0.797	2.160	3.597	13.601
30.984	5.036	11.214	16.853	13.180	4.580	1.615	0.085	0.700	2.431	3.639	12.966
31.586	9.136	10.071	16.639	13.891	5.627	1.536	0.083	0.564	2.681	3.646	12.284
31.843	17.550	9.186	16.910	14.363	6.854	1.487	0.081	0.437	3.101	3.533	11.813
28.014	20.979	10.300	16.871	14.613	8.103	1.465	0.078	0.419	3.533	2.871	9.170
9.729	24.129	11.586	16.973	14.780	8.364	1.019	0.075	0.463	3.207	2.321	8.884
6.171	26.857	11.014	15.120	14.357	7.536	0.576	0.121	0.533	2.909	1.944	8.956
4.829	27.286	10.871	13.337	5.069	6.439	0.399	0.167	2.766	2.771	1.676	9.106

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1996	29	5.000	8.500	9.930	4.220	1.100	1.030	0.155	0.219	12.600	1.670	1.160	4.190
1996	30	3.200		14.200	11.500	0.923	1.090	1.800	0.153	5.560	6.640	1.260	3.680
1996	31	2.600		15.500		0.752		2.450	0.121		8.300		2.400
1997	1	2.880	7.720	11.500	12.200	1.900	1.060	0.511	0.235	0.224	0.604	17.800	3.540
1997	2	2.970	6.630	25.300	18.500	1.870	1.000	0.460	0.220	0.216	0.540	32.500	2.720
1997	3	5.360	5.800	15.500	22.100	11.800	0.917	0.445	0.208	0.210	0.490	13.600	2.150
1997	4	6.920	5.500	8.960	19.100	13.200	0.852	0.468	0.193	0.188	0.460	7.930	2.350
1997	5	51.200	9.000	5.610	21.100	5.200	0.779	0.430	0.186	0.172	0.450	5.720	2.410
1997	6	19.100	12.300	4.700	27.400	6.560	0.726	0.405	0.178	0.220	0.307	4.200	2.210
1997	7	9.580	10.900	3.960	14.700	4.180	0.685	0.425	0.171	0.260	0.296	3.440	2.020
1997	8	8.300	8.930	3.650	6.020	3.250	0.719	0.460	0.168	0.230	0.257	2.940	1.900
1997	9	12.800	7.800	3.350	4.240	3.300	0.750	0.540	0.164	0.210	0.225	2.480	1.860
1997	10	11.600	6.820	3.100	3.560	3.320	0.657	0.510	0.190	0.228	0.214	2.150	1.760
1997	11	8.990	5.830	2.800	3.240	2.970	0.579	0.460	0.228	0.243	0.190	1.890	1.600
1997	12	7.700	5.000	2.570	3.240	4.000	0.516	0.420	0.280	0.260	0.185	1.720	1.420
1997	13	6.750	4.230	2.460	3.870	3.720	0.485	0.385	0.340	0.240	0.173	1.560	1.330
1997	14	6.000	3.750	1.790	5.550	2.950	0.439	0.355	0.240	0.228	0.163	1.510	1.240
1997	15	5.700	3.480	2.050	5.380	4.460	0.406	0.370	0.280	0.210	0.157	1.420	1.160
1997	16	5.300	3.170	2.150	5.080	7.380	0.404	0.330	0.338	0.198	0.154	1.330	1.140
1997	17	5.000	3.040	2.070	6.080	5.010	0.516	0.520	0.270	0.220	0.153	1.270	1.120
1997	18	4.850	3.000	2.000	4.130	3.850	0.499	0.856	0.214	0.240	0.147	1.190	1.110
1997	19	4.650	7.490	1.930	3.400	3.400	0.428	0.730	0.172	0.270	0.134	1.170	1.120
1997	20	4.450	19.500	1.730	3.070	3.090	0.447	0.640	0.147	0.300	0.127	1.180	1.130
1997	21	4.300	86.900	1.700	2.890	2.650	0.694	0.560	0.563	0.360	0.131	1.660	1.030
1997	22	8.770	90.400	1.680	2.760	2.230	2.800	0.500	0.885	0.305	0.159	2.930	0.985
1997	23	38.200	29.600	1.660	2.580	1.940	2.000	0.460	0.655	0.280	0.170	2.470	1.010
1997	24	34.100	15.300	1.640	2.400	1.720	7.630	0.420	0.380	0.258	0.167	1.940	0.989
1997	25	25.000	10.700	1.620	2.130	1.570	3.610	0.385	0.310	0.250	0.164	1.650	1.150
1997	26	18.100	10.600	20.400	1.880	1.420	1.810	0.340	0.258	0.245	0.182	2.070	1.370
1997	27	16.000	12.300	29.700	1.700	1.380	1.180	0.335	0.219	0.240	0.317	5.060	1.340
1997	28	13.600	19.700	56.600	2.180	1.140	0.914	0.350	0.222	0.236	0.494	5.530	1.170
1997	29	11.100		101.000	2.340	1.080	0.741	0.300	0.224	0.228	0.994	5.470	1.020
1997	30	9.430		45.500	1.990	1.130	0.596	0.280	0.203	0.380	2.380	3.910	0.950
1997	31	8.340		17.100		1.120		0.255	0.200		4.600		0.895
1998	1	0.830	1.410	21.800	4.430								
1998	2	0.800	1.300	26.100									
1998	3	2.550	1.220	15.300									
1998	4	12.000	1.130	11.400									
1998	5	20.100	1.050	6.800									
1998	6	64.800	0.970	5.060									
1998	7	27.600	0.900	4.160									
1998	8	34.600	0.820	4.370									
1998	9	20.300	0.775	40.100									
1998	10	12.500	0.750	26.900									

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.257	25.643	11.576	11.054	3.126	5.253	0.297	0.186	4.529	2.669	1.486	9.264
4.057		13.033	9.326	2.276	4.176	0.471	0.196	5.276	3.301	1.359	9.389
3.857		14.847		1.684		0.762	0.203		3.961		5.331
4.171	12.041	15.671	40.357	2.017	1.190	1.337	0.299	0.221	0.312	3.824	3.890
3.596	10.403	15.057	40.086	1.980	1.130	0.887	0.282	0.215	0.353	8.441	4.043
3.647	8.946	15.086	39.000	3.397	1.064	0.692	0.264	0.214	0.388	10.338	4.054
4.057	7.789	14.837	33.643	5.040	1.023	0.591	0.242	0.209	0.420	11.401	3.667
10.773	7.489	14.124	22.229	5.471	0.980	0.522	0.225	0.202	0.450	12.076	3.221
12.976	7.899	13.039	19.643	6.074	0.922	0.474	0.211	0.204	0.462	12.336	2.756
14.001	8.264	10.790	19.300	6.387	0.860	0.449	0.199	0.213	0.450	12.170	2.486
14.776	8.437	9.669	18.417	6.580	0.811	0.442	0.189	0.214	0.400	10.047	2.251
16.180	8.604	6.533	16.380	6.784	0.775	0.453	0.181	0.213	0.355	5.759	2.129
17.071	8.750	4.761	13.731	5.573	0.738	0.463	0.179	0.215	0.316	4.123	2.073
17.367	8.797	3.881	11.466	4.111	0.699	0.461	0.184	0.223	0.277	3.260	1.966
11.153	8.226	3.447	8.914	3.940	0.662	0.460	0.197	0.236	0.239	2.689	1.824
9.389	7.073	3.127	5.553	3.534	0.627	0.457	0.220	0.239	0.220	2.311	1.699
8.877	6.051	2.817	4.246	3.359	0.592	0.447	0.230	0.234	0.201	2.036	1.587
8.506	5.273	2.589	4.154	3.531	0.547	0.434	0.246	0.231	0.187	1.819	1.481
7.434	4.611	2.417	4.274	4.114	0.498	0.404	0.271	0.230	0.177	1.654	1.379
6.491	4.071	2.270	4.634	4.356	0.478	0.406	0.282	0.228	0.168	1.529	1.287
5.900	3.667	2.156	4.761	4.481	0.466	0.462	0.280	0.228	0.162	1.429	1.217
5.464	4.023	2.064	4.784	4.396	0.454	0.507	0.265	0.229	0.154	1.350	1.174
5.136	6.204	1.960	4.670	4.306	0.448	0.543	0.237	0.238	0.148	1.296	1.146
4.893	18.083	1.947	4.290	4.263	0.485	0.572	0.283	0.257	0.143	1.317	1.116
5.331	30.500	1.894	3.916	3.944	0.827	0.591	0.370	0.270	0.144	1.533	1.091
10.031	34.276	1.824	3.559	3.167	1.055	0.609	0.415	0.282	0.146	1.696	1.072
14.189	36.027	1.763	3.033	2.697	2.071	0.595	0.431	0.288	0.148	1.791	1.053
17.067	37.127	1.709	2.747	2.371	2.516	0.528	0.445	0.289	0.150	1.857	1.059
18.989	37.571	4.347	2.530	2.089	2.713	0.472	0.457	0.285	0.157	1.986	1.095
20.639	36.543	8.343	2.334	1.844	2.818	0.429	0.467	0.277	0.184	2.540	1.125
21.967	26.943	16.186	2.233	1.629	2.849	0.399	0.418	0.259	0.236	3.093	1.145
22.300		30.374	2.173	1.464	2.555	0.370	0.324	0.248	0.355	3.456	1.150
18.190		36.637	2.089	1.349	2.354	0.344	0.259	0.262	0.671	3.661	1.141
14.510		38.846		1.263		0.321	0.234		1.304		1.128
1.082	1.191	7.766									
1.001	1.205	11.051									
1.174	1.247	12.759									
2.721	1.299	13.873									
5.446	1.294	13.939									
14.568	1.219	13.537									
18.383	1.140	12.946									
23.207	1.056	10.456									
25.993	0.981	12.456									
27.414	0.914	14.113									

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	11	5.400	1.000	8.760									
1998	12	4.000	1.190	4.980									
1998	13	3.200	1.180	3.590									
1998	14	2.700	0.960	2.700									
1998	15	2.500	0.810	2.400									
1998	16	2.350	0.700	2.270									
1998	17	1.800	1.040	2.070									
1998	18	1.530	1.630	2.130									
1998	19	1.320	3.160	6.640									
1998	20	1.170	4.130	10.600									
1998	21	1.020	4.210	6.520									
1998	22	0.880	3.520	4.520									
1998	23	0.800	3.100	3.980									
1998	24	1.130	3.350	3.410									
1998	25	1.410	3.600	5.010									
1998	26	1.200	6.340	43.600									
1998	27	0.925	7.870	54.200									
1998	28	0.772	8.300	26.400									
1998	29	1.080		19.800									
1998	30	1.500		8.930									
1998	31	1.450		5.710									
2001	1				13.000	0.540	1.440	0.188	0.052	0.074	0.166	2.030	15.400
2001	2				11.600	0.506	1.270	0.164	0.082	0.072	0.169	3.810	7.640
2001	3				16.700	0.461	1.750	0.150	0.071	0.071	0.164	5.150	5.010
2001	4				27.500	0.426	4.760	0.158	0.054	0.067	0.157	10.400	3.830
2001	5				30.200	0.404	2.720	0.130	0.049	0.063	0.201	5.300	3.530
2001	6				38.500	0.374	1.730	0.122	0.042	0.063	1.020	2.510	3.370
2001	7				40.300	0.347	1.160	0.135	0.039	0.058	1.550	2.000	2.860
2001	8				52.400	0.372	0.809	0.140	0.037	0.051	0.825	1.850	2.260
2001	9				22.300	0.400	0.631	0.138	0.038	0.044	0.569	3.280	1.910
2001	10				9.590	0.359	0.530	0.121	0.038	0.048	0.458	3.130	1.570
2001	11				6.520	0.332	1.050	0.109	0.036	0.048	0.389	2.350	1.350
2001	12				10.600	0.352	1.630	0.104	0.036	0.042	0.486	1.790	1.200
2001	13				6.330	0.320	1.290	0.104	0.036	0.039	1.190	1.470	1.420
2001	14				3.300	0.286	0.839	0.101	0.038	0.038	1.740	1.330	2.000
2001	15				2.450	0.278	0.624	0.097	0.040	0.038	4.950	1.210	1.930
2001	16				2.010	0.260	0.533	0.095	0.050	0.039	4.110	1.210	1.730
2001	17				2.030	0.245	0.477	0.102	0.079	0.038	10.800	0.982	2.990
2001	18				2.200	0.254	0.403	0.104	0.088	0.038	6.290	0.877	14.000
2001	19				1.690	0.220	0.345	0.099	0.123	0.049	3.400	0.903	12.500
2001	20				1.430	0.197	0.320	0.092	0.267	0.087	2.250	1.430	11.800
2001	21				1.410	0.194	0.298	0.091	0.221	0.119	1.730	1.820	6.740
2001	22				1.530	0.292	0.832	0.099	0.174	0.105	1.460	1.860	4.520
2001	23				1.370	1.010	1.310	0.095	0.142	0.088	1.710	1.780	4.570

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
26.471	0.895	13.736									
24.171	0.915	13.476									
15.371	0.945	13.266									
11.814	0.954	13.057									
7.229	0.952	12.776									
4.664	0.941	7.371									
3.136	0.983	3.824									
2.583	1.073	2.877									
2.200	1.354	3.114									
1.910	1.776	4.116									
1.670	2.240	4.661									
1.439	2.627	4.964									
1.217	2.970	5.209									
1.121	3.300	5.400									
1.104	3.581	5.811									
1.087	4.036	11.091									
1.052	4.570	17.320									
1.017	5.154	20.160									
1.045		22.343									
1.145		23.050									
1.191		23.379									
				0.694	6.477	0.320	0.057	0.087	0.182	5.706	9.987
				0.631	5.144	0.264	0.060	0.084	0.190	5.054	10.344
				0.580	3.794	0.224	0.061	0.081	0.183	3.904	9.997
				0.534	3.114	0.197	0.061	0.077	0.175	4.441	9.841
				0.500	2.477	0.174	0.060	0.072	0.173	4.589	9.536
				0.468	2.239	0.158	0.058	0.069	0.292	4.513	8.883
			25.400	0.437	2.119	0.150	0.056	0.067	0.490	4.457	5.949
			31.029	0.413	2.028	0.143	0.053	0.064	0.584	4.431	4.071
			32.557	0.398	1.937	0.139	0.047	0.060	0.641	4.356	3.253
			31.541	0.383	1.763	0.135	0.042	0.056	0.683	4.067	2.761
			28.544	0.370	1.233	0.128	0.040	0.054	0.716	2.917	2.407
			25.744	0.362	1.077	0.124	0.038	0.051	0.757	2.416	2.074
			21.149	0.355	1.014	0.122	0.037	0.047	0.781	2.267	1.796
			15.863	0.346	0.968	0.117	0.037	0.044	0.808	2.171	1.673
			8.727	0.332	0.942	0.111	0.037	0.042	1.397	2.080	1.626
			5.829	0.312	0.928	0.104	0.039	0.042	1.903	1.784	1.600
			4.749	0.296	0.920	0.102	0.045	0.040	3.381	1.477	1.803
			4.131	0.285	0.828	0.101	0.052	0.039	4.224	1.267	3.610
			2.859	0.266	0.644	0.100	0.065	0.040	4.640	1.140	5.224
			2.159	0.249	0.506	0.099	0.098	0.047	4.791	1.135	6.707
			1.889	0.235	0.429	0.097	0.124	0.058	4.790	1.205	7.384
			1.757	0.237	0.458	0.097	0.143	0.068	4.291	1.297	7.754
			1.666	0.345	0.569	0.097	0.156	0.075	3.949	1.379	8.160

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	24				1.180	0.950	0.799	0.088	0.110	0.091	4.790	1.610	9.820
2001	25				0.952	1.520	0.557	0.072	0.100	0.113	7.490	5.140	3.800
2001	26				0.817	10.600	0.429	0.066	0.096	0.214	8.370	7.440	2.700
2001	27				0.744	11.200	0.347	0.062	0.093	0.213	13.200	4.920	2.250
2001	28				0.647	9.520	0.288	0.055	0.096	0.215	6.640	5.670	1.850
2001	29				0.594	7.180	0.235	0.055	0.097	0.186	4.270	7.940	1.650
2001	30				0.566	3.400	0.196	0.058	0.082	0.167	3.040	23.400	1.280
2001	31					2.000		0.054	0.074		2.390		1.040
2002	1	1.060	3.530	4.400	5.540	3.750	2.470	0.200	0.116	0.067	0.300	0.340	0.382
2002	2	1.180	3.430	3.630	4.580	5.070	1.590	0.149	0.069	0.071	0.430	0.338	0.340
2002	3	1.340	3.060	21.300	4.140	6.510	0.993	0.115	0.047	0.086	0.412	0.325	0.315
2002	4	1.400	2.300	11.000	5.350	4.480	0.906	0.097	0.043	0.074	0.382	0.315	0.294
2002	5	1.370	1.990	5.000	5.700	3.430	1.040	0.083	0.038	0.081	0.416	0.330	0.304
2002	6	1.310	2.200	3.350	6.120	2.880	0.924	0.065	0.035	0.091	0.408	0.431	0.319
2002	7	1.280	2.050	2.290	5.560	2.550	0.662	0.060	0.032	0.091	0.367	0.618	0.303
2002	8	1.260	1.780	2.230	9.720	2.110	0.479	0.056	0.030	0.092	0.333	0.981	0.287
2002	9	1.290	1.490	28.400	62.300	2.250	0.368	0.083	0.031	0.089	0.317	0.980	0.247
2002	10	1.340	1.520	32.200	16.400	3.070	0.355	0.076	0.027	0.096	0.300	1.090	0.219
2002	11	1.780	2.530	7.320	8.560	2.220	0.315	0.056	0.025	0.106	0.316	3.390	0.253
2002	12	2.100	2.830	4.670	6.780	2.400	3.510	0.047	0.024	0.109	0.341	3.800	0.315
2002	13	2.200	2.270	7.430	21.000	7.540	4.310	0.040	0.025	0.111	0.376	2.460	0.356
2002	14	2.070	1.900	7.660	9.740	8.440	7.370	0.038	0.031	0.154	0.377	1.730	0.350
2002	15	2.240	1.630	4.470	6.920	6.770	15.200	0.035	0.200	0.201	0.356	1.410	0.353
2002	16	1.920	1.540	3.910	5.550	18.300	25.400	0.034	0.303	0.198	0.362	1.050	0.322
2002	17	1.980	1.350	2.130	4.670	26.100	14.300	0.032	0.154	0.191	0.355	0.877	0.273
2002	18	1.710	1.250	1.520	4.410	9.440	7.560	0.030	0.107	0.182	0.405	0.800	0.231
2002	19	1.810	1.220	1.180	6.180	5.860	4.350	0.030	0.075	0.204	0.539	0.698	0.359
2002	20	1.890	4.870	1.240	4.690	4.130	2.810	0.028	0.057	0.280	0.524	0.701	7.280
2002	21	1.790	28.000	1.230	3.320	3.330	2.650	0.029	0.047	0.837	0.360	0.845	9.460
2002	22	1.630	20.600	0.819	2.910	2.800	4.460	0.033	0.091	0.491	0.369	1.140	4.830
2002	23	1.730	12.500	0.829	2.560	2.300	2.870	0.055	0.216	0.317	0.328	1.200	3.620
2002	24	4.240	7.320	0.907	2.150	2.010	1.950	0.066	0.174	0.261	0.292	1.050	3.130
2002	25	4.940	12.800	0.906	2.060	1.540	1.400	0.055	0.103	0.243	0.292	0.892	2.940
2002	26	4.350	27.200	0.846	1.880	1.390	0.900	0.044	0.071	0.240	0.365	0.702	2.630
2002	27	3.890	15.400	0.743	1.580	1.070	0.760	0.043	0.053	0.285	0.455	0.498	2.260
2002	28	4.910	7.380	1.070	2.980	0.783	0.657	0.055	0.047	0.349	0.442	0.463	2.010
2002	29	6.180		2.130	7.290	0.728	0.423	0.073	0.045	0.357	0.423	0.435	1.890
2002	30	4.400		5.380	4.820	1.390	0.287	0.396	0.046	0.335	0.350	0.463	1.650
2002	31	3.040		4.190		2.100		0.371	0.068		0.309		2.810
2003	1	5.680	0.209	0.345	4.980	0.496	0.109	0.036	0.117	0.035	0.087	3.140	10.200
2003	2	4.210	0.215	0.343	4.480	2.050	0.086	0.032	0.145	0.032	0.609	7.700	7.880
2003	3	3.370	0.250	0.340	4.190	2.170	0.081	0.028	1.010	0.031	2.080	21.800	6.320
2003	4	2.200	0.300	0.350	3.310	1.460	0.074	0.024	5.610	0.030	6.190	33.000	4.980
2003	5	1.700	0.560	0.380	3.490	1.140	0.332	0.022	2.890	0.028	9.920	15.900	3.870

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			1.544	0.445	0.615	0.095	0.161	0.082	3.090	1.469	9.136
			1.366	0.626	0.637	0.091	0.162	0.093	3.261	2.078	7.679
			1.241	2.109	0.649	0.086	0.159	0.117	3.971	3.011	6.279
			1.143	3.681	0.653	0.082	0.134	0.135	5.536	3.510	4.914
			1.034	5.013	0.652	0.077	0.116	0.148	6.237	4.060	4.216
			0.901	5.997	0.566	0.070	0.105	0.160	6.639	4.929	3.806
			0.786	6.339	0.407	0.065	0.096	0.171	6.829	8.017	3.336
				6.489		0.060	0.091		6.486		2.081
1.690	4.329	12.417	2.843	3.480	1.419	0.661	0.157	0.057	0.301	0.383	0.548
1.473	4.197	11.802	3.376	3.910	1.447	0.482	0.160	0.057	0.328	0.380	0.469
1.343	4.079	13.218	3.861	4.571	1.436	0.370	0.161	0.061	0.353	0.361	0.414
1.279	3.706	10.518	4.473	4.986	1.454	0.275	0.159	0.065	0.366	0.343	0.385
1.239	3.107	8.785	4.983	5.050	1.498	0.193	0.154	0.070	0.376	0.330	0.362
1.243	2.793	8.113	5.089	4.420	1.432	0.142	0.103	0.077	0.383	0.341	0.345
1.277	2.651	7.281	5.284	4.096	1.226	0.110	0.054	0.080	0.388	0.385	0.322
1.306	2.401	6.971	5.881	3.861	0.942	0.089	0.042	0.084	0.393	0.477	0.309
1.321	2.124	10.510	14.127	3.459	0.767	0.080	0.037	0.086	0.376	0.569	0.296
1.321	1.904	12.067	15.879	2.967	0.676	0.074	0.034	0.088	0.360	0.678	0.282
1.376	1.937	11.541	16.337	2.644	0.592	0.068	0.031	0.092	0.351	1.117	0.276
1.480	2.057	11.494	16.491	2.497	0.945	0.063	0.029	0.096	0.340	1.613	0.278
1.607	2.067	12.077	18.617	3.163	1.428	0.060	0.028	0.099	0.336	1.903	0.283
1.720	2.046	12.844	19.214	4.004	2.387	0.057	0.028	0.108	0.337	2.062	0.290
1.860	2.024	13.164	18.814	4.670	4.490	0.054	0.052	0.124	0.340	2.123	0.299
1.950	2.031	9.666	10.707	6.963	8.066	0.047	0.091	0.139	0.347	2.133	0.310
2.041	2.007	5.370	9.031	10.253	10.058	0.040	0.109	0.153	0.355	2.102	0.317
2.031	1.824	4.541	8.439	11.284	11.093	0.037	0.121	0.164	0.367	1.732	0.314
1.990	1.594	4.043	8.353	11.779	11.213	0.034	0.128	0.177	0.396	1.289	0.321
1.946	1.966	3.159	6.023	11.291	10.999	0.032	0.132	0.201	0.417	1.038	1.310
1.906	5.694	2.240	5.106	10.561	10.324	0.031	0.135	0.299	0.414	0.912	2.611
1.819	8.404	1.718	4.533	9.994	8.790	0.031	0.119	0.340	0.416	0.873	3.251
1.791	9.970	1.278	4.106	7.709	5.571	0.034	0.107	0.357	0.411	0.894	3.722
2.114	10.823	1.104	3.746	4.267	3.807	0.039	0.110	0.367	0.402	0.919	4.130
2.576	12.473	1.016	3.410	3.139	2.927	0.042	0.109	0.376	0.386	0.932	4.517
2.939	16.184	0.968	2.796	2.500	2.434	0.044	0.108	0.381	0.361	0.933	4.841
3.224	17.689	0.897	2.351	2.063	2.141	0.046	0.108	0.382	0.352	0.904	4.124
3.670	14.743	0.874	2.303	1.699	1.857	0.050	0.108	0.312	0.363	0.849	3.060
4.320	13.767	1.062	2.929	1.403	1.280	0.056	0.101	0.293	0.371	0.749	2.640
4.701		1.712	3.251	1.273	0.911	0.105	0.077	0.296	0.374	0.643	2.359
4.530		2.181		1.286		0.148	0.062		0.377		2.313
2.704	0.221	0.397	17.139	0.410	0.666	0.035	0.044	0.041	0.144	6.577	8.961
2.930	0.218	0.378	13.679	0.569	0.504	0.034	0.060	0.039	0.218	6.417	9.250
3.089	0.221	0.363	11.991	0.783	0.404	0.033	0.199	0.037	0.501	7.989	9.473
3.116	0.231	0.355	10.279	0.938	0.316	0.032	0.995	0.035	1.361	11.826	9.540
3.089	0.280	0.355	6.063	1.076	0.248	0.030	1.403	0.033	2.728	13.167	8.464

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	6	1.200	0.400	0.340	2.130	6.920	0.727	0.021	15.400	0.027	6.760	9.460	3.230
2003	7	1.300	0.280	0.338	2.340	5.040	0.327	0.023	6.010	0.026	3.830	6.350	2.480
2003	8	0.635	0.250	0.350	1.380	3.560	0.150	0.029	2.640	0.025	2.480	4.400	2.230
2003	9	0.560	0.230	0.320	1.450	2.690	2.530	0.030	1.030	0.024	1.650	3.120	2.000
2003	10	0.520	0.215	0.310	10.600	2.000	2.310	0.027	1.540	0.024	1.090	2.430	2.110
2003	11	0.490	0.207	0.330	19.500	6.590	1.430	0.028	1.720	0.024	0.693	2.570	23.500
2003	12	0.460	0.197	0.300	17.000	16.000	0.900	0.039	6.670	0.025	0.415	4.000	13.100
2003	13	0.440	0.190	0.288	9.240	14.800	0.651	0.043	4.500	0.025	0.195	5.570	7.420
2003	14	0.420	0.184	0.280	6.510	8.280	0.572	0.036	2.160	0.025	0.797	5.520	6.340
2003	15	0.400	0.182	0.278	5.700	5.350	0.181	0.031	0.634	0.032	24.600	6.390	4.650
2003	16	0.375	0.181	0.283	4.530	3.850	0.090	0.030	0.106	0.035	13.400	14.400	3.480
2003	17	0.360	0.188	0.400	3.060	3.400	0.074	0.029	0.079	0.033	6.600	18.100	7.280
2003	18	0.340	0.200	0.950	2.510	2.880	0.074	0.028	0.065	0.029	4.160	12.900	6.530
2003	19	0.320	0.230	2.000	2.560	2.150	0.719	0.025	0.057	0.033	3.300	48.000	4.940
2003	20	0.300	0.270	4.400	2.460	1.640	0.131	0.024	0.052	0.043	2.770	25.100	3.800
2003	21	0.290	0.320	9.000	2.210	1.550	0.077	0.025	0.050	0.039	2.280	11.500	3.410
2003	22	0.280	0.400	26.000	2.070	1.010	0.060	3.160	0.053	0.038	1.640	7.170	2.730
2003	23	0.270	0.480	32.600	1.750	0.639	0.051	0.324	0.051	0.061	1.060	5.430	4.800
2003	24	0.260	0.440	36.800	1.250	1.620	0.044	0.065	0.047	0.065	0.611	4.810	17.600
2003	25	0.250	0.405	51.300	0.938	1.850	0.038	0.047	0.045	0.095	1.860	5.860	11.900
2003	26	0.240	0.380	28.700	0.671	1.220	0.035	0.039	0.045	0.101	8.820	4.760	6.910
2003	27	0.230	0.370	16.000	0.376	0.782	0.036	0.037	0.046	0.165	10.800	4.510	4.830
2003	28	0.225	0.360	15.300	0.174	0.684	0.035	0.036	0.045	0.351	6.140	11.400	3.970
2003	29	0.220		33.000	0.116	0.814	0.032	0.030	0.042	0.123	6.510	15.200	16.200
2003	30	0.215		14.400	0.097	0.751	0.035	0.027	0.038	0.089	6.350	10.800	52.500
2003	31	0.210		7.590		0.300		0.025	0.037		4.280		15.600
2004	1	8.270	0.510	0.541	12.100	1.760	1.910	0.328	0.438	0.443	0.219	0.991	16.600
2004	2	5.830	0.510	3.890	8.390	8.060	1.520	0.287	0.390	0.364	0.222	6.140	16.900
2004	3	23.800	0.515	19.600	6.660	10.000	0.987	0.265	0.384	0.324	0.219	10.500	10.300
2004	4	14.300	0.521	20.300	5.240	5.430	0.690	0.259	0.332	0.299	0.218	7.100	6.960
2004	5	6.920	0.507	76.300	3.760	8.720	0.605	0.266	0.298	0.281	0.216	28.300	5.810
2004	6	4.860	0.511	104.000	3.230	6.510	0.558	0.271	0.270	0.274	0.213	17.200	4.980
2004	7	2.090	0.530	27.600	3.200	5.440	0.512	2.170	0.259	0.332	0.209	8.820	5.670
2004	8	1.900	0.510	13.900	3.130	4.330	0.446	8.710	0.250	0.417	0.207	5.590	36.600
2004	9	1.800	0.500	9.470	2.870	5.980	0.420	3.550	0.245	0.413	0.213	4.020	24.700
2004	10	1.700	0.490	7.360	2.510	11.900	0.448	1.620	0.243	0.458	0.211	3.260	15.200
2004	11	1.630	0.485	6.090	2.200	6.850	0.398	0.778	0.249	0.397	0.213	2.730	10.700
2004	12	1.550	0.480	5.360	1.960	4.540	0.341	0.565	0.299	0.342	0.214	1.970	8.100
2004	13	1.250	0.475	4.820	2.030	3.400	0.304	0.461	0.263	0.313	0.216	1.300	6.710
2004	14	0.995	0.470	4.030	2.120	3.200	3.940	0.645	0.255	0.290	0.215	0.886	5.200
2004	15	0.950	0.465	3.570	1.810	7.730	13.700	1.240	0.252	0.276	0.227	0.716	4.400
2004	16	0.900	0.465	3.890	1.560	4.970	4.930	3.580	0.246	0.272	0.246	0.689	3.500
2004	17	0.850	0.475	3.340	1.790	3.450	2.680	2.920	0.251	0.270	0.277	0.681	3.100
2004	18	0.770	0.485	2.690	14.800	2.860	1.820	11.300	0.270	0.269	0.295	0.705	2.800

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.024	0.306	0.351	4.310	2.048	0.244	0.028	3.600	0.031	3.676	13.611	6.754
2.809	0.316	0.348	3.560	2.754	0.248	0.027	4.455	0.030	4.211	13.907	5.566
2.088	0.322	0.349	3.046	3.191	0.254	0.026	4.815	0.028	4.553	14.087	4.427
1.566	0.324	0.345	2.613	3.283	0.603	0.025	4.941	0.027	4.701	13.433	3.587
1.159	0.319	0.341	3.529	3.259	0.921	0.025	5.017	0.026	4.560	10.666	2.986
0.915	0.306	0.338	5.841	3.991	1.115	0.026	4.461	0.025	3.775	6.319	5.631
0.738	0.254	0.327	7.771	6.114	1.196	0.028	5.001	0.025	2.417	4.619	6.950
0.629	0.224	0.319	8.787	7.240	1.185	0.031	3.444	0.025	1.479	4.063	7.549
0.504	0.210	0.311	9.383	7.703	1.220	0.033	2.894	0.025	1.046	3.944	8.100
0.470	0.201	0.301	10.000	7.959	1.225	0.033	2.608	0.026	4.206	4.229	8.446
0.444	0.194	0.296	10.440	8.124	0.876	0.033	2.476	0.027	5.884	5.840	8.657
0.421	0.190	0.308	9.363	8.324	0.557	0.034	2.267	0.028	6.671	8.079	9.396
0.399	0.189	0.397	6.936	7.794	0.363	0.034	2.031	0.029	7.167	9.554	6.971
0.379	0.194	0.640	4.873	5.816	0.337	0.032	1.086	0.030	7.579	15.840	5.806
0.359	0.205	1.227	3.904	3.936	0.263	0.029	0.450	0.033	7.947	18.630	5.289
0.341	0.224	2.473	3.290	2.974	0.192	0.027	0.149	0.035	8.159	19.484	4.870
0.324	0.256	6.148	2.771	2.354	0.175	0.474	0.066	0.036	4.879	19.596	4.596
0.309	0.298	10.764	2.374	1.896	0.169	0.516	0.058	0.039	3.116	18.314	4.784
0.294	0.334	15.964	2.116	1.641	0.165	0.522	0.054	0.044	2.260	16.416	6.259
0.281	0.364	23.157	1.891	1.494	0.160	0.524	0.051	0.053	1.932	15.410	7.026
0.270	0.385	26.971	1.621	1.361	0.062	0.526	0.049	0.063	2.720	9.233	7.307
0.260	0.399	28.629	1.324	1.239	0.049	0.528	0.048	0.081	3.867	6.291	7.454
0.251	0.405	29.529	1.033	1.115	0.043	0.530	0.047	0.125	4.419	6.277	7.534
0.242		30.529	0.754	1.087	0.039	0.083	0.046	0.137	5.114	7.424	9.459
0.234		27.929	0.517	1.103	0.036	0.040	0.044	0.141	5.870	8.191	16.273
0.227		23.756		0.914		0.034	0.043		6.394		15.987
15.469	0.538	0.518	39.071	2.094	5.060	0.577	0.361	0.460	0.243	0.722	6.376
15.314	0.529	0.937	27.041	2.893	3.720	0.461	0.364	0.474	0.238	1.464	8.590
18.024	0.522	3.321	20.064	3.950	2.901	0.397	0.368	0.482	0.232	2.880	9.873
19.500	0.519	5.794	17.399	4.380	2.111	0.354	0.363	0.454	0.227	3.827	10.606
18.174	0.515	15.268	15.821	5.330	1.602	0.320	0.355	0.428	0.222	7.813	10.164
11.369	0.513	32.162	9.569	6.000	1.247	0.295	0.351	0.365	0.219	10.200	9.703
9.439	0.515	36.033	6.083	6.560	0.969	0.549	0.339	0.331	0.217	11.293	9.603
8.529	0.515	37.941	4.801	6.927	0.760	1.747	0.312	0.327	0.215	11.950	12.460
7.953	0.513	38.739	4.013	6.630	0.603	2.213	0.291	0.334	0.214	11.647	13.574
4.796	0.510	36.990	3.420	6.901	0.526	2.407	0.271	0.353	0.212	10.613	14.274
2.986	0.505	34.960	2.986	7.104	0.484	2.481	0.259	0.367	0.212	9.989	14.809
2.219	0.501	24.826	2.729	6.507	0.446	2.523	0.259	0.376	0.211	6.227	15.136
1.703	0.496	10.657	2.557	6.063	0.410	2.551	0.258	0.382	0.212	3.956	15.383
1.546	0.487	7.290	2.403	5.743	0.900	2.333	0.258	0.376	0.213	2.822	15.316
1.411	0.481	5.814	2.214	6.229	2.793	1.266	0.258	0.356	0.216	2.126	10.716
1.282	0.476	5.017	2.027	6.084	3.437	1.270	0.258	0.335	0.220	1.650	7.687
1.161	0.474	4.443	1.924	4.877	3.756	1.456	0.259	0.309	0.230	1.282	5.959
1.038	0.474	3.957	3.724	4.307	3.959	2.959	0.262	0.290	0.241	0.992	4.830

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	19	0.730	0.494	2.310	13.800	2.400	1.110	15.800	0.276	0.266	0.271	0.718	2.500
2004	20	0.700	0.500	5.380	6.080	1.900	0.695	6.180	0.271	0.264	0.258	0.693	2.300
2004	21	0.680	0.527	10.200	4.630	1.590	0.584	3.080	0.270	0.262	0.255	0.740	2.150
2004	22	0.650	0.554	6.820	4.200	1.520	0.761	1.660	0.266	0.262	0.250	0.760	2.070
2004	23	0.625	0.541	5.420	3.390	8.370	0.687	0.842	0.265	0.259	0.245	0.766	1.980
2004	24	0.605	0.523	3.790	2.860	78.100	0.872	0.595	0.264	0.258	0.905	0.855	1.900
2004	25	0.590	0.514	27.400	2.470	22.400	1.100	0.462	0.264	0.258	2.160	1.400	1.880
2004	26	0.575	0.508	92.600	2.600	10.900	0.715	0.375	0.264	0.257	0.947	1.320	1.850
2004	27	0.560	0.505	55.500	2.420	6.720	0.562	0.350	0.268	0.258	0.587	1.830	1.830
2004	28	0.545	0.503	23.900	2.070	6.220	0.504	0.373	0.496	0.250	0.473	8.900	1.820
2004	29	0.535	0.508	14.800	1.820	4.170	0.445	0.350	0.464	0.235	0.401	8.210	1.810
2004	30	0.525		47.000	1.520	3.040	0.387	0.299	0.715	0.224	0.487	6.370	1.850
2004	31	0.515		27.600		2.460		0.345	0.567		1.170		37.900
2005	1	71.300	0.585	1.200	42.700	8.750	0.329	0.150	0.151	0.197	2.780	0.326	14.300
2005	2	36.600	0.565	1.120	21.900	7.100	0.301	0.145	0.146	0.190	1.050	0.345	9.030
2005	3	43.500	0.525	1.070	13.200	7.360	0.284	0.141	0.143	0.185	0.691	0.364	6.300
2005	4	20.600	0.518	1.020	15.200	6.410	0.276	0.166	0.142	0.184	0.559	0.351	5.110
2005	5	12.300	0.515	0.980	25.800	4.910	0.274	0.224	0.149	0.198	0.498	0.351	3.600
2005	6	10.500	0.520	0.960	22.700	3.790	0.287	0.221	0.142	0.199	0.453	0.407	2.900
2005	7	7.510	0.650	1.000	16.200	3.380	0.256	0.198	0.144	0.204	0.412	0.435	2.200
2005	8	5.230	1.500	1.800	10.800	2.880	0.240	0.190	0.155	0.213	0.387	0.414	1.800
2005	9	3.850	4.000	3.000	7.310	2.190	0.231	0.176	0.146	0.208	0.379	0.962	1.550
2005	10	3.350	3.200	3.600	5.640	1.590	0.222	0.160	0.138	0.211	0.302	3.490	1.450
2005	11	2.930	2.200	3.000	4.440	1.480	0.207	0.150	0.130	0.208	0.248	2.880	1.180
2005	12	3.030	1.500	2.600	3.490	1.060	0.199	0.143	0.133	0.199	0.235	2.040	1.080
2005	13	52.700	1.200	2.300	2.900	0.863	0.212	0.138	0.132	0.196	0.254	1.520	0.990
2005	14	46.100	1.400	2.080	2.380	1.830	0.271	0.134	0.128	0.194	0.261	1.210	0.905
2005	15	11.000	3.000	1.920	1.970	5.590	0.714	0.133	0.128	0.196	0.276	1.340	0.850
2005	16	6.000	8.500	1.720	1.620	4.360	0.671	0.170	0.128	0.201	0.283	30.300	0.780
2005	17	3.800	6.500	1.570	1.460	2.810	0.462	0.277	0.126	0.209	0.287	16.200	0.725
2005	18	2.600	4.600	1.450	1.330	1.940	0.444	0.351	0.126	0.206	0.298	7.800	0.680
2005	19	2.000	3.400	1.370	1.200	1.410	0.395	0.370	14.300	0.204	0.307	5.400	0.650
2005	20	1.480	2.800	1.280	1.320	1.070	0.321	0.251	9.930	0.206	0.292	4.400	0.625
2005	21	1.170	2.350	1.190	1.580	0.843	0.278	0.209	1.860	0.203	0.297	3.400	0.600
2005	22	1.080	2.120	1.150	1.240	0.734	0.257	0.186	0.463	0.206	0.321	2.600	0.580
2005	23	0.990	1.950	1.140	1.340	0.684	0.237	0.166	0.299	0.222	0.336	2.200	0.570
2005	24	0.900	1.800	1.800	4.910	0.658	0.220	0.160	0.240	0.221	0.354	2.000	1.500
2005	25	0.860	1.680	5.000	9.490	0.574	0.202	0.157	0.213	0.345	0.357	1.800	2.710
2005	26	0.826	1.550	10.600	7.090	0.502	0.189	0.163	0.196	0.842	0.354	1.820	5.880
2005	27	0.790	1.450	16.000	18.400	0.445	0.178	0.176	0.190	0.849	0.350	1.770	6.030
2005	28	0.730	1.350	33.500	16.300	0.413	0.169	0.192	0.193	0.520	0.342	7.560	5.650
2005	29	0.690		61.500	10.700	0.424	0.159	0.174	0.196	8.090	0.331	75.600	9.230
2005	30	0.660		55.100	6.470	0.399	0.155	0.161	0.199	9.260	0.340	32.300	9.710
2005	31	0.620		65.600		0.363		0.152	0.207		0.325		7.140

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.921	0.476	3.521	5.416	4.001	4.069	5.135	0.259	0.279	0.250	0.814	4.030
0.842	0.479	3.601	5.994	3.787	4.125	5.952	0.260	0.272	0.256	0.727	3.400
0.797	0.487	4.483	6.353	3.557	3.646	6.300	0.262	0.268	0.261	0.706	2.964
0.754	0.500	4.947	6.694	2.670	1.797	6.360	0.264	0.266	0.265	0.712	2.631
0.715	0.511	5.166	6.956	3.156	1.191	5.969	0.267	0.265	0.264	0.723	2.414
0.680	0.518	5.230	7.109	13.820	0.933	5.637	0.269	0.263	0.354	0.748	2.243
0.654	0.522	8.760	5.347	16.611	0.830	4.088	0.268	0.261	0.621	0.847	2.111
0.632	0.524	21.659	3.747	17.826	0.773	1.885	0.266	0.260	0.717	0.933	2.019
0.612	0.525	28.819	3.224	18.514	0.754	1.052	0.266	0.259	0.764	1.096	1.951
0.593	0.521	30.776	2.859	19.176	0.743	0.665	0.298	0.257	0.795	2.262	1.904
0.576		31.916	2.519	19.554	0.698	0.478	0.326	0.254	0.817	3.326	1.867
0.562		37.856	2.251	18.793	0.655	0.401	0.391	0.249	0.851	4.126	1.849
0.549		41.257		7.987		0.365	0.434		0.889		6.991
16.909	0.700	1.569	40.714	11.029	0.411	0.172	0.167	0.197	3.241	0.338	19.307
21.873	0.663	1.450	42.329	10.687	0.382	0.164	0.165	0.196	3.342	0.337	20.340
27.826	0.625	1.346	41.929	10.726	0.359	0.157	0.160	0.195	3.320	0.339	20.980
30.509	0.595	1.251	39.314	9.013	0.339	0.155	0.153	0.194	3.279	0.340	21.457
32.007	0.570	1.170	34.214	7.386	0.318	0.163	0.149	0.194	3.275	0.343	20.891
33.243	0.550	1.100	29.586	6.399	0.302	0.172	0.146	0.194	2.184	0.353	10.506
28.901	0.554	1.050	22.529	5.957	0.287	0.178	0.145	0.194	0.920	0.368	6.206
19.463	0.685	1.136	17.971	5.119	0.274	0.184	0.146	0.196	0.579	0.381	4.420
14.784	1.175	1.404	15.887	4.417	0.264	0.188	0.146	0.199	0.483	0.469	3.351
9.049	1.558	1.766	14.807	3.593	0.255	0.191	0.145	0.202	0.427	0.916	2.659
6.524	1.798	2.049	13.270	2.889	0.245	0.188	0.143	0.206	0.383	1.277	2.097
5.200	1.939	2.280	10.083	2.339	0.235	0.177	0.141	0.206	0.345	1.518	1.737
11.229	2.036	2.471	7.254	1.920	0.224	0.165	0.140	0.206	0.317	1.677	1.464
16.741	2.143	2.626	5.280	1.699	0.226	0.156	0.137	0.204	0.295	1.788	1.279
17.566	2.357	2.643	4.019	2.086	0.294	0.148	0.134	0.202	0.279	1.920	1.144
17.873	3.000	2.460	3.206	2.396	0.357	0.147	0.131	0.201	0.266	6.111	1.034
17.937	3.471	2.170	2.609	2.570	0.391	0.164	0.129	0.200	0.263	7.927	0.930
17.890	3.814	1.949	2.164	2.636	0.425	0.192	0.129	0.200	0.271	8.630	0.859
17.743	4.086	1.773	1.837	2.686	0.453	0.225	2.153	0.201	0.281	9.110	0.797
10.426	4.314	1.627	1.611	2.716	0.468	0.241	3.552	0.202	0.286	9.521	0.745
4.007	4.450	1.500	1.497	2.575	0.469	0.252	3.800	0.204	0.291	9.834	0.701
2.590	4.324	1.390	1.393	1.881	0.404	0.259	3.848	0.205	0.298	10.014	0.663
1.874	3.389	1.307	1.353	1.356	0.342	0.259	3.872	0.208	0.305	6.000	0.633
1.460	2.717	1.340	1.846	1.048	0.307	0.242	3.888	0.210	0.315	3.971	0.744
1.211	2.300	1.847	3.011	0.853	0.273	0.214	3.901	0.230	0.323	3.114	1.034
1.044	2.036	3.166	3.853	0.724	0.243	0.185	1.886	0.321	0.330	2.603	1.781
0.945	1.843	5.269	6.293	0.634	0.223	0.174	0.494	0.413	0.338	2.227	2.553
0.882	1.700	9.884	8.396	0.573	0.207	0.171	0.256	0.458	0.345	2.821	3.274
0.827		18.506	9.747	0.529	0.193	0.170	0.218	1.584	0.346	13.250	4.510
0.779		26.214	10.480	0.488	0.182	0.169	0.204	2.875	0.347	17.550	5.816
0.739		35.329		0.446		0.168	0.199		0.343		6.621

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	1	5.390	13.200	2.500	20.200	1.450	11.800	0.095	0.162	0.067	0.822	5.700	77.100
2006	2	4.560	8.370	2.420	10.700	1.240	5.060	0.098	0.158	0.072	0.784	3.820	50.500
2006	3	4.140	9.760	2.350	6.670	1.070	4.260	0.085	0.486	0.112	0.747	2.960	18.900
2006	4	4.670	12.100	2.300	6.260	0.930	3.980	0.077	1.110	0.146	1.010	2.590	11.600
2006	5	15.500	6.900	2.250	4.650	0.834	2.660	0.065	0.886	0.155	2.040	2.540	7.600
2006	6	10.200	6.000	2.200	6.340	0.747	1.630	0.060	0.422	0.121	1.850	2.640	6.400
2006	7	7.500	5.450	2.150	10.100	0.651	1.190	0.059	0.251	0.145	1.310	2.900	5.500
2006	8	6.440	5.100	2.100	14.800	0.580	1.050	0.056	0.174	0.243	1.050	6.200	4.900
2006	9	5.290	4.750	3.200	7.120	0.515	1.020	0.048	0.130	0.338	0.893	5.760	4.500
2006	10	4.420	4.420	72.500	4.850	0.486	0.800	0.080	0.104	0.338	0.716	3.520	4.200
2006	11	5.670	4.200	68.200	3.680	0.655	0.629	0.152	0.087	0.304	0.454	5.640	4.770
2006	12	23.900	3.900	69.300	3.620	2.890	0.513	1.560	0.079	0.255	11.700	9.980	21.200
2006	13	27.200	3.700	88.400	12.500	3.230	0.415	4.020	0.073	0.331	6.010	6.960	54.500
2006	14	39.900	3.500	69.800	8.710	2.270	0.352	1.430	0.073	0.339	3.510	5.850	25.200
2006	15	16.600	3.350	16.600	7.120	1.700	0.280	0.692	0.081	0.320	5.110	5.290	16.100
2006	16	8.400	3.250	8.500	4.510	1.620	0.232	0.398	0.074	0.291	2.080	21.900	12.500
2006	17	6.100	18.500	4.800	3.250	2.410	0.193	0.254	0.074	0.275	10.200	24.200	9.490
2006	18	11.600	24.500	3.400	2.500	10.400	0.177	0.199	0.076	0.334	25.600	11.400	7.070
2006	19	9.460	19.000	2.380	2.050	14.100	0.167	0.163	0.070	0.453	10.200	6.160	5.210
2006	20	11.500	14.800	2.070	1.710	7.330	0.163	0.288	0.079	0.441	5.880	3.720	4.020
2006	21	22.300	10.700	1.830	1.450	4.710	0.138	0.691	0.075	0.354	2.750	2.560	3.250
2006	22	8.600	6.700	1.680	1.460	3.390	0.122	0.340	0.064	0.320	4.950	2.000	3.160
2006	23	4.800	4.900	1.600	9.280	2.500	0.108	0.387	0.058	0.383	14.600	1.760	13.600
2006	24	3.700	4.100	1.520	24.000	1.910	0.101	0.234	0.064	0.699	9.160	1.650	12.500
2006	25	2.550	3.600	1.710	11.600	1.560	0.086	0.162	0.104	0.813	6.660	1.630	8.360
2006	26	1.980	3.200	2.680	6.920	1.390	0.081	0.154	0.171	0.828	5.360	1.640	6.460
2006	27	1.620	2.950	4.510	4.460	1.250	0.088	0.906	0.172	0.836	4.350	1.640	4.950
2006	28	1.850	2.750	5.650	3.030	0.993	0.107	0.539	0.119	0.822	12.000	1.710	3.630
2006	29	8.900		6.070	2.270	0.818	0.142	0.342	0.112	0.770	21.700	1.850	2.970
2006	30	59.000		6.830	1.790	0.615	0.103	0.327	0.094	0.764	15.000	18.400	2.620
2006	31	30.400		7.730		2.670		0.230	0.079		9.230		2.430
2007	1	10.900	0.590	0.330	4.850	2.380	0.476	0.058	0.068	0.083	0.176	0.777	2.010
2007	2	11.400	0.570	0.350	7.300	1.990	0.377	0.057	0.067	0.086	0.197	0.764	1.960
2007	3	6.750	0.545	0.405	6.360	1.590	0.301	0.057	0.065	0.089	0.282	0.756	4.210
2007	4	5.150	0.520	0.380	47.200	1.310	0.366	0.058	0.061	0.096	0.318	0.761	5.720
2007	5	24.500	0.500	0.355	16.100	1.140	0.583	0.059	0.059	0.117	0.337	0.758	4.650
2007	6	26.500	0.485	0.338	8.360	0.952	0.748	0.060	0.059	0.103	0.358	0.856	4.210
2007	7	19.800	0.470	0.320	5.810	0.827	0.485	0.059	0.058	0.097	0.410	0.977	3.000
2007	8	12.800	0.455	0.316	4.500	0.775	0.308	0.153	0.060	0.097	0.481	0.978	2.580
2007	9	9.230	0.440	0.335	3.790	0.700	0.224	0.320	0.058	0.096	0.574	0.949	2.250
2007	10	5.400	0.430	0.380	3.710	1.260	0.146	0.222	0.058	0.099	0.586	0.901	2.030
2007	11	3.900	0.425	0.445	4.250	1.230	0.106	0.205	0.057	0.137	0.661	0.871	1.850
2007	12	4.600	0.415	0.590	13.600	0.916	0.087	0.109	0.057	0.196	0.637	0.873	1.670
2007	13	16.100	0.405	1.150	15.800	0.698	0.075	0.071	0.057	0.198	0.609	0.885	1.580

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
7.004	16.707	3.429	7.667	4.503	2.791	0.100	0.380	0.116	0.808	10.477	14.853
6.816	17.620	3.074	8.813	3.023	3.315	0.102	0.381	0.102	0.804	10.257	21.834
6.546	18.783	2.824	9.121	2.187	3.745	0.103	0.321	0.094	0.792	10.059	24.300
6.406	20.247	2.639	9.209	1.683	4.172	0.101	0.402	0.097	0.817	8.714	25.723
7.301	19.961	2.503	9.006	1.369	4.435	0.095	0.480	0.104	0.991	5.977	26.564
7.371	12.390	2.396	8.936	1.152	4.580	0.083	0.493	0.107	1.145	4.211	27.214
7.423	8.826	2.310	9.274	0.989	4.369	0.077	0.496	0.117	1.223	3.307	25.371
7.573	7.669	2.253	8.503	0.865	2.833	0.071	0.498	0.142	1.256	3.379	15.057
7.677	7.151	2.364	7.991	0.761	2.256	0.064	0.494	0.180	1.271	3.656	8.486
7.717	6.389	12.386	7.731	0.678	1.761	0.064	0.440	0.212	1.267	3.736	6.386
7.860	5.260	21.800	7.363	0.638	1.283	0.074	0.293	0.235	1.188	4.171	5.410
9.060	4.831	31.379	7.216	0.932	0.976	0.288	0.178	0.249	2.568	5.234	7.353
11.489	4.503	43.693	8.096	1.287	0.802	0.854	0.128	0.279	3.162	5.851	14.224
16.117	4.224	53.357	7.897	1.518	0.683	1.049	0.103	0.307	3.476	6.273	17.039
17.569	3.974	55.429	6.800	1.678	0.573	1.140	0.090	0.318	4.056	6.143	18.639
18.013	3.760	56.186	6.427	1.836	0.460	1.190	0.082	0.311	4.226	8.449	19.781
18.253	5.771	46.514	6.199	2.111	0.373	1.215	0.077	0.302	5.581	11.403	20.537
19.100	8.671	37.257	6.030	3.503	0.309	1.222	0.076	0.306	9.173	12.226	20.866
17.037	10.829	27.697	5.806	5.104	0.259	1.022	0.074	0.335	8.959	11.680	18.581
14.794	12.414	15.364	4.264	5.690	0.223	0.489	0.075	0.350	8.940	11.217	11.370
12.280	13.443	5.654	3.227	6.039	0.193	0.384	0.076	0.353	8.831	10.747	8.234
11.137	13.921	3.523	2.419	6.280	0.170	0.333	0.073	0.353	8.809	10.277	6.386
10.623	14.157	2.537	3.100	6.406	0.153	0.332	0.071	0.366	10.597	7.400	6.543
10.280	12.100	2.069	6.064	6.334	0.139	0.329	0.069	0.426	10.449	4.179	6.973
8.987	9.114	1.827	7.364	5.071	0.126	0.324	0.073	0.495	7.743	2.783	7.157
7.919	6.857	1.870	8.060	3.256	0.114	0.322	0.088	0.548	7.051	2.137	7.336
6.507	5.164	2.219	8.453	2.387	0.103	0.411	0.101	0.605	6.833	1.840	7.469
3.586	4.029	2.764	8.679	1.856	0.099	0.389	0.107	0.672	8.154	1.719	7.523
3.629		3.391	8.794	1.489	0.102	0.389	0.114	0.736	10.547	1.697	7.496
11.371		4.139	7.724	1.219	0.101	0.381	0.119	0.790	10.604	4.074	5.927
15.186		5.026		1.328		0.380	0.122		10.614		4.489
4.851	0.709	0.377	20.896	3.256	0.960	0.059	0.071	0.072	0.190	0.776	1.980
5.557	0.668	0.366	14.996	3.229	0.973	0.059	0.069	0.075	0.195	0.773	1.959
5.814	0.631	0.365	9.390	3.193	0.867	0.059	0.067	0.078	0.209	0.769	2.277
6.031	0.600	0.363	12.804	3.013	0.618	0.058	0.066	0.083	0.223	0.764	2.813
9.107	0.573	0.360	13.519	2.316	0.517	0.058	0.065	0.090	0.241	0.763	3.207
12.519	0.548	0.358	13.671	1.800	0.499	0.058	0.064	0.094	0.264	0.774	3.531
15.000	0.526	0.354	13.711	1.456	0.477	0.058	0.062	0.096	0.297	0.807	3.680
15.271	0.506	0.352	13.661	1.226	0.453	0.072	0.061	0.098	0.340	0.836	3.761
14.961	0.488	0.350	13.160	1.042	0.431	0.109	0.060	0.099	0.394	0.862	3.803
14.769	0.471	0.346	12.781	0.995	0.409	0.133	0.059	0.101	0.438	0.883	3.491
14.590	0.458	0.356	6.646	0.983	0.371	0.154	0.058	0.107	0.487	0.899	2.939
11.747	0.446	0.389	6.289	0.951	0.301	0.161	0.058	0.118	0.530	0.915	2.513
10.261	0.434	0.505	7.351	0.915	0.204	0.163	0.058	0.131	0.565	0.919	2.137

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2007	14	9.540	0.395	21.000	8.770	0.572	0.068	0.062	0.055	0.200	0.593	0.924	1.500
2007	15	6.200	0.387	52.100	6.870	0.623	0.062	0.063	0.054	0.172	0.591	0.944	1.430
2007	16	3.900	0.380	46.600	5.270	1.550	0.060	0.062	0.054	0.159	0.594	0.942	1.370
2007	17	2.650	0.375	29.500	4.310	1.770	0.059	0.065	0.052	0.139	0.584	0.918	1.350
2007	18	1.950	0.365	21.300	3.720	1.360	0.060	0.063	0.052	0.142	0.590	0.885	1.330
2007	19	1.640	0.360	15.700	3.160	1.060	0.064	0.184	0.054	0.145	0.631	0.889	1.390
2007	20	1.400	0.375	11.200	2.700	0.908	0.066	0.839	0.055	0.148	0.681	1.120	1.550
2007	21	1.270	0.400	8.900	2.320	0.804	0.060	0.437	0.055	0.145	0.656	1.830	1.680
2007	22	1.160	0.440	41.300	2.030	0.584	0.058	0.224	0.056	0.148	0.620	3.270	2.100
2007	23	1.070	0.430	62.000	1.910	0.467	0.057	0.131	0.059	0.150	0.711	2.920	8.300
2007	24	0.980	0.415	36.200	2.600	0.391	0.057	0.105	0.061	0.147	0.753	2.380	24.500
2007	25	0.920	0.390	26.800	2.180	0.335	0.056	0.089	0.067	0.162	0.823	2.110	22.100
2007	26	0.860	0.375	48.600	1.840	0.286	0.058	0.084	0.068	0.183	0.784	1.980	15.400
2007	27	0.800	0.355	45.600	2.570	1.040	0.059	0.075	0.067	0.224	0.784	1.970	11.700
2007	28	0.740	0.347	23.300	6.020	2.110	0.060	0.069	0.063	0.210	0.797	1.890	8.910
2007	29	0.690		11.100	4.560	1.290	0.060	0.067	0.063	0.195	0.767	1.940	7.730
2007	30	0.660		7.290	3.240	0.876	0.059	0.067	0.081	0.180	0.774	1.960	6.990
2007	31	0.625		5.530		0.642		0.067	0.081		0.748		6.340
2008	1	5.470	8.000	3.400	150.000	0.723	0.677	1.660	0.446	0.629	1.490	1.520	7.810
2008	2	3.800	6.000	3.100	77.100	0.996	0.440	1.150	0.267	0.313	1.280	1.330	6.850
2008	3	3.400	5.200	5.000	54.800	2.240	0.392	0.908	0.144	0.189	3.570	1.980	6.600
2008	4	3.200	4.800	25.000	51.700	14.800	0.526	0.595	0.093	0.123	4.500	4.560	7.750
2008	5	3.800	14.000	22.100	48.700	7.120	0.512	0.341	0.156	0.094	2.170	3.200	8.750
2008	6	4.820	33.200	18.200	59.300	3.380	13.500	0.200	4.750	0.087	1.500	2.100	7.500
2008	7	36.400	18.400	13.500	50.300	2.290	5.660	0.128	2.560	0.099	1.270	1.600	6.400
2008	8	136.000	12.000	11.000	32.800	3.510	1.700	0.097	1.310	0.280	1.220	10.100	5.600
2008	9	133.000	8.000	9.000	24.600	2.440	1.620	0.078	3.230	4.480	4.200	10.500	6.500
2008	10	31.800	5.700	10.000	15.400	1.630	6.210	0.065	24.400	5.040	3.790	8.470	7.000
2008	11	20.400	4.200	7.500	15.800	1.390	9.080	0.064	13.900	1.570	1.830	7.070	6.000
2008	12	16.200	3.400	6.750	18.900	1.320	2.830	0.071	5.890	1.140	1.400	7.900	5.100
2008	13	10.600	3.000	6.100	12.200	1.180	1.420	0.193	10.600	1.000	1.220	16.900	4.300
2008	14	8.020	2.800	5.600	7.080	1.090	1.230	0.122	24.700	66.000	1.110	22.100	3.700
2008	15	6.480	2.640	5.200	4.520	1.290	1.200	0.074	11.300	72.800	1.020	43.600	35.600
2008	16	4.400	2.500	4.800	3.150	1.190	12.100	0.060	4.770	25.600	1.130	48.300	46.100
2008	17	3.600	3.000	4.450	2.360	1.100	9.470	0.055	2.030	12.900	1.150	26.400	21.700
2008	18	3.000	31.000	4.200	1.830	1.130	3.470	0.051	1.420	6.700	1.060	18.000	14.100
2008	19	2.700	32.800	5.000	1.580	1.330	1.670	0.053	3.620	3.070	0.956	13.300	12.000
2008	20	2.400	22.100	21.000	1.440	1.270	1.330	0.996	2.480	1.710	0.934	10.600	10.500
2008	21	2.200	16.000	13.500	1.290	1.130	1.100	3.420	1.310	1.360	1.070	9.250	8.500
2008	22	2.050	12.000	8.000	1.170	1.070	1.170	4.990	0.983	1.110	1.080	7.500	5.200
2008	23	1.950	8.800	5.000	1.080	0.968	1.170	21.100	0.735	0.988	0.978	5.400	4.500
2008	24	1.850	7.600	4.000	0.991	0.852	1.040	8.240	0.479	0.873	0.863	4.980	5.200
2008	25	1.800	6.500	3.400	0.922	0.691	0.783	2.320	0.321	0.738	0.957	5.100	20.000
2008	26	1.760	5.600	3.100	0.918	0.569	0.441	1.250	0.212	0.567	1.210	6.080	18.000

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
8.796	0.424	3.459	7.774	0.879	0.145	0.163	0.057	0.146	0.592	0.912	1.923
7.853	0.414	10.857	8.113	0.857	0.110	0.150	0.057	0.157	0.607	0.907	1.759
7.091	0.405	17.466	8.324	0.978	0.086	0.113	0.056	0.166	0.610	0.906	1.633
6.699	0.397	21.626	8.410	1.051	0.074	0.091	0.055	0.172	0.610	0.908	1.536
6.420	0.389	24.606	8.334	1.070	0.067	0.071	0.054	0.172	0.600	0.910	1.461
5.997	0.381	26.764	6.843	1.090	0.064	0.081	0.054	0.165	0.599	0.912	1.421
3.897	0.377	28.200	4.971	1.120	0.063	0.191	0.054	0.158	0.609	0.946	1.417
2.716	0.377	26.471	4.050	1.154	0.062	0.245	0.054	0.150	0.618	1.075	1.443
1.996	0.385	24.929	3.359	1.148	0.061	0.268	0.054	0.147	0.622	1.408	1.539
1.591	0.392	27.129	2.879	0.993	0.061	0.278	0.055	0.145	0.639	1.690	2.529
1.353	0.398	28.086	2.634	0.796	0.060	0.283	0.056	0.146	0.663	1.899	5.836
1.206	0.401	28.871	2.414	0.650	0.060	0.287	0.058	0.149	0.696	2.074	8.803
1.094	0.404	33.571	2.226	0.539	0.059	0.273	0.060	0.155	0.718	2.230	10.804
1.009	0.401	38.486	2.207	0.558	0.058	0.164	0.062	0.166	0.733	2.351	12.254
0.933	0.393	40.543	2.736	0.745	0.058	0.111	0.063	0.175	0.753	2.360	13.287
0.866		36.229	3.097	0.846	0.058	0.089	0.064	0.182	0.774	2.170	14.091
0.807		28.413	3.287	0.904	0.058	0.079	0.067	0.186	0.783	2.033	13.904
0.756		24.031		0.940		0.074	0.070		0.782		11.310
1.690	4.329	12.417	2.843	3.480	1.419	0.661	0.157	0.057	0.301	0.383	0.548
1.473	4.197	11.802	3.376	3.910	1.447	0.482	0.160	0.057	0.328	0.380	0.469
1.343	4.079	13.218	3.861	4.571	1.436	0.370	0.161	0.061	0.353	0.361	0.414
1.279	3.706	10.518	4.473	4.986	1.454	0.275	0.159	0.065	0.366	0.343	0.385
1.239	3.107	8.785	4.983	5.050	1.498	0.193	0.154	0.070	0.376	0.330	0.362
1.243	2.793	8.113	5.089	4.420	1.432	0.142	0.103	0.077	0.383	0.341	0.345
1.277	2.651	7.281	5.284	4.096	1.226	0.110	0.054	0.080	0.388	0.385	0.322
1.306	2.401	6.971	5.881	3.861	0.942	0.089	0.042	0.084	0.393	0.477	0.309
1.321	2.124	10.510	14.127	3.459	0.767	0.080	0.037	0.086	0.376	0.569	0.296
1.321	1.904	12.067	15.879	2.967	0.676	0.074	0.034	0.088	0.360	0.678	0.282
1.376	1.937	11.541	16.337	2.644	0.592	0.068	0.031	0.092	0.351	1.117	0.276
1.480	2.057	11.494	16.491	2.497	0.945	0.063	0.029	0.096	0.340	1.613	0.278
1.607	2.067	12.077	18.617	3.163	1.428	0.060	0.028	0.099	0.336	1.903	0.283
1.720	2.046	12.844	19.214	4.004	2.387	0.057	0.028	0.108	0.337	2.062	0.290
1.860	2.024	13.164	18.814	4.670	4.490	0.054	0.052	0.124	0.340	2.123	0.299
1.950	2.031	9.666	10.707	6.963	8.066	0.047	0.091	0.139	0.347	2.133	0.310
2.041	2.007	5.370	9.031	10.253	10.058	0.040	0.109	0.153	0.355	2.102	0.317
2.031	1.824	4.541	8.439	11.284	11.093	0.037	0.121	0.164	0.367	1.732	0.314
1.990	1.594	4.043	8.353	11.779	11.213	0.034	0.128	0.177	0.396	1.289	0.321
1.946	1.966	3.159	6.023	11.291	10.999	0.032	0.132	0.201	0.417	1.038	1.310
1.906	5.694	2.240	5.106	10.561	10.324	0.031	0.135	0.299	0.414	0.912	2.611
1.819	8.404	1.718	4.533	9.994	8.790	0.031	0.119	0.340	0.416	0.873	3.251
1.791	9.970	1.278	4.106	7.709	5.571	0.034	0.107	0.357	0.411	0.894	3.722
2.114	10.823	1.104	3.746	4.267	3.807	0.039	0.110	0.367	0.402	0.919	4.130
2.576	12.473	1.016	3.410	3.139	2.927	0.042	0.109	0.376	0.386	0.932	4.517
2.939	16.184	0.968	2.796	2.500	2.434	0.044	0.108	0.381	0.361	0.933	4.841

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	27	1.730	5.000	2.880	0.845	0.485	0.291	0.931	0.145	0.478	4.120	7.040	61.000
2008	28	1.700	4.450	2.800	0.885	0.363	2.910	0.631	0.104	0.519	9.820	7.880	225.000
2008	29	1.800	3.800	2.600	0.955	0.281	11.600	0.347	0.129	0.447	6.100	7.830	54.000
2008	30	9.000		2.800	0.851	0.234	4.940	0.294	1.230	0.886	3.000	8.110	21.000
2008	31	13.900		7.000		0.406		0.482	1.090		1.780		13.300
2009	1	10.200	0.830	11.100	3.960	34.500	3.780	1.790	0.196	0.751	0.907	8.360	5.000
2009	2	8.100	0.855	4.600	3.830	11.400	2.800	1.370	0.162	0.512	0.616	4.570	4.640
2009	3	6.850	0.820	2.200	15.800	5.910	1.990	1.140	0.139	0.396	0.668	3.710	23.900
2009	4	5.700	0.765	1.590	26.500	3.880	1.470	0.839	0.130	0.333	1.250	3.080	14.500
2009	5	4.950	0.730	2.380	12.300	2.750	1.170	0.581	0.156	0.292	1.810	3.110	7.220
2009	6	4.250	0.710	18.100	9.480	2.090	0.980	0.425	0.162	0.273	2.070	6.580	4.590
2009	7	3.600	0.990	32.200	6.480	1.750	0.838	0.348	0.129	0.252	4.990	5.880	3.370
2009	8	3.150	3.970	42.500	6.720	1.490	0.856	0.310	0.117	0.237	6.880	4.170	2.610
2009	9	2.850	8.900	51.000	10.700	4.930	1.170	0.258	0.362	0.227	7.230	3.090	2.740
2009	10	2.480	9.600	18.100	13.200	10.500	1.120	0.214	35.800	0.216	24.700	2.410	2.100
2009	11	2.270	45.600	48.800	9.410	4.810	0.939	0.204	11.000	0.205	10.300	1.920	1.380
2009	12	2.080	126.000	13.000	5.680	3.240	0.905	0.194	3.300	0.202	4.960	1.530	1.700
2009	13	2.050	41.000	6.300	4.140	2.290	0.762	0.165	1.470	0.200	3.350	1.370	2.030
2009	14	1.820	19.000	4.900	3.430	4.100	0.594	0.141	0.869	0.198	2.340	1.230	2.390
2009	15	1.630	11.300	5.380	2.800	4.790	0.483	0.122	0.534	0.187	1.790	1.130	2.880
2009	16	1.540	7.950	7.540	2.340	9.180	0.414	0.118	0.366	0.172	1.430	0.979	1.930
2009	17	1.430	5.330	9.320	1.910	8.660	0.377	0.108	0.283	0.168	1.140	0.884	1.620
2009	18	1.340	3.690	14.000	1.700	4.540	0.504	0.101	0.236	0.170	0.944	0.840	1.420
2009	19	1.250	2.780	9.360	1.520	2.980	0.463	0.103	0.248	0.167	0.824	0.818	1.280
2009	20	1.160	1.600	4.540	1.440	2.040	0.529	0.100	0.290	0.168	0.741	1.010	1.180
2009	21	1.130	1.290	3.560	2.180	1.510	0.719	0.096	1.370	0.172	0.676	1.180	1.130
2009	22	1.100	1.120	3.140	2.070	1.180	0.605	0.093	0.996	0.190	0.659	1.110	1.060
2009	23	1.120	1.020	3.010	1.790	1.020	0.431	0.102	0.699	0.202	0.709	1.000	1.010
2009	24	1.070	0.930	2.510	1.510	0.907	0.336	0.128	0.536	0.191	2.910	0.955	0.960
2009	25	1.010	0.870	2.340	1.540	0.745	0.305	0.149	0.393	0.180	3.560	1.040	1.040
2009	26	0.955	0.900	2.970	5.430	0.646	0.296	0.165	0.337	0.167	2.270	2.610	4.810
2009	27	0.910	18.300	3.360	7.710	1.530	0.247	0.170	0.286	0.170	1.740	2.780	5.050
2009	28	0.865	25.000	3.400	5.780	14.900	0.226	0.154	0.310	0.220	1.570	2.210	3.600
2009	29	0.830		6.690	5.580	24.700	0.374	0.277	1.250	0.975	1.440	2.000	2.500
2009	30	0.800		8.060	4.840	9.490	0.911	0.535	2.450	1.480	2.340	5.370	1.820
2009	31	0.780		4.370		6.180		0.273	1.190		12.500		1.570
2010	1	1.500	2.000	0.665	1.820	0.335	0.190	2.810	0.685	0.076	1.760	1.050	29.000
2010	2	1.210	1.550	0.655	1.610	0.352	0.324	1.780	0.586	0.074	1.130	0.841	11.700
2010	3	1.110	1.300	0.670	1.410	6.220	3.360	1.220	0.505	0.094	0.838	0.750	5.950
2010	4	1.020	1.150	0.700	1.240	4.550	4.110	0.917	0.443	0.121	0.598	0.770	4.220
2010	5	0.920	1.000	0.685	1.120	2.680	2.290	0.675	0.511	0.143	0.464	0.749	2.850
2010	6	0.830	0.910	0.650	1.350	4.480	6.400	0.482	0.325	0.142	0.402	0.622	2.000
2010	7	0.760	0.850	0.660	1.550	3.650	5.570	0.509	0.250	0.130	0.409	0.490	1.500
2010	8	0.700	0.790	0.775	4.020	30.300	2.500	0.677	0.260	0.110	0.335	0.450	1.250

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.224	17.689	0.897	2.351	2.063	2.141	0.046	0.108	0.382	0.352	0.904	4.124
3.670	14.743	0.874	2.303	1.699	1.857	0.050	0.108	0.312	0.363	0.849	3.060
4.320	13.767	1.062	2.929	1.403	1.280	0.056	0.101	0.293	0.371	0.749	2.640
4.701		1.712	3.251	1.273	0.911	0.105	0.077	0.296	0.374	0.643	2.359
4.530		2.181		1.286		0.148	0.062		0.377		2.313
57.500	0.853	8.303	4.687	9.340	8.747	0.593	0.253	0.939	0.586	4.317	3.001
56.086	0.839	8.814	4.810	10.749	9.054	0.745	0.252	0.964	0.648	4.646	3.516
48.350	0.826	8.996	6.587	10.817	9.120	0.865	0.248	0.980	0.719	4.927	6.557
17.021	0.811	9.099	9.887	10.270	7.201	0.950	0.245	0.983	0.874	5.143	8.231
10.014	0.797	9.310	10.689	9.837	3.840	1.001	0.227	0.846	1.101	5.381	8.947
7.621	0.784	9.281	10.891	9.339	2.624	1.008	0.174	0.535	1.257	5.987	9.317
6.236	0.814	10.310	11.193	8.897	1.861	0.928	0.153	0.401	1.759	5.041	9.031
5.229	1.263	14.796	11.587	4.181	1.443	0.716	0.142	0.328	2.612	4.443	8.690
4.479	2.412	21.424	12.569	3.257	1.211	0.557	0.171	0.287	3.557	4.231	8.419
3.854	3.666	23.696	12.197	3.913	1.086	0.425	5.265	0.261	6.990	4.046	5.304
3.364	10.071	30.440	9.756	4.046	1.010	0.334	6.818	0.243	8.283	3.880	3.430
2.954	27.967	31.957	8.810	4.116	0.973	0.279	7.267	0.230	8.733	3.654	2.641
2.640	33.723	30.271	8.047	4.144	0.941	0.242	7.454	0.220	8.916	2.910	2.276
2.386	36.296	26.371	7.611	4.480	0.907	0.212	7.560	0.212	8.537	2.246	2.136
2.169	37.343	21.069	7.051	4.951	0.853	0.185	7.619	0.205	7.810	1.811	2.174
1.981	37.207	14.860	5.857	5.559	0.745	0.165	7.620	0.197	6.981	1.510	2.059
1.831	36.597	13.606	4.244	5.296	0.639	0.150	2.546	0.190	3.616	1.292	1.990
1.699	30.610	8.634	3.143	5.257	0.577	0.136	1.008	0.185	2.279	1.138	1.996
1.580	13.007	8.114	2.549	5.220	0.514	0.123	0.572	0.180	1.688	1.036	1.936
1.453	7.379	7.863	2.163	5.184	0.481	0.113	0.404	0.176	1.316	0.984	1.814
1.354	4.849	7.671	1.984	4.814	0.498	0.107	0.475	0.172	1.078	0.977	1.634
1.279	3.394	7.351	1.880	4.299	0.516	0.103	0.541	0.172	0.916	0.974	1.374
1.219	2.404	6.704	1.801	3.133	0.518	0.100	0.589	0.177	0.813	0.977	1.243
1.167	1.776	5.731	1.744	2.025	0.512	0.103	0.625	0.180	1.066	0.988	1.149
1.120	1.373	4.066	1.721	1.483	0.484	0.110	0.647	0.181	1.440	1.016	1.094
1.078	1.104	3.153	2.280	1.150	0.460	0.119	0.660	0.181	1.646	1.272	1.599
1.042	3.490	2.984	3.176	1.077	0.420	0.129	0.660	0.182	1.789	1.525	2.151
1.004	6.877	2.961	3.690	2.990	0.349	0.137	0.508	0.189	1.917	1.672	2.504
0.966		3.469	4.191	6.350	0.316	0.164	0.544	0.301	2.028	1.799	2.710
0.920		4.190	4.627	7.560	0.385	0.225	0.795	0.483	2.261	2.424	2.826
0.879		4.456		8.313		0.246	0.888		3.631		2.913
2.979	4.664	0.591	1.976	0.507	0.314	18.134	1.704	0.092	2.258	3.077	7.204
2.464	3.457	0.607	1.941	0.478	0.293	16.574	1.182	0.086	2.387	2.714	8.519
1.901	2.786	0.623	1.929	1.254	0.715	15.424	0.904	0.086	2.478	1.746	8.669
1.533	2.264	0.644	1.889	1.817	1.251	12.255	0.739	0.089	2.538	1.279	8.661
1.307	1.864	0.659	1.693	2.131	1.534	3.523	0.636	0.096	2.411	1.043	8.691
1.166	1.544	0.666	1.524	2.710	2.412	1.821	0.547	0.104	1.213	0.882	8.697
1.050	1.251	0.669	1.443	3.181	3.178	1.199	0.472	0.111	0.800	0.753	8.174
0.936	1.079	0.685	1.757	7.462	3.508	0.894	0.411	0.116	0.597	0.667	4.210

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	9	0.625	0.740	1.000	6.340	16.600	1.750	1.790	0.618	0.108	0.272	0.426	1.090
2010	10	0.570	0.780	1.750	3.630	8.590	2.320	2.790	1.110	0.112	0.231	0.402	0.960
2010	11	0.580	0.750	6.750	2.750	4.960	1.890	1.370	0.903	0.113	0.208	0.365	0.940
2010	12	0.590	0.670	37.000	2.090	3.720	1.400	1.320	0.559	0.113	0.200	0.345	1.020
2010	13	0.550	0.640	114.000	1.620	3.250	1.440	1.370	0.376	0.110	0.186	0.326	0.890
2010	14	0.530	0.615	75.400	1.350	11.600	1.320	1.020	0.283	0.107	0.285	0.331	0.820
2010	15	0.510	0.595	41.300	1.170	6.370	1.020	0.864	0.294	0.097	0.399	0.344	0.795
2010	16	0.495	0.580	24.300	1.110	3.810	0.901	1.440	0.395	0.129	0.381	0.335	0.770
2010	17	0.485	0.565	15.600	1.050	2.530	0.966	1.100	0.292	0.549	0.317	0.659	0.745
2010	18	0.500	0.554	11.600	0.968	1.880	0.721	0.723	0.224	0.460	0.277	1.030	0.715
2010	19	0.515	0.530	8.950	0.835	1.390	0.527	0.775	0.185	0.301	0.250	1.060	0.700
2010	20	0.500	0.505	6.420	0.721	1.120	0.409	0.609	0.169	0.223	0.238	1.020	0.690
2010	21	0.465	0.500	4.410	0.671	0.920	0.316	0.476	0.162	0.182	0.262	0.866	0.685
2010	22	0.460	0.515	3.680	0.656	0.828	0.312	0.410	0.149	0.204	0.346	0.980	0.675
2010	23	0.455	0.540	3.570	0.574	0.801	0.554	35.600	0.144	0.338	0.352	3.770	0.665
2010	24	0.445	0.560	3.060	0.491	0.667	21.600	20.000	0.137	0.292	2.710	3.790	0.660
2010	25	3.400	0.550	2.650	0.558	0.551	12.700	8.430	0.123	0.231	5.000	2.500	0.655
2010	26	10.000	0.580	1.850	0.784	0.468	9.270	4.240	0.114	0.198	3.380	4.900	0.645
2010	27	6.000	0.600	1.500	0.608	0.407	23.100	2.450	0.099	0.178	7.530	4.270	0.590
2010	28	4.800	0.640	1.520	0.483	0.361	61.800	1.600	0.096	1.350	4.040	2.640	0.660
2010	29	3.800		2.490	0.431	0.305	12.400	1.230	0.093	8.790	2.400	1.960	0.640
2010	30	3.150		2.530	0.350	0.253	4.860	0.949	0.086	3.300	1.750	5.160	0.600
2010	31	2.900		2.120		0.213		0.774	0.081		1.390		1.100
2011	1	59.300	0.783	3.670	4.030	4.590	2.280	0.337	0.090	0.124	1.470	2.170	15.100
2011	2	40.300	0.757	2.830	5.120	3.870	1.790	0.295	0.078	0.124	0.972	1.890	9.040
2011	3	10.000	0.735	2.270	5.010	3.300	1.540	1.470	0.095	0.122	0.761	1.700	5.970
2011	4	5.700	0.717	2.040	34.500	3.030	14.500	0.683	0.144	0.148	0.777	1.490	11.200
2011	5	3.990	0.702	17.100	24.300	2.630	11.600	0.419	0.112	0.260	0.642	1.270	34.100
2011	6	3.280	0.689	23.000	9.000	2.440	4.640	0.321	0.092	0.231	0.510	1.170	15.900
2011	7	2.750	0.678	13.300	6.550	2.440	3.050	0.258	0.094	0.177	0.364	1.090	9.290
2011	8	2.520	0.662	7.870	5.870	2.100	15.900	0.211	0.087	0.149	0.276	1.010	5.400
2011	9	1.950	0.617	5.580	5.050	1.810	6.310	0.172	0.427	0.129	0.226	1.020	3.730
2011	10	1.740	0.554	9.180	5.490	1.670	3.390	0.144	0.385	0.119	0.197	1.090	2.820
2011	11	1.720	0.501	32.000	6.470	1.560	2.470	0.129	0.203	0.113	0.180	1.080	2.280
2011	12	1.640	0.461	16.000	4.820	1.450	2.010	0.117	0.140	0.120	0.180	1.140	2.010
2011	13	1.420	0.433	8.310	3.680	1.490	1.620	0.100	0.108	0.152	0.248	1.220	1.820
2011	14	1.290	0.428	6.050	3.090	2.740	1.360	0.083	0.102	0.151	16.300	1.310	1.820
2011	15	1.230	0.435	4.610	2.650	10.300	1.110	0.074	0.096	0.158	15.300	1.470	38.100
2011	16	1.180	0.498	9.570	2.920	8.570	0.941	0.071	0.089	0.154	12.300	1.450	21.500
2011	17	1.160	0.700	31.200	4.020	11.400	0.839	0.068	0.079	0.152	5.970	1.320	8.460
2011	18	1.220	14.200	91.100	3.970	7.000	0.715	0.060	0.077	0.167	3.500	1.170	4.670
2011	19	1.250	20.100	28.700	3.270	32.500	0.567	0.058	0.075	0.204	2.720	1.070	3.420
2011	20	1.190	12.300	10.800	16.700	10.300	0.473	0.054	0.108	0.514	47.400	1.080	2.860
2011	21	1.160	7.710	9.400	10.500	5.640	0.408	0.052	0.481	0.322	20.800	0.988	3.240

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.852	0.963	0.734	2.433	9.783	3.711	0.896	0.416	0.121	0.474	0.608	2.694
0.775	0.889	0.889	2.750	10.121	3.563	1.120	0.502	0.124	0.387	0.558	1.981
0.712	0.831	1.753	2.966	10.180	3.246	1.185	0.568	0.123	0.332	0.501	1.513
0.665	0.784	6.941	3.104	10.329	3.119	1.277	0.575	0.118	0.294	0.443	1.251
0.625	0.746	23.134	3.143	10.153	2.410	1.404	0.582	0.114	0.263	0.401	1.093
0.592	0.712	33.811	3.114	11.289	1.803	1.477	0.587	0.110	0.245	0.378	0.996
0.565	0.684	39.600	2.707	7.870	1.591	1.503	0.592	0.109	0.254	0.363	0.931
0.546	0.661	42.929	1.960	6.043	1.470	1.453	0.560	0.112	0.270	0.350	0.885
0.534	0.631	44.907	1.591	5.177	1.277	1.212	0.443	0.174	0.282	0.386	0.854
0.523	0.603	45.600	1.337	4.737	1.110	1.120	0.346	0.224	0.292	0.481	0.822
0.512	0.583	41.593	1.158	4.404	0.985	1.042	0.293	0.250	0.299	0.584	0.776
0.505	0.563	26.224	1.029	4.100	0.838	0.933	0.263	0.267	0.307	0.683	0.748
0.496	0.547	16.083	0.932	2.574	0.694	0.855	0.246	0.277	0.303	0.759	0.729
0.489	0.536	10.709	0.859	1.783	0.593	0.790	0.225	0.293	0.296	0.850	0.711
0.483	0.530	7.747	0.782	1.353	0.544	5.670	0.189	0.322	0.292	1.341	0.696
0.477	0.529	5.956	0.702	1.087	3.491	8.370	0.167	0.286	0.634	1.788	0.684
0.891	0.529	4.677	0.644	0.897	5.203	9.471	0.153	0.253	1.308	1.998	0.676
2.246	0.536	3.663	0.636	0.765	6.452	9.966	0.143	0.238	1.755	2.547	0.668
3.032	0.549	2.960	0.620	0.663	9.693	10.229	0.133	0.232	2.797	3.011	0.654
3.651	0.569	2.547	0.593	0.583	18.477	10.390	0.123	0.399	3.337	3.264	0.650
4.129		2.377	0.561	0.509	20.203	10.507	0.115	1.625	3.630	3.404	0.645
4.514		2.229	0.529	0.430	20.819	5.557	0.107	2.048	3.830	3.603	0.636
4.864		2.094		0.365		2.810	0.099		3.641		0.699
9.076	0.887	3.041	2.851	7.879	4.910	0.605	0.125	0.166	1.015	9.054	19.820
14.741	0.853	2.779	3.129	7.741	4.113	0.508	0.101	0.142	1.112	4.867	20.966
16.086	0.820	2.607	3.460	7.590	3.164	0.602	0.094	0.129	1.188	3.196	21.677
16.806	0.791	2.530	8.067	7.116	4.407	0.607	0.100	0.127	1.066	2.463	23.066
17.284	0.765	4.649	11.237	4.734	5.466	0.587	0.102	0.145	0.910	2.034	26.944
17.667	0.742	7.646	12.179	3.690	5.603	0.564	0.101	0.161	0.850	1.750	21.973
17.903	0.723	9.173	12.644	3.186	5.629	0.540	0.101	0.169	0.785	1.540	14.371
9.791	0.706	9.773	12.907	2.830	7.574	0.522	0.100	0.173	0.615	1.374	12.986
4.313	0.686	10.166	12.897	2.536	8.220	0.505	0.150	0.174	0.508	1.250	12.227
3.133	0.660	11.153	12.966	2.303	8.484	0.315	0.192	0.173	0.427	1.163	11.777
2.564	0.629	15.433	8.961	2.093	6.766	0.236	0.200	0.168	0.342	1.104	10.503
2.229	0.595	15.276	6.179	1.924	5.396	0.193	0.204	0.148	0.276	1.086	5.919
1.963	0.558	13.177	5.419	1.789	4.964	0.162	0.206	0.137	0.239	1.093	3.907
1.754	0.522	12.141	4.924	1.831	4.723	0.137	0.207	0.133	2.515	1.124	2.840
1.570	0.490	11.676	4.464	3.003	2.610	0.117	0.209	0.135	4.662	1.190	7.511
1.460	0.473	12.246	4.160	3.969	1.843	0.103	0.160	0.138	6.386	1.251	10.050
1.377	0.494	15.391	3.950	5.359	1.479	0.092	0.117	0.143	7.211	1.284	10.856
1.306	2.451	23.834	3.593	6.136	1.228	0.082	0.099	0.151	7.685	1.297	11.197
1.250	5.256	25.649	3.371	10.571	1.022	0.073	0.089	0.163	8.048	1.287	11.399
1.217	6.952	26.004	5.231	11.830	0.858	0.067	0.089	0.214	14.784	1.267	11.547
1.199	7.992	26.483	6.290	12.244	0.722	0.062	0.144	0.239	15.427	1.221	11.750

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	22	1.140	5.590	10.400	6.500	3.840	0.379	0.049	0.422	0.259	8.470	0.922	8.210
2011	23	1.110	4.670	6.940	9.060	3.140	0.761	0.049	0.241	0.254	4.750	0.990	5.930
2011	24	1.080	3.470	5.090	6.750	4.120	1.030	0.046	0.210	0.322	3.450	1.040	3.810
2011	25	1.040	2.580	3.790	4.830	3.120	0.975	0.051	0.337	0.295	3.800	1.020	2.970
2011	26	1.000	2.270	3.180	4.360	7.370	0.810	0.248	0.296	0.230	31.200	0.989	2.510
2011	27	0.963	2.020	2.690	6.350	8.180	0.650	0.145	0.211	1.630	13.400	1.480	2.370
2011	28	0.923	2.610	2.250	19.300	5.800	0.558	0.102	0.164	1.730	6.620	6.950	2.050
2011	29	0.884		2.110	9.750	4.190	0.484	0.095	0.130	0.932	4.270	50.700	1.850
2011	30	0.847		2.410	5.970	3.680	0.421	0.101	0.119	0.819	3.160	62.500	1.990
2011	31	0.812		3.290		2.870		0.095	0.121		2.560		2.390
2012	1	9.680	16.900	1.100	0.782	0.864	0.331	0.051	0.079	0.198	0.580	12.300	0.423
2012	2	22.400	10.500	1.240	0.833	0.896	9.080	0.045	0.083	0.196	0.542	7.180	2.600
2012	3	9.640	5.580	9.140	0.692	4.360	4.830	0.041	0.078	0.197	0.489	4.170	7.980
2012	4	6.130	3.930	5.790	0.655	36.400	3.890	0.040	0.069	0.228	0.470	2.830	4.260
2012	5	4.130	3.250	4.650	0.605	7.790	2.360	0.037	0.065	0.251	0.492	2.180	4.830
2012	6	3.180	3.400	3.170	0.525	4.160	1.610	0.037	0.062	0.265	0.532	1.760	2.940
2012	7	2.840	3.870	13.500	0.467	2.750	1.150	0.035	0.056	0.274	0.539	1.470	2.200
2012	8	2.760	2.830	67.100	0.441	2.570	0.856	0.033	0.050	0.534	0.518	1.210	2.180
2012	9	2.520	2.670	18.500	0.447	2.360	0.758	0.030	0.052	0.663	0.518	1.010	3.130
2012	10	2.320	1.910	7.650	0.428	2.020	0.661	0.030	0.135	0.460	0.519	0.887	2.790
2012	11	2.090	1.440	6.520	0.434	1.570	0.470	0.058	0.363	0.348	0.577	0.802	2.510
2012	12	2.380	1.320	11.900	0.521	1.240	0.554	0.073	0.209	0.296	0.678	0.813	1.910
2012	13	4.860	1.230	41.400	0.400	1.050	0.827	0.071	0.114	0.276	0.752	1.550	1.470
2012	14	3.570	1.160	15.200	0.341	0.888	0.489	0.070	0.095	0.342	1.210	1.710	1.310
2012	15	2.670	1.070	9.230	0.353	0.772	0.341	0.073	0.086	0.529	1.700	1.430	1.140
2012	16	2.330	1.020	7.130	0.389	0.656	0.264	0.096	0.075	0.423	1.520	1.220	1.250
2012	17	3.780	1.090	5.310	0.352	0.570	0.243	0.082	0.081	0.337	1.280	1.030	4.240
2012	18	9.300	1.030	4.190	0.303	0.489	0.265	0.074	0.096	0.365	1.100	0.881	5.910
2012	19	4.700	0.947	3.410	0.279	0.425	0.222	0.070	0.066	0.498	0.971	0.814	4.060
2012	20	2.940	0.814	2.830	0.289	0.372	0.166	0.072	0.063	0.445	1.020	0.787	2.870
2012	21	2.450	0.821	2.430	0.345	0.322	0.170	0.071	0.067	0.380	1.630	0.729	2.930
2012	22	2.100	1.070	2.130	0.354	0.451	0.519	0.079	0.075	0.366	1.730	0.654	2.940
2012	23	3.040	1.190	1.860	0.314	0.498	0.207	0.077	0.078	0.390	2.630	0.663	2.350
2012	24	11.400	1.280	1.620	0.456	0.369	0.161	0.072	0.088	0.428	5.310	0.719	1.880
2012	25	5.350	1.030	1.420	0.878	0.303	0.120	0.067	0.094	0.431	2.510	0.636	1.540
2012	26	3.870	0.788	1.190	1.340	0.252	0.110	0.176	0.114	0.394	1.730	0.601	0.890
2012	27	3.480	0.884	0.981	1.060	0.218	0.098	0.222	0.150	0.431	2.120	0.547	0.816
2012	28	3.030	0.970	0.994	0.780	0.194	0.083	0.140	0.176	0.351	6.880	0.488	1.090
2012	29	2.230	1.060	0.962	0.632	0.180	0.075	0.097	0.183	0.310	7.940	0.481	0.837
2012	30	2.520		0.810	0.569	0.200	0.062	0.078	0.192	0.394	13.400	0.489	0.753
2012	31	2.520		0.777		0.222		0.078	0.198		8.600		0.658
2013	1	0.610	7.950	1.150	19.600	2.710	7.920	3.090	35.400	0.297	0.950	69.500	1.750
2013	2	0.537	5.410	1.140	8.960	2.340	9.460	1.980	12.300	0.431	0.824	19.200	1.680
2013	3	0.498	4.240	1.120	6.010	2.020	8.350	1.470	4.070	0.390	0.712	9.650	1.370

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.186	8.728	27.310	6.840	11.321	0.617	0.059	0.190	0.253	14.451	1.143	7.480
1.176	9.324	26.934	7.717	10.546	0.592	0.056	0.212	0.267	13.373	1.077	5.256
1.164	9.720	23.204	8.107	9.506	0.619	0.053	0.231	0.292	13.013	1.037	4.591
1.139	8.060	10.731	8.230	8.951	0.656	0.051	0.268	0.310	13.056	1.016	4.349
1.103	5.513	7.086	8.386	5.361	0.691	0.078	0.299	0.314	17.124	1.004	4.219
1.070	4.044	5.927	6.907	5.059	0.716	0.091	0.314	0.473	12.267	1.061	4.149
1.037	3.316	4.906	8.164	5.081	0.738	0.099	0.269	0.674	10.241	1.913	3.979
1.000		3.721	8.629	5.131	0.753	0.105	0.227	0.770	9.641	9.024	3.070
0.962		3.074	8.187	5.209	0.704	0.113	0.210	0.851	9.414	17.811	2.507
0.924		2.817		5.030		0.120	0.197		9.287		2.304
3.263	4.936	1.016	0.928	0.875	0.228	0.086	0.124	0.173	0.413	7.567	0.524
6.104	5.883	1.010	0.877	0.877	1.489	0.075	0.111	0.185	0.429	8.346	0.804
7.143	6.183	2.169	0.836	1.309	2.148	0.065	0.090	0.191	0.442	8.639	1.858
7.726	6.311	2.883	0.787	6.357	2.676	0.057	0.080	0.199	0.448	8.060	2.389
8.051	6.457	3.421	0.736	7.359	2.988	0.050	0.076	0.209	0.468	7.237	3.009
8.221	6.583	3.736	0.696	7.863	3.189	0.045	0.073	0.219	0.500	5.574	3.360
8.286	6.776	5.513	0.651	8.174	3.322	0.041	0.070	0.230	0.521	4.556	3.605
7.297	4.766	14.941	0.603	8.418	3.397	0.038	0.066	0.278	0.512	2.971	3.856
4.457	3.647	17.407	0.547	8.627	2.208	0.036	0.062	0.345	0.508	2.090	3.931
3.411	3.123	17.194	0.510	8.293	1.612	0.035	0.070	0.382	0.513	1.621	3.190
2.834	2.767	17.299	0.478	3.317	1.124	0.037	0.112	0.399	0.528	1.331	2.940
2.584	2.491	18.334	0.466	2.381	0.866	0.042	0.132	0.406	0.554	1.136	2.523
2.824	2.181	23.796	0.448	1.937	0.754	0.047	0.140	0.407	0.586	1.106	2.313
2.929	1.794	24.039	0.430	1.671	0.659	0.052	0.145	0.417	0.682	1.140	2.186
2.916	1.543	15.771	0.418	1.414	0.586	0.058	0.151	0.416	0.851	1.172	2.037
2.889	1.307	14.147	0.409	1.171	0.515	0.067	0.154	0.382	0.994	1.202	1.769
3.097	1.190	13.813	0.399	0.964	0.455	0.075	0.146	0.364	1.102	1.222	1.976
4.127	1.131	13.480	0.380	0.809	0.426	0.077	0.108	0.367	1.177	1.233	2.461
4.459	1.078	12.267	0.345	0.693	0.379	0.077	0.088	0.396	1.219	1.234	2.769
4.184	1.019	6.757	0.329	0.596	0.284	0.077	0.080	0.420	1.257	1.125	2.969
4.024	0.970	4.933	0.330	0.515	0.239	0.077	0.076	0.425	1.317	0.984	3.200
3.943	0.970	3.919	0.330	0.469	0.264	0.078	0.075	0.402	1.322	0.874	3.457
4.044	0.995	3.166	0.319	0.447	0.256	0.075	0.075	0.397	1.480	0.794	3.614
5.133	1.022	2.639	0.334	0.418	0.244	0.074	0.076	0.410	2.056	0.750	3.277
4.569	1.022	2.243	0.416	0.391	0.224	0.073	0.076	0.420	2.257	0.715	2.653
4.450	0.999	1.926	0.568	0.367	0.208	0.088	0.083	0.405	2.366	0.684	2.200
4.527	1.009	1.662	0.678	0.345	0.198	0.109	0.095	0.403	2.523	0.650	1.907
4.610	1.030	1.456	0.740	0.326	0.185	0.119	0.111	0.399	3.273	0.615	1.644
4.629	1.029	1.290	0.780	0.288	0.122	0.122	0.126	0.391	4.160	0.591	1.343
4.554		1.140	0.816	0.245	0.101	0.122	0.142	0.391	5.699	0.566	1.115
3.286		1.019		0.224		0.123	0.158		6.169		0.941
0.808	13.048	1.180	13.893	3.700	8.960	8.129	5.361	0.194	1.593	21.666	2.113
0.757	13.721	1.170	14.779	3.387	10.077	8.322	7.051	0.236	1.273	23.016	1.913
0.712	14.231	1.159	14.954	2.994	11.089	8.424	7.580	0.271	1.065	21.123	1.700

Daily Discharge at Station 02GA039 Conestogo River above Drayton

Unit: m³/s

YEAR	DD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	4	0.461	3.380	1.110	6.160	1.750	4.170	1.980	2.080	0.294	0.732	6.020	1.560
2013	5	0.445	2.560	1.110	10.500	1.510	2.630	2.470	1.270	0.233	0.821	4.730	8.420
2013	6	0.447	2.000	1.100	7.760	1.330	2.360	3.220	0.878	0.190	0.917	4.390	8.820
2013	7	0.449	1.560	1.110	11.500	1.160	1.830	2.160	1.790	2.140	43.300	11.900	4.180
2013	8	0.422	1.300	1.120	16.800	1.020	1.550	8.220	2.880	3.210	21.700	8.160	2.420
2013	9	0.412	1.210	1.250	30.300	0.939	1.220	8.540	1.690	1.430	8.920	7.970	2.040
2013	10	0.446	1.280	2.040	67.700	1.130	1.480	5.160	1.030	0.849	5.420	8.170	1.430
2013	11	1.050	1.480	16.900	28.200	2.180	23.500	3.130	0.686	0.562	3.860	9.430	1.370
2013	12	13.800	1.660	73.400	25.200	1.740	8.940	2.100	0.521	0.419	2.880	9.200	1.190
2013	13	53.800	1.720	38.400	33.400	1.540	4.460	1.550	0.443	0.344	2.780	5.580	1.140
2013	14	29.900	1.680	19.300	15.200	1.360	2.740	1.190	0.382	0.298	2.800	4.420	1.030
2013	15	9.310	1.580	11.200	9.400	1.240	1.930	0.963	0.318	0.261	2.470	3.740	1.010
2013	16	4.890	1.480	7.320	8.750	1.050	2.100	0.802	0.269	0.243	5.020	3.450	1.020
2013	17	2.890	1.400	5.550	6.190	0.848	4.470	0.704	0.233	0.222	5.510	8.860	1.020
2013	18	1.890	1.350	4.490	14.000	0.719	2.670	0.630	0.208	0.196	9.670	31.500	0.995
2013	19	1.440	1.320	3.780	46.200	0.638	1.780	0.592	0.186	0.180	6.880	12.000	0.950
2013	20	1.190	1.290	3.090	14.500	0.878	1.300	0.638	0.177	0.232	9.340	6.460	0.962
2013	21	1.030	1.260	2.860	7.300	6.190	0.982	0.563	0.164	56.200	9.660	4.490	1.330
2013	22	0.908	1.240	2.570	5.340	13.100	0.955	0.523	0.155	32.200	23.400	6.010	2.750
2013	23	0.827	1.210	2.430	4.280	4.870	0.933	0.510	0.149	8.850	10.300	7.080	2.700
2013	24	0.769	1.200	2.330	3.950	2.970	0.679	0.520	0.134	4.710	7.180	4.200	1.590
2013	25	0.732	1.190	2.350	4.530	2.130	0.631	0.470	0.128	3.060	6.680	3.080	1.400
2013	26	0.698	1.180	2.760	4.770	1.640	0.757	0.474	0.136	2.170	9.750	2.860	1.340
2013	27	0.671	1.170	4.780	4.060	1.270	0.556	0.368	0.142	1.580	22.900	2.580	1.150
2013	28	0.667	1.160	6.810	3.400	1.190	25.300	0.244	0.206	1.250	12.100	1.730	1.050
2013	29	1.450		13.900	3.340	32.300	20.200	0.433	0.168	1.100	6.720	1.220	0.926
2013	30	52.200		24.100	3.090	12.400	6.370	0.342	0.150	1.040	5.090	1.570	0.804
2013	31	27.700		25.300		6.000		0.269	0.257		25.600		0.677

Station 02GA039 Conestogo River above Drayton

7-day moving window average **Unit: m³/s**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.622	14.619	1.147	14.861	2.664	11.514	8.627	7.842	0.284	0.944	20.254	1.554
0.566	14.777	1.137	14.376	2.394	7.276	5.366	7.962	0.293	0.883	19.970	2.510
0.522	7.606	1.127	12.041	2.107	5.841	2.940	8.038	0.299	0.857	19.870	3.596
0.492	3.871	1.120	10.070	1.831	5.246	2.339	8.255	0.568	6.894	17.913	3.969
0.466	2.921	1.116	9.670	1.590	4.336	3.071	3.610	0.984	9.858	9.150	4.064
0.448	2.321	1.131	12.719	1.390	3.159	4.009	2.094	1.127	11.015	7.546	4.116
0.440	1.899	1.263	21.531	1.263	2.177	4.536	1.660	1.192	11.687	7.334	4.124
0.524	1.627	3.519	24.680	1.324	4.939	4.700	1.461	1.231	12.134	7.821	4.097
2.432	1.499	13.846	26.780	1.357	5.840	4.647	1.354	1.257	12.428	8.460	3.064
10.054	1.459	19.174	30.443	1.387	6.140	4.409	1.291	1.279	12.694	8.630	1.967
14.261	1.476	21.773	30.971	1.416	6.270	4.270	1.090	1.016	6.909	7.561	1.517
15.531	1.516	23.213	29.914	1.447	6.324	3.233	0.724	0.595	4.161	6.930	1.316
16.171	1.554	24.080	26.836	1.463	6.450	2.128	0.521	0.425	3.604	6.284	1.170
16.520	1.571	24.581	18.049	1.423	6.877	1.491	0.407	0.336	3.617	6.383	1.111
16.640	1.553	22.809	16.020	1.214	3.901	1.134	0.339	0.283	4.447	9.536	1.058
14.874	1.504	12.863	19.020	1.056	2.879	0.919	0.291	0.249	5.019	9.936	1.024
7.359	1.443	7.819	16.320	0.962	2.427	0.788	0.253	0.233	5.956	10.061	0.998
3.234	1.383	5.470	15.191	1.652	2.176	0.699	0.222	8.219	6.936	10.071	1.041
2.034	1.334	4.237	14.611	3.346	2.037	0.636	0.199	12.782	9.926	10.396	1.290
1.454	1.296	3.539	13.973	3.892	1.870	0.594	0.182	14.011	10.680	10.914	1.530
1.151	1.267	3.079	13.653	4.195	1.328	0.568	0.168	14.653	10.919	10.249	1.611
0.985	1.244	2.773	12.300	4.397	1.037	0.545	0.156	15.062	10.491	6.189	1.669
0.879	1.224	2.627	6.381	4.540	0.891	0.528	0.149	15.346	10.901	4.883	1.725
0.805	1.207	2.869	4.890	4.596	0.785	0.490	0.144	15.539	12.839	4.329	1.751
0.753	1.193	3.433	4.333	3.881	4.259	0.444	0.150	7.689	13.187	3.934	1.711
0.831		5.051	4.047	6.624	7.008	0.431	0.152	3.246	10.804	3.250	1.451
8.170		8.147	3.877	7.700	7.785	0.407	0.152	2.130	10.060	2.463	1.180
12.017		11.429		8.133		0.371	0.170		12.691		1.050

Appendix C: Monthly Minimums of 7-day Moving Window Average

Station 02GA039 Conestogo River above Drayton

Monthly minimum of 7-day moving window average **Unit: m³/s**

YEAR		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1973		0.82	0.563	0.550	0.683	0.873	0.345	0.016	0.012	0.005	0.017	0.122	0.235
1974		0.59	0.356	0.622	0.931	1.050	0.175	0.026	0.015	0.021	0.055	0.103	0.267
1975		0.31	0.341	1.874	3.301	0.260	0.201	0.070	0.086	0.291	0.264	0.466	0.702
1976		0.44	0.616	3.869	1.371	0.484	0.130	0.293	0.117	0.118	0.479	0.665	0.464
1977		0.27	0.214	0.444	0.908	0.084	0.059	0.052	0.110	0.267	0.833	0.613	0.839
1978		0.57	0.340	0.339	2.869	0.825	0.148	0.040	0.042	0.034	0.326	0.321	0.774
1979		0.39	0.219	0.422	1.871	0.749	0.103	0.024	0.030	0.027	0.026	0.408	1.270
1980		0.56	0.236	0.175	1.366	0.478	0.145	0.059	0.044	0.061	0.316	0.887	0.696
1981		0.36	0.369	0.729	1.170	0.553	0.198	0.039	0.050	0.544	2.137	1.018	0.455
1982		0.33	0.261	0.251	2.893	0.302	0.361	0.120	0.076	0.144	0.605	0.894	2.279
1983		0.52	0.513	2.111	0.877	1.803	0.021	0.017	0.062	0.219	0.571	1.163	0.903
1984		0.22	0.200	0.778	1.439	0.543	0.309	0.052	0.031	0.147	0.155	0.501	0.869
1985		0.52	0.394	5.400	1.483	0.204	0.119	0.000	0.020	0.183	0.092	0.913	0.803
1986		0.63	0.649	0.601	1.563	0.362	0.387	0.077	0.108	0.938	2.229	0.893	1.553
1987		0.79	0.560	0.625	0.740	0.211	0.002	0.016	0.008	0.001	0.078	1.000	2.454
1988		0.58	1.130	1.033	1.641	0.554	0.064	0.038	0.055	0.062	0.096	1.569	0.479
1989		0.88	0.345	0.325	1.090	0.847	0.363	0.032	0.028	0.068	0.212	0.462	0.442
1990		0.46	1.706	0.837	1.188	0.654	0.222	0.115	0.104	0.124	0.788	1.022	2.687
1991		0.86	0.816	2.976	2.549	0.433	0.087	0.066	0.103	0.097	0.112	0.241	1.086
1992		1.57	1.008	1.736	3.174	0.411	0.160	0.153	0.634	1.920	0.620	1.257	1.261
1993		0.88	0.490	0.423	4.056	0.412	0.527	0.156	0.102	0.129	0.330	0.370	0.474
1994		0.31	0.390	0.890	2.099	1.122	0.111	0.081	0.063	0.066	0.100	0.197	0.941
1995		0.56	0.514	0.473	1.238	0.792	0.094	0.103	0.119	0.029	0.026	0.471	0.684
1996		0.44	1.250	0.821	4.557	1.684	0.679	0.290	0.075	0.082	0.593	1.359	2.070
1997		3.60	3.667	1.709	2.089	1.263	0.448	0.321	0.179	0.202	0.143	1.296	1.053
1998		1.00	0.895	2.877									
2001					0.786	0.235	0.407	0.060	0.037	0.039	0.173	1.135	1.600
2002		1.24	1.594	0.874	2.303	1.273	0.592	0.031	0.028	0.057	0.301	0.330	0.276
2003		0.23	0.189	0.296	0.517	0.410	0.036	0.025	0.043	0.025	0.144	3.944	2.986
2004		0.55	0.474	0.518	1.924	2.094	0.410	0.295	0.258	0.249	0.211	0.706	1.849
2005		0.74	0.550	1.050	1.353	0.446	0.182	0.147	0.129	0.194	0.263	0.337	0.633
2006		3.59	3.760	1.827	2.419	0.638	0.099	0.064	0.069	0.094	0.792	1.697	4.489
2007		0.76	0.377	0.346	2.207	0.539	0.058	0.058	0.054	0.072	0.190	0.763	1.417
2008		1.24	1.594	0.874	2.303	1.273	0.592	0.031	0.028	0.057	0.301	0.330	0.276
2009		0.88	0.784	2.961	1.721	1.077	0.316	0.100	0.142	0.172	0.586	0.974	1.094
2010		0.48	0.529	0.591	0.529	0.365	0.293	0.790	0.099	0.086	0.245	0.350	0.636
2011		0.92	0.473	2.530	2.851	1.789	0.592	0.051	0.089	0.127	0.239	1.004	2.304
2012		2.58	0.970	1.010	0.319	0.224	0.101	0.035	0.062	0.173	0.413	0.566	0.524
2013		0.44	1.19	1.12	3.88	0.96	0.78	0.37	0.14	0.19	0.86	2.46	1.00
Avg.		**0.84**	**0.803**	**1.234**	**1.849**	**0.744**	**0.261**	**0.114**	**0.091**	**0.192**	**0.419**	**0.863**	**1.180**
Max.		3.60	3.760	5.400	4.557	2.094	0.785	0.790	0.634	1.920	2.229	3.944	4.489
Min.		0.22	0.189	0.175	0.319	0.084	0.002	0.000	0.008	0.001	0.017	0.103	0.235
5th centile	5%	0.27	0.212	0.289	0.528	0.210	0.034	0.016	0.014	0.018	0.026	0.186	0.275

*This is the minimum of monthly minimum of 7-day average

< = approx. For 7Q20 5%

Appendix D: Summary of $7Q_{20}$ Values

Estimate of monthly 7Q20 of Conestogo River at Drayton
(Fitted to Log-Pearson III distribution)

Month	7Q20 (m^3/s)	No. of date	Coef. of determination , R2
Jan	0.265	38	0.92
Feb	0.205	38	0.94
Mar	0.245	38	0.97
April	0.526	38	0.99
May	0.171	38	0.98
Jun	0.019	38	0.97
Jul	0.007	38	0.90
Aug	0.015	38	0.86
Sept	0.008	38	0.74
Oct	0.035	38	0.93
Nov	0.175	38	0.94
Dec	0.282	38	0.99

Appendix E: $7Q_{20}$ Calculation Table and Graphs

Fitting the Pearson type III distribution: to January 7-day average low flow
Ref: http://gergs.net/2014/11/fitting-pearson-type-3/

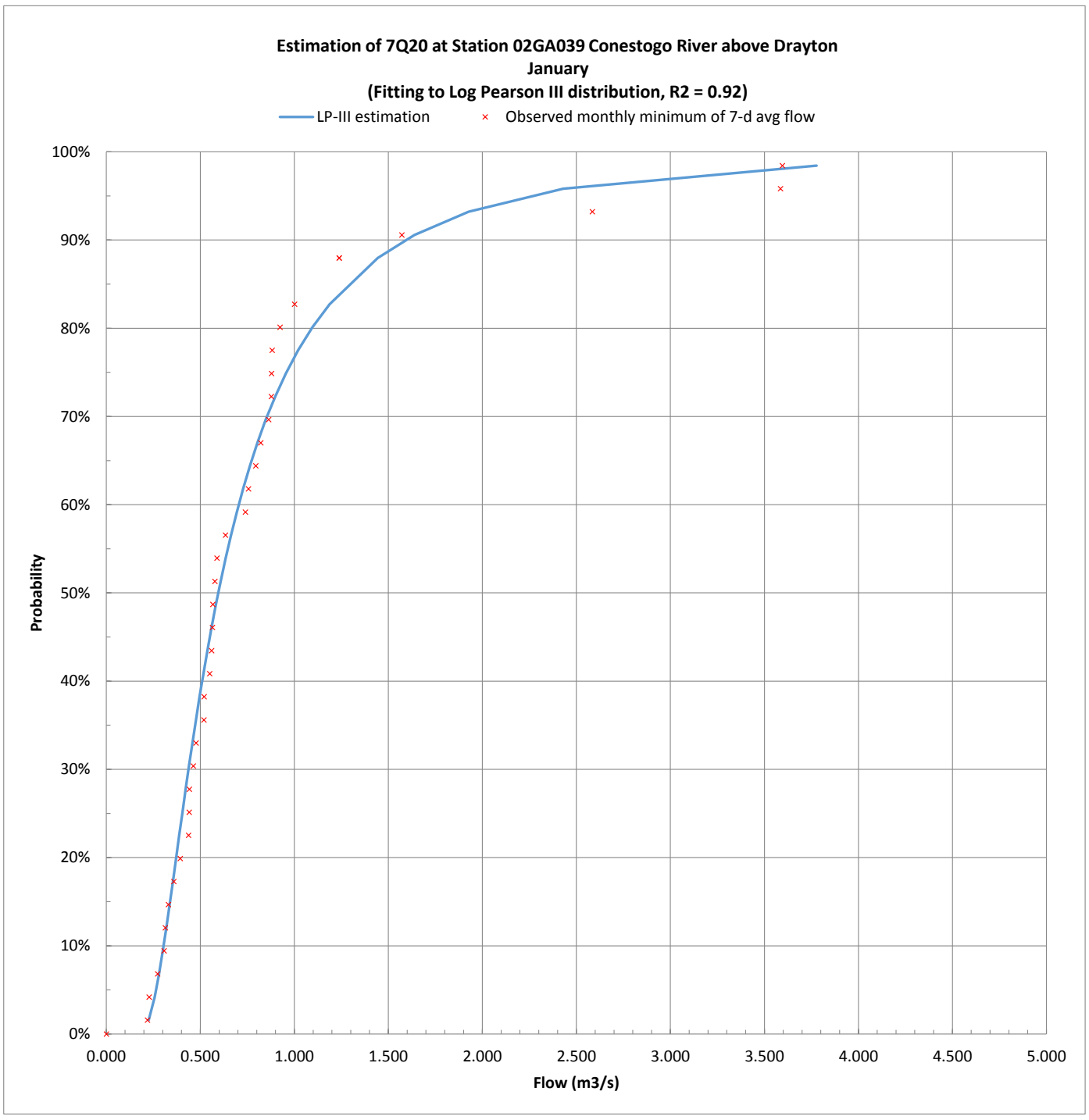
Sample	Plotting position	Normal distribution	P-III by moments
[μ = -0.184		μ = -0.184	μ = -0.184
σ = 0.288	$P_{Cunnane}$ = (i-0.4) / (n+0.2)	σ = 0.288	σ = 0.288
γ_1 = 0.870	[$P_{Weibull}$ = i / (n+1)]	[fitted by moments]	γ_1 = 0.870
n = 38			Σ sq : 0.82

95th percentile Flow: **0.265** **m3/s**
Coef. of determination R2: **0.92**

Plotting data

Rank	Sorted flow	Log flow	$P_{Cunnane}$	z-scale	P_{normal}	z-scale	$PIII_{moments}$	z-scale	z-error squared	x(P)	Estimated flow	LP-III estimation	Observed monthly minimum of 7-d avg flow
1	3.596	0.556	1.57%	-2.1518	0.51%	-2.5700	1.76%	-2.1064	0.00206	0.577	3.778	98.43%	
2	3.586	0.555	4.19%	-1.7292	0.51%	-2.5658	1.77%	-2.1038	0.14032	0.386	2.430	95.81%	
3	2.584	0.412	6.81%	-1.4904	1.92%	-2.0716	3.67%	-1.7906	0.09015	0.285	1.927	93.19%	
4	1.571	0.196	9.42%	-1.3151	9.33%	-1.3209	10.23%	-1.2687	0.00215	0.214	1.638	90.58%	
5	1.239	0.093	12.04%	-1.1729	16.81%	-0.9617	16.01%	-0.9942	0.03192	0.159	1.443	87.96%	
6	1.239	0.093	12.04%	-1.1729	16.81%	-0.9617	16.01%	-0.9942	0.03192	0.159	1.443	87.96%	
7	1.001	0.000	17.28%	-0.9433	26.11%	-0.6399	23.23%	-0.7311	0.04500	0.074	1.187	82.72%	
8	0.924	-0.034	19.90%	-0.8454	30.16%	-0.5198	26.50%	-0.6281	0.04720	0.040	1.096	80.10%	
9	0.881	-0.055	22.51%	-0.7550	32.70%	-0.4483	28.59%	-0.5655	0.03590	0.008	1.020	77.49%	
10	0.879	-0.056	25.13%	-0.6704	32.87%	-0.4434	28.73%	-0.5612	0.01193	-0.020	0.955	74.87%	
11	0.878	-0.057	27.75%	-0.5903	32.93%	-0.4420	28.78%	-0.5599	0.00093	-0.047	0.898	72.25%	
12	0.864	-0.064	30.37%	-0.5139	33.82%	-0.4175	29.53%	-0.5381	0.00059	-0.071	0.848	69.63%	
13	0.821	-0.086	32.98%	-0.4403	36.63%	-0.3417	31.92%	-0.4700	0.00088	-0.095	0.804	67.02%	
14	0.794	-0.100	35.60%	-0.3691	38.54%	-0.2912	33.58%	-0.4239	0.00300	-0.117	0.764	64.40%	
15	0.756	-0.121	38.22%	-0.2997	41.39%	-0.2176	36.11%	-0.3555	0.00311	-0.138	0.727	61.78%	
16	0.739	-0.131	40.84%	-0.2317	42.73%	-0.1832	37.33%	-0.3232	0.00837	-0.159	0.694	59.16%	
17	0.634	-0.198	43.46%	-0.1648	51.99%	0.0499	46.19%	-0.0955	0.00480	-0.178	0.663	56.54%	
18	0.589	-0.230	46.07%	-0.0986	56.40%	0.1611	50.74%	0.0186	0.01374	-0.197	0.635	53.93%	
19	0.577	-0.239	48.69%	-0.0328	57.56%	0.1907	51.98%	0.0497	0.00680	-0.216	0.608	51.31%	
20	0.566	-0.247	51.31%	0.0328	58.68%	0.2193	53.19%	0.0800	0.00223	-0.234	0.583	48.69%	
21	0.564	-0.249	53.93%	0.0986	58.89%	0.2247	53.41%	0.0857	0.00017	-0.252	0.560	46.07%	
22	0.560	-0.252	56.54%	0.1648	59.35%	0.2366	53.92%	0.0984	0.00441	-0.270	0.538	43.46%	
23	0.549	-0.260	59.16%	0.2317	60.46%	0.2653	55.14%	0.1293	0.01049	-0.287	0.516	40.84%	
24	0.520	-0.284	61.78%	0.2997	63.61%	0.3480	58.70%	0.2199	0.00637	-0.304	0.496	38.22%	
25	0.519	-0.285	64.40%	0.3691	63.76%	0.3522	58.88%	0.2245	0.02092	-0.322	0.477	35.60%	
26	0.477	-0.321	67.02%	0.4403	68.36%	0.4778	64.34%	0.3674	0.00532	-0.339	0.458	32.98%	
27	0.463	-0.335	69.63%	0.5139	69.98%	0.5237	66.32%	0.4213	0.00858	-0.357	0.440	30.37%	
28	0.441	-0.355	72.25%	0.5903	72.42%	0.5952	69.40%	0.5072	0.00691	-0.375	0.422	27.75%	
29	0.440	-0.356	74.87%	0.6704	72.55%	0.5991	69.57%	0.5120	0.02510	-0.393	0.405	25.13%	
30	0.437	-0.360	77.49%	0.7550	72.94%	0.6109	70.07%	0.5264	0.05225	-0.411	0.388	22.51%	
31	0.393	-0.406	80.10%	0.8454	77.97%	0.7711	76.72%	0.7295	0.01342	-0.431	0.371	19.90%	
32	0.359	-0.445	82.72%	0.9433	81.75%	0.9059	81.92%	0.9121	0.00097	-0.451	0.354	17.28%	
33	0.331	-0.481	85.34%	1.0511	84.89%	1.0316	86.30%	1.0939	0.00183	-0.472	0.337	14.66%	
34	0.313	-0.504	87.96%	1.1729	86.72%	1.1134	88.86%	1.2189	0.00212	-0.496	0.319	12.04%	
35	0.307	-0.512	90.58%	1.3151	87.32%	1.1419	89.69%	1.2640	0.00261	-0.522	0.301	9.42%	
36	0.273	-0.564	93.19%	1.4904	90.69%	1.3220	94.16%	1.5684	0.00609	-0.552	0.281	6.81%	
37	0.227	-0.644	95.81%	1.7292	94.50%	1.5979	98.32%	2.1251	0.15675	-0.589	0.258	4.19%	
38	0.218	-0.661	98.43%	2.1518	95.13%	1.6579	98.83%	2.2669	0.01325	-0.647	0.225	1.57%	

3.596	98.43%
3.586	95.81%
2.584	93.19%
1.571	90.58%
1.239	87.96%
1.239	87.96%
1.001	82.72%
0.924	80.10%
0.881	77.49%
0.879	74.87%
0.878	72.25%
0.864	69.63%
0.821	67.02%
0.794	64.40%
0.756	61.78%
0.739	59.16%
0.634	56.54%
0.589	53.93%
0.577	51.31%
0.566	48.69%
0.564	46.07%
0.560	43.46%
0.549	40.84%
0.520	38.22%
0.519	35.60%
0.477	32.98%
0.463	30.37%
0.441	27.75%
0.440	25.13%
0.437	22.51%
0.393	19.90%
0.359	17.28%
0.331	14.66%
0.313	12.04%
0.307	9.42%
0.273	6.81%
0.227	4.19%
0.218	1.57%
0.000	0.00%


Estimation of 7Q20 at Station 02GA039 Conestogo River above Drayton
January
(Fitting to Log Pearson III distribution, R2 = 0.92)
LP-III estimation
Observed monthly minimum of 7-d avg flow
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
Flow (m3/s)

Fitting the Pearson type III distribution: to Feburary 7-day average low flow
Ref: http://gergs.net/2014/11/fitting-pearson-type-3/

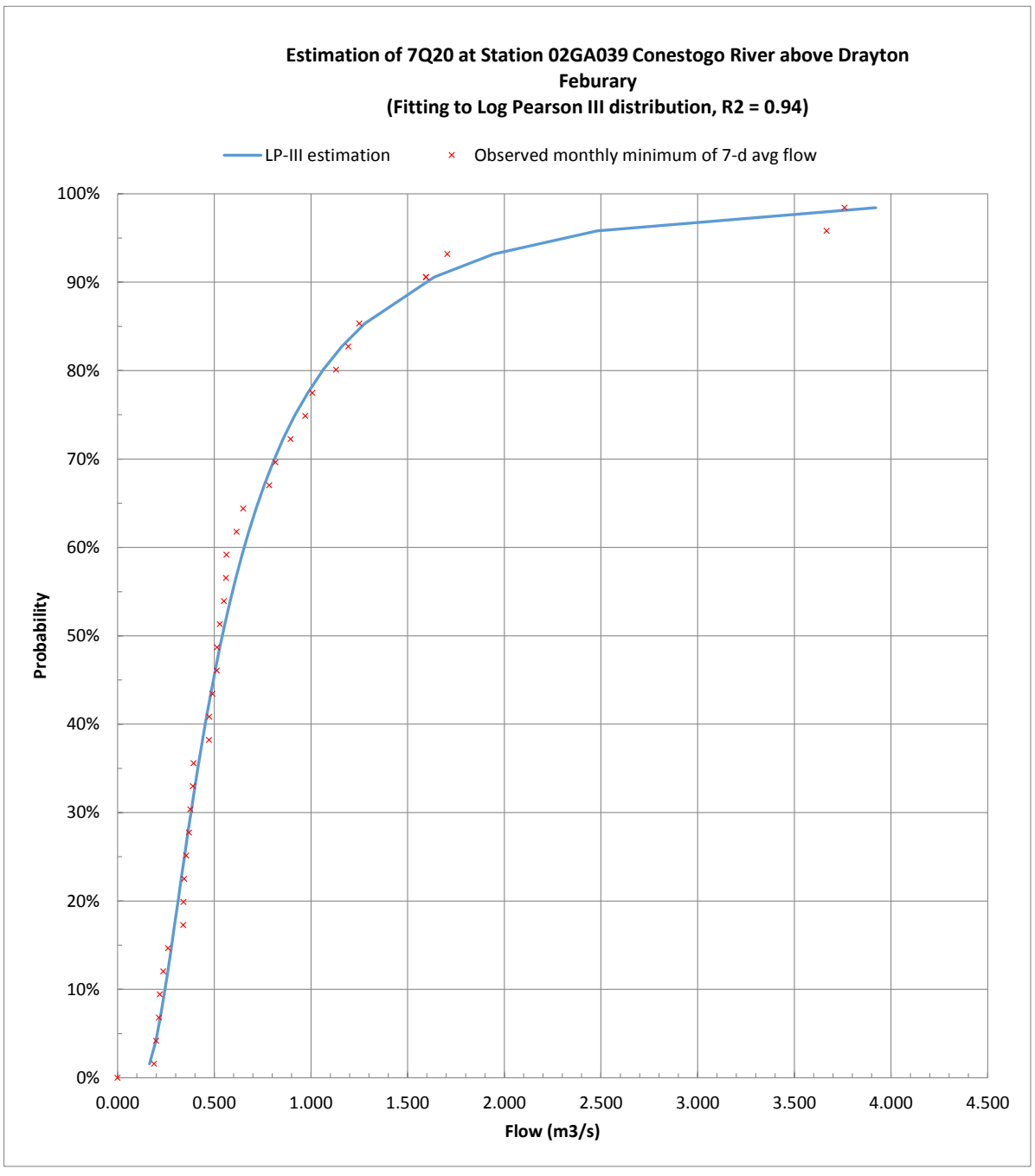
Sample	Plotting position	Normal distribution	P-III by moments
[μ = -0.229		μ = -0.229	μ = -0.229
σ = 0.322	$P_{Cunnane} = (i-0.4) / (n+0.2)$	σ = 0.322	σ = 0.322
γ_1 = 0.699	[$P_{Weibull} = i / (n+1)$]	[fitted by moments]	γ_1 = 0.699
n = 38			Σ sq : 0.57

95th percentile Flow: **0.205** **m3/s**
Coef. of determination R2: **0.94**

Plotting data

Rank	Sorted flow	Log flow	$P_{Cunnane}$	z-scale	P_{normal}	z-scale	$PIII_{moments}$	z-scale	z-error squared	x(P)	Estimated flow	LP-III estimation	Observed monthly minimum of 7-d avg flow
1	3.760	0.575	1.57%	-2.1518	0.63%	-2.4974	1.72%	-2.1145	0.00139	0.593	3.921	98.43%	
2	3.667	0.564	4.19%	-1.7292	0.69%	-2.4637	1.82%	-2.0921	0.13166	0.394	2.480	95.81%	
3	1.706	0.232	6.81%	-1.4904	7.61%	-1.4315	8.73%	-1.3574	0.01768	0.289	1.944	93.19%	
4	1.594	0.203	9.42%	-1.3151	9.01%	-1.3404	9.90%	-1.2873	0.00077	0.214	1.637	90.58%	
5	1.594	0.203	9.42%	-1.3151	9.01%	-1.3404	9.90%	-1.2873	0.00077	0.214	1.637	90.58%	
6	1.250	0.097	14.66%	-1.0511	15.57%	-1.0123	15.23%	-1.0265	0.00061	0.107	1.278	85.34%	
7	1.193	0.077	17.28%	-0.9433	17.13%	-0.9492	16.48%	-0.9747	0.00099	0.064	1.160	82.72%	
8	1.130	0.053	19.90%	-0.8454	19.05%	-0.8762	18.03%	-0.9141	0.00472	0.027	1.064	80.10%	
9	1.008	0.003	22.51%	-0.7550	23.52%	-0.7217	21.67%	-0.7832	0.00080	-0.007	0.983	77.49%	
10	0.970	-0.013	25.13%	-0.6704	25.12%	-0.6707	22.99%	-0.7392	0.00474	-0.038	0.915	74.87%	
11	0.895	-0.048	27.75%	-0.5903	28.71%	-0.5618	25.99%	-0.6438	0.00286	-0.068	0.856	72.25%	
12	0.816	-0.088	30.37%	-0.5139	33.12%	-0.4367	29.75%	-0.5317	0.00032	-0.095	0.804	69.63%	
13	0.784	-0.106	32.98%	-0.4403	35.06%	-0.3837	31.44%	-0.4834	0.00185	-0.121	0.758	67.02%	
14	0.649	-0.188	35.60%	-0.3691	44.87%	-0.1289	40.38%	-0.2435	0.01578	-0.145	0.716	64.40%	
15	0.616	-0.211	38.22%	-0.2997	47.71%	-0.0573	43.11%	-0.1736	0.01590	-0.169	0.678	61.78%	
16	0.563	-0.250	40.84%	-0.2317	52.55%	0.0641	47.91%	-0.0525	0.03211	-0.191	0.643	59.16%	
17	0.560	-0.252	43.46%	-0.1648	52.79%	0.0699	48.14%	-0.0466	0.01396	-0.214	0.612	56.54%	
18	0.550	-0.260	46.07%	-0.0986	53.81%	0.0956	49.18%	-0.0205	0.00609	-0.235	0.582	53.93%	
19	0.529	-0.277	48.69%	-0.0328	55.90%	0.1485	51.35%	0.0338	0.00443	-0.256	0.555	51.31%	
20	0.514	-0.289	51.31%	0.0328	57.36%	0.1854	52.87%	0.0721	0.00154	-0.277	0.529	48.69%	
21	0.513	-0.290	53.93%	0.0986	57.50%	0.1892	53.03%	0.0760	0.00051	-0.297	0.505	46.07%	
22	0.490	-0.310	56.54%	0.1648	59.90%	0.2507	55.59%	0.1407	0.00058	-0.317	0.482	43.46%	
23	0.474	-0.325	59.16%	0.2317	61.66%	0.2967	57.52%	0.1897	0.00177	-0.337	0.460	40.84%	
24	0.473	-0.325	61.78%	0.2997	61.74%	0.2987	57.61%	0.1919	0.01163	-0.357	0.439	38.22%	
25	0.394	-0.405	64.40%	0.3691	70.75%	0.5462	67.96%	0.4666	0.00951	-0.377	0.419	35.60%	
26	0.390	-0.409	67.02%	0.4403	71.22%	0.5600	68.53%	0.4825	0.00178	-0.398	0.400	32.98%	
27	0.377	-0.424	69.63%	0.5139	72.75%	0.6052	70.37%	0.5351	0.00045	-0.418	0.382	30.37%	
28	0.369	-0.433	72.25%	0.5903	73.63%	0.6321	71.45%	0.5666	0.00056	-0.439	0.364	27.75%	
29	0.356	-0.449	74.87%	0.6704	75.27%	0.6831	73.48%	0.6273	0.00186	-0.461	0.346	25.13%	
30	0.345	-0.463	77.49%	0.7550	76.58%	0.7249	75.10%	0.6777	0.00597	-0.483	0.329	22.51%	
31	0.341	-0.467	80.10%	0.8454	76.99%	0.7384	75.62%	0.6941	0.02287	-0.506	0.312	19.90%	
32	0.340	-0.469	82.72%	0.9433	77.14%	0.7435	75.81%	0.7003	0.05901	-0.531	0.295	17.28%	
33	0.261	-0.584	85.34%	1.0511	86.45%	1.1009	87.80%	1.1648	0.01292	-0.557	0.277	14.66%	
34	0.236	-0.627	87.96%	1.1729	89.16%	1.2351	91.25%	1.3562	0.03361	-0.585	0.260	12.04%	
35	0.219	-0.660	90.58%	1.3151	90.98%	1.3394	93.48%	1.5127	0.03905	-0.618	0.241	9.42%	
36	0.214	-0.670	93.19%	1.4904	91.43%	1.3679	94.02%	1.5568	0.00441	-0.656	0.221	6.81%	
37	0.200	-0.699	95.81%	1.7292	92.79%	1.4601	95.58%	1.7035	0.00066	-0.704	0.198	4.19%	
38	0.189	-0.724	98.43%	2.1518	93.78%	1.5364	96.64%	1.8303	0.10334	-0.782	0.165	1.57%	

3.760	98.43%
3.667	95.81%
1.706	93.19%
1.594	90.58%
1.594	90.58%
1.250	85.34%
1.193	82.72%
1.130	80.10%
1.008	77.49%
0.970	74.87%
0.895	72.25%
0.816	69.63%
0.784	67.02%
0.649	64.40%
0.616	61.78%
0.563	59.16%
0.560	56.54%
0.550	53.93%
0.529	51.31%
0.514	48.69%
0.513	46.07%
0.490	43.46%
0.474	40.84%
0.473	38.22%
0.394	35.60%
0.390	32.98%
0.377	30.37%
0.369	27.75%
0.356	25.13%
0.345	22.51%
0.341	19.90%
0.340	17.28%
0.261	14.66%
0.236	12.04%
0.219	9.42%
0.214	6.81%
0.200	4.19%
0.189	1.57%
0.000	0.00%


Estimation of 7Q20 at Station 02GA039 Conestogo River above Drayton
Feburary
(Fitting to Log Pearson III distribution, R2 = 0.94)
LP-III estimation
Observed monthly minimum of 7-d avg flow
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
Flow (m3/s)

Fitting the Pearson type III distribution: to March 7-day average low flow
Ref: http://gergs.net/2014/11/fitting-pearson-type-3/

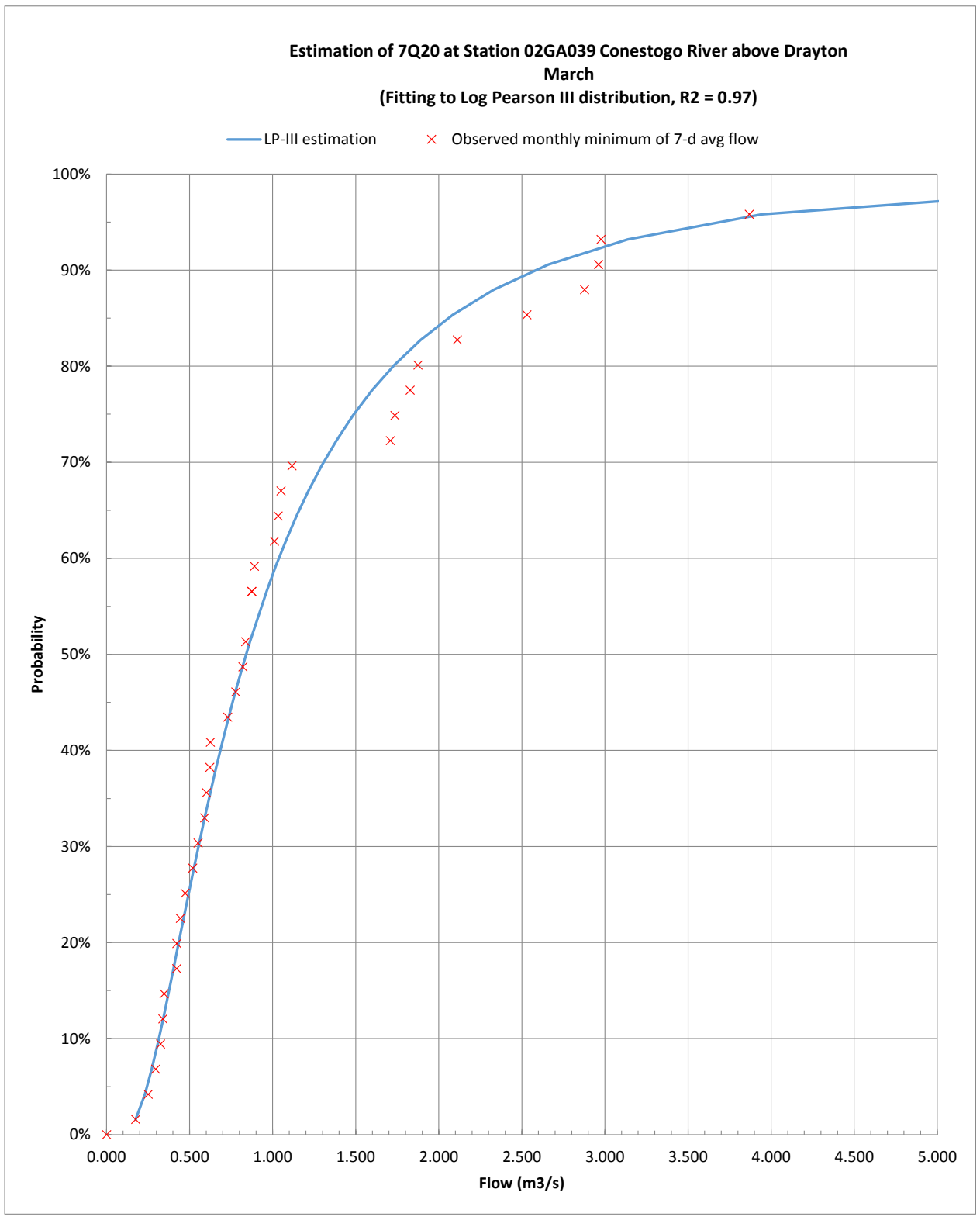
Sample		Plotting position	Normal distribution	P-III by moments
[μ =	-0.057		μ = -0.057	μ = -0.057
σ =	0.357	$P_{Cunnane}$ = (i-0.4) / (n+0.2)	σ = 0.357	σ = 0.357
γ_1 =	0.311	[$P_{Weibull}$ = i / (n+1)]	[fitted by moments]	γ_1 = 0.311
n =	38			Σ sq : 0.48

95th percentile Flow: **0.245** **m3/s**
Coef. of determination R2: **0.97**

Plotting data

Rank	Sorted flow	Log flow	$P_{Cunnane}$	z-scale	P_{normal}	z-scale	$PIII_{moments}$	z-scale	z-error squared	x(P)	Estimated flow	LP-III estimation	Observed monthly minimum of 7-d avg flow
1	5.400	0.732	1.57%	-2.1518	1.36%	-2.2093	2.03%	-2.0480	0.01077	0.778	5.993	98.43%	
2	3.869	0.588	4.19%	-1.7292	3.56%	-1.8040	4.37%	-1.7093	0.00040	0.596	3.944	95.81%	
3	2.976	0.474	6.81%	-1.4904	6.88%	-1.4851	7.56%	-1.4350	0.00307	0.496	3.136	93.19%	
4	2.961	0.472	9.42%	-1.3151	6.95%	-1.4792	7.64%	-1.4299	0.01319	0.425	2.659	90.58%	
5	2.877	0.459	12.04%	-1.1729	7.44%	-1.4441	8.09%	-1.3993	0.05125	0.367	2.330	87.96%	
6	2.530	0.403	14.66%	-1.0511	9.89%	-1.2879	10.35%	-1.2618	0.04437	0.319	2.084	85.34%	
7	2.111	0.325	17.28%	-0.9433	14.27%	-1.0680	14.34%	-1.0652	0.01488	0.277	1.890	82.72%	
8	1.874	0.273	19.90%	-0.8454	17.79%	-0.9233	17.52%	-0.9337	0.00780	0.238	1.732	80.10%	
9	1.827	0.262	22.51%	-0.7550	18.61%	-0.8923	18.26%	-0.9053	0.02261	0.204	1.598	77.49%	
10	1.736	0.239	25.13%	-0.6704	20.33%	-0.8299	19.82%	-0.8480	0.03154	0.171	1.483	74.87%	
11	1.709	0.233	27.75%	-0.5903	20.88%	-0.8107	20.32%	-0.8303	0.05759	0.141	1.383	72.25%	
12	1.116	0.048	30.37%	-0.5139	38.48%	-0.2928	36.69%	-0.3401	0.03020	0.112	1.295	69.63%	
13	1.050	0.021	32.98%	-0.4403	41.33%	-0.2190	39.42%	-0.2683	0.02961	0.085	1.215	67.02%	
14	1.033	0.014	35.60%	-0.3691	42.11%	-0.1990	40.18%	-0.2487	0.01450	0.058	1.144	64.40%	
15	1.010	0.004	38.22%	-0.2997	43.17%	-0.1722	41.20%	-0.2224	0.00598	0.033	1.078	61.78%	
16	0.890	-0.051	40.84%	-0.2317	49.28%	-0.0181	47.21%	-0.0699	0.02619	0.008	1.018	59.16%	
17	0.874	-0.058	43.46%	-0.1648	50.14%	0.0036	48.08%	-0.0483	0.01358	-0.016	0.963	56.54%	
18	0.874	-0.058	43.46%	-0.1648	50.14%	0.0036	48.08%	-0.0483	0.01358	-0.016	0.963	56.54%	
19	0.837	-0.077	48.69%	-0.0328	52.25%	0.0563	50.18%	0.0046	0.00140	-0.064	0.863	51.31%	
20	0.821	-0.085	51.31%	0.0328	53.16%	0.0793	51.11%	0.0278	0.00003	-0.087	0.818	48.69%	
21	0.778	-0.109	53.93%	0.0986	55.79%	0.1456	53.78%	0.0948	0.00001	-0.110	0.775	46.07%	
22	0.729	-0.137	56.54%	0.1648	58.88%	0.2244	56.95%	0.1751	0.00011	-0.134	0.735	43.46%	
23	0.625	-0.204	59.16%	0.2317	65.94%	0.4109	64.35%	0.3679	0.01855	-0.157	0.697	40.84%	
24	0.622	-0.207	61.78%	0.2997	66.21%	0.4182	64.64%	0.3755	0.00574	-0.180	0.660	38.22%	
25	0.601	-0.221	64.40%	0.3691	67.66%	0.4582	66.18%	0.4174	0.00234	-0.204	0.625	35.60%	
26	0.591	-0.229	67.02%	0.4403	68.44%	0.4801	67.02%	0.4404	0.00000	-0.229	0.591	32.98%	
27	0.550	-0.260	69.63%	0.5139	71.45%	0.5665	70.26%	0.5319	0.00032	-0.253	0.558	30.37%	
28	0.518	-0.286	72.25%	0.5903	73.89%	0.6400	72.92%	0.6103	0.00040	-0.279	0.526	27.75%	
29	0.473	-0.325	74.87%	0.6704	77.35%	0.7505	76.72%	0.7295	0.00350	-0.306	0.495	25.13%	
30	0.444	-0.353	77.49%	0.7550	79.62%	0.8282	79.23%	0.8143	0.00352	-0.334	0.464	22.51%	
31	0.423	-0.374	80.10%	0.8454	81.22%	0.8860	81.00%	0.8778	0.00105	-0.363	0.433	19.90%	
32	0.422	-0.375	82.72%	0.9433	81.30%	0.8888	81.08%	0.8810	0.00388	-0.395	0.403	17.28%	
33	0.346	-0.461	85.34%	1.0511	87.06%	1.1292	87.50%	1.1503	0.00983	-0.429	0.372	14.66%	
34	0.339	-0.470	87.96%	1.1729	87.62%	1.1560	88.12%	1.1809	0.00006	-0.468	0.341	12.04%	
35	0.325	-0.489	90.58%	1.3151	88.65%	1.2079	89.26%	1.2403	0.00560	-0.512	0.308	9.42%	
36	0.296	-0.529	93.19%	1.4904	90.69%	1.3216	91.50%	1.3720	0.01402	-0.565	0.272	6.81%	
37	0.251	-0.600	95.81%	1.7292	93.58%	1.5203	94.60%	1.6069	0.01497	-0.637	0.231	4.19%	
38	0.175	-0.757	98.43%	2.1518	97.50%	1.9596	98.42%	2.1503	0.00000	-0.758	**0.175**	1.57%	

5.400	98.43%
3.869	95.81%
2.976	93.19%
2.961	90.58%
2.877	87.96%
2.530	85.34%
2.111	82.72%
1.874	80.10%
1.827	77.49%
1.736	74.87%
1.709	72.25%
1.116	69.63%
1.050	67.02%
1.033	64.40%
1.010	61.78%
0.890	59.16%
0.874	56.54%
0.874	56.54%
0.837	51.31%
0.821	48.69%
0.778	46.07%
0.729	43.46%
0.625	40.84%
0.622	38.22%
0.601	35.60%
0.591	32.98%
0.550	30.37%
0.518	27.75%
0.473	25.13%
0.444	22.51%
0.423	19.90%
0.422	17.28%
0.346	14.66%
0.339	12.04%
0.325	9.42%
0.296	6.81%
0.251	4.19%
0.175	1.57%
0.000	0.00%


Estimation of 7Q20 at Station 02GA039 Conestogo River above Drayton
March
(Fitting to Log Pearson III distribution, R2 = 0.97)
LP-III estimation
Observed monthly minimum of 7-d avg flow
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
Flow (m3/s)

Fitting the Pearson type III distribution: to April 7-day average low flow
Ref: http://gergs.net/2014/11/fitting-pearson-type-3/

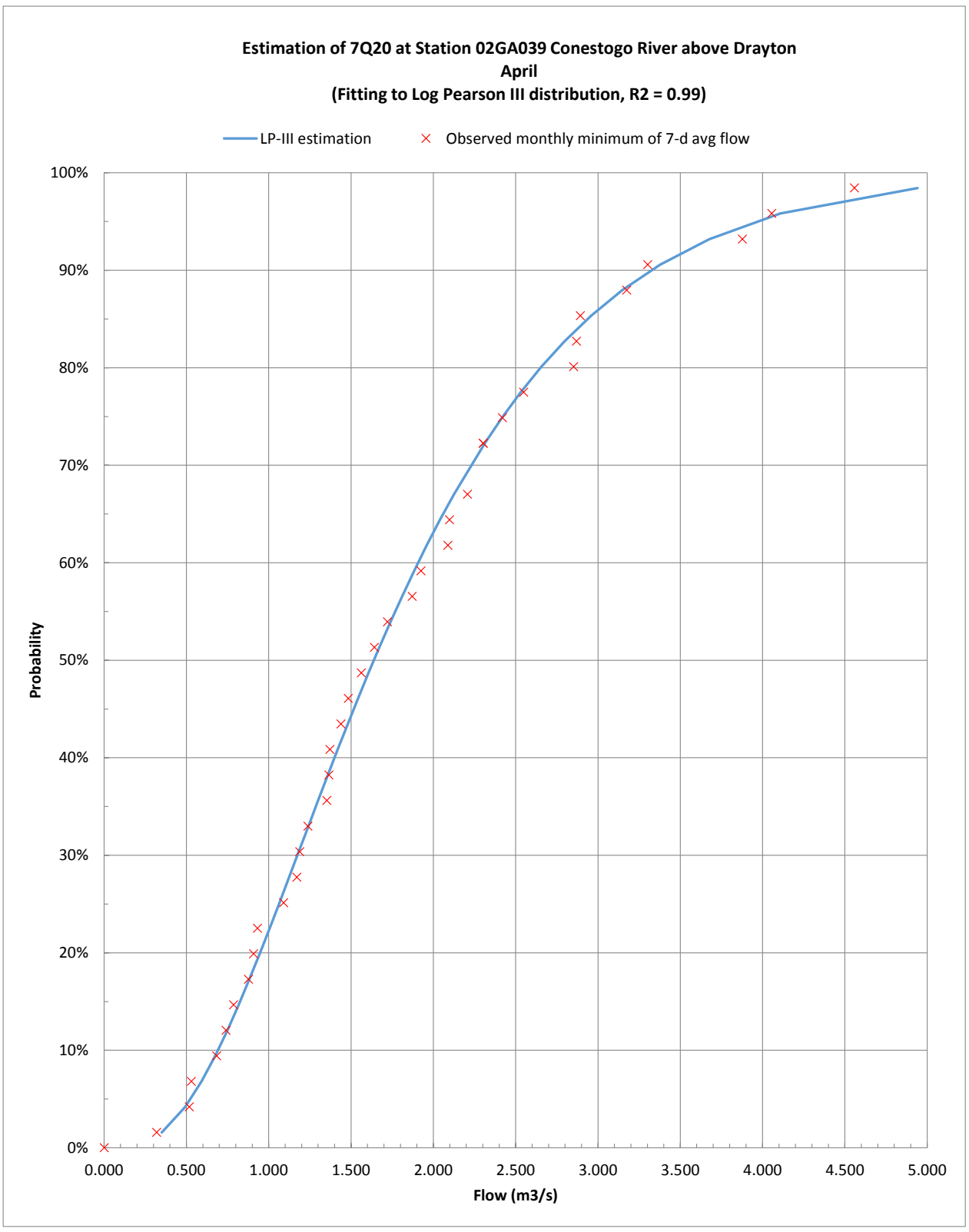
Sample	Plotting position	Normal distribution	P-III by moments
[μ = 0.194		μ = 0.194	μ = 0.194
σ = 0.268	$P_{Cunnane} = (i-0.4) / (n+0.2)$	σ = 0.268	σ = 0.268
γ_1 = -0.464	[$P_{Weibull} = i / (n+1)$]	[fitted by moments]	γ_1 = -0.464
n = 38			Σ sq : 0.18

95th percentile Flow: **0.526** m3/s
Coef. of determination R2: **0.99**

Plotting data

Rank	Sorted flow	Log flow	$P_{Cunnane}$	z-scale	P_{normal}	z-scale	$PIII_{moments}$	z-scale	z-error squared	x(P)	Estimated flow	LP-III estimation	Observed monthly minimum of 7-d avg flow
1	4.557	0.659	1.57%	-2.1518	4.15%	-1.7339	2.49%	-1.9624	0.03587	0.694	4.942	98.43%	
2	4.056	0.608	4.19%	-1.7292	6.12%	-1.5451	4.44%	-1.7013	0.00078	0.614	4.108	95.81%	
3	3.877	0.589	6.81%	-1.4904	7.05%	-1.4721	5.44%	-1.6038	0.01285	0.565	3.676	93.19%	
4	3.301	0.519	9.42%	-1.3151	11.28%	-1.2117	10.22%	-1.2690	0.00213	0.529	3.377	90.58%	
5	3.174	0.502	12.04%	-1.1729	12.55%	-1.1480	11.70%	-1.1901	0.00030	0.498	3.147	87.96%	
6	2.893	0.461	14.66%	-1.0511	15.92%	-0.9976	15.67%	-1.0079	0.00187	0.471	2.958	85.34%	
7	2.869	0.458	17.28%	-0.9433	16.26%	-0.9840	16.07%	-0.9917	0.00235	0.447	2.797	82.72%	
8	2.851	0.455	19.90%	-0.8454	16.50%	-0.9742	16.35%	-0.9802	0.01817	0.424	2.656	80.10%	
9	2.549	0.406	22.51%	-0.7550	21.41%	-0.7923	22.12%	-0.7682	0.00017	0.403	2.530	77.49%	
10	2.419	0.384	25.13%	-0.6704	23.96%	-0.7075	25.08%	-0.6719	0.00000	0.383	2.417	74.87%	
11	2.303	0.362	27.75%	-0.5903	26.50%	-0.6281	27.99%	-0.5831	0.00005	0.364	2.312	72.25%	
12	2.303	0.362	27.75%	-0.5903	26.50%	-0.6281	27.99%	-0.5831	0.00005	0.364	2.312	72.25%	
13	2.207	0.344	32.98%	-0.4403	28.80%	-0.5593	30.60%	-0.5072	0.00447	0.327	2.125	67.02%	
14	2.099	0.322	35.60%	-0.3691	31.65%	-0.4776	33.79%	-0.4183	0.00242	0.310	2.040	64.40%	
15	2.089	0.320	38.22%	-0.2997	31.92%	-0.4698	34.09%	-0.4100	0.01216	0.292	1.960	61.78%	
16	1.924	0.284	40.84%	-0.2317	36.80%	-0.3371	39.42%	-0.2684	0.00135	0.275	1.883	59.16%	
17	1.871	0.272	43.46%	-0.1648	38.52%	-0.2920	41.25%	-0.2210	0.00316	0.258	1.810	56.54%	
18	1.721	0.236	46.07%	-0.0986	43.78%	-0.1566	46.77%	-0.0809	0.00031	0.241	1.740	53.93%	
19	1.641	0.215	48.69%	-0.0328	46.83%	-0.0795	49.90%	-0.0025	0.00092	0.223	1.672	51.31%	
20	1.563	0.194	51.31%	0.0328	50.00%	0.0000	53.08%	0.0773	0.00198	0.206	1.606	48.69%	
21	1.483	0.171	53.93%	0.0986	53.39%	0.0851	56.43%	0.1618	0.00399	0.188	1.542	46.07%	
22	1.439	0.158	56.54%	0.1648	55.33%	0.1339	58.31%	0.2097	0.00202	0.170	1.480	43.46%	
23	1.371	0.137	59.16%	0.2317	58.40%	0.2122	61.25%	0.2858	0.00293	0.152	1.419	40.84%	
24	1.366	0.135	61.78%	0.2997	58.65%	0.2184	61.48%	0.2919	0.00006	0.133	1.359	38.22%	
25	1.353	0.131	64.40%	0.3691	59.24%	0.2338	62.05%	0.3067	0.00390	0.114	1.300	35.60%	
26	1.238	0.093	67.02%	0.4403	64.70%	0.3773	67.14%	0.4437	0.00001	0.094	1.241	32.98%	
27	1.188	0.075	69.63%	0.5139	67.16%	0.4443	69.38%	0.5066	0.00005	0.073	1.182	30.37%	
28	1.170	0.068	72.25%	0.5903	68.04%	0.4689	70.18%	0.5295	0.00369	0.051	1.124	27.75%	
29	1.090	0.038	74.87%	0.6704	72.01%	0.5832	73.74%	0.6353	0.00123	0.027	1.065	25.13%	
30	0.931	-0.031	77.49%	0.7550	79.93%	0.8393	80.69%	0.8665	0.01243	0.002	1.005	22.51%	
31	0.908	-0.042	80.10%	0.8454	81.03%	0.8790	81.64%	0.9017	0.00317	-0.025	0.945	19.90%	
32	0.877	-0.057	82.72%	0.9433	82.52%	0.9353	82.92%	0.9512	0.00006	-0.054	0.882	17.28%	
33	0.786	-0.105	85.34%	1.0511	86.74%	1.1142	86.57%	1.1063	0.00305	-0.088	0.817	14.66%	
34	0.740	-0.131	87.96%	1.1729	88.69%	1.2103	88.27%	1.1884	0.00024	-0.126	0.749	12.04%	
35	0.683	-0.166	90.58%	1.3151	91.01%	1.3415	90.30%	1.2988	0.00027	-0.171	0.675	9.42%	
36	0.529	-0.276	93.19%	1.4904	96.03%	1.7542	94.90%	1.6357	0.02112	-0.228	0.592	6.81%	
37	0.517	-0.286	95.81%	1.7292	96.33%	1.7909	95.20%	1.6649	0.00413	-0.308	0.492	4.19%	
38	0.319	-0.496	98.43%	2.1518	99.50%	2.5724	98.82%	2.2621	0.01216	-0.456	**0.350**	1.57%	

4.557	98.43%
4.056	95.81%
3.877	93.19%
3.301	90.58%
3.174	87.96%
2.893	85.34%
2.869	82.72%
2.851	80.10%
2.549	77.49%
2.419	74.87%
2.303	72.25%
2.303	72.25%
2.207	67.02%
2.099	64.40%
2.089	61.78%
1.924	59.16%
1.871	56.54%
1.721	53.93%
1.641	51.31%
1.563	48.69%
1.483	46.07%
1.439	43.46%
1.371	40.84%
1.366	38.22%
1.353	35.60%
1.238	32.98%
1.188	30.37%
1.170	27.75%
1.090	25.13%
0.931	22.51%
0.908	19.90%
0.877	17.28%
0.786	14.66%
0.740	12.04%
0.683	9.42%
0.529	6.81%
0.517	4.19%
0.319	1.57%
0.000	0.00%


Estimation of 7Q20 at Station 02GA039 Conestogo River above Drayton
April
(Fitting to Log Pearson III distribution, R2 = 0.99)
LP-III estimation
Observed monthly minimum of 7-d avg flow
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
Flow (m3/s)

Fitting the Pearson type III distribution: to May 7-day average low flow
Ref: http://gergs.net/2014/11/fitting-pearson-type-3/

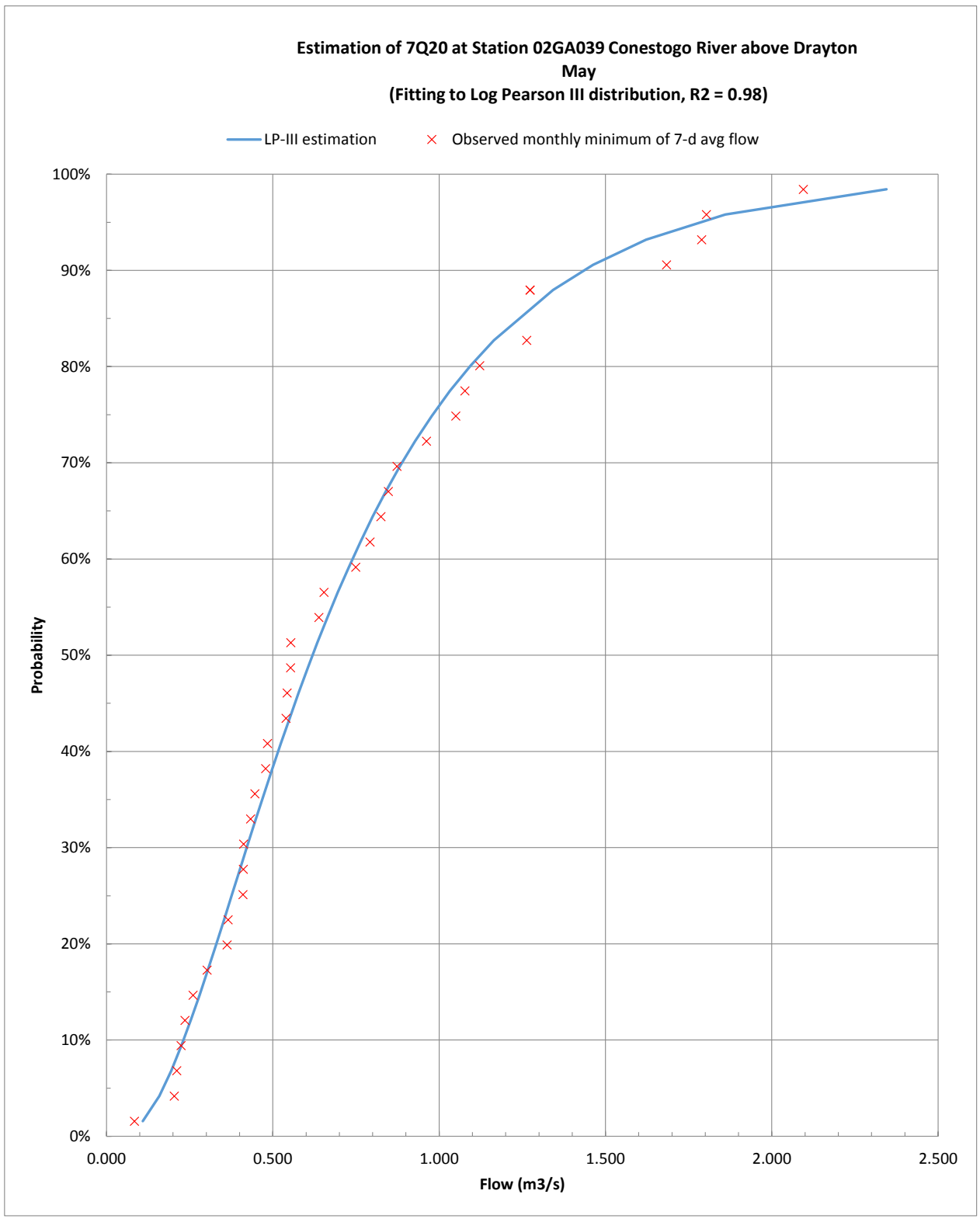
Sample		Plotting position	Normal distribution	P-III by moments
[μ =	-0.227		μ = -0.227	μ = -0.227
σ =	0.310	$P_{Cunnane}$ = (i-0.4) / (n+0.2)	σ = 0.310	σ = 0.310
γ_1 =	-0.369	[$P_{Weibull}$ = i / (n+1)]	[fitted by moments]	γ_1 = -0.369
n =	38			Σ sq : 0.51

95th percentile Flow: **0.171** **m3/s**
Coef. of determination R2: **0.98**

Plotting data

Rank	Sorted flow	Log flow	$P_{Cunnane}$	z-scale	P_{normal}	z-scale	$PIII_{moments}$	z-scale	z-error squared	x(P)	Estimated flow	LP-III estimation	Observed monthly minimum of 7-d avg flow
1	2.094	0.321	1.57%	-2.1518	3.87%	-1.7661	2.61%	-1.9422	0.04391	0.370	2.345	98.43%	
2	1.803	0.256	4.19%	-1.7292	5.98%	-1.5564	4.71%	-1.6738	0.00308	0.270	1.860	95.81%	
3	1.789	0.253	6.81%	-1.4904	6.11%	-1.5453	4.85%	-1.6598	0.02870	0.210	1.622	93.19%	
4	1.684	0.226	9.42%	-1.3151	7.21%	-1.4606	6.00%	-1.5544	0.05728	0.165	1.462	90.58%	
5	1.273	0.105	12.04%	-1.1729	14.24%	-1.0695	13.86%	-1.0866	0.00744	0.128	1.342	87.96%	
6	1.273	0.105	12.04%	-1.1729	14.24%	-1.0695	13.86%	-1.0866	0.00744	0.128	1.342	87.96%	
7	1.263	0.101	17.28%	-0.9433	14.50%	-1.0583	14.15%	-1.0737	0.01701	0.066	1.164	82.72%	
8	1.122	0.050	19.90%	-0.8454	18.61%	-0.8923	18.83%	-0.8841	0.00150	0.039	1.094	80.10%	
9	1.077	0.032	22.51%	-0.7550	20.18%	-0.8353	20.61%	-0.8202	0.00425	0.014	1.033	77.49%	
10	1.050	0.021	25.13%	-0.6704	21.20%	-0.7994	21.77%	-0.7802	0.01205	-0.010	0.978	74.87%	
11	0.962	-0.017	27.75%	-0.5903	24.91%	-0.6773	25.93%	-0.6455	0.00305	-0.033	0.928	72.25%	
12	0.873	-0.059	30.37%	-0.5139	29.40%	-0.5417	30.90%	-0.4987	0.00023	-0.055	0.882	69.63%	
13	0.847	-0.072	32.98%	-0.4403	30.87%	-0.4996	32.50%	-0.4538	0.00018	-0.076	0.840	67.02%	
14	0.825	-0.084	35.60%	-0.3691	32.19%	-0.4623	33.94%	-0.4141	0.00202	-0.097	0.800	64.40%	
15	0.792	-0.102	38.22%	-0.2997	34.29%	-0.4047	36.20%	-0.3532	0.00286	-0.117	0.763	61.78%	
16	0.749	-0.125	40.84%	-0.2317	37.15%	-0.3278	39.25%	-0.2728	0.00169	-0.138	0.728	59.16%	
17	0.654	-0.185	43.46%	-0.1648	44.54%	-0.1372	46.94%	-0.0767	0.00777	-0.158	0.695	56.54%	
18	0.638	-0.195	46.07%	-0.0986	45.88%	-0.1035	48.31%	-0.0425	0.00315	-0.178	0.664	53.93%	
19	0.554	-0.257	48.69%	-0.0328	53.80%	0.0954	56.21%	0.1564	0.03579	-0.198	0.634	51.31%	
20	0.553	-0.257	51.31%	0.0328	53.86%	0.0968	56.27%	0.1578	0.01562	-0.218	0.605	48.69%	
21	0.543	-0.265	53.93%	0.0986	54.90%	0.1231	57.29%	0.1837	0.00724	-0.239	0.577	46.07%	
22	0.539	-0.268	56.54%	0.1648	55.26%	0.1323	57.64%	0.1928	0.00078	-0.259	0.550	43.46%	
23	0.484	-0.315	59.16%	0.2317	61.20%	0.2845	63.35%	0.3410	0.01195	-0.281	0.524	40.84%	
24	0.478	-0.320	61.78%	0.2997	61.80%	0.3003	63.92%	0.3563	0.00320	-0.302	0.499	38.22%	
25	0.446	-0.351	64.40%	0.3691	65.51%	0.3990	67.39%	0.4508	0.00668	-0.324	0.474	35.60%	
26	0.433	-0.363	67.02%	0.4403	66.97%	0.4390	68.75%	0.4889	0.00236	-0.348	0.449	32.98%	
27	0.412	-0.385	69.63%	0.5139	69.48%	0.5095	71.07%	0.5555	0.00173	-0.372	0.425	30.37%	
28	0.411	-0.386	72.25%	0.5903	69.53%	0.5110	71.12%	0.5569	0.00112	-0.397	0.401	27.75%	
29	0.410	-0.388	74.87%	0.6704	69.74%	0.5168	71.31%	0.5624	0.01166	-0.423	0.377	25.13%	
30	0.365	-0.437	77.49%	0.7550	75.08%	0.6769	76.16%	0.7116	0.00188	-0.452	0.353	22.51%	
31	0.362	-0.441	80.10%	0.8454	75.44%	0.6884	76.49%	0.7222	0.01516	-0.482	0.329	19.90%	
32	0.302	-0.520	82.72%	0.9433	82.75%	0.9443	83.03%	0.9552	0.00014	-0.516	0.305	17.28%	
33	0.260	-0.585	85.34%	1.0511	87.57%	1.1540	87.32%	1.1415	0.00816	-0.554	0.280	14.66%	
34	0.235	-0.628	87.96%	1.1729	90.18%	1.2921	89.65%	1.2621	0.00796	-0.596	0.253	12.04%	
35	0.224	-0.649	90.58%	1.3151	91.32%	1.3609	90.68%	1.3215	0.00004	-0.647	0.225	9.42%	
36	0.211	-0.676	93.19%	1.4904	92.60%	1.4464	91.85%	1.3949	0.00912	-0.711	0.195	6.81%	
37	0.204	-0.691	95.81%	1.7292	93.25%	1.4946	92.45%	1.4360	0.08598	-0.800	0.159	4.19%	
38	0.084	-1.078	98.43%	2.1518	99.69%	2.7414	99.27%	2.4398	0.08297	-0.963	**0.109**	1.57%	

2.094	98.43%
1.803	95.81%
1.789	93.19%
1.684	90.58%
1.273	87.96%
1.273	87.96%
1.263	82.72%
1.122	80.10%
1.077	77.49%
1.050	74.87%
0.962	72.25%
0.873	69.63%
0.847	67.02%
0.825	64.40%
0.792	61.78%
0.749	59.16%
0.654	56.54%
0.638	53.93%
0.554	51.31%
0.553	48.69%
0.543	46.07%
0.539	43.46%
0.484	40.84%
0.478	38.22%
0.446	35.60%
0.433	32.98%
0.412	30.37%
0.411	27.75%
0.410	25.13%
0.365	22.51%
0.362	19.90%
0.302	17.28%
0.260	14.66%
0.235	12.04%
0.224	9.42%
0.211	6.81%
0.204	4.19%
0.084	1.57%


Estimation of 7Q20 at Station 02GA039 Conestogo River above Drayton
May
(Fitting to Log Pearson III distribution, R2 = 0.98)
LP-III estimation
Observed monthly minimum of 7-d avg flow
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.000
0.500
1.000
1.500
2.000
2.500
Flow (m3/s)

Fitting the Pearson type III distribution: to June 7-day average low flow
Ref: http://gergs.net/2014/11/fitting-pearson-type-3/

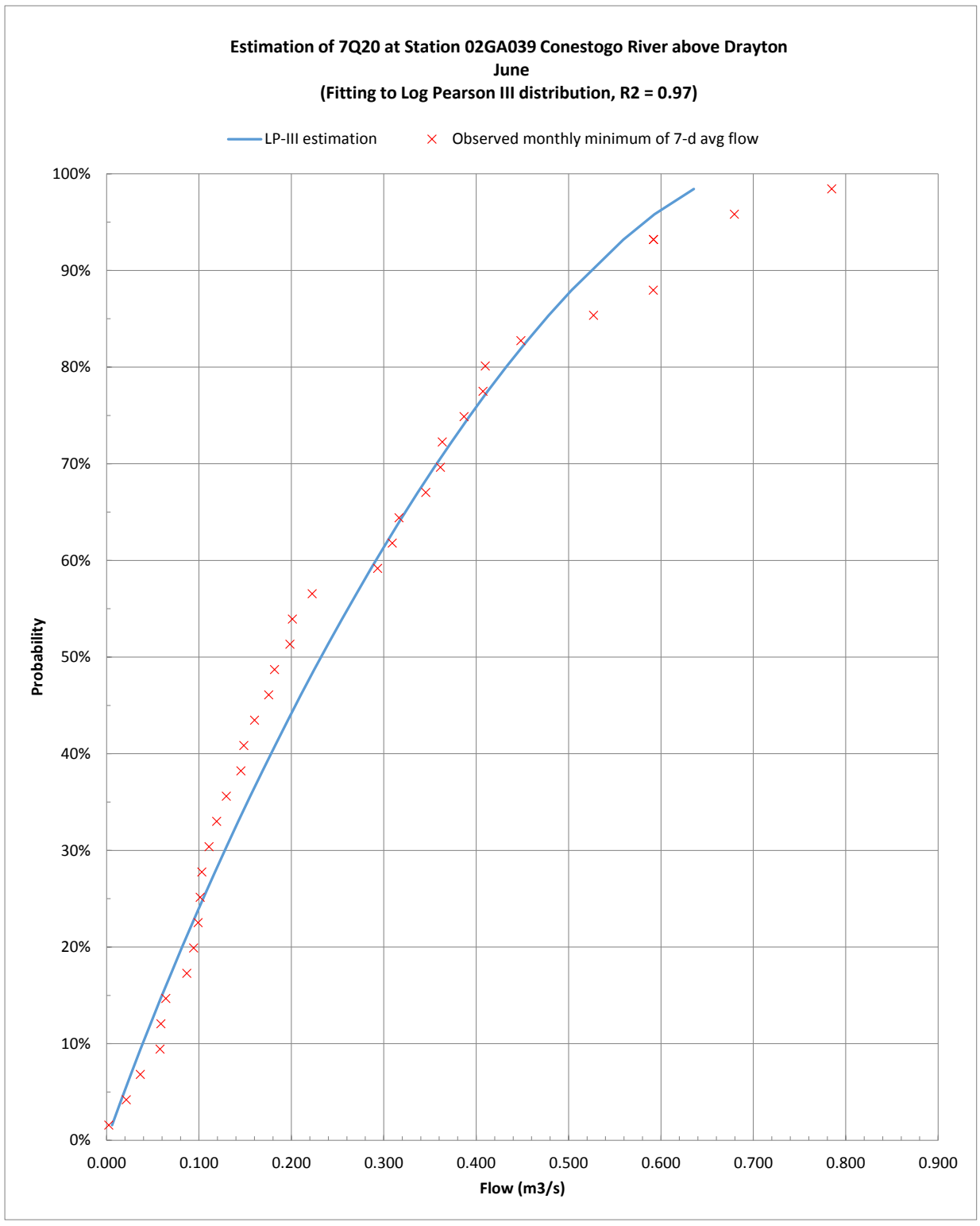
Sample		Plotting position	Normal distribution		P-III by moments	
[μ =	-0.761		μ =	-0.761	μ =	-0.761
σ =	0.488	$P_{Cunnane}$ = (i-0.4) / (n+0.2)	σ =	0.488	σ =	0.488
γ_1 =	-1.641	[$P_{Weibull}$ = i / (n+1)]	[fitted by moments]		γ_1 =	-1.641
n =	38				Σ sq :	4.56

95th percentile Flow: **0.019** **m3/s**
Coef. of determination R2: **0.97**

Plotting data

Rank	Sorted flow	Log flow	$P_{Cunnane}$	z-scale	P_{normal}	z-scale	$PIII_{moments}$	z-scale	z-error squared	x(P)	Estimated flow	LP-III estimation	Observed monthly minimum of 7-d avg flow
1	0.785	-0.105	1.57%	-2.1518	8.95%	-1.3441	#N/A	#N/A		-0.197	0.636	98.43%	
2	0.679	-0.168	4.19%	-1.7292	11.21%	-1.2157	0.02%	-3.5843	3.44135	-0.227	0.593	95.81%	
3	0.592	-0.228	6.81%	-1.4904	13.72%	-1.0931	4.27%	-1.7200	0.05273	-0.252	0.559	93.19%	
4	0.592	-0.228	6.81%	-1.4904	13.72%	-1.0931	4.27%	-1.7200	0.05273	-0.252	0.559	93.19%	
5	0.592	-0.228	12.04%	-1.1729	13.72%	-1.0928	4.28%	-1.7189	0.29810	-0.298	0.503	87.96%	
6	0.527	-0.278	14.66%	-1.0511	16.11%	-0.9898	9.68%	-1.2998	0.06181	-0.320	0.478	85.34%	
7	0.448	-0.348	17.28%	-0.9433	19.88%	-0.8461	18.07%	-0.9128	0.00093	-0.342	0.455	82.72%	
8	0.410	-0.387	19.90%	-0.8454	22.18%	-0.7660	22.84%	-0.7443	0.01022	-0.363	0.433	80.10%	
9	0.407	-0.390	22.51%	-0.7550	22.35%	-0.7604	23.17%	-0.7333	0.00047	-0.385	0.412	77.49%	
10	0.387	-0.412	25.13%	-0.6704	23.74%	-0.7146	25.87%	-0.6473	0.00053	-0.406	0.392	74.87%	
11	0.363	-0.440	27.75%	-0.5903	25.50%	-0.6587	29.13%	-0.5495	0.00167	-0.428	0.373	72.25%	
12	0.361	-0.442	30.37%	-0.5139	25.66%	-0.6538	29.42%	-0.5412	0.00075	-0.450	0.355	69.63%	
13	0.345	-0.462	32.98%	-0.4403	26.97%	-0.6138	31.70%	-0.4760	0.00127	-0.473	0.337	67.02%	
14	0.316	-0.500	35.60%	-0.3691	29.61%	-0.5358	36.06%	-0.3569	0.00015	-0.496	0.319	64.40%	
15	0.309	-0.510	38.22%	-0.2997	30.34%	-0.5146	37.21%	-0.3263	0.00071	-0.519	0.303	61.78%	
16	0.293	-0.533	40.84%	-0.2317	31.98%	-0.4682	39.69%	-0.2613	0.00087	-0.543	0.286	59.16%	
17	0.222	-0.653	43.46%	-0.1648	41.21%	-0.2221	51.73%	0.0433	0.04328	-0.568	0.270	56.54%	
18	0.201	-0.697	46.07%	-0.0986	44.75%	-0.1319	55.64%	0.1418	0.05779	-0.594	0.255	53.93%	
19	0.198	-0.702	48.69%	-0.0328	45.21%	-0.1205	56.12%	0.1539	0.03487	-0.621	0.240	51.31%	
20	0.182	-0.741	51.31%	0.0328	48.32%	-0.0422	59.27%	0.2346	0.04071	-0.648	0.225	48.69%	
21	0.175	-0.756	53.93%	0.0986	49.57%	-0.0108	60.48%	0.2658	0.02797	-0.677	0.210	46.07%	
22	0.160	-0.795	56.54%	0.1648	52.80%	0.0703	63.47%	0.3443	0.03223	-0.707	0.196	43.46%	
23	0.148	-0.828	59.16%	0.2317	55.48%	0.1379	65.81%	0.4073	0.03081	-0.739	0.182	40.84%	
24	0.145	-0.838	61.78%	0.2997	56.24%	0.1570	66.44%	0.4246	0.01560	-0.773	0.169	38.22%	
25	0.130	-0.887	64.40%	0.3691	60.21%	0.2588	69.67%	0.5148	0.02123	-0.808	0.155	35.60%	
26	0.119	-0.924	67.02%	0.4403	63.06%	0.3335	71.85%	0.5784	0.01906	-0.846	0.142	32.98%	
27	0.111	-0.955	69.63%	0.5139	65.46%	0.3977	73.61%	0.6314	0.01381	-0.887	0.130	30.37%	
28	0.103	-0.987	72.25%	0.5903	67.83%	0.4631	75.30%	0.6841	0.00879	-0.931	0.117	27.75%	
29	0.101	-0.994	74.87%	0.6704	68.37%	0.4780	75.68%	0.6959	0.00065	-0.979	0.105	25.13%	
30	0.099	-1.004	77.49%	0.7550	69.09%	0.4983	76.17%	0.7119	0.00185	-1.031	0.093	22.51%	
31	0.094	-1.027	80.10%	0.8454	70.69%	0.5445	77.27%	0.7478	0.00952	-1.090	0.081	19.90%	
32	0.087	-1.062	82.72%	0.9433	73.11%	0.6163	78.88%	0.8024	0.01983	-1.156	0.070	17.28%	
33	0.064	-1.194	85.34%	1.0511	81.23%	0.8866	84.05%	0.9966	0.00297	-1.233	0.058	14.66%	
34	0.059	-1.231	87.96%	1.1729	83.23%	0.9633	85.29%	1.0488	0.01540	-1.324	0.047	12.04%	
35	0.058	-1.238	90.58%	1.3151	83.56%	0.9764	85.49%	1.0576	0.06630	-1.436	0.037	9.42%	
36	0.036	-1.439	93.19%	1.4904	91.74%	1.3881	90.63%	1.3186	0.02951	-1.583	0.026	6.81%	
37	0.021	-1.672	95.81%	1.7292	96.90%	1.8663	94.42%	1.5911	0.01907	-1.800	0.016	4.19%	
38	0.002	-2.641	98.43%	2.1518	99.99%	3.8521	99.39%	2.5079	0.12683	-2.230	**0.006**	1.57%	

0.785	98.43%
0.679	95.81%
0.592	93.19%
0.592	93.19%
0.592	87.96%
0.527	85.34%
0.448	82.72%
0.410	80.10%
0.407	77.49%
0.387	74.87%
0.363	72.25%
0.361	69.63%
0.345	67.02%
0.316	64.40%
0.309	61.78%
0.293	59.16%
0.222	56.54%
0.201	53.93%
0.198	51.31%
0.182	48.69%
0.175	46.07%
0.160	43.46%
0.148	40.84%
0.145	38.22%
0.130	35.60%
0.119	32.98%
0.111	30.37%
0.103	27.75%
0.101	25.13%
0.099	22.51%
0.094	19.90%
0.087	17.28%
0.064	14.66%
0.059	12.04%
0.058	9.42%
0.036	6.81%
0.021	4.19%
0.002	1.57%


Estimation of 7Q20 at Station 02GA039 Conestogo River above Drayton
June
(Fitting to Log Pearson III distribution, R2 = 0.97)
LP-III estimation
Observed monthly minimum of 7-d avg flow
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
Flow (m3/s)

Fitting the Pearson type III distribution: to July 7-day average low flow

Ref: http://gergs.net/2014/11/fitting-pearson-type-3/

Sample	Plotting position	Normal distribution	P-III by moments
[μ = -1.199		μ = -1.199	μ = -1.199
σ = 0.509	$P_{Cunnane}$ = (i-0.4) / (n+0.2)	σ = 0.509	σ = 0.509
γ_1 = -0.769	[$P_{Weibull}$ = i / (n+1)]	[fitted by moments]	γ_1 = -0.769
n = 38			Σ sq : 3.58

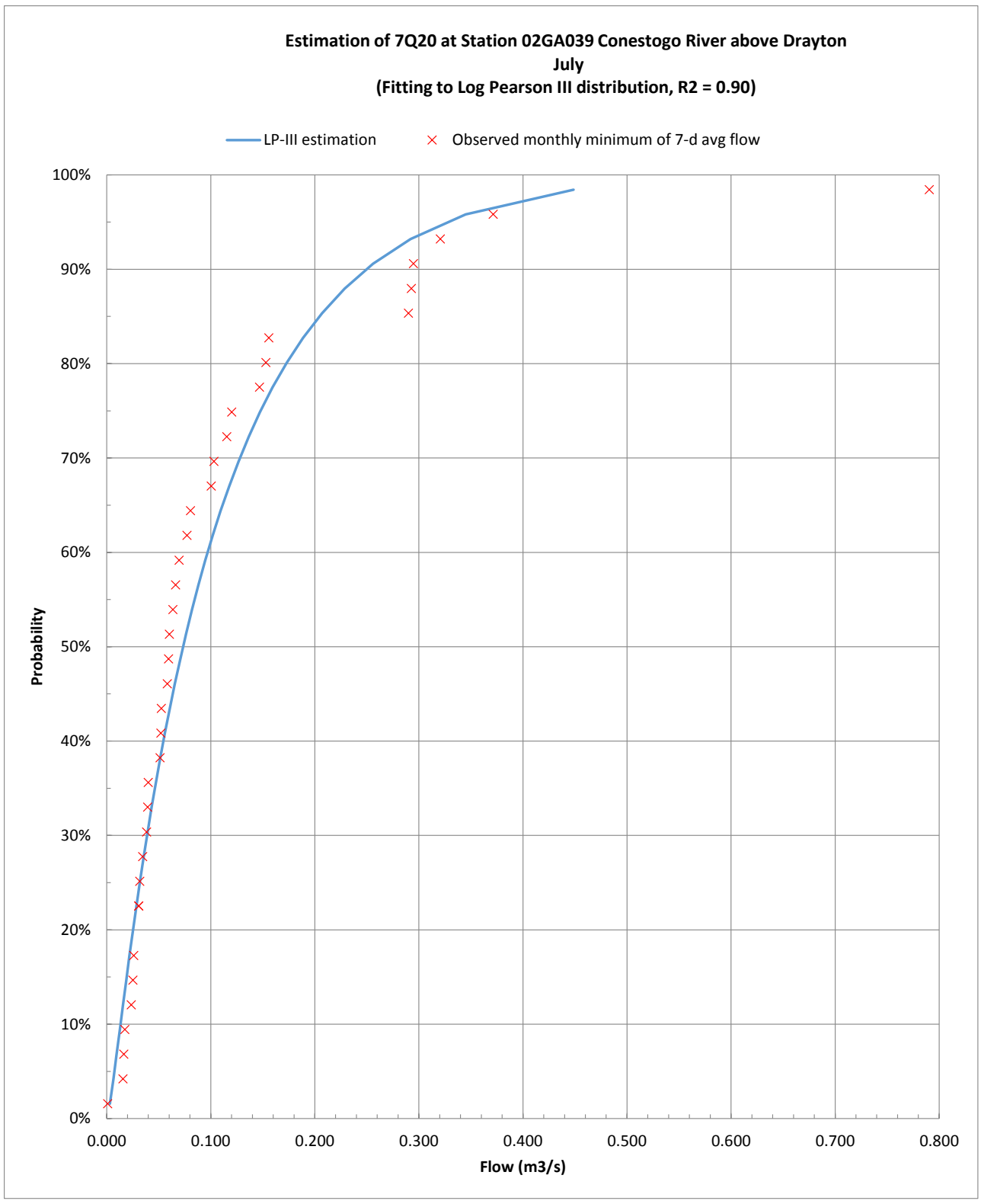
95th percentile Flow: **0.007** **m3/s**

Coef. of determination R2: **0.90**

Rank	Sorted flow	Log flow	$P_{Cunnane}$	z-scale	P_{normal}	z-scale	$PIII_{moments}$	z-scale	z-error squared	x(P)	Estimated flow	LP-III estimation	Observed monthly minimum of 7-d avg flow
1	0.790	-0.102	1.57%	-2.1518	1.55%	-2.1566	0.03%	-3.4198	1.60775	-0.348	0.449	98.43%	
2	0.371	-0.430	4.19%	-1.7292	6.53%	-1.5117	3.28%	-1.8416	0.01262	-0.462	0.345	95.81%	
3	0.321	-0.494	6.81%	-1.4904	8.28%	-1.3863	5.24%	-1.6225	0.01745	-0.535	0.292	93.19%	
4	0.295	-0.531	9.42%	-1.3151	9.44%	-1.3141	6.64%	-1.5035	0.03550	-0.592	0.256	90.58%	
5	0.293	-0.533	12.04%	-1.1729	9.53%	-1.3087	6.75%	-1.4948	0.10363	-0.641	0.229	87.96%	
6	0.290	-0.538	14.66%	-1.0511	9.67%	-1.3003	6.93%	-1.4814	0.18509	-0.684	0.207	85.34%	
7	0.156	-0.807	17.28%	-0.9433	22.06%	-0.7701	23.25%	-0.7307	0.04517	-0.724	0.189	82.72%	
8	0.153	-0.815	19.90%	-0.8454	22.53%	-0.7543	23.86%	-0.7108	0.01810	-0.762	0.173	80.10%	
9	0.147	-0.833	22.51%	-0.7550	23.60%	-0.7193	25.23%	-0.6672	0.00771	-0.798	0.159	77.49%	
10	0.120	-0.920	25.13%	-0.6704	29.19%	-0.5478	32.24%	-0.4609	0.04387	-0.832	0.147	74.87%	
11	0.115	-0.938	27.75%	-0.5903	30.37%	-0.5137	33.68%	-0.4212	0.02859	-0.865	0.136	72.25%	
12	0.103	-0.987	30.37%	-0.5139	33.86%	-0.4164	37.80%	-0.3106	0.04132	-0.897	0.127	69.63%	
13	0.100	-0.998	32.98%	-0.4403	34.65%	-0.3948	38.72%	-0.2865	0.02366	-0.929	0.118	67.02%	
14	0.081	-1.094	35.60%	-0.3691	41.81%	-0.2066	46.69%	-0.0830	0.08186	-0.961	0.109	64.40%	
15	0.077	-1.113	38.22%	-0.2997	43.27%	-0.1695	48.24%	-0.0441	0.06533	-0.992	0.102	61.78%	
16	0.070	-1.158	40.84%	-0.2317	46.76%	-0.0813	51.86%	0.0467	0.07752	-1.023	0.095	59.16%	
17	0.066	-1.179	43.46%	-0.1648	48.41%	-0.0400	53.53%	0.0885	0.06416	-1.055	0.088	56.54%	
18	0.064	-1.197	46.07%	-0.0986	49.83%	-0.0043	54.95%	0.1243	0.04967	-1.086	0.082	53.93%	
19	0.060	-1.220	48.69%	-0.0328	51.64%	0.0410	56.72%	0.1692	0.04081	-1.118	0.076	51.31%	
20	0.059	-1.226	51.31%	0.0328	52.12%	0.0533	57.19%	0.1812	0.02203	-1.151	0.071	48.69%	
21	0.058	-1.234	53.93%	0.0986	52.78%	0.0699	57.83%	0.1975	0.00978	-1.184	0.066	46.07%	
22	0.052	-1.280	56.54%	0.1648	56.37%	0.1603	61.22%	0.2850	0.01445	-1.218	0.061	43.46%	
23	0.052	-1.284	59.16%	0.2317	56.64%	0.1673	61.47%	0.2917	0.00360	-1.252	0.056	40.84%	
24	0.051	-1.290	61.78%	0.2997	57.11%	0.1791	61.91%	0.3030	0.00001	-1.288	0.051	38.22%	
25	0.040	-1.398	64.40%	0.3691	65.22%	0.3914	69.16%	0.5003	0.01721	-1.326	0.047	35.60%	
26	0.039	-1.404	67.02%	0.4403	65.68%	0.4036	69.55%	0.5115	0.00506	-1.365	0.043	32.98%	
27	0.038	-1.415	69.63%	0.5139	66.48%	0.4256	70.24%	0.5313	0.00030	-1.406	0.039	30.37%	
28	0.035	-1.461	72.25%	0.5903	69.70%	0.5159	72.97%	0.6118	0.00046	-1.449	0.036	27.75%	
29	0.032	-1.499	74.87%	0.6704	72.23%	0.5896	75.06%	0.6764	0.00004	-1.495	0.032	25.13%	
30	0.031	-1.511	77.49%	0.7550	73.01%	0.6130	75.70%	0.6967	0.00339	-1.545	0.029	22.51%	
31	0.031	-1.511	77.49%	0.7550	73.01%	0.6130	75.70%	0.6967	0.00339	-1.545	0.029	22.51%	
32	0.026	-1.585	82.72%	0.9433	77.61%	0.7592	79.43%	0.8216	0.01481	-1.660	0.022	17.28%	
33	0.025	-1.600	85.34%	1.0511	78.46%	0.7879	80.11%	0.8456	0.04225	-1.728	0.019	14.66%	
34	0.024	-1.628	87.96%	1.1729	80.04%	0.8430	81.37%	0.8914	0.07921	-1.806	0.016	12.04%	
35	0.017	-1.759	90.58%	1.3151	86.45%	1.1008	86.43%	1.0999	0.04631	-1.901	0.013	9.42%	
36	0.016	-1.784	93.19%	1.4904	87.52%	1.1513	87.28%	1.1396	0.12306	-2.021	0.010	6.81%	
37	0.016	-1.804	95.81%	1.7292	88.28%	1.1892	87.88%	1.1692	0.31362	-2.193	0.006	4.19%	
38	0.001	-3.000	98.43%	2.1518	99.98%	3.5415	99.68%	2.7251	0.32872	-2.517	0.003	1.57%	

Plotting data

0.790	98.43%
0.371	95.81%
0.321	93.19%
0.295	90.58%
0.293	87.96%
0.290	85.34%
0.156	82.72%
0.153	80.10%
0.147	77.49%
0.120	74.87%
0.115	72.25%
0.103	69.63%
0.100	67.02%
0.081	64.40%
0.077	61.78%
0.070	59.16%
0.066	56.54%
0.064	53.93%
0.060	51.31%
0.059	48.69%
0.058	46.07%
0.052	43.46%
0.052	40.84%
0.051	38.22%
0.040	35.60%
0.039	32.98%
0.038	30.37%
0.035	27.75%
0.032	25.13%
0.031	22.51%
0.031	22.51%
0.026	17.28%
0.025	14.66%
0.024	12.04%
0.017	9.42%
0.016	6.81%
0.016	4.19%
0.001	1.57%


Estimation of 7Q20 at Station 02GA039 Conestogo River above Drayton
July
(Fitting to Log Pearson III distribution, R2 = 0.90)
LP-III estimation
Observed monthly minimum of 7-d avg flow
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
Flow (m3/s)

Fitting the Pearson type III distribution: to August 7-day average low flow
Ref: http://gergs.net/2014/11/fitting-pearson-type-3/

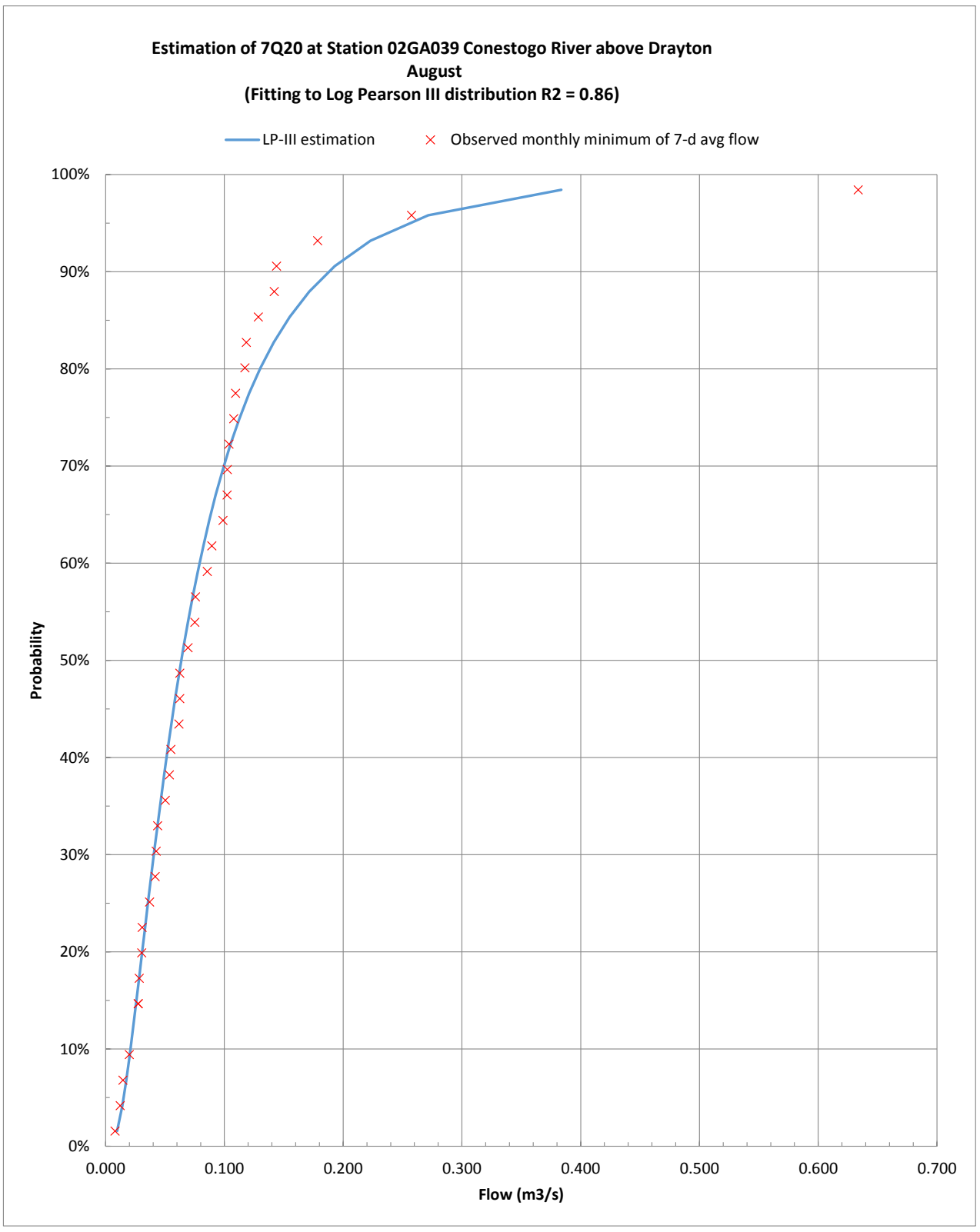
Sample	Plotting position	Normal distribution	P-III by moments
[μ = -1.200		μ = -1.200	μ = -1.200
σ = 0.372	$P_{Cunnane}$ = (i-0.4) / (n+0.2)	σ = 0.372	σ = 0.372
γ_1 = -0.069	[$P_{Weibull}$ = i / (n+1)]	[fitted by moments]	γ_1 = -0.069
n = 38			Σ sq : 1.02

95th percentile Flow: **0.015** **m3/s**
Coef. of determination R2: **0.86**

Plotting data

Rank	Sorted flow	Log flow	$P_{Cunnane}$	z-scale	P_{normal}	z-scale	$PIII_{moments}$	z-scale	z-error squared	x(P)	Estimated flow	LP-III estimation	Observed monthly minimum of 7-d avg flow
1	0.634	-0.198	1.57%	-2.1518	0.35%	-2.6964	0.28%	-2.7732	0.38614	-0.416	0.384	98.43%	
2	0.258	-0.589	4.19%	-1.7292	5.00%	-1.6448	4.79%	-1.6654	0.00407	-0.566	0.272	95.81%	
3	0.179	-0.748	6.81%	-1.4904	11.20%	-1.2161	11.09%	-1.2220	0.07205	-0.652	0.223	93.19%	
4	0.144	-0.842	9.42%	-1.3151	16.74%	-0.9646	16.75%	-0.9640	0.12328	-0.715	0.193	90.58%	
5	0.142	-0.847	12.04%	-1.1729	17.12%	-0.9494	17.14%	-0.9485	0.05037	-0.766	0.171	87.96%	
6	0.129	-0.890	14.66%	-1.0511	20.23%	-0.8334	20.33%	-0.8300	0.04889	-0.810	0.155	85.34%	
7	0.119	-0.926	17.28%	-0.9433	23.04%	-0.7375	23.20%	-0.7323	0.04449	-0.849	0.142	82.72%	
8	0.117	-0.931	19.90%	-0.8454	23.43%	-0.7248	23.60%	-0.7194	0.01587	-0.885	0.130	80.10%	
9	0.110	-0.960	22.51%	-0.7550	25.94%	-0.6453	26.15%	-0.6386	0.01355	-0.918	0.121	77.49%	
10	0.108	-0.967	25.13%	-0.6704	26.54%	-0.6268	26.77%	-0.6199	0.00255	-0.949	0.113	74.87%	
11	0.104	-0.984	27.75%	-0.5903	28.01%	-0.5827	28.26%	-0.5751	0.00023	-0.978	0.105	72.25%	
12	0.103	-0.989	30.37%	-0.5139	28.50%	-0.5681	28.76%	-0.5603	0.00216	-1.006	0.099	69.63%	
13	0.102	-0.990	32.98%	-0.4403	28.55%	-0.5665	28.82%	-0.5587	0.01400	-1.033	0.093	67.02%	
14	0.099	-1.005	35.60%	-0.3691	29.98%	-0.5250	30.27%	-0.5167	0.02178	-1.059	0.087	64.40%	
15	0.089	-1.049	38.22%	-0.2997	34.17%	-0.4078	34.52%	-0.3983	0.00971	-1.085	0.082	61.78%	
16	0.086	-1.067	40.84%	-0.2317	36.01%	-0.3583	36.38%	-0.3482	0.01358	-1.110	0.078	59.16%	
17	0.076	-1.121	43.46%	-0.1648	41.56%	-0.2133	41.98%	-0.2023	0.00141	-1.135	0.073	56.54%	
18	0.075	-1.123	46.07%	-0.0986	41.81%	-0.2066	42.24%	-0.1956	0.00942	-1.159	0.069	53.93%	
19	0.069	-1.158	48.69%	-0.0328	45.54%	-0.1120	45.99%	-0.1006	0.00460	-1.184	0.066	51.31%	
20	0.063	-1.204	51.31%	0.0328	50.38%	0.0095	50.84%	0.0210	0.00014	-1.208	0.062	48.69%	
21	0.062	-1.205	53.93%	0.0986	50.49%	0.0122	50.95%	0.0237	0.00561	-1.232	0.059	46.07%	
22	0.062	-1.210	56.54%	0.1648	51.02%	0.0257	51.48%	0.0371	0.01629	-1.257	0.055	43.46%	
23	0.055	-1.260	59.16%	0.2317	56.37%	0.1603	56.81%	0.1715	0.00363	-1.282	0.052	40.84%	
24	0.054	-1.270	61.78%	0.2997	57.45%	0.1879	57.89%	0.1990	0.01014	-1.308	0.049	38.22%	
25	0.050	-1.299	64.40%	0.3691	60.45%	0.2650	60.86%	0.2757	0.00873	-1.334	0.046	35.60%	
26	0.044	-1.358	67.02%	0.4403	66.45%	0.4249	66.80%	0.4343	0.00004	-1.360	0.044	32.98%	
27	0.043	-1.371	69.63%	0.5139	67.71%	0.4596	68.04%	0.4687	0.00204	-1.388	0.041	30.37%	
28	0.042	-1.380	72.25%	0.5903	68.56%	0.4834	68.87%	0.4922	0.00962	-1.417	0.038	27.75%	
29	0.037	-1.432	74.87%	0.6704	73.35%	0.6236	73.59%	0.6306	0.00158	-1.447	0.036	25.13%	
30	0.031	-1.511	77.49%	0.7550	79.84%	0.8358	79.94%	0.8393	0.00711	-1.479	0.033	22.51%	
31	0.030	-1.517	80.10%	0.8454	80.29%	0.8521	80.38%	0.8554	0.00010	-1.513	0.031	19.90%	
32	0.028	-1.548	82.72%	0.9433	82.57%	0.9374	82.61%	0.9390	0.00002	-1.550	0.028	17.28%	
33	0.028	-1.560	85.34%	1.0511	83.33%	0.9673	83.35%	0.9683	0.00687	-1.591	0.026	14.66%	
34	0.028	-1.560	85.34%	1.0511	83.33%	0.9673	83.35%	0.9683	0.00687	-1.591	0.026	14.66%	
35	0.020	-1.699	90.58%	1.3151	91.03%	1.3426	90.89%	1.3338	0.00035	-1.692	0.020	9.42%	
36	0.015	-1.836	93.19%	1.4904	95.66%	1.7127	95.46%	1.6915	0.04045	-1.759	0.017	6.81%	
37	0.012	-1.906	95.81%	1.7292	97.12%	1.8986	96.93%	1.8701	0.01984	-1.851	0.014	4.19%	
38	0.008	-2.097	98.43%	2.1518	99.21%	2.4134	99.09%	2.3610	0.04376	-2.015	**0.010**	1.57%	

0.634	98.43%
0.258	95.81%
0.179	93.19%
0.144	90.58%
0.142	87.96%
0.129	85.34%
0.119	82.72%
0.117	80.10%
0.110	77.49%
0.108	74.87%
0.104	72.25%
0.103	69.63%
0.102	67.02%
0.099	64.40%
0.089	61.78%
0.086	59.16%
0.076	56.54%
0.075	53.93%
0.069	51.31%
0.063	48.69%
0.062	46.07%
0.062	43.46%
0.055	40.84%
0.054	38.22%
0.050	35.60%
0.044	32.98%
0.043	30.37%
0.042	27.75%
0.037	25.13%
0.031	22.51%
0.030	19.90%
0.028	17.28%
0.028	14.66%
0.028	14.66%
0.020	9.42%
0.015	6.81%
0.012	4.19%
0.008	1.57%


Estimation of 7Q20 at Station 02GA039 Conestogo River above Drayton
August
(Fitting to Log Pearson III distribution R2 = 0.86)
LP-III estimation
Observed monthly minimum of 7-d avg flow
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
Flow (m3/s)

Fitting the Pearson type III distribution: to September 7-day average low flow

Ref: http://gergs.net/2014/11/fitting-pearson-type-3/

Sample	Plotting position	Normal distribution	P-III by moments
[μ = -1.031		μ = -1.031	μ = -1.031
σ = 0.567	$P_{Cunnane}$ = (i-0.4) / (n+0.2)	σ = 0.567	σ = 0.567
γ_1 = -0.891	[$P_{Weibull}$ = i / (n+1)]	[fitted by moments]	γ_1 = -0.891
n = 38			Σ sq : 2.32

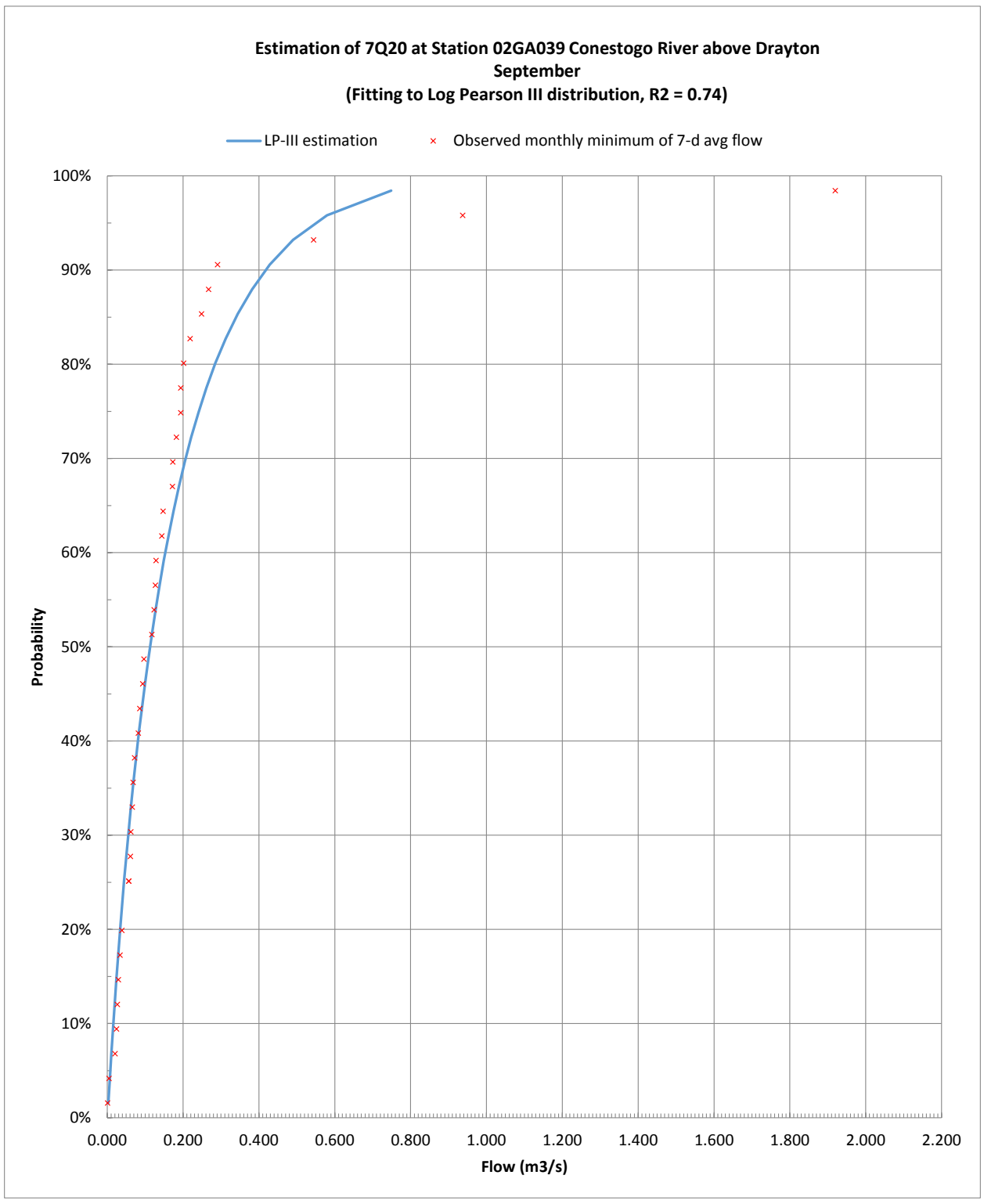
95th percentile Flow: **0.008** **m3/s**

Coef. of determination R2: **0.74**

Plotting data

Rank	Sorted flow	Log flow	$P_{Cunnane}$	z-scale	P_{normal}	z-scale	$PIII_{moments}$	z-scale	z-error squared	x(P)	Estimated flow	LP-III estimation	Observed monthly minimum of 7-d avg flow
1	1.920	0.283	1.57%	-2.1518	1.02%	-2.3176	#N/A	#N/A		-0.126	0.749	98.43%	
2	0.938	-0.028	4.19%	-1.7292	3.85%	-1.7687	0.45%	-2.6096	0.77514	-0.237	0.579	95.81%	
3	0.544	-0.264	6.81%	-1.4904	8.82%	-1.3521	5.08%	-1.6368	0.02143	-0.310	0.490	93.19%	
4	0.291	-0.536	9.42%	-1.3151	19.15%	-0.8724	19.31%	-0.8665	0.20127	-0.368	0.429	90.58%	
5	0.267	-0.573	12.04%	-1.1729	20.95%	-0.8081	21.82%	-0.7785	0.15558	-0.418	0.382	87.96%	
6	0.249	-0.605	14.66%	-1.0511	22.60%	-0.7521	24.07%	-0.7040	0.12049	-0.463	0.344	85.34%	
7	0.219	-0.660	17.28%	-0.9433	25.67%	-0.6536	28.17%	-0.5777	0.13366	-0.505	0.312	82.72%	
8	0.202	-0.695	19.90%	-0.8454	27.67%	-0.5927	30.78%	-0.5022	0.11779	-0.545	0.285	80.10%	
9	0.194	-0.713	22.51%	-0.7550	28.72%	-0.5617	32.11%	-0.4645	0.08437	-0.583	0.261	77.49%	
10	0.194	-0.713	25.13%	-0.6704	28.73%	-0.5612	32.14%	-0.4638	0.04266	-0.619	0.240	74.87%	
11	0.183	-0.739	27.75%	-0.5903	30.30%	-0.5158	34.11%	-0.4095	0.03268	-0.655	0.221	72.25%	
12	0.173	-0.762	30.37%	-0.5139	31.76%	-0.4746	35.90%	-0.3610	0.02337	-0.690	0.204	69.63%	
13	0.172	-0.764	32.98%	-0.4403	31.91%	-0.4701	36.10%	-0.3558	0.00714	-0.724	0.189	67.02%	
14	0.147	-0.831	35.60%	-0.3691	36.24%	-0.3521	41.24%	-0.2213	0.02185	-0.758	0.175	64.40%	
15	0.144	-0.841	38.22%	-0.2997	36.89%	-0.3348	41.99%	-0.2021	0.00953	-0.792	0.161	61.78%	
16	0.129	-0.890	40.84%	-0.2317	40.20%	-0.2481	45.72%	-0.1074	0.01545	-0.826	0.149	59.16%	
17	0.127	-0.897	43.46%	-0.1648	40.63%	-0.2370	46.20%	-0.0955	0.00480	-0.860	0.138	56.54%	
18	0.124	-0.908	46.07%	-0.0986	41.41%	-0.2169	47.05%	-0.0740	0.00060	-0.895	0.127	53.93%	
19	0.118	-0.929	48.69%	-0.0328	42.87%	-0.1797	48.62%	-0.0347	0.00000	-0.930	0.117	51.31%	
20	0.097	-1.014	51.31%	0.0328	48.79%	-0.0304	54.73%	0.1187	0.00738	-0.966	0.108	48.69%	
21	0.094	-1.029	53.93%	0.0986	49.84%	-0.0039	55.77%	0.1452	0.00217	-1.003	0.099	46.07%	
22	0.086	-1.067	56.54%	0.1648	52.52%	0.0632	58.37%	0.2114	0.00217	-1.040	0.091	43.46%	
23	0.082	-1.085	59.16%	0.2317	53.76%	0.0945	59.55%	0.2418	0.00010	-1.079	0.083	40.84%	
24	0.072	-1.141	61.78%	0.2997	57.68%	0.1937	63.17%	0.3365	0.00135	-1.119	0.076	38.22%	
25	0.068	-1.167	64.40%	0.3691	59.44%	0.2389	64.76%	0.3788	0.00009	-1.161	0.069	35.60%	
26	0.066	-1.178	67.02%	0.4403	60.20%	0.2584	65.43%	0.3969	0.00189	-1.204	0.062	32.98%	
27	0.062	-1.205	69.63%	0.5139	62.02%	0.3060	67.02%	0.4406	0.00537	-1.251	0.056	30.37%	
28	0.061	-1.215	72.25%	0.5903	62.69%	0.3237	67.61%	0.4567	0.01784	-1.300	0.050	27.75%	
29	0.057	-1.246	74.87%	0.6704	64.78%	0.3795	69.40%	0.5071	0.02665	-1.352	0.044	25.13%	
30	0.057	-1.246	74.87%	0.6704	64.78%	0.3795	69.40%	0.5071	0.02665	-1.352	0.044	25.13%	
31	0.039	-1.411	80.10%	0.8454	74.83%	0.6691	77.58%	0.7580	0.00764	-1.470	0.034	19.90%	
32	0.034	-1.474	82.72%	0.9433	78.26%	0.7810	80.25%	0.8506	0.00859	-1.539	0.029	17.28%	
33	0.029	-1.533	85.34%	1.0511	81.21%	0.8856	82.51%	0.9351	0.01346	-1.617	0.024	14.66%	
34	0.027	-1.573	87.96%	1.1729	83.05%	0.9560	83.91%	0.9910	0.03310	-1.707	0.020	12.04%	
35	0.025	-1.610	90.58%	1.3151	84.61%	1.0200	85.11%	1.0411	0.07508	-1.816	0.015	9.42%	
36	0.021	-1.681	93.19%	1.4904	87.40%	1.1455	87.23%	1.1375	0.12451	-1.956	0.011	6.81%	
37	0.005	-2.301	95.81%	1.7292	98.74%	2.2393	97.09%	1.8947	0.02740	-2.156	0.007	4.19%	
38	0.001	-2.942	98.43%	2.1518	99.96%	3.3695	99.48%	2.5630	0.16907	-2.537	**0.003**	1.57%	

1.920	98.43%
0.938	95.81%
0.544	93.19%
0.291	90.58%
0.267	87.96%
0.249	85.34%
0.219	82.72%
0.202	80.10%
0.194	77.49%
0.194	74.87%
0.183	72.25%
0.173	69.63%
0.172	67.02%
0.147	64.40%
0.144	61.78%
0.129	59.16%
0.127	56.54%
0.124	53.93%
0.118	51.31%
0.097	48.69%
0.094	46.07%
0.086	43.46%
0.082	40.84%
0.072	38.22%
0.068	35.60%
0.066	32.98%
0.062	30.37%
0.061	27.75%
0.057	25.13%
0.057	25.13%
0.039	19.90%
0.034	17.28%
0.029	14.66%
0.027	12.04%
0.025	9.42%
0.021	6.81%
0.005	4.19%
0.001	1.57%


Estimation of 7Q20 at Station 02GA039 Conestogo River above Drayton
September
(Fitting to Log Pearson III distribution, R2 = 0.74)
LP-III estimation
Observed monthly minimum of 7-d avg flow
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.000
0.200
0.400
0.600
0.800
1.000
1.200
1.400
1.600
1.800
2.000
2.200
Flow (m3/s)

Fitting the Pearson type III distribution: to October 7-day average low flow
Ref: http://gergs.net/2014/11/fitting-pearson-type-3/

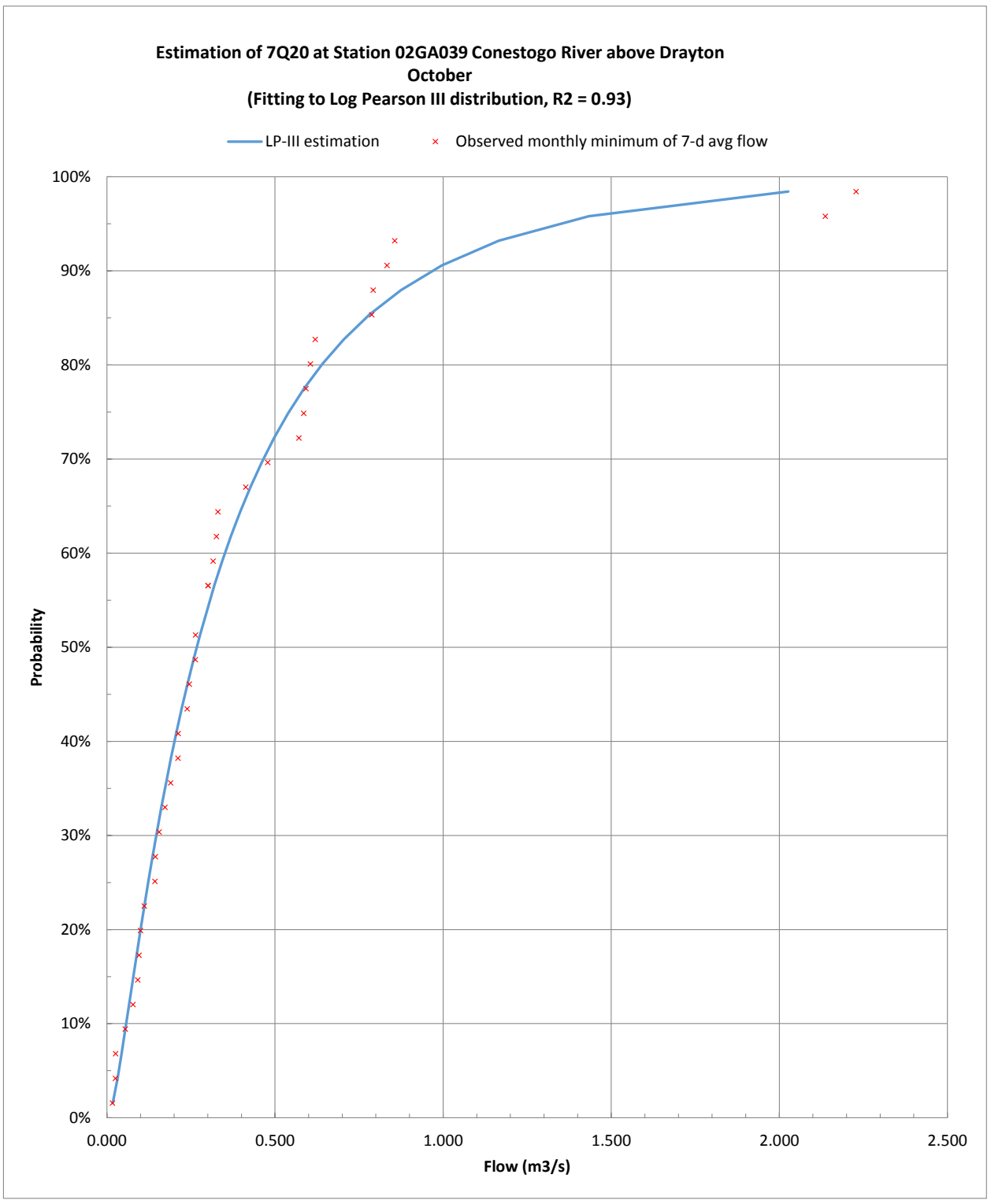
Sample		Plotting position	Normal distribution	P-III by moments	
[μ =	-0.607		μ = -0.607	μ =	-0.607
σ =	0.482	$P_{Cunnane}$ = (i-0.4) / (n+0.2)	σ = 0.482	σ =	0.482
γ_1 =	-0.413	[$P_{Weibull}$ = i / (n+1)]	[fitted by moments]	γ_1 =	-0.413
n =	38			Σ sq :	0.77

95th percentile Flow: **0.035** **m3/s**
Coef. of determination R2: **0.93**

Plotting data

Rank	Sorted flow	Log flow	$P_{Cunnane}$	z-scale	P_{normal}	z-scale	$PIII_{moments}$	z-scale	z-error squared	x(P)	Estimated flow	LP-III estimation	Observed monthly minimum of 7-d avg flow
1	2.229	0.348	1.57%	-2.1518	2.37%	-1.9827	1.15%	-2.2730	0.01468	0.307	2.027	98.43%	
2	2.137	0.330	4.19%	-1.7292	2.59%	-1.9449	1.32%	-2.2192	0.24008	0.156	1.433	95.81%	
3	0.857	-0.067	6.81%	-1.4904	13.13%	-1.1203	12.50%	-1.1503	0.11565	0.067	1.166	93.19%	
4	0.833	-0.079	9.42%	-1.3151	13.66%	-1.0956	13.12%	-1.1209	0.03770	-0.002	0.996	90.58%	
5	0.792	-0.101	12.04%	-1.1729	14.69%	-1.0498	14.30%	-1.0667	0.01127	-0.058	0.875	87.96%	
6	0.788	-0.103	14.66%	-1.0511	14.80%	-1.0452	14.43%	-1.0614	0.00010	-0.108	0.781	85.34%	
7	0.620	-0.208	17.28%	-0.9433	20.36%	-0.8288	20.85%	-0.8116	0.01734	-0.152	0.704	82.72%	
8	0.605	-0.218	19.90%	-0.8454	20.97%	-0.8074	21.56%	-0.7873	0.00337	-0.193	0.641	80.10%	
9	0.593	-0.227	22.51%	-0.7550	21.53%	-0.7880	22.20%	-0.7655	0.00011	-0.232	0.586	77.49%	
10	0.586	-0.232	25.13%	-0.6704	21.85%	-0.7773	22.56%	-0.7534	0.00690	-0.268	0.539	74.87%	
11	0.571	-0.243	27.75%	-0.5903	22.50%	-0.7553	23.31%	-0.7287	0.01915	-0.303	0.498	72.25%	
12	0.479	-0.320	30.37%	-0.5139	27.58%	-0.5953	29.05%	-0.5520	0.00146	-0.337	0.460	69.63%	
13	0.413	-0.384	32.98%	-0.4403	32.19%	-0.4624	34.14%	-0.4086	0.00101	-0.370	0.427	67.02%	
14	0.330	-0.481	35.60%	-0.3691	39.72%	-0.2605	42.22%	-0.1961	0.02992	-0.402	0.396	64.40%	
15	0.326	-0.487	38.22%	-0.2997	40.18%	-0.2487	42.70%	-0.1839	0.01340	-0.434	0.369	61.78%	
16	0.316	-0.500	40.84%	-0.2317	41.21%	-0.2222	43.78%	-0.1566	0.00564	-0.465	0.343	59.16%	
17	0.301	-0.521	43.46%	-0.1648	42.94%	-0.1780	45.57%	-0.1112	0.00288	-0.496	0.319	56.54%	
18	0.301	-0.521	43.46%	-0.1648	42.94%	-0.1780	45.57%	-0.1112	0.00288	-0.496	0.319	56.54%	
19	0.264	-0.579	48.69%	-0.0328	47.67%	-0.0584	50.41%	0.0103	0.00186	-0.558	0.277	51.31%	
20	0.263	-0.579	51.31%	0.0328	47.73%	-0.0569	50.47%	0.0118	0.00044	-0.589	0.257	48.69%	
21	0.245	-0.610	53.93%	0.0986	50.30%	0.0074	53.04%	0.0763	0.00050	-0.621	0.239	46.07%	
22	0.239	-0.622	56.54%	0.1648	51.27%	0.0319	54.01%	0.1007	0.00411	-0.653	0.222	43.46%	
23	0.212	-0.673	59.16%	0.2317	55.45%	0.1371	58.10%	0.2046	0.00074	-0.686	0.206	40.84%	
24	0.211	-0.675	61.78%	0.2997	55.62%	0.1414	58.27%	0.2087	0.00828	-0.720	0.191	38.22%	
25	0.190	-0.721	64.40%	0.3691	59.40%	0.2378	61.89%	0.3026	0.00443	-0.755	0.176	35.60%	
26	0.173	-0.762	67.02%	0.4403	62.67%	0.3231	64.97%	0.3846	0.00310	-0.790	0.162	32.98%	
27	0.155	-0.809	69.63%	0.5139	66.27%	0.4197	68.32%	0.4766	0.00139	-0.828	0.149	30.37%	
28	0.144	-0.840	72.25%	0.5903	68.62%	0.4851	70.47%	0.5381	0.00273	-0.867	0.136	27.75%	
29	0.143	-0.844	74.87%	0.6704	68.87%	0.4923	70.71%	0.5448	0.01577	-0.909	0.123	25.13%	
30	0.112	-0.952	77.49%	0.7550	76.36%	0.7179	77.44%	0.7533	0.00000	-0.953	0.111	22.51%	
31	0.100	-0.999	80.10%	0.8454	79.26%	0.8153	80.00%	0.8416	0.00001	-1.001	0.100	19.90%	
32	0.096	-1.020	82.72%	0.9433	80.44%	0.8575	81.04%	0.8795	0.00407	-1.054	0.088	17.28%	
33	0.092	-1.036	85.34%	1.0511	81.34%	0.8904	81.83%	0.9089	0.02022	-1.113	0.077	14.66%	
34	0.078	-1.109	87.96%	1.1729	85.14%	1.0424	85.16%	1.0435	0.01674	-1.180	0.066	12.04%	
35	0.055	-1.260	90.58%	1.3151	91.24%	1.3558	90.56%	1.3140	0.00000	-1.260	0.055	9.42%	
36	0.026	-1.580	93.19%	1.4904	97.84%	2.0216	96.86%	1.8605	0.13701	-1.361	0.044	6.81%	
37	0.026	-1.590	95.81%	1.7292	97.94%	2.0415	96.97%	1.8763	0.02162	-1.501	0.032	4.19%	
38	0.017	-1.781	98.43%	2.1518	99.26%	2.4377	98.55%	2.1847	0.00109	-1.760	**0.017**	1.57%	

2.229	98.43%
2.137	95.81%
0.857	93.19%
0.833	90.58%
0.792	87.96%
0.788	85.34%
0.620	82.72%
0.605	80.10%
0.593	77.49%
0.586	74.87%
0.571	72.25%
0.479	69.63%
0.413	67.02%
0.330	64.40%
0.326	61.78%
0.316	59.16%
0.301	56.54%
0.301	56.54%
0.264	51.31%
0.263	48.69%
0.245	46.07%
0.239	43.46%
0.212	40.84%
0.211	38.22%
0.190	35.60%
0.173	32.98%
0.155	30.37%
0.144	27.75%
0.143	25.13%
0.112	22.51%
0.100	19.90%
0.096	17.28%
0.092	14.66%
0.078	12.04%
0.055	9.42%
0.026	6.81%
0.026	4.19%
0.017	1.57%


Estimation of 7Q20 at Station 02GA039 Conestogo River above Drayton
October
(Fitting to Log Pearson III distribution, R2 = 0.93)
LP-III estimation
Observed monthly minimum of 7-d avg flow
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.000
0.500
1.000
1.500
2.000
2.500
Flow (m3/s)

Fitting the Pearson type III distribution: to November 7-day average low flow

Ref: http://gergs.net/2014/11/fitting-pearson-type-3/

Sample	Plotting position	Normal distribution	P-III by moments
[μ = -0.182		μ = -0.182	μ = -0.182
σ = 0.335	$P_{Cunnane}$ = (i-0.4) / (n+0.2)	σ = 0.335	σ = 0.335
γ_1 = -0.276	[$P_{Weibull}$ = i / (n+1)]	[fitted by moments]	γ_1 = -0.276
n = 38			Σ sq : 0.79

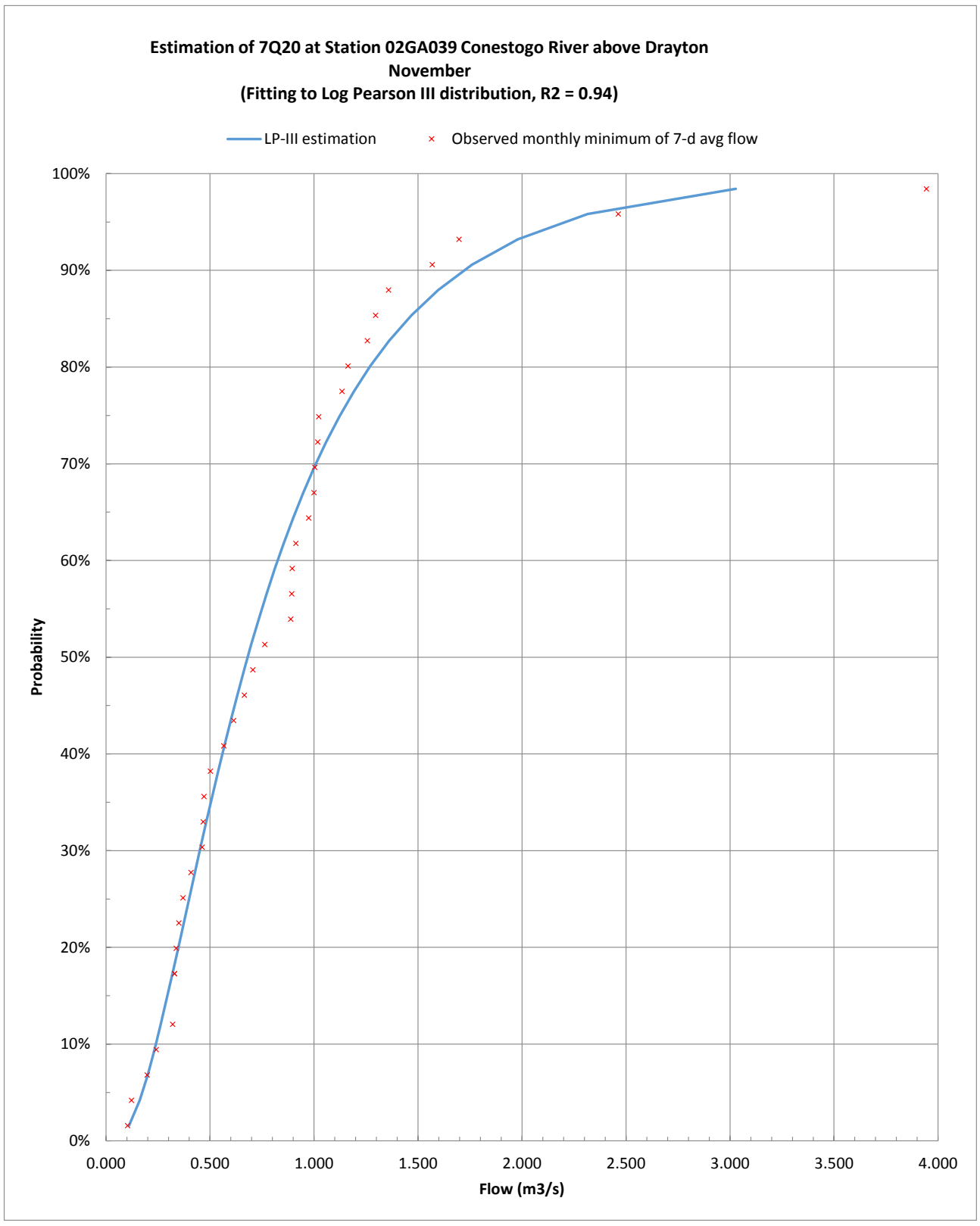
95th percentile Flow: **0.175** **m3/s**

Coef. of determination R2: **0.94**

Plotting data

Rank	Sorted flow	Log flow	$P_{Cunnane}$	z-scale	P_{normal}	z-scale	$PIII_{moments}$	z-scale	z-error squared	x(P)	Estimated flow	LP-III estimation	Observed monthly minimum of 7-d avg flow
1	3.944	0.596	1.57%	-2.1518	1.00%	-2.3255	0.48%	-2.5873	0.18963	0.481	3.028	98.43%	
2	2.463	0.391	4.19%	-1.7292	4.32%	-1.7144	3.40%	-1.8251	0.00918	0.365	2.315	95.81%	
3	1.697	0.230	6.81%	-1.4904	10.91%	-1.2313	10.34%	-1.2622	0.05209	0.296	1.979	93.19%	
4	1.569	0.196	9.42%	-1.3151	12.94%	-1.1290	12.57%	-1.1470	0.02824	0.245	1.759	90.58%	
5	1.359	0.133	12.04%	-1.1729	17.30%	-0.9426	17.35%	-0.9403	0.05410	0.203	1.597	87.96%	
6	1.296	0.113	14.66%	-1.0511	18.91%	-0.8811	19.13%	-0.8731	0.03171	0.167	1.468	85.34%	
7	1.257	0.099	17.28%	-0.9433	20.01%	-0.8413	20.33%	-0.8298	0.01288	0.134	1.361	82.72%	
8	1.163	0.066	19.90%	-0.8454	22.93%	-0.7410	23.53%	-0.7215	0.01534	0.104	1.271	80.10%	
9	1.135	0.055	22.51%	-0.7550	23.92%	-0.7088	24.61%	-0.6869	0.00464	0.076	1.191	77.49%	
10	1.022	0.010	25.13%	-0.6704	28.32%	-0.5734	29.36%	-0.5429	0.01625	0.050	1.121	74.87%	
11	1.018	0.008	27.75%	-0.5903	28.51%	-0.5677	29.56%	-0.5370	0.00285	0.025	1.058	72.25%	
12	1.004	0.002	30.37%	-0.5139	29.10%	-0.5503	30.20%	-0.5186	0.00002	0.000	1.001	69.63%	
13	1.000	0.000	32.98%	-0.4403	29.30%	-0.5448	30.41%	-0.5127	0.00524	-0.023	0.948	67.02%	
14	0.974	-0.011	35.60%	-0.3691	30.46%	-0.5114	31.65%	-0.4776	0.01177	-0.046	0.899	64.40%	
15	0.913	-0.040	38.22%	-0.2997	33.48%	-0.4267	34.86%	-0.3891	0.00799	-0.068	0.854	61.78%	
16	0.894	-0.049	40.84%	-0.2317	34.46%	-0.4000	35.89%	-0.3614	0.01681	-0.091	0.812	59.16%	
17	0.893	-0.049	43.46%	-0.1648	34.55%	-0.3975	35.99%	-0.3588	0.03763	-0.112	0.772	56.54%	
18	0.887	-0.052	46.07%	-0.0986	34.83%	-0.3900	36.28%	-0.3510	0.06371	-0.134	0.734	53.93%	
19	0.763	-0.118	48.69%	-0.0328	42.34%	-0.1933	44.08%	-0.1489	0.01347	-0.156	0.698	51.31%	
20	0.706	-0.151	51.31%	0.0328	46.29%	-0.0933	48.10%	-0.0476	0.00646	-0.178	0.664	48.69%	
21	0.665	-0.177	53.93%	0.0986	49.40%	-0.0151	51.23%	0.0310	0.00457	-0.200	0.631	46.07%	
22	0.613	-0.212	56.54%	0.1648	53.55%	0.0891	55.36%	0.1347	0.00090	-0.222	0.599	43.46%	
23	0.566	-0.247	59.16%	0.2317	57.69%	0.1938	59.41%	0.2381	0.00004	-0.245	0.569	40.84%	
24	0.501	-0.300	61.78%	0.2997	63.71%	0.3507	65.21%	0.3910	0.00834	-0.268	0.539	38.22%	
25	0.471	-0.327	64.40%	0.3691	66.70%	0.4315	68.05%	0.4690	0.00999	-0.292	0.510	35.60%	
26	0.466	-0.331	67.02%	0.4403	67.17%	0.4446	68.50%	0.4816	0.00170	-0.317	0.482	32.98%	
27	0.462	-0.336	69.63%	0.5139	67.64%	0.4578	68.94%	0.4942	0.00039	-0.342	0.454	30.37%	
28	0.408	-0.389	72.25%	0.5903	73.15%	0.6173	74.10%	0.6463	0.00314	-0.369	0.427	27.75%	
29	0.370	-0.432	74.87%	0.6704	77.23%	0.7466	77.88%	0.7680	0.00953	-0.398	0.400	25.13%	
30	0.350	-0.456	77.49%	0.7550	79.34%	0.8182	79.81%	0.8349	0.00639	-0.428	0.374	22.51%	
31	0.337	-0.472	80.10%	0.8454	80.68%	0.8663	81.05%	0.8796	0.00117	-0.460	0.347	19.90%	
32	0.330	-0.482	82.72%	0.9433	81.47%	0.8952	81.76%	0.9064	0.00136	-0.495	0.320	17.28%	
33	0.330	-0.482	82.72%	0.9433	81.47%	0.8952	81.76%	0.9064	0.00136	-0.495	0.320	17.28%	
34	0.321	-0.494	87.96%	1.1729	82.40%	0.9306	82.61%	0.9390	0.05470	-0.580	0.263	12.04%	
35	0.241	-0.618	90.58%	1.3151	90.33%	1.3005	89.89%	1.2754	0.00158	-0.633	0.233	9.42%	
36	0.197	-0.705	93.19%	1.4904	94.08%	1.5619	93.41%	1.5073	0.00028	-0.699	0.200	6.81%	
37	0.122	-0.912	95.81%	1.7292	98.54%	2.1801	97.92%	2.0382	0.09548	-0.791	0.162	4.19%	
38	0.103	-0.985	98.43%	2.1518	99.18%	2.3989	98.68%	2.2207	0.00475	-0.958	**0.110**	1.57%	

3.944	98.43%
2.463	95.81%
1.697	93.19%
1.569	90.58%
1.359	87.96%
1.296	85.34%
1.257	82.72%
1.163	80.10%
1.135	77.49%
1.022	74.87%
1.018	72.25%
1.004	69.63%
1.000	67.02%
0.974	64.40%
0.913	61.78%
0.894	59.16%
0.893	56.54%
0.887	53.93%
0.763	51.31%
0.706	48.69%
0.665	46.07%
0.613	43.46%
0.566	40.84%
0.501	38.22%
0.471	35.60%
0.466	32.98%
0.462	30.37%
0.408	27.75%
0.370	25.13%
0.350	22.51%
0.337	19.90%
0.330	17.28%
0.330	17.28%
0.321	12.04%
0.241	9.42%
0.197	6.81%
0.122	4.19%
0.103	1.57%


Estimation of 7Q20 at Station 02GA039 Conestogo River above Drayton
November
(Fitting to Log Pearson III distribution, R2 = 0.94)
LP-III estimation
Observed monthly minimum of 7-d avg flow
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
Flow (m3/s)

Fitting the Pearson type III distribution: to December 7-day average low flow
Ref: http://gergs.net/2014/11/fitting-pearson-type-3/

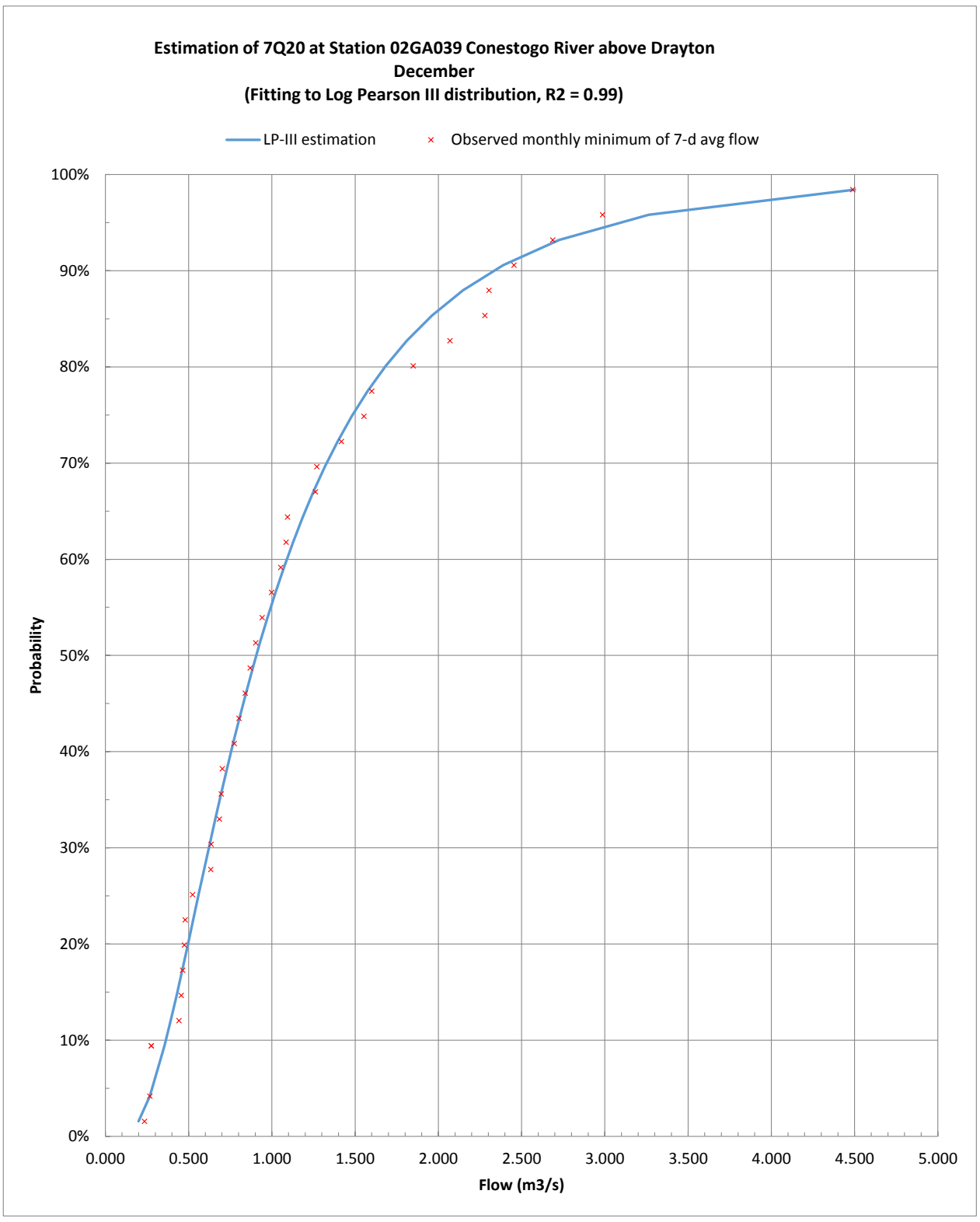
Sample	Plotting position	Normal distribution	P-III by moments
[μ = -0.039		μ = -0.039	μ = -0.039
σ = 0.315	$P_{Cunnane}$ = (i-0.4) / (n+0.2)	σ = 0.315	σ = 0.315
γ_1 = 0.078	[$P_{Weibull}$ = i / (n+1)]	[fitted by moments]	γ_1 = 0.078
n = 38			Σ sq : 0.55

95th percentile Flow: **0.282** **m3/s**
Coef. of determination R2: **0.99**

Plotting data

Rank	Sorted flow	Log flow	$P_{Cunnane}$	z-scale	P_{normal}	z-scale	$PIII_{moments}$	z-scale	z-error squared	x(P)	Estimated flow	LP-III estimation	Observed monthly minimum of 7-d avg flow
1	4.489	0.652	1.57%	-2.1518	1.41%	-2.1946	1.59%	-2.1479	0.00002	0.653	4.502	98.43%	
2	2.986	0.475	4.19%	-1.7292	5.13%	-1.6320	5.35%	-1.6115	0.01386	0.514	3.264	95.81%	
3	2.687	0.429	6.81%	-1.4904	6.86%	-1.4865	7.06%	-1.4717	0.00035	0.435	2.725	93.19%	
4	2.454	0.390	9.42%	-1.3151	8.67%	-1.3615	8.83%	-1.3510	0.00129	0.378	2.389	90.58%	
5	2.304	0.363	12.04%	-1.1729	10.13%	-1.2744	10.26%	-1.2669	0.00883	0.332	2.148	87.96%	
6	2.279	0.358	14.66%	-1.0511	10.40%	-1.2589	10.53%	-1.2519	0.04029	0.293	1.962	85.34%	
7	2.070	0.316	17.28%	-0.9433	13.00%	-1.1265	13.06%	-1.1233	0.03243	0.258	1.810	82.72%	
8	1.849	0.267	19.90%	-0.8454	16.59%	-0.9703	16.57%	-0.9713	0.01586	0.226	1.684	80.10%	
9	1.600	0.204	22.51%	-0.7550	22.03%	-0.7710	21.88%	-0.7764	0.00046	0.197	1.575	77.49%	
10	1.553	0.191	25.13%	-0.6704	23.28%	-0.7298	23.09%	-0.7359	0.00430	0.170	1.480	74.87%	
11	1.417	0.151	27.75%	-0.5903	27.31%	-0.6036	27.03%	-0.6119	0.00046	0.145	1.395	72.25%	
12	1.270	0.104	30.37%	-0.5139	32.54%	-0.4526	32.17%	-0.4629	0.00260	0.120	1.319	69.63%	
13	1.261	0.101	32.98%	-0.4403	32.90%	-0.4426	32.53%	-0.4531	0.00016	0.097	1.249	67.02%	
14	1.094	0.039	35.60%	-0.3691	40.25%	-0.2468	39.78%	-0.2590	0.01214	0.074	1.186	64.40%	
15	1.086	0.036	38.22%	-0.2997	40.68%	-0.2359	40.20%	-0.2482	0.00266	0.052	1.127	61.78%	
16	1.053	0.023	40.84%	-0.2317	42.30%	-0.1942	41.81%	-0.2067	0.00062	0.031	1.073	59.16%	
17	0.998	-0.001	43.46%	-0.1648	45.23%	-0.1198	44.72%	-0.1327	0.00103	0.009	1.022	56.54%	
18	0.941	-0.026	46.07%	-0.0986	48.46%	-0.0387	47.94%	-0.0517	0.00220	-0.012	0.974	53.93%	
19	0.903	-0.044	48.69%	-0.0328	50.74%	0.0186	50.22%	0.0056	0.00148	-0.032	0.928	51.31%	
20	0.869	-0.061	51.31%	0.0328	52.84%	0.0714	52.33%	0.0584	0.00066	-0.053	0.885	48.69%	
21	0.839	-0.076	53.93%	0.0986	54.74%	0.1191	54.23%	0.1063	0.00006	-0.074	0.844	46.07%	
22	0.803	-0.095	56.54%	0.1648	57.17%	0.1806	56.67%	0.1680	0.00001	-0.094	0.805	43.46%	
23	0.774	-0.111	59.16%	0.2317	59.12%	0.2306	58.64%	0.2183	0.00018	-0.115	0.767	40.84%	
24	0.702	-0.154	61.78%	0.2997	64.29%	0.3662	63.87%	0.3549	0.00305	-0.137	0.730	38.22%	
25	0.696	-0.157	64.40%	0.3691	64.69%	0.3769	64.27%	0.3657	0.00001	-0.158	0.695	35.60%	
26	0.684	-0.165	67.02%	0.4403	65.58%	0.4011	65.18%	0.3902	0.00251	-0.180	0.660	32.98%	
27	0.636	-0.197	69.63%	0.5139	69.24%	0.5028	68.90%	0.4931	0.00043	-0.203	0.626	30.37%	
28	0.633	-0.199	72.25%	0.5903	69.46%	0.5090	69.12%	0.4994	0.00827	-0.227	0.593	27.75%	
29	0.524	-0.281	74.87%	0.6704	77.95%	0.7706	77.80%	0.7654	0.00903	-0.252	0.560	25.13%	
30	0.479	-0.320	77.49%	0.7550	81.45%	0.8946	81.39%	0.8922	0.01883	-0.278	0.527	22.51%	
31	0.474	-0.324	80.10%	0.8454	81.78%	0.9070	81.72%	0.9049	0.00354	-0.306	0.495	19.90%	
32	0.464	-0.333	82.72%	0.9433	82.54%	0.9360	82.50%	0.9346	0.00007	-0.336	0.462	17.28%	
33	0.455	-0.342	85.34%	1.0511	83.27%	0.9647	83.25%	0.9641	0.00758	-0.369	0.428	14.66%	
34	0.442	-0.354	87.96%	1.1729	84.23%	1.0039	84.24%	1.0042	0.02845	-0.406	0.393	12.04%	
35	0.276	-0.559	90.58%	1.3151	95.10%	1.6542	95.33%	1.6781	0.13176	-0.449	0.355	9.42%	
36	0.276	-0.559	90.58%	1.3151	95.10%	1.6542	95.33%	1.6781	0.13176	-0.449	0.355	9.42%	
37	0.267	-0.574	95.81%	1.7292	95.56%	1.7022	95.80%	1.7283	0.00000	-0.574	0.266	4.19%	
38	0.235	-0.629	98.43%	2.1518	96.97%	1.8761	97.20%	1.9108	0.05806	-0.701	**0.199**	1.57%	

4.489	98.43%
2.986	95.81%
2.687	93.19%
2.454	90.58%
2.304	87.96%
2.279	85.34%
2.070	82.72%
1.849	80.10%
1.600	77.49%
1.553	74.87%
1.417	72.25%
1.270	69.63%
1.261	67.02%
1.094	64.40%
1.086	61.78%
1.053	59.16%
0.998	56.54%
0.941	53.93%
0.903	51.31%
0.869	48.69%
0.839	46.07%
0.803	43.46%
0.774	40.84%
0.702	38.22%
0.696	35.60%
0.684	32.98%
0.636	30.37%
0.633	27.75%
0.524	25.13%
0.479	22.51%
0.474	19.90%
0.464	17.28%
0.455	14.66%
0.442	12.04%
0.276	9.42%
0.276	9.42%
0.267	4.19%
0.235	1.57%


Estimation of 7Q20 at Station 02GA039 Conestogo River above Drayton
December
(Fitting to Log Pearson III distribution, R2 = 0.99)
LP-III estimation
Observed monthly minimum of 7-d avg flow
Probability
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
Flow (m3/s)

Appendix F: Ontario Provincial Water Quality Network Data

Stations:

- Station ID: 16018410002 (data from 1990 to 2006)
- Station ID: 16018407502 (data from 2007 to 2014)

Parameters:

- Table F-1
  - Total ammonia nitrogen (AMMONIUM, TOTAL UNFIL.REAC; NNHTUR)
  - Total nitrates
  - Nitrite
  - Nitrate (calculated)
  - Total Kjeldahl Nitrogen
  - pH (PH FIELD; FWPH)
  - Water temperature (TEMPERATURE, WATER; FWTEMP)
- Table F-2
- Total Phosphorus (PHOSPHORUS, UNFILTERED TOTAL; PPUT)
  - Dissolved oxygen
  - TSS (Residue, Particulate; RSP)

Graphs are presented for select parameters.

Corrections to Raw Data

Station	Parameter	Date	Original Value	Correction	Updated Value
16018410002	Dissolved Oxygen	August-21-01	0.0737	Multiplied by 100	7.37
16018410002	Dissolved Oxygen	June-12-01	0.0786	Multiplied by 100	7.86
16018410002	Dissolved Oxygen	June-14-00	0.088	Multiplied by 100	8.8
16018410002	Dissolved Oxygen	September-24-01	0.092	Multiplied by 100	9.2
16018410002	Dissolved Oxygen	April-24-01	0.099	Multiplied by 100	9.9
16018410002	Dissolved Oxygen	November-28-01	0.109	Multiplied by 100	10.9
16018410002	Ph field	June-14-00	0.0791	Multiplied by 100	7.91
16018410002	Ph field	June-12-01	0.0818	Multiplied by 100	8.18
16018410002	Ph field	September-24-01	0.0818	Multiplied by 100	8.18
16018410002	Ph field	August-21-01	0.0822	Multiplied by 100	8.22
16018410002	Ph field	November-28-01	0.0828	Multiplied by 100	8.28
16018410002	Ph field	April-24-01	0.0842	Multiplied by 100	8.42
16018410002	TEMPERATURE, WATER	June-08-99	71.6	Reversed the “71”	17.6
16018410002	TEMPERATURE, WATER	June-12-01	1.9	Multiplied by 10	19
16018410002	TEMPERATURE, WATER	August-21-01	2.1	Multiplied by 10	21
16018410002	TEMPERATURE, WATER	September-24-01	1.6	Multiplied by 10	16

Table F-1: Ontario Provincial Water Quality Network Data for Selected Parameters

Parameter	AMMONIUM, TOTAL UNFIL.REAC	NITRATES TOTAL, UNFIL.REAC	NITRITE, UNFILTERED REACTIVE	Nitrate (Calculated)	NITROGEN, TOT, KJELDAHL/ UNF.REA	PH FIELD	TEMPERATURE, WATER
Unit	mg/L	mg/L	mg/L	mg/L	mg/L	-	°C
Code	NNHTUR	NNOTUR	NNO2UR	(NNOTUR - NNO2UR)	NNTKUR	FWPH	FWTEMP
January							
10/01/1990					0.75	7.74	0.7
29/01/1991					0.7	7.8	0.8
08/01/1992					0.71	8	0.1
12/01/1993					0.58	8.1	0.3
12/01/1994					0.8	7.37	0.8
12/01/1995	0.06	2.04	0.002	2.038	0.62	7.93	15
18/01/1996	0.016	1.92	0.009	1.911	1.58	8.06	1
23/01/2001	0.102	3.2	0.032	3.168	0.76	8.04	0.9
30/01/2013	0.197	3.2	0.045	3.155	1.4	8.01	1.6
75th percentile	0.126	3.2	0.03525	3.15825	0.8	8.04	1.0
n	4	4	4	4	9	9	9
February							
13/02/1990					0.63	8.05	1.1
12/02/1991					0.8	7.82	0.3
05/02/1992					0.6	8.5	0.1
09/02/1993					0.58	8.05	0.4
02/02/1994					0.9	7.56	0.8
15/02/1995	0.046	2.8	0.028	2.772	0.58	8	0.3
18/02/1997	0.084	2.14	0.022	2.118	0.7	8.18	0.4
03/02/1998	0.168	2.01	0.015	1.995	0.9	8.03	0
24/02/1999	0.026	7.85	0.019	7.831	0.8	8.05	0.5
12/02/2002	0.038	4.94	0.019	4.921	0.62	8.25	1.5
75th percentile	0.084	4.94	0.022	4.921	0.8	8.15	0.725
n	5	5	5	5	10	10	10
March							
14/03/1990					0.975	7.69	6.2
06/03/1991					0.74	7.75	2
11/03/1992					0.76		0.6
03/03/1993					1.06		1.2
08/03/1994					1.8	7.85	1.4
08/03/1995	0.444	2.25	0.023	2.227	1.26	7.76	0.7
14/03/2000	0.02	4.87	0.018	4.852	0.74	8.3	0.46
25/03/2003	0.169	5.28	0.037	5.243	1.1	7.91	2.8
30/03/2004	0.111	3.19	0.02	3.17	1.27	7.95	5
15/03/2007	0.289	4.16	0.028	4.132	1.18	7.75	2
28/03/2007	0.05	3.52	0.016	3.504	0.65	7.94	5.9
18/03/2009	0.061	2.19	0.015	2.175		8.25	5
11/03/2011	0.102	4.14	0.016	4.124	0.87	7.75	0.3
18/03/2011	0.12	2.71	0.023	2.687	1.08	7.72	1.7
12/03/2013	0.141	4.94	0.024	4.916	0.73	7.75	0.1
75th percentile	0.162	4.6925	0.02375	4.672	1.16	7.94	3.9
n	10	10	10	10	14	13	15
April							
03/04/1991					0.69	8.1	6.5
02/04/1992					0.64	8.05	0.8
06/04/1993					0.74	7.89	1.6
13/04/1994					1.4	8.07	5.8
11/04/1995	0.002	1.41	0.004	1.406	0.52	8.65	7.2
29/04/1997	0.04	1.39	0.017	1.373	0.64	7.86	11.9
01/04/1998	0.024	2.99	0.018	2.972	0.68	8.47	11.4
22/04/1999	0.008	2.25	0.021	2.229	0.78	8.33	9.4
26/04/2000	0.018	6.4	0.021	6.379	0.76	8.41	10.6
24/04/2001	0.01	2.32	0.034	2.286	0.6	8.42	12.7
05/04/2005	0.048	4.15	0.014	4.136	0.72	8.01	3.5
04/04/2007	0.095	4.7	0.03	4.67	1.63	7.9	4.5
04/04/2008	0.131	4.68	0.02	4.66	0.85	7.96	1.1
06/04/2009	0.02	4.53	0.012	4.518	0.7	8	3.1
19/04/2010	0.024	2.48	0.014	2.466	0.78	8.35	11.5
11/04/2011	0.027	3.72	0.013	3.707	0.61	8.26	11.9
16/04/2012	0.043	2.11	0.02	2.09	0.6	8.02	15.1
18/04/2013	0.014	4.14	0.017	4.123	0.19	8.29	10
11/04/2014	0.175	2.51	0.021	2.489	0.66	8.03	3.4
30/04/2014	0.173	3.4	0.027	3.373	0.86		

Parameter	AMMONIUM, TOTAL UNFIL.REAC	NITRATES TOTAL, UNFIL.REAC	NITRITE, UNFILTERED REACTIVE	Nitrate (Calculated)	NITROGEN, TOT, KJELDAHL/ UNF.REA	PH FIELD	TEMPERATURE, WATER
Unit	mg/L	mg/L	mg/L	mg/L	mg/L	-	°C
Code	NNHTUR	NNOTUR	NNO2UR	(NNOTUR - NNO2UR)	NNTKUR	FWPH	FWTEMP
75th percentile	0.05975	4.245	0.021	4.2315	0.78	8.34	11.45
n	16	16	16	16	20	19	19
May							
15/05/1991					0.68	8.1	24.4
12/05/1992					0.63	8.23	20
04/05/1993					0.64	8.04	14.5
10/05/1994					0.64	8.52	11.7
02/05/1995	0.008	3.54	0.009	3.531	0.62	8.56	9.7
26/05/1997	0.018	1.2	0.017	1.183	0.6	7.85	14.3
12/05/1998	0.01	0.21	0.012	0.198	0.68	9.5	14.5
11/05/1999	0.01	0.145	0.008	0.137	0.74	8.41	17.2
14/05/2000	0.064	8.06	0.063	7.997	1.28	8.04	11.4
23/05/2001	0.038	1.51	0.028	1.482	0.88	8.24	15.9
08/05/2002	0.036	3.11	0.049	3.061	0.8	8.39	11.3
12/05/2003	0.057	5.74	0.045	5.695	1.09	8.14	9.9
12/05/2004	0.015	3.67	0.03	3.64	0.67	8.5	18.7
09/05/2005	0.003	2.96	0.024	2.936	0.57	8.32	16.1
22/05/2007	0.028	1.17	0.012	1.158	0.75	8.19	19.2
21/05/2008	0.004	2.21	0.01	2.2	0.75	8.48	10.9
05/05/2009	0.011	4.28	0.019	4.261	0.67	8.49	14.6
25/05/2010	0.022		0.053	-0.053	0.62	8.23	24.4
17/05/2011	0.126	9.14	0.044	9.096	1.01	8.28	9.9
04/05/2012	0.274	8.85	0.12	8.73	2	7.69	13.6
15/05/2012	0.021	2.15	0.019	2.131	0.74	8.37	19.3
16/05/2013	0.021	2.35	0.015	2.335	1.12	8.41	16.4
12/05/2014					0.67	8.26	18.8
75th percentile	0.0375	4.28	0.04475	4.10575	0.84	8.445	18.75
n	18	17	18	18	23	23	23
June							
28/06/1990					1.15	8.15	20.1
12/06/1991					0.75	7.69	18.6
02/06/1992					0.53	8.1	19.5
08/06/1993					0.76	8	17.4
22/06/1994					0.8	8.36	24.7
06/06/1995	0.002	4.47	0.029	4.441	0.72	8.38	21.1
23/06/1997	0.05	5.75	0.159	5.591	1.34	7.82	23.2
16/06/1998	0.066	2.58	0.067	2.513	1	7.96	19.9
08/06/1999	0.05	0.55	0.031	0.519	0.82	8	17.6
14/06/2000	0.08	10.2	0.065	10.135	1.24	7.91	18.4
12/06/2001	0.056	3.82	0.104	3.716	0.92	8.18	19
10/06/2002	0.028	1.22	0.026	1.194	0.68	7.88	22
24/06/2003	0.067	2.43	0.051	2.379	1.08	7.94	22.6
08/06/2004	0.021	1.71	0.024	1.686	0.65	8.2	22.2
06/06/2005	0.045	0.293	0.011	0.282	0.66	8.24	24.2
19/06/2006	0.035	0.494	0.017	0.477	0.72	8.36	25.7
19/06/2007	0.039	0.026	0.007	0.019	0.83	8.65	24.4
24/06/2008	0.014	4.58	0.04	4.54	0.86	8.4	22.1
15/06/2009	0.022	1.61	0.023	1.587	0.72	8.17	21.1
21/06/2010	0.029	4.11	0.044	4.066	0.8	8.04	24.7
20/06/2011	0.074	2.17	0.037	2.133	0.74	8.1	23
18/06/2012	0.056	3.74	0.046	3.694	0.89	8.2	24.8
17/06/2013	0.065	5.79	0.035	5.755	0.77	8	18.8
16/06/2014	0.078	2.03	0.032	1.998	0.68	8.07	23.6
75th percentile	0.0655	4.29	0.0485	4.2535	0.8975	8.21	23.75
n	19	19	19	19	24	24	24
July							
25/07/1990					0.68	8.15	23.6
11/07/1991					1.02	7.85	22.8
07/07/1992					0.63	8.37	20.5
29/07/1993					0.7	5.4	24.2
19/07/1994					0.94	8.32	26.1
18/07/1995	0.048	1.37	0.046	1.324	1.1	7.8	24
09/07/1996	0.058	0.075	0.008	0.067	0.7	8.11	19.3
22/07/1997	0.054	0.27	0.013	0.257	0.84	7.91	23.6
21/07/1998	0.042	0.065	0.009	0.056	0.82	8.24	24.1

Parameter	AMMONIUM, TOTAL UNFIL.REAC	NITRATES TOTAL, UNFIL.REAC	NITRITE, UNFILTERED REACTIVE	Nitrate (Calculated)	NITROGEN, TOT, KJELDAHL/ UNF.REA	PH FIELD	TEMPERATURE, WATER
Unit	mg/L	mg/L	mg/L	mg/L	mg/L	-	°C
Code	NNHTUR	NNOTUR	NNO2UR	(NNOTUR - NNO2UR)	NNTKUR	FWPH	FWTEMP
21/07/1999	0.05	0.065	0.007	0.058	0.88	8.37	23.3
18/07/2000	0.008	3.2	0.033	3.167	0.92	8.31	20.3
24/07/2001	0.052	0.054	0.003	0.051	0.78	8.27	26.5
18/07/2002	0.084	0.005	0.004	0.001	0.87	8.07	25.7
06/07/2004	0.044	0.721	0.012	0.709	0.66	8.35	19.9
19/07/2005	0.037	0.177	0.01	0.167	0.73	8.26	26.2
17/07/2006	0.048	4.83	0.123	4.707	1.01	8.09	27.4
16/07/2007	0.038	0.043	0.007	0.036	0.78	8.43	23.5
21/07/2008	0.04	1.95	0.033	1.917	1.25	8.08	22.7
14/07/2009	0.044	1.01	0.014	0.996	0.73	8.22	22.9
19/07/2010	0.032	1.24	0.015	1.225	0.76	8	23.6
18/07/2011	0.064	0.234	0.01	0.224	0.79	8.17	29
16/07/2012	0.022	0.028	0.003	0.025	1.09	8.56	27.8
09/07/2013	0.071	5	0.035	4.965	0.76	7.73	20.8
75th percentile	0.0535	1.3375	0.0285	1.29925	0.93	8.315	25.9
n	18	18	18	18	23	23	23
August							
16/08/1990					0.57	8.3	20.7
29/08/1991					0.56	8.18	23.9
11/08/1992					2	7.7	18.2
31/08/1993					0.6	8.8	23.2
16/08/1994					0.64	8.45	20.4
08/08/1995	0.052	0.17	0.006	0.164	0.78	7.89	24.5
23/08/1995	0.018	0.06	0.033	0.027	0.74	8.02	20.2
08/08/1996	0.04	0.12	0.009	0.111	0.74	7.81	26.7
18/08/1997	0.026	0.185	0.011	0.174	0.64	8.12	18.8
11/08/1998	0.026	0.165	0.011	0.154	0.76	8.07	24
18/08/1999	0.02	0.005	0.003	0.002	0.76	8.36	21.1
29/08/2000	0.022	0.042	0.002	0.04	0.6	8.27	22.6
21/08/2001	0.046	0.083	0.004	0.079	0.68	8.22	21
13/08/2002	0.046	0.046	0.009	0.037	0.79	7.99	25.5
06/08/2003	0.042	5.56	0.049	5.511	1.29	7.88	19.8
12/08/2003	0.062	5.56	0.043	5.517	1.03	7.99	20
10/08/2004	0.032	0.197	0.007	0.19	0.76	8.15	20.3
15/08/2005	0.039	0.037	0.005	0.032	0.71	8.34	23.3
14/08/2006	0.054	0.105	0.007	0.098	0.94	8.15	21.3
13/08/2007	0.027	0.011	0.004	0.007	0.8	8.52	25.4
12/08/2008	0.003	2.67	0.01	2.66	0.86	7.85	19
10/08/2009	0.047	3.62	0.047	3.573	1.55		
16/08/2010	0.03	0.74	0.012	0.728	0.65	8.19	24.4
15/08/2011					0.73	8.32	23.9
13/08/2012	0.035	0.193	0.014	0.179	0.67	8.09	23.1
13/08/2013	0.031	1.15	0.009	1.141	0.75	7.97	19.1
25/08/2014	0.053	0.324	0.007	0.317	0.6	8.14	23.7
75th percentile	0.046	0.74	0.012	0.728	0.795	8.2925	23.9
n	21	21	21	21	27	26	26
September							
18/09/1990					0.59	8.2	12.1
26/09/1991					0.44	8.29	11.6
01/09/1992					0.78	8.4	15.6
21/09/1993					0.62	8.31	12
29/09/1994	0.028	0.09	0.004	0.086	0.54	8.44	13.4
12/09/1995	0.042	0.045	0.007	0.038	0.58	8.3	17
05/09/1996	0.024	0.045	0.005	0.04	0.66	8.32	21.1
16/09/1997	0.01	0.085	0.005	0.08	0.56	8.26	19.4
15/09/1998	0.028	0.04	0.003	0.037	0.66	8.13	21
15/09/1999	0.018	0.025	0.006	0.019	0.7	8.43	17.3
26/09/2000	0.002	3.54	0.021	3.519	0.84	8.47	11.7
24/09/2001	0.034	0.081	0.006	0.075	0.52	8.18	16
17/09/2002	0.016	0.032	0.004	0.028	0.58	7.94	19.2
16/09/2003	0.026	0.069	0.005	0.064	0.75	8.18	18.2
07/09/2004	0.02	0.096	0.005	0.091	0.6	8.25	22
12/09/2005	0.004	0.033	0.004	0.029	0.73	8.14	23.2
05/09/2006	0.028	0.101	0.006	0.095	0.71	8.17	18.4
17/09/2007	0.008	0.046	0.003	0.043	0.55	8.69	16.8
15/09/2008	0.055	2.6	0.037	2.563	1.48	7.75	15.9

Parameter	AMMONIUM, TOTAL UNFIL.REAC	NITRATES TOTAL, UNFIL.REAC	NITRITE, UNFILTERED REACTIVE	Nitrate (Calculated)	NITROGEN, TOT, KJELDAHL/ UNF.REA	PH FIELD	TEMPERATURE, WATER
Unit	mg/L	mg/L	mg/L	mg/L	mg/L	-	°C
Code	NNHTUR	NNOTUR	NNO2UR	(NNOTUR - NNO2UR)	NNTKUR	FWPH	FWTEMP
14/09/2009	0.022	0.036	0.004	0.032	0.62	8.37	20
20/09/2010	0.021	0.544	0.007	0.537	0.64	8.5	15.9
12/09/2011					0.66	8.38	22.9
12/09/2012	0.048	0.083	0.006	0.077		8.47	21.2
16/09/2013	0.031	1.2	0.008	1.192	0.7	8.03	16
18/09/2014	0.024		0.006		0.69	8.33	15
75th percentile	0.02875	0.0985	0.00625	0.093	0.7025	8.4	20
n	20	19	20	19	24	25	25
October							
30/10/1990					0.72	8.49	6.5
10/10/1991					0.74	8.4	12.5
08/10/1992					0.61		10.4
13/10/1993					0.58	8.4	4.9
18/10/1994	0.054	0.085	0.004	0.081	0.5	8.5	11.4
18/10/1995	0.014	0.265	0.007	0.258	0.6	8.5	10.2
08/10/1996	0.002	1.7	0.01	1.69	0.7	8.41	11
22/10/2002	0.017	0.203	0.004	0.199	0.53	8.23	7.1
28/10/2003	0.003	6.41	0.019	6.391	0.79	8.25	6.7
19/10/2004	0.028	0.576	0.007	0.569	0.49	8.19	7
17/10/2005	0.033	0.684	0.014	0.67	0.57	8.26	13
18/10/2006	0.029		0.026		1.03	7.73	10.1
09/10/2008	0.002	3.6	0.016	3.584	0.71	8.23	13
19/10/2009	0.007	3.34			0.62	8.35	6.6
26/10/2010	0.03	6.61	0.023	6.587	0.78	8.16	12.9
18/10/2011					0.87	7.93	10
15/10/2012	0.028	0.686	0.022	0.664	0.47	8.4	9.7
22/10/2013	0.061	3.94	0.02	3.92	0.76	7.74	8.4
20/10/2014	0.025	3.58	0.008	3.572	1.01	8.12	9.2
75th percentile	0.02975	3.6	0.02	3.668	0.77	8.4	11.2
n	14	13	13	12	19	18	19
November							
13/11/1990					0.63	8.37	2.1
13/11/1991					0.46	8.2	1.8
19/11/1992					0.7	8.1	1.6
30/11/1993					0.74	8.35	1
08/11/1994	0.018	6.5	0.04	6.46	1.04	8.51	7.9
21/11/1995	0.028	5.21	0.015	5.195	0.8		2.2
05/11/1996	0.004	2.37	0.008	2.362	0.72	8.18	4.9
28/11/2000	0.182	9.12	0.027	9.093	0.92	8.15	3
28/11/2001	0.02	6.53	0.021	6.509	0.84	8.28	0.6
06/11/2008	0.01	3.26	0.012	3.248	0.7	8.22	9.4
23/11/2009	0.006	2.42	0.014	2.406	0.65	8.25	6.3
24/11/2010	0.023	4.64	0.014	4.626	0.1	8.17	4.4
17/11/2011	0.02	3.05	0.011	3.039	0.76	8.2	4.9
13/11/2012	0.043	6.69	0.035	6.655	0.9	8.44	4.8
24/11/2014	0.184	3.76	0.056	3.704	0.82	7.64	6.1
75th percentile	0.0355	6.515	0.031	6.4845	0.83	8.3325	5.5
n	11	11	11	11	15	14	15
December							
18/12/1990						8.19	1.4
10/12/1991					0.88	7.92	2.3
22/12/1992					0.59	8.2	0.3
07/12/1993					0.68	8.42	1.9
20/12/1994	0.014	2.1	0.009	2.091	0.68	8.46	8
09/12/1997	0.002	1.7	0.008	1.692	0.52	8.38	1.2
14/12/1998	0.04	8.9	0.079	8.821	0.76	8.33	1.6
07/12/1999	0.008	9.96	0.02	9.94	0.84	8.14	3.4
75th percentile	0.0205	9.165	0.03475	9.10075	0.8	8.39	2.575
n	4	4	4	4	7	8	8
Total n	**160**	**157**	**159**		**215**	**212**	**216**

Table F-2: Ontario Provincial Water Quality Network data for selected parameters

				Dissolved oxygen level diagnoses [2]	
Parameter	**PHOSPHORUS, UNFILTERED TOTAL**	**RESIDUE, PARTICULATE [1]**	**TEMPERATURE, WATER**	**DISSOLVED OXYGEN**	**Minimum acceptable DO level (water water biota) based on measured water temperature (as per PWQO)**
Code	**PPUT**	**RSP**	**FWTEMP**	**DO**	
Unit	**mg/L**	**mg/L**	**°C**	**mg/L**	**[PASS / FAIL]**
January					
1990-01-10	0.048		0.7	12.2	8 (PASS)
1991-01-29	0.087		0.8	14.29	8 (PASS)
1992-01-08	0.031		0.1	14.56	8 (PASS)
1993-01-12	0.024		0.3	13.64	8 (PASS)
1994-01-12	0.026		0.8	12.7	8 (PASS)
1995-01-12	0.018	5.1	15	12.8	6 (PASS)
1996-01-18	0.32	148	1	12.4	8 (PASS)
2001-01-23	0.026	4	0.9	13.3	8 (PASS)
2013-01-30	0.25	223	1.6	13.1	8 (PASS)
75th Percentile	**0.087**	**167**	**1**	**13.6**	**All passing**
Minimum			**0.1**	**12.2**	
n	**9**	**4**	**9**	**9**	**-**
February					
1990-02-13	0.037		1.1	13.2	8 (PASS)
1991-02-12	0.052		0.3	13.18	8 (PASS)
1992-02-05	0.017		0.1	13.22	8 (PASS)
1993-02-09	0.022		0.4	12.69	8 (PASS)
1994-02-02	0.052		0.8	10.48	8 (PASS)
1995-02-15	0.022	7.42	0.3	11.83	8 (PASS)
1997-02-18	0.068	26	0.4	10.66	8 (PASS)
1998-02-03	0.086	24.5	0	11.94	8 (PASS)
1999-02-24	0.034	4.5	0.5	13.94	8 (PASS)
2002-02-12	0.028	4.5	1.5	14.46	8 (PASS)
75th Percentile	**0.052**	**24.5**	**0.73**	**13.22**	**All passing**
Minimum			**0**	**10.48**	
n	**10**	**5**	**10**	**10**	**-**
March					
1990-03-14	0.135		6.2	13.3	7 (PASS)
1991-03-06	0.059		2	13.03	8 (PASS)
1992-03-11	0.094		0.6	13.12	8 (PASS)
1993-03-03	0.05		1.2	12.66	8 (PASS)
1994-03-08	0.26		1.4	10.37	8 (PASS)
1995-03-08	0.162	17.8	0.7	14.33	8 (PASS)
2000-03-14	0.024	5	0.46	13.73	8 (PASS)
2003-03-25	0.164	72.8	2.8	12.85	8 (PASS)
2004-03-30	0.278	163	5	12.69	7 (PASS)
2007-03-15	0.217	17.1	2	13.2	8 (PASS)
2007-03-28	0.089	25.7	5.9	11.43	7 (PASS)
2009-03-18	0.0875	30.9	5	12.99	7 (PASS)
2011-03-11	0.19	87.7	0.3	14.93	8 (PASS)
2011-03-18	0.305	175	1.7	14.48	8 (PASS)
2013-03-12	0.126	105	0.1	13.41	8 (PASS)
75th Percentile	**0.204**	**100.7**	**3.9**	**13.6**	**All passing**
Minimum			**0.1**	**10.37**	
n	**15**	**10**	**15**	**15**	**-**
April					
1991-04-03	0.034		6.5	13.36	7 (PASS)
1992-04-02	0.038		0.8	14.06	8 (PASS)
1993-04-06	0.096		1.6	14.58	8 (PASS)
1994-04-13	0.185		5.8	11.8	7 (PASS)
1995-04-11	0.016	4.62	7.2	13.59	7 (PASS)
1997-04-29	0.024	10	11.9	10.91	6 (PASS)
1998-04-01	0.042	14.5	11.4	10.56	6 (PASS)
1999-04-22	0.016	3.5	9.4	11.52	7 (PASS)
2000-04-26	0.024	5.5	10.6	11.66	6 (PASS)
2001-04-24	0.032	8.5	12.7	9.9	6 (PASS)
2005-04-05	0.076	21.3	3.5	13.74	8 (PASS)
2007-04-04	0.283	113	4.5	11.62	8 (PASS)
2008-04-04	0.119	39.6	1.1	13.58	8 (PASS)
2009-04-06	0.047	16.7	3.1	12.42	8 (PASS)
2010-04-19	0.015	4	11.5	12.4	6 (PASS)
2011-04-11	0.035	14	11.9	11.69	6 (PASS)
2012-04-16	0.022	5.8	15.1	11.2	6 (PASS)
2013-04-18	0.043	29	10	13.15	6 (PASS)
2014-04-11	0.172	81	3.4	12.18	8 (PASS)
2014-04-30	0.098	40.1			
75th Percentile	**0.097**	**31.7**	**11.5**	**13.5**	**All passing**
Minimum			**0.8**	**9.9**	
n	**20**	**16**	**19**	**19**	**-**
May					
1991-05-15	0.024		24.4	9.93	5 (PASS)
1992-05-12	0.035		20	11.26	5 (PASS)
1993-05-04	0.03		14.5	9.1	6 (PASS)
1994-05-10	0.014		11.7	10.58	6 (PASS)
1995-05-02	0.014	5.05	9.7	13.47	7 (PASS)
1997-05-26	0.03	7	14.3	11.04	6 (PASS)
1998-05-12	0.026	7	14.5	9.4	6 (PASS)
1999-05-11	0.02	6.5	17.2	10.34	6 (PASS)

				Dissolved oxygen level diagnoses (2)	
Parameter	**PHOSPHORUS, UNFILTERED TOTAL**	**RESIDUE, PARTICULATE (1)**	**TEMPERATURE, WATER**	**DISSOLVED OXYGEN**	**Minimum acceptable DO level (water water biota) based on measured water temperature (as per PWQO)**
Code	**PPUT**	**RSP**	**FWTEMP**	**DO**	
Unit	**mg/L**	**mg/L**	**°C**	**mg/L**	**[PASS / FAIL]**
2000-05-14	0.112	41.5	11.4	9.9	6 (PASS)
2001-05-23	0.034	8.5	15.9	9.95	6 (PASS)
2002-05-08	0.026	5.5	11.3	11.39	6 (PASS)
2003-05-12	0.076	29.6	9.9	10.57	7 (PASS)
2004-05-12	0.017	6.1	18.7	13.45	6 (PASS)
2005-05-09	0.019	6.3	16.1	11.57	6 (PASS)
2007-05-22	0.02	5.2	19.2	13.05	6 (PASS)
2008-05-21	0.012	2.4	10.9	10.51	6 (PASS)
2009-05-05	0.018	6	14.6	13.9	6 (PASS)
2010-05-25	0.011	4.4	24.4	11.48	5 (PASS)
2011-05-17	0.072	26.5	9.9	12.13	7 (PASS)
2012-05-04	0.31	129	13.6	9.14	6 (PASS)
2012-05-15	0.018	4.3	19.3	10.82	6 (PASS)
2013-05-16	0.015	4	16.4	11.85	6 (PASS)
2014-05-12	0.023	7.3	18.8	11.2	6 (PASS)
75th Percentile	**0.032**	**7.9**	**18.8**	**11.7**	**All passing**
Minimum			**9.7**	**9.1**	
n	**23**	**19**	**23**	**23**	**-**
June					
1990-06-28	0.032		20.1	8.4	5 (PASS)
1991-06-12	0.04		18.6	7.58	6 (PASS)
1992-06-02	0.016		19.5	10.21	6 (PASS)
1993-06-08	0.026		17.4	7.62	6 (PASS)
1994-06-22	0.032		24.7	7.49	5 (PASS)
1995-06-06	0.026	8.46	21.1	11.58	5 (PASS)
1997-06-23	0.062	15.5	23.2	8.75	5 (PASS)
1998-06-16	0.078	40.5	19.9	7.1	6 (PASS)
1999-06-08	0.026	7.5	17.6	8.36	6 (PASS)
2000-06-14	0.108	30	18.4	8.8	6 (PASS)
2001-06-12	0.032	8.5	19	7.86	6 (PASS)
2002-06-10	0.016		22	7.09	5 (PASS)
2003-06-24	0.037	10	22.6	8.52	5 (PASS)
2004-06-08	0.016	4.8	22.2	11.05	5 (PASS)
2005-06-06	0.026	9.5	24.2	7.52	5 (PASS)
2006-06-19	0.022	5.6	25.7	7.68	5 (PASS)
2007-06-19	0.036	9.3	24.4	8.16	5 (PASS)
2008-06-24	0.018	6.3	22.1	10.37	5 (PASS)
2009-06-15	0.02	6	21.1	10.41	5 (PASS)
2010-06-21	0.019	6.2	24.7	9.3	5 (PASS)
2011-06-20	0.028	9.3	23	10.04	5 (PASS)
2012-06-18	0.025	6.1	24.8	9.32	5 (PASS)
2013-06-17	0.08	54.6	18.8	10.15	6 (PASS)
2014-06-16	0.03	16.4	23.6	10.1	5 (PASS)
75th Percentile	**0.036**	**14.1**	**23.8**	**10.1**	**All passing**
Minimum			**17.4**	**7.09**	
n	**24**	**18**	**24**	**24**	**-**
July					
1990-07-25	0.027		23.6	8.9	5 (PASS)
1991-07-11	0.045		22.8	8.2	5 (PASS)
1992-07-07	0.024		20.5	8.3	5 (PASS)
1993-07-29	0.03		24.2	7.6	5 (PASS)
1994-07-19	0.058		26.1	8.65	5 (PASS)
1995-07-18	0.052	19	24	6.59	5 (PASS)
1996-07-09	0.028	9	19.3	5.92	6 (FAIL cold water biota, PASS warm water biota*)
1997-07-22	0.044	18.5	23.6	6.9	5 (PASS)
1998-07-21	0.044	15.5	24.1	7.75	5 (PASS)
1999-07-21	0.028	11.5	23.3	7.5	5 (PASS)
2000-07-18	0.024	6.5	20.3	8.69	5 (PASS)
2001-07-24	0.032	10.5	26.5	7.08	5 (PASS)
2002-07-18	0.053	12.6	25.7	7.65	5 (PASS)
2004-07-06	0.031	9.5	19.9	9.18	6 (PASS)
2005-07-19	0.039	17.1	26.2	7.5	5 (PASS)
2006-07-17	0.031	8.5	27.4	7.44	5 (PASS)
2007-07-16	0.042	20.7	23.5	9.12	5 (PASS)
2008-07-21	0.072	22	22.7	8.53	5 (PASS)
2009-07-14	0.03	12.5	22.9	10.2	5 (PASS)
2010-07-19	0.025	8	23.6	9.67	5 (PASS)
2011-07-18	0.044	15.4	29	9.18	5 (PASS)
2012-07-16	0.067	18.8	27.8	9.7	5 (PASS)
2013-07-09	0.118	64.7	20.8	7.89	5 (PASS)
75th Percentile	**0.049**	**18.7**	**25.9**	**9.01**	**1 not passing**
Minimum			**19.3**	**5.92**	
n	**23**	**18**	**23**	**23**	**-**
August					
1990-08-16	0.022		20.7	8.8	5 (PASS)
1991-08-29	0.02		23.9	7.04	5 (PASS)
1992-08-11	0.765		18.2	8.4	6 (PASS)
1993-08-31	0.018		23.2	8.8	5 (PASS)
1994-08-16	0.038		20.4	10	5 (PASS)
1995-08-08	0.026	6	24.5	6.6	5 (PASS)

				Dissolved oxygen level diagnoses (2)	
Parameter	**PHOSPHORUS, UNFILTERED TOTAL**	**RESIDUE, PARTICULATE (1)**	**TEMPERATURE, WATER**	**DISSOLVED OXYGEN**	**Minimum acceptable DO level (water water biota) based on measured water temperature (as per PWQO)**
Code	**PPUT**	**RSP**	**FWTEMP**	**DO**	
Unit	**mg/L**	**mg/L**	**°C**	**mg/L**	**[PASS / FAIL]**
1995-08-23	0.042	20	20.2	7.01	5 (PASS)
1996-08-08	0.028	12	26.7	5.9	5 (PASS)
1997-08-18	0.04	25	18.8	7.56	6 (PASS)
1998-08-11	0.044	17.5	24	7.4	5 (PASS)
1999-08-18	0.038	12.5	21.1	7.92	5 (PASS)
2000-08-29	0.028	9.5	22.6	8.4	5 (PASS)
2001-08-21	0.038	16.5	21	7.37	5 (PASS)
2002-08-13	0.037	10.9	25.5	8.01	5 (PASS)
2003-08-06	0.139	44	19.8	8.18	6 (PASS)
2003-08-12	0.068	17.9	20	8.97	5 (PASS)
2004-08-10	0.043	16.4	20.3	8.7	5 (PASS)
2005-08-15	0.029	8	23.3	8.55	5 (PASS)
2006-08-14	0.042	17.8	21.3	8.99	5 (PASS)
2007-08-13	0.031	11.6	25.4	11.82	5 (PASS)
2008-08-12	0.035	12.8	19	10.08	6 (PASS)
2009-08-10	0.255	134			
2010-08-16	0.018	8.2	24.4	8.75	5 (PASS)
2011-08-15	0.043	17.2	23.9	10.73	5 (PASS)
2012-08-13	0.039	11.5	23.1	9.18	5 (PASS)
2013-08-13	0.022	6.9	19.1	10.74	6 (PASS)
2014-08-25	0.019	10.6	23.7	9.16	5 (PASS)
75th Percentile	**0.043**	**17.7**	**23.9**	**9.1**	**All passing**
Minimum			**18.2**	**5.9**	
n	**27**	**22**	**26**	**26**	**-**
September					
1990-09-18	0.023		12.1	10	6 (PASS)
1991-09-26	0.017		11.6	10.88	6 (PASS)
1992-09-01	0.028		15.6	10.5	6 (PASS)
1993-09-21	0.016		12	9.8	6 (PASS)
1994-09-29	0.028	15.4			
1995-09-12	0.026	16	17	10.05	6 (PASS)
1996-09-05	0.03	16	21.1	5.83	5 (PASS)
1997-09-16	0.034	18	19.4	7.7	6 (PASS)
1998-09-15	0.034	13.5	21	7.87	5 (PASS)
1999-09-15	0.028	10.5	17.3	8.88	6 (PASS)
2000-09-26	0.024	4	11.7	11.13	6 (PASS)
2001-09-24	0.026	12.5	16	9.2	6 (PASS)
2002-09-17	0.024	8.8	19.2	8.03	6 (PASS)
2003-09-16	0.033	12.7	18.2	7.92	6 (PASS)
2004-09-07	0.032	12.7	22	7.67	5 (PASS)
2005-09-12	0.032	8.7	23.2	12.58	5 (PASS)
2006-09-05	0.027	9	18.4	9.55	6 (PASS)
2007-09-17	0.021	7.5	16.8	9.59	6 (PASS)
2008-09-15	0.228	51.4	15.9	7.9	6 (PASS)
2009-09-14	0.02	8	20	9.47	5 (PASS)
2010-09-20	0.03	9.9	15.9	11.19	6 (PASS)
2011-09-12	0.043	18.1	22.9	11.45	5 (PASS)
2012-09-12		11	21.2	10.2	5 (PASS)
2013-09-16	0.024	7.8	16	15.16	6 (PASS)
2014-09-18	0.009	8.2	15	12.24	6 (PASS)
75th Percentile	**0.032**	**15.4**	**20.3**	**10.9**	**All passing**
Minimum			**11.6**	**5.83**	
n	**24**	**21**	**24**	**24**	**-**
October					
1990-10-30	0.017		6.5	14.68	7 (PASS)
1991-10-10	0.033		12.5	9.79	6 (PASS)
1992-10-08	0.015		10.4	10.32	6 (PASS)
1993-10-13	0.014		4.9	11.24	8 (PASS)
1994-10-18	0.018	8.09	11.4	10.77	6 (PASS)
1995-10-18	0.026	13	10.2	11.76	6 (PASS)
1996-10-08	0.022	9	11	9.05	6 (PASS)
2002-10-22	0.02	4.9	7.1	11.7	7 (PASS)
2003-10-28	0.033	4.7	6.7	12.34	7 (PASS)
2004-10-19	0.03	10.8	7	11.83	7 (PASS)
2005-10-17	0.027	9.5	13	10.97	6 (PASS)
2006-10-18	0.184	50.5	10.1	10.74	6 (PASS)
2008-10-09	0.031	6.7	13	12.56	6 (PASS)
2009-10-19	0.006	4.6	6.6	12.54	7 (PASS)
2010-10-26	0.039	12.3	12.9	11.41	6 (PASS)
2011-10-18	0.06	15.5	10	11.47	6 (PASS)
2012-10-15	0.021	12.9	9.7	10.73	7 (PASS)
2013-10-22	0.151	46.8	8.4	11.94	7 (PASS)
2014-10-20	0.021	5	9.2	9.75	7 (PASS)
75th Percentile	**0.033**	**12.95**	**11.2**	**11.9**	**All passing**
Minimum			**4.9**	**9.05**	
n	**19**	**15**	**19**	**19**	**-**
November					
1990-11-13	0.026		2.1	12.61	8 (PASS)
1991-11-13	0.016		1.8	14.08	8 (PASS)
1992-11-19	0.028		1.6	12.78	8 (PASS)
1993-11-30	0.04		1	12.9	8 (PASS)

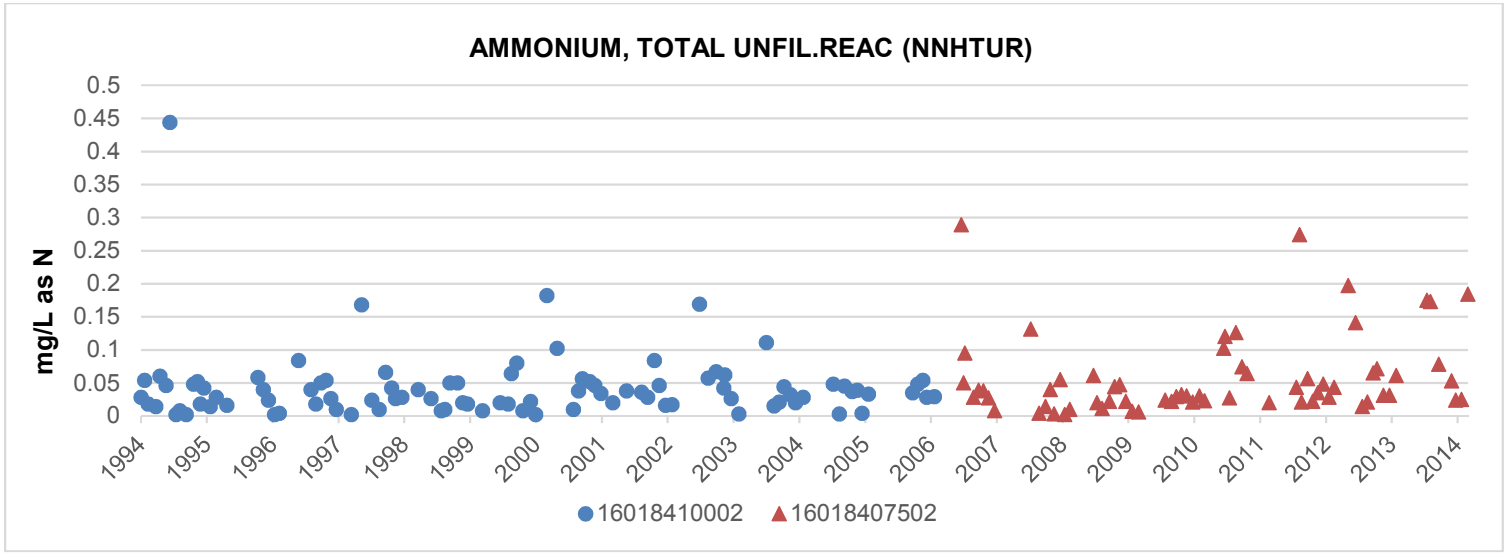
				Dissolved oxygen level diagnoses (2)	
Parameter	**PHOSPHORUS, UNFILTERED TOTAL**	**RESIDUE, PARTICULATE (1)**	**TEMPERATURE, WATER**	**DISSOLVED OXYGEN**	**Minimum acceptable DO level (water water biota) based on measured water temperature (as per PWQO)**
Code	**PPUT**	**RSP**	**FWTEMP**	**DO**	
Unit	**mg/L**	**mg/L**	**°C**	**mg/L**	**[PASS / FAIL]**
1994-11-08	0.056	17.5	7.9	11.88	7 (PASS)
1995-11-21	0.036	5	2.2	13.68	8 (PASS)
1996-11-05	0.012	4	4.9	12.04	8 (PASS)
2000-11-28	0.1	28	3	12.84	8 (PASS)
2001-11-28	0.038	9	0.6	10.9	8 (PASS)
2008-11-06		7	9.4	13.98	7 (PASS)
2009-11-23	0.013	3.3	6.3	12.45	7 (PASS)
2010-11-24	0.022	11	4.4	15.63	8 (PASS)
2011-11-17	0.022	8.8	4.9	13.6	8 (PASS)
2012-11-13	0.012	3.6	4.8	18.77	8 (PASS)
2014-11-24	0.415	185	6.1	12.04	7 (PASS)
75th Percentile	**0.040**	**14.3**	**5.5**	**13.8**	**All passing**
Minimum			**0.6**	**10.9**	
n	**14**	**11**	**15**	**15**	**-**
December					
1990-12-18			1.4	13.03	8 (PASS)
1991-12-10	0.061		2.3	13.18	8 (PASS)
1992-12-22	0.026		0.3	13.76	8 (PASS)
1993-12-07	0.028		1.9	13.15	8 (PASS)
1994-12-20	0.026	4.09	8	14.99	7 (PASS)
1997-12-09	0.016	5	1.2	14.6	8 (PASS)
1998-12-14	0.02	6	1.6	13.61	8 (PASS)
1999-12-07	0.05	12.5	3.4	12.49	8 (PASS)
75th Percentile	**0.039**	**7.6**	**2.575**	**13.97**	**All passing**
Minimum			**0.3**	**12.49**	
n	**7**	**4**	**8**	**8**	**-**
Total n	**215**	**163**	**215**	**215**	

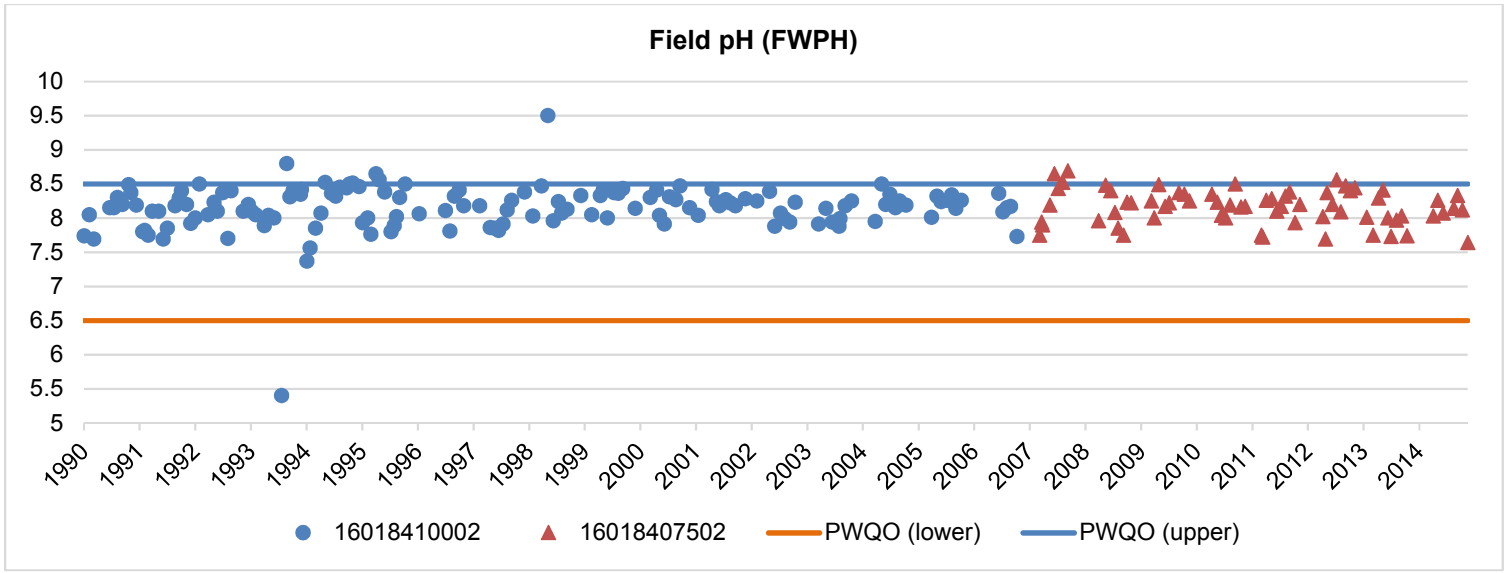
(1) Highlighted cells calculated by subtracting RSF from RST.

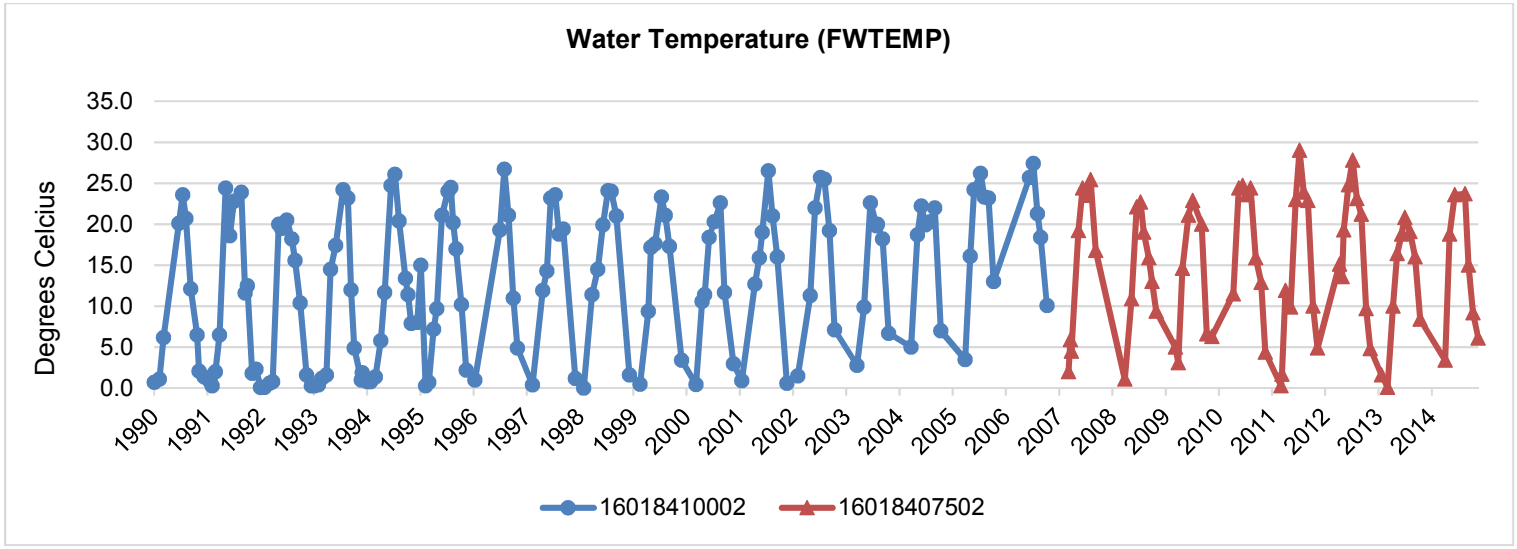
(2) Acceptability of dissolved oxygen (DO) levels is based on (i) water temperature, (ii) the type of biota (e.g. cold water or warm water), and (iii) the objective being a minimum as opposed to a maximum (as opposed to contaminants). And since the PWQO is a minimum, all readings (and not just a statistical parameter such as the average or 75th percentile) must be greater than the objective. Therefore, the corresponding water temperature for each dissolved oxygen value is given, along with the specific minimum DO level for the given temperature. As per PWQO, cold water biota have a higher minimum objective, and as such it is used here as a conservative measure. The PWQOs for each are given below. See *Water Management Policies, Guidelines, Provincial Water Quality Objectives* (MOEE, 1994, Appendix A updated February 1999) for more information.

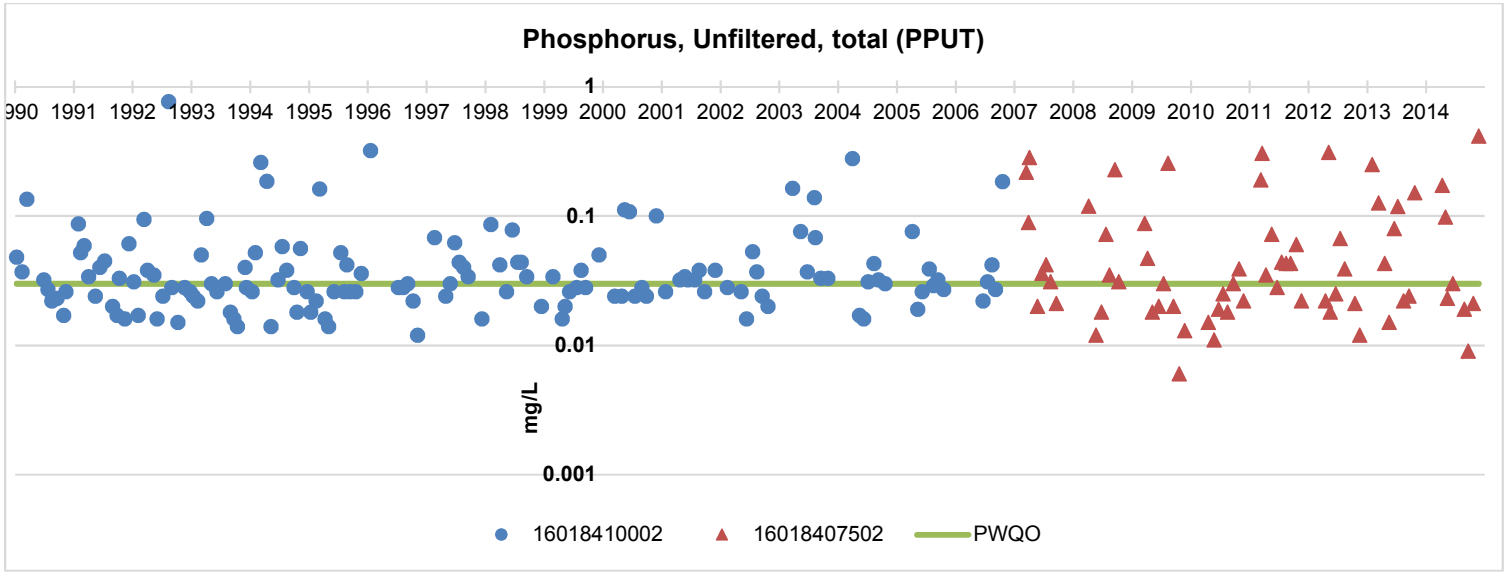
Temperature	Minimum dissolved oxygen concentration (MOEE, 1994)	
	Cold water biota	Warm water biota
°C	mg/L	mg/L
0	8	7
5	7	6
10	6	5
15	6	5
20	5	4
25	5	4

*This one DO measurement (5.92 mg/L DO) marginally fails to meet the PWQO for cold water biota (6 mg/L DO), but meets the PWQO for warm water biota (5 mg/L DO). The temperature for this reading (19.3 °C) is also marginally below the next threshold of 20 °C, for which the value would be acceptable for both types of biota. Note also that this value occurred


AMMONIUM, TOTAL UNFIL.REAC (NNHTUR)
mg/L as N
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
16018410002
16018407502


Field pH (FWPH)
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
16018410002
16018407502
PWQO (lower)
PWQO (upper)


Water Temperature (FWTEMP)
Degrees Celcius
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
16018410002
16018407502


Phosphorus, Unfiltered, total (PPUT)
1
0.1
0.01
0.001
mg/L
990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
16018410002
16018407502
PWQO

Appendix G: NH_3 Calculation Table

pKa = 0.09018 + 2729.92 / (273.16 + T°C)

fNH3 = 1 / (10^(pKa - pH) + 1)

Observed data					Calculation of NH3-N		
Month / Date	SAMPLE TYPE	AMMONIUM, TOTAL	PH FIELD	TEMPERATURE, WATER	pKa	fNH3	NH3-N
		NNHTFR (1990-1994), NNHTUR (1995-2013)	FWPH	FWTEMP			
		mg/L		°C	-	-	mg/L as N
January							
10/01/1990	FILTER.REAC	0.092	7.74	0.7	10.1	0.48%	0.0004
29/01/1991	FILTER.REAC	0.104	7.8	0.8	10.1	0.55%	0.0006
08/01/1992	FILTER.REAC	0.028	8	0.1	10.1	0.82%	0.0002
12/01/1993	FILTER.REAC	0.002	8.1	0.3	10.1	1.05%	0.0000
12/01/1994	FILTER.REAC	0.27	7.37	0.8	10.1	0.21%	0.0006
12/01/1995	UNFIL.REAC	0.06	7.93	15	9.6	2.27%	0.0014
18/01/1996	UNFIL.REAC	0.016	8.06	1	10.0	1.02%	0.0002
23/01/2001	UNFIL.REAC	0.102	8.04	0.9	10.1	0.97%	0.0010
30/01/2013	UNFIL.REAC	0.197	8.01	1.6	10.0	0.95%	0.0019
75th percentile		0.104	8.04	1.0			0.0010
n		*9*	*9*	*9*	*9*	*9*	*9*
February							
13/02/1990	FILTER.REAC	0.002	8.05	1.1	10.0	1.00%	0.0000
12/02/1991	FILTER.REAC	0.194	7.82	0.3	10.1	0.56%	0.0011
05/02/1992	FILTER.REAC	0.068	8.5	0.1	10.1	2.56%	0.0017
09/02/1993	FILTER.REAC	0.078	8.05	0.4	10.1	0.95%	0.0007
02/02/1994	FILTER.REAC	0.124	7.56	0.8	10.1	0.32%	0.0004
15/02/1995	UNFIL.REAC	0.046	8	0.3	10.1	0.84%	0.0004
18/02/1997	UNFIL.REAC	0.084	8.18	0.4	10.1	1.27%	0.0011
03/02/1998	UNFIL.REAC	0.168	8.03	0	10.1	0.88%	0.0015
24/02/1999	UNFIL.REAC	0.026	8.05	0.5	10.1	0.96%	0.0002
12/02/2002	UNFIL.REAC	0.038	8.25	1.5	10.0	1.63%	0.0006
75th percentile		0.114	8.1475	0.725			0.0011
n		*10*	*10*	*10*	*10*	*10*	*10*
March							
14/03/1990	FILTER.REAC	0.092	7.69	6.2	9.9	0.67%	0.0006
06/03/1991	FILTER.REAC	0.136	7.75	2	10.0	0.54%	0.0007
11/03/1992	FILTER.REAC	0.106		0.6	10.1		
03/03/1993	FILTER.REAC	0.292		1.2	10.0		
08/03/1994	FILTER.REAC	0.44	7.85	1.4	10.0	0.65%	0.0029
08/03/1995	UNFIL.REAC	0.444	7.76	0.7	10.1	0.50%	0.0022

Observed data					Calculation of NH3-N		
Month / Date	SAMPLE TYPE	AMMONIUM, TOTAL	PH FIELD	TEMPERATURE, WATER	pKa	fNH3	NH3-N
		NNHTFR (1990-1994), NNHTUR (1995-2013)	FWPH	FWTEMP			
		mg/L		°C	-	-	mg/L as N
14/03/2000	UNFIL.REAC	0.02	8.3	0.46	10.1	1.68%	0.0003
25/03/2003	UNFIL.REAC	0.169	7.91	2.8	10.0	0.84%	0.0014
30/03/2004	UNFIL.REAC	0.111	7.95	5	9.9	1.10%	0.0012
15/03/2007	UNFIL.REAC	0.289	7.75	2	10.0	0.54%	0.0016
28/03/2007	UNFIL.REAC	0.05	7.94	5.9	9.9	1.15%	0.0006
18/03/2009	UNFIL.REAC	0.061	8.25	5	9.9	2.17%	0.0013
11/03/2011	UNFIL.REAC	0.102	7.75	0.3	10.1	0.47%	0.0005
18/03/2011	UNFIL.REAC	0.12	7.72	1.7	10.0	0.50%	0.0006
12/03/2013	UNFIL.REAC	0.141	7.75	0.1	10.1	0.47%	0.0007
75th percentile		0.229	7.94	3.9			0.0014
n		*15*	*13*	*15*	*15*	*13*	*13*
April							
03/04/1991	FILTER.REAC	0.082	8.1	6.5	9.9	1.74%	0.0014
02/04/1992	FILTER.REAC	0.036	8.05	0.8	10.1	0.98%	0.0004
06/04/1993	FILTER.REAC	0.126	7.89	1.6	10.0	0.73%	0.0009
13/04/1994	FILTER.REAC	0.104	8.07	5.8	9.9	1.54%	0.0016
11/04/1995	UNFIL.REAC	0.002	8.65	7.2	9.8	6.23%	0.0001
29/04/1997	UNFIL.REAC	0.04	7.86	11.9	9.7	1.54%	0.0006
01/04/1998	UNFIL.REAC	0.024	8.47	11.4	9.7	5.76%	0.0014
22/04/1999	UNFIL.REAC	0.008	8.33	9.4	9.8	3.65%	0.0003
26/04/2000	UNFIL.REAC	0.018	8.41	10.6	9.7	4.77%	0.0009
24/04/2001	UNFIL.REAC	0.01	8.42	12.7	9.6	5.68%	0.0006
05/04/2005	UNFIL.REAC	0.048	8.01	3.5	10.0	1.12%	0.0005
04/04/2007	UNFIL.REAC	0.095	7.9	4.5	9.9	0.94%	0.0009
04/04/2008	UNFIL.REAC	0.131	7.96	1.1	10.0	0.82%	0.0011
06/04/2009	UNFIL.REAC	0.02	8	3.1	10.0	1.06%	0.0002
19/04/2010	UNFIL.REAC	0.024	8.35	11.5	9.7	4.47%	0.0011
11/04/2011	UNFIL.REAC	0.027	8.26	11.9	9.7	3.77%	0.0010
16/04/2012	UNFIL.REAC	0.043	8.02	15.1	9.6	2.80%	0.0012
18/04/2013	UNFIL.REAC	0.014	8.29	10	9.7	3.50%	0.0005
11/04/2014	UNFIL.REAC	0.175	8.03	3.4	10.0	1.16%	0.0020
30/04/2014	UNFIL.REAC	0.173					
75th percentile		0.09725	8.34	11.45			0.0011
n		*20*	*19*	*19*	*19*	*19*	*19*
May							

Observed data					Calculation of NH3-N		
Month / Date	SAMPLE TYPE	AMMONIUM, TOTAL	PH FIELD	TEMPERATURE, WATER	pKa	fNH3	NH3-N
		NNHTFR (1990-1994), NNHTUR (1995-2013)	FWPH	FWTEMP			
		mg/L		°C	-	-	mg/L as N
15/05/1991	FILTER.REAC	0.01	8.1	24.4	9.3	6.41%	0.0006
12/05/1992	FILTER.REAC	0.016	8.23	20	9.4	6.30%	0.0010
04/05/1993	FILTER.REAC	0.028	8.04	14.5	9.6	2.80%	0.0008
10/05/1994	FILTER.REAC	0.002	8.52	11.7	9.7	6.56%	0.0001
02/05/1995	UNFIL.REAC	0.008	8.56	9.7	9.7	6.18%	0.0005
26/05/1997	UNFIL.REAC	0.018	7.85	14.3	9.6	1.80%	0.0003
12/05/1998	UNFIL.REAC	0.01	9.5	14.5	9.6	45.39%	0.0045
11/05/1999	UNFIL.REAC	0.01	8.41	17.2	9.5	7.65%	0.0008
14/05/2000	UNFIL.REAC	0.064	8.04	11.4	9.7	2.22%	0.0014
23/05/2001	UNFIL.REAC	0.038	8.24	15.9	9.5	4.83%	0.0018
08/05/2002	UNFIL.REAC	0.036	8.39	11.3	9.7	4.80%	0.0017
12/05/2003	UNFIL.REAC	0.057	8.14	9.9	9.7	2.48%	0.0014
12/05/2004	UNFIL.REAC	0.015	8.5	18.7	9.4	10.22%	0.0015
09/05/2005	UNFIL.REAC	0.003	8.32	16.1	9.5	5.84%	0.0002
22/05/2007	UNFIL.REAC	0.028	8.19	19.2	9.4	5.47%	0.0015
21/05/2008	UNFIL.REAC	0.004	8.48	10.9	9.7	5.68%	0.0002
05/05/2009	UNFIL.REAC	0.011	8.49	14.6	9.6	7.57%	0.0008
25/05/2010	UNFIL.REAC	0.022	8.23	24.4	9.3	8.45%	0.0019
17/05/2011	UNFIL.REAC	0.126	8.28	9.9	9.7	3.39%	0.0043
04/05/2012	UNFIL.REAC	0.274	7.69	13.6	9.6	1.19%	0.0033
15/05/2012	UNFIL.REAC	0.021	8.37	19.3	9.4	8.11%	0.0017
16/05/2013	UNFIL.REAC	0.021	8.41	16.4	9.5	7.23%	0.0015
12/05/2014			8.26	18.8	9.4	6.19%	
75th percentile		0.034	8.445	18.75			0.0017
n		*22*	*23*	*23*	*23*	*23*	*22*
June							
28/06/1990	FILTER.REAC	0.03	8.15	20.1	9.4	5.34%	0.0016
12/06/1991	FILTER.REAC	0.03	7.69	18.6	9.4	1.72%	0.0005
02/06/1992	FILTER.REAC	0.008	8.1	19.5	9.4	4.59%	0.0004
08/06/1993	FILTER.REAC	0.048	8	17.4	9.5	3.17%	0.0015
22/06/1994	FILTER.REAC	0.04	8.36	24.7	9.3	11.29%	0.0045
06/06/1995	UNFIL.REAC	0.002	8.38	21.1	9.4	9.33%	0.0002
23/06/1997	UNFIL.REAC	0.05	7.82	23.2	9.3	3.19%	0.0016
16/06/1998	UNFIL.REAC	0.066	7.96	19.9	9.4	3.46%	0.0023
08/06/1999	UNFIL.REAC	0.05	8	17.6	9.5	3.21%	0.0016

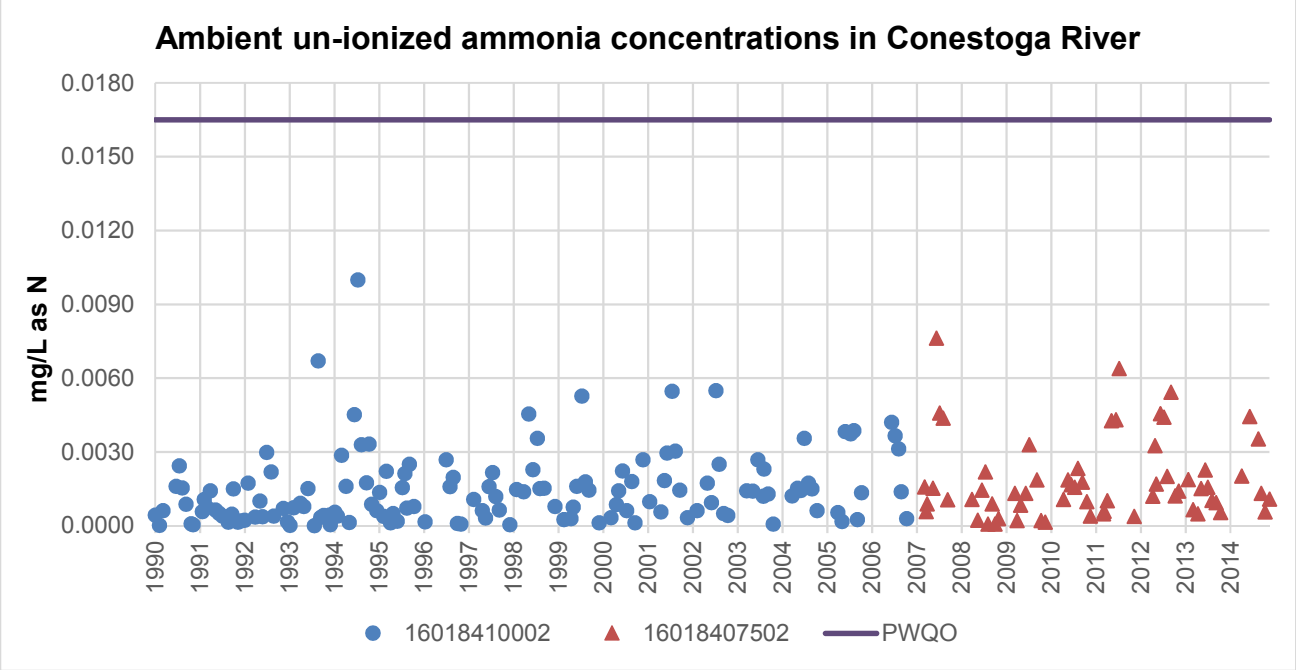
Observed data					Calculation of NH3-N		
Month / Date	SAMPLE TYPE	AMMONIUM, TOTAL	PH FIELD	TEMPERATURE, WATER	pKa	fNH3	NH3-N
		NNHTFR (1990-1994), NNHTUR (1995-2013)	FWPH	FWTEMP			
		mg/L		°C	-	-	mg/L as N
14/06/2000	UNFIL.REAC	0.08	7.91	18.4	9.5	2.78%	0.0022
12/06/2001	UNFIL.REAC	0.056	8.18	19	9.4	5.28%	0.0030
10/06/2002	UNFIL.REAC	0.028	7.88	22	9.3	3.36%	0.0009
24/06/2003	UNFIL.REAC	0.067	7.94	22.6	9.3	4.00%	0.0027
08/06/2004	UNFIL.REAC	0.021	8.2	22.2	9.3	6.86%	0.0014
06/06/2005	UNFIL.REAC	0.045	8.24	24.2	9.3	8.52%	0.0038
19/06/2006	UNFIL.REAC	0.035	8.36	25.7	9.2	12.02%	0.0042
19/06/2007	UNFIL.REAC	0.039	8.65	24.4	9.3	19.54%	0.0076
24/06/2008	UNFIL.REAC	0.014	8.4	22.1	9.3	10.38%	0.0015
15/06/2009	UNFIL.REAC	0.022	8.17	21.1	9.4	5.97%	0.0013
21/06/2010	UNFIL.REAC	0.029	8.04	24.7	9.3	5.74%	0.0017
20/06/2011	UNFIL.REAC	0.074	8.1	23	9.3	5.83%	0.0043
18/06/2012	UNFIL.REAC	0.056	8.2	24.8	9.3	8.14%	0.0046
17/06/2013	UNFIL.REAC	0.065	8	18.8	9.4	3.50%	0.0023
16/06/2014	UNFIL.REAC	0.078	8.07	23.6	9.3	5.69%	0.0044
75th percentile		0.05825	8.21	23.75			0.0039
n		*24*	*24*	*24*	*24*	*24*	*24*
July							
25/07/1990	FILTER.REAC	0.036	8.15	23.6	9.3	6.77%	0.0024
11/07/1991	FILTER.REAC	0.012	7.85	22.8	9.3	3.32%	0.0004
07/07/1992	FILTER.REAC	0.034	8.37	20.5	9.4	8.78%	0.0030
29/07/1993	FILTER.REAC	0.046	5.4	24.2	9.3	0.01%	0.0000
19/07/1994	FILTER.REAC	0.088	8.32	26.1	9.2	11.36%	0.0100
18/07/1995	UNFIL.REAC	0.048	7.8	24	9.3	3.23%	0.0015
09/07/1996	UNFIL.REAC	0.058	8.11	19.3	9.4	4.62%	0.0027
22/07/1997	UNFIL.REAC	0.054	7.91	23.6	9.3	4.01%	0.0022
21/07/1998	UNFIL.REAC	0.042	8.24	24.1	9.3	8.47%	0.0036
21/07/1999	UNFIL.REAC	0.05	8.37	23.3	9.3	10.54%	0.0053
18/07/2000	UNFIL.REAC	0.008	8.31	20.3	9.4	7.63%	0.0006
24/07/2001	UNFIL.REAC	0.052	8.27	26.5	9.2	10.51%	0.0055
18/07/2002	UNFIL.REAC	0.084	8.07	25.7	9.2	6.55%	0.0055
06/07/2004	UNFIL.REAC	0.044	8.35	19.9	9.4	8.09%	0.0036
19/07/2005	UNFIL.REAC	0.037	8.26	26.2	9.2	10.10%	0.0037
17/07/2006	UNFIL.REAC	0.048	8.09	27.4	9.2	7.63%	0.0037
16/07/2007	UNFIL.REAC	0.038	8.43	23.5	9.3	12.07%	0.0046

Observed data					Calculation of NH3-N		
Month / Date	SAMPLE TYPE	AMMONIUM, TOTAL	PH FIELD	TEMPERATURE, WATER	pKa	fNH3	NH3-N
		NNHTFR (1990-1994), NNHTUR (1995-2013)	FWPH	FWTEMP			
		mg/L		°C	-	-	mg/L as N
21/07/2008	UNFIL.REAC	0.04	8.08	22.7	9.3	5.47%	0.0022
14/07/2009	UNFIL.REAC	0.044	8.22	22.9	9.3	7.50%	0.0033
19/07/2010	UNFIL.REAC	0.032	8	23.6	9.3	4.89%	0.0016
18/07/2011	UNFIL.REAC	0.064	8.17	29	9.1	9.99%	0.0064
16/07/2012	UNFIL.REAC	0.022	8.56	27.8	9.2	20.04%	0.0044
09/07/2013	UNFIL.REAC	0.071	7.73	20.8	9.4	2.21%	0.0016
75th percentile		0.053	8.315	25.9			0.0045
n		*23*	*23*	*23*	*23*	*23*	*23*
August							
16/08/1990	FILTER.REAC	0.02	8.3	20.7	9.4	7.68%	0.0015
29/08/1991	FILTER.REAC	0.002	8.18	23.9	9.3	7.36%	0.0001
11/08/1992	FILTER.REAC	0.128	7.7	18.2	9.5	1.71%	0.0022
31/08/1993	FILTER.REAC	0.028	8.8	23.2	9.3	23.95%	0.0067
16/08/1994	FILTER.REAC	0.032	8.45	20.4	9.4	10.31%	0.0033
08/08/1995	UNFIL.REAC	0.052	7.89	24.5	9.3	4.08%	0.0021
23/08/1995	UNFIL.REAC	0.018	8.02	20.2	9.4	4.04%	0.0007
08/08/1996	UNFIL.REAC	0.04	7.81	26.7	9.2	3.97%	0.0016
18/08/1997	UNFIL.REAC	0.026	8.12	18.8	9.4	4.56%	0.0012
11/08/1998	UNFIL.REAC	0.026	8.07	24	9.3	5.85%	0.0015
18/08/1999	UNFIL.REAC	0.02	8.36	21.1	9.4	8.95%	0.0018
29/08/2000	UNFIL.REAC	0.022	8.27	22.6	9.3	8.18%	0.0018
21/08/2001	UNFIL.REAC	0.046	8.22	21	9.4	6.60%	0.0030
13/08/2002	UNFIL.REAC	0.046	7.99	25.5	9.2	5.43%	0.0025
06/08/2003	UNFIL.REAC	0.042	7.88	19.8	9.4	2.88%	0.0012
12/08/2003	UNFIL.REAC	0.062	7.99	20	9.4	3.73%	0.0023
10/08/2004	UNFIL.REAC	0.032	8.15	20.3	9.4	5.41%	0.0017
15/08/2005	UNFIL.REAC	0.039	8.34	23.3	9.3	9.91%	0.0039
14/08/2006	UNFIL.REAC	0.054	8.15	21.3	9.4	5.79%	0.0031
13/08/2007	UNFIL.REAC	0.027	8.52	25.4	9.2	16.20%	0.0044
12/08/2008	UNFIL.REAC	0.003	7.85	19	9.4	2.54%	0.0001
10/08/2009	UNFIL.REAC	0.047					
16/08/2010	UNFIL.REAC	0.03	8.19	24.4	9.3	7.77%	0.0023
15/08/2011			8.32	23.9	9.3	9.88%	
13/08/2012	UNFIL.REAC	0.035	8.09	23.1	9.3	5.75%	0.0020
13/08/2013	UNFIL.REAC	0.031	7.97	19.1	9.4	3.34%	0.0010

Observed data					Calculation of NH3-N		
Month / Date	SAMPLE TYPE	AMMONIUM, TOTAL	PH FIELD	TEMPERATURE, WATER	pKa	fNH3	NH3-N
		NNHTFR (1990-1994), NNHTUR (1995-2013)	FWPH	FWTEMP			
		mg/L		°C	-	-	mg/L as N
25/08/2014	UNFIL.REAC	0.053	8.14	23.7	9.3	6.67%	0.0035
75th percentile		0.046	8.2925	23.9			0.0030
n		*26*	*26*	*26*	*26*	*26*	*25*
September							
18/09/1990	FILTER.REAC	0.026	8.2	12.1	9.7	3.35%	0.0009
26/09/1991	FILTER.REAC	0.012	8.29	11.6	9.7	3.94%	0.0005
01/09/1992	FILTER.REAC	0.006	8.4	15.6	9.5	6.70%	0.0004
21/09/1993	FILTER.REAC	0.008	8.31	12	9.7	4.24%	0.0003
29/09/1994	UNFIL.REAC	0.028	8.44	13.4	9.6	6.24%	0.0017
12/09/1995	UNFIL.REAC	0.042	8.3	17	9.5	5.95%	0.0025
05/09/1996	UNFIL.REAC	0.024	8.32	21.1	9.4	8.23%	0.0020
16/09/1997	UNFIL.REAC	0.01	8.26	19.4	9.4	6.45%	0.0006
15/09/1998	UNFIL.REAC	0.028	8.13	21	9.4	5.43%	0.0015
15/09/1999	UNFIL.REAC	0.018	8.43	17.3	9.5	8.03%	0.0014
26/09/2000	UNFIL.REAC	0.002	8.47	11.7	9.7	5.89%	0.0001
24/09/2001	UNFIL.REAC	0.034	8.18	16	9.5	4.27%	0.0015
17/09/2002	UNFIL.REAC	0.016	7.94	19.2	9.4	3.15%	0.0005
16/09/2003	UNFIL.REAC	0.026	8.18	18.2	9.5	4.99%	0.0013
07/09/2004	UNFIL.REAC	0.02	8.25	22	9.3	7.53%	0.0015
12/09/2005	UNFIL.REAC	0.004	8.14	23.2	9.3	6.45%	0.0003
05/09/2006	UNFIL.REAC	0.028	8.17	18.4	9.5	4.95%	0.0014
17/09/2007	UNFIL.REAC	0.008	8.69	16.8	9.5	13.28%	0.0011
15/09/2008	UNFIL.REAC	0.055	7.75	15.9	9.5	1.62%	0.0009
14/09/2009	UNFIL.REAC	0.022	8.37	20	9.4	8.50%	0.0019
20/09/2010	UNFIL.REAC	0.021	8.5	15.9	9.5	8.46%	0.0018
12/09/2011			8.38	22.9	9.3	10.49%	
12/09/2012	UNFIL.REAC	0.048	8.47	21.2	9.4	11.31%	0.0054
16/09/2013	UNFIL.REAC	0.031	8.03	16	9.5	3.06%	0.0009
18/09/2014	UNFIL.REAC	0.024	8.33	15	9.6	5.52%	0.0013
75th percentile		0.028	8.4	20			0.0016
n		*24*	*25*	*25*	*25*	*25*	*24*
October							
30/10/1990	FILTER.REAC	0.002	8.49	6.5	9.9	4.17%	0.0001
10/10/1991	FILTER.REAC	0.028	8.4	12.5	9.6	5.36%	0.0015
08/10/1992	FILTER.REAC	0.028		10.4	9.7		

Observed data					Calculation of NH3-N		
Month / Date	SAMPLE TYPE	AMMONIUM, TOTAL	PH FIELD	TEMPERATURE, WATER	pKa	fNH3	NH3-N
		NNHTFR (1990-1994), NNHTUR (1995-2013)	FWPH	FWTEMP			
		mg/L		°C	-	-	mg/L as N
13/10/1993	FILTER.REAC	0.014	8.4	4.9	9.9	3.01%	0.0004
18/10/1994	UNFIL.REAC	0.054	8.5	11.4	9.7	6.15%	0.0033
18/10/1995	UNFIL.REAC	0.014	8.5	10.2	9.7	5.63%	0.0008
08/10/1996	UNFIL.REAC	0.002	8.41	11	9.7	4.91%	0.0001
22/10/2002	UNFIL.REAC	0.017	8.23	7.1	9.8	2.45%	0.0004
28/10/2003	UNFIL.REAC	0.003	8.25	6.7	9.8	2.48%	0.0001
19/10/2004	UNFIL.REAC	0.028	8.19	7	9.8	2.22%	0.0006
17/10/2005	UNFIL.REAC	0.033	8.26	13	9.6	4.09%	0.0014
18/10/2006	UNFIL.REAC	0.029	7.73	10.1	9.7	1.00%	0.0003
09/10/2008	UNFIL.REAC	0.002	8.23	13	9.6	3.83%	0.0001
19/10/2009	UNFIL.REAC	0.007	8.35	6.6	9.8	3.08%	0.0002
26/10/2010	UNFIL.REAC	0.03	8.16	12.9	9.6	3.25%	0.0010
18/10/2011			7.93	10	9.7	1.56%	
15/10/2012	UNFIL.REAC	0.028	8.4	9.7	9.7	4.36%	0.0012
22/10/2013	UNFIL.REAC	0.061	7.74	8.4	9.8	0.89%	0.0005
20/10/2014	UNFIL.REAC	0.025	8.12	9.2	9.8	2.25%	0.0006
75th percentile		0.02875	8.4	11.2			0.0010
n		*18*	*18*	*19*	*19*	*18*	*17*
November							
13/11/1990	FILTER.REAC	0.002	8.37	2.1	10.0	2.25%	0.0000
13/11/1991	FILTER.REAC	0.01	8.2	1.8	10.0	1.50%	0.0001
19/11/1992	FILTER.REAC	0.06	8.1	1.6	10.0	1.17%	0.0007
30/11/1993	FILTER.REAC	0.022	8.35	1	10.0	1.97%	0.0004
08/11/1994	UNFIL.REAC	0.018	8.51	7.9	9.8	4.85%	0.0009
21/11/1995	UNFIL.REAC	0.028		2.2	10.0		
05/11/1996	UNFIL.REAC	0.004	8.18	4.9	9.9	1.84%	0.0001
28/11/2000	UNFIL.REAC	0.182	8.15	3	10.0	1.47%	0.0027
28/11/2001	UNFIL.REAC	0.02	8.28	0.6	10.1	1.62%	0.0003
06/11/2008	UNFIL.REAC	0.01	8.22	9.4	9.8	2.86%	0.0003
23/11/2009	UNFIL.REAC	0.006	8.25	6.3	9.9	2.40%	0.0001
24/11/2010	UNFIL.REAC	0.023	8.17	4.4	9.9	1.73%	0.0004
17/11/2011	UNFIL.REAC	0.02	8.2	4.9	9.9	1.92%	0.0004
13/11/2012	UNFIL.REAC	0.043	8.44	4.8	9.9	3.27%	0.0014
24/11/2014	UNFIL.REAC	0.184	7.64	6.1	9.9	0.59%	0.0011
75th percentile		0.0355	8.3325	5.5			0.0008

Observed data					Calculation of NH3-N		
Month / Date	SAMPLE TYPE	AMMONIUM, TOTAL	PH FIELD	TEMPERATURE, WATER	pKa	fNH3	NH3-N
		NNHTFR (1990-1994), NNHTUR (1995-2013)	FWPH	FWTEMP			
		mg/L		°C	-	-	mg/L as N
n		*15*	*14*	*15*	*15*	*14*	*14*
December							
18/12/1990	FILTER.REAC		8.19	1.4	10.0	1.41%	
10/12/1991	FILTER.REAC	0.024	7.92	2.3	10.0	0.82%	0.0002
22/12/1992	FILTER.REAC	0.012	8.2	0.3	10.1	1.32%	0.0002
07/12/1993	FILTER.REAC	0.002	8.42	1.9	10.0	2.48%	0.0000
20/12/1994	UNFIL.REAC	0.014	8.46	8	9.8	4.37%	0.0006
09/12/1997	UNFIL.REAC	0.002	8.38	1.2	10.0	2.14%	0.0000
14/12/1998	UNFIL.REAC	0.04	8.33	1.6	10.0	1.97%	0.0008
07/12/1999	UNFIL.REAC	0.008	8.14	3.4	10.0	1.49%	0.0001
75th percentile		0.019	8.39	2.575			0.0004
n		*7*	*8*	*8*	*8*	*8*	*7*
Total n		***213***	***212***	***216***	***216***	***212***	***207***



Appendix H: Dye Tracer Study Report

Hutchinson Environmental Sciences Ltd.
202-501 Krug Street, Kitchener, ON N2B 1L3 | 519-576-1711
www.environmentalsciences.ca

Memorandum – DRAFT

Date: **January 20, 2017**

To: **Brad McRoberts (Township of Mapleton)**

From: **Tara Roumeliotis and Deborah Sinclair**

Re: **Mapleton WWTF – Dye Tracer Study in Conestoga River**

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1. Introduction

The Township of Mapleton (Township) is undertaking a Schedule C Class Environmental Assessment (EA) of the Mapleton Wastewater Treatment Facility (WWTF) to meet predicted future wastewater demands. A Receiving Water Impact Assessment (RWIA) was completed by Exp. Services Inc. (Exp) in April 2016. As a condition of approval of the RWIA, the Ministry of the Environment and Climate Change (MOECC) required that the Township undertake a dye tracer study to verify the mixing zone of the wastewater discharge. Hutchinson Environmental Sciences Limited (HESL) was retained by the Township to complete the dye tracer study. The purpose of the dye tracer study was to delineate the extent of the mixing zone in the Conestoga River, and to measure the dilution of the effluent in the mixing zone.

1.1 Study Area

The Mapleton WWTF is located at 7101 Sideroad 15 in Drayton, Ontario. The Mapleton WWTF discharges treated wastewater to a receiving channel located in a wetland area. The receiving channel discharges in to the Conestoga River approximately 305 m downstream of the WWTF outfall. The receiving channel enters the northern side of the Conestoga River at a widening of the river (Figure 1). At this location, a small island (approximately 70 m long by 10 m wide) divides the Conestoga River into two distinct channels with areas of connectivity between the two channels throughout the island (Photograph 1). The Conestoga River flows approximately 950 m from its confluence with the WWTF-receiving channel before discharging in to the north east arm of Conestoga Lake (at the Concession 8 bridge, Figure 1).

1.2 Mapleton WWTF Environmental Compliance Approval and Agency Consultation

The Mapleton WWTF discharges on a seasonal basis, according to its Environmental Compliance Approval (ECA) #0963-A4ZMVA, which sets out the following schedule:

Table 1. Monthly Discharge Schedule – Mapleton WWTF

Month	Effluent Flow (m^3/d)
March	1,581
April	3,154
October	233
November	1,754
December	4,000

Further, the ECA allows for additional discharge of treated effluent in the above-noted months up to a rate equal to 10% of the flow in the Conestoga River (Condition 9(1) of the ECA):

"…discharge in excess of these daily discharges is allowed if the minimum 10:1 of the streamflow to daily discharge rate for the applicable period of that design streamflow occurs, based on actual measurements of flow rate in the Conestoga River."

During an October 14, 2016 site reconnaissance conducted by staff from the Township, Grand River Conservation Authority (GRCA), and HESL, flow was not observed in the receiving channel. (The WWTF was discharging at a rate of 233 m^3/d on this date). Further, from historical observations made by Township and Ontario Clean Water Agency (OCWA) staff (OCWA operate the WWTF on behalf of the Township), flow in the receiving channel has been intermittent, with no flow during the summer months. The receiving channel likely only flows seasonally after significant rain events, snowmelt, and higher WWTF effluent flows.

Based on a telephone conversation between the Township, GRCA and HESL staff and Paul Odom at the MOECC on October 14, 2016 immediately following the site reconnaissance, the decision was made to increase WWTF effluent flows up to 10% of Conestoga River flows and continue to regularly (i.e., twice weekly) monitor the receiving channel for flow through to the Conestoga River. (Although this increase is acceptable according to the WWTF's ECA, it is understood that prior to this date, OCWA operators were following the effluent flows prescribed in the ECA and reproduced in Table 1, above, and were not increasing effluent flows up to 10% of the Conestoga River flow).

With the increased Mapleton WWTF effluent flows (beginning on October 20, 2016) coinciding with increased seasonal precipitation, the receiving channel was observed by Township staff to be flowing on October 25, 2016 through to November 17, 2016 (i.e., the date the dye tracer study was carried out). Regular monitoring of the receiving channel was ceased after the dye tracer study was completed.

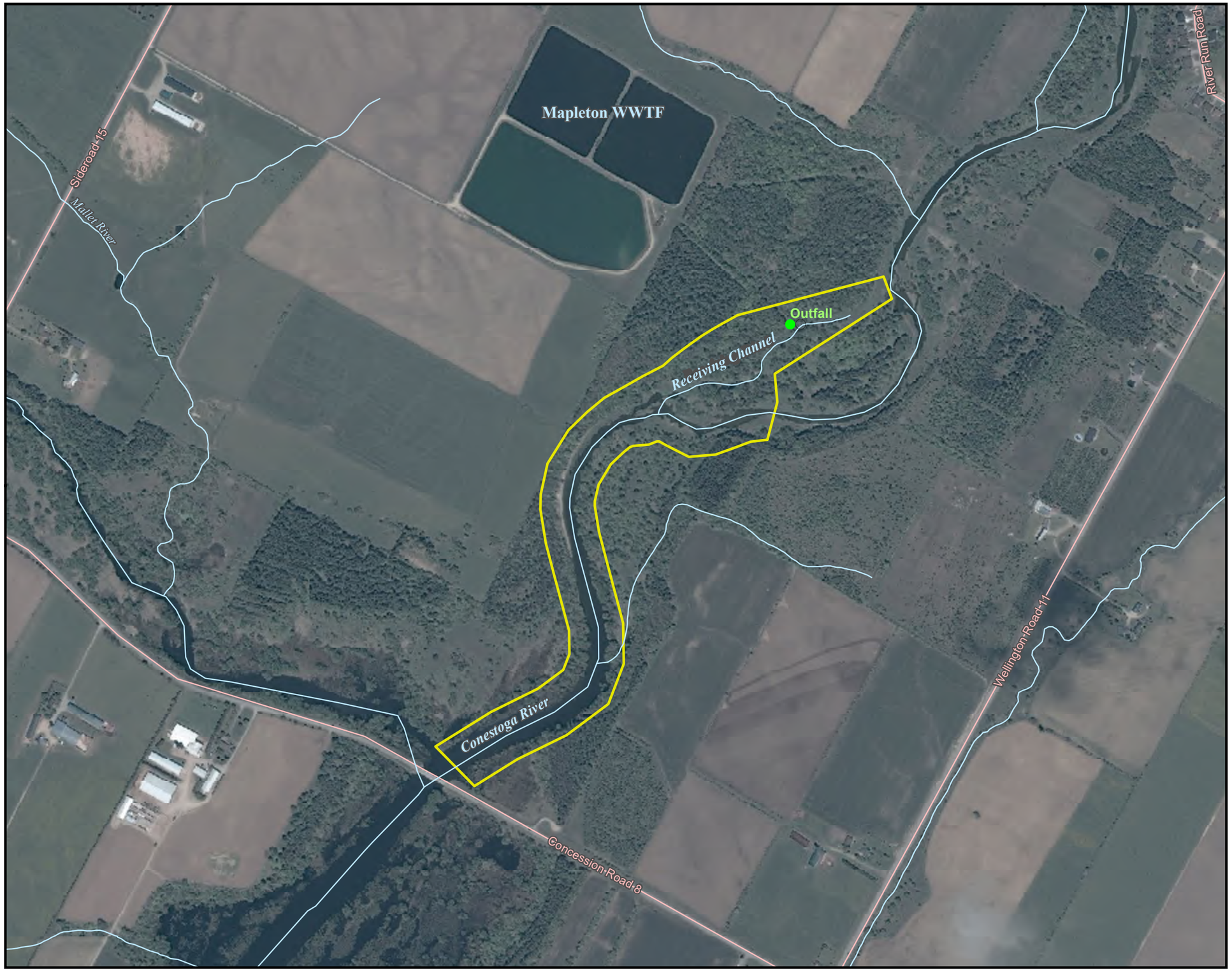
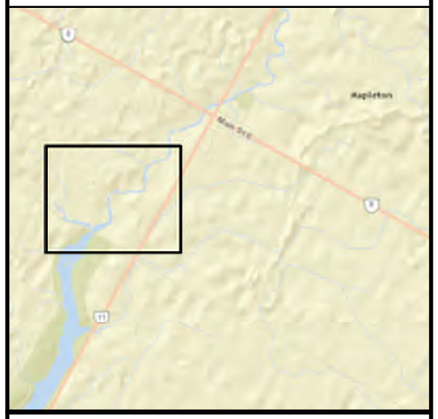


Figure 1:
Mapleton WWTF Dye Tracer Study Area

- Outfall
- Stream
- Road
- Study Area



N

0 50 100 200 300 400 m

Prepared by: Eric Dilligeard
Data Source: LIO, HESL, Esri Imagery.
Coordinate System: NAD 1983 UTM Zone 17N

Project Lead: Tara Roumeliotis
Project: Dye Tracer Study for the Mapleton WWTF.
Project#: 160075

January 2017

Hutchinson Environmental Sciences Ltd.

2. Methodology

2.1 Dye Tracer Study

The dye tracer study was conducted on November 17, 2016. Rhodamine WT dye, a fluorescent xanthene dye, was used as the dye tracer. Rhodamine dye was chosen because it is a stable, non-toxic, cost effective tracer that is easily visible or measured in the field. Rhodamine dye tracers are also very robust over a variety of different flow regimes. The MOECC's Spills Action Centre was notified of the study on November 17, 2016 prior to releasing the dye (Report #2284-AFSLZU).

Approximately 55 mL of Rhodamine WT 20% dye was mixed into 75 L of receiving channel-water, creating a 150 mg/L Rhodamine WT dye solution. A peristaltic pump was used to discharge the solution at a constant flow of 1 L/min. The dye was discharged into the receiving channel approximately 130 m upstream of the confluence with the Conestoga River (Figure 2, Photograph 1). The location of the injection point was selected to ensure that the dye was fully mixed in the receiving channel before discharging to the Conestoga River. Once mixed, the concentration in the receiving channel was about 0.115 mg/L (115 µg/L).

On the morning of the study, Township staff breached two beaver dams that were located in the Conestoga River, just downstream of the confluence with the receiving channel.

The test started at 11:20 am and ran for 5.5 hours. Rhodamine WT dye was first measured in the Conestoga River upstream of the confluence with the receiving channel. Rhodamine WT dye concentrations were then measured downstream in the Conestoga River along eight transects (Figure 2). Transects were located: 2 m (cross-section 1), 28 m (cross-section 2), 63 m (cross-section 3), 114 m (cross-section 4), 287 m (cross-section 5), 483 m (cross-section 6), 706 m (cross-section 7), and 845 m (cross-section 8) downstream of the confluence with the receiving channel. At each downstream transect, Rhodamine WT dye concentrations were measured across the channel, starting from the left bank moving towards the right bank until background (upstream) concentrations were measured. Readings were measured at 1 to 2 m intervals, depending on the river width at the cross-section. Dye measurements began at cross-section 1 one and a half hours after the start of the dye study to give time to allow the dye to mix with the Conestoga River, and progressed downstream.

All water depths at each cross-section location were less than 1 m, and all Rhodamine WT measurements were taken mid-depth. (At water depths greater than 1 m, field measurements would have been collected at 20% and 80% of the water depth). Rhodamine WT dye concentrations were measured using a calibrated YSI OMS Sonde with Rhodamine probe (i.e., a fluorometer). The fluorometers were capable of measuring concentrations of Rhodamine WT with a resolution of 0.1 µg/L. The Rhodamine WT optical sensors were calibrated in the field on a 2-point scale that included 0 µg/L and 100 µg/L Rhodamine WT. The 100 µg/L solution was mixed in the field from a 20% Rhodamine WT dye solution, which was obtained from a national supplier, and Conestoga River water.

The coordinates of each transect were recorded with a GPS (Figure 2) and are provided in Appendix A.

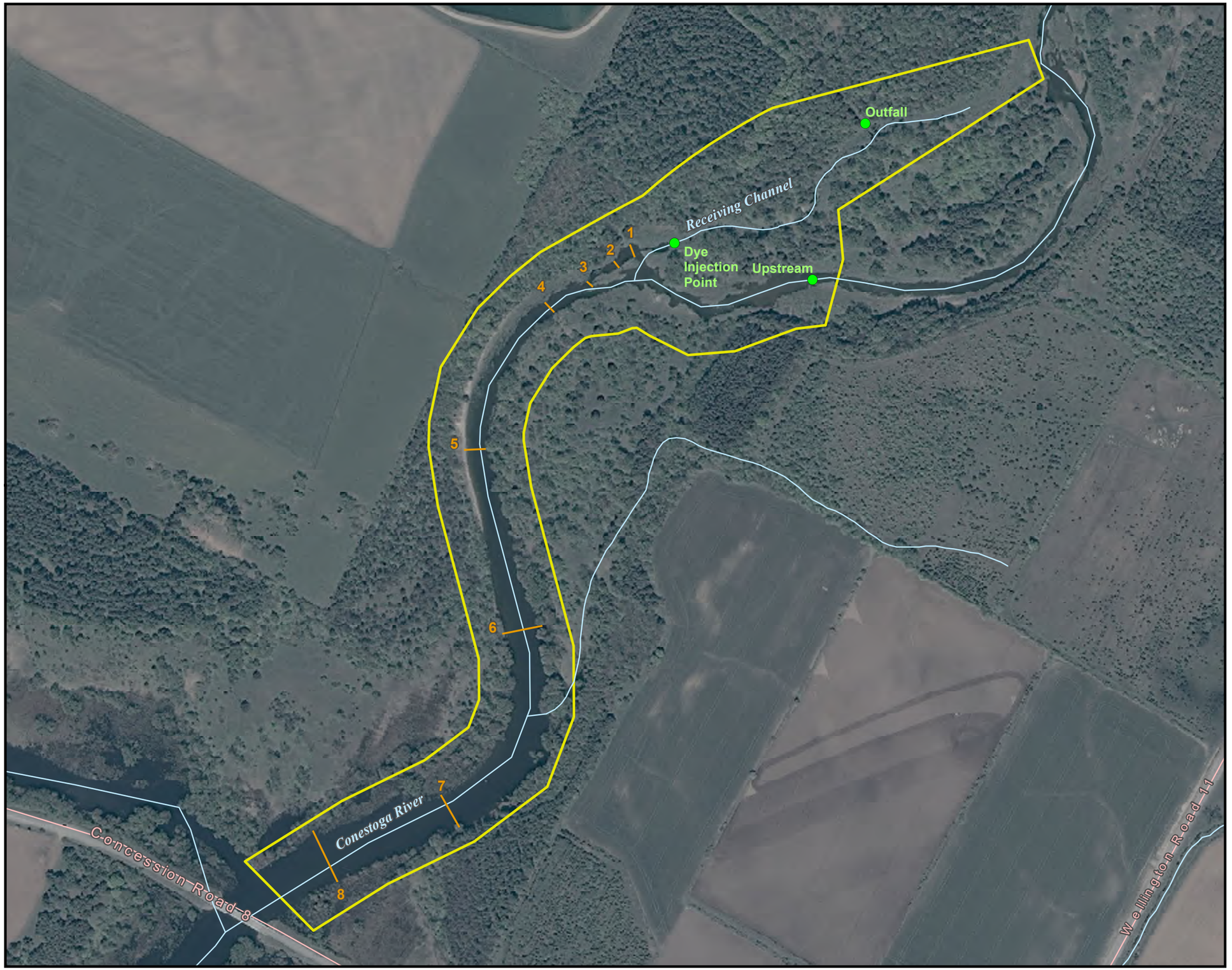
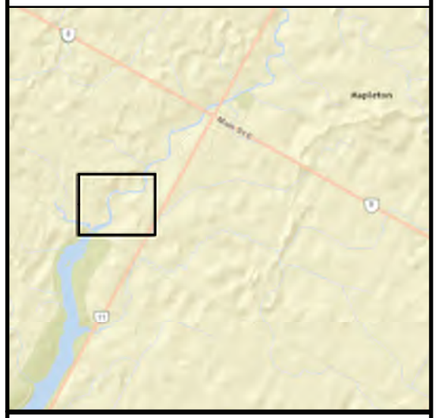


Figure 2:
Dye Tracer Study and Monitoring Cross Section Locations

- Monitoring Location (Outfall & Upstream)
- Cross Section
- Stream
- Road
- Study Area



N

0 25 50 100 150 200 m

Prepared by: Eric Dilligeard
Data Source: LIO, HESL, Esri Imagery.
Coordinate System: NAD 1983 UTM Zone 17N

Project Lead: Tara Roumeliotis
Project: Dye Tracer Study for the Mapleton WWTF.
Project#: 160075

January 2017

Hutchinson Environmental Sciences Ltd.

2.2 Imagery

One2One Photography was retained to take aerial photography using a drone to document the visible extent of the plume. A photographic log is provided in Appendix B. The digital video captured by the drone will be provided to the Township on a USB.

2.3 Water Quality

Once the effluent plume had been spatially delineated through the field measurements, water samples were collected from the plume centreline (i.e., the location of highest Rhodamine WT dye concentration) at each cross-section location. Water samples were also collected 1) upstream of the confluence with the receiving channel, in the main channel of the Conestoga River; and 2) at the WWTF outfall to the receiving channel (i.e., the effluent quality) (Figure 2). Samples were analysed for: carbonaceous biochemical oxygen demand (cBOD), total phosphorus (TP), total Kjeldahl nitrogen (TKN), nitrate (NO_3), nitrite (NO_2), total ammonia nitrogen (TAN), and total suspended solids (TSS), and chloride. Upstream, effluent, and cross-sections 1 to 5 were also analysed for dissolved phosphorus, to confirm potential sediment interference. Field measurements of dissolved oxygen (DO), temperature, conductivity, and pH were taken at each sampling location. Field pH and temperature were used to calculate un-ionized ammonia using the equation in the Appendix A of *Water Management Policies, Guidelines and Provincial Water Quality Objectives (*MOE, 1994).

Water samples were stored in the dark, on ice, and shipped on the day of the dye tracer study to ALS in Waterloo, Ontario, a fully accredited commercial laboratory, for chemical analyses.

2.4 Streamflow

During the dye study, streamflow was measured at the upstream and cross-section 8 (Figure 2) sampling stations using a HACH brand electromagnetic flow meter. Stream velocity was measured at a minimum of 10 points across the river cross-section. At points where the depth was less than 0.75 m, the velocity was measured at 0.6 of the depth below the water surface. Where water depths were greater the 0.75 m the velocity was measured at 0.2 and 0.8 of the depth below the water surface and the mean of these values computed. The area-velocity method was used to calculate stream discharge. Manual streamflow measurements are generally accurate to within 6-19% (Harmel et al. 2006) of the actual flow in the watercourse, with lower flows being less accurate.

3. Results

3.1 Streamflow

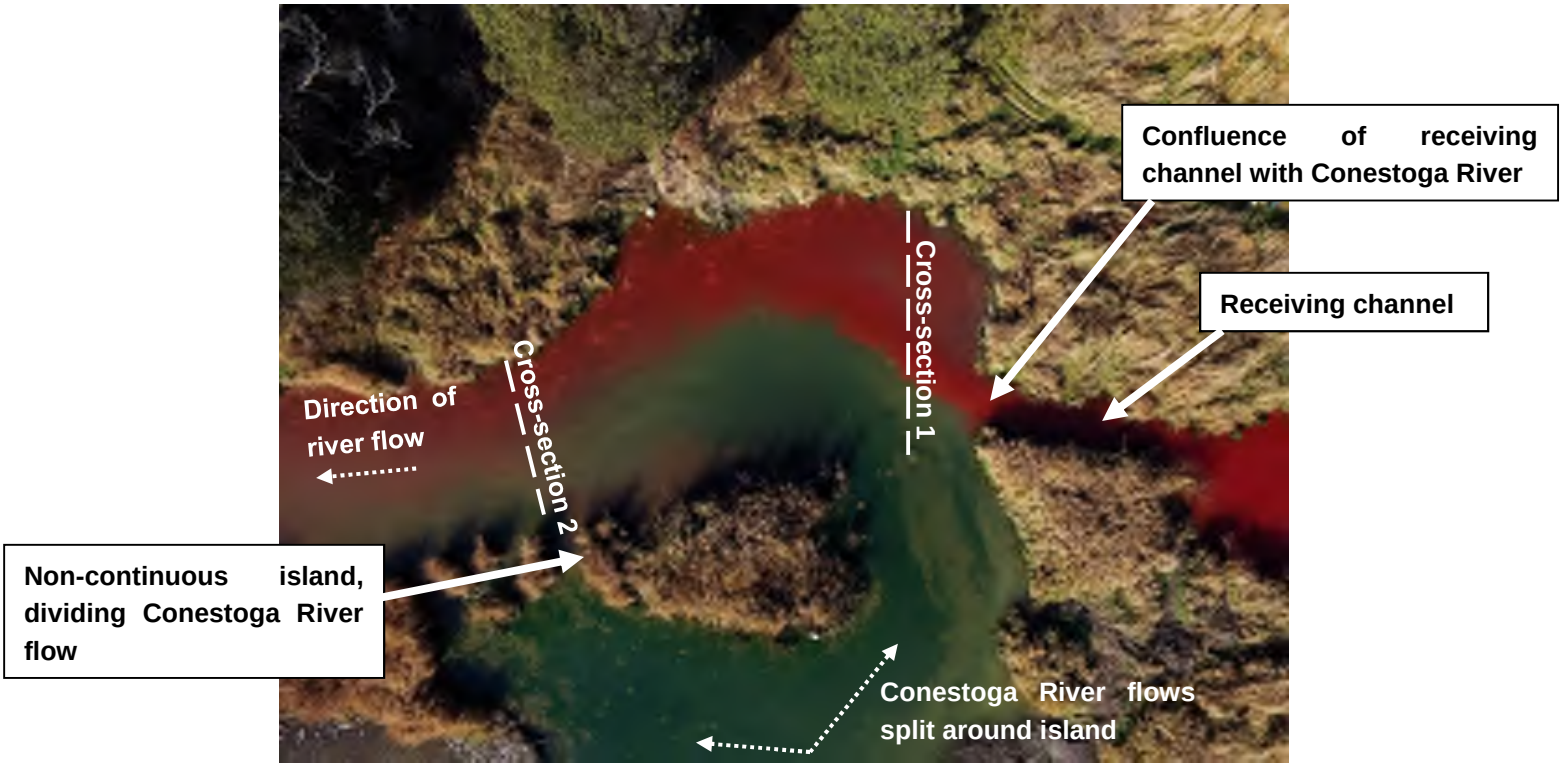
Measured streamflows are presented in Table 1. The flow in the Conestoga River upstream of the confluence with the receiving channel was 153 L/s, the flow of WWTP effluent was 26.4 L/s (personal communication, S. Craggs, OCWA, November 30, 2016), and the measured flow at cross-section 8 was 154 L/s.

Table 2 Measured Streamflow, November 17, 2016

	Upstream	Effluent	Cross-Section 8
Flow (L/s)	153	26.4	154

3.2 Dye Study

The receiving channel discharges into Conestoga River approximately 305 m downstream of the outfall location, at a widening of the Conestoga River. The receiving channel discharges to the northern portion of the river, divided by a non-continuous island located near the confluence (Figure 2, Photograph 1).



Photograph 1 Zone of initial mixing (0-50 m downstream of confluence)

Table 3 presents a summary of the dye study results. (Full results for each cross-section are presented in Appendix C). Figure 3 presents the Rhodamine WT dye concentration moving from left to right bank (facing upstream) at cross-sections 1 through 8 (denoted by their distance from the Conestoga River's confluence with the receiving channel – 2 m through 845 m). Figure 4 graphically presents the Rhodamine WT dye plume centerline and edge, in comparison against the river width.

Rhodamine WT dye concentrations were highest at cross-section 1 and decreased downstream (Table 3). At cross-section 1, the highest Rhodamine WT dye concentration (consisting of approximately 100% effluent from the receiving channel) was measured 8 m from the left bank, at the approximate location

where the discharge channel enters the Conestoga River, which also represented the plume edge (Photograph 1). By cross-section 2 and 3, the effluent plume had mixed across the northern portion of the river (which was divided by the island feature seen in Photograph 1), although higher concentrations were measured closer to the left bank (Table 3, Figure 4). Maximum dye concentrations tended toward the left bank between 28 and 287 m downstream (cross-sections 2 to 5; Table 3, Figure 3). By cross-section 6 (at 483 m downstream), Rhodamine WT dye concentrations were approximately equal (± 5 µg/L) across the width of the river (Table 3, Figure 3) suggesting that the effluent was homogenously mixed with the Conestoga River at this point (at a river flow of 153 L/s and effluent discharge of 26 L/s).

Table 3. Summary of Rhodamine WT Dye Study Results, November 17, 2016

Cross-Section	Distance from Confluence (m)	Peak concentration (µg/L)	Location of Peak dye concentration* (m)	Location of Plume Edge* (m)	Channel Width (m)
1	2	116.2	8.0	8.0	14.0
2	28	54.6	0.6	11.0	11.0
3	63	29.7	0.6	7.0	7.0
4	114	30.3	1.6	16.5	16.5
5	287	16.7	1.0	11.9	11.9
6	483	10	6.0	17.1	17.1
7	706	5.7	7.5	10.6	10.6
8	845	3.5	3.5	9.0	9.0

Notes: * - Distance from left bank

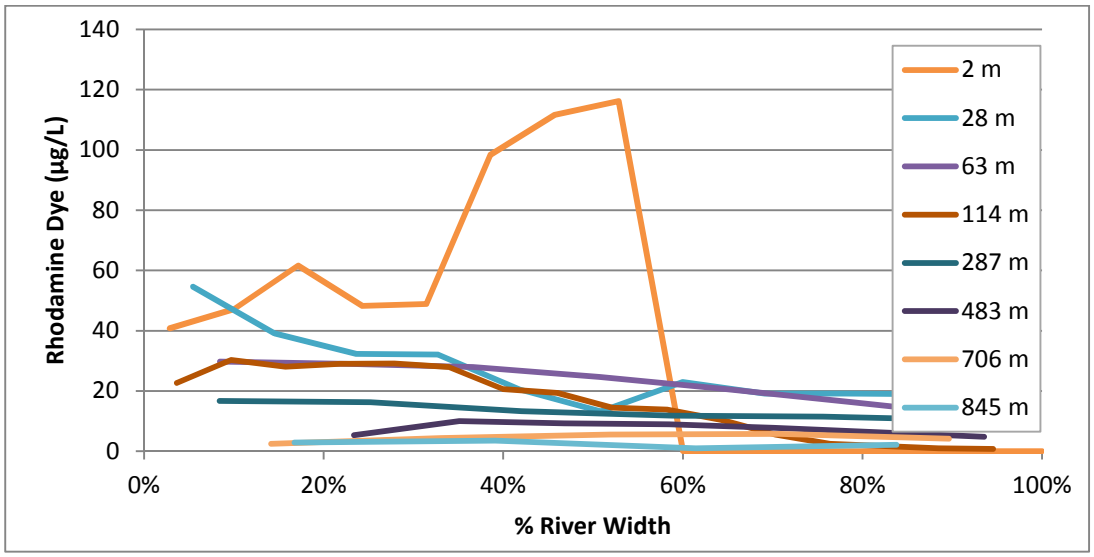


Figure 3 Rhodamine Dye Profiles, November 17, 2016

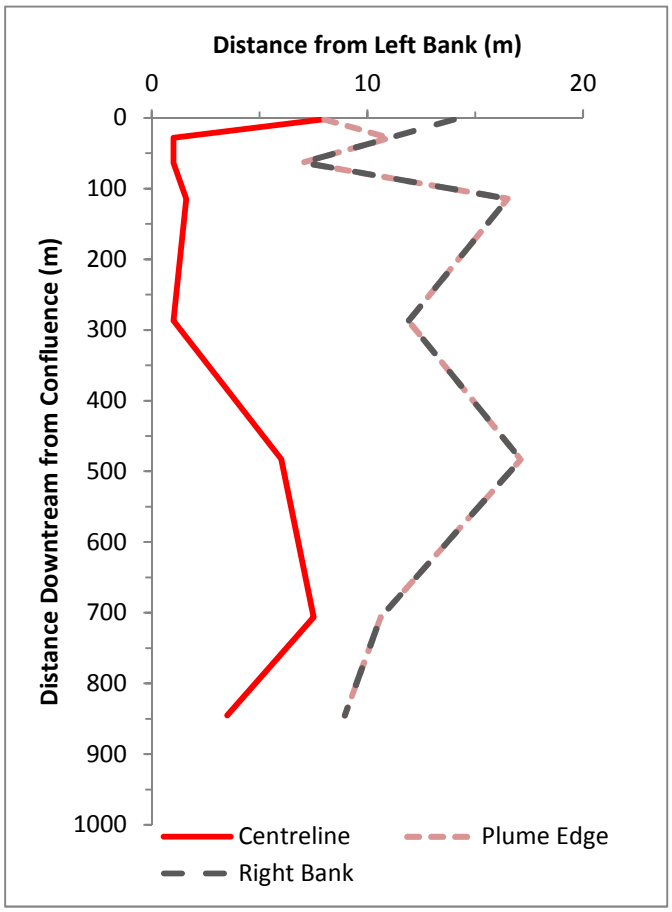
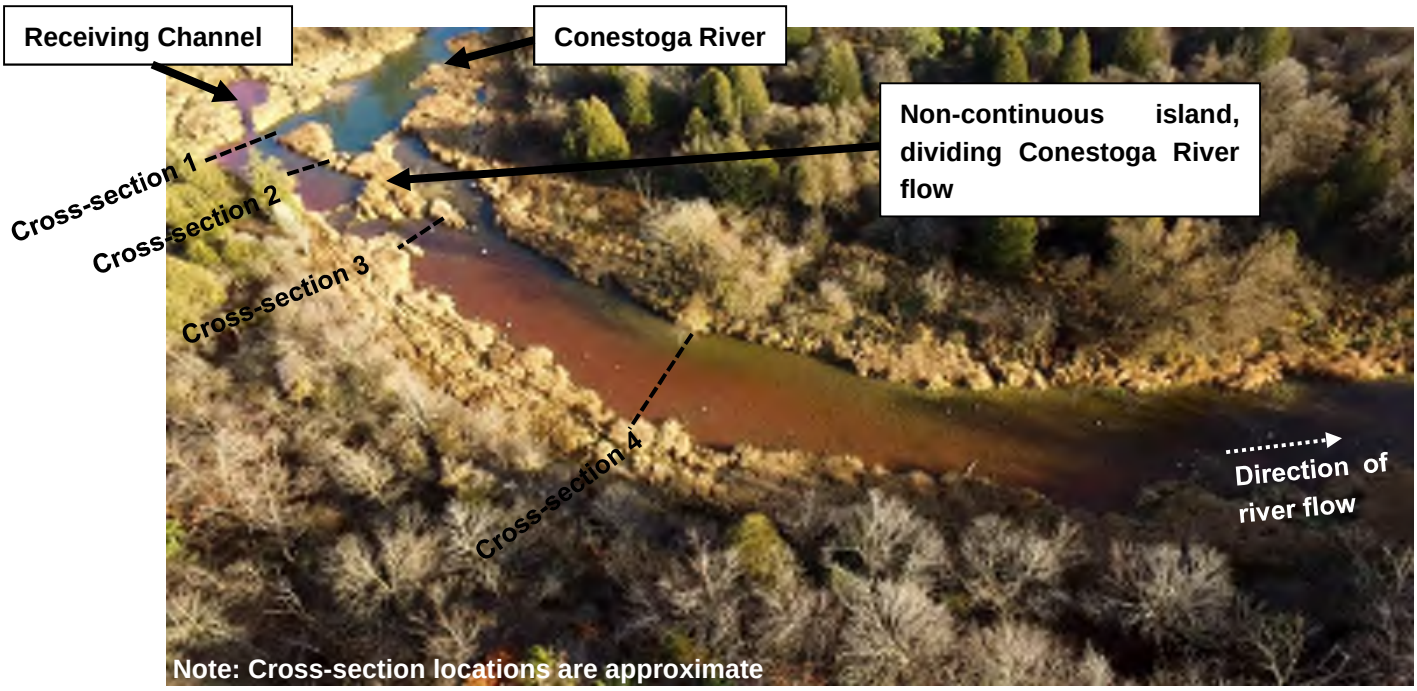


Figure 4 Location of Plume Centreline and Edge, November 17, 2016

The November 17, 2016 dye tracer study found that the effluent from the receiving channel was contained to the northern side (left bank) of the island in the Conestoga River which splits the river flows at the receiving channel discharge location (Photograph 1 and 2). Downstream of this island (i.e., immediately downstream of cross-section 3), the effluent plume quickly mixed across the entire width of the river, such that at cross-section 4 the Rhodamine WT dye tracer was detected at all points across the width of the river. The plume centreline (location of highest rhodamine concentration) tended toward the left bank for about 300 m downstream of the confluence (i.e., between cross-section 5 and 6), then became homogenously mixed by cross-section 6 (Photograph 3).



Photograph 2. Zone of initial mixing (0-150 m+ downstream of confluence)

Photograph 3. Approximately 150 m to 450 m downstream of mixing zone

From an effluent mixing zone and fish passage perspective, the island in the Conestoga River was effective in isolating the effluent to the north side of the island while providing an area for safe fish passage along the south side of the island. Cross-section 4 represents the first downstream location where the plume was spread across the entire width of the river and was therefore a key location in determining if there was safe fish passage at this point downstream of the effluent-receiving channel discharge. From Appendix C, Rhodamine WT dye concentrations at cross-section 4 dropped to less than 10% of the initial effluent-receiving channel concentration (of about 115 µg/L) by 11 m from the left bank. The width of the river at this cross-section was 16.9 m, which equated to 5.9 m (or 40%) of river width containing less than 10% of the initial effluent-receiving channel dye concentration.

Un-ionized ammonia is toxic to aquatic species and is therefore an important parameter to examine when considering safe fish passage around a mixing zone. On the day of the dye tracer study, un-ionized ammonia concentrations (as calculated using the laboratory-reported total ammonia nitrogen concentrations and in-field measured pH and temperature) were below the PWQO of 0.0164 mg/L as N at all cross-sections and in the effluent itself.

Therefore, based on the Rhodamine WT dye tracer and water quality results, there was safe fish passage alongside the Mapleton WPCP effluent plume on the day of the dye tracer study. Further, the dye tracer results indicate that downstream of the receiving channel discharge point, where the plume was fully spread across the width of the Conestoga River, there was approximately 40% of the river width available where the effluent made up less than 10% of the river volume (at effluent flows of 26 L/s and river flows of 153 L/s). At higher river flows, there would be even greater river width available, as the increased Conestoga River flows would tend to keep the WPCP plume toward the left bank for a greater downstream distance.

3.3 Water Quality

Water quality samples were collected at the location (measured as distance from left bank) with the highest dye concentration. The results are presented in Table 4. The full laboratory certificate of analysis can be found in Appendix C. Total phosphorus, un-ionized ammonia, dissolved oxygen, and pH were compared to Ontario Ministry of Environment's (MOE) Provincial Water Quality Objectives (PWQO) for the protection of aquatic life (MOE, 1994). Chloride, nitrite and nitrate values were compared to the Canadian Council of Ministers of the Environment's Canadian Water Quality Guidelines (CWQG) for the Protection of Aquatic Life (CCME 2012). Effluent quality was compared to ECA limits.

Field Parameters

Temperature, pH, dissolved oxygen and conductivity were measured at each sampling station (Table 4). Conductivity of the effluent was 707 µS/cm, approximately 100 µS/cm greater than the upstream/background conductivity of Conestoga River. Conductivity was highest at cross-section 1 (727 µS/cm) and decreased downstream to 631 µS/cm at cross-section 8. The watercourse was well oxygenated at all stations and above the PWQO for warm and cold water biota. Supersaturated conditions (> 100% DO) was recorded at many stations (including upstream), indicating photosynthesis by algae. pH was elevated (above the PWQO of 8.5) at cross-sections 6, 7, and 8. The high pH at these stations may also be due to photosynthesis (removing carbon dioxide from the water) as indicated by supersaturated oxygen conditions. The pH of the effluent was within the ECA effluent limit of 6.0 to 9.5.

Laboratory Data

Relative to upstream conditions, concentrations of most parameters increased in the initial mixing zone, then decreased downstream. The effluent chloride concentration was 228 mg/L. The concentration at cross-section 1 was 229 mg/L, and decreased downstream to 144 mg/L at cross-section 8. The upstream (background) and downstream concentrations were all above the CWQG of 120 mg/L.

The upstream concentration of phosphorus was 0.0218 mg/L, below the PWQO of 0.03 mg/L. The effluent concentration of 0.0963 mg/L was well below the effluent limit of 0.5 mg/L. Concentrations were elevated, and above the PWQO in the first 300 m downstream of the confluence, and decreased to below the PWQO at cross-section 6 and further downstream. Dissolved phosphorus concentrations were analysed in the upstream, effluent, and cross-section 1 to 5 samples. Dissolved phosphorus concentrations were low in the Conestoga River, indicating the much of the phosphorus measured in the first 300 m downstream of the confluence was particulate.

Concentrations of nitrogen species increased downstream of the confluence (similar to phosphorus), and decreased further downstream. The concentration of total ammonia nitrogen in the effluent (0.056 mg/L) was well below the ECA limit of 5.0 mg/L. Total ammonia concentrations were low at all downstream stations, and the calculated un-ionized ammonia concentrations were well below the PWQO of 0.0164 mg/L – N (Table 4). Nitrate and nitrite concentrations in the effluent were low (<0.01 mg/L – N and <0.05 mg/L – N, respectively). Downstream nitrate concentrations were all below the upstream background concentration of 1.36 mg/L and the CWQG of 3 mg/L-N. Nitrite was below detection at all stations (Table 4).

The total suspended solids concentration in the effluent (5.6 mg/L) was similar to the upstream concentration in the Conestoga River (4 mg/L). Concentrations were higher (31.2 – 44.2 mg/L) downstream of the confluence with the receiving channel at cross-sections 2 to 4, but decreased to upstream concentrations at cross-section 6. The higher TSS concentrations at cross-sections 2 to 4 were likely due to disruption of bottom sediments during removal of the beaver dam and cross-section measurements.

cBOD was below detection at all stations including the effluent, indicating little to no oxygen demand.

Table 4 Conestoga River Water Quality, November 17, 2016

	Units	PWQO	Upstream	Effluent[c]	Cross-Section1	Cross-Section 2	Cross-Section3	Cross-Section 4	Cross-Section 5	Cross-Section 6	Cross-Section 7	Cross-Section 8
Distance Downstream of Confluence (m)					2	28	63	114	287	483	706	845
Field												
Temperature	ºC		6.44	6.95	6.60	6.77	6.78	7.60	7.22	7.31	7.83	7.94
pH		6.5-8.5	8.23	8.79	8.27	8.37	8.42	8.43	8.50	8.55	8.67	8.68
Conductivity	µS/cm		600	707	729	667	689	652	629	627	631	631
Specific Conductivity	µS/cm		930	1,078	1,115	1,020	981	977	952	947	939	936
Dissolved Oxygen	mg/L	7/6[a]	12.89	13.71	11.59	13.30	13.85	14.79	14.90	15.17	15.47	15.51
Dissolved Oxygen	%	54/47[a]	104.8	113.1	95.9	107.7	113.5	124.7	123.8	126.2	130.7	131.3
Laboratory												
Chloride	mg/L	120[b]	132	228	229	179	164	158	149	146	145	144
Total Phosphorus	mg/L	0.03	0.0218	0.0963	0.105	0.0734	0.0741	0.0635	0.0408	0.0272	0.0268	0.0240
Total Dissolved Phosphorus	mg/L		0.0089	0.0564	0.0498	0.0235	0.0148	0.0164	0.0136			
Total Kjeldahl Nitrogen	mg/L		0.74	1.22	1.12	0.98	0.90	0.96	0.82	0.73	0.72	0.69
Total Ammonia (as N)	mg/L		0.028	0.056	0.081	0.051	0.035	0.037	0.026	0.048	<0.020	0.074
Un-ionized ammonia (as N)	mg/L	0.0164	0.0006	0.0046	0.0021	0.0016	0.0013	0.0015	0.0012	0.0024	0.0013	0.0051
Nitrate (as N)	mg/L	3[b]	1.36	<0.10	<0.10	0.66	0.85	0.85	1.02	1.04	1.02	1.00
Nitrite (as N)	mg/L	0.06[b]	<0.010	<0.050	<0.050	<0.050	<0.050	<0.050	<0.010	<0.010	<0.010	<0.010
Total Suspended Solids	mg/L		4.0	5.8	10.5	44.2	35.1	31.2	11.9	3.5	4.0	5.4
cBOD	mg/L		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0

Notes: a - PWQO for cold water and warm water biota respectively at 5ºC; b – CWQG; effluent limits: cBOD5 – 7.5 mg/L (Apr – Oct), 10.0 mg/L (Mar, Nov & Dec), total ammonia nitrogen – 5.0 mg/L; total phosphorus 0.5 mg/L; pH – 6.0-9.5. Shaded cells represent results measured above PWQO/CWQG/ECA limits.

4. Summary and Conclusions

The Township of Mapleton (Township) is undertaking a Schedule C Class Environmental Assessment (EA). As a condition of approval of the Receiving Water Impact Assessment (completed by Exp. Services Inc. in April 2016), the Ministry of the Environment and Climate Change (MOECC) required that the Township undertake a dye tracer study to verify the mixing zone of the wastewater discharge. The dye tracer study was conducted on November 17, 2016 whereby Rhodamine WT dye concentrations were measured in the Conestoga River along eight transects located between 2 m and 845 m downstream of the confluence with the effluent-receiving channel. Water samples were collected from the plume centreline (i.e., the location of highest Rhodamine WT dye concentration) at each cross-section location and streamflow was measured at the upstream and cross-section 8 stations. The study had the following conclusions:

- At the confluence between the effluent-receiving channel and the Conestoga River, the WPCP effluent from the receiving channel was contained to the northern side (left bank) due to the presence of an island in the Conestoga River located at the receiving channel discharge location, which splits the river flows at this point;
- The island in the Conestoga River located at the confluence between the effluent-receiving channel and the river was effective in isolating the effluent to the north side of the island while providing an area for safe fish passage along the south side of the island.
- Downstream of this island (approximately 75 m downstream of the confluence with the effluent-receiving channel) the effluent plume mixed across the entire width of the river, such that at cross-section 4 (114 m downstream), the Rhodamine WT dye tracer was detected at all points across the width of the river. At this location, there was approximately 40% of the river width available for fish passage where the effluent made up less than 10% of the river volume (at effluent flows of 26 L/s and river flows of 153 L/s);
- The highest dye concentrations were measured near the left bank between 28 and 287 m downstream of the confluence with the effluent-receiving channel;
- By about 480 m downstream, Rhodamine WT dye concentrations were approximately equal across the width of the river indicating that the effluent was homogenously mixed with Conestoga River at this point (at a river flow of 153 L/s and effluent discharge of 26 L/s);
- On the day of the dye tracer study, un-ionized ammonia concentrations were below the PWQO of 0.0164 mg/L as N at all cross-sections in the Conestoga River and in the effluent itself; and
- Based on the Rhodamine WT dye tracer and water quality results, there was safe fish passage alongside the Mapleton WPCP effluent plume on the day of the dye tracer study. At higher river flows, there would be even greater river width available, as increased Conestoga River flows would tend to keep the WPCP plume toward the left bank for a greater downstream distance.

5. Closing

Thank you for the opportunity to work on this interesting project. If you have any questions, or require any further information please do not hesitate to contact us.

6. References

Canadian Council of Ministers of the Environment. 2012. Canadian water quality guidelines for the protection of aquatic life: Nitrate. In: Canadian environmental quality guidelines, Canadian Council of Ministers of the Environment, Winnipeg.

Exp. Services Inc. 2016. Receiving Water Impact Assessment.

Harmel, R. D., R. J. Cooper, R. M. Slade, R. L. Haney, J. G. Arnold. 2006. Cumulative uncertainty in measured streamflow and water quality data for small watersheds. American Society of Agricultural and Biological Engineers Vol. 49(3): 689-701 ISSN 0001-2351

Ontario Ministry of Environment and Energy. 1994. Water Management Policies, Guidelines and Provincial Water Quality Objectives

Appendix A. Cross-Section GPS Co-ordinates

GPS Co-ordinates - Cross-Section Mid-Points (NAD83 UTM17)

Cross-Section	Easting	Northing
1	524859.8	4843494.0
2	524843.0	4843479.5
3	524815.0	4843458.8
4	524772.3	4843434.5
5	524693.9	4843284.8
6	524743.9	4843094.8
7	524667.8	4842903.7
8	524536.2	4842856.2

Appendix B. Photographic Log

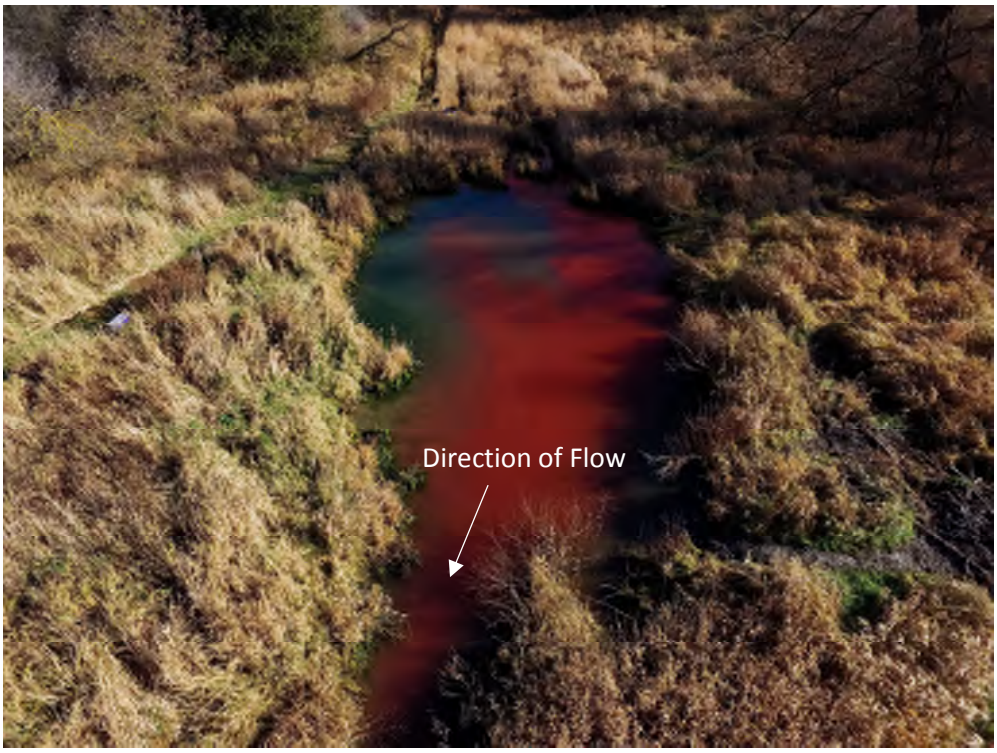


Photo A. Small pond in receiving channel just upstream of discharge point to Con estoga River. Dye tracer at about 25 minutes in to the study; dye has not yet filled pond completely.

Photo B. At receiving channel discharge point to Conestoga River. Dye tracer at about 25 minutes in to the study; dye has not yet filled pond completely and has only begun entering the River.

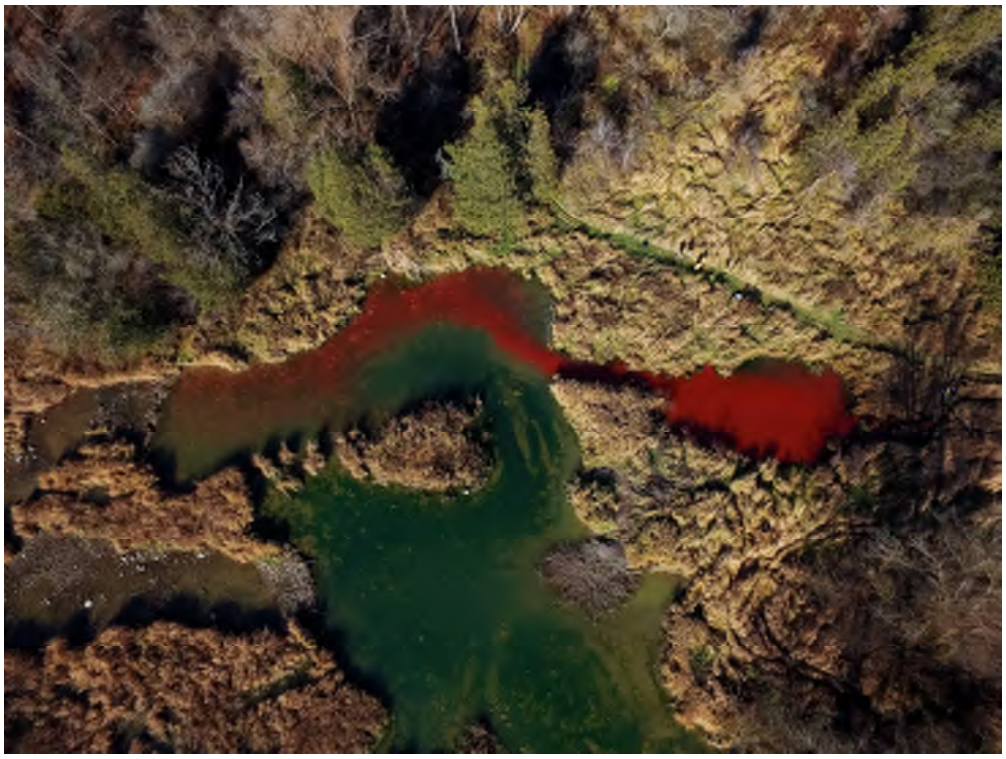


Photo C. Receiving channel discharging in to Conestoga River, between receiving channel and cross-section 3. Dye tracer at about 60 minutes in to the study.

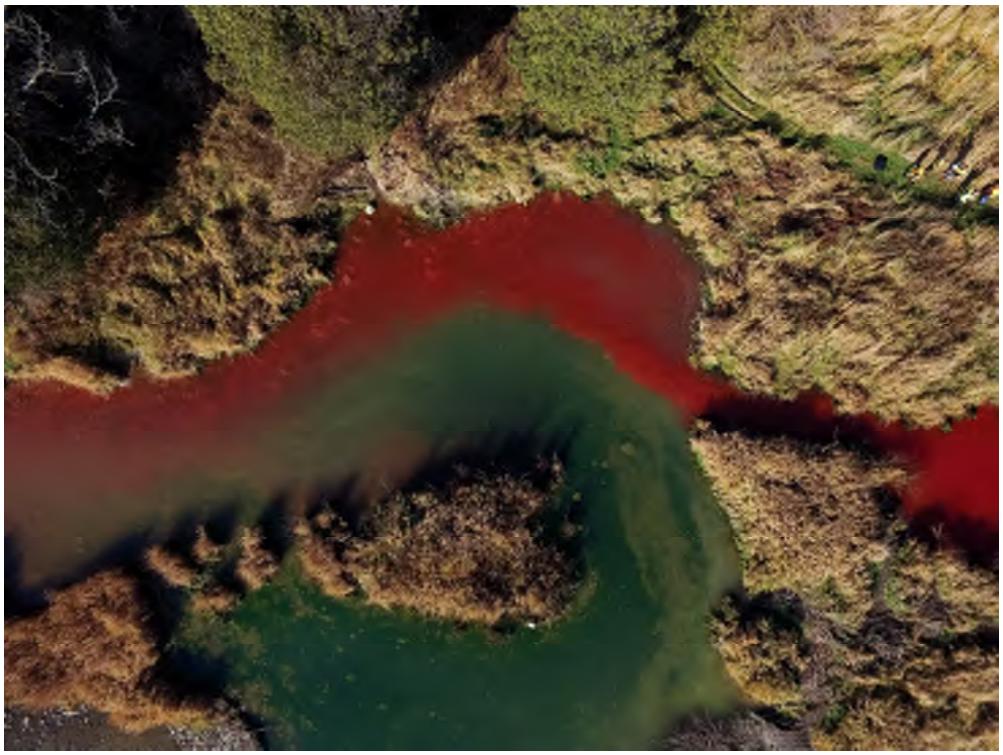


Photo D. Zoomed in photo of receiving channel discharging in to Conestoga River, between receiving channel and cross-section 2.

Photo E. Cross-section 2 to downstream of cross-section 4. Breached beaver dams are visible in photograph.

Photo F. Cross-section 4 to cross-section 5.

Photo G. Receiving channel through to downstream of cross-section 4.

Photo H. Downstream of cross-section 5

Photo I. Cross-section 5 and 6. HESL scientists collecting Rhodamine measurements at cross-section 6.

Appendix C. Full Rhodamine Dye Results and Laboratory Certificate of Analysis

Rhodamine Dye Concentrations

Cross-Section 1

Distance from left bank (m)	Rhodamine concentration (μg/L)	Comment
0.6	0	LWE
1.0	40.8	
2.0	47.2	
3.0	61.6	
4.0	48.2	
5.0	48.9	
6.0	98.4	
7.0	111.7	
8.0	116.2	
9.0	0	RWE

Cross-Section 2

Distance from left bank (m)	Rhodamine concentration (μg/L)	Comment
0.4	0	LWE
1.0	54.6	
2.0	39.1	
3.0	32.3	
4.0	32.1	
5.0	20.5	
6.0	13.2	
7.0	23.0	
8.0	19.1	
9.0	19.1	
10.0	18.9	
11.1	17.7	
11.4	0	RWE

Cross-Section 3

Distance from left bank (m)	Rhodamine concentration (μg/L)	Comment
0.4	0	LWE
1.0	29.7	
2.0	29.0	
3.0	27.9	
4.0	24.6	
5.0	20.6	
6.0	16.3	
7.0	11.8	
7.5	0	RWE

Cross-Section 4

Distance from left bank (m)	Rhodamine concentration (μg/L)	Comment
0.4	0	LWE
1.0	22.6	
2.0	30.3	
3.0	28.1	
4.0	29.0	
5.0	29.1	
6.0	27.9	
7.0	20.6	
8.0	19.3	
9.0	14.5	
10.0	13.8	
11.0	10.4	
12.0	5.5	
13.0	2.4	
14.0	1.7	
15.0	1.0	
16.0	0.8	
16.9	0	RWE

Cross-Section 5

Distance from left bank (m)	Rhodamine concentration (μg/L)	Comment
1	0	LWE
2.0	16.7	
4.0	16.3	
6.0	13.3	
8.0	11.8	
10.0	11.5	
12.0	10.3	
12.9	0	RWE

Cross-Section 6

Distance from left bank (m)	Rhodamine concentration (μg/L)	Comment
1.1	0	LWE/too shallow to measure
5.0	5.3	
7.0	10.0	
9.0	9.2	
11.0	8.9	
13.0	7.8	
15.0	6.3	
17.0	4.8	
18.1	0	RWE

Cross-Section 7

Distance from left bank (m)	Rhodamine concentration (μg/L)	Comment
0.5	0	LWE
2.0	2.4	
4.0	4.4	
6.0	5.5	
8.0	5.7	
10.0	4.1	
11.0	0	RWE

Cross-Section 8

Distance from left bank (m)	Rhodamine concentration (μg/L)	Comment
0.5	0	LWE
2.0	2.9	
4.0	3.5	
6.0	1	
8.0	2.1	
9.5	0	RWE

HUTCHINSON ENVIRONMENTAL SCIENCES LTD
ATTN: TARA ROUMELIOTIS
501 Krug St.
Suite 202
Kitchener ON N2B 1L3

Date Received: 18-NOV-16
Report Date: 06-DEC-16 07:42 (MT)
Version: FINAL REV. 2

Client Phone: 519-576-1711

Certificate of Analysis

Lab Work Order #: L1859958

Project P.O. #: NOT SUBMITTED
Job Reference: J160075
C of C Numbers:
Legal Site Desc:

Comments: 01-DEC-16 Total Dissolved Phosphorus added to samples L1859958-1 to -7.

LAURA ERMETA
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1859958-1 EFFLUENT Sampled By: CLIENT on 17-NOV-16 Matrix: WATER							
Physical Tests							
Total Suspended Solids	5.8		2.0	mg/L	24-NOV-16	25-NOV-16	R3603001
Anions and Nutrients							
Ammonia, Total (as N)	0.056		0.020	mg/L		22-NOV-16	R3601127
Chloride (Cl)	228	DLM	2.5	mg/L		23-NOV-16	R3602316
Nitrate (as N)	<0.10	DLM	0.10	mg/L		23-NOV-16	R3602316
Nitrite (as N)	<0.050	DLM	0.050	mg/L		23-NOV-16	R3602316
Total Kjeldahl Nitrogen	1.22		0.15	mg/L	28-NOV-16	28-NOV-16	R3605275
Phosphorus (P)-Total Dissolved	0.0564		0.0030	mg/L	05-DEC-16	06-DEC-16	R3611158
Phosphorus, Total	0.0963		0.0030	mg/L	24-NOV-16	24-NOV-16	R3602694
Aggregate Organics							
BOD Carbonaceous	<2.0		2.0	mg/L	21-NOV-16	26-NOV-16	R3604082
L1859958-2 UPSTREAM Sampled By: CLIENT on 17-NOV-16 Matrix: WATER							
Physical Tests							
Total Suspended Solids	4.0		2.0	mg/L	24-NOV-16	25-NOV-16	R3603001
Anions and Nutrients							
Ammonia, Total (as N)	0.028		0.020	mg/L		22-NOV-16	R3601127
Chloride (Cl)	132		0.50	mg/L		23-NOV-16	R3602316
Nitrate (as N)	1.36		0.020	mg/L		23-NOV-16	R3602316
Nitrite (as N)	<0.010		0.010	mg/L		23-NOV-16	R3602316
Total Kjeldahl Nitrogen	0.74		0.15	mg/L	28-NOV-16	28-NOV-16	R3605275
Phosphorus (P)-Total Dissolved	0.0089		0.0030	mg/L	05-DEC-16	06-DEC-16	R3611158
Phosphorus, Total	0.0218		0.0030	mg/L	24-NOV-16	24-NOV-16	R3602694
Aggregate Organics							
BOD Carbonaceous	<2.0		2.0	mg/L	21-NOV-16	26-NOV-16	R3604082
L1859958-3 CROSS-SECTION 1 Sampled By: CLIENT on 17-NOV-16 Matrix: WATER							
Physical Tests							
Total Suspended Solids	10.5		2.0	mg/L	24-NOV-16	25-NOV-16	R3603001
Anions and Nutrients							
Ammonia, Total (as N)	0.081		0.020	mg/L		22-NOV-16	R3601127
Chloride (Cl)	229	DLM	2.5	mg/L		23-NOV-16	R3602316
Nitrate (as N)	<0.10	DLM	0.10	mg/L		23-NOV-16	R3602316
Nitrite (as N)	<0.050	DLM	0.050	mg/L		23-NOV-16	R3602316
Total Kjeldahl Nitrogen	1.12		0.15	mg/L	28-NOV-16	28-NOV-16	R3605275
Phosphorus (P)-Total Dissolved	0.0498		0.0030	mg/L	05-DEC-16	06-DEC-16	R3611158
Phosphorus, Total	0.105	DLHC	0.030	mg/L	24-NOV-16	24-NOV-16	R3602694
Aggregate Organics							
BOD Carbonaceous	<2.0		2.0	mg/L	21-NOV-16	26-NOV-16	R3604082
L1859958-4 CROSS-SECTION 2 Sampled By: CLIENT on 17-NOV-16							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1859958-4 CROSS-SECTION 2 Sampled By: CLIENT on 17-NOV-16 Matrix: WATER							
Physical Tests							
Total Suspended Solids	44.2		2.0	mg/L	24-NOV-16	25-NOV-16	R3603001
Anions and Nutrients							
Ammonia, Total (as N)	0.051		0.020	mg/L		22-NOV-16	R3601127
Chloride (Cl)	179	DLM	2.5	mg/L		23-NOV-16	R3602316
Nitrate (as N)	0.66	DLM	0.10	mg/L		23-NOV-16	R3602316
Nitrite (as N)	<0.050	DLM	0.050	mg/L		23-NOV-16	R3602316
Total Kjeldahl Nitrogen	0.98		0.15	mg/L	24-NOV-16	24-NOV-16	R3602668
Phosphorus (P)-Total Dissolved	0.0235		0.0030	mg/L	05-DEC-16	06-DEC-16	R3611158
Phosphorus, Total	0.0734		0.0030	mg/L	24-NOV-16	24-NOV-16	R3602694
Aggregate Organics							
BOD Carbonaceous	<2.0		2.0	mg/L	21-NOV-16	26-NOV-16	R3604082
L1859958-5 CROSS-SECTION 3 Sampled By: CLIENT on 17-NOV-16 Matrix: WATER							
Physical Tests							
Total Suspended Solids	35.1		2.0	mg/L	24-NOV-16	25-NOV-16	R3603001
Anions and Nutrients							
Ammonia, Total (as N)	0.035		0.020	mg/L		22-NOV-16	R3601127
Chloride (Cl)	164	DLM	2.5	mg/L		23-NOV-16	R3602316
Nitrate (as N)	0.85	DLM	0.10	mg/L		23-NOV-16	R3602316
Nitrite (as N)	<0.050	DLM	0.050	mg/L		23-NOV-16	R3602316
Total Kjeldahl Nitrogen	0.90		0.15	mg/L	24-NOV-16	24-NOV-16	R3602668
Phosphorus (P)-Total Dissolved	0.0148		0.0030	mg/L	05-DEC-16	06-DEC-16	R3611158
Phosphorus, Total	0.0741		0.0030	mg/L	24-NOV-16	24-NOV-16	R3602694
Aggregate Organics							
BOD Carbonaceous	<2.0		2.0	mg/L	21-NOV-16	26-NOV-16	R3604082
L1859958-6 CROSS-SECTION 4 Sampled By: CLIENT on 17-NOV-16 Matrix: WATER							
Physical Tests							
Total Suspended Solids	31.2		2.0	mg/L	24-NOV-16	25-NOV-16	R3603001
Anions and Nutrients							
Ammonia, Total (as N)	0.037		0.020	mg/L		22-NOV-16	R3601127
Chloride (Cl)	158	DLM	2.5	mg/L		23-NOV-16	R3602316
Nitrate (as N)	0.85	DLM	0.10	mg/L		23-NOV-16	R3602316
Nitrite (as N)	<0.050	DLM	0.050	mg/L		23-NOV-16	R3602316
Total Kjeldahl Nitrogen	0.96		0.15	mg/L	24-NOV-16	24-NOV-16	R3602668
Phosphorus (P)-Total Dissolved	0.0164		0.0030	mg/L	05-DEC-16	06-DEC-16	R3611158
Phosphorus, Total	0.0635		0.0030	mg/L	24-NOV-16	24-NOV-16	R3602694
Aggregate Organics							
BOD Carbonaceous	<2.0		2.0	mg/L	21-NOV-16	26-NOV-16	R3604082
L1859958-7 CROSS-SECTION 5 Sampled By: CLIENT on 17-NOV-16							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1859958-7 CROSS-SECTION 5 Sampled By: CLIENT on 17-NOV-16 Matrix: WATER							
Physical Tests							
Total Suspended Solids	11.9		2.0	mg/L	24-NOV-16	25-NOV-16	R3603001
Anions and Nutrients							
Ammonia, Total (as N)	0.026		0.020	mg/L		22-NOV-16	R3601127
Chloride (Cl)	149		0.50	mg/L		23-NOV-16	R3602316
Nitrate (as N)	1.02		0.020	mg/L		23-NOV-16	R3602316
Nitrite (as N)	<0.010		0.010	mg/L		23-NOV-16	R3602316
Total Kjeldahl Nitrogen	0.82		0.15	mg/L	24-NOV-16	24-NOV-16	R3602668
Phosphorus (P)-Total Dissolved	0.0136		0.0030	mg/L	05-DEC-16	06-DEC-16	R3611158
Phosphorus, Total	0.0408		0.0030	mg/L	24-NOV-16	24-NOV-16	R3602694
Aggregate Organics							
BOD Carbonaceous	<2.0		2.0	mg/L	21-NOV-16	26-NOV-16	R3604082
L1859958-8 CROSS-SECTION 6 Sampled By: CLIENT on 17-NOV-16 Matrix: WATER							
Physical Tests							
Total Suspended Solids	3.5		2.0	mg/L	24-NOV-16	25-NOV-16	R3603001
Anions and Nutrients							
Ammonia, Total (as N)	0.048		0.020	mg/L		22-NOV-16	R3601127
Chloride (Cl)	146		0.50	mg/L		23-NOV-16	R3602316
Nitrate (as N)	1.04		0.020	mg/L		23-NOV-16	R3602316
Nitrite (as N)	<0.010		0.010	mg/L		23-NOV-16	R3602316
Total Kjeldahl Nitrogen	0.73		0.15	mg/L	24-NOV-16	24-NOV-16	R3602668
Phosphorus, Total	0.0272		0.0030	mg/L	24-NOV-16	24-NOV-16	R3602694
Aggregate Organics							
BOD Carbonaceous	<2.0		2.0	mg/L	21-NOV-16	26-NOV-16	R3604082
L1859958-9 CROSS-SECTION 7 Sampled By: CLIENT on 17-NOV-16 Matrix: WATER							
Physical Tests							
Total Suspended Solids	4.0		2.0	mg/L	24-NOV-16	25-NOV-16	R3603001
Anions and Nutrients							
Ammonia, Total (as N)	<0.020		0.020	mg/L		22-NOV-16	R3601127
Chloride (Cl)	145		0.50	mg/L		23-NOV-16	R3602316
Nitrate (as N)	1.02		0.020	mg/L		23-NOV-16	R3602316
Nitrite (as N)	<0.010		0.010	mg/L		23-NOV-16	R3602316
Total Kjeldahl Nitrogen	0.72		0.15	mg/L	24-NOV-16	24-NOV-16	R3602668
Phosphorus, Total	0.0268		0.0030	mg/L	24-NOV-16	24-NOV-16	R3602694
Aggregate Organics							
BOD Carbonaceous	<2.0		2.0	mg/L	21-NOV-16	26-NOV-16	R3604082
L1859958-10 CROSS-SECTION 8 Sampled By: CLIENT on 17-NOV-16 Matrix: WATER							
Physical Tests							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1859958-10 CROSS-SECTION 8 Sampled By: CLIENT on 17-NOV-16 Matrix: WATER							
Physical Tests							
Total Suspended Solids	5.4		2.0	mg/L	24-NOV-16	25-NOV-16	R3603001
Anions and Nutrients							
Ammonia, Total (as N)	0.074		0.020	mg/L		22-NOV-16	R3601127
Chloride (Cl)	144		0.50	mg/L		23-NOV-16	R3602316
Nitrate (as N)	1.00		0.020	mg/L		23-NOV-16	R3602316
Nitrite (as N)	<0.010		0.010	mg/L		23-NOV-16	R3602316
Total Kjeldahl Nitrogen	0.69		0.15	mg/L	24-NOV-16	24-NOV-16	R3602668
Phosphorus, Total	0.0240		0.0030	mg/L	24-NOV-16	24-NOV-16	R3602695
Aggregate Organics							
BOD Carbonaceous	<2.0		2.0	mg/L	21-NOV-16	26-NOV-16	R3604082

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Sample Parameter Qualifier key listed:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
BOD-C-WT	Water	BOD Carbonaceous	APHA 5210 B (CBOD)

This analysis is carried out using procedures adapted from APHA Method 5210B - "Biochemical Oxygen Demand (BOD)". All forms of biochemical oxygen demand (BOD) are determined by diluting and incubating a sample for a specified time period, and measuring the oxygen depletion using a dissolved oxygen meter. Dissolved BOD (SOLUBLE) is determined by filtering the sample through a glass fibre filter prior to dilution. Carbonaceous BOD (CBOD) is determined by adding a nitrification inhibitor to the diluted sample prior to incubation.

CL-IC-WT	Water	Chloride by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

NH3-WT	Water	Ammonia, Total as N	EPA 350.1

Sample is measured colorimetrically. When sample is turbid a distillation step is required, sample is distilled into a solution of boric acid and measured colorimetrically.

NO2-IC-WT	Water	Nitrite in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-IC-WT	Water	Nitrate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

P-T-COL-WT	Water	Total P in Water by Colour	APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is deteremined colourimetrically after persulphate digestion of the sample.

P-TD-COL-WT	Water	Total Dissolved P in Water by Colour	APHA 4500-P B E

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Dissolved Phosphorus is determined colourimetrically after persulphate digestion of a sample that has been lab or field filtered through a 0.45 micron membrane filter.

P-TD-COL-WT	Water	Total Dissolved P in Water by Colour	APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Dissolved Phosphorus is determined colourimetrically after persulphate digestion of a sample that has been lab or field filtered through a 0.45 micron membrane filter.

SOLIDS-TSS-WT	Water	Suspended solids	APHA 2540 D-Gravimetric

A well-mixed sample is filtered through a weighed standard glass fibre filter and the residue retained is dried in an oven at 104–1°C for a minimum of four hours or until a constant weight is achieved.

TKN-WT	Water	Total Kjeldahl Nitrogen	APHA 4500-N

Sample is digested to convert the TKN to ammonium sulphate. The ammonia ions are heated to produce a colour complex. The absorbance measured by the instrument is proportional to the concentration of ammonium sulphate in the sample and is reported as TKN.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

Reference Information

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid weight of sample
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1859958 Report Date: 06-DEC-16

Client: HUTCHINSON ENVIRONMENTAL SCIENCES LTD
501 Krug St. Suite 202
Kitchener ON N2B 1L3

Contact: TARA ROUMELIOTIS

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
BOD-C-WT	**Water**							
Batch R3604082								
WG2436972-2 DUP		**L1859958-1**						
BOD Carbonaceous		<2.0	<2.0	RPD-NA	mg/L	N/A	20	26-NOV-16
WG2436972-6 DUP		**L1859958-9**						
BOD Carbonaceous		<2.0	<2.0	RPD-NA	mg/L	N/A	20	26-NOV-16
WG2436972-3 LCS								
BOD Carbonaceous			96.5		%		85-115	26-NOV-16
WG2436972-7 LCS								
BOD Carbonaceous			101.0		%		85-115	26-NOV-16
WG2436972-1 MB								
BOD Carbonaceous			<2.0		mg/L		2	26-NOV-16
WG2436972-5 MB								
BOD Carbonaceous			<2.0		mg/L		2	26-NOV-16
CL-IC-WT	**Water**							
Batch R3602316								
WG2438537-4 DUP		**L1859805-3**						
Chloride (Cl)		<0.50	<0.50	RPD-NA	mg/L	N/A	25	23-NOV-16
WG2438537-2 LCS								
Chloride (Cl)			101.0		%		70-130	23-NOV-16
WG2438537-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	23-NOV-16
WG2438537-5 MS		**L1859805-3**						
Chloride (Cl)			105.3		%		70-130	23-NOV-16
NH3-WT	**Water**							
Batch R3601127								
WG2437509-16 DUP		**L1859733-61**						
Ammonia, Total (as N)		0.395	0.388		mg/L	1.7	20	22-NOV-16
WG2437509-14 LCS								
Ammonia, Total (as N)			99.9		%		85-115	22-NOV-16
WG2437509-13 MB								
Ammonia, Total (as N)			<0.020		mg/L		0.02	22-NOV-16
WG2437509-15 MS		**L1859733-61**						
Ammonia, Total (as N)			85.9		%		75-125	22-NOV-16
NO2-IC-WT	**Water**							
Batch R3602316								
WG2438537-4 DUP		**L1859805-3**						
Nitrite (as N)		<0.010	<0.010	RPD-NA	mg/L	N/A	25	23-NOV-16
WG2438537-2 LCS								

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-IC-WT	**Water**							
Batch R3602316								
WG2438537-2 LCS								
Nitrite (as N)			102.2		%		70-130	23-NOV-16
WG2438537-1 MB								
Nitrite (as N)			<0.010		mg/L		0.01	23-NOV-16
WG2438537-5 MS		**L1859805-3**						
Nitrite (as N)			105.7		%		70-130	23-NOV-16
NO3-IC-WT	**Water**							
Batch R3602316								
WG2438537-4 DUP		**L1859805-3**						
Nitrate (as N)		<0.020	<0.020	RPD-NA	mg/L	N/A	25	23-NOV-16
WG2438537-2 LCS								
Nitrate (as N)			101.3		%		70-130	23-NOV-16
WG2438537-1 MB								
Nitrate (as N)			<0.020		mg/L		0.02	23-NOV-16
WG2438537-5 MS		**L1859805-3**						
Nitrate (as N)			105.4		%		70-130	23-NOV-16
P-T-COL-WT	**Water**							
Batch R3602694								
WG2439257-3 DUP		**L1859805-3**						
Phosphorus, Total		0.0055	0.0062		mg/L	11	20	24-NOV-16
WG2439257-2 LCS								
Phosphorus, Total			101.6		%		80-120	24-NOV-16
WG2439257-1 MB								
Phosphorus, Total			<0.0030		mg/L		0.003	24-NOV-16
WG2439257-4 MS		**L1859805-3**						
Phosphorus, Total			92.4		%		70-130	24-NOV-16
Batch R3602695								
WG2439258-3 DUP		**L1859958-10**						
Phosphorus, Total		0.0240	0.0299	J	mg/L	0.0059	0.006	24-NOV-16
WG2439258-2 LCS								
Phosphorus, Total			102.4		%		80-120	24-NOV-16
WG2439258-1 MB								
Phosphorus, Total			<0.0030		mg/L		0.003	24-NOV-16
WG2439258-4 MS		**L1859958-10**						
Phosphorus, Total			84.0		%		70-130	24-NOV-16
P-TD-COL-WT	**Water**							

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Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-TD-COL-WT	**Water**							
Batch R3611158								
WG2446012-3 DUP		**L1859958-1**						
Phosphorus (P)-Total	Dissolved	0.0564	0.0615		mg/L	8.7	20	06-DEC-16
WG2446012-2 LCS								
Phosphorus (P)-Total	Dissolved		99.2		%		80-120	06-DEC-16
WG2446012-1 MB								
Phosphorus (P)-Total	Dissolved		<0.0030		mg/L		0.003	06-DEC-16
WG2446012-4 MS		**L1859958-1**						
Phosphorus (P)-Total	Dissolved		96.8		%		70-130	06-DEC-16
SOLIDS-TSS-WT	**Water**							
Batch R3603001								
WG2439389-3 DUP		**L1859868-3**						
Total Suspended Solids		488	452		mg/L	7.8	20	25-NOV-16
WG2439389-2 LCS								
Total Suspended Solids			100.0		%		85-115	25-NOV-16
WG2439389-1 MB								
Total Suspended Solids			<2.0		mg/L		2	25-NOV-16
TKN-WT	**Water**							
Batch R3602668								
WG2439376-3 DUP		**L1859958-4**						
Total Kjeldahl Nitrogen		0.98	0.95		mg/L	3.2	20	24-NOV-16
WG2439376-2 LCS								
Total Kjeldahl Nitrogen			96.1		%		75-125	24-NOV-16
WG2439376-1 MB								
Total Kjeldahl Nitrogen			<0.15		mg/L		0.15	24-NOV-16
WG2439376-4 MS		**L1859958-4**						
Total Kjeldahl Nitrogen			106.3		%		70-130	24-NOV-16
Batch R3605275								
WG2441421-3 DUP		**L1859481-8**						
Total Kjeldahl Nitrogen		0.76	0.81		mg/L	6.2	20	28-NOV-16
WG2441421-2 LCS								
Total Kjeldahl Nitrogen			110.4		%		75-125	28-NOV-16
WG2441421-1 MB								
Total Kjeldahl Nitrogen			<0.15		mg/L		0.15	28-NOV-16
WG2441421-4 MS		**L1859481-8**						
Total Kjeldahl Nitrogen			105.9		%		70-130	28-NOV-16

Quality Control Report

Workorder: L1859958 Report Date: 06-DEC-16

Client: HUTCHINSON ENVIRONMENTAL SCIENCES LTD
501 Krug St. Suite 202
Kitchener ON N2B 1L3
Contact: TARA ROUMELIOTIS

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Appendix C – Natural Heritage Report

Mapleton Water Pollution Control Plant Class Environmental Assessment

Natural Environment Characterization Report

Prepared for:
exp. Services Inc.
85 Edwin Street
Kitchener, ON
N2H 4N7

Project No. 1615 | December 2015

NATURAL RESOURCE SOLUTIONS INC.
Aquatic, Terrestrial and Wetland Biologists

Mapleton Water Pollution Control Plant
Class Environmental Assessment
Natural Environment Characterization Report

Project Team:

Elaine Gosnell	Senior Terrestrial/Wetland Biologist, Project Manager
Steve Burgin	Aquatic Biologist
Andrew Dean	Terrestrial & Wetland Biologist
Kaitlin Boddaert	GIS Analyst

Report submitted on December 15, 2015

Elaine Gosnell
Project Manager
Senior Terrestrial/Wetland Biologist

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1.0 Introduction

Natural Resource Solutions Inc. (NRSI) was retained as part of a team with exp. Services of Brampton to prepare a Class Environmental Assessment (EA) for upgrades to the existing Mapleton Water Pollution Control Plant (WPCP) and servicing system, located southwest of the Town of Drayton, Ontario. Supporting infrastructure to the WPCP was also addressed in this study, including the Drayton and Moorefield Sewage Pumping Stations.

The Mapleton Water Pollution Control Plant (WPCP) is located on the west side of the upper branch of the Conestogo River, just south of the town of Drayton (Map 1a). The property is dominated by the presence of the open water lagoons with the remainder of the site being agricultural land. The WPCP discharge flows are directed underground through a 600mm pipe and released overland into a wetland which then drains to the Conestogo River approximately 350m downstream from the outfall. The outlet pipe traverses the Conestogo Lake Conservation Area lands which are owned and managed by the Grand River Conservation Authority (GRCA). These lands are primarily forested with portions of deciduous and coniferous forest, and coniferous plantation. The receiving wetland is an unmapped and unevaluated natural feature which is regulated by GRCA.

The Drayton Sewage Pumping Station (SPS) is located immediately to the west of the intersection of Mill Street and River Run Road within the town of Drayton, Ontario (Map 1b). The property is comprised of actively mown lawn, sewage pumping infrastructure, with nearby wetland and treed natural features associated with the Conestogo River.

The Moorefield SPS is located approximately 225m east of the intersection of Booth Street and McGivern Street, in the town of Moorefield, Ontario (Map 1c). The property is comprised of actively mown lawn, sewage pumping infrastructure, with nearby agricultural fields and residential properties.

This report summarizes background information on natural heritage features, as well as the results of field surveys including Ecological Land Classification (ELC), a spring vascular flora inventory, breeding bird and herpetofaunal surveys and a detailed aquatic habitat characterization. The detailed characterization of existing natural features was used to inform an analysis of natural feature significance and sensitivity within the study area with consideration for applicable County and provincial policies and legislation.

1.1 Study Area

The term “study area” refers to the subject property plus the surrounding area (approximately 120m) for which additional information was collected and reviewed (as could be gathered without direct access to these areas). Habitats between the Mapleton WPCP and the Conestogo River were surveyed in order to accurately characterize the natural features in the receiving habitats of the treated wastewater effluent.

The study area also includes the pumping stations in Drayon and Moorefield where investigations of the natural area immediately adjacent to each of the pumping stations were carried out.

Background data on wildlife species and Species At Risk (SAR) was collected from the local surrounding area (up to 10km).

2.0 Methods

2.1 Background Review and Habitat Screening

A review of existing natural heritage information was completed to identify key natural heritage features and species that are known or have potential to occur within the study area and the local vicinity (up to 10km). Requests for background information were sent to the Ministry of Natural Resources and Forestry (MNRF) - Guelph District as well as to the GRCA. Background information relevant to the study area was also collected and reviewed from sources including the following:

- Natural Heritage Information Centre (NHIC) (MNRF 2015b);
- Land Information Ontario (LIO) data base mapping (MNRF 2015b);
- Wellington County Official Plan (2015);
- GRCA (J. Wagler, pers. comm. 2015);
- MNRF (J. Pinder, pers. comm. 2015);
- Department of Fisheries and Oceans Canada (DFO) (DFO 2015a,b);
- Wellington County Upper Tier Species At Risk List (MNRF 2014)
- Atlas of the Mammals of Ontario (Dobbyn 1994);
- Ontario Reptile and Amphibian Atlas (Ontario Nature 2015);
- Ontario Butterfly Atlas (Jones *et al.* 2015); and
- Ontario Breeding Bird Atlas (BSC *et al.* 2008).

Based on the results of the background information review, a total of 31 Species at Risk (SAR) and 21 Species of Conservation Concern (SCC) have been recorded from within 10km of the study area. For the purposes of this report, SAR are defined as species listed as Threatened or Endangered provincially which are afforded protection under the *Endangered Species Act*, 2007 (ESA). Within Ontario, SCC refers to:

- Species designated provincially as Special Concern;
- Species that have been assigned a conservation status (S-Rank) of S1 to S3 or SH by the NHIC;
- Species that are designated federally as Threatened or Endangered by the Committee for the Status of Endangered Wildlife in Canada (COSEWIC) but not provincially by the Committee on the Status of Species at Risk in Ontario (COSSARO). These species are protected by the federal *Species at Risk Act* but not provincially by the ESA.

Habitat for SCC may be considered Significant Wildlife Habitat (SWH), which is afforded protection under the Provincial Policy Statement (MMAH 2014) and municipal natural heritage protection policies.

A preliminary screening exercise was conducted on the list of SAR and SCC to determine which species have suitable habitat within the study area. This involved cross-referencing the preferred habitat for reported SAR and SCC (MNRF 2000, MNRF 2015c) against habitats known to occur in the study area. This was completed to ensure that the potential presence of all significant species within the study area was adequately assessed to inform the EA.

Based on this screening exercise, potentially suitable habitat for 8 SAR and 9 SCC were identified within the study area. Full results of the SAR and SCC screening exercise are provided in Appendix I.

A preliminary screening for the presence of SWH was also completed for the study area. The Significant Wildlife Habitat Technical Guide (SWHTG) is a guideline document that outlines the types of habitats that the MNRF considers significant in Ontario as well as criteria to identify these habitats (MNRF 2000, MNRF 2015c). The SWHTG groups SWH into four broad categories: seasonal concentration areas, rare vegetation communities and specialized wildlife habitat, habitats of SCC, and animal movement corridors. This screening involved the comparison of criteria outlined in the SWHTG against habitats known to occur in the study area. Significant Wildlife Habitat is discussed further under Significance and Sensitivity below.

2.2 Field Studies

Aquatic and terrestrial field surveys were undertaken within the study area in 2015 to characterize natural features and identify those that are significant and sensitive and that have potential to be adversely affected by the proposed development. A total of six site visits were completed in 2015. Field investigations on the WPCP property focused on the natural areas southeast of the settling ponds, including the drainage channel at the outfall pipe and the Conestogo River at the eastern and western extents of the channel. Surveys were undertaken in accordance with provincial and local standards and guidance documents.

The Drayton and Moorefield Sewage Pumping Stations were surveyed to characterize the adjacent natural habitats.

NRSI biologists conducted an initial reconnaissance of the site on April 17, 2015 to note spring conditions. A full aquatic site assessment was completed on July 28, 2015 to characterize the aquatic features within the study area. This detailed aquatic habitat assessment was completed for the length of the existing swale that receives water from the WPCP, for a total of approximately 480m. From the outlet structure the swale extends approximately 180m downstream to the east and approximately 300m upstream to the west with both the inlet and outlet of the swale connecting with the Conestogo River. During the field work, detailed aquatic habitat information was recorded including the following:

- adjacent lands (valley form, riparian habitat, canopy cover, land use etc.);
- channel morphology;
- substrate type and composition;
- water quality (including water temperature, dissolved oxygen, conductivity, pH, and total dissolved solids);
- instream habitat and cover (including critical life stage areas);
- flow conditions; and
- suitability of the site for SAR freshwater mussels, particularly at the downstream extent.

Vegetation communities within the study area were described and mapped using the Ecological Land Classification (ELC) system for southern Ontario (Lee *et al.* 1998, Lee 2008) on May 27, 2015. A detailed spring vegetation inventory was completed with a focus on habitats within and adjacent to the effluent outlet pipe. Emphasis was placed on the identification of any federally, provincially, or locally significant vegetation species that may occur in the study area. Natural habitats within and adjacent to the Drayton and Moorefield Sewage Pumping Stations were similarly surveyed and mapped.

Due to the presence of wetland habitat within the study area, amphibian call surveys were conducted to characterize potential amphibian breeding habitat. Two evening field surveys were conducted in 2015 according to the Ontario Marsh Monitoring Protocol (BSC 2009): April 16 (20:36-20:39), and May 26 (21:55-21:58).

One early morning breeding bird survey was conducted in 2015 to document breeding bird species according to the Ontario Breeding Bird Atlas standardized methods (OBBA 2001): June 9 (6:05-8:05).

During all terrestrial field surveys, targeted reptile visual encounter surveys were conducted, including potential basking and nesting areas. Systematic area searches by ELC polygon were conducted within the study area natural features.

All incidental observations of birds, mammals, herpetofauna, butterflies, dragonflies, and damselflies were documented on all field visits. This included direct observations of individuals, as well as signs of wildlife presence (i.e. tracks, scat, dens, nests, etc.).

3.0 Existing Conditions

3.1 Physiography, Geology, Soils and Drainage

The study area consists of agricultural tableland fronting onto Sideroad 15, with constructed settling ponds for municipal wastewater treatment at the rear of the subject property. Beyond the rear of the property and down gradient (i.e. east) from settling ponds is the wooded valley slope associated with the Conestogo River with the bottomland and riverine habitats at the base of the slope, associated with the river and floodplain. Surficial geology conditions in the study area vary from deposits of gravel and sand along the Conestogo River and floodplain, to deposits of diamicton in the upper valley slopes and tableland (GRCA 2015). Diamicton refers to a variety of unconsolidated materials of unknown origin. Drainage in the study area is flowing predominately southeast, towards the Conestogo River, and then south to Conestoga Lake approximately 1.5km downstream. Beyond the study area, topography is predominantly flat to gently-rolling, with slopes associated with riparian areas.

3.2 Vegetation Communities

A total of 8 vegetation communities were documented within the study area, including agricultural lands, treed areas (deciduous, coniferous, plantation), and a marsh wetland feature. Agricultural lands within the study area consist of annual row crops (OAGM1), and pasture (OAGM4). Vegetation communities identified within the study area are described in Table 1 below. Refer to Maps 2a-c for study area ELC communities and surrounding study area land uses.

Table 1. Vegetation Communities Identified within the Study Area

ELC Ecosite Type	ELC Description	Environmental Characteristics
Wetland		
MAMM1-3	Reed Canary Grass Mineral Meadow Marsh	This marsh community is found within the swale upstream and downstream of the current effluent outfall, and is a narrow linear feature that connects to the Conestogo River at both ends. The understorey is comprised of Sandbar Willow (*Salix exigua*), Missouri Willow (*Salix eriocephala*), and White Elm (*Ulmus americana*). The groundcover is dominated by Reed Canary Grass (*Phalaris arundinacea*), with lesser amounts of Spotted Jewelweed (*Impatiens capensis*), and Aquatic Sedge (*Carex aquatilis*). This community is also found along the riparian corridor of the Conestogo River nearby the Drayton Sewage Pumping Station. Dominant species include Reed-canary Grass, Sandbar Willow, and Soft-stem Bulrush (*Schoenoplectus tabernaemontani*).
Forest		
FOCM4	Fresh-Moist White Cedar Conifeorus Forest	This coniferous forest community is found along the notable slope towards the MAMM1-3 community. It is dominated by White Cedar (*Thuja occidentalis*), Sugar Maple (*Acer saccharum*), and Trembling Aspen (*Populus tremuloides*) in the canopy. The sub-canopy is comprised of White Cedar, White Ash (*Fraxinus americana*), and Black Cherry (*Prunus serotina*). The understorey layer is characterized by Choke Cherry (*Prunus virginiana*), Alternate-leaved Dogwood (*Cornus alternifolia*), and European Buckthorn (*Rhamnus cathartica*). Groundcover vegetation is comprised of Field Horsetail (*Equisetum arvense*), Downy Yellow Violet (*Viola pubescens*), and Spinulose Wood Fern (*Dryopteris carthusiana*).
FOCM6	Naturalized Coniferous Plantation	This naturalized coniferous plantation community was formerly planted with White Spruce (*Picea glauca*) and Scot's Pine (*Pinus sylvestris*), and is now noted as having good regeneration of native species. The canopy is dominated by White Spruce, White Elm, and Basswood (*Tilia americana*). The sub-canopy is characterized by White Spruce, Scot's Pine, Basswood, and White Cedar. The understorey layer is dominated by European Buckthorn, Choke Cherry, and Alternate-leaved Dogwood. Groundcover vegetation is comprised of Garlic Mustard (*Alliaria petiolata*), Wild Geranium (*Geranium maculatum*), and Enchanter's Nightshade (*Circaea lutetiana ssp. canadensis*).
FODM4	Dry-Fresh Upland Deciduous Forest	This forest community exists adjacent to the settling ponds within the subject property. It is dominated by Norway Maple (*Acer platanoides*), Basswood, White Ash, Scot's Pine, and Hawthorn (*Crataegus spp.*) in the canopy and sub-canopy. Understorey vegetation is characterized by Choke Cherry, Alternate-leaved Dogwood, and Black Raspberry (*Rubus occidentalis*). The groundcover layer is comprised of Wild Strawberry (*Fragaria virginiana*), Dame's Rocket (*Hesperis matronalis*), and Yellow Avens (*Geum allepicum*).
FODM5	Dry-Fresh Sugar Maple Deciduous Forest	This forest community is dominated by Sugar Maple, Basswood, and Black Cherry in the canopy. The sub-canopy is comprised of Sugar Maple, White Ash, and Ironwood (*Ostrya virginiana*). Understorey vegetation is characterized by Choke Cherry and Alternate-leaved Dogwood. The groundcover vegetation is comprised of Wild Geranium, Enchanter's Nightshade, and Zig-zag Goldenrod (*Solidago flexicaulis*).
FOMM7	Fresh-Moist White Cedar – Hardwood Mixed Forest	This forest community is located within the floodplain of the Conestogo River. It is dominated by Crack Willow (*Salix fragilis*), White Elm, White Cedar, Manitoba Maple (*Acer negundo*), and Hawthorn in the canopy and sub-canopy. The understorey layer is characterized by European Buckthorn, Manitoba Maple, and Choke Cherry. The groundcover vegetation is comprised of Garlic Mustard, Reed Canary Grass, Dame's Rocket, and Swamp Buttercup (*Ranunculus hispidus var. caricetorum*). A distinct habitat inclusion exists within this community: Coniferous Plantation (TAGM1), dominated by White Spruce.
FODM7-7	Fresh-Moist Lowland	This forest community exists along the slopes of the Conestogo River valley adjacent to the Drayton Sewage Pumping Station. Dominant species

ELC Ecosite Type	ELC Description	Environmental Characteristics
	Manitoba Maple Deciduous Forest	include Manitoba Maple, Crack Willow, Black Walnut (*Juglans nigra*), Garlic Mustard, and Common Burdock (*Arctium minus ssp. minus*). Strong slopes towards the river characterize this feature.
Cultural		
TAGM1	Coniferous Plantation	This plantation community was formerly planted with White Pine (*Pinus strobus*), White Spruce, and Tamarack (*Larix laricina*), which comprises the canopy. The sub-canopy is dominated by regenerating White Ash, Alternate-leaved Dogwood, and European Buckthorn. The understorey layer is characterized by Choke Cherry, Black Raspberry, and Red Elderberry (*Sambucus racemosa*). The groundcover flora is comprised of Wild Strawberry, Dame's Rocket, and Field Horsetail. Norway Maple was observed to be regenerating within this feature.

3.3 Vascular Flora

A total of 137 species of vascular flora were identified within the study area natural features shown on Maps 2a-c. A complete list of inventoried species is provided in Appendix II. Of the 137 species observed, approximately 24% were non-native species.

Appendix I lists federally and provincially significant flora species known from the study area vicinity (within 1 km) based the results of background review and whether suitable habitat is present for each within the study area. During field surveys conducted by NRSI biologists, 1 provincially significant vascular flora species was observed within the study area: American Gromwell (*Lithospermum latifolium*). This species was observed throughout the wooded valleylands of the Conestoga River, along the outfall. In addition, 6 regionally significant plant species were observed in the study area. These significant species, their current status ranks, and a description of the habitat in which they occur are presented in Table 2.

3.4 Wildlife

Birds
A total of 82 bird species have been recorded in the vicinity of the study area (BSC *et al.* 2008, MNRF 2015b). Of these, 35 were observed by NRSI during field surveys. Refer to Appendix III for a complete list of all bird species known and observed in the study area and vicinity, including highest breeding evidence codes in accordance with the OBBA (2001).

Appendix I lists federally and provincially significant bird species known from the study area vicinity (within 10 km) based the results of background review and whether suitable habitat is present for each within the study area. Habitat is present in the study area, but off-site for 5 SAR birds including Eastern Wood-pewee (*Contopus virens*), Bobolink (*Dolichonyx oryzivorous*), Bald Eagle (*Haliaeetus leucocephalus*), Wood Thrush (*Hylocichla mustelina*) and Eastern Meadowlark (*Sturnella magna*). A sixth SAR bird, Barn Swallow (*Hirundo rustica*), nests on buildings and man-made structures and has potential to nest on-site, but was not observed during any of the field visits.

During field surveys conducted by NRSI biologists, 2 provincially significant bird species were observed within the study area: one bird SAR, Bobolink, and one bird SCC, Eastern Wood-pewee. In addition, a total of 10 regionally significant bird species were observed in the study area. These significant species, their current status ranks, and a description of the habitat in which they occur are presented in Table 3. Further

discussion of the Bobolink and Eastern Wood-pewee observations is provided in the Significance and Sensitivity section of this report.

Herpetofauna
A total of 6 reptile and amphibian species have been recorded form the vicinity of the study area (Ontario Nature 2015). American Toad (*Anaxyrus americanus*) and Spring Peeper (*Pseudacris crucifer*) were documented during the amphibian call surveys, whereas Gray Treefrog (*Hyla versicolor*) was recorded incidentally. A complete list of all herpetofauna species known from the study area is provided in Appendix IV.

Appendix I lists federally and provincially significant herpetofauna species known from the study area vicinity (within 10 km) based the results of background review and whether suitable habitat is present for each within the study area. During field surveys conducted by NRSI biologists, one provincially and regionally significant herpetofauna species was observed within the study area: Snapping Turtle (*Chelydra serpentina*). This turtle was observed along the road in between the settling ponds and the treed areas at the eastern extent of the subject property. No evidence of turtle nesting evidence was documented within the study area. No other regionally, provincially or federally significant herpetofauna species were observed, but suitable habitat is present in the study area for Eastern Milksnake (*Lampropeltis taylori triangulum*) and Eastern Ribbonsnake (*Thamnophis sauritus septentrionalis*) in the meadow, forest and marsh habitats adjacent to the site.
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Table 2. Significant Vascular Flora Observed in the Study Area

Scientific Name	Common Name	SRANK[1]	COSEWIC[2]/ COSSARO[3]	Regional Status[4]	Location(s) of Species Observation
Lithospermum latifolium	American Gromwell	S3	--	R	FOCM4, TAGM1, FODM5, FODM4, FOCM6
Acer saccharum ssp. nigrum	Black Maple	S4?	--	R	FODM5, FOCM6
Zizia aurea	Golden Alexanders	S5	--	R	MAMM1-3, FOMM7
Rudbeckia laciniata	Tall Coneflower	S5	--	R	FOMM7
Carex woodii	Wood's Sedge	S4	--	R	FODM5
Lilium michiganense	Michigan Lily	S5	--	R	MAMM1-3

[1,3]MNRF 2015a, [2]Government of Canada 2015, [4]Dougan & Associates 2009

LEGEND	
SRANK	**Wellington County Status**
S3 Vulnerable	R Native, Present, Rare
S4 Apparently Secure	
S5 Secure	

Table 3. Significant Bird Species Observed in the Study Area

Scientific Name	Common Name	SRANK[1]	COSEWIC[2]/COSSARO[3]	Regional Status[4]	Location(s) of Species Observation	Evidence of Breeding within Subject Property?
Dolichonyx oryzivorus	Bobolink	S4B	T/THR	√*	Disturbance Area/ OAGM1	None observed
Contopus virens	Eastern Wood-Pewee	S4B	SC/SC	√	FODM5, FOCM4	Possible; singing males documented.
Butorides virescens	Green Heron	S4B	--	**	MAMM1-3	None observed
Ardea herodias	Great Blue Heron	S4B	--	**	MAMM1-3	None observed
Larus delawarensis	Ring-billed Gull	S5B, S4N	--	**	Flying overhead	None observed
Colaptes auratus	Northern Flicker	S4B	--	√*	FOCM4, FOMM7	Possible; observed in suitable nesting habitat.
Certhia americana	Brown Creeper	S5B	--	√*	FODM5, TAGM1, FOCM4	Possible; singing males documented.
Junco hyemalis	Dark-eyed Junco	S5B	--	√	FODM4, FODM5	Possible; singing males documented.
Pheucticus ludovicianus	Rose-breasted Grosbeak	S4B	--	√*	TAGM1	Possible; singing males documented.
Icterus galbula	Baltimore Oriole	S4B	--	√*	TAGM1	None observed

[1,3]MNRF 2015a, [2]Government of Canada 2015, [4]Dougan & Associates 2009

LEGEND	
SRANK	**COSEWIC/COSSARO**
S4 Apparently Secure	T/THR Threatened
S5 Secure	
Wellington County Status	
√ Significant and rare	
√* Significant but not rare	
** Only habitats that support/recently supported active nests considered significant	

Mammals
A total of 28 mammal species are documented within the vicinity of the study area (Dobbyn 1994). The following mammal species were observed incidentally during field investigations in the study area: Coyote (*Canis latrans*), Northern Raccoon (*Procyon lotor*), and White-tailed Deer (*Odocoileus virginianus*). A complete list of all mammal species known from the study area is provided in Appendix V.

Based on a review of background information, 2 mammal SAR, Little Brown Myotis (*Myotis lucifugus*) and Northern Myotis (*Myotis septentrionalis*) have potential to occur within the study area based on existing records in the vicinity and presence of suitable forested habitat adjacent to the site (Appendix I). No mammal SAR or SCC were observed during field surveys in the study area, however, targeted surveys for mammals were not completed. As well, no regionally significant mammal species were documented within the study area.

Butterflies
A total of 63 butterfly species are documented within the vicinity of the study area (Jones *et al.* 2015). No butterfly species were observed incidentally during field investigations in the study area. A complete list of all butterfly species known from the study area is provided in Appendix VI.

Based on a review of background information, 2 butterfly SCC, Dion Skipper (*Euphyes dion*) and West Virginia White (*Pieris virginiensis*), were identified as having potential to occur within the study area based on existing records in the vicinity and presence of suitable habitat in the forested areas adjacent to the site (Appendix I). No targeted surveys for butterflies or other insects were completed. As well, no regionally significant butterfly species were documented within the study area.

3.5 Aquatic Habitat

The upper Conestogo River generally consists of a number of warmwater tributaries and municipal drains that flow into the main channel and eventually into Conestogo Lake, approximately 7.0km downstream from the town of Drayton. The adjacent lands surrounding the river are intensively farmed and heavily drained. The Conestogo River in the vicinity of the study area consists of a relatively wide (10-20m) and flat channel with depths less than 1.0m during the summer months. The aquatic habitat is characterized by shallow pools, riffles, and runs that flow over a variety of substrates that range from cobble, pebble and gravel throughout the main channel to finer substrates, mainly silt and detritus within the backwater areas. The river suffers from impacts due to low baseflow, warm temperatures, lack of riparian vegetation and agricultural runoff input, as well as seasonal water level changes as manipulated by the downstream Conestoga dam. Under the right conditions, algae mats may also form throughout backwater areas.

The following is a description of the aquatic habitat present in the vicinity of the study area based on field surveys conducted on April 17 and July 28, 2015. The aquatic features assessed include the drainage swale that traverses the southern portion of the study area as well as the Conestogo River at the inlet and outlet of the drainage swale (Map 3).

The swale acts as an overflow channel for the Conestogo River during high flow events (e.g. spring freshet). The swale extends approximately 500m from east to west connecting to the Conestogo River at both ends. During both the spring and summer site visits the channel was noted to be disconnected from the river at the upstream end but was connected at the downstream end, indicating a difference in gradient and flow through the channel from upstream to down. The WPCP outlets water to the swale and flow was noted from the outlet pipe during the site visit in April.

The swale was noted to be relatively wide with channel widths ranging from approximately 30m at the narrowest to 50m at the widest. Beyond the extents of the channel the adjacent lands sloped gently to the southeast and were fairly steep to the northwest. These banks are well vegetated, dominated mainly by forest as described in the vegetation communities section of this report. Little to no standing water was observed upstream of the outfall and soils in the channel were dry at the July 28 visit. There was a network of dry, narrow channels throughout this stretch, which indicated that water flows through it at some point in the year. Substrates were predominantly fine and comprised of clay, sand, and silt. Erosion was noted along the outside bank of the Conestogo River at the inlet to the drainage swale on the east side of the swale. The eroded bank height was approximately 1.0m.

At the location of the WPCP outfall, effluent flows over rip rap before entering the drainage swale. Water was observed flowing from the outlet pipe and overland through the swale during the April reconnaissance site visit. In July, however, only standing pools of water were observed from the outlet with no overland flow. These pools varied in size from approximately $5m^2$ to $200m^2$. Almost all of these pools were noted to hold stranded fish, which were observed to be mostly small-bodied minnow species.

A small amount of watercress and some iron staining was observed within the swale, indicating an area of potential groundwater discharge. The vegetation within the channel downstream of the outlet structure included terrestrial grasses and herbaceous plants, however a greater proportion of the plants were wetland or aquatic species. These included Spotted Joe-pye Weed (*Eupatorium maculatum*), Spotted Water Hemlock (*Cicuta maculata*) and Spotted Jewelweed (*Impatiens capensis*) around the standing pools, and Water Plaintain (*Alisma plantago-aquatica*), Arrowhead (S*agittaria sp.*), and Water Smartweed (*Polygonum amphibium*) within the pools. Moderately heavy algae growth was also noted in the majority of the pools.

At the downstream extent of the drainage swale, a large pool connects to the Conestogo River through a narrow channel. The river splits and flows around a small island near the confluence. The aquatic habitat throughout this area of the Conestogo River is relatively diverse including shallow pools, riffles, and runs, which provide a good amount of cover in addition to undercut banks and overhanging bank vegetation. Substrates vary from coarse gravel and cobble to sand, silt, and clay. Some areas of muck and detritus were also noted.

3.6 Fish and Mussel Community

Historical fish sampling records were obtained from the GRCA and MNRF and have been included in Appendix VII.

Generally, the fish community within the Conestogo River and Conestogo Lake was found to be comprised of species that are common and widespread throughout southern Ontario. The most common species within the study area are indicative of coolwater thermal regimes, however warmwater species were also noted. The fish species known are relatively tolerant to changes in water quality and habitat conditions. Several different environments and trophic levels are represented indicating the presence of a variety of habitats. During the July 28 survey conducted by NRSI biologists, young-of-year Smallmouth Bass (*Micropterus dolomieu*), Rainbow Darter (*Etheostoma caeruleum*), and several small schools of unidentified cyprinids were observed utilizing the habitat near the outlet from the drainage swale within the Conestogo River.

No SAR fish are known to occur within the vicinity of the study area based on DFO SAR red-line mapping (DFO 2015a), NHIC (MNRF 2015b), or correspondence with DFO (D. Balint, pers. comm. 2015) and MNRF (J. Pinder, pers. comm. 2015).

Live freshwater mussels were observed within the Conestogo River in the vicinity of the swale confluence. These were identified as Creeper (*Strophitus undulatus*), a relatively common and widespread species within Ontario.

One SAR mussel species, Rainbow (*Villosa iris*), is known from the Conestogo River in the vicinity of the study area. This species has historically been observed upstream of the study area between Main Street and Wellington Street in Drayton (DFO 2015b). Rainbow mussel is currently listed as Endangered provincially and federally and is protected under Schedule 1 of the Species at Risk Act (SARA). Habitat for this species is also protected under the federal *Fisheries Act*.

Rainbow mussels generally require clean, well-oxygenated stretches of river and are most often found at water depths less than 1m in substrates consisting of cobble, gravel, and sand. They are usually found in or near riffles and along the edges of emergent vegetation in moderate to strong current (COSEWIC 2006). Like many mussels, the larval form of this species requires specific fish hosts to carry out a portion of its life cycle. Potential hosts for the Rainbow in Canada include Striped Shiner (*Luxilus chrysocephalus*), Smallmouth Bass, Largemouth Bass (*Micropterus salmoides*), Green Sunfish (*Lepomis cyanellus*), Greenside Darter (*Etheostoma blennioides*), Rainbow Darter, and Yellow Perch (*Perca flavescens*), several of which are known to occur within the Conestogo River (COSEWIC 2006).

4.0 Natural Feature Significance and Sensitivity

Analysis of the significance and sensitivity of existing natural features was used to identify those features and habitats that are sensitive to disturbance based on the rarity or significance of the feature or the functions/processes and/or policies, legislation, or planning related studies. The following is a brief discussion of the results of this analysis with regards to significant natural areas and features which may represent constraints to be considered as part of the selection of a preferred alternative design for the proposed WPCP upgrades.

4.1 Wetlands

One wetland is present within the study area, a small Reed-canary Grass Graminoid Mineral Meadow Marsh (MAMM1-3), which is unevaluated. This wetland feature is the receiving habitat for the WPCP effluent discharge. All wetlands are considered Core Greenlands in the Wellington County Official Plan (Wellington County 2015). The wetland feature is regulated by the GRCA under Ontario Regulation 150/06. Development or alteration of regulated lands or wetland areas of influence are prohibited unless permitted by the GRCA under policies of Ont. Reg. 150/06. Based on the size of the wetland feature within the study area (i.e.1.3ha), the area of influence around the wetland is 30m from the confirmed wetland boundary (GRCA 2013).

An OWES wetland evaluation of the MAMM1-3 feature may be required during detailed design, in consultation with the MNRF, to further inform protection and impact mitigation measures. The need for the evaluation will be dependent on the design of the preferred alternative and the potential for impact to the feature. Consultation with the GRCA may also be required to confirm and accurately survey the wetland boundary as part of detailed design of the proposed undertaking if there is potential for impact to this feature.

4.2 Woodlands

Woodlands comprise the majority of the natural features within the study area, including areas of coniferous plantation (Map 2). Woodlands greater than 4ha, and plantations greater than 10ha, are considered Significant Woodland, and are included in the Greenlands network in Wellington County (Wellington County 2015). Based on the sizes of the contiguous woodland features within the study area, the following vegetation communities are designated as Significant Woodland: FODM4, FODM5, FOCM6, FOCM4, FOMM7.

Development or site alteration may be permitted in Significant Woodlands or within their adjacent lands (within 120m) provided it is demonstrated to the satisfaction of the County that no negative impacts to the feature or its ecological function will result (Wellington County 2015).

4.3 Valleylands

Valleylands are natural areas that occur in a valley or other landform depression that has water flowing through or standing for some period of the year (MMAH 2014). Significant Valleylands are included in the Greenlands network in Wellington County, however valleylands have not been specifically defined in the Official Plan schedule mapping

(Wellington County 2015). The following vegetation communities within the study area may qualify as Significant Valleyland: FODM5, TAGM1, FOCM6, and FOCM4.

Development or site alteration may be permitted in Significant Valleylands or within their adjacent lands (within 120m) provided it is demonstrated to the satisfaction of the County that no negative impacts to the feature or its ecological function will result (Wellington County 2015).

4.4 Significant Wildlife Habitat

The results of background information review, agency consultation, and field studies were used to assess the presence of SWH within the study area based on the PPS (MMAH 2014), the Natural Heritage Reference Manual (MNRF 2010) and the SWHTG (MNRF 2015c).

Based on background information and field investigations, a total of 4 SWH types were confirmed within the study area: Special Concern and Rare Wildlife Species, Seeps and Springs, Terrestrial Crayfish, and Deer Winter Congregation Area. Development or site alteration is not permitted within or adjacent to (within 120m) SWH unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions as outlined in Section 2.1.5 of the PPS (MMAH 2014). This is also consistent with the Wellington County OP (2015). The following sections briefly discuss each of the Confirmed SWH types, which are also shown on Map 4.

Special Concern and Rare Wildlife Species
Special Concern and Rare Wildlife Species are those species defined above as SCC. The following SCC were confirmed within the study area during field studies conducted in 2015: Eastern Wood-pewee, and American Gromwell. Refer to Tables 2 and 3 earlier in this report for the locations of these SCC observations. The valley woodlands between the WPCP and the Conestoga River are therefore confirmed SWH.

Seeps and Springs
Seeps and Springs are areas where ground water comes to the surface and are often found within headwater areas within forested habitats (MNRF 2015c). Multiple seeps were observed within the FOCM4 vegetation community, qualifying this vegetation community as SWH.

Terrestrial Crayfish
Terrestrial Crayfish inhabit wet meadows, mudflats, and edges of shallow marshes by constructing burrows in suitable habitats (MNRF 2015c). Several crayfish chimneys were observed within the MAMM1-3 vegetation community, qualifying this habitat as SWH.

Deer Winter Congregation Area
A Deer Winter Congregation Area has been identified by MNRF within and adjacent to the study area. The Congregation Area is associated with the Conestogo River valley and adjacent treed areas extending approximately from the Town of Drayton to the northeastern extent of the Conestogo Lake

Conservation Area, where the river intersects Concession Road 8. An undefined Animal Movement Corridor is associated with this SWH type.

As well, the following SWH types remain as Candidate SWH for the study area: Bat Maternity Colonies, and Turtle Nesting Area. All other candidate SWH types were ruled out as not occurring within the study area.

4.5 Fish Habitat

The Conestogo River offers direct habitat for a variety of warmwater and coolwater predatory and baitfish species year round. The swale within the study area was noted to provide direct fish habitat as well, including seasonal habitat for certain species. During spring freshet water is likely to flow through the entire length of the swale as the water levels within the Conestogo River rise. This allows fish access to the swale in the spring. A dead adult Northern Pike was observed near the eastern end of the swale in April, 2015, which indicates that there is access here at some point in the year. Northern Pike spawn in the spring following ice-off, utilizing inundated areas of riparian vegetation to lay their eggs (Eakins 2015) and may be using the inundated drainage swale to spawn. As water levels inundate the swale it also provides access for other fish species. This was evident during summer aquatic habitat surveys as small-bodied fish were observed within the disconnected pools throughout the swale. When water levels decrease throughout the spring and summer, fish stranding occurs as pools are disconnected from the main channel of the Conestogo River. One large pool was observed to be connected to the Conestogo River at the downstream extent of the swale, allowing fish to access it throughout the summer. A decrease in water levels as a result of management of the downstream dam or environmental conditions may cause this pool to disconnect at times of very low water.

Any physical works proposed within the swale (i.e. the WPCP pipe outfall) will require a DFO self-assessment screening exercise. The self-assessment tool is utilized to determine if serious harm to fish or fish habitat, as defined by the federal *Fisheries Act*, will occur based on details of the proposed activity. DFO should be made aware of the proposed undertaking to ensure that the project is not causing serious harm to fish or fish habitat (D. Balint, pers. comm. 2015). The *Fisheries Act* also establishes regulations that include minimum effluent quality standards under the *Wastewater Systems Effluent Regulations*. These regulations specify requirements for monitoring, record-keeping, reporting, and toxicity testing and are administered through Environment Canada. Both DFO and Environment Canada should be consulted throughout the course of the project.

4.6 Habitat of Provincially Endangered and Threatened Species

Species at Risk observations within the study area is limited to Bobolink. In addition, as identified in the SAR/SCC screening exercise (Appendix I), suitable habitats exist within the study area for several SAR bats, fish, and a freshwater mussel species. These species and their respective habitats are discussed in further detail below.

Bobolink
Pasture fields (OAGM4) within the study area may provide suitable breeding habitat for Bobolink. Suitable breeding habitat for Bobolink includes, but is not

limited to, hayfields, pastures, old or abandoned fields, remnant prairies, savannahs, or alvar grasslands (MNRF 2013). This species is designated as provincially Threatened; therefore, this species and its general habitat is protected under the ESA. Similar to many grassland birds in Ontario, Bobolink populations are shrinking due to changes in land use and the loss of suitable habitat that has resulted from development and changes in agricultural practices. Habitat for Bobolink is protected under the General Habitat provisions of the ESA and is categorized as 1) a nest area and 10 m around the nest, 2) the area between 10 m and 60 m of the nest or center of approximated defended territory, and 3) the area of continuous suitable habitat between 60 m and 300 m of the nest or approximated center of defended territory (MNRF 2013).

A total of 3 Bobolink individuals were observed on the subject property within the agricultural field (OAGM1) and the adjacent Disturbance Area (Map 2a) during the June 9 field visit. The OAGM1 polygon is characterized by annual row crops (i.e. corn, soy, wheat), whereas the Disturbance Area is characterized by sparse weedy vegetation resulting from past disturbance from the adjacent settling pond constructions. As such, suitable breeding habitat for Bobolink does not exist within the Mapleton WPCP subject property but is present within the study area in the pastures (OAGM4) on adjacent lands. Within the scope of this study, Bobolink nesting was not confirmed within the Mapleton WPCP subject property, however there is no suitable breeding habitat on-site.

Little Brown Myotis and Northern Myotis
Little Brown Myotis (*Myotis lucifuga*) will use buildings and occasionally tree cavities as maternity and day roost sites (MNRF 2000), both of which are present within the study area. Northern Myotis (*Myotis septentrionalis*) prefer tree cavities or spaces under loose bark and will occasionally use buildings for maternity and day roost sites (MNRF 2000), all of which are also present within the study area. These species are listed as Endangered in Ontario; therefore, these species and their general habitats are protected under the ESA. Myotis species are experiencing significant declines in population sizes throughout eastern North America due to the fungus, *Pseudogymnoascus destructans* which causes “white nose syndrome”, and is terminal to bats. Bats are affected by the fungus during hibernation where it grows on their muzzles, ears, and wing membranes and results in the arousal of individuals from hibernation more frequently, and/or for longer periods than normal, and in the premature expenditure of fat reserves which they rely on for winter survival.

Specific field surveys to identify suitable bat habitat were not conducted within the scope of this study. Trees and/or buildings within the study area may provide suitable maternity colony or roosting habitat for SAR bats. If the proposed undertaking includes removal of suitable bat habitat, additional targeted surveys may be required, in consultation with the MNRF, to assess the use of these habitats by SAR bats. The need for targeted surveys and MNRF consultation will be determined based on details of the preferred alternative design.

Rainbow Mussel

The Conestogo River provides suitable habitat that may be utilized by Rainbow mussels in the vicinity of the study area. These habitats include gravel and cobble riffles and runs with moderate flow and water depths less than 1 m. No suitable habitat for Rainbow was found in the swale. The aquatic habitat in the swale was limited to shallow, standing pools of water that may dry up during summer months. Many of these pools were observed with algae mats and provided no riffle habitat or gravel/cobble substrates.

Rainbow mussel is designated as Threatened provincially and Endangered federally; therefore, this species and its general habitat are protected provincially under the ESA and federally under the SARA. The MNRF and DFO should be involved throughout the design phase to ensure there are no impacts to Rainbow mussel or its habitat.

Due to the nature of the project, there may be impacts related to water quality, which may have an effect of Rainbow mussels as a result of their feeding habits. Water quality objectives and best practices should be incorporated as per Environment Canada and MOECC to achieve the effluent quality standards as set out by the *Wastewater Systems Effluent Regulations* of the *Fisheries Act*, regulations under the *Ontario Water Resources Act*, and under the *Environmental Protection Act* (if applicable).

5.0 Summary of Natural Feature Constraints

A summary of natural features identified as constraints to the proposed Mapleton WPCP works are provided below and are shown on Map 4. Although many of these features are identified as significant, there are allowances in the provincial and local policies to permit activities that create or maintain infrastructure authorized under an EA process. The design of the preferred alternative should seek to minimize impacts to these features wherever possible.

- The swale wetland feature Reed-canary Grass Graminoid Mineral Meadow Marsh (MAMM1-3, Map 2a) is protected under provincial and local policies and regulated by the GRCA.
- Significant Woodlands are associated with portions of the forested area between the Mapleton WPCP settling ponds and the Conestogo River. Additional studies may be required once the preferred alternative is selected to inform potential impacts to these features (e.g. slope stability assessment).
- The design of the preferred alternative should have regard for SWH; additional targeted surveys may be considered during detailed design to confirm/rule out Candidate SWH.
- The Conestogo River upstream and downstream of the study area provides potential habitat for Rainbow mussel, a SAR. Potential effluent impacts to water quality will need to be considered and consultation with Environment Canada and DFO should occur once the preferred alternative is selected.
- The Conestogo River upstream and downstream of the study area provides fish habitat. Limited fish habitat was also observed within the swale on a seasonal basis. If physical works within the Conestogo River or swale are planned as part of the preferred alternative, then consultation with DFO will be required to ensure there is no serious harm to fish as per the Fisheries Act.
- Potential habitat for SAR bats is present within the forested portions of the study area. Potential impacts to these SAR will need to be considered in consultation with MNRF once the preferred alternative is selected.

6.0 References

Bird Studies Canada, Environment Canada's Canadian Wildlife Service, Ontario Nature, Ontario Field Ornithologists and Ontario Ministry of Natural Resources. 2006. Ontario Breeding Bird Atlas Database, 31 January 2008. http://www.birdsontario.org/atlas/aboutdata.jsp?lang=en (Accessed September 2015)

Bird Studies Canada (BSC). 2009. Marsh Monitoring Program Participant's Handbook for Surveying Amphibians. 2009 Edition. Published by Bird Studies Canada in Cooperation with Environment Canada and the U.S. Environmental Protection Agency. February 2009.

COSEWIC. 2006. COSEWIC assessment and status report on the Rainbow mussel Villosa iris in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 38 pp. www.sararegistry.gc.ca/status/status_e.cfm.

Department of Fisheries and Oceans Canada (DFO). 2015a. Aquatic Species at Risk Red-line Mapping. http://www.conservation-ontario.on.ca/what-we-do/watershed-stewardship/aquatic-species-at-risk.

Department of Fisheries and Oceans Canada (DFO). 2015b. Species at Risk Site Summary Report.

Dobbyn, J.S. 1994. Atlas of the Mammals of Ontario. Don Mills, Federation of Ontario Naturalists.

Dougan and Associates. 2009. City of Guelph Natural Heritage Strategy Phase 2: Terrestrial Inventory & Natural Heritage System Updates. Vol2. Appendices.

Eakins, R. J. 2015. Ontario Freshwater Fishes Life History Database. Version 4.61. On-line database. (http://www.ontariofishes.ca) (Accessed November 2015).

Government of Canada. 2015. Species at Risk Public Registry: Species Index. Last updated May 29, 2015. http://www.sararegistry.gc.ca/sar/index/default_e.cfm (Accessed November 2015)

Grand River Conservation Authority (GRCA). 2015. Grand River Conservation Network: Interactive Mapping Tool. http://www.grandriver.ca/index/document.cfm?Sec=63&Sub1=0&sub2=0

Grand River Conservation Authority (GRCA). 2013. Policies for the Administration for the Development Interference with Wetlands and Alterations of Shorelines and Watercourses Regulation: Ontario Regulation 150/06. January 25, 2013.

Grand River Conservation Authority (GRCA). 2005. GRCA's EIS Guidelines and Submissions Standards for Wetlands. August 26, 2005.

Jones, C., R. Layberry, and A. Macnaughton. 2015. Ontario Butterfly Atlas Online. Toronto Entomologists' Association. Last updated June 1, 2015. http://www.ontarioinsects.org/atlas_online.htm (Accessed July 2015).

Layberry, R.A., P.W. Hall, and J.D. Lafontaine. 1998. The Butterflies of Canada. University of Toronto Press, Toronto, Canada.

Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig and S. McMurray. 1998. Ecological Land Classification for Southern Ontario: First Approximation and its Application. Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.

Lee, H. 2008. Southern Ontario Ecological Land Classification - Vegetation Type List. Ontario Ministry of Natural Resources: London, Ontario.

Ontario Breeding Bird Atlas (OBBA). 2001. Guide for Participants. Atlas Management Board, Federation of Ontario Naturalists, Don Mills.

Ontario Ministry of Municipal Affairs and Housing (MMAH). 2014. Provincial Policy Statement.

Ontario Ministry of Natural Resources and Forestry (MNRF). 2015a. Species at Risk in Ontario (SARO) List. Accessed November 2015. http://www.ontario.ca/environment-and-energy/species-risk-ontario-list

Ontario Ministry of Natural Resources and Forestry (MNRF). 2015b. Natural Heritage Information Centre (NHIC): Biodiversity Explorer, Land Information Ontario. Accessed November 2015. http://www.giscoeapp.lrc.gov.on.ca/web/MNR/NHLUPS/NaturalHeritage/Viewer/Viewer.html

Ontario Ministry of Natural Resources and Forestry (MNRF). 2015c. Significant Wildlife Habitat Ecoregion 6E Criterion Schedule: Addendum to Significant Wildlife Habitat Technical Guide. MNRF, January 2015.

Ontario Ministry of Natural Resources and Forestry (MNRF). 2014. Wellington County Upper Tier Species At Risk List. September 25, 2014.

Ontario Ministry of Natural Resources and Forestry (MNRF). 2013. General Habitat Description for the Bobolink (*Dolichonyx oryzivorus*).

Ontario Ministry of Natural Resources and Forestry (MNRF). 2010. Natural Heritage Reference Manual for Policies of the Provincial Policy Statement, Second Edition. March 18, 2010.

Ontario Ministry of Natural Resources and Forestry (MNRF). 2000. Significant Wildlife Habitat Technical Guide. October 2000.

Ontario Nature. 2015. Reptiles and Amphibians of Ontario Range Maps. Last Updated June 2015. http://www.ontarioinsects.org/herpatlas/herp_online.html (Accessed July 2015).

Reznicek, A.A., E.G. Voss, and B.S. Walters. 2011. Michigan Flora Online. University of Michigan, February 2011. Accessed June 26, 2015. http://www.michiganflora.net/home.aspx

Wellington County. 2015. Wellington County Official Plan. Amendment made February 17, 2015.

Authorities Consulted

Balint, David. 2015. Species at Risk Coordinator, Department of Fisheries and Oceans Canada. Personal Communication (e-mail correspondence to Steve Burgin), November 12, 2015.

Pinder, Jessica. 2015. Assistant Fisheries Technician, Ministry of Natural Resources and Forestry, Guelph District. Personal Communication (e-mail correspondence to Todd Hagedorn), May 14, 2015.

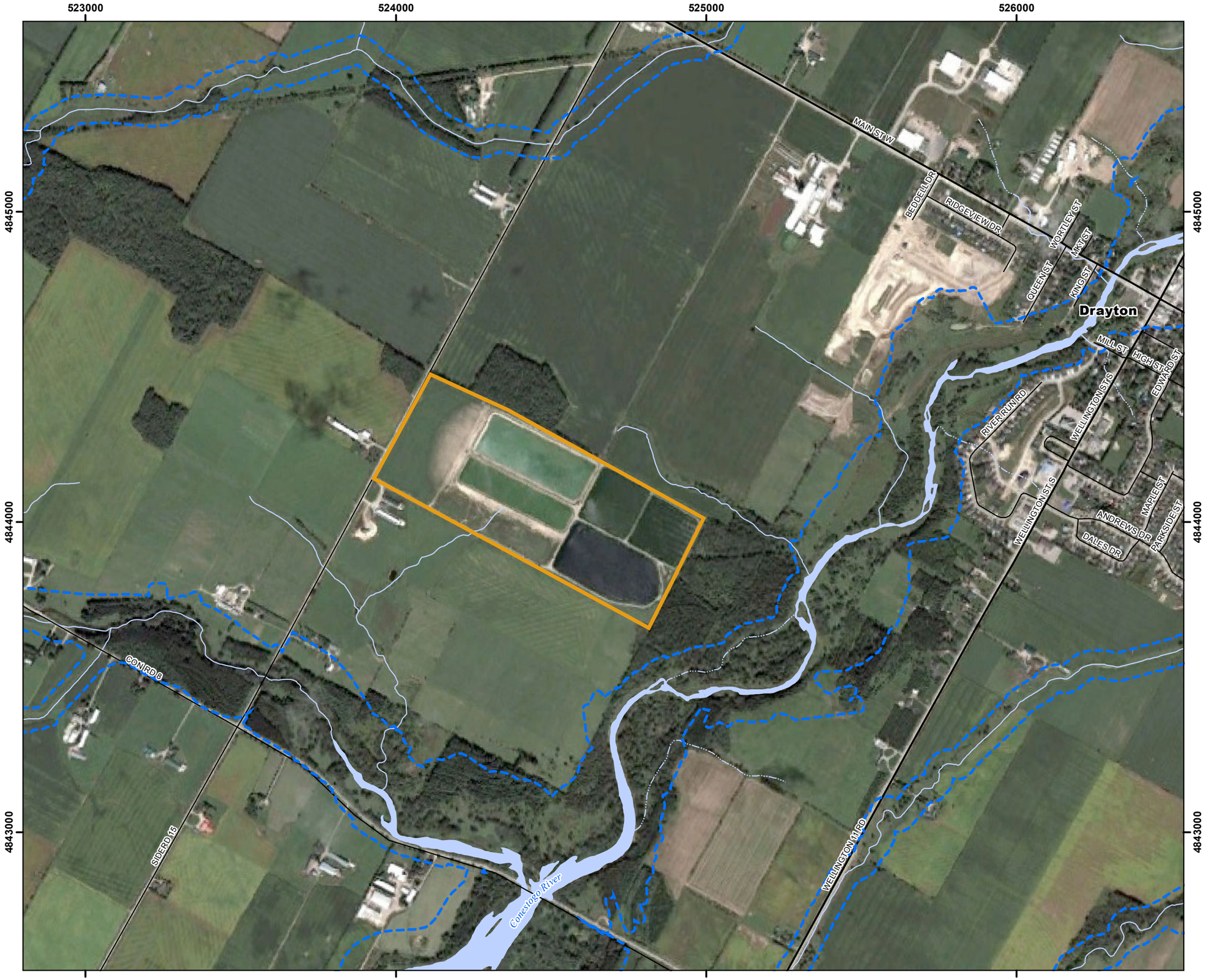
Wagler, Jason. 2015. Resource Planner, Grand River Conservation Authority. Personal Communication (e-mail correspondence to Todd Hagedorn), May 7, 2015.

MAPS

Map 1

Mapleton WPCP Class EA

Study Area



Legend

- Subject Property
- Primary Road
- Secondary Road
- Permanent Watercourse
- Intermittent Watercourse
- GRCA Regulation Limit
- Water Body

Natural Resource Solutions Inc.
Aquatic, Terrestrial and Wetland Biologists

Project: 1615 Date: December 14, 2015	NAD83 - UTM Zone 17 Size: 11x17" **1:12,000**

0 200 400 600 800 Metres

N

Path: X:\1615_MapletonWWTPClassEA\NRSI_1615_Map1_StudyArea_12K_2015_12_02_MGN.mxd

Map 2a

Mapleton WPCP Class EA

Vegetation Communities and Wildlife Survey Locations

Legend

- Subject Property
- Anuran Station (ANR)
- Effluent Discharge Point
- Effluent Outlet Pipe
- Permanent Watercourse
- Intermittent Watercourse
- Ecological Land Classification (ELC)

(CVI_3) Sewage and Water Treatment
(CVR_4) Rural Property
(FOCM4) Fresh-Moist White Cedar Coniferous Forest Ecosite
(FOCM6) Naturalized Coniferous Plantation
(FODM/SWDM) Deciduous Forest/Deciduous Swamp
(FODM4) Dry-Fresh Upland Deciduous Forest Ecosite
(FODM5) Dry-Fresh Sugar Maple Deciduous Forest Ecosite
(FOMM7) Fresh-Moist White Cedar-Hardwood Mixed Forest Ecosite
(MAMM1-3) Reed-canary Grass Graminoid Mineral Meadow Marsh Type
(OAGM1) Annual Row Crops
(OAGM4) Pasture
(TAGM1) Coniferous Plantation

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Aquatic, Terrestrial and Wetland Biologists

Project: 1615
Date: December 14, 2015

NAD83 - UTM Zone 17
Size: 11x17"
1:6,000

0 100 200 300 Metres

N

Path: X:\1615_MapletonWWTPClassEA\NRSI_1615_Map2_ELC_5K_2015_12_01_MGN.mxd

Map 2b

Mapleton WPCP Class EA

Vegetation Communities and Wildlife Survey Locations

526000 526200 526400

4844800 4844600 4844400

RIDGEVIEW DR
QUEEN ST
KING ST
MKT ST
MAIN ST W
MAIN ST E
WELLINGTON ST N
WELLINGTON ST S
MILL ST
HIGH ST
SPRING ST
EDWARD ST
RIVER RUN RD

Drayton

FODM7-7
MAMM1-3
FODM7-7
MAMM1-3
FODM7-7

Legend

- Permanent Watercourse
- Intermittent Watercourse
- Ecological Land Classification (ELC)

(FODM7-7) Fresh-Moist Manitoba Maple Lowland Deciduous Forest Type

(MAMM1-3) Reed-canary Grass Graminoid Mineral Meadow Marsh Type

NATURAL RESOURCE SOLUTIONS INC.
Aquatic, Terrestrial and Wetland Biologists

Project: 1615
Date: December 14, 2015

NAD83 - UTM Zone 17
Size: 11x17"
1:2,000

0 30 60 90 120 Metres

N

Path: X:\1615_MapletonWWTPClassEA\NRSI_1615_Map2_ELC_5K_2015_12_01_MGN.mxd

Map 2c

Mapleton WPCP Class EA

Vegetation Communities and Wildlife Survey Locations

Legend

- Ecological Land Classification (ELC)
- (CVI_3) Sewage and Water Treatment
- (CVR_4) Rural Property
- (OAGM1) Annual Row Crops

NATURAL RESOURCE SOLUTIONS INC.
Aquatic, Terrestrial and Wetland Biologists

Project: 1615
Date: December 14, 2015

NAD83 - UTM Zone 17
Size: 11x17"
1:2,000

N

0 30 60 90 120 Metres

Path: X:\1615_MapletonWWTPClassEA\NRSI_1615_Map2_ELC_5K_2015_12_01_MGN.mxd

Map 3

Mapleton WPCP Class EA

Aquatic Habitat Survey Locations

Legend

- Subject Property
- Aquatic Habitat Point
- Watercress and Iron Staining
- Effluent Discharge Point
- Effluent Outlet Pipe
- Permanent Watercourse
- Intermittent Watercourse
- Water Body
- GRCA Regulation Limit

Natural Resource Solutions Inc.
Aquatic, Terrestrial and Wetland Biologists

Project: 1615
Date: December 14, 2015

NAD83 - UTM Zone 17
Size: 11x17"
1:5,000

N

0 100 200 300 Metres

Path: X:\1615_MapletonWWTPClassEA\NRSI_1615_Map3_AQUHabitat_5K_2015_12_01_MGN.mxd

Map 4

Mapleton WPCP Class EA

Natural Features Constraints

Legend

- Subject Property
- Permanent Watercourse
- Intermittent Watercourse
- GRCA Regulation Limit
- Seeps and Springs
- Terrestrial Crayfish
- Special Concern and Rare Wildlife Species
- Core Greenlands
- Greenlands
- Deer Winter Congregation Area

NATURAL RESOURCE SOLUTIONS INC.
Aquatic, Terrestrial and Wetland Biologists

Project: 1615 Date: December 14, 2015	NAD83 - UTM Zone 17 Size: 11x17" **1:5,000**

0 100 200 300 Metres

N

Path: X:\1615_MapletonWWTPClassEA\NRSI_1615_Map4_NaturalFeaturesConstraints_5K_2015_11_27_MGN.mxd

APPENDIX I

Species at Risk and Species of Conservation Concern Habitat Screening Results

Federally, Provincially and Regionally Significant Species Known from the Study Area and Vicinity

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Habitat Preference[5,6,7,8]	Background Source	Suitable Habitats within Study Area	Observed by NRSI
Vascular Flora									
Castanea dentata	American Chestnut	S2	END	E	Schedule 1	Moist to well drained forests on sand, occasionally heavy soils.	MNRF 2014	No	No
Juglans cinerea	Butternut	S3?	END	E	Schedule 1	Generally grows in rich, moist, and well-drained soils often found along streams. It may also be found on well-drained gravel sites, especially those made up of limestone. It is also infrequently found on dry, rocky and sterile soils.	MNRF 2014	Yes	No
Lithospermum latifolium	American Gromwell	S3	--	--	--	River floodplains, woods and open areas near edges of woods.	MNRF 2015b	Yes	Yes
Panax quinquefolius	American Ginseng	S3	END	E	Schedule 1	Deep leaf litter in rich, moist deciduous woods, especially on rocky, shaded cool slopes in sweet soil.	MNRF 2014	No	No
Potamogeton hillii	Hill's Pondweed	S2	SC	SC	Schedule 1	Highly alkaline waters of ditches, beaver ponds and slow-moving cold waters.	MNRF 2014	No	No
Birds									
Ammodramus henslowii	Henslow's Sparrow	SHB	END	E	Schedule 1	Large, fallow, grassy area with ground mat of dead vegetation, dense herbaceous vegetation, ground litter and some song perches; neglected weedy fields; wet meadows; cultivated uplands; a moderate amount of moisture needed; requires a minimum tract of grassland of 40 ha, but usually in areas >100 ha.	MNRF 2014	No	No
Asio flammeus	Short-eared Owl	S2N, S4B	SC	SC	Schedule 3	Grasslands, open areas or meadows that are grassy or bushy; marshes, bogs or tundra; both diurnal and nocturnal habits; ground nester; destruction of wetlands by drainage for agriculture is an important factor in the decline of this species; home range 25 - 125 ha; requires 75-100 ha of contiguous open habitat.	MNRF 2014	No	No
Caprimulgus vociferus	Eastern Whip-poor-will	S4B	THR	T	Schedule 1	Dry, open, deciduous woodlands of small to medium trees; oak or beech with lots of clearings and shaded leaflitter; wooded edges, forest clearings with little herbaceous growth; pine plantations; associated with >100ha forests.	MNRF 2014	No	No

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Habitat Preference[5,6,7,8]	Background Source	Suitable Habitats within Study Area	Observed by NRSI
Cardellina canadensis	Canada Warbler	S4B	SC	T	Schedule 1	Interior forest species; dense, mixed coniferous, deciduous forests with closed canopy, wet bottomlands of cedar or alder; shrubby undergrowth in cool moist mature woodlands; riparian habitat; usually requires at least 30ha.	MNRF 2014	No	No
Chaetura pelagica	Chimney Swift	S4B, S4N	THR	T	Schedule 1	Commonly found in urban areas near buildings; nests in hollow trees, crevices of rock cliffs, chimneys; highly gregarious; feeds over open water.	MNRF 2014; BSC et al. 2008	No	No
Childonias niger	Black Tern	S3B	SC	NAR	--	Wetlands, coastal or inland marshes; large cattail marshes, marshy edges of rivers, lakes or ponds, wet open fens, wet meadows; returns to same area to nest each year in loose colonies; must have shallow (0.5 to 1m deep) water and areas of open water near nests; requires marshes >20 ha in size; feeds over adjacent grasslands.	MNRF 2014	No	No
Chordeiles minor	Common Nighthawk	S4B	SC	T	Schedule 1	Open ground; clearings in dense forests; ploughed fields; gravel beaches or barren areas with rocky soils; open woodlands; flat gravel roofs.	MNRF 2014	No	No
Colinus virginianus	Northern Bobwhite	S1	END	E	Schedule 1	Grassland, prairie or hay fields with woody cover in form of thickets, tangles of vines, shrubs; fence rows or woodland edges; cropland growing corn, soybeans or small grains and clover or grass; well-drained sandy or loamy soil; pond edges.	MNRF 2014	No	No
Contopus cooperi	Olive-sided Flycatcher	S4B	SC	T	Schedule 1	Semi-open, conifer forest, prefers spruce; near pond, lake or river; treed wetlands for nesting; burns with dead trees for perching.	MNRF 2014	No	No
Contopus virens	Eastern Wood-pewee	S4B	SC	SC	--	Open, deciduous, mixed or coniferous forest; predominated by oak with little understory; forest clearings, edges; farm woodlots, parks.	MNRF 2014; BSC et al. 2008	Yes	Yes

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Habitat Preference[5,6,7,8]	Background Source	Suitable Habitats within Study Area	Observed by NRSI
Dolichonyx oryzivorus	Bobolink	S4B	THR	T	--	Large, open expansive grasslands with dense ground cover; hayfields, meadows or fallow fields; marshes; requires tracts of grassland >50 ha.	MNRF 2015b; MNRF 2014; BSC et al. 2008	Yes, suitable habitat occurs within adjacent agricultural lands, however not within the subject property.	Yes
Empidonax virescens	Acadian Flycatcher	S2S3B	END	E	Schedule 1	Mature, shady, deciduous forests; heavily wooded ravines; creek bottoms or river swamps; availability of good quality habitat is limiting factor; needs at least 30 ha of forest.	MNRF 2014	No	No
Haliaeetus leucocephalus	Bald Eagle	S2N, S4B	SC	NAR	--	Require large continuous area of deciduous or mixed woods around large lakes, rivers; require area of 255 ha for nesting, shelter, feeding, roosting; prefer open woods with 30 to 50% canopy cover; nest in tall trees 50 to 200m from shore; require tall, dead, partially dead trees within 400 m of nest for perching.	MNRF 2014	Yes	No
Hirundo rustica	Barn Swallow	S4B	THR	T	--	Farmlands or rural areas; cliffs, caves, rock niches; buildings or other man-made structures for nesting; open country near body of water.	MNRF 2014; BSC et al. 2008	Yes. Man-made structures on-site.	No
Hylocichla mustelina	Wood Thrush	S4B	SC	T	--	Undisturbed moist mature deciduous or mixed forest with deciduous sapling growth; near pond or swamp; hardwood forest edges; must have some trees higher than 12m.	MNRF 2014; BSC et al. 2008	Yes	No
Icteria virens	Yellow-breasted Chat	S2B	END	E	Schedule 1	Thickets, tall tangles of shrubbery beside streams, ponds; requires tracts of grassland >50 ha overgrown bushy clearings with deciduous thickets; nests above ground in bush, vines etc.	MNRF 2014	No	No
Ixobrychus exilis	Least Bittern	S4B	THR	T	Schedule 1	Deep marshes, swamps, bogs; marshy borders of lakes, ponds, streams, ditches; dense emergent vegetation of cattail, bulrush, sedge; nests in cattails; intolerant of loss of habitat and human disturbance.	MNRF 2014	No	No

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Habitat Preference[5,6,7,8]	Background Source	Suitable Habitats within Study Area	Observed by NRSI
Lanius ludovicianus	Loggerhead Shrike	S2B	END	E	Schedule 1	Grazed pasture, marginal farmland with scattered hawthorn shrubs, hedgerows; fence posts, wires and associated low-lying wetland; located on core areas of limestone plain adjacent to Canadian Shield; greatest threat is fragmentation of suitable habitat due to natural succession; probably needs at least 25 ha of suitable habitat.	MNRF 2014	No	No
Melanerpes erythrocephalus	Red-headed Woodpecker	S4B	SC	T	Schedule 1	Open, deciduous forest with little understory; fields or pasture lands with scattered large trees; wooded swamps; orchards, small woodlots or forest edges; groves of dead or dying trees; feeds on insects and stores nuts or acorns for winter; loss of habitat is limiting factor; requires cavity trees with at least 40 cm dbh; require about 4 ha for a territory.	MNRF 2014	No	No
Parkesia motacilla	Louisiana Waterthrush	S3B	SC	SC	Schedule 1	Prefers wooded ravines with running streams; also woodlands swamps; large tracts of mature deciduous or mixed forests; canopy cover is essential; has strong affinity to nest sites; nests on ground.	MNRF 2014	No	No
Riparia riparia	Bank Swallow	S4B	THR	T	--	Sand, clay or gravel river banks or steep riverbank cliffs; lakeshore bluffs of easily crumbled sand or gravel; gravel pits, road-cuts, grassland or cultivated fields that are close to water.	MNRF 2014; BSC et al. 2008	No	No
Setophaga citrina	Hooded Warbler	S3B	SC	NAR	Schedule 1	Favours mature, deciduous forest (Carolinian), particularly along stream bottoms, ravine edges and where saplings and shrubbery grow; nests above ground in small shrubs; feeds on or near ground.	MNRF 2014	No	No
Sturnella magna	Eastern Meadowlark	S4B	THR	T	--	Open, grassy meadows, farmland, pastures, hayfields or grasslands with elevated singing perches; cultivated land and weedy areas with trees; old orchards with adjacent, open grassy areas >10 ha in size.	MNRF 2015b; MNRF 2014; BSC et al. 2008	Yes, suitable habitat occurs within adjacent agricultural lands, however not within the subject property.	No

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Habitat Preference[5,6,7,8]	Background Source	Suitable Habitats within Study Area	Observed by NRSI
Tyto alba	Barn Owl	S1	END	E	Schedule 1	Open areas such as fields, agricultural lands with scattered woodlots, buildings and/or orchards; grasslands, sedge meadows, marshes; snow-cover limits ability to catch prey; species has intolerance to severe cold; nests in hollow trees and live trees >46 cm dbh; also nests in barns, abandoned buildings.	MNRF 2014	No	No
Vermivora chrysoptera	Golden-winged Warbler	S4B	SC	T	Schedule 1	Early successional habitat; shrubby, grassy abandoned fields with small deciduous trees bordered by low woodland and wooded swamps; alder bogs; deciduous, damp woods; shrubbery clearings in deciduous woods with saplings and grasses; brier-woodland edges; requires >10 ha of habitat.	MNRF 2014	No	No
Herpetofauna									
Ambystoma jeffersonianum	Jefferson Salamander	S2	END	E	Schedule 1	Damp shady deciduous forest, swamps, moist pasture, lakeshores; temporary woodland pools for breeding; hides under leaf litter, stones or in decomposing logs.	MNRF 2014	No	No
Chelydra serpentina serpentina	Snapping Turtle	S3	SC	SC	Schedule 1	Permanent, semi-permanent fresh water; marshes, swamps or bogs; rivers and streams with soft muddy banks or bottoms; often uses soft soil or clean dry sand on south-facing slopes for nest sites.	MNRF 2014; Ontario Nature 2015	Yes	Yes
Clemmys guttata	Spotted Turtle	S3	END	E	Schedule 1	Unpolluted, shallow bodies of water such as streams, ponds, wet meadows, marshes or swamps with aquatic vegetation, logs or clumps of vegetation for basking. Nest is dug near water in fine-textured soil (e.g. sand) or moss. Vulnerable to factors affecting water quality, vegetation composition and structure. Average home range size 3.7 ha.	MNRF 2014	No	No
Emydoidea blandingii	Blanding's Turtle (*Great Lakes/St Lawrence pop.*)	S3	THR	T	Schedule 1	Shallow water marshes, bogs, ponds or swamps, or coves in larger lakes with soft muddy bottoms and aquatic vegetation; basks on logs, stumps, or banks.	MNRF 2014	No	No

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Habitat Preference[5,6,7,8]	Background Source	Suitable Habitats within Study Area	Observed by NRSI
Graptemys geographica	Northern Map Turtle	S3	SC	SC	Schedule 1	Large bodies of water with soft bottoms, and aquatic vegetation; basks on logs or rocks or on beaches and grassy edges, will bask in groups; uses soft soil or clean dry sand for nest sites; may nest at some distance from water; home range size is larger for females (about 70ha) than males (about 30ha) and includes hibernation, basking, nesting and feeding areas; aquatic corridors (e.g. stream) are required for movement.	MNRF 2014	No	No
Lampropeltis taylori triangulum	Eastern Milksnake	S3	SC	SC	Schedule 1	Farmlands, meadows, hardwood or aspen stands; pine forest with brushy or woody cover; river bottoms or bog woods; hides under logs, stones, or boards or in outbuildings.	MNRF 2014	Yes	No
Sistrurus catenatus	Massasauga Rattlesnake	S3	THR	T	Schedule 1	use upland, old field in summer; marsh, shrub swamp or bog; rivers and streams that provide sedge or low vegetative growth; in fall and winter; hibernate underground in mammal burrows, under rotting stumps,in rock crevices	MNRF 2014	No	No
Thamnophis butleri	Butler's Gartersnake	S2	END	E	Schedule 1	wet meadows, pastures, margins of marshes and streams, and open country	MNRF 2014	No	No
Thamnophis sauritus septentrionalis	Eastern Ribbonsnake	S3	SC	SC	Schedule 1	Sunny grassy areas with low dense vegetation near bodies of shallow permanent quiet water; wet meadows, grassy marshes or sphagnum bogs; borders of ponds, lakes or streams.	MNRF 2014	Yes	No
Mammals									
Myotis leibii	Eastern Small-footed Bat	S2S3	END	--	--	roosts in caves, mine shafts, crevices or buildings that are in or near woodland; hibernates in cold dry caves or mines; maternity colonies in caves or buildings; hunts in forests	MNRF 2014	No	No
Myotis lucifuga	Little Brown Myotis	S4	END	E	Schedule 1	uses caves, quarries, tunnels, hollow trees or buildings for roosting; winters in humid caves; maternity sites in dark warm areas such as attics and barns; feeds primarily in wetlands, forest edges	MNRF 2014	Yes	No

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Habitat Preference[5,6,7,8]	Background Source	Suitable Habitats within Study Area	Observed by NRSI
Myotis septentrionalis	Northern Myotis	S3	END	E	Schedule 1	hibernates during winter in mines or caves; roosts in houses, manmade structures but prefers hollow trees or under loose bark; hunts within forests, below canopy	MNRF 2014	Yes	No
Urocyon cineroargenteus	Grey Fox	S1	THR	T	Schedule 1	Hardwood forests with a mix of fields and woods; swamps; wooded, brushy or rocky habitats; woodland farmland edge; old fields with thickets. Dens in hollow log or tree. Individual has numerous winter dens throughout its range which is > 40ha.	MNRF 2014	No	No
Insects									
Bombus affinis	Rusty-patched Bumblebee	S1	END	E	Schedule 1	can be found in open habitat such as mixed farmland, urban settings, savannah, open woods and sand dunes	MNRF 2015b; MNRF 2014	No	No
Danaus plexippus	Monarch	S2N, S4B	SC	SC	Schedule 1	Host plant is Milkweed (*Asclepias* spp.)	MNRF 2014	No. Host plant not observed.	No
Euphyes dion	Dion Skipper	S3	--	--	--	Host plants are sedges: *Carex lacustris; Carex hyalinolepis; Carex stricta.*	Jones et al. 2015	Yes. Host plant observed.	No
Pieris virginiensis	West Virginia White	S3	--	SC	--	Host plant is Toothwort (*Cardamine* spp.)	MNRF 2014	Yes. Host plant observed.	No
Fish									
Clinostomus elongatus	Redside Dace	S2	END	E	Schedule 3	generally found in pools and slow-moving areas of small headwater streams with a moderate to high gradient	MNRF 2014	No	No
Moxostoma duquesnei	Black Redhorse	S2	THR	T	--	generally lives in moderately sized rivers and streams, with generally moderate to fast currents; it is not known to occur upstream of Conestogo Lake	MNRF 2014	No	No
Notropis photogenis	Silver Shiner	S2S3	THR	T	Schedule 3	generally prefer moderate to large, deep, relatively clear streams with swift currents, and moderate to high gradients; it is not known to occur upstream of Conestogo Lake	MNRF 2014	No	No
Molluscs									
Villosa iris	Rainbow Mussel	S2S3	THR	E	Schedule 1	most abundant in shallow, well-oxygenated reaches of small- to medium-sized rivers and sometimes lakes, on substrates of cobble, gravel, sand and occasionally mud	MNRF 2015b; MNRF 2014	Yes	No

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Habitat Preference[5,6,7,8]	Background Source	Suitable Habitats within Study Area	Observed by NRSI
Lampsilis fasciola	Wavy-rayed Lampmussel	S1	THR	SC	Schedule 1	generally inhabit clear rivers and streams of a variety of sizes, where the water flow is steady and the substrate is stable	MNRF 2014	No	No

[1,2]MNRF 2015a, [3,4]Government of Canada 2015, [5]MNRF 2000, [6]Reznicek et al. 2011, [7]Layberry et al. 1998, [8]MNRF 2014

LEGEND
SRANK
S1 Critically Imperiled
S2 Imperiled
S3 Vulnerable
S4 Apparently Secure
B Breeding
N Non-breeding
S#? Rank Uncertain
COSSARO/COSEWIC
END/E Endangered
THR/T Threatened
SC/SC Special Concern
NAR Not at Risk
SARA Schedule
Schedule 1 Officially Protected under SARA
Schedule 3 Special concern; may be reassessed for consideration for inclusion to Schedule 1

APPENDIX II

Vascular Flora Reported From the Subject Property

Vascular Plant Species Reported From the Study Area

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Wellington County[5]	NHIC Data[6]	NRSI Observed						
								FOCM4	TAGM1	FODM5	FODM4	FOCM6	MAMM1-3	FOMM7
Pteridophytes	**Ferns & Allies**													
Dryopteridaceae	**Wood Fern Family**													
Athyrium filix-femina var. angustum	Northern Lady Fern	S5						x						
Cystopteris bulbifera	Bulblet Fern	S5												x
Dryopteris carthusiana	Spinulose Wood Fern	S5						x				x		
Dryopteris marginalis	Marginal Wood Fern	S5							x					
Matteuccia struthiopteris var. pensylvanica	Ostrich Fern	S5												x
Onoclea sensibilis	Sensitive Fern	S5											x	
Equisetaceae	**Horsetail Family**													
Equisetum arvense	Field Horsetail	S5						x	x				x	
Gymnosperms	**Conifers**													
Cupressaceae	**Cypress Family**													
Thuja occidentalis	White Cedar	S5						x				x		x
Pinaceae	**Pine Family**													
Larix laricina	Tamarack	S5							x					
Picea glauca	White Spruce	S5							x			x		x
Pinus strobus	Eastern White Pine	S5												x
Pinus sylvestris	Scot's Pine	SE5							x		x	x		
Dicotyledons	**Dicots**													
Aceraceae	**Maple Family**													
Acer negundo	Manitoba Maple	S5											x	x
Acer platanoides	Norway Maple	SE5							x		x	x		x
Acer saccharum ssp. saccharum	Sugar Maple	S5						x	x	x		x		
Acer saccharum ssp. nigrum	Black Maple	S4?				R				x		x		
Acer X freemanii	Freeman's Maple													x
Apiaceae	**Carrot or Parsley Family**													
Aegopodium podagraria	Goutweed	SE5												x
Angelica atropurpurea	Dark-purple Alexanders	S5											x	x
Cicuta maculata	Spotted Water-hemlock	S5						x	x				x	x
Zizia aurea	Golden Alexanders	S5				R							x	x
Asteraceae	**Composite or Aster Family**													
Arctium lappa	Great Burdock	SE5								x	x	x		x
Cirsium arvense	Canada Thistle	SE5							x					
Cirsium vulgare	Bull Thistle	SE5							x					
Erigeron annuus	Daisy Fleabane	S5							x					
Eupatorium perfoliatum	Perfoliate Thoroughwort	S5											x	
Eupatorium rugosum	White Snakeroot	S5										x		
Eupatorium maculatum ssp. maculatum	Spotted Joe-pye-weed	S5											x	
Euthamia graminifolia	Flat-topped Bushy Goldenrod	S5									x			
Inula helenium	Elecampane	SE5												x
Prenanthes alba	White Rattlesnake-root	S5						x						
Rudbeckia laciniata	Tall Coneflower	S5				R								x
Solidago altissima var. altissima	Tall Goldenrod	S5									x			
Solidago flexicaulis	Zig-zag Goldenrod	S5							x	x				
Solidago gigantea	Giant Goldenrod	S5						x	x	x	x	x	x	x
Symphyotrichum lanceolatum var. lanceolatum	Tall White Aster	S5											x	
Symphyotrichum lateriflorum var. lateriflorum	Calico Aster	S5										x		
Symphyotrichum puniceum	Purple-stemmed Aster	S5						x	x				x	
Taraxacum officinale	Common Dandelion	SE5									x			
Tussilago farfara	Coltsfoot	SE5												x

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Wellington County[5]	NHIC Data[6]	NRSI Observed						
								FOCM4	TAGM1	FODM5	FODM4	FOCM6	MAMM1-3	FOMM7
Balsaminaceae	**Touch-me-not Family**													
Impatiens capensis	Spotted Touch-me-not	S5						x	x	x			x	x
Berberidaceae	**Barberry Family**													
Caulophyllum thalictroides	Blue Cohosh	S5								x				
Betulaceae	**Birch Family**													
Betula alleghaniensis	Yellow Birch	S5						x		x				
Ostrya virginiana	Hop Hornbeam	S5								x				
Boraginaceae	**Borage Family**													
Cynoglossum officinale	Hound's-tongue	SE5							x				x	x
Lithospermum latifolium	American Gromwell	S3				R	x	x	x	x	x	x		
Myosotis scorpioides	Mouse-ear Scorpion-grass	SNA												x
Brassicaceae	**Mustard Family**													
Alliaria petiolata	Garlic Mustard	SE5								x	x	x		x
Barbarea vulgaris	Yellow Rocket	SE5											x	
Cardamine diphylla	Two-leaved Toothwort	S5						x						
Hesperis matronalis	Dame's Rocket	SE5							x	x	x	x	x	x
Caprifoliaceae	**Honeysuckle Family**													
Lonicera tatarica	Tartarian Honeysuckle	SE5								x	x			
Sambucus racemosa ssp. pubens	Red-berried Elderberry	S5							x					
Triosteum aurantiacum	Wild Coffee	S5						x				x		
Viburnum opulus	Guelder Rose	SE4						x				x		
Convolvulaceae	**Morning-glory Family**													
Calystegia sepium	Hedge Bindweed	S5											x	
Cornaceae	**Dogwood Family**													
Cornus alternifolia	Alternate-leaved Dogwood	S5								x	x	x		
Cornus stolonifera	Red-osier Dogwood	S5								x				
Cucurbitaceae	**Gourd Family**													
Echinocystis lobata	Prickly Cucumber	S5											x	
Fagaceae	**Beech Family**													
Quercus macrocarpa	Bur Oak	S5						x						
Geraniaceae	**Geranium Family**													
Geranium maculatum	Spotted Crane's-bill	S5						x	x	x		x		
Geranium robertianum	Herb Robert	SE5							x					x
Grossulariaceae	**Currant Family**													
Ribes cynosbati	Prickly Gooseberry	S5							x			x		
Ribes rubrum	Red Currant	SE5									x			
Guttiferae	**St. John's-wort Family**													
Hypericum perforatum	Common St. John's-wort	SE5							x					
Hydrophyllaceae	**Water-leaf Family**													
Hydrophyllum virginianum	Virginia Water-leaf	S5							x					
Lamiaceae	**Mint Family**													
Glechoma hederacea	Creeping Charlie	SE5												x
Mentha arvensis ssp. borealis	American Wild Mint	S5											x	
Prunella vulgaris ssp. lanceolata	Heal-all	S5										x		
Teucrium canadense ssp. canadense	Wood Germander	S5?							x			x		x
Oleaceae	**Olive Family**													
Fraxinus americana	White Ash	S5							x	x	x			
Fraxinus nigra	Black Ash	S5												x
Fraxinus pennsylvanica	Green Ash	S5						x						
Ligustrum vulgare	Common Privet	SE5									x			
Onagraceae	**Evening-primrose Family**													
Circaea lutetiana ssp. canadensis	Yellowish Enchanter's Nightshade	S5								x	x	x		

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Wellington County[5]	NHIC Data[6]	NRSI Observed						
								FOCM4	TAGM1	FODM5	FODM4	FOCM6	MAMM1-3	FOMM7
Oxalidaceae	**Wood Sorrel Family**													
Oxalis stricta	Upright Yellow Wood-sorrel	S5							x			x		
Papaveraceae	**Poppy Family**													
Sanguinaria canadensis	Bloodroot	S5										x		
Plantaginaceae	**Plantain Family**													
Plantago rugelii	Rugel's Plantain	S5												
Rumex obtusifolius ssp. obtusifolius	Bitter Dock	SE5												x
Primulaceae	**Primrose Family**													
Lysimachia ciliata	Fringed Loosestrife	S5								x		x		x
Lysimachia nummularia	Moneywort	SE5												x
Ranunculaceae	**Buttercup Family**													
Anemone canadensis	Canada Anemone	S5											x	
Anemone quinquefolia var. quinquefolia	Wood Anemone	S5										x		
Caltha palustris	Marsh-marigold	S5											x	x
Clematis virginiana	Virgin's-bower	S5												x
Ranunculus hispidus var. caricetorum	Swamp Buttercup	S5											x	x
Thalictrum dioicum	Early Meadow-rue	S5								x		x		
Thalictrum pubescens	Tall Meadow-rue	S5												x
Rhamnaceae	**Buckthorn Family**													
Rhamnus cathartica	Common Buckthorn	SE5						x	x		x	x		x
Rosaceae	**Rose Family**													
Amelanchier laevis	Smooth Juneberry	S5										x		
Crataegus species	Hawthorn species									x	x	x		x
Fragaria virginiana	Wild Strawberry	S5							x	x				
Geum allepicum	Yellow Avens	S5									x			
Geum canadense	White Avens	S5								x				
Argentia anserina ssp. anserina	Silverweed	S5											x	
Prunus serotina	Black Cherry	S5						x		x				
Prunus virginiana ssp. virginiana	Choke Cherry	S5						x	x	x	x	x		x
Pyrus communis	Common Pear	SE4												x
Rubus idaeus ssp. melanolasius	Wild Red Raspberry	S5							x		x	x		
Rubus pubescens	Dwarf Raspberry	S5									x			
Sorbus aucuparia	European Mountain-ash	SE4										x		
Spiraea alba	Narrow-leaved Meadow-sweet	S5											x	
Salicaceae	**Willow Family**													
Populus tremuloides	Trembling Aspen	S5						x						
Salix eriocephala	Heart-leaved Willow	S5											x	
Salix exigua	Sandbar Willow	S5											x	
Salix fragilis	Crack Willow	SE5												x
Salix purpurea	Basket Willow	SE4											x	
Scrophulariaceae	**Figwort Family**													
Veronica americana	American Speedwell	S5												x
Veronica filiformis	Hair-like Speedwell	SE2												x
Veronica serpyllifolia ssp. serpyllifolia	Thyme-leaved Speedwell	SE5							x					
Solanaceae	**Nightshade Family**													
Solanum dulcamara	Bitter Nightshade	SE5							x					x
Tiliaceae	**Linden Family**													
Tilia americana	American Basswood	S5							x	x	x	x		x
Ulmaceae	**Elm Family**													
Ulmus americana	White Elm	S5						x	x	x	x	x	x	x
Urticaceae	**Nettle Family**													
Laportea canadensis	Wood Nettle	S5												x

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Wellington County[5]	NHIC Data[6]	NRSI Observed						
								FOCM4	TAGM1	FODM5	FODM4	FOCM6	MAMM1-3	FOMM7
Urtica dioica ssp. gracilis	American Stinging Nettle	S5											x	x
Violaceae	**Violet Family**													
Viola pubescens	Downy Yellow Violet	S5						x	x					
Viola sororia	Woolly Blue Violet	S5						x	x					x
Vitaceae	**Grape Family**													
Parthenocissus vitacea	Woodbine	S5								x	x	x		
Vitis riparia	Riverbank Grape	S5										x		
Monocotyledons	**Monocots**													
Araceae	**Arum Family**													
Arisaema triphyllum	Jack-in-the-pulpit	S5						x		x				x
Cyperaceae	**Sedge Family**													
Carex aquatilis	Aquatic Sedge	S5											x	
Carex blanda	Woodland Sedge	S5						x				x		
Carex communis	Fibrous Rooted Sedge	S5								x		x		
Carex lacustris	Lake-bank Sedge	S5											x	
Carex rosea	Stellate Sedge	S5								x				
Carex woodii	Wood's Sedge	S4				R				x				
Eleocharis smallii	Small's Spike-rush	S5											x	
Iridaceae	**Iris Family**													
Iris versicolor	Multi-coloured Blue-flag	S5											x	
Liliaceae	**Lily Family**													
Allium tricoccum	Wild Leek	S5								x		x		
Lilium michiganense	Michigan Lily	S5				R							x	
Trillium grandiflorum	White Trillium	S5						x				x		
Poaceae	**Grass Family**													
Dactylis glomerata	Orchard Grass	SE5									x			x
Phalaris arundinacea	Reed Canary Grass	S5							x		x		x	x
Phleum pratense	Timothy	SE5											x	x
Poa pratensis ssp. pratensis	Kentucky Bluegrass	S5								x	x			
Smilacaceae	**Catbrier Family**													
Smilax herbacea	Herbaceous Carrion Flower	S4								x				
Typhaceae	**Cattail Family**													
Typha latifolia	Broad-leaved Cattail	S5											x	
							Total	**28**	**38**	**35**	**28**	**41**	**36**	**50**

1,2MNRF 2015a, 3,4Government of Canada 2015, 5Dougan & Associates 2009, 6MNRF 2015b

LEGEND
SRANK
S3 Vulnerable
S4 Apparently Secure
S5 Secure
S#? Rank Uncertain
SE Exotic Species
Wellington County
R Native, Present, Rare

APPENDIX III

Bird Species Reported From the Study Area

Bird Species Reported From the Study Area

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Wellington County Status[5]	OBBA[6] 17NJ24	NHIC Data[7]	NRSI Observed
Anatidae	**Ducks, Geese & Swans**								
Branta canadensis	Canada Goose	S5					FY		X
Aix sponsa	Wood Duck	S5					FY		
Anas rubripes	American Black Duck	S4				√	H		
Anas platyrhynchos	Mallard	S5					FY		X
Phasianidae	**Partridges, Grouse & Turkeys**								
Meleagris gallopavo	Wild Turkey	S5					--		X
Bonasa umbellus	Ruffed Grouse	S4					H		X
Ardeidae	**Herons & Bitterns**								
Butorides virescens	Green Heron	S4B				**	H		X
Ardea herodias	Great Blue Heron	S4B				**	NB		X
Cathartidae	**Vultures**								
Cathartes aura	Turkey Vulture	S5B				√	H		
Accipitridae	**Hawks, Kites, Eagles & Allies**								
Circus cyaneus	Northern Harrier	S4B	NAR	NAR		√*	CF		
Accipiter striatus	Sharp-shinned Hawk	S5	NAR			√*	H		
Buteo jamaicensis	Red-tailed Hawk	S5	NAR	NAR			FY		
Rallidae	**Railes, Gallinules & Coots**								
Porzana carolina	Sora	S4B				√	S		
Charadriidae	**Plovers**								
Charadrius vociferus	Killdeer	S5B, S5N					NY		X
Scolopacidae	**Sandpipers, Phalaropes & Allies**								
Actitis macularia	Spotted Sandpiper	S5					FY		X
Bartramia longicauda	Upland Sandpiper	S4B				√	FY		
Scolopax minor	American Woodcock	S4B					H		
Laridae	**Gulls, Terns & Skimmers**								
Larus delawarensis	Ring-billed Gull	S5B, S4N				**	--		X
Columbidae	**Pigeons & Doves**								
Columba livia	Rock Pigeon	SNA					AE		
Zenaida macroura	Mourning Dove	S5					NY		X
Strigidae	**Typical Owls**								
Megascops asio	Eastern Screech-Owl	S4	NAR	NAR			A		
Apodidae	**Swifts**								
Chaetura pelagica	Chimney Swift	S4B, S4N	THR	T	Schedule 1	√	V		
Trochilidae	**Hummingbirds**								
Archilochus colubris	Ruby-throated Hummingbird	S5B					H		
Alcedinidae	**Kingfishers**								
Megaceryle alcyon	Belted Kingfisher	S4B				√	CF		
Picidae	**Woodpeckers**								

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Wellington County Status[5]	OBBA[6] 17NJ24	NHIC Data[7]	NRSI Observed
Melanerpes carolinus	Red-bellied Woodpecker	S4				√	S		
Picoides pubescens	Downy Woodpecker	S5					P		
Colaptes auratus	Northern Flicker	S4B				√*	FY		H
Dryocopus pileatus	Pileated Woodpecker	S5				√*	S		
Falconidae	**Caracaras & Falcons**								
Falco sparverius	American Kestrel	S4				√*	FY		
Tyrannidae	**Tyrant Flycathers**								
Contopus virens	Eastern Wood-Pewee	S4B	SC	SC		√	T		S
Empidonax minimus	Least Flycatcher	S4B				√	T		
Sayornis phoebe	Eastern Phoebe	S5B					NY		
Myiarchus crinitus	Great Crested Flycatcher	S4B					T		S
Tyrannus tyrannus	Eastern Kingbird	S4B				√*	CF		
Vireonidae	**Vireos**								
Vireo gilvis	Warbling Vireo	S5B					D		
Vireo olivaceus	Red-eyed Vireo	S5B					T		S
Corvidae	**Crows & Jays**								
Cyanocitta cristata	Blue Jay	S5					FY		S
Corvus brachyrhynchos	American Crow	S5B					CF		H
Alaudidae	**Larks**								
Eremophila alpestris	Horned Lark	S5B					FY		
Hirundinidae	**Swallows**								
Tachycineta bicolor	Tree Swallow	S4B					AE		X
Stelgidopteryx serripennis	Northern Rough-winged Swallow	S4B					P		
Riparia riparia	Bank Swallow	S4B	THR	T		√* (only significant in nesting colonies >100)	AE		
Petrochelidon pyrrhonota	Cliff Swallow	S4B				** (only significant in nesting colonies >8)	NY		
Hirundo rustica	Barn Swallow	S4B	THR	T			CF		
Paridae	**Chickadees & Titmice**								
Poecile atricapillus	Black-capped Chickadee	S5					FY		S
Sittidae	**Nuthatches**								
Sitta carolinensis	White-breasted Nuthatch	S5					T		H
Certhiidae	**Creepers**								
Certhia americana	Brown Creeper	S5B				√*	--		S
Troglodytidae	**Wrens**								
Troglodytes aedon	House Wren	S5B					FY		S

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Wellington County Status[5]	OBBA[6] 17NJ24	NHIC Data[7]	NRSI Observed
Turdidae	**Thrushes**								
Sialia sialis	Eastern Bluebird	S5B	NAR	NAR			H		
Catharus fuscescens	Veery	S4B				√*	S		
Hylocichla mustelina	Wood Thrush	S4B	SC	T		√*	T		
Turdus migratorius	American Robin	S5B					NE		S
Mimidae	**Mockingbirds, Thrashers & Allies**								
Dumetella carolinensis	Gray Catbird	S4B					A		S
Toxostoma rufum	Brown Thrasher	S4B				√	S		
Sturnidae	**Starlings**								
Sturnus vulgaris	European Starling	SNA					CF		
Bombycillidae	**Waxwings**								
Bombycilla cedrorum	Cedar Waxwing	S5B					FY		H
Parulidae	**Wood Warblers**								
Seiurus aurocapillus	Ovenbird	S4B				√*	T		
Geothylpis philadelphia	Mourning Warbler	S4B					V		S
Geothylpis trichas	Common Yellowthroat	S5B					T		S
Setophaga petechia	Yellow Warbler	S5B					NB		
Setophaga pinus	Pine Warbler	S5B				√*	S		
Setophaga coronata	Yellow-rumped Warbler	S5B					S		
Emberizidae	**New World Sparrows & Allies**								
Pipilo erythrophthalmus	Eastern Towhee	S4B				√*	T		
Spizella passerina	Chipping Sparrow	S5B					AE		
Spizella pallida	Clay-colored Sparrow	S4B				√	S		
Spizella pusilla	Field Sparrow	S4B				√*	S		
Pooecetes gramineus	Vesper Sparrow	S4B				√*	S		
Melospiza melodia	Song Sparrow	S5B					NY		S
Passerculus sandwichensis	Savannah Sparrow	S4B				√*	CF		
Junco hyemalis	Dark-eyed Junco	S5B				√	--		S
Cardinalidae	**Cardinals, Grosbeaks & Allies**								
Cardinalis cardinalis	Northern Cardinal	S5					T		S
Pheucticus ludovicianus	Rose-breasted Grosbeak	S4B				√*	CF		S
Passerina cyanea	Indigo Bunting	S4B					CF		S
Icteridae	**Blackbirds**								
Dolichonyx oryzivorus	Bobolink	S4B	THR	T	No Schedule	√*	V	X	X
Agelaius phoeniceus	Red-winged Blackbird	S4					NY		H
Sturnella magna	Eastern Meadowlark	S4B	THR	T		√*	FY	X	
Quiscalus quiscula	Common Grackle	S5B					NY		
Molothrus ater	Brown-headed Cowbird	S4B					P		
Icterus galbula	Baltimore Oriole	S4B				√*	AE		X
Fringillidae	**Finches & Allies**								
Carpodacus mexicanus	House Finch	SNA					AE		

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Wellington County Status[5]	OBBA[6] 17NJ24	NHIC Data[7]	NRSI Observed
Spinus tristis	American Goldfinch	S5B					FY		X
Passeridae	**Old World Sparrows**								
Passer domesticus	House Sparrow	SNA					CF		
						Total	82	2	35

[1,2]MNRF 2015a, [3,4]Government of Canada 2015, [5]Dougan & Associates 2009, [6]BSC et al. 2008, [7]MNRF2015b

LEGEND
SRANK
S4 Apparently Secure
S5 Secure
SNA Unranked
COSSARO/COSEWIC
NAR Not at Risk
SC Special Concern
THR/T Threatened
SARA Schedule
Schedule 1 Officially protected under SARA
Wellington County
√ Significant and rare
√* Significant but not rare
** Only habitats that support/recently supported active nests considered signficant

APPENDIX IV

Herpetofauna Reported From the Study Area

Reptile and Amphibian Species Reported From the Study Area

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Wellington County Status[5]	Ontario Reptile and Amphibian Atlas[6]	NRSI Observed
Turtles								
Chelydra serpentina serpentina	Snapping Turtle	S3	SC	SC	Schedule 1	R	x	x
Toads and Frogs								
Anaxyrus americanus	American Toad	S5				X	x	x
Hyla versicolor	Tetraploid Gray Treefrog	S5				X		x
Pseudacris crucifer	Spring Peeper	S5				X	x	x
Lithobates pipiens	Northern Leopard Frog	S5	NAR	NAR		X	x	
Lithobates sylvatica	Wood Frog	S5				X	x	
						Total	**5**	**4**

[1,2]MNRF 2015a, [3,4]Government of Canada 2015, [5]Dougan & Associates 2009, [6]Ontario Nature 2015

LEGEND
SRANK
S3 Vulnerable
S5 Secure
COSSARO/COSEWIC
NAR Not at Risk
SC Special Concern
SARA Schedule
Schedule 1 Officially protected under SARA
Wellington County
X Common
R Rare

APPENDIX V

Mammals Reported From the Study Area

Mammal Species Reported From the Study Area

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Wellington County Status[5]	Ontario Mammal Atlas[6]	NRSI Observed
Didelphimorphia	**Opossums**							
Didelphis virginiana	Virginia Opossum	S4				X	x	
Insectivora	**Shrews and Moles**							
Sorex cinereus	Masked Shrew	S5				X	x	
Chiroptera	**Bats**							
Eptesicus fuscus	Big Brown Bat	S5				X	x	
Lasiurus cinereus	Hoary Bat	S4				X	x	
Myotis lucifugus	Little Brown Myotis	S4	END	E	Schedule 1	X	x	
Myotis septentrionalis	Northern Myotis	S3	END	E	Schedule 1	R	x	
Lagomorpha	**Rabbits and Hares**							
Lepus americanus	Snowshoe Hare	S5				R	x	
Lepus europaeus	European Hare	SNA				X	x	
Sylvilagus floridanus	Eastern Cottontail	S5				X	x	
Rodentia	**Rodents**							
Castor canadensis	Beaver	S5				X	x	
Erethizon dorsatum	Porcupine	S5				X	x	
Glaucomys sabrinus	Northern Flying Squirrel	S5				R	x	
Marmota monax	Woodchuck	S5				X	x	
Microtus pennsylvanicus	Meadow Vole	S5				X	x	
Ondatra zibethicus	Muskrat	S5				X	x	
Peromyscus leucopus	White-footed Mouse	S5				X	x	
Peromyscus maniculatus	Deer Mouse	S5				X	x	
Rattus norvegicus	Norway Rat	SNA				X	x	
Sciurus carolinensis	Eastern Gray Squirrel	S5				X	x	
Tamiasciurus hudsonicus	Red Squirrel	S5				X	x	
Tamias striatus	Eastern Chipmunk	S5				X	x	
Carnivora	**Carnivores**							
Canis latrans	Coyote	S5				X	x	x
Mephitis mephitis	Striped Skunk	S5				X	x	
Mustela frenata	Long-tailed Weasel	S4				R	x	
Mustela vison	American Mink	S4				X	x	
Procyon lotor	Northern Raccoon	S5				X	x	x
Vulpes vulpes	Red Fox	S5				X	x	

Scientific Name	Common Name	SRANK[1]	COSSARO[2]	COSEWIC[3]	SARA Schedule[4]	Wellington County Status[5]	Ontario Mammal Atlas[6]	NRSI Observed
Artiodactyla	**Deer and Bison**							
Odocoileus virginianus	White-tailed Deer	S5				X	x	x
						Total	28	3

[1,2]MNRF 2015a, [3,4]Government of Canada 2015, [5]Dougan & Associates 2009, [6]Dobbyn 1994

LEGEND
SRANK
S3 Vulnerable
S4 Apparently Secure
S5 Secure
SNA Unranked
COSSARO/COSEWIC
END/E Endangered
SARA Schedule
Schedule 1 Officially protected under SARA
Wellington County
X Present
R Rare

APPENDIX VI

Lepidoptera Reported From the Study Area

Butterfly Species Reported From the Study Area

Scientific Name	Common Name	SRANK[1]	OMNR[2]	COSEWIC[3]	SARA Schedule[4]	Wellington County Status[5]	TEA Atlas[6]
Hesperiidae	**Skippers**						
Anatrytone logan	Delaware Skipper	S4				X	X
Ancyloxypha numitor	Least Skipper	S5					X
Carterocephalus palaemon	Arctic Skipper	S5					X
Epargyreus clarus	Silver-spotted Skipper	S4					X
Erynnis baptisiae	Wild Indigo Duskywing	S4				X	X
Euphyes dion	Dion Skipper	S3				X	X
Euphyes vestris	Dun Skipper	S5					X
Hylephila phyleus	Fiery Skipper	SNA					X
Poanes hobomok	Hobomok Skipper	S5					X
Polites mystic	Long Dash Skipper	S5					X
Polites peckius	Peck's Skipper	S5					X
Polites themistocles	Tawny-edged Skipper	S5					X
Pompeius verna	Little Glassywing	S4				X	X
Thymelicus lineola	European Skipper	SNA					X
Papilionidae	**Swallowtails**						
Papilio glaucus	Eastern Tiger Swallowtail	S5					X
Papilio polyxenes	Black Swallowtail	S5					X
Pieridae	**Whites and Sulphurs**						
Colias eurytheme	Orange Sulphur	S5					X
Colias philodice	Clouded Sulphur	S5					X
Pieris rapae	Cabbage White	SNA					X
Lycaenidae	**Harvesters, Coppers, Hairstreaks, Blues**						
Callophrys niphon	Eastern Pine Elfin	S5					X
Celastrina ladon	Spring Azure	S5					X
Celastrina neglecta	Summer Azure	S5					X
Glaucopsyche lygdamus	Silvery Blue	S5					X
Lycaena hyllus	Bronze Copper	S5					X
Satyrium acadica	Acadian Hairstreak	S4					X
Satyrium calanus	Banded Hairstreak	S4					X
Satyrium liparops	Striped Hairstreak	S5					X
Satyrium titus	Coral Hairstreak	S5					X
Nymphalidae	**Brush-footed Butterflies**						
Aglais milberti	Milbert's Tortoiseshell	S5					X
Boloria bellona	Meadow Fritillary	S5					X
Cercyonis pegala	Common Wood-Nymph	S5					X

Scientific Name	Common Name	SRANK[1]	OMNR[2]	COSEWIC[3]	SARA Schedule[4]	Wellington County Status[5]	TEA Atlas[6]
Coenonympha tullia	Common Ringlet	S5					X
Danaus plexippus	Monarch	S2N, S4B	SC	SC	Schedule 1	X*	X
Enodia anthedon	Northern Pearly-Eye	S5					X
Euphydryas phaeton	Baltimore Checkerspot	S4					X
Junonia coenia	Common Buckeye	SNA					X
Lethe appalachia	Appalachian Brown	S4					X
Lethe eurydice	Eyed Brown / Northern Eyed Brown	S5					X
Limenitis archippus	Viceroy	S5					X
Limenitis arthemis arthemis	White Admiral/Banded Purple	S5					X
Limentis arthemis astyanax	Red-spotted Purple	S5					X
Megisto cymela	Little Wood-Satyr	S5					X
Nymphalis antiopa	Mourning Cloak	S5					X
Phyciodes cocyta	Northern Crescent	S5					X
Phyciodes tharos	Pearl Crescent	S4					X
Polygonia comma	Eastern Comma	S5					X
Polygonia interrogationis	Question Mark	S5					X
Polygonia progne	Grey Comma	S5					X
Speyeria cybele	Great Spangled Fritillary	S5					X
Vanessa atalanta	Red Admiral	S5					X
Vanessa cardui	Painted Lady	S5					X
Vanessa virginiensis	American Lady	S5					X
						Total	**63**

[1,2]MNRF 2015a, [3,4]Government of Canada 2015, [5]Dougan & Associates 2009, [6]Jones et al. 2015

LEGEND
SRANK
S2 Imperiled
S3 Vulnerable
S4 Apparently Secure
S5 Secure
SNA Unranked
COSSARO/COSEWIC
SC Special Concern
SARA Schedule
Schedule 1 Officially protected under SARA
Wellington County
X Rare
X* Significant only within City of Guelph

APPENDIX VII

Fish Species Reported From the Study Area

Fish Species Reported from the Vicinity of the Study Area

Scientific Name	Common Name	GRCA Data[1]	Location (GRCA data)[1]	MNRF Data[2]	Year of MNRF Observation[2]	S-rank[3]	National Status (SARA)[3]	Provincial Status (ESA)[3]	Environment[3]	Trophic Level[3]	Thermal Regime[3]
Cyprinidae	**Carps and Minnows**										
Cyprinus carpio	Common Carp	x	Lake			SNA	No Status	No Status	Benthopelagic	Plankitove/Detritivore	Warmwater
Hybognathus hankinsoni	Brassy Minnow	x	River			S5	No Status	No Status	Benthic	Plankitove/Detritivore	Coolwater
Luxilus cornutus	Common Shiner	x	Lake	x	1991	S5	No Status	No Status	Benthopelagic	Invertivore	Coolwater
Nocomis biguttatus	Hornyhead Chub			x	1991	S4	Not at Risk	Not at Risk	Benthopelagic	Plankitove/Herbivore	Coolwater
Nocomis micropogon	River Chub	x	River			S4	Not at Risk	Not at Risk	Benthopelagic	Planktivore/Invertivore	Coolwater
Notropis atherinoides	Emerald Shiner	x	River			S5	No Status	No Status	Benthopelagic	Planktivore	Coolwater
Pimephales notatus	Bluntnose Minnow	x	River			S5	Not at Risk	Not at Risk	Benthopelagic	Detritivore	Warmwater
Semotilus atromaculatus	Creek Chub	x	River/Lake	x	1991	S5	No Status	No Status	Benthopelagic	Invertivore/Carnivore	Coolwater
Catostomidae	**Suckers**										
Catostomus commersonii	White Sucker	x	River/Lake	x	1999;1991;1972	S5	No Status	No Status	Benthic	Invertivore/Detritivore	Coolwater
Hypentelium nigricans	Northern Hog Sucker	x	River			S4	No Status	No Status	Benthic	Invertivore/Herbivore	Warmwater
Moxostoma sp.	Redhorse species			x	1999	N/A	N/A	N/A	N/A	N/A	N/A
Ictaluridae	**North American Catfishes**										
Ameiurus nebulosus	Brown Bullhead	x	Lake	x	1972	S5	No Status	No Status	Benthic	Invertivore/Herbivore/Carnivore	Warmwater
Noturus flavus	Stonecat	x	River			S4	No Status	No Status	Benthic	Invertivore/Carnivore	Warmwater
Esocidae	**Pikes**										
Esox lucius	Northern Pike	x	Lake	x	2009;1999;1992	S5	No Status	No Status	Benthopelagic	Carnivore	Coolwater
Centrarchidae	**Sunfishes and Basses**										
Ambloplites rupestris	Rock Bass	x	River/Lake	x	1991	S5	No Status	No Status	Benthopelagic	Invertivore/Carnivore	Coolwater
Lepomis macrochirus	Bluegill			x	1972	S5	No Status	No Status	Benthopelagic	Intritivore	Warmwater
Micropterus dolomieu	Smallmouth Bass	x	River/Lake	x	2009	S5	No Status	No Status	Benthopelagic	Invertivore/Carnivore	Coolwater
Micropterus salmoides	Largemouth Bass	x	Lake			S5	No Status	No Status	Benthopelagic	Invertivore/Carnivore	Warmwater
Morone Saxatilis	Striped Bass	x	River			SNA	No Status	No Status	N/A	N/A	N/A
Percidae	**Perches and Darters**										
Etheostoma caeruleum	Rainbow Darter					S4	No Status	No Status	Benthic	Invertivore	Coolwater
Etheostoma flabellare	Fantail Darter	x	River			S4	No Status	No Status	Benthic	Invertivore	Coolwater
Etheostoma nigrum	Johnny Darter	x	River	x	1991	S5	No Status	No Status	Benthic	Invertivore	Coolwater
Perca flavescens	Yellow Perch	x	Lake	x	1999	S5	No Status	No Status	Benthopelagic	Invertivore/Detritivore	Coolwater
Sander vitreus	Walleye (Yellow Pickerel)	x	Lake			S5	No Status	No Status	Benthopelagic	Invertivore/Carnivore	Coolwater

[1]GRCA, pers. comm. 2015; [2]MNRF, pers. comm. 2015; [3]Eakins 2015

LEGEND
SRANK
S4 Apparently Secure
S5 Secure
SNA Unranked

Appendix D – Archaeological Screening Self Assessment

Ontario

Ministry of Tourism, Culture and Sport

Programs & Services Branch
401 Bay Street, Suite 1700
Toronto ON M7A 0A7

Criteria for Evaluating Archaeological Potential

A Checklist for the Non-Specialist

The **purpose of the checklist** is to determine:

- if a property(ies) or project area may contain archaeological resources i.e., have archaeological potential
- it includes all areas that may be impacted by project activities, including – but not limited to:
  - the main project area
  - temporary storage
  - staging and working areas
  - temporary roads and detours

Processes covered under this checklist, such as:

- *Planning Act*
- *Environmental Assessment Act*
- *Aggregates Resources Act*
- *Ontario Heritage Act* – Standards and Guidelines for Conservation of Provincial Heritage Properties

Archaeological assessment

If you are not sure how to answer one or more of the questions on the checklist, you may want to hire a licensed consultant archaeologist (see page 4 for definitions) to undertake an archaeological assessment.

The assessment will help you:

- identify, evaluate and protect archaeological resources on your property or project area
- reduce potential delays and risks to your project

Note: By law, archaeological assessments **must** be done by a licensed consultant archaeologist. Only a licensed archaeologist can assess – or alter – an archaeological site.

What to do if you:

- **find an archaeological resource**

  If you find something you think may be of archaeological value during project work, you must – by law – stop all activities immediately and contact a licensed consultant archaeologist

  The archaeologist will carry out the fieldwork in compliance with the *Ontario Heritage Act* [s.48(1)].

- **unearth a burial site**

  If you find a burial site containing human remains, you must immediately notify the appropriate authorities (i.e., police, coroner's office, and/or Registrar of Cemeteries) and comply with the *Funeral, Burial and Cremation Services Act*.

Other checklists

Please use a separate checklist for your project, if:

- you are seeking a Renewable Energy Approval under Ontario Regulation 359/09 – separate checklist
- your Parent Class EA document has an approved screening criteria (as referenced in Question 1)

Please refer to the Instructions pages when completing this form.

Project or Property Name

Mapleton Wastewater Class Environmental Assessment

Project or Property Location (upper and lower or single tier municipality)

Community of Drayton, Mapleton Township

Proponent Name

Township of Mapleton

Proponent Contact Information

Brad McRoberts, CAO Clerk, Township of MApleton Tel: 519.638.3313

Screening Questions

	Yes	No
1. Is there a pre-approved screening checklist, methodology or process in place?	☐	☑

If Yes, please follow the pre-approved screening checklist, methodology or process.

If No, continue to Question 2.

	Yes	No
2. Has an archaeological assessment been prepared for the property (or project area) and been accepted by MTCS?	☐	☑

If Yes, do **not** complete the rest of the checklist. You are expected to follow the recommendations in the archaeological assessment report(s).

The proponent, property owner and/or approval authority will:

- summarize the previous assessment
- add this checklist to the project file, with the appropriate documents that demonstrate an archaeological assessment was undertaken e.g., MTCS letter stating acceptance of archaeological assessment report

The summary and appropriate documentation may be:

- submitted as part of a report requirement e.g., environmental assessment document
- maintained by the property owner, proponent or approval authority

If No, continue to Question 3.

	Yes	No
3. Are there known archaeological sites on or within 300 metres of the property (or the project area)?	☐	☑
4. Is there Aboriginal or local knowledge of archaeological sites on or within 300 metres of the property (or project area)?	☐	☑
5. Is there Aboriginal knowledge or historically documented evidence of past Aboriginal use on or within 300 metres of the property (or project area)?	☐	☑
6. Is there a known burial site or cemetery on the property or adjacent to the property (or project area)?	☐	☑
7. Has the property (or project area) been recognized for its cultural heritage value?	☐	☑

If Yes to any of the above questions (3 to 7), do **not** complete the checklist. Instead, you need to hire a licensed consultant archaeologist to undertake an archaeological assessment of your property or project area.

If No, continue to question 8.

	Yes	No
8. Has the entire property (or project area) been subjected to recent, extensive and intensive disturbance?	☑	☐

If Yes to the preceding question, do **not** complete the checklist. Instead, please keep and maintain a summary of documentation that provides evidence of the recent disturbance.

An archaeological assessment is not required.

If No, continue to question 9.

	Yes	No
9. Are there present or past water sources within 300 metres of the property (or project area)?	☐	☐

If Yes, an archaeological assessment is required.

If No, continue to question 10.

	Yes	No
10. Is there evidence of two or more of the following on the property (or project area)?	☐	☐

- elevated topography
- pockets of well-drained sandy soil
- distinctive land formations
- resource extraction areas
- early historic settlement
- early historic transportation routes

If Yes, an archaeological assessment is required.

If No, there is low potential for archaeological resources at the property (or project area).

The proponent, property owner and/or approval authority will:

- summarize the conclusion
- add this checklist with the appropriate documentation to the project file

The summary and appropriate documentation may be:

- submitted as part of a report requirement e.g., under the *Environmental Assessment Act, Planning Act* processes
- maintained by the property owner, proponent or approval authority

Instructions

Please have the following available, when requesting information related to the screening questions below:

- a clear map showing the location and boundary of the property or project area
  - large scale and small scale showing nearby township names for context purposes
- the municipal addresses of all properties within the project area
- the lot(s), concession(s), and parcel number(s) of all properties within a project area

In this context, the following definitions apply:

- **consultant archaeologist** means, as defined in Ontario regulation as an archaeologist who enters into an agreement with a client to carry out or supervise archaeological fieldwork on behalf of the client, produce reports for or on behalf of the client and provide technical advice to the client. In Ontario, these people also are required to hold a valid professional archaeological licence issued by the Ministry of Tourism, Culture and Sport.
- **proponent** means a person, agency, group or organization that carries out or proposes to carry out an undertaking or is the owner or person having charge, management or control of an undertaking.

1. Is there a pre-approved screening checklist, methodology or process in place?

An existing checklist, methodology or process may be already in place for identifying archaeological potential, including:

- one prepared and adopted by the municipality e.g., archaeological management plan
- an environmental assessment process e.g., screening checklist for municipal bridges
- one that is approved by the Ministry of Tourism, Culture and Sport under the Ontario government's Standards & Guidelines for Conservation of Provincial Heritage Properties [s. B.2.]

2. Has an archaeological assessment been prepared for the property (or project area) and been accepted by MTCS?

Respond 'yes' to this question, if all of the following are true:

- an archaeological assessment report has been prepared and is in compliance with MTCS requirements
  - a letter has been sent by MTCS to the licensed archaeologist confirming that MTCS has added the report to the Ontario Public Register of Archaeological Reports (Register)
- the report states that there are no concerns regarding impacts to archaeological sites

Otherwise, if an assessment has been completed and deemed compliant by the MTCS, and the ministry recommends further archaeological assessment work, this work will need to be completed.

For more information about archaeological assessments, contact:

- approval authority
- proponent
- consultant archaeologist
- Ministry of Tourism, Culture and Sport at archaeology@ontario.ca

3. Are there known archaeological sites on or within 300 metres of the property (or project area)?

MTCS maintains a database of archaeological sites reported to the ministry.

For more information, contact MTCS Archaeological Data Coordinator at archaeology@ontario.ca.

4. Is there Aboriginal or local knowledge of archaeological sites on or within 300 metres of the property?

Check with:

- Aboriginal communities in your area
- local municipal staff

They may have information about archaeological sites that are not included in MTCS' database.

Other sources of local knowledge may include:

- property owner
- local heritage organizations and historical societies
- local museums
- municipal heritage committee
- published local histories

5. Is there Aboriginal knowledge or historically documented evidence of past Aboriginal use on or within 300 metres of the property (or property area)?

Check with:

- Aboriginal communities in your area
- local municipal staff

Other sources of local knowledge may include:

- property owner
- local heritage organizations and historical societies
- local museums
- municipal heritage committee
- published local histories

6. Is there a known burial site or cemetery on the property or adjacent to the property (or project area)?

For more information on known cemeteries and/or burial sites, see:

- Cemeteries Regulation Unit, Ontario Ministry of Consumer Services – for database of registered cemeteries
- Ontario Genealogical Society (OGS) – to locate records of Ontario cemeteries, both currently and no longer in existence; cairns, family plots and burial registers
- Canadian County Atlas Digital Project – to locate early cemeteries

In this context, 'adjacent' means 'contiguous', or as otherwise defined in a municipal official plan.

7. Has the property (or project area) been recognized for its cultural heritage value?

There is a strong chance there may be archaeological resources on your property (or immediate area) if it has been listed, designated or otherwise identified as being of cultural heritage value by:

- your municipality
- Ontario government
- Canadian government

This includes a property that is:

- designated under *Ontario Heritage Act* (the OHA), including:
  - individual designation (Part IV)
  - part of a heritage conservation district (Part V)
  - an archaeological site (Part VI)
- subject to:
  - an agreement, covenant or easement entered into under the OHA (Parts II or IV)
  - a notice of intention to designate (Part IV)
  - a heritage conservation district study area by-law (Part V) of the OHA
- listed on:
  - a municipal register or inventory of heritage properties
  - Ontario government's list of provincial heritage properties
  - Federal government's list of federal heritage buildings
- part of a:
  - National Historic Site
  - UNESCO World Heritage Site
- designated under:
  - *Heritage Railway Station Protection Act*
  - *Heritage Lighthouse Protection Act*
- subject of a municipal, provincial or federal commemorative or interpretive plaque.

To determine if your property or project area is covered by any of the above, see:

- Part A of the MTCS Criteria for Evaluating Potential for Built Heritage and Cultural Heritage Landscapes

Part VI – Archaeological Sites

Includes five sites designated by the Minister under Regulation 875 of the Revised Regulation of Ontario, 1990 (Archaeological Sites) and 3 marine archaeological sites prescribed under Ontario Regulation 11/06.

For more information, check Regulation 875 and Ontario Regulation 11/06.

8. Has the entire property (or project area) been subjected to recent extensive and intensive ground disturbance?

Recent: after-1960

Extensive: over all or most of the area

Intensive: thorough or complete disturbance

Examples of ground disturbance include:

- quarrying
- major landscaping – involving grading below topsoil
- building footprints and associated construction area
  - where the building has deep foundations or a basement
- infrastructure development such as:
  - sewer lines
  - gas lines
  - underground hydro lines
  - roads
  - any associated trenches, ditches, interchanges. **Note**: this applies only to the excavated part of the right-of-way; the remainder of the right-of-way or corridor may not have been impacted.

A ground disturbance does **not** include:

- agricultural cultivation
- gardening
- landscaping

Site visits

You can typically get this information from a site visit. In that case, please document your visit in the process (e.g., report) with:

- photographs
- maps
- detailed descriptions

If a disturbance isn't clear from a site visit or other research, you need to hire a licensed consultant archaeologist to undertake an archaeological assessment.

9. Are there present or past water bodies within 300 metres of the property (or project area)?

Water bodies are associated with past human occupations and use of the land. About 80-90% of archaeological sites are found within 300 metres of water bodies.

Present

- Water bodies:
  - primary - lakes, rivers, streams, creeks
  - secondary - springs, marshes, swamps and intermittent streams and creeks
- accessible or inaccessible shoreline, for example:
  - high bluffs
  - swamps
  - marsh fields by the edge of a lake
  - sandbars stretching into marsh

Water bodies not included:

- man-made water bodies, for example:
  - temporary channels for surface drainage
  - rock chutes and spillways
  - temporarily ponded areas that are normally farmed
  - dugout ponds
- artificial bodies of water intended for storage, treatment or recirculation of:
  - runoff from farm animal yards
  - manure storage facilities
  - sites and outdoor confinement areas

Past

Features indicating past water bodies:

- raised sand or gravel beach ridges – can indicate glacial lake shorelines
- clear dip in the land – can indicate an old river or stream
- shorelines of drained lakes or marshes
- cobble beaches

You can get information about water bodies through:

- a site visit
- aerial photographs
- 1:10,000 scale Ontario Base Maps - or equally detailed and scaled maps.

10. Is there evidence of two or more of the following on the property (or project area)?

- elevated topography
- pockets of well-drained sandy soil
- distinctive land formations
- resource extraction areas
- early historic settlement
- early historic transportation routes

- **Elevated topography**

  Higher ground and elevated positions - surrounded by low or level topography - often indicate past settlement and land use.

  Features such as eskers, drumlins, sizeable knolls, plateaus next to lowlands, or other such features are a strong indication of archaeological potential.

  Find out if your property or project area has elevated topography, through:

  - site inspection
  - aerial photographs
  - topographical maps

- **Pockets of well-drained sandy soil, especially within areas of heavy soil or rocky ground**

  Sandy, well-drained soil - in areas characterized by heavy soil or rocky ground - may indicate archaeological potential

  Find out if your property or project area has sandy soil through:

  - site inspection
  - soil survey reports

- **Distinctive land formations**

  Distinctive land formations include – but are not limited to:

  - waterfalls
  - rock outcrops
  - rock faces
  - caverns
  - mounds, etc.

  They were often important to past inhabitants as special or sacred places. The following sites may be present – or close to – these formations:

  - burials
  - structures
  - offerings
  - rock paintings or carvings

  Find out if your property or project areas has a distinctive land formation through:

  - a site visit
  - aerial photographs
  - 1:10,000 scale Ontario Base Maps - or equally detailed and scaled maps.

- **Resource extraction areas**

  The following resources were collected in these extraction areas:

  - food or medicinal plants e.g., migratory routes, spawning areas, prairie
  - scarce raw materials e.g., quartz, copper, ochre or outcrops of chert
  - resources associated with early historic industry e.g., fur trade, logging, prospecting, mining

  Aboriginal communities may hold traditional knowledge about their past use or resources in the area.

- **Early historic settlement**

  Early Euro-Canadian settlement include – but are not limited to:

  - early military or pioneer settlement e.g., pioneer homesteads, isolated cabins, farmstead complexes
  - early wharf or dock complexes
  - pioneers churches and early cemeteries

  For more information, see below – under the early historic transportation routes.

- **Early historic transportation routes** - such as trails, passes, roads, railways, portage routes, canals.

  For more information, see:

  - historical maps and/or historical atlases
    - for information on early settlement patterns such as trails (including Aboriginal trails), monuments, structures, fences, mills, historic roads, rail corridors, canals, etc.
    - Archives of Ontario holds a large collection of historical maps and historical atlases
    - digital versions of historic atlases are available on the Canadian County Atlas Digital Project
  - commemorative markers or plaques such as local, provincial or federal agencies
  - municipal heritage committee or other local heritage organizations
    - for information on early historic settlements or landscape features (e.g., fences, mill races, etc.)
    - for information on commemorative markers or plaques