A MULTI-METHOD APPROACH FOR DETERMINING A PHOSPHOROUS BUDGET FOR THE SHUSWAP AND SALMON RIVERS IN SOUTHERN INTERIOR BRITISH COLUMBIA

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The following individuals certify that they have read, and recommend to the College of Graduate Studies for acceptance, a thesis/dissertation entitled:

A MULTI-METHOD APPROACH FOR DETERMINING A PHOSPHOROUS BUDGET FOR THE SHUSWAP AND SALMON RIVERS IN SOUTHERN INTERIOR BRITISH COLUMBIA

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Abstract

Phosphorous (P) is a limiting nutrient in most freshwater systems, meaning growth rates of organisms are directly related to the amount available, and when in surplus, it can lead to excess plant and algae growth known as eutrophication (Dupas et al. 2015). Eutrophication can reduce oxygen levels in water and can potentially be harmful to human and animal health (Wolf and Klaiber 2017). Excess algae growth was reported in Shuswap and Mara Lakes in Southern Interior British Columbia and was said to be due to excess P from two rivers of concern; the Shuswap and Salmon Rivers (TriStar 2014). The aim of this study was to quantify the amount of total P (TP) and total dissolved P (TDP) entering these lakes from the Shuswap and Salmon Rivers. I sampled surface water and groundwater and used three hydrologic modeling techniques to quantify the TP and TDP flux from three individual sources; incremental flow sub-watersheds (IFSW, ungauged portions of the watersheds), tributary watersheds, and upper reaches. The techniques used included extrapolation, run-off coefficients, and geochemical methods. The fluxes of P calculated for all sub-watersheds were regressed with land uses in sub-watersheds to determine TP and TDP export coefficients for forested, urban, and agriculture land uses. The TP and TDP fluxes were greatest from IFSW in both the Shuswap and Salmon River watersheds, which is where the majority of the anthropogenic activities take place. Within the two river watersheds, the anthropogenic land uses (urban and agriculture) were estimated to contribute 7-66 times more TP and TDP than the undisturbed forest, depending on the technique used to estimate discharge. Knowledge of these inputs can be used to inform management practices to decrease future P loadings into the lakes system, thus reducing eutrophication risk.

Lay Summary

Excess phosphorous (P) in lakes and rivers can cause them to become overgrown with plants and algae. This reduces water quality, affecting human and animal health, as well as economic drivers like recreation. The purpose of this study was to determine the amount of P entering Shuswap and Mara Lakes in Southern Interior BC, from two rivers; the Shuswap and Salmon Rivers. Using three methods, a range was estimated for the total P coming from different sources in the watersheds. These values were then used to estimate yearly contribution of P from urban, agricultural, and forested land uses. Urban and agricultural land uses were shown to contribute 7-66 more P than the surrounding forest, depending on the method used. The estimated P contribution can be used in future management scenarios to reduce P in the rivers, and ultimately the lakes.

Preface

Figure 1 was modified from Havens and Nurnberg 2009. The text was modified to more clearly represent the relationship highlighted within the figure.

Figures 2 and 3 were modified from maps created and disturbed by the Fraser Basin Council to members of the Shuswap Watershed Council in 2016. The original map was created using ArcGIS® software by Esri. ArcGIS® is the intellectual property of Esri and are used herein under license. Copyright © Esri. All rights reserved. For more information about Esri® software, please visit www.esri.com.

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Figures 10 and 11 were created by an undergraduate research assistant working under me in 2018. The maps were again created using the student desktop version of ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. Copyright © Esri. All rights reserved. For more information about Esri® software, please visit www.esri.com.

All other figures and tables are original works created by the author, me, Megan Ludwig.

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Abbreviations

AGNPS = agricultural non-point source

ALUI = agriculture land use inventory

ANOVA = analysis of variance

BC = British Columbia

BMP = best management practice

C = Celsius

Ca = calcium

CDOM = colored dissolved organic matter

cm = centimeter

DOM = dissolved organic matter

ECM = export coefficient model

EMMA = end-member mixing analysis

GIS = geographical information systems

ha = hectares

HDP = high density polyethylene

ICP-OES = Inductively coupled plasma optical emission spectroscopy

IFSW = incremental flow sub-watershed

K = potassium

kg = kilogram

km = kilometer

m = meter

Mg = magnesium

mm = millimeter

MDL = minimum detection limit

Na = sodium

NEDD = N-(1-Naphthyl) ethylenediamine

P = phosphorous

PP = particulate phosphorous

PPB = parts per billion

PVC = polyvinyl chloride

Q = discharge

RC = runoff coefficient

SLIPP = Shuswap Lake Integrated Planning Process

Sr = strontium

SWAT = soil water analysis tool

TDP = total dissolved phosphorous

TP = total phosphorous

USGS = United States Geological Survey

UV = ultra violet

WEBS = watershed evaluation of beneficial management

WWTP = wastewater treatment plant

Y = year

Glossary

Tributary Sub-Watershed: Watershed areas that contribute to large creeks and streams that ultimately contribute discharge to the mainstem of the river. These creeks and streams typically run year-round.

Upper Reaches: The portion of the watershed that contributes discharge to the river that flows through the defined 0 km mark in the study. It is essentially the discharge present at the most upstream site in the study.

Incremental Flow Sub-Watershed (IFSW): These sub-watersheds can be considered ungauged portions of the watershed that directly contribute discharge to the river in the form of runoff, as well as groundwater inflows, seasonal stream, and agricultural ditches that directly run into the river. They do not contribute to tributary sub-watershed or upper reaches.

Yield: Defined as a mass or volume per unit area. For discharge yield it is volume per area and for phosphorous (and other physical constituents) it is mass per area.

Runoff Coefficient: A dimensionless coefficient that refers to the proportion of precipitation that will runoff and reach surrounding water bodies. The coefficient is based on the land use on which the precipitation falls. For example, impermeable surfaces such as pavement would have higher coefficients that permeable surfaces such a grass.

Export Coefficient: The amount in terms of mass that a constituent, such as P, will be exported in water to the surrounding water body, having units of mass per area per time.

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Finally, the biggest thanks must go to my parents. Every step I make in life you have been there to support and encourage me. You are full of endless advice and support that have kept me moving forward. Having you both as a foundation has been the reason I have been able to achieve so much. Thank you.

Dedication

To my family, your endless support and guidance is the only reason I have made it so far.

1 Literature Review

Note, the subject of phosphorus (P) and P management has been extensively reviewed, and much of the subject matter within this chapter is based on reference papers and not primary sources.

Phosphorous (P) is considered a limiting nutrient in most aquatic systems, meaning growth rates of organisms are directly related to the amount of available P (Dupas et al. 2015). When in surplus, P can cause eutrophication, or enrichment leading to excess plant and algae growth (ibid.). Excess plant and algae growth can, in turn, lead to greater light attenuation and a build-up of dead plant matter, lowering oxygen levels (ibid.). Oxygen is depleted as the bacteria consume the dead plant material, as well as the oxygen, eventually leading to hypoxia (ibid.). Some algae also release toxins that are harmful to human and animal health (ibid.).

Sensitivity to eutrophication varies greatly based on lake characteristics such as size, flushing rate, watershed properties etc., but a relationship has been shown to exist between P concentration and chlorophyll *a* (Rast and Lee 1978). Chlorophyll *a* is the green pigment within algae that leads to decreased transparency in waters (ibid.). There is a log-log relationship between P and chlorophyll *a* (Fig. 1) meaning that increased loadings of P will result in an increase of chlorophyll *a* (ibid.). This relationship has been shown to exist in water bodies of varying sizes, drainage areas, and land use densities within the watershed (ibid.).

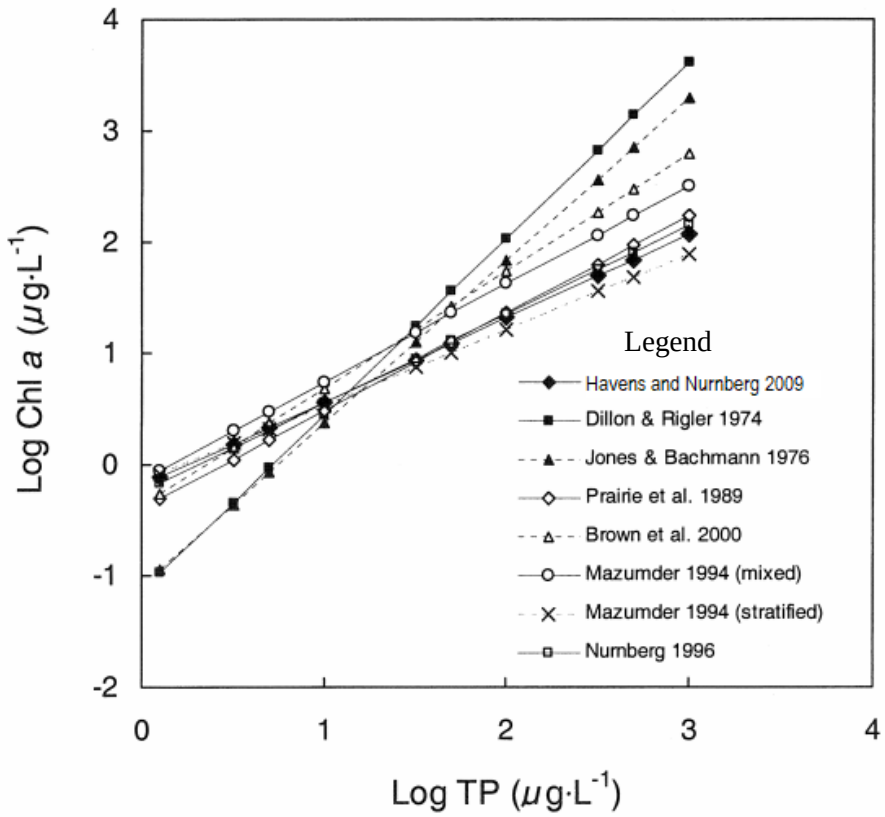

Figure 1: *Chlorophyll* a *and total phosphorous relationship from several studies. Modified from Havens and Nurnberg (2009) to clearly show linear relationship.*

Chlorophyll *a* is associated with the absorption and scattering of light that reduces transparency within lakes, as measured by a Secchi disk (Rast and Lee 1978). Secchi disks are a common and simple way to measure transparency in waters. Transparency is measured by lowering an opaque disk (Secchi disk) marked with black and white quadrants, until it is no longer visible by an observer, which is considered the Secchi depth (ibid.). Secchi depth (water clarity) and chlorophyll *a*, have an inverse log-linear relationship; with increased chlorophyll *a* resulting in reduced Secchi depth readings (ibid.). Determining what is an acceptable depth of clarity measured by Secchi depth can thus determine the acceptable amount of P to be entering a water body.

1.1 Phosphorous Pools and Fluxes

Natural sources of P include mineral weathering and atmospheric deposition. P is released by the weathering of rocks containing the mineral apatite. Apatite is composed of 18%

P, naturally releasing an average of 0 to 0.048 kg ha^{-1} y^{-1} (Dillon and Kirschner 1977) from rocks to surrounding water bodies through weathering. The second natural source, atmospheric deposition, is derived primarily from precipitation and wind erosion. In western Canada, atmospheric deposition is estimated to contribute 0.2 kg ha^{-1} y^{-1} P (Shaw et al 1988).

Anthropogenic sources potentially contribute much greater amounts of P to the surrounding environment than natural sources (Yuan et al. 2013). In most watersheds surveyed by USDA in the United States, approximately 30% of the P inputs come from point sources, predominantly from industrial and municipal wastewater, with some P contributed by storm water runoff drains (Sharpley et al 2007).

The remaining 60% of the P inputs are from non-point sources, mainly agricultural runoff (Yuan et al. 2013). The main sources of agricultural non-point sources P are livestock manure and fertilizer, which combined, are the largest source of P in most agriculturally impacted watersheds in the North America (ibid.). Although P from manure and fertilizer can quickly be transferred to surface waters in large rainfall events, much of the P from these sources is retained in soils, creating legacy P (Sharpley et al 2007). Legacy P in soils is P in greater than of the crop requirements and can persist even after fertilization or manure spreading has stopped (ibid.).

Legacy P is created by the application of excess fertilizer or manure on crops without reference to meet specific nutrient goals (Kleinman et al 2011). Fertilization and manure application are on average 2-4 times the crop requirement of P (Sharpley and Withers 1994). Once legacy P develops, it can take many years for P levels to decline back to the agronomic level through export, even without fertilization or manure spreading. The slow decline can potentially mask management improvements (ibid.).

The P from its relative pools and sources is transferred into surface waters in one of three main ways: surface runoff, soil erosion, or subsurface flow (Nellesen et al 2011). First, surface runoff occurs when there is excess water flowing over the land surface, usually in the form of snowmelt or stormwater. Surface runoff happens when rainfall or snowmelt exceeds infiltration rates. Surface runoff is an agent of soil erosion, the second pathway, which suspends material, exports dissolved and particulate P to surface waters (Buda and Kleinman 2009).

Soil erosion, the second transport pathway, is the most visible transport pathway, moving sediment from the surrounding watershed into the surface waters (ibid.). Soil erosion is considered a form of runoff, but occurs when soils have low stability and there is sufficient power from flowing water or air to move the soils (ibid.). Erosion is different from runoff, as it carries large amounts of sediments and is not confined to the top layer of soils(ibid.).

The final pathway is subsurface flow. Subsurface flow is the flow from surface waters through the soil and groundwater. This can result in the leaching of P from the surface and subsurface waters to groundwater, which can then be can be transported to the surface waters including drainage ditches (Sims et al 1998).

The main sinks of P during transport are soil sorption and plant uptake (Zhou et al 2016). Sorption is the reaction of water-soluble P in soil solution with constituents to form more stable compounds. The sorption reaction takes place on the soil surface constituents, usually clay, oxides of iron and aluminum, or organic matter. The P can diffuse towards the center of the particle, becoming less biologically available (Yuan et al 2017). The other main sink is uptake by plants. P is essential to plant and organism growth, so bio-available forms are taken up rapidly (Kang et al 2009). The P is not completely lost from the system unless the plants are removed, but the P held within living plants is not directly available for export to surrounding waterbodies where algae or other organisms could use it for growth (ibid.).

1.2 Approaches to determine P pools and fluxes

1.2.1 Land Use Coefficient Modeling

Waterbodies are linked to their watershed through the transport of material carried through runoff and wind transport, such as P (Chen et al 2009). Transport of P in watersheds increases with anthropogenic activities, which increases land disturbance, erosion and impervious surfaces, as well as creates additional P sources (ibid.). The type of land use and its density in the watershed therefore has a large impact on P loadings (ibid.). To predict loadings based on land use, one of two common modelling approaches are used; export coefficient models (ECM) or deterministic models (ibid.).

Export coefficient models (ECM) use a unit load approach, predicting loadings in terms of mass area^{-1} time^{-1} based on different land use types (Chen et al 2009). The ECM approach is most commonly used to predict eutrophication in lakes, by estimating the export of nutrients

from areas under different land uses and summing them together to get total P loading into the waterbody (ibid.). Sources are categorized by land use (ranching, residential, forested etc). The model works to determine the relationship between the land use type and the P concentration of runoff, using a combination of field experiments and statistics (ibid.). The model then generates a coefficient for each different land use source (ibid.). The most commonly used model equation for P is the Phosphorous Export Coefficient Approach;

$$L = \sum_{i=1}^{m} C_i A_i \qquad \textbf{(1)},$$

where L is the loading kg y^{-1}, m is the number of land uses, C_i is the P export coefficient for the land use i (kg ha^{-1} yr^{-1}), and A_i is the area of land use (ha) (Soranno et al 1996).

The second common approach to export coefficient modelling is the use of deterministic models. These models use continuous simulation of pollutants and the processes from transportation, transformation and output, to determine the pollution occurrence, time and source (Chen et al 2009). Common examples of this model include Agricultural Non-Point Source (AGNPS) and Soil Water Analysis Tool (SWAT) (ibid.). These models require large amounts of data including: topographic maps, soil maps, hydrologic parameters, land use maps, cultivation practice, precipitation, temperature, location of point sources, discharge characteristic of point sources, and management practices (ibid.). Due to the complexity, it requires special knowledge and skills to create estimates, and consequently sufficient data to run models seldom exists (ibid.).

The relative accuracy of the SWAT model and the ECM model were compared in predicting TP loads in the Kan Watershed in Iran (Delkash et al 2014). For this watershed, SWAT created better estimates of TP loadings on small time scales, averaging an error of just 7% relative to the measured TP load. Despite the simplicity of the ECM approach, the model estimated yearly loadings with an error of just 9% of the measured TP loads in watersheds that had relatively flat topography. Topography cannot be accounted for in the ECM, and therefore is the biggest source for error in TP load estimates (ibid.). In high-relief sub-watersheds TP load estimates had errors as large as 33% (ibid.). Overall, with data being the main constraint in most studies, the ECM is considered a reliable approach as long the watershed topography is not excessively steep, though the threshold for slope was not explicitly stated (ibid.).

1.2.3 Mass Balances

A mass balance using measured P values can be used to determine the amount of P coming in from different sources, creating a watershed scale P budget. A mass balance is a quantitative accounting of inputs and outputs into a system, derived from the law of conservation of mass, stating that mass cannot be created or destroyed (Kendall and McDonnell 1998). The basic equation dictating a mass balance is;

$$\textit{inputs} - \textit{outputs} = \textit{the change in storage} \qquad \textbf{(2)}$$

A hydrologic mass balance is commonly known as water balance and refers to the flow of liquid water throughout a hydrological system. Because P is transported mainly by water, a hydrological mass balance can be paired with nutrient concentration measurements throughout the watershed to create a nutrient mass balance. Because eutrophication depends on P inputs, mass balances are useful tools to determine the overall quantity of nutrients entering a water system and make recommendations to manage these nutrients (Paces 1972). The approach to a nutrient mass balance is derived from the law of the conservation of mass, following Equation 2.

1.2.4 Source Tracing by Geochemical Mass Balances

Because it is difficult to measure every input into a watershed, geochemical mass balances can be used to improve accuracy of predictions. Geochemical mass balances use changes in conservative elements, or elements that will keep consistent chemical characteristics as they travel through the watershed, to determine the inputs of non-conservative constituents such as P (Kendall and McDonnell 1998). This is done by multiplying the source contributions estimated using geochemical mass balances with measured concentrations (ibid.). Geochemical mass balances are dependent on a hydrologic mass balances, with hydrologic flow driving the movement of geochemical constituents throughout the system (Mockler et al. 2016). Hydrologic balances dictate the source, pathway, and residence time, of the geochemical constituents in a liquid solution, thus dictating reduction, oxidation, absorption, and other processes that affect water quality (Kendall and McDonnell 1998).

Geochemical mass balances commonly inform end-member mixing analysis (EMMA) to determine source contribution of end-members in a mixture of end-members. An end-member can be defined as component or source of which a mixture of water is made of. EMMA uses changes in concentration of conservative tracers to determine the proportional contribution from

end-members in water samples composed of mixtures of the end-members EMMA (Kendall and McDonnell 1998). The simplest version of EMMA is the binary mixing model, which contains only two sources representing end-members;

$$X_1 = \frac{(C_{mix} - C_2)}{(C_1 - C_2)} * 100 \qquad \textbf{(3)},$$

where X_1 is the percentage of end-member 1 in the water mixture, C_1 is the concentration of the tracer in end-member 1, C_2 is the concentration of the tracer in end-member 2, C_{mix} is the concentration of the tracer in the water mixture (Eberts et al 2013).

1.3 Management of P

In watersheds where land-use coefficient modelling or mass balance approaches have identified sources of excess P, best management practices (BMPs) can be put into place to reduce P loadings into surrounding surface waters. BMPs are soil and water conservation practices that focus on management techniques and social actions that work to ensure environmental protection (Sharpley et al 2006). For P, the goal of BMPs is to minimize surface runoff, erosion and transport via surface and subsurface flow. Minimizing P loss to surface water is most commonly executed through the reduction of erosion and runoff, which reduces the transport of P rich soils into the water body, or by increasing retention time of P rich waters before they reach the surrounding surface waters, which allow for P particles to settle out of the water (ibid.).

BMPs that work towards the reduction of P flux into surrounding surface waters comes in two main forms; erosion and runoff reduction and flow path management (Sharpley et al 2006). Reduction of erosion and runoff works to minimize the transport of P to surface waters (ibid.). Likewise, flow path management reduces P loading into surrounding water bodies by increasing retention of P rich waters before they reach the surrounding water body (ibid.).

There are three main BMPs to reduce erosion and runoff; conservation tillage, bank stabilization, cover crops and field management practices (Tiessan et al 2010). All three work to stabilize and the soils and reduce transport of P via erosion and runoff pathways.

First, conservation tillage is the act of leaving a minimum of 30% of the residues from previous crops on the soil surface after harvest, whereas conventional tillage would incorporate all crop residue into the soils (Tiessan et al 2010). Conservation tillage reduces erosion losses

which are common for bare soils and is a very common practice in Canada (ibid.). It is effective in reducing export of particulate forms of P, especially on sloped fields (ibid.).

The second common BMP that works towards reducing erosion and runoff is bank stabilization. Stabilization is usually done by planting vegetation along the river or stream edge, as the roots will work to stabilize the banks (Kronvang et al 2012). Many times, this is paired with exclusion fencing of livestock to protect the vegetation that buffers and stabilize the bank (ibid.). Exclusion fencing works to keep the livestock from destroying the vegetation as well as keep the livestock off the bank edge to reduce direct erosion (ibid.). The fencing also eliminates direct deposit of manure in water bodies (ibid.).

The final type of BMPs commonly used to reduce erosion and runoff are is field management. One form of field management is cover crops. Cover crops are fast growing plants such as barley, planted after harvest to reduce erosion and increase infiltration (Sharpley et al 2006). This can be paired with strip cropping, terracing or other field management practices, which all aim to reduce erosion (ibid.). This practice is not effective unless the land is sloping and is in a wet climate prone to high runoff rates (ibid.).

The flow-path management BMPs work to reduce P loadings into the river by increasing retention of P before P-rich waters reach the surrounding water body (Tiessan et al 2011). Increasing retention allows for settlement of particulate P and uptake of bio-available P by plants (ibid.). The two main BMPs that increase retention time are settlement basins and conservation buffers.

First, settlement basins are large ponds or basins that are meant to slow runoff and water and allow for settling of particulate forms of P (Tiessan et al 2011). The basins are not intentionally vegetated and are only meant to slow the waters entering. By slowing the water, this also effectively reduces erosion. TP flux has been shown to be reduced by 20-50% in these basins (ibid.) Settlement basins are effective in areas where the majority of P transport comes from episodic large flows like snowmelt and stormflow, as the basins can retain large volumes of water, allowing P to settle out (ibid.).

Second, conservation buffers are vegetated strips of land used to reduce nutrient loss through physical retention of particulate nutrients and uptake by vegetation. There are three main

types of conservation buffers; riparian buffers, grassed waterways, and constructed wetlands (Hoffman et al 2009). First, riparian buffers are vegetated strips along stream and river banks. They work to stabilize banks, reducing erosion, while also capturing eroding soil and particulate forms of P (ibid.). Second, grassed waterways, which consist of runoff channels and sloped fields planted with permanent vegetation to trap soil, particulate P, and reduce erosion (Sharpley et al 2006). Finally, constructed wetlands, which are a form of riparian buffer meant to attenuate runoff and scavenge P into sediments and biota (from particulate and dissolved P) (ibid.). They are built where smaller riparian buffers would be insufficient to mitigate due to large volumes of discharge (ibid.).

All conservation buffers generally have a greater retention of particulate P than dissolved P. Buffers are best used when erosion is the main transport pathway, as it means the source of P is usually in particulate form and is easily captured (Hoffman et al 2009). To increase P uptake and retention, conservation buffers need a low-angle slope to slow the water down, soils that infiltrate to assist with binding of nutrients, and wider is generally better as retention time of water increases and velocity decreases (ibid.). Previous studies have shown TP and TDP retention rates of 32-93% in constructed wetlands.

2 Project Overview

2.1 Motivation

The aim of the project was to determine the sources of total phosphorus (TP) and total dissolved phosphorus (TDP) into the Shuswap and Salmon Rivers, because the rivers were determined to be the main contributors of P to the Shuswap and Mara Lake system (Tri-Star 2014). Despite their large size (309.6 and 19.5 km^2, respectively) and rapid flushing rate (~ 2 years) (ibid.), Shuswap and Mara Lake in Southern Interior British Columbia experienced large-scale algae blooms in 2008 and 2010, respectively. There is no official threshold level to determine what an algae bloom is, but it can be considered a concentration of hundreds to thousands of algae cells per milliliter, depending on the algae species present which results in lowering of oxygen levels (Wolf and Klaiber 2017). No algae blooms have been reported since, but elevated algae growth was reported in 2011 and 2012. The algae blooms were determined to be associated with phosphorous (P) entering the lakes from the Shuswap and Salmon Rivers (Tri-Star 2014). Using export coefficient models (ECM), the Shuswap and Salmon Rivers were identified to be the majority contributors of P into Shuswap and Mara Lakes, greater than any of the other rivers that enter lakes.

Algae blooms are not only harmful to human and livestock health, but they also reduce tourism, thus hurting the economy, consequently making prevention of future algae blooms within the Shuswap and Mara Lakes system a top priority. Identifying the sources and transport mechanisms of P into Shuswap and Mara Lakes from the Shuswap and Salmon rivers, is essential to remediate P loadings and prevent future algae blooms.

2.1.2 Past Studies

The potential sources of P entering the Shuswap and Mara Lakes system were examined in a study undertaken by Shuswap Lake Integrated Planning Process (SLIPP) in 2014 (TriStar 2014). Contributions of TP from permitted discharges, direct loadings (e.g. Enderby waste water treatment plant), and non-point source loadings, including tributaries, to the overall P budget into the Shuswap-Mara Lake system were estimated by an ECM. The exercise estimated TP loadings for individual land uses using a combination of runoff coefficients and TP concentrations taken from literature (ibid.).

It was concluded that nearly all the P (98%) was coming in from the rivers that act as tributaries to the lakes (e.g. Shuswap, Salmon and Eagle Rivers) (TriStar 2014). The remaining

2% of the TP load was said to come from salmon carcasses and direct discharge from a wastewater treatment plant on Shuswap Lake (ibid.). The TP load from atmospheric deposition and other natural sources were not estimated. The majority of the P was calculated to be from the Shuswap and Salmon Rivers. The Shuswap River was said to contribute 94.2% of the TP to Mara Lake, while the Salmon River was said to contribute 62% of the TP to Shuswap Lake, or a total contribution of 78.1% between the two rivers into the Shuswap- Mara lake system (ibid.). The study also inferred that the majority of the P entering the lake system was from agriculture storm water runoff (ibid.).

2.2 Hypotheses and Objectives

Incremental flow sub watersheds (IFSW) are sub-watersheds that make up the greater watershed of the river but are not part of tributary sub-watersheds (watersheds of major creeks in the area) or upper reaches (the contribution watershed above the 0 km mark). IFSW are ungauged sub basins, but also include direct contributions to the rivers from groundwater, seasonal streams, agriculture ditches, etc. Because IFSW exist in low elevation areas of the watershed that contain the majority of the anthropogenic activities within the watershed, I hypothesized that they would be the largest contributors of TP and TDP load for both the Shuswap and Salmon Rivers. Anthropogenic activities, particularly agriculture and urban areas, are known to have large exports of P. For agriculture areas, the increased P export is due the spreading of P rich fertilizer and manure on the lands. In urban areas, much of the increased P export is due the impermeable surfaces which drastically increase runoff and transport particulate and dissolved forms of P into the river systems.

My research aimed to measure and estimate the TP and TDP in the lower Shuswap and Salmon Rivers so that land managers have a baseline to work from to reduce loadings into the two rivers and ultimately the Shuswap and Mara Lakes system. In order to quantify the TP and TDP from tributaries sub-watersheds, IFSW, and contribution from upper reaches (areas above the defined 0 km mark). I have chosen to use a robust approach using a combination of field measurements of P concentrations and three estimation methods for hydrologic inputs; extrapolation, runoff coefficients (RC), and geochemical methods. Finally, I calculated P export coefficients for land use types including forested, agriculture and urban within the watershed and compared them to literature values, all of which can be used in future management practices.

2.3 Use of Novel Tracers in End-Member Mixing Analysis (EMMA)

My research also explored the option of using two novel tracers; colored dissolved organic matter (CDOM) and nitrate, in end-member mixing analysis (EMMA), a part of the geochemical method. For EMMA, constituents can be used as tracers if they exhibit conservative behavior within the system.

2.3.1 CDOM as a tracer

Colored dissolved organic matter (CDOM) is the fraction of dissolved organic matter (DOM) that is responsible for the absorption of ultra-violet (UV) light. It is a major component in the light attenuation responsible for transparency of freshwater. In high concentrations, CDOM can create a yellow-brown color and absorb visible light. CDOM works to protect biota in freshwater from harmful UV radiation and photo-bleaching. (Stedmon et al 2010, Chen et al 2014)

CDOM is created primarily through the degradation of aquatic and terrestrial plant matter. In fresh water systems like the Shuswap and Salmon Rivers, water contribution is dominated by runoff, therefor terrestrial (allochthonous) inputs dominate over aquatic inputs (autochthonous). When allochthonous inputs are greater than autochthonous inputs, CDOM is shown to behave conservatively (Stedmon et al 2010). The half-life of CDOM in literature ranges from 40 to 1,930 days (Chen et al 2014, Reche et al 2000), and as long as half-life time exceeds average residence time, it is effectively conservative. These characteristics make it a candidate for use in EMMA where residence time of water is greater than 40 days (Stedmon et al 2010).

There have been very few applications for the use of CDOM as a conservative tracer in mixing models. A successful application of CDOM in EMMA was done in the North Sea Transition Zone by Stedmon et al (2010). Using a three end-member mixing model, the study measured the concentrations of CDOM in the three end-members at 440 nm to separate out the proportion of water from the Baltic Sea Outflow, German Bight and Central North Sea that made up the North Sea Transition Zone. The study successfully demonstrated the utility of CDOM as an indicator of mass mixing models, as verified using salinity and temperature mixing models. (Stedmon et al 2010). To my knowledge, my study the first use of CDOM in EMMA in freshwater systems.

Successful application of CDOM in end-member mixing analysis could allow for continuous estimation by EMMA. Optical sensors could be installed to measure CDOM absorbance values, allowing for continuous estimation of flow characteristics, eliminating the need for frequent field sampling. This could mean more accurate EMMA data with less interpolation, at lesser costs.

2.3.2 Nitrate as a Tracer

Nitrate has low sorption characteristics, allowing it to follow the same pathways as water. It is not considered a conservative tracer, as it is subject to biological processes that change its chemical characteristics such as denitrification, ammonification and nitrate reduction (Brusland et al 2009). If residence time is short enough though, it can be shown to behave conservatively (ibid.). The chemical changes of nitrate were shown to take several days in the Columbia River, exceeding residence time, and therefore behaving conservatively consistent with residence time (ibid.). In the Shuswap and Salmon River system, residence time never exceeds 0.81 days, which is longer than the estimated 5 to 10 days it takes for nitrate's chemical characteristics to change (ibid.), therefore nitrate can be considered effectively conservative and potentially qualify as a tracer in EMMA in the Shuswap and Salmon Rivers (ibid.).

2.4 Site Description

2.4.1 Geography

The Shuswap and Salmon Rivers lie in central southern interior of British Columbia. The Shuswap River (Fig. 2) originates at the Blanket Glacier in the Sawtooth Region of the Monashee Mountains. The Upper Shuswap River then runs south through Greenbush Lake to Sugar Lake for 52 kms. The Middle Shuswap River runs about 55 kms in length from Sugar Lake out to Cherryville, BC where it turns and runs north to Mabel Lake. The study area for this project was the Lower Shuswap River, which exits Mabel Lake flowing east to Enderby, BC. From Enderby the river flows north to Mara Lake (73kms), the terminus of the river.

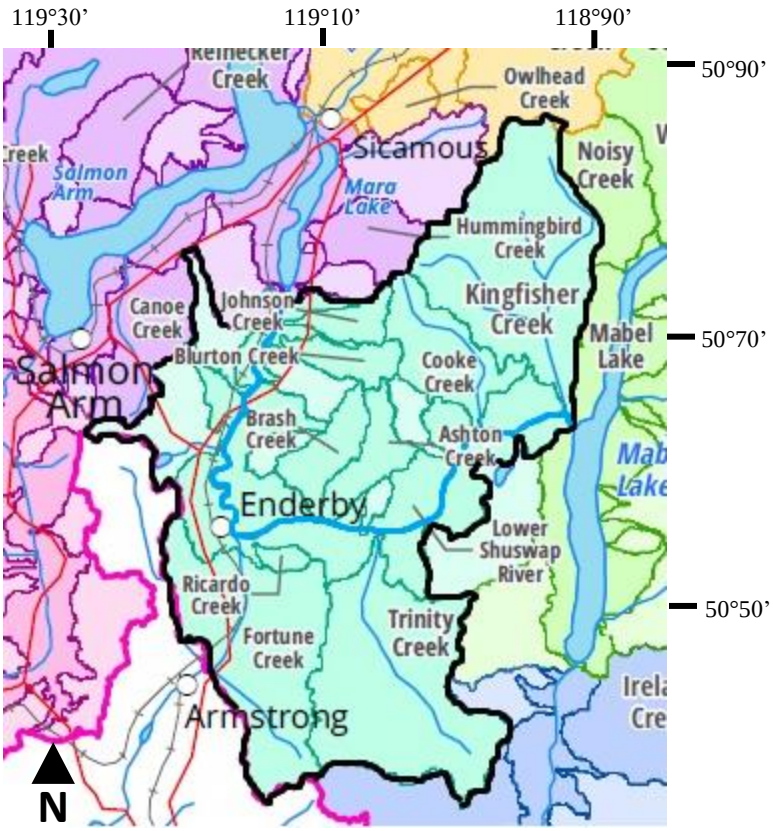

Figure 2: *Map of the Lower Shuswap Watershed. The Shuswap River is represented by a thicker blue line. Modified with permission from the Fraser Basin Council. Datum : NAD 83 (2016)*

The Salmon River (Fig. 3) originates in the Thompson Plateau, southwest of Salmon Arm, BC where it flows west into Salmon Lake. Upon exiting Salmon Lake, it flows northeast into the Westwold Valley (~43kms). The study area on the Salmon River was the Lower Salmon River from Westwold, BC to Highway 1 (66 km). At Westwold, the river flow is entirely subsurface (hyporheic), outside of spring freshet. The majority of the flow returns to the surface and re-emerges just west of Falkland (Tri-Star 2014). The river continues east, following Highway 97, into Falkland, BC before turning north and running through the Silver Creek community and into its terminus at Shuswap Lake.

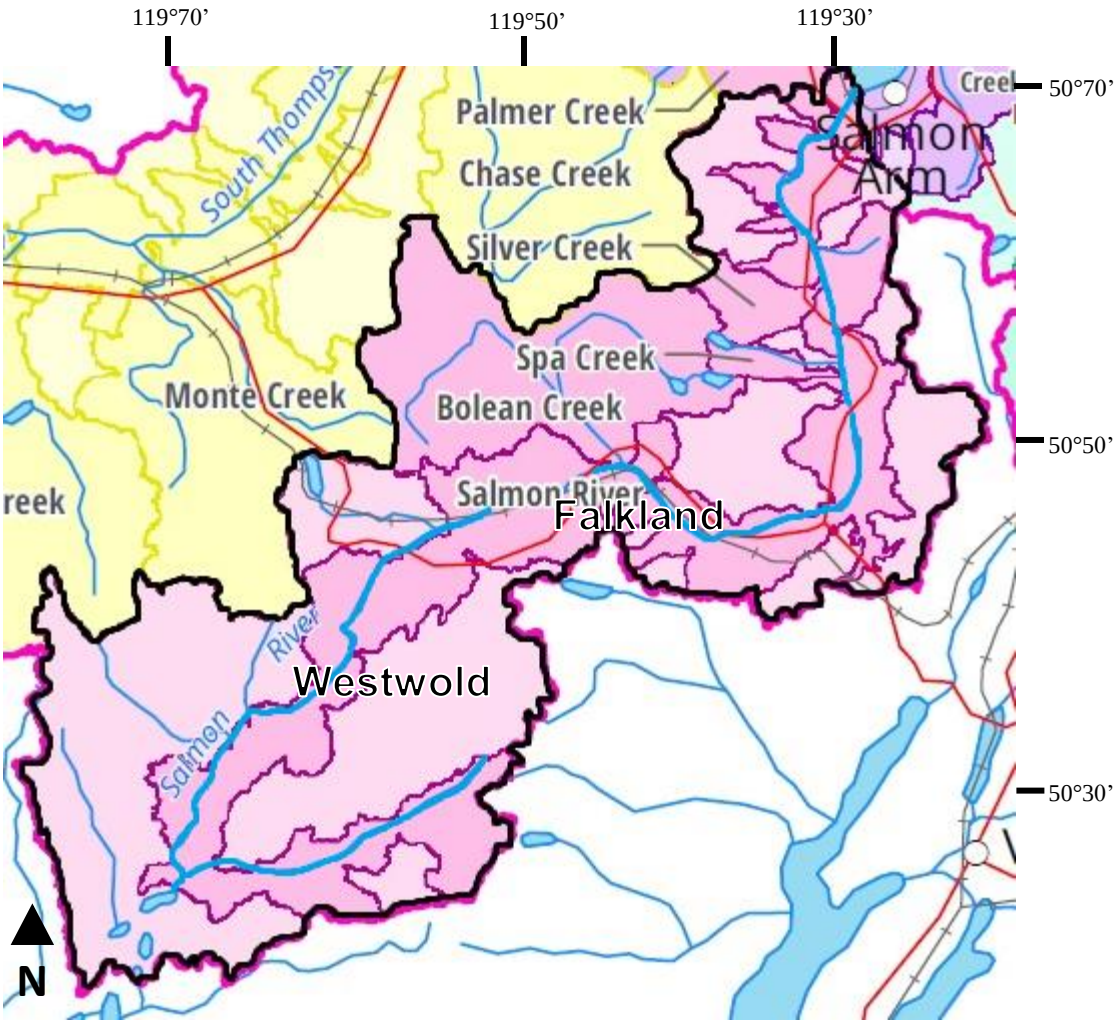

Figure 3: *Map of Salmon River Watershed. The Salmon River is represented by a thicker blue line. Modified from the Fraser Basin Council. Datum: NAD 83 (2016).*

2.4.2 Geology and Soils

The majority of the bedrock in the Shuswap and Salmon river watershed is metamorphic (Kowalenko et al 2009). The rock consists mainly of schists, argillite, gneiss, and phyllite (ibid.). Soils in the higher elevations of Shuswap and Salmon River watersheds are dominated by sandy porous soils derived from glaciofluvial materials rich in sand (ibid.). Closer to the rivers in the valley bottom of the watersheds, the soil is mainly silty clay, rich in organic matter and derived from glaciolacustrine sediments (ibid.). In general, the valley bottom soils are richer in organic matter and contain more silt and clays than the soils dominating the uplands (ibid.).

2.4.3 Climate

The Shuswap and Salmon River watersheds cover several different climate zones. The climate zone at the climate station in the Salmon River Watershed near Falkland, BC is considered to be semi-arid, while the climate stations near Mara Lake and Salmon Arm, BC are temperate continental, with the general gradient in the two watersheds being drier climate to the west, with increasing in rainfall to the east (Climate Data 1911-2010, Ministry of the Environment). The watersheds also include semi-arid sub-alpine and temperate mountainous environments on the surrounding highland plateau, with rainfall and snowfall increasing with elevation and temperature decreasing with elevation (ibid.). The watersheds have four distinct seasons throughout, with warm summers, and mild winters. Temperatures range from an average of -2°C in the winter to 27.3°C in the summertime, according to climate stations at Falkland and Salmon Arm, BC (ibid.).

Average rainfall at the Falkland and Salmon Arm climate stations range from 287-551 mm average per year (Climate Data 1911-2010, Ministry of the Environment). Greater rainfall occurs at the climate station in Salmon Arm, BC which averages 150 days of precipitation per year (ibid.). The low end of the rainfall occurs at a climate station near Falkland, which averages 129 days of rain per year (ibid.). Snow is also greatest at the climate station in Salmon Arm, averaging 182 cm of snow and 58 snowy days a year (ibid.). The Falkland climate station receives only 72 cm of snow and 28 snowy days per year on average. Snow accumulation is much greater in the highland mountainous areas as compared to the valley climate stations, averaging around 12 m per year (ibid.).

The average growing season for the lower elevations (less than 500 m) of Shuswap and Salmon River watersheds is May through September, averaging 139 frost free days a year (Agriculture Land Use Inventory 2013-2014). Snow cover in the watersheds extends from December through the first half of March and soils remain frozen from early November through April, with this season being extended in higher elevations (ibid.). Snowmelt generally begins in mid-March in the lower elevations of the watersheds but can occur anytime throughout the winter. The rate of snowmelt is dependent on weather, sometimes melting nearly all the snow in less than a week or melting slowly over the course of several weeks in colder years, more slowly at higher elevations (ibid.). Due to the warmer temperatures, combined with low rainfall in

summer, irrigation is required in some areas throughout the watershed, usually in the summer and fall months (ibid.).

2.4.4 Hydrological Regime

The Lower Shuswap and Salmon River lie mostly within the North Columbian Mountain Hydrologic Zone, as defined by Environment Canada (BCGW Data Store 2010). About half of the Salmon River watershed is considered part of the Fraser Plateau Hydrologic Zone (ibid.). Both hydrologic zones are classified as having snowmelt hydrological regimes, with snow being the dominant source of discharge (ibid.). The snowmelt regime reaches a maximum discharge during freshet, when snowmelt occurs (ibid.). The Fraser Plateau Hydrologic Zone differs from the North Columbian Mountain Hydrologic Zone only in quantity, having lesser precipitation and snow accumulation, but are qualitatively the same (ibid.).

2.4.5 Anthropogenic Activities

The watersheds have many low-lying flood plains that have low gradient topography used extensively for agriculture (Agriculture Land Use Inventory 2013-2014). The flood plain soils are well suited for agriculture, because they are comprised of glaciolacustrine soils rich in organic material (ibid.). The soils also contain little to no coarse materials and have high agriculture productivity rates due to their ability to retain water and nutrients (ibid.). The majority of the crops in the watershed are irrigated in the summer and fall months (ibid.).

The economy within the study area is dominated by logging, agriculture and tourism activities (ibid.). Extensive logging of Crown land takes place in the upper reaches of the Shuswap River near Mabel Lake, while private logging and woodlots are more common in the lower reaches of the watershed (ibid.). Ranching and farming are the dominant land use and economic driver in the valley bottoms near the river's edge (ibid.). Within the farms, livestock types include beef, dairy, swine, poultry and feed lots (ibid.). Recreation and tourism are also a large industry, with boating, fishing, hiking and other outdoor activities being the main form of recreation in the summer (ibid.). In the winter, snow cat and helicopter skiing operations operate in the higher elevation mountains in the region, while cross country skiing and snowmobile recreation are more prominent activities at lower elevations (ibid.).

The Shuswap and Salmon River watershed contains several towns and settlements. The community of Enderby along the Shuswap River is the most densely populated, with a

population of 2,964 (Canadian Census 2016). Other settlements include Westwold, Falkland, and Silver Creek along the Salmon River and Kingfisher, Ashton Creek, Grindrod, Mara and the Splatsin Band Reserve Lands along the Shuswap River. An estimated 14,878 people reside in the study area of both the Salmon and Shuswap River watershed (ibid.). Population is relatively stable in the region, growing 0.08% since the 2006 census (ibid). According to the census, around 25% of all homes in the region are second homes, meaning that a large part of the population may be unaccounted for during tourism season (May – September) as they are non – permanent residents (ibid.).

When comparing the human population to the livestock population, in terms of animal unit equivalents (AUE), the livestock population is about 3.8 times greater than human population, and estimated to be 7,740 AUE (AUE, Agriculture Land Use Inventory 2008, 2013-2014).The total human population residing within the Shuswap and Salmon River watershed for the study is equivalent to 2,038 animal unit equivalents (). The population of Enderby (20% of the total population within the two watersheds) is served by the Enderby waste water treatment plant, while the remaining portion is on septic. Note that the city of Salmon Arm is not considered a source of P to the Salmon River, as wastewater and other discharge drain directly into Shuswap Lake.

3 Methods

3.1 Hydrometric Measurements

3.1.1 Field Sites and Sampling

Discharge was measured by Water Office of Canada's hydrometric stations on the mainstem of the Shuswap and Salmon Rivers. On the Shuswap River, the station is located at 29 km (Fig. 4), midway down the river. For the Salmon River, the station is located at 66 km (Fig. 5), at the outlet into Shuswap Lake. Sample sites for discharge and surface water sampling were then spread across the mainstem of the rivers and upstream of the confluence in major tributaries and the river.

Sites were then selected along the two rivers to measure discharge and take surface water samples. At every site, discharge was either measured or estimated, and P samples were taken. Thirteen sites, including the seven major tributaries and six mainstem sites (Fig. 4), were selected on the Shuswap River from the outlet of Mabel Lake to upstream of Mara Lake (72 km). On the Salmon River (Fig. 5), sites were selected from the Westwold Aquifer outlet near Falkland, BC downstream to the Shuswap Lake outlet, including the three major tributaries and four mainstem sites.

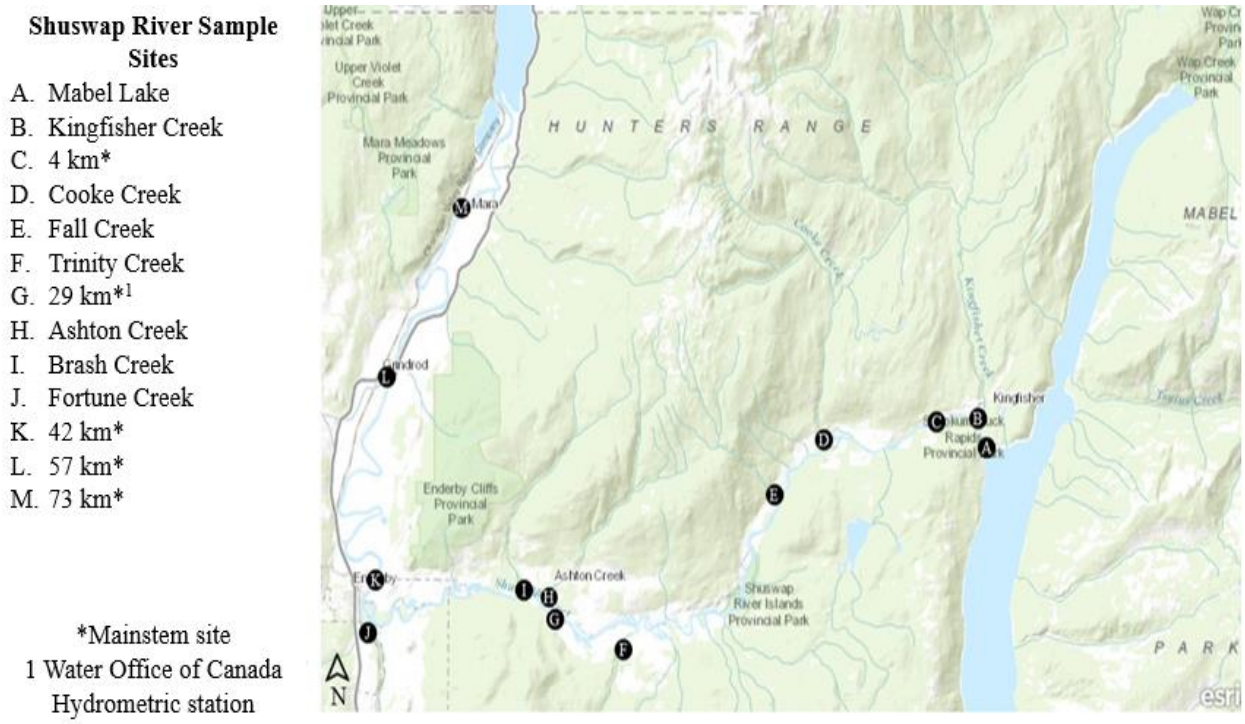

Figure 4: *Shuswap River sample sites, map modified using ESRI online*

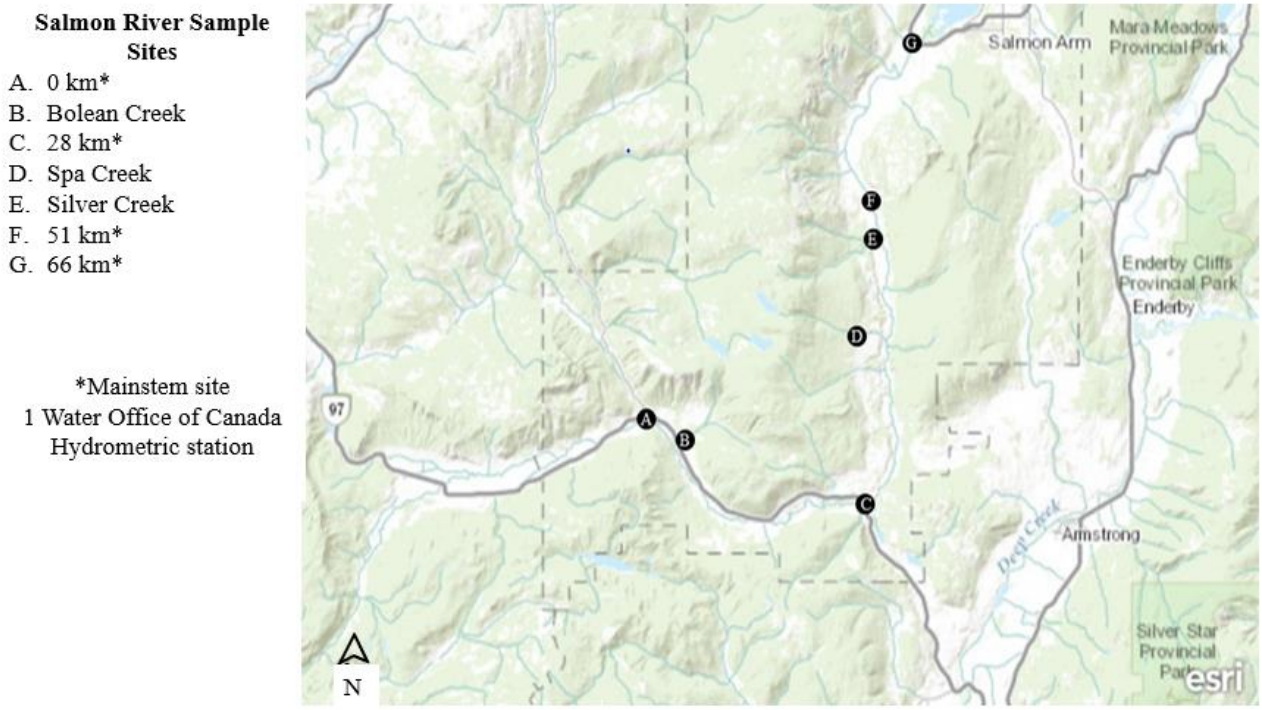

Figure 5*: Shuswap River Sample Sites, map modified using ESRI online*

Water samples were collected from surface water in high-density polyethylene (HDP) bottles that were rinsed twice with the water sample before collection. Sample bottles were immediately loaded into a cooler and subsequently transferred to a refrigerator on return to the laboratory (usually within 8 hours).

Surface water sampling along the rivers and tributaries was more frequent during times of greater discharge and less frequent during times of small discharge. During fall and winter months, sampling was as infrequent as one time per month, due to presence of ice and snow in these months, there was a lack of runoff and therefore a lack of change in discharge and phosphorous (P) concentrations between visits. During freshet, sampling increased to a maximum frequency of 3-4 times per week. In the case of large storm events that created significant runoff events, frequency was also increased.

3.1.2 Sampling for Incremental Flow Sub Watersheds (IFSW)

IFSW are considered the ungauged portions of the watersheds that act as sub-watersheds but are not part of tributary sub-watersheds. IFSW are known to contribute discharge to the mainstem of the rivers, but are not able to be measured directly as tributaries are. IFSW sources are comprised of groundwater and unmetered surface waters, which includes seasonal streams, agriculture ditches, or any surface water entering the streams that is not directly measured.

Groundwater was considered one part of the IFSW contribution. Groundwater was sampled approximately two times per year under the assumption that groundwater composition changes slowly.

Groundwater was sampled using a removable piezometer. The piezometer consisted of a 1.5 m long PVC pipe capped on one end (Fig. 6). The bottom 10 cm immediately above the cap was screened – small slits were added so water could flow into the pipe. The screen slits were small enough that only very fine sediments could enter pipe. To sample, a metal pipe was driven into the ground to create a pilot hole into which the piezometer was placed. The piezometer was placed just below the water table, where it sat for several minutes and filled with water. Polyurethane tubing was then used to vacuum out the water sample from the pipe.

Sampling of groundwater occurred along the length of the Shuswap River (Fig. 7) and on a portion of the Salmon River (Fig. 8). Sampling along the Salmon River was limited to a small portion due to land access issues. Sampling occurred when the height of the river was safe for boating and well below the high-water mark.

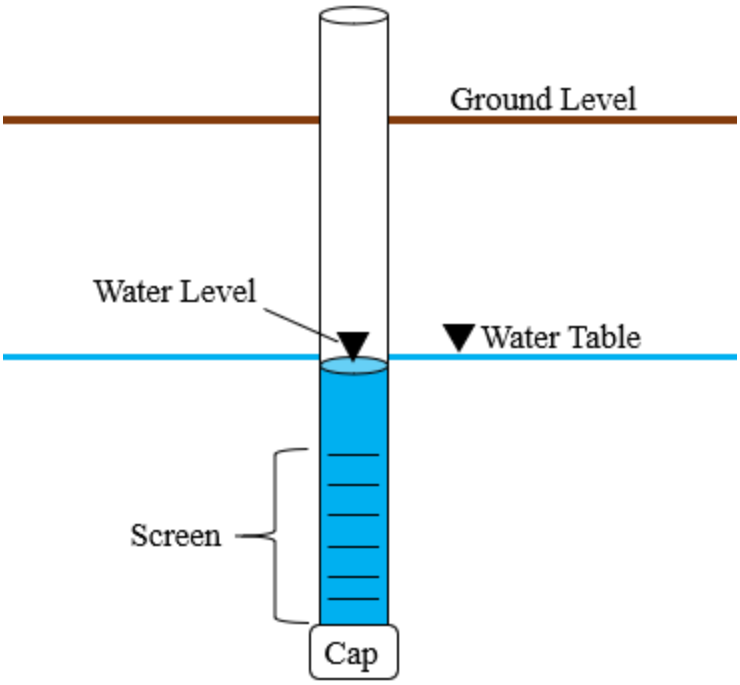

Figure 6: *Piezometer design for groundwater sampling*

Unmetered surface water was considered the second part of the contribution from IFSW. Sampling occurred only during times of greater runoff (freshet). Sources for collection included small streams, agriculture ditches and any flowing water entering the river systems that may not be accounted for in regular sampling (Fig. 7,8).

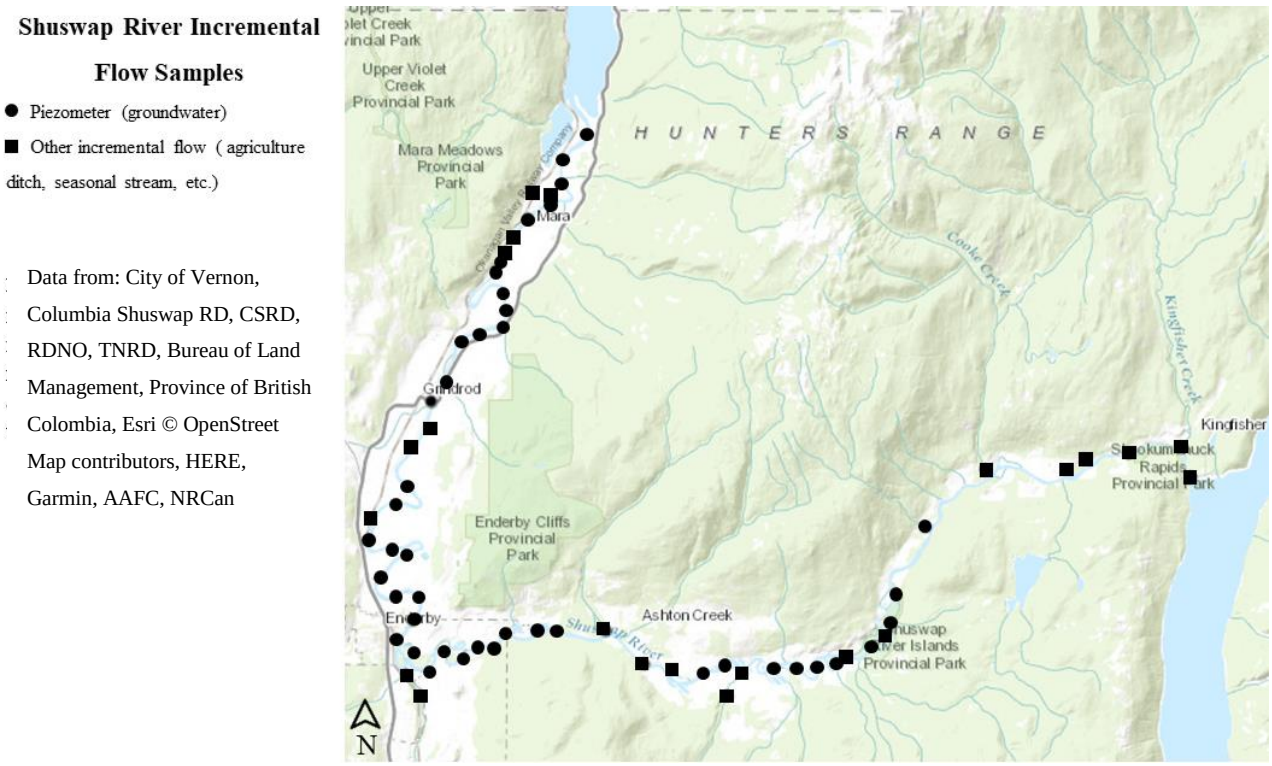

Figure 7: *Incremental flow samples along the Shuswap River*

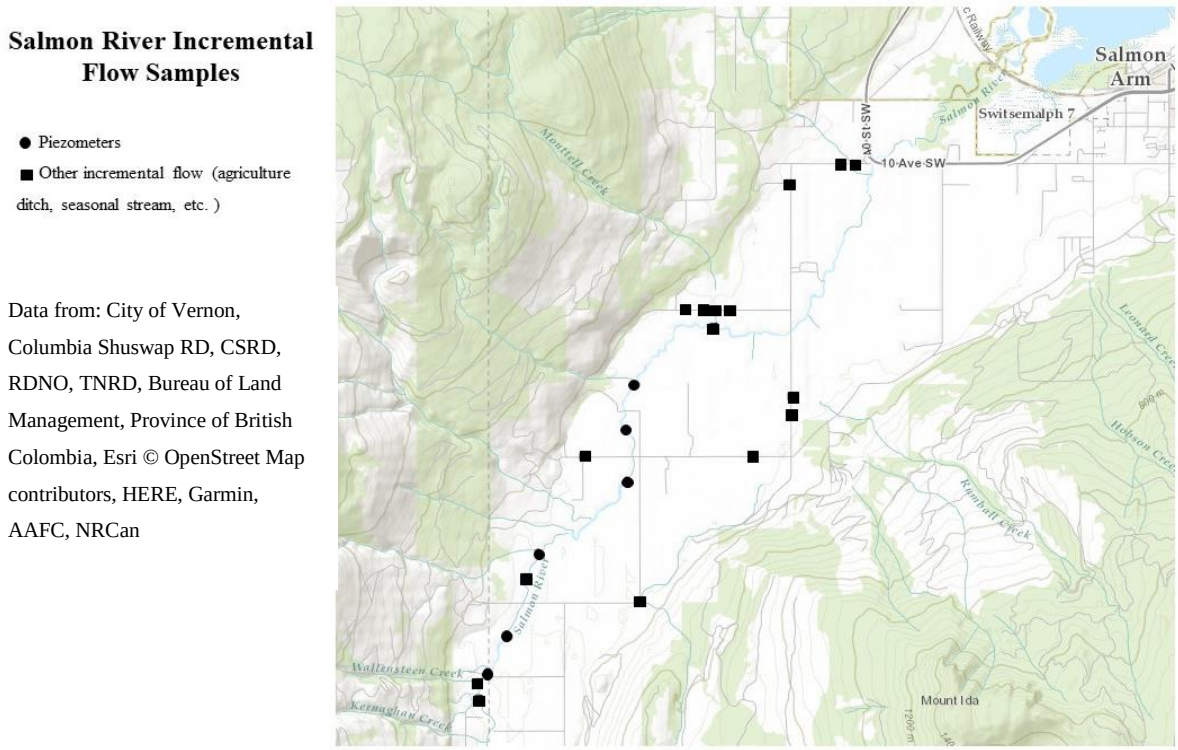

Figure 8: *Incremental flow samples sites along the Salmon River*

3.1.3 Measured Discharge

Discharge was measured at one site along the mainstem by the Water Office of Canada hydrometric stations along each river, while the tributaries were measured within the study using stage height and discharge meters. Measured discharge was at 29 km on the Shuswap River (Fig. 1) and 66 km on the Salmon River (Fig. 2)

Within the tributaries, stage height was measured using staff gauges and pressure transducers. Staff gauges were installed on metal fence posts in back eddies along the creeks. The stage height on the staff gauges was recorded at the time of sampling. Staff gauges also had pressure transducers attached to directly to them. Pressure transducers recorded stage height at 15-minute intervals.

Tributary discharge was monitored by measuring discharge with a flow meter at different river stages to produce a rating curve. The discharge was measured in the tributaries by subdividing the width of the tributary into several sections of equal width and measuring the depth and velocity (taken at 6/10th depth) within each. The area of each subsection was then

multiplied by the measured velocity to obtain a discharge value (m^3s^{-1}). Total discharge for the tributary sub-section was then obtained by summing all the subsection discharges (Turnipseed 2010).

Subsequently, the stage height and measured discharge at each tributary were correlated to create a rating curve (e.g. Kingfisher Creek, Fig. 9). The rating curve was used to predict the discharge based on semi-continuous measurements of stage height (Appendix B) (Turnipseed 2010). The hydrograph for each tributary is the resultant of the measured stage and estimated discharge from the rating curve.

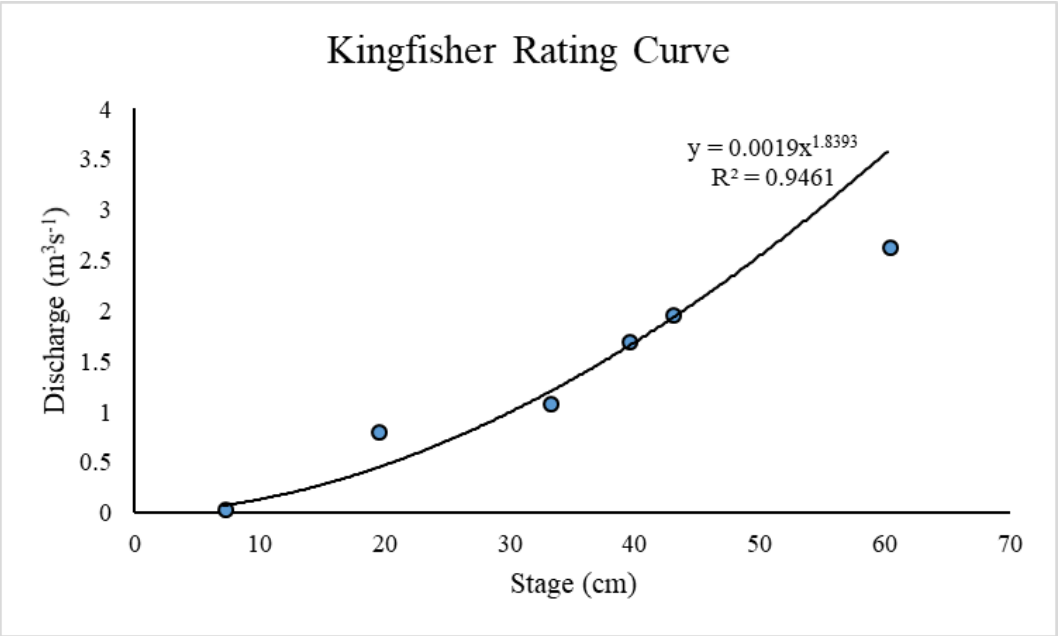

Figure 9: *Discharge rating curve for Kingfisher Creek on the Shuswap River*

3.1.4 Analytical Measurements for Discharge Estimates

Discharge of ungauged portions of the watersheds (IFSW, the outflow at the 0 km sites, and other unmetered sites along the mainstem) on each river were calculated using three methods; extrapolation, runoff coefficients (RC), and geochemical methods. The extrapolation and RC method do not require any chemical measurements, but the geochemical does. The geochemical method requires the measurement of geochemical tracers; base cations, colored dissolved organic matter (CDOM), and nitrate to estimate discharge from EMMA.

First, samples were measured for 5 different elements; Calcium (Ca), Magnesium (Mg) , Potassium (K), Sodium (Na) and Strontium (Sr). Elements were selected as they are known to act conservatively in most fresh water systems, and therefore work well as tracers. The elements were analysed using a Thermo-Electron Corporation, iCap 6000 Series XR Inductively Coupled Plasma- Optical Emission Spectrometer (ICP-OES). The instrument was calibrated using multi-element external standards. Five standards of different concentrations were run to produce calibration curves. An internal standard of yttrium was used to correct for variation between samples. Blanks and reference solutions were run through on a 60-sample interval, as well as replicates on 40 of the samples to determine variation.

Second, CDOM was analyzed within the samples. Samples were filtered through 0.7-micron glass fiber filters and measured for UV absorption on a Cary 50 WinUV Spectrophotometer. Absorption was scanned from 240nm to 750nm in a 1 cm quartz cuvette. The absorption values for 240, 310, 335, 340, 350 and 440 nm were chosen for EMMA. These wavelengths were chosen from literature (Stedmon et al 2010, Chen et al 2014) and because they exhibited the greatest difference in absorbance values between end-members.

Third, samples were analyzed for nitrate using the reduction by vanadium chloride method. Nitrate in all the samples were converted to nitrite by vanadium chloride III reduction. Griess reagent was added in order to colorimetricaly determine nitrate concentration. The absorbance of each sample was measured using a Cary 50 spectrophotometer in a 1cm path length cuvette at 540 nm (Miranda et al 2001).

3.2 Discharge Estimates

Discharge was estimated for incremental flow sub-watershed (IFSW), the outflow at the 0 km site, and other unmetered sites along the mainstem on each river using three methods:

extrapolation, runoff coefficients (RC), and geochemical methods. The methods are summarized in Table 1.

***Table 1**: Summary of discharge estimation methods*

Method	Summary of Steps
Extrapolation	1. Determine the average daily discharge yield from tributary sub-watersheds (mm day^{-1}) 2. Extrapolate the discharge yield to IFSW by multiplying the area of land occupied by IFSW by the average yield of the tributary sub-watersheds (found in step 1) 3. Use mass balance techniques to determine the discharge of the ungauged reaches by adding or subtracting measured tributary discharge and estimated IFSW discharge from the discharge measured at the Water Office of Canada hydrometric station (Equations 4-6)
Runoff Coefficients (RC)	1. Determine the runoff coefficient- proportion of precipitation that will reach the surrounding water body-from literature for urban, agriculture and forested land uses based on watershed characteristics that best match the study watershed. 2. Determine the area of urban, agriculture, and forested land use within IFSW 3. Retrieve daily precipitation data for the area 4. Determine discharge from IFSW by multiplying precipitation (m) by area of each land (m^2) and the runoff coefficient pertaining to that land use (unitless) to get the discharge (m^3) 5. Use mass balance techniques to determine the discharge of the ungauged reaches by adding or subtracting measured tributary discharge and estimated IFSW discharge from the discharge measured at the Water Office of Canada hydrometric station (Equations 4-6)
Geochemical	1. Determine a conservative tracer for the area – for this study tracers included elements, CDOM and nitrate. 2. Retrieve water samples and determine the concentration of tracers from a mixed sample (C_{mix}), and two end-members in question (C_1, C_2). 3. Use EMMA to determine the proportion of water from the end-members (Equations 8a – 9c)

3.3.1 Extrapolation

Using the extrapolation method, water yield (mm day^{-1}) was calculated for each of the tributary sub-watersheds. The mean of the daily yield from the tributary sub-watersheds for each

river was applied to incremental flow sub-watersheds (IFSW) for each river. This was done by multiplying the area of land defined as IFSW by the yield (mm day^{-1}) to determine a volumetric contribution of discharge. The tributary sub-watersheds with a mean elevation of less than 1,100 m were used in the Shuswap River to better represent the low elevations of IFSW. For the Salmon River, all three measured tributaries were used were used for the estimation.

Once daily discharge for IFSW was calculated, a mass balance approach was used to calculated discharge at ungauged sites along the mainstem of both rivers. The ungauged sites along the Shuswap River included 0km, 42km, 57 km and 73km. For 0 km the discharge was estimated by Equation 4;

$$Q_0 = Q_{29} - Q_{T(0,29)} - Q_{IF(0,29)} \qquad \textbf{(4)},$$

where Q_0 is the discharge at the 0 km site, $Q_{T\,(0,29)}$ is the total tributary discharge between 0 km and 29 km on the Shuswap River, and $Q_{IF(0,29)}$ is the total IFSW discharge between 0 km and 29 km on the Shuswap River.

Discharge for 52 km, 64 km, and 73 km site was estimated by,

$$Q_X = Q_{29} + Q_{T(29,X)} + Q_{IF(29,X)} \qquad \textbf{(5)},$$

where Q_x is the discharge at site 42 km, 57km, or 73 km, Q_{29} is the measured discharge at 29 km, $Q_{T(29,X)}$ is the total tributary discharge between 29km and 52 km, 64 km or 73 km s, and $Q_{IF(29,X)}$ is the total IFSW discharge between 29km and 42 km ,57 km or 73 km.

For the Salmon River, the discharge at ungauged mainstem sites (0 km, 28 km, and 51 km) was calculated by,

$$Q_X = Q_{66} - Q_{T(X,66)} - Q_{IF(X,66)} \qquad \textbf{(6)},$$

where Q_x is the discharge at site 0km, 28 km or 51 km, Q_{66} is the measured discharge at 29 km, $Q_{T(X,66)}$ is the total tributary discharge between 0 km, 28 km, or 51 km and 66 km sites, and $Q_{IF(X,66)}$ is the total IFSW between 0 km, 28 km, or 51 km and 66 km sites.

3.2.2 RC Method

The RC method estimates IFSW discharge using runoff coefficients. The land use within the watersheds was divided into three main categories – urban/residential, forested, and

agriculture and assigned a runoff coefficient from literature (Table 2). Runoff coefficients were chosen from areas with similar climate and soil conditions as the study area. The runoff coefficients assume that 0.76 of the water would enter the river system. This method is meant to be similar to that of the 2014 TriStar study, which assumed that 0.6 of the precipitation would reach the river system.

Table 2: *Runoff coefficients used for estimates in the RC method*

Land Use	**Runoff Coefficient (R_c)**	**Source**
Urban/Residential	0.45	Oregon Hydraulics Manual 2014
Forested	0.11	Koslov 1981
Agriculture	0.2	Koslov 1981

The runoff coefficient was paired with daily precipitation data in the area acquired from the Ministry of the Environment (2016-2018, Appendix F) to determine the discharge from IFSW using the following equation,

$$Q_{IF} = \sum(A_i * PPT * Rc) \qquad \textbf{(7)},$$

where Q_{IF} is the discharge in m^3day^{-1}, A_i is the area of land use i (defined as urban/residential, forested or agriculture) in m^2, PPT is total daily precipitation in m, and R_c is the runoff coefficient (unit-less). The discharge time series was then smoothed using a one-week running average to increase transit time to the river from one day to seven days. The value used in the running average is an arbitrary number that is meant to represent the response time of the watershed to storm runoff events, based on tributary storm response. Literature values for tributary storm response in similar watersheds typically ranged from the 5-14 days (Sutcliffe 2004).

Once IFSW were calculated, a mass balance approach was used to estimate discharge at ungauged sites along the Shuswap and Salmon Rivers (Equations 4-6).

3.2.3 Geochemical Method

The geochemical method uses end-member mixing analysis (EMMA) to determine the discharge of IFSW and ungauged portions of the mainstem river. The method used three types of tracers; base cations, CDOM, and nitrate.

Once the tracer concentration was determined in each water sample, EMMA was used to determine discharge from IFSW. The EMMA equation to determine the percentage of discharge from IFSW in a mixed water sample (Equation 3, Chapter 1) was derived using the following series equations, where end-member 1 would be considered IFSW;

$$Q_{mix} = Q_1 + Q_2 \qquad \textbf{(8a)},$$

$$C_{mix} = C_1 + C_2 \qquad \textbf{(8b)},$$

$$Q_{mix}C_{mix} = Q_1C_1 + Q_2C_2 \qquad \textbf{(8c)},$$

where Q_{mix} is the discharge at the of the mixed water sample, Q_1 is the discharge of end-member 1, Q_2 is the discharge of end-member 2 , C_{mix} is the concentration of the tracer in the mixed water sample, C_1 is the concentration of the tracer in end-member 1, and C_2 is the concentration of the tracer in end-member 2. Equation 8a was then rearranged to read;

$$Q_2 = Q_{mix} - Q_1 \qquad \textbf{(8d)},$$

and then substituted into Equation 8c to read;

$$Q_{mix}C_{mix} = Q_1C_1 + (Q_m - Q_1)C_2 \qquad \textbf{(8e)}.$$

Equation 8e was then rearranged and solved to read;

$$\frac{Q_1}{Q_{mix}} = \frac{C_{mix}-C_2}{C_1-C_2} \qquad \textbf{(8f)},$$

which is the equivalent of Equation 3 (Chapter 1), where X_1 is the proportion of Q_1 in Q_{mix} or $\frac{Q_1}{Q_{mix}}$, and Equation 8f is then multiplied by 100 to determine the proportion in terms of percent;

$$X_1 = \frac{C_{mix}-C_2}{C_1-C_2} * 100 \qquad \textbf{(3).}$$

EMMA was also used to calculate the discharge from Mabel Lake, and other ungauged sites along the mainstem of the rivers. The EMMA equation (Kendall and McDonnell 1998) was adapted for each site to include the tributaries, the general equation was as follows;

$$Q_{DS} = Q_{US} + Q_{T1} + Q_{T2} + \ldots Q_{Tn} \qquad \textbf{(9a)},$$

$$Q_{DS}C_{DS} = Q_{US}C_{US} + Q_{T1}C_{T1} + Q_{T2}C_{T2} + \ldots Q_{TN}C_{TN} \qquad \textbf{(9b)},$$

where Q_{DS} represents the discharge of water in m^3day^{-1} at the downstream site, Q_{US} represents the discharge of water in m^3day^{-1} at the upstream site, Q_T represents the discharge of water in

m^3day^{-1}at a tributary n between the upstream and downstream sites, C_{DS} represent the concentration of the given tracer in mg L^{-1} at the downstream site, C_{US} represent the concentration of the given tracer in mg L^{-1} at the upstream site, C_T represent the concentration of the given tracer in mg L^{-1} at tributary "n" between the upstream and the downstream sites. All variables are known except Q_{DS} or Q_{US}, therefore Equation 9a is substituted into Equation 9b to solve for one unknown.

For example, to solve for Q_{US}, the Equation 9a would be substituted into Equation 9b and rearranged to read;

$$Q_{US} = \frac{Q_{T1}C_{T1}+Q_{T2}C_{T2}+\ldots Q_{TN}C_{TN}-C_{DS}(Q_{T1}+Q_{T2}+\ldots Q_{TN})}{C_{DS}-C_{US}} \quad \textbf{(9c)}.$$

Results for discharge estimated by different tracers were compared using analysis of variance (ANOVA) to test if significant differences existed between the estimates of each model from each individual tracer type. The α was set at 0.05, with the null hypothesis (H_0) being that there is not significant difference between groups. The outputs between individual element (cation) models and individual wavelengths were tested separately. If the null was accepted, an average discharge value was compiled for each sample date for each EMMA type (element, CDOM, or nitrate). The average of the element model was then tested for variance against the average of the CDOM models as well as the output values from the nitrate model. An average of all the outputs that were considered not significantly different were used for the final calculations of P flux in order to reduce error.

3.3 Phosphorous Calculations

All water samples (mainstem site, IFSW, and tributaries) were analyzed for total P (TP) and total dissolved P (TDP) in order to estimate TP and TDP load.

3.3.1 P Phosphorous Measurements

Total and total dissolved phosphorous were measured using the colorimetric determination of phosphorus – ascorbic acid method (Murphy 1962). The TP concentration was analyzed using unfiltered samples, while the TDP samples were filtered through a 0.45-micron glass fiber filter before analysis. After filtering, the TP and TDP analysis was the same, adding 0.2 grams of potassium persulphate to 25 ml of sample and then autoclaved for 60 minutes to convert all phosphorous to phosphate. Subsequently, a color reagent was added, and colorimetric absorbance of each samples was then read on a Milton Roy 401 spectrometer in a 5cm path

length cuvette at 885 nm. Calibration curves were used to determine final concentrations. Curves were created by measuring the absorbance of standards with known concentrations. Standards were made from 0 ppb to 200 ppb P (ibid.). Only calibration curves with R^2 values greater than 0.99 were not used. The equation produced by the curve was then used to determine the sample concentration based on absorbance measurements.

3.3.2 P Phosphorous Flux Estimates

The concentration value of TP and TDP was linearly interpolated between sample dates. This was meant to create an estimate for every day of the year using the following equation;

$$y = y_1 + (x - x_1)\frac{y_2 - y_1}{x_2 - x_1} \qquad \textbf{(10)},$$

where y is the interpolated value, y_1 = concentration of nutrients on sample date 1 (mg L^{-1}), x is any date between two sampling dates, x_1 is sample date 1, y_2 is concentration on sample date 2 (mg L^{-1}), and x_2 is sample date 2.

Next, daily nutrient concentration and daily discharge were multiplied together to determine the amount of TP and TDP in terms of flux. Flux was calculated for each of the three sources (0 km sites, tributaries and IFSW), as well as total flux for the whole river. Flux is a function expressed as a mass per unit time calculated using Equation 11;

$$\frac{mg}{L} * \frac{m^3}{day} * \frac{1000\,L}{m^3} * \frac{kg}{1000000\,mg} = \frac{kg}{day} \qquad \textbf{(11)}.$$

The yield for individual tributaries, IFSW, and the entire watershed were then calculated using flux and area;

$$Yield_i = \frac{Flux_i}{Area_i} \qquad \textbf{(12)},$$

where the yield of land use i (kg $ha^{-1}y^{-1}$) is equal to the flux of land use i (kg y^{-1}) divided by the area of land use i (Ha).

3.4 P Export Coefficients

Export coefficients were calculated to determine the amount of TP and TDP being exported off the land by different land use types (forested, agriculture and urban) into the Shuswap and Salmon Rivers.

First, the proportion of discharge in IFSW samples coming from valley or upland sources was estimated using geochemical methods outlined in Equation 8. For upland sources, the tracer

concentrations were considered to be the average of tributaries, which originate in the upland areas. The tracer concentrations for the valley sources were an average of concentrations of shallow groundwater samples taken at the bottom of long valleys, away from river meanders, where upland flows were likely to flow deep underground. The valley proportion of the water was used to determine land use coefficients, as anthropogenic land use is most dominant in valley bottoms.

Second, data from the Agriculture Land Use Inventory (2013-2014, 2008) was used in GIS to determine the areas of different land use types within the two watersheds (Fig. 10, Fig 11). The land uses were then grouped together to into urban, agriculture and forested, defined in Table 3.

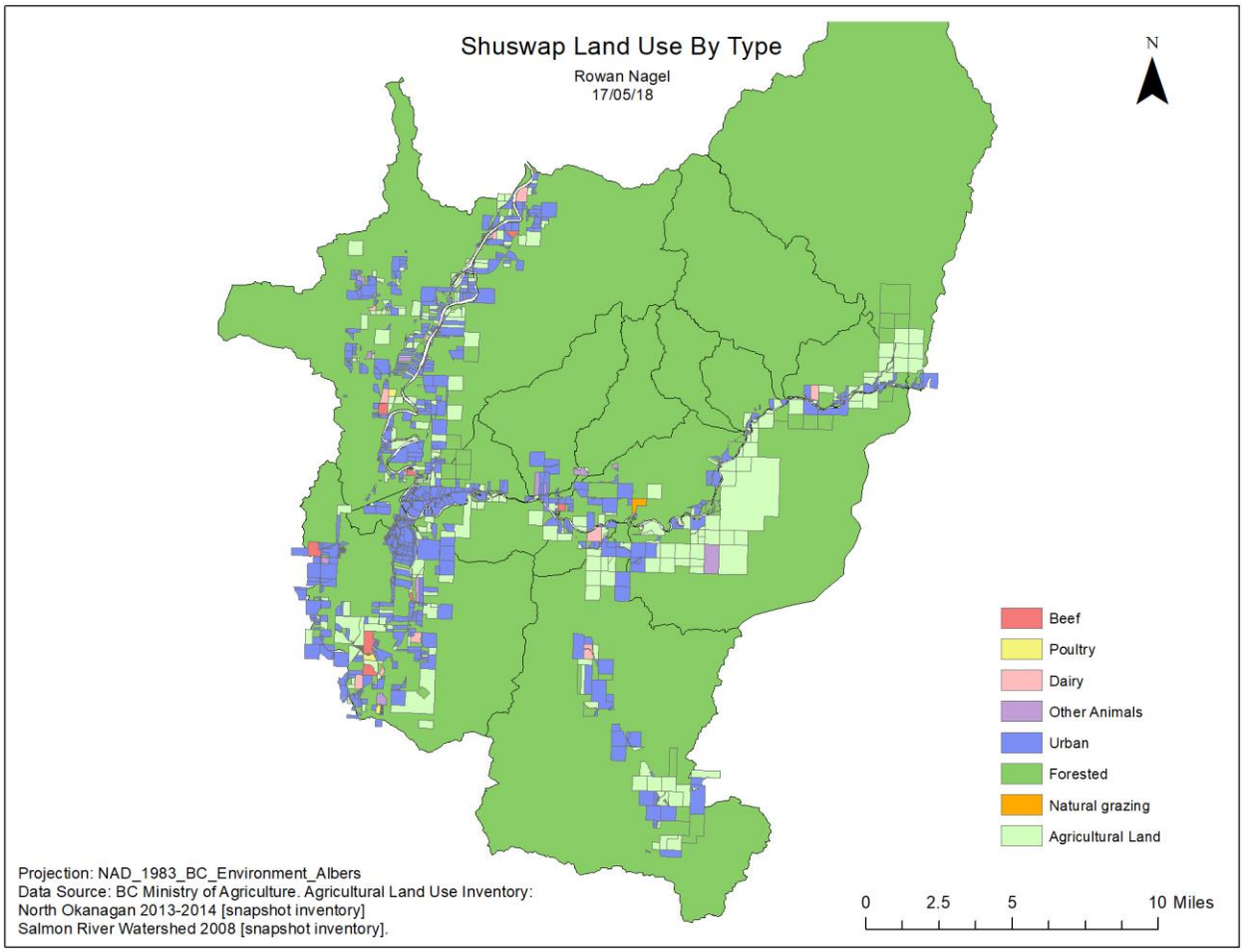

Figure 10: *Land uses in the Lower Shuswap River, modified from Rowan Nagel*

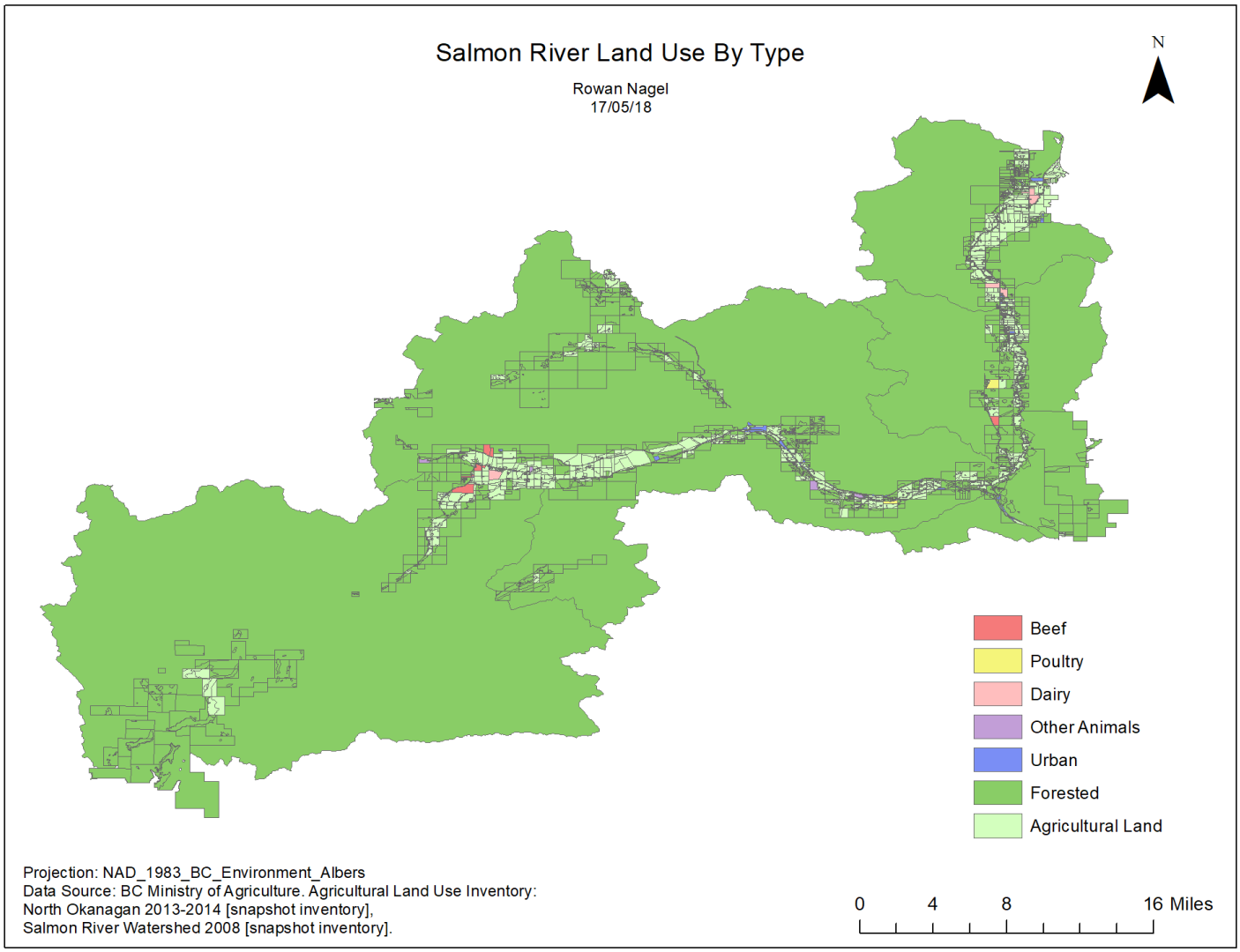

Figure 11*: Land uses in the Lower Salmon River, created by Rowan Nagel*

Table 3: *Land use definitions for Fig. 9 and 10*

Land Use	Definition
Urban	Including: Band Settlements and first nations land, commercial areas, dumps, schools, energy transmission, golf courses, gravel extraction, industrial areas, and single-family homes. These uses are overridden if the land also includes agricultural uses (e.g., if a home has a dairy farm, the single-family home classification is overridden by the Dairy classification.
Agriculture	Cropland, dairy, cattle, poultry, and other animals
Forested	Designated Parks or reserves, Forestry zones, protected areas or reserves, camping areas, and traditional land us

Export coefficients for TP and TDP for three different land uses; urban, agricultural, and forested were calculated using multiple regression. Note, that figures 7 and 8 subdivide the land use, but it is regrouped into three categories for the regression.

The starting yield values for urban and agriculture land use the slope of a linear correlation between area of each land use and total loading in the reach (kg y^{-1}). The forested value was assumed to be the mean yield from the tributaries, with the exception of Fortune Creek and Bolean Creek, as they have extensive anthropogenic activities within their watersheds and are not indicative of background.

The regression was set to have a maximum of 20 iterations and a convergence tolerance of 0.001. The area of the land use types were independent variables, and yield for the sub-watersheds (kg ha^{-1} y^{-1}) was considered the dependent value. Independent variables were set to a have lower bound of zero, as to not allow for negative export coefficients. The expectation function was set to

$$Y_i = \frac{C_u A_u + C_a A_a + C_F A_F}{A_i} \qquad \textbf{(13)},$$

where Y_i is the P yield (kg ha^{-1} y^{-1}) of watershed i, C_u is P export coefficient for urban land (kg ha^{-1} y^{-1}), A_u is the area for urban land use (ha) , C_a is the P export coefficient for agriculture land use (kg ha^{-1} y^{-1}), A_a is the area of agriculture land use (ha), C_f is the export coefficient for forested areas (kg ha^{-1} y^{-1}), A_f is the area of forested land use (ha), and Ai is the area of watershed i (ha).

4 Results

4.1 Hydrometric Measurements – Shuswap River

Discharge in the Shuswap River (Fig. 12) peaks in the spring months following freshet (May-June) and reaches base flow in the fall months (September-November). The trend was typical of a snowmelt hydrological regime observed throughout interior British Columbia (BC). The mean annual discharge for July 2016- February 2018 was 13% greater than average discharge (Water Office of Canada 1911-2014).

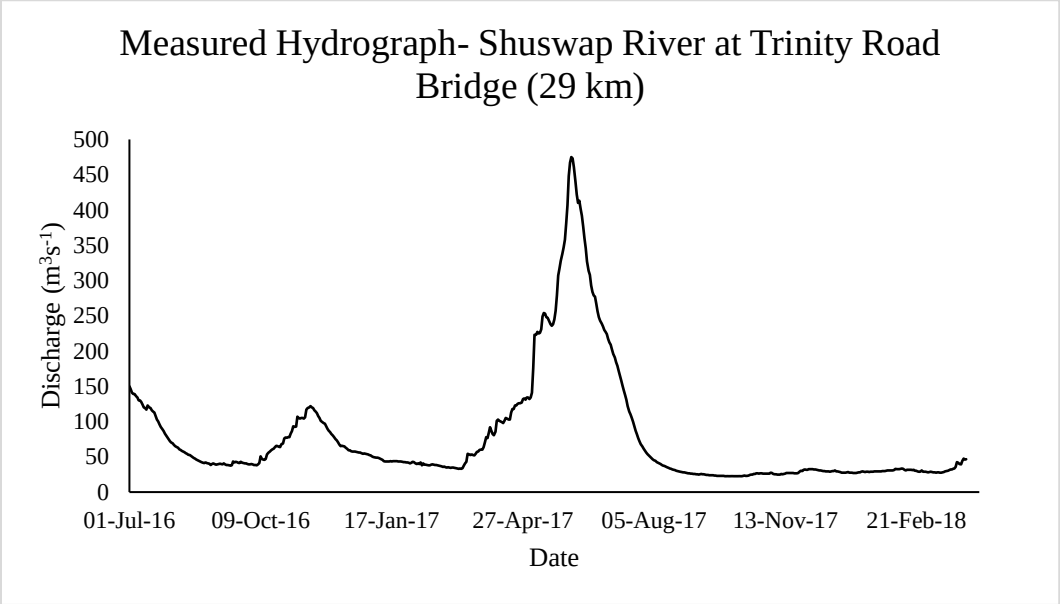

Figure 12: *Shuswap River discharge measured at 29 km for the duration of sampling. Data from the Water Office of Canada.*

The tributaries in the Shuswap River basin had hydrographs typical of a snowmelt hydrological regime, peaking during freshet, and decreasing to baseflow in the fall and winter months (e.g. Kingfisher Creek, Fig. 13). Many of the tributaries ran dry in the summer of 2017, with discharge in all the tributaries reaching 1.2 m^3s^{-1} or less. Similar to the mainstem of the Shuswap River, peak flow in the tributaries was about 25 times greater than baseflow. Among the tributaries, greater yield values (Table 4) were positively correlated with mean watershed elevation (R^2= 0.7817, Fig. 14).

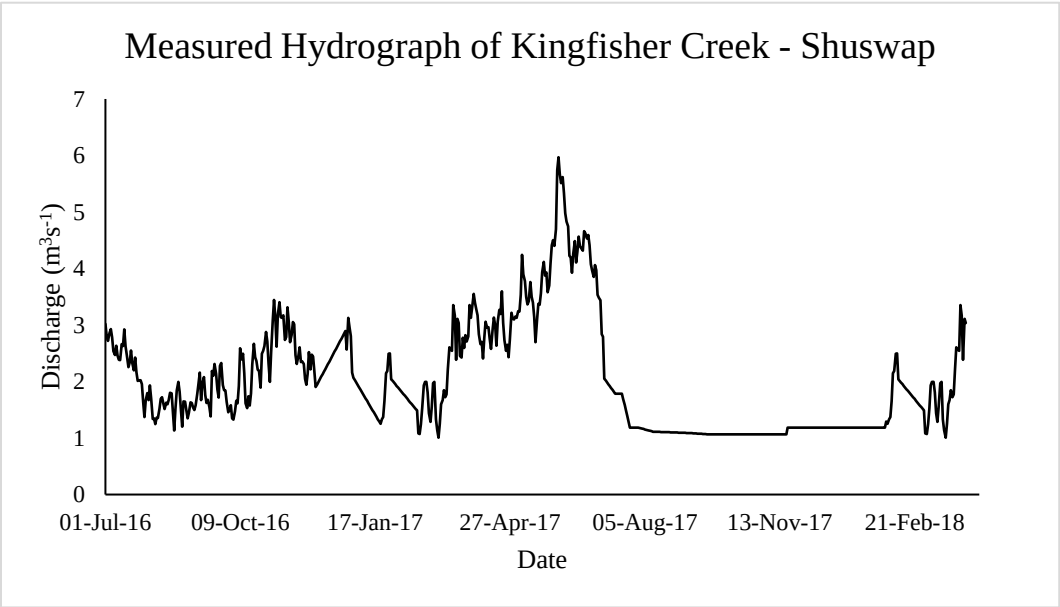

Figure 13: *Measured discharge of Kingfisher Creek, a tributary along the Shuswap River*

Table 4: *Watershed and discharge characteristics of tributaries in the Shuswap River*

Tributary	Watershed Area (Ha)	Watershed Mean Elevation (m)	Annual Discharge (m^3y^{-1})	Yield (mm y^{-1})
Kingfisher Creek	11,200	1,130	64,200,000	57
Cooke Creek	3,920	1,400	64,500,000	164
Falls Creek	1,550	775	2,720,000	17
Trinity Creek	13,300	1,010	33,800,000	25
Ashton Creek	2,450	1,040	7,920,000	32
Brash Creek	3,490	1,000	6,300,000	18
Fortune Creek	14,300	690	3,370,000	2
Tributary Mean	7,170	1,025	26,100,000	45

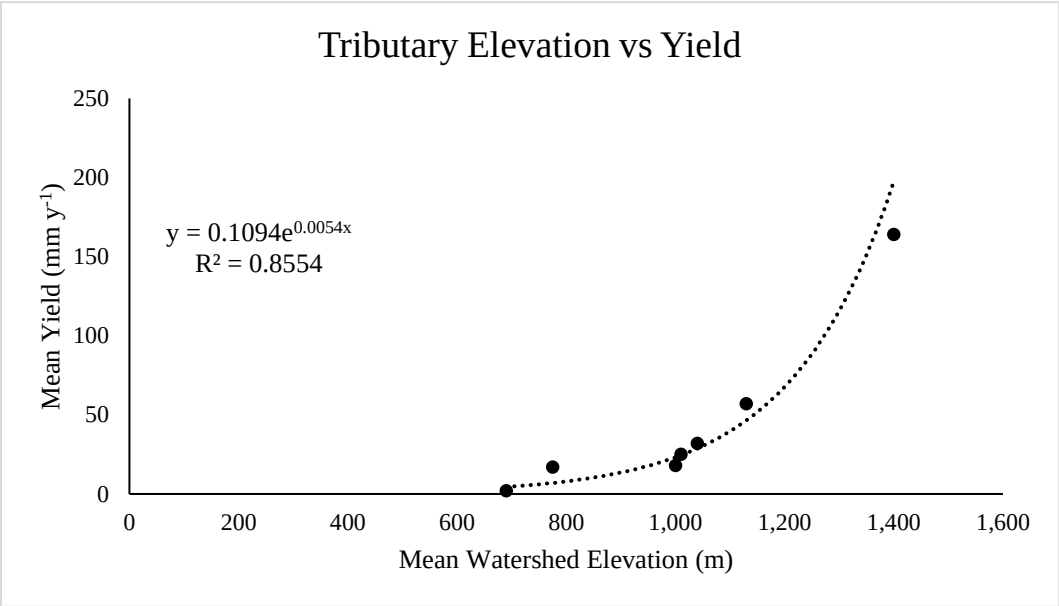

Figure 14: *Elevation and Yield correlation plot for tributaries in the Shuswap River*

4.2 Discharge Estimates for Mabel Lake and Incremental Flow Sub-watersheds (IFSW)

4.2.1 Extrapolation Method

The extrapolation method estimates discharge in IFSW from the average yield from metered tributary sub-watersheds with mean watershed elevations less than 1,100 m (Appendix D). The lower elevation watersheds were used, as the majority of the IFSW are in lower elevations, and hence the yield from lower elevation watershed would be more representative. Thus, the resultant hydrograph for IFSW follows a snowmelt hydrological regime (Fig. 15A) with the same pattern as the mean of the four metered watersheds. Annually, IFSW contributes 5.01E7 m^3 y^{-1} when estimated by the extrapolation method.

The hydrograph for Mabel Lake is calculated by difference of discharge, subtracting the sum of tributary discharge and IFSW above the 29 km from the measured discharge at 29 km (Fig 16A). The calculated Mabel Lake outflow is qualitatively similar to the discharge measured at 29 km because tributaries and IFSW inputs are small between 0 and 29 km. Annually, Mabel Lake contributes the majority of the discharge to the Shuswap River, totalling to 2.42E09 m^3 y^{-1}.

Discharge is measured at a hydrometric station midway down the length of the study area (29 km), therefore total discharge at 72 km was estimated. The total discharge is sum of tributary and IFSW discharge between 29 and 72 km added to the measured discharge at 29 km. The 72 km hydrograph (Fig. 17A) looks similar to the measured hydrograph at 29 km (Fig. 12), with a maximum during freshet. This is because inputs from IFSW and tributaries are small, and the timing of IFSW inputs is extrapolated.

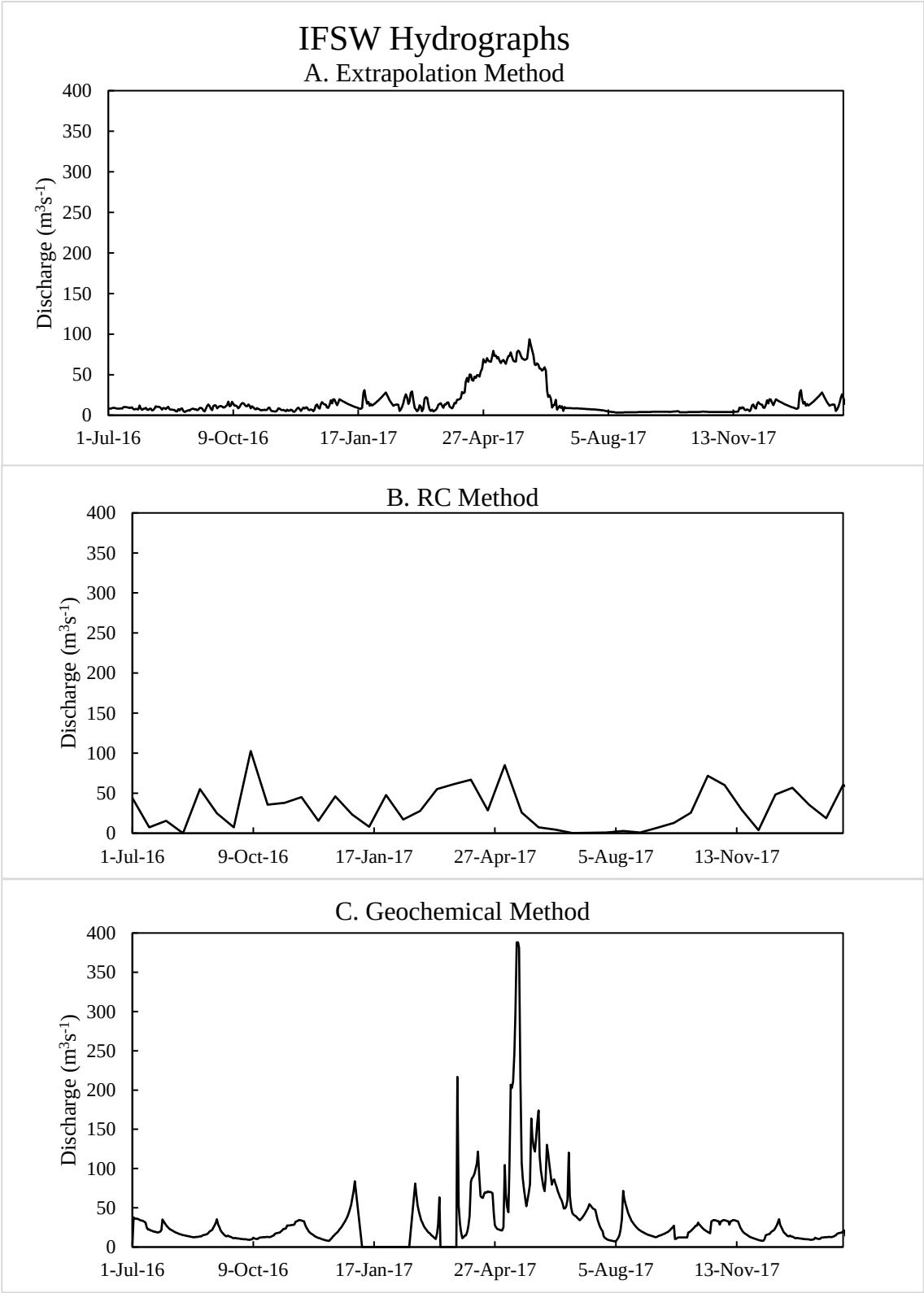

Figure 15*: Discharge from IFSW in the Shuswap River.*

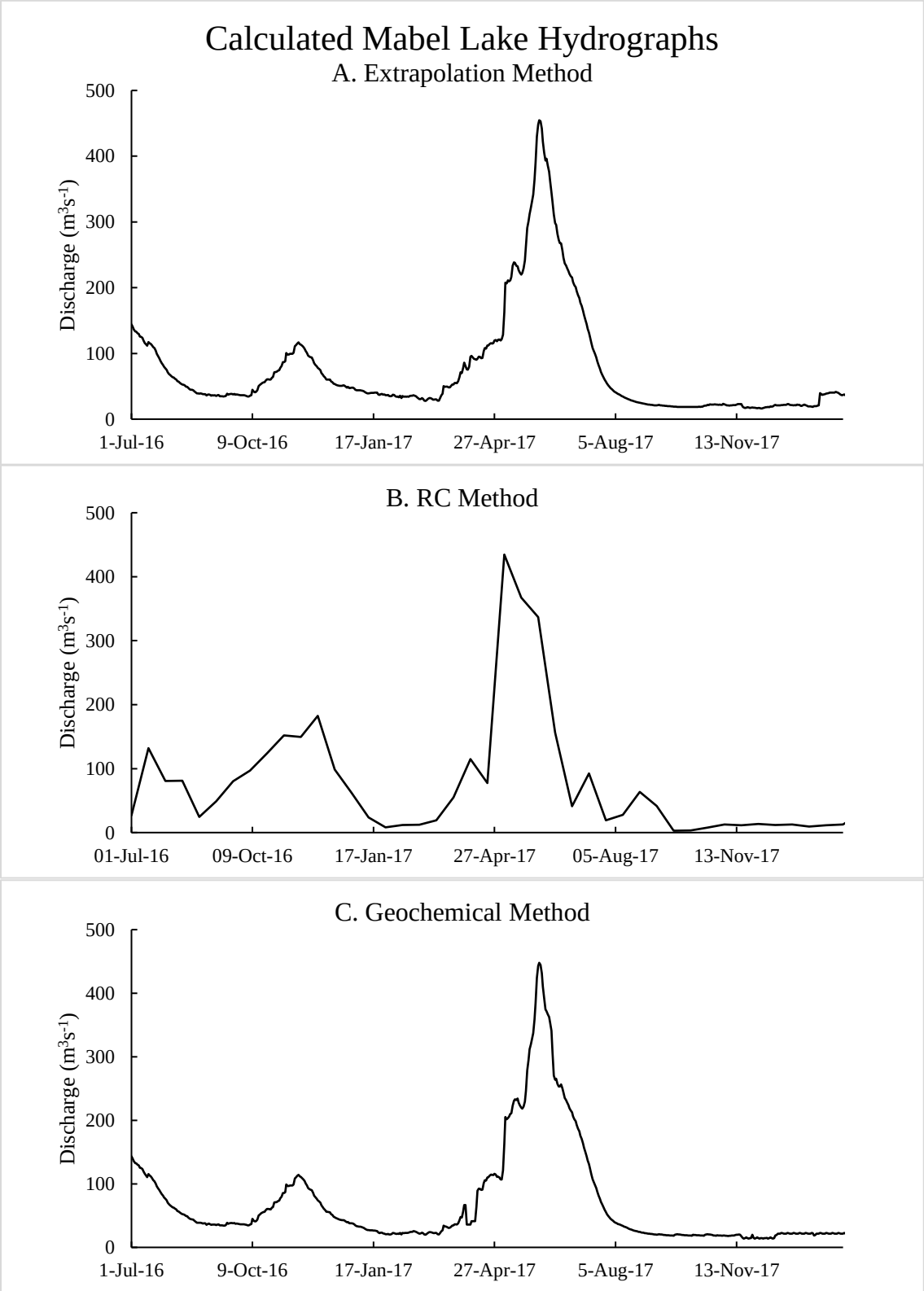

Figure 16*: Discharge from Mabel Lake into the Shuswap River*

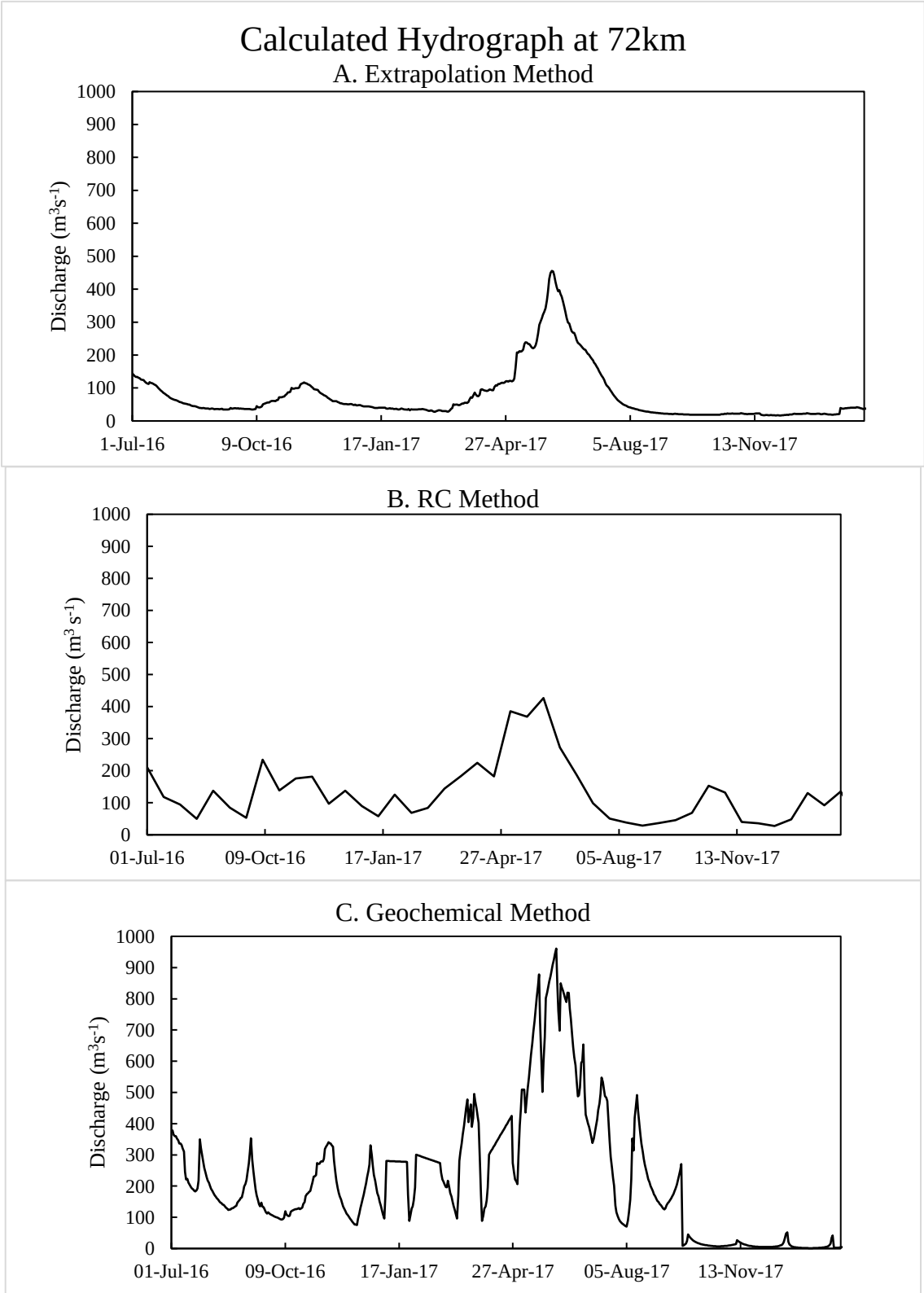

Figure 17*: Total Discharge from the Shuswap River at 72 km*

4.2.2 Runoff Coefficient Method

The RC method estimates discharge in IFSW using precipitation data (Appendix F) paired with runoff coefficients, as outlined in the methods section (Chapter 3). The method uses daily precipitation data, with an assumed transit time of one week, similar to the individual tributary response time in the watersheds, to eliminate daily peaks that coincide with rainfall events. The hydrograph for IFSW (Fig. 15B) was less indicative of a snowmelt hydrological regime, and was more responsive to rainfall events, despite smoothing. The maximum discharge from IFSW occurred in the fall months following periods of heavy rainfall and had smaller maxim throughout the winter coinciding with precipitation events. Despite the maximum discharge being in the fall months, dissimilar to the other two methods, the onset and of increased discharge during freshet still occurs at the same time, just at a smaller magnitude. Using the RC method, it is difficult to determine snowmelt rates, as the method uses precipitation totals and does not allow for factoring in snow accumulation and melt, unless done manually. Annually, IFSW was predicted to contribute 1.01E9 m^3 y^{-1}, about 20 times more than the discharge predicted by the extrapolation method.

The Mabel Lake discharge (0 km) is calculated by difference, just as in the extrapolation method. The hydrograph for Mabel Lake (Fig. 16B) is less affected by daily precipitation events, as inputs from IFSW and tributaries are small, therefore the hydrograph reflects that of snowmelt hydrological regime. The annual discharge from Mabel Lake (2.12E9 m^3 y^{-1}) as estimated by the RC method was 40% less than the extrapolation method. Because both the methods calculate Mabel Lake by difference, and the RC method estimated IFSW discharge to be greater than the extrapolation method, the Mabel Lake discharge is thereby predicted to be slightly lower by the RC method.

The discharge at 72 km is calculated by summing the discharge from IFSW and tributaries with the measured discharge at 29 km (Fig. 17B). The hydrograph at 72 km, as estimated by the RC method, is typical of a snowmelt hydrological regime and is similar to the extrapolation method in terms of seasonality and magnitude, estimating discharge to be 26.8% less than the extrapolation method annually. There are some greater peaks in discharge the fall months of 2017 which coincide with heavy rainfall that are not seen in the extrapolation.

4.2.3 Geochemical Method

End-member mixing analysis (EMMA) was used to determine discharge of IFSW and Mabel Lake. EMMA was performed for all 6 possible chemical end-members on a reach by reach basis. End-members were tested for significantly different mixing behavior using ANOVA. For the Shuswap River, there was no significant difference among chemical end-members ($p<0.05$; Appendix E for ANOVA results for individual models). Consequently, the model outputs for all end-members were used in the final analyses.

Discharge from IFSW was calculated by using changes in geochemical end-members to determine the relative proportion of IFSW in mixed waters. The hydrograph for IFSW followed a snowmelt hydrograph (Fig. 15C). Annually, IFSW were predicted to contribute 9.71E8 m^3 y^{-1}. The estimate was double that of the extrapolation method. The estimate was similar to the RC method, with discharge between the two differing by less than 5%. Though the annual estimates were similar, the geochemical method had maximum discharge for IFSW that was nearly 10 times greater than the other two methods.

The Mabel Lake discharge (0 km) is calculated independently using EMMA, and not by difference. The hydrograph for Mabel Lake (Fig. 16C) is similar to the hydrograph of the measured discharge at 29 km, following that of a snowmelt hydrological regime. The variation in annual discharge from Mabel Lake between the three methods is relatively small, with all having similar estimates. The annual discharge as predicted by the geochemical methods is 11% greater than the extrapolation method, and 84% greater than the RC method. The similarity for all three methods is due to lack of change chemically due to the small influence IFSW have in the reach between 0 and 29 km, which are the sites used to estimate discharge from Mabel Lake.

The total discharge at 72 km was calculated using EMMA resulted in a hydrograph typical of snowmelt regime (Fig. 17C). The overall discharge differs from the RC and extrapolation method in magnitude, estimating about half again as much discharge during freshet. Outside of freshet, the three methods had similar estimates of discharge, with the geochemical method estimate being the largest (1-2 times greater discharge, on average). The greater estimates in discharge are likely because the geochemical method can account for inputs from groundwater and large snowmelt events that would be difficult to capture using the

extrapolation and RC method. It may also overestimate, as it counts irrigation returns as discharge from IFSW, which originate from the river.

4.3 Phosphorous Mass Balance Results – Shuswap River

4.3.1 Phosphorous measurements

The TP concentration at main-stem sites generally increased downstream between 0 km and 72 km (Fig. 18). The TP concentrations generally follow the pattern of lesser concentrations in the winter and greater concentrations in the spring months during freshet. The greater TP concentrations in fall of 2016 as compared to fall of 2017, were due to unseasonably large amounts of rainfall increasing runoff. When TP was undetectable, the concentration was set to the minimum detection limit (MDL) of 0.0013 mg L^{-1}.

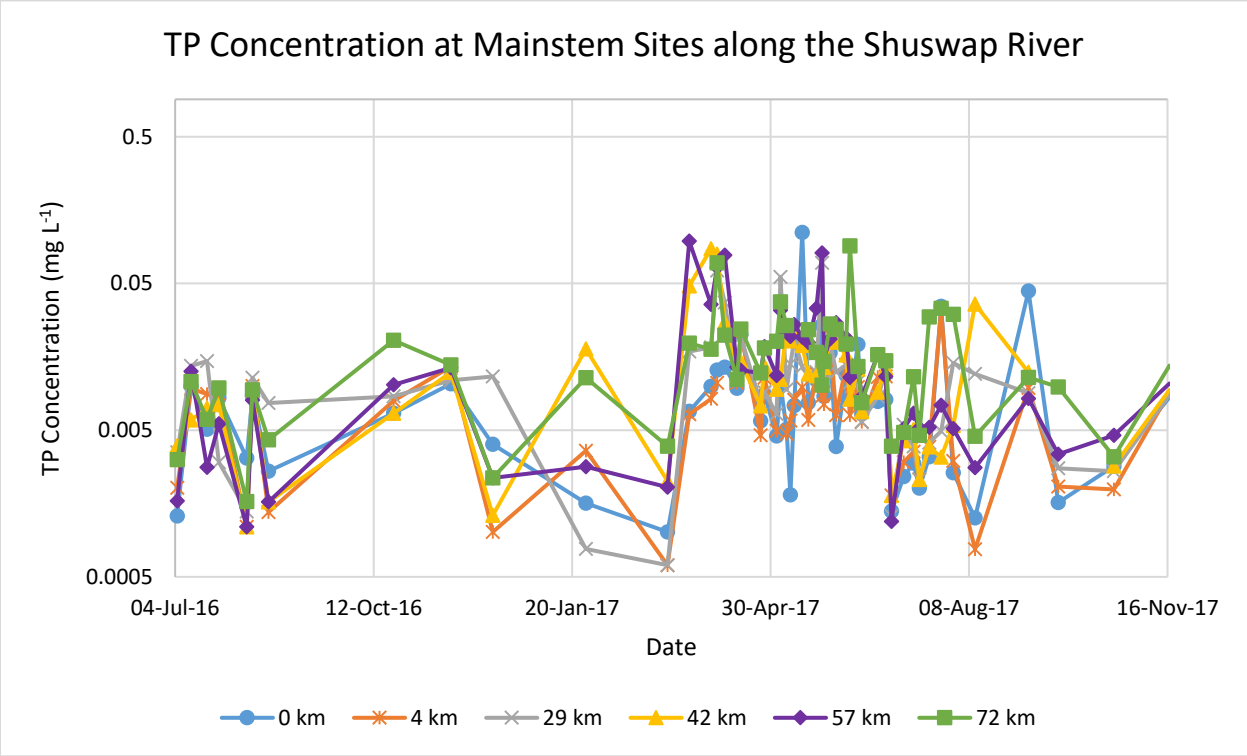

***Figure 18**: Concentration of TP measured throughout the year at main-stem sites along the Shuswap River graphed on a log scale*

Concentrations of TDP followed a similar trend to TP, generally increasing downstream between 0 km and 72 km (Fig. 19). TDP concentrations were lower in the winter months of January and February and had a small definable peak in the spring months of freshet. The greater TDP concentrations in fall of 2016 as compared to fall of 2017, were due to unseasonably large amounts of rainfall increasing runoff. TDP made up about 50% of the TP concentration, with the other 50% consisting of particulate P (PP).

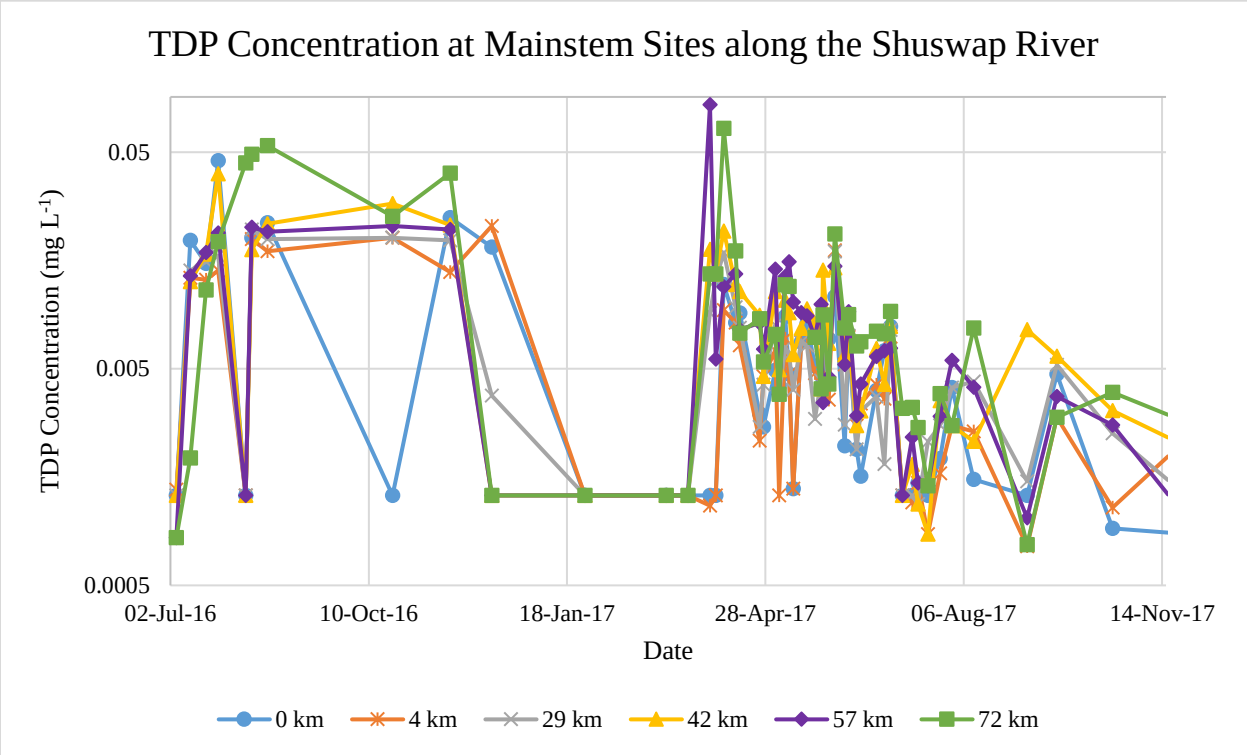

Figure 19*: Concentration of TDP at main-stem site along the Shuswap River graphed on a log scale*

The concentrations of TP and TDP were not significantly dependent on discharge (Fig. 20A, B) because the regression was not significant (p-value >>0.05). This indicates that concentration for both TP and TDP is random and can not be attributed to discharge. This is because the dominant source of discharge is Mabel Lake (0 km), which has low concentrations of TP and TDP, and the concentrations downstream of Mabel Lake are greatly influenced by inputs from IFSW. The fall of 2016 had concentrations of TDP similar to that of freshet, which may be due to the timing of manure spreading in conjunction with high runoff from the abnormal amounts of precipitation.

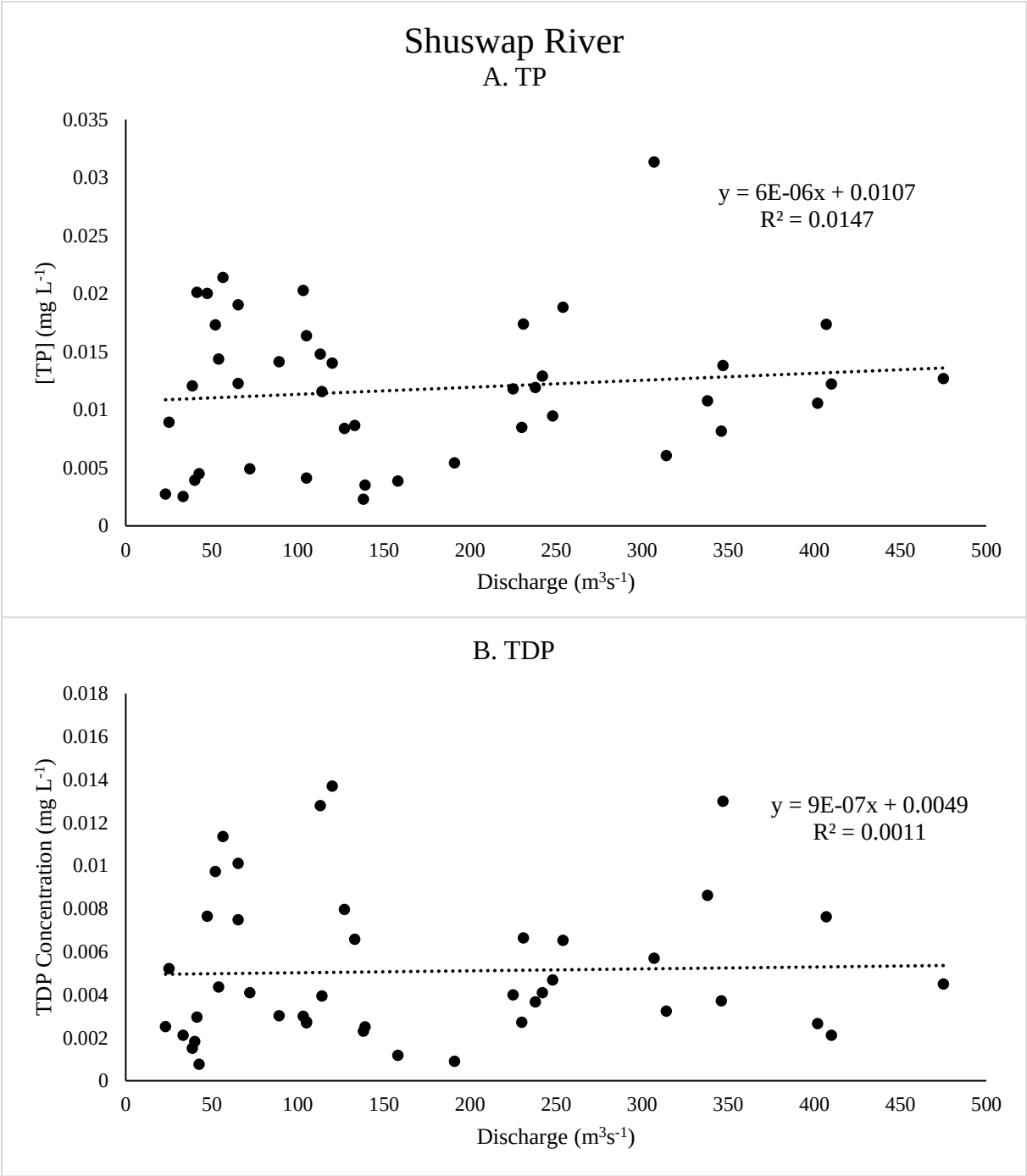

Figure 20: *Correlation of discharge vs concentration of TP and TDP in the mainstem of the Shuswap River*

The TP concentrations in the tributaries reached a maximum during freshet (e.g. Kingfisher Creek, Fig. 21), much like the mainstem sites. Once again, the greater TP concentrations in fall of 2016 as compared to fall of 2017, were due to unseasonably large amounts of rainfall increasing runoff. Throughout the year, when concentrations were

undetectable, they were set at the MDL of 0.0013 mg L^{-1}. The TP concentrations in tributaries were relatively small, averaging 0.0214 mg L^{-1} (Table 5).

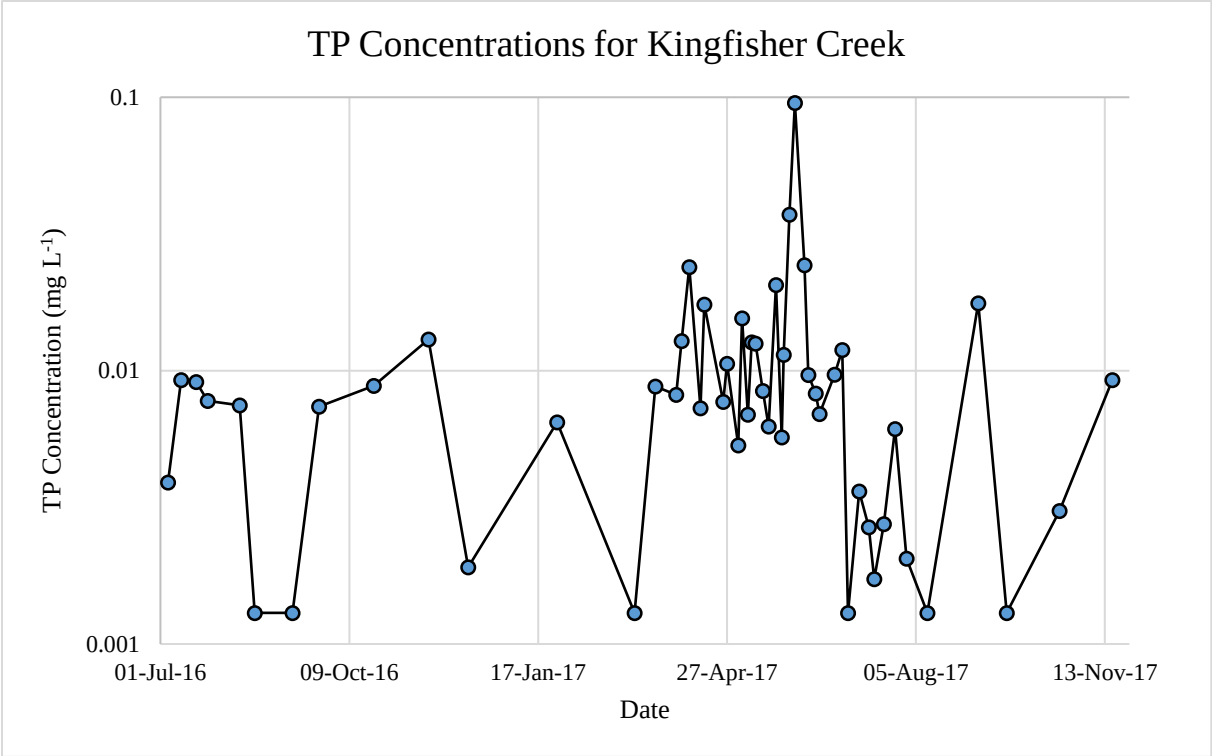

Figure 21*: TP concentration seasonality in Kingfisher Creek , a tributary along the Shuswap River*

Table 5: *Watershed and characteristics for TP in tributaries along the Shuswap River*

Tributary	Watershed Area (Ha)	Average [TP] (mg L^{-1})	Annual flux (kg $year^{-1}$)	Yield (kg ha^{-1} $year^{-1}$)
Kingfisher Creek	11,200	0.0149	982	0.087
Cooke Creek	3,900	0.0131	656	0.168
Falls Creek	1,550	0.0157	54.5	0.035
Trinity Creek	13,300	0.0310	1,930	0.145
Ashton Creek	2,450	0.0150	182	0.074
Brash Creek	3,490	0.0252	116	0.033
Fortune Creek	14,300	0.0352	152	0.011
Tributary Total	57,400	0.0214	4,070	0.071
Incremental Flows	48,000	0.0684	7,030-68,700	1.46 – 14.3

The maximum TDP concentrations in the tributaries were in Fall 2016 and had second maximum during freshet (e.g. Kingfisher Creek, Fig. 22). The high concentrations in fall of 2016 was due to unseasonably high rainfall. The concentration of TDP was undetectable at times

throughout the year and set to the MDL. The mean concentration of TDP was 0.0096 mg L^{-1} (Table 6). Most of the tributaries have little to no anthropogenic activities on them, and are influenced primarily by the forested landscape, therefore the concentrations are representative of background, or undisturbed portions of the watershed.

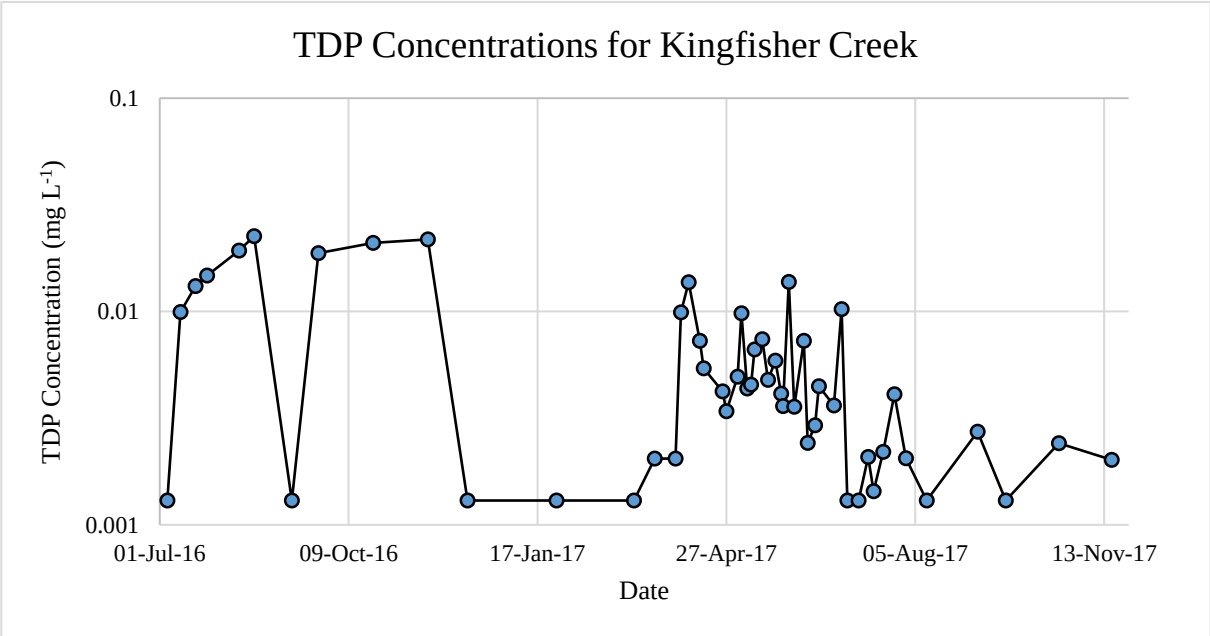

Figure 22*: TDP concentration seasonality in Kingfisher Creek, a tributary in the Shuswap River*

Table 6: *Watershed and characteristics for TDP in tributaries along the Shuswap River*

Tributary/Source	Watershed Area (Ha)	Average [TDP] (mg L^{-1})	Annual flux (kg $year^{-1}$)	Yield (kg ha^{-1} $year^{-1}$)
Kingfisher Creek	11,200	0.0051	332	0.03
Cooke Creek	3,900	0.0066	307	0.079
Falls Creek	1,550	0.0060	16.7	0.012
Trinity Creek	13,300	0.0107	356	0.027
Ashton Creek	2,450	0.0065	70.7	0.029
Brash Creek	3,490	0.0139	99.7	0.029
Fortune Creek	14,300	0.0185	85.8	0.006
Tributary Total	57,370	0.0096	1,270	0.022
Incremental Flows	48,000	0.0404	1,240-36,300	0.258-7.57

The concentrations of TP in tributaries were dependent on discharge (e.g. Kingfisher Creek, Fig. 23A). Although the correlation was weak (R^2= 0.35), the regression was significant (p-value < 0.05) due to the large sample size. Concentrations are expected to increase with

discharge, as the tributaries should not be affected by IFSW. The TDP concentration (Fig 23B), however, was not dependent on discharge (R^2 = 0.0142, p-value >> 0.05).

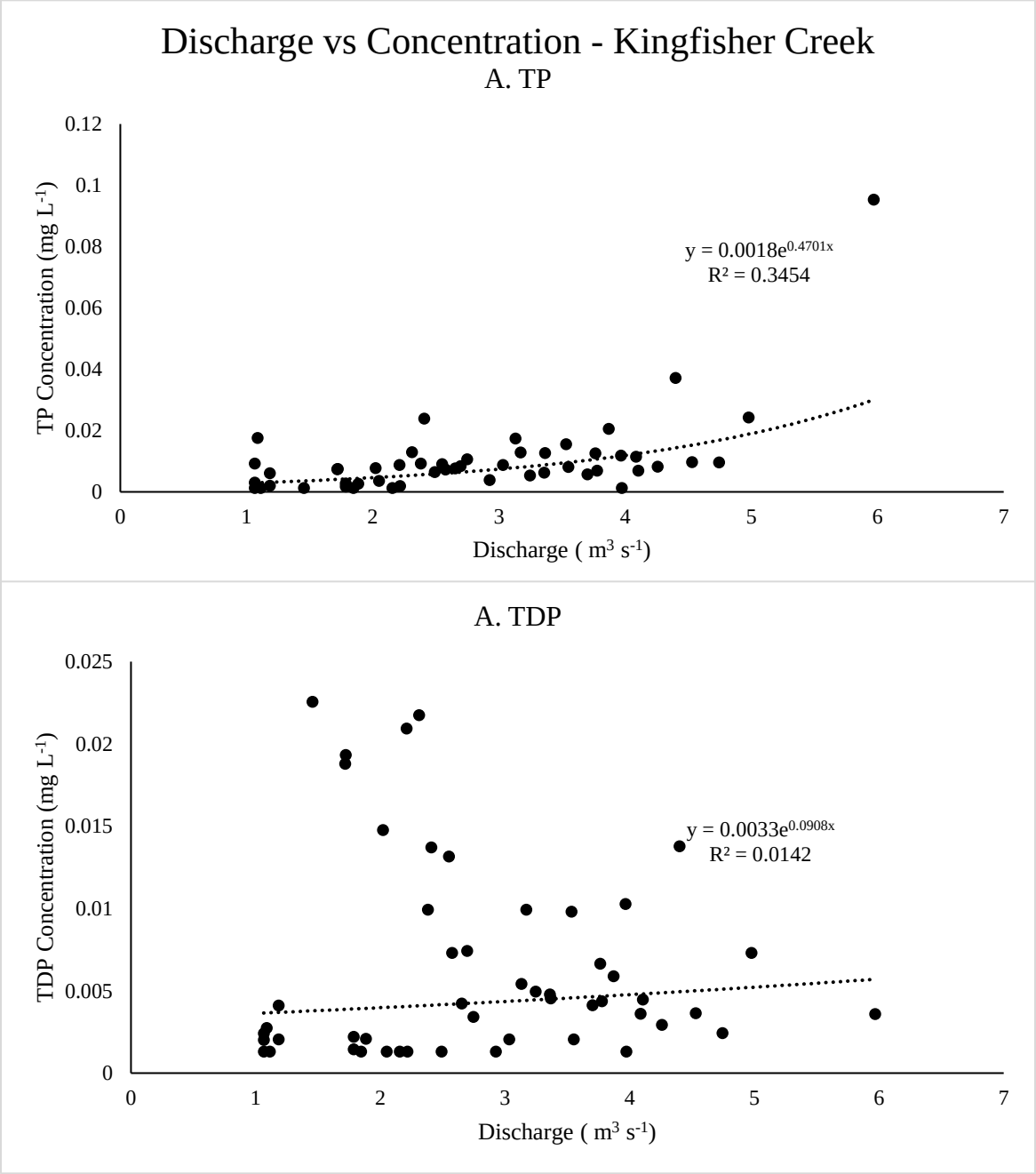

Figure 23*: Discharge and concentration correlations in Kingfisher Creek for TP and TDP*

Total tributary flux followed the same trend as the snowmelt hydrograph (Fig. 24), with maximum values occurring in the spring during freshet. Small peaks in flux were observed outside of freshet, which correspond with abnormally rainy periods. Annually, tributaries contributed 4,090 kg y^{-1} of TP and 1,240 kg y^{-1} of TDP (Table 5,6). The daily average TP flux is about 53 times greater in the spring freshet than in baseflow, and 210 times greater in the spring than baseflow for TDP. The annual tributary yield for TP and TDP ranges from 0.011-0.145 kg ha^{-1} yr^{-1} and 0.006 – 0.079 kg ha^{-1} y^{-1}, respectively. These yields are considered small, and are indicative of undisturbed areas, as the tributaries are not heavily influenced by anthropogenic activities.

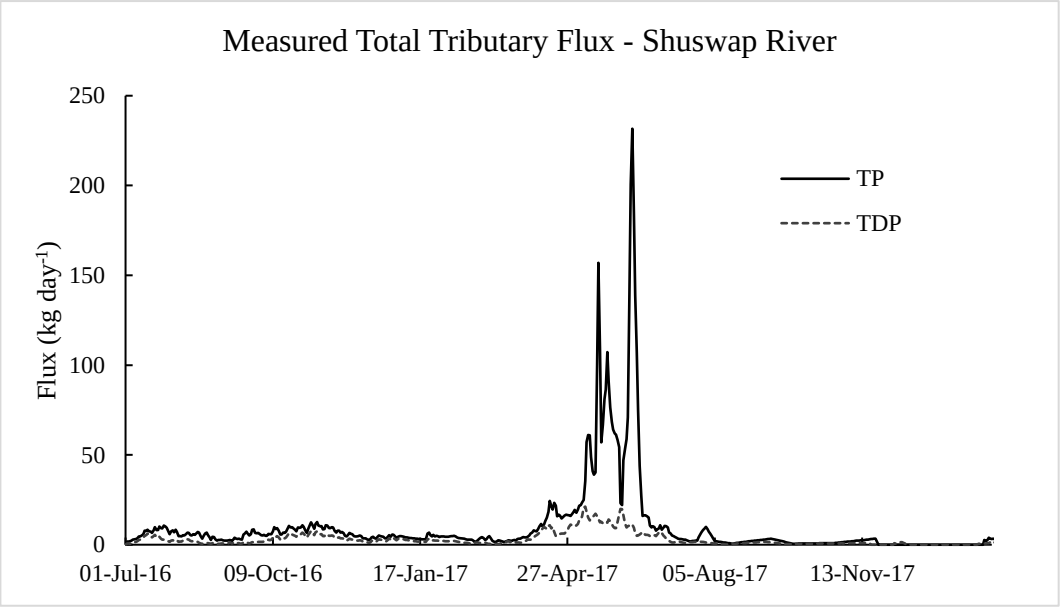

Figure 24: *TP and TDP flux for all the tributaries along the Shuswap River totalled*

4.4 P Loading from IFSW and Mabel Lake

The TP and TDP concentration from IFSW are not measured continuously throughout the year, therefore they can not be represented in the same way as mainstem sites and tributaries. For IFSW, agriculture ditches and seasonal streams were sampled during freshet, when they are the dominant source of discharge. In the summer and fall, groundwater becomes the dominant source of discharge for IFSW, and are therefor sampled. The concentration for both TP and TDP is similar between both the piezometers and the ditch water of IFSW (Fig. 25A, B), with the mean TP concentration between the piezometers and ditches differing by 36.4% and TDP concentration differing by 76%. The similarity allows for the piezometers and ditch waters to be grouped together as IFSW concentrations for analyses. The mean concentration of IFSW is double the tributaries (Tables 5,6). The IFSW samples for both the Shuswap and Salmon River were also combined to create one dataset, as it was difficult, to distinguish groundwater and ditch water discharge from each other.

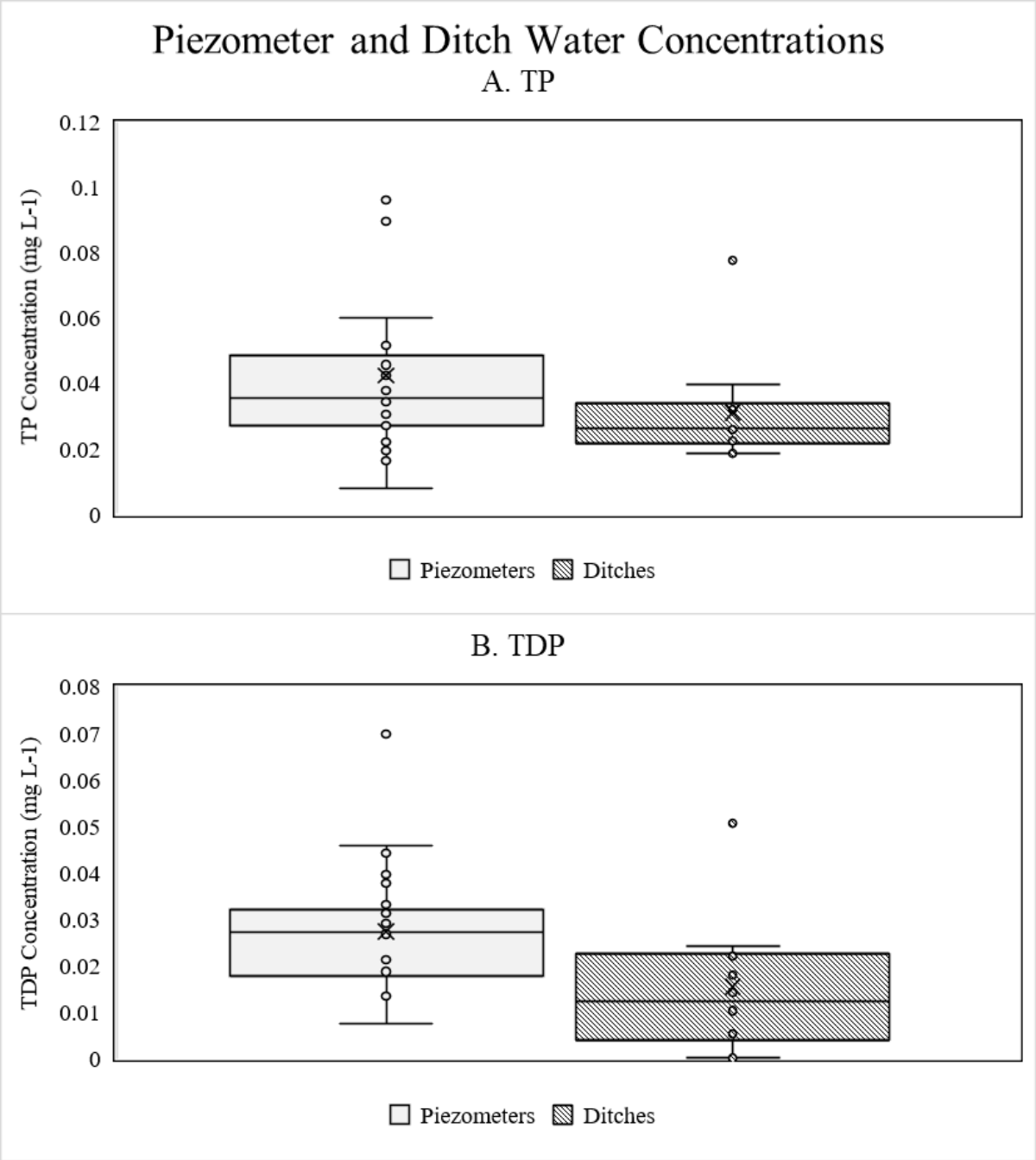

Figure 25*: TP and TDP concentrations in piezometers and ditches/seasonal streams*

4.4.1 Extrapolation Method

All three methods use the same concentration data, meaning that flux trends will change solely on discharge estimates. For the extrapolation method, IFSW flux was calculated using the measured concentration values of piezometers and ditch water in conjunction with the discharge yield of tributary sub-watersheds. The TP and TDP flux from IFSW followed the trend of snowmelt hydrological regime, reaching a maximum during spring freshet (Fig. 26A). The TP flux during freshet was 2.5 times greater than during the months of baseflow (fall and winter), with an annual contribution of 7,120 kg y^{-1}. TDP made up about half of the flux, following the same trend as the TP flux through the year. Because TDP was about half and followed the same trend, freshet daily flux was also about 2.5 times greater than during the months of baseflow. The annual contribution of TDP flux was 4,150 kg y^{-1} as estimated by the extrapolation method.

The flux calculated for TP and TDP from Mabel Lake follows that of a snowmelt hydrological regime (Fig. 27A). The TP flux reached a maximum during freshet that is about four times greater than during baseflow. By this method, Mabel Lake contributed the majority (Table 5) of the TP flux, which corresponds directly with it being the majority discharge contributor. The TDP flux from Mabel followed the same trend as TP, making up about half of the TP flux. The TDP maximum flux was also during freshet and was about 6 times greater in freshet than during baseflow periods. As with TP, Mabel Lake was the majority contributor of TDP flux, contributing 67.2%, corresponding with its large contribution to discharge (Table 7).

The TP flux for the entire river (0 to 72 km), an estimated parameter that uses measured discharge from 29 km summed with IFSW and tributaries, followed the trend of snowmelt hydrological regime, reaching a maximum during freshet (Fig. 28A). This is expected, because flux is a product of discharge and concentration, and during freshet discharge increases by a large amount, much more than concentration. Although concentration is not correlated with discharge, the increased discharge is enough to increase overall flux. For the extrapolation method, the TP flux during freshet was about three times greater than during the winter months during baseflow. Annually, the river gained 10,500 kg y^{-1} of TP from IFSW and tributaries between 0 and 72 km. TDP follows the same trend, which is typical of a snowmelt hydrological regime. The TDP flux is four times greater during freshet than in the winter months during baseflow. Annually, there was a net gain of 5,190 kg y^{-1} between 0 and 72 km (Table 7).

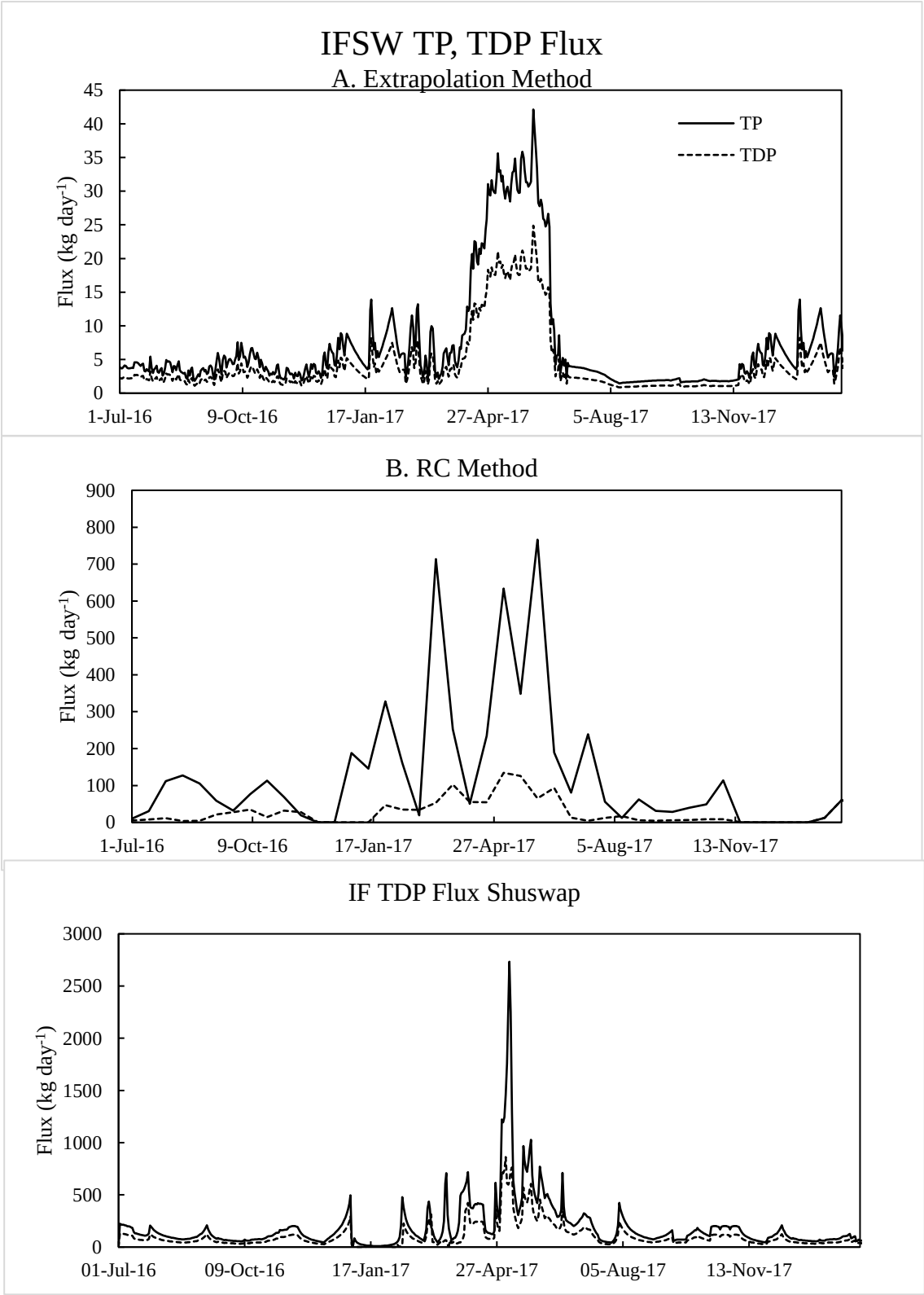

Figure 26*: IFSW TP and TDP Flux for the Shuswap River, note the axes differ for each method in order to show seasonality*

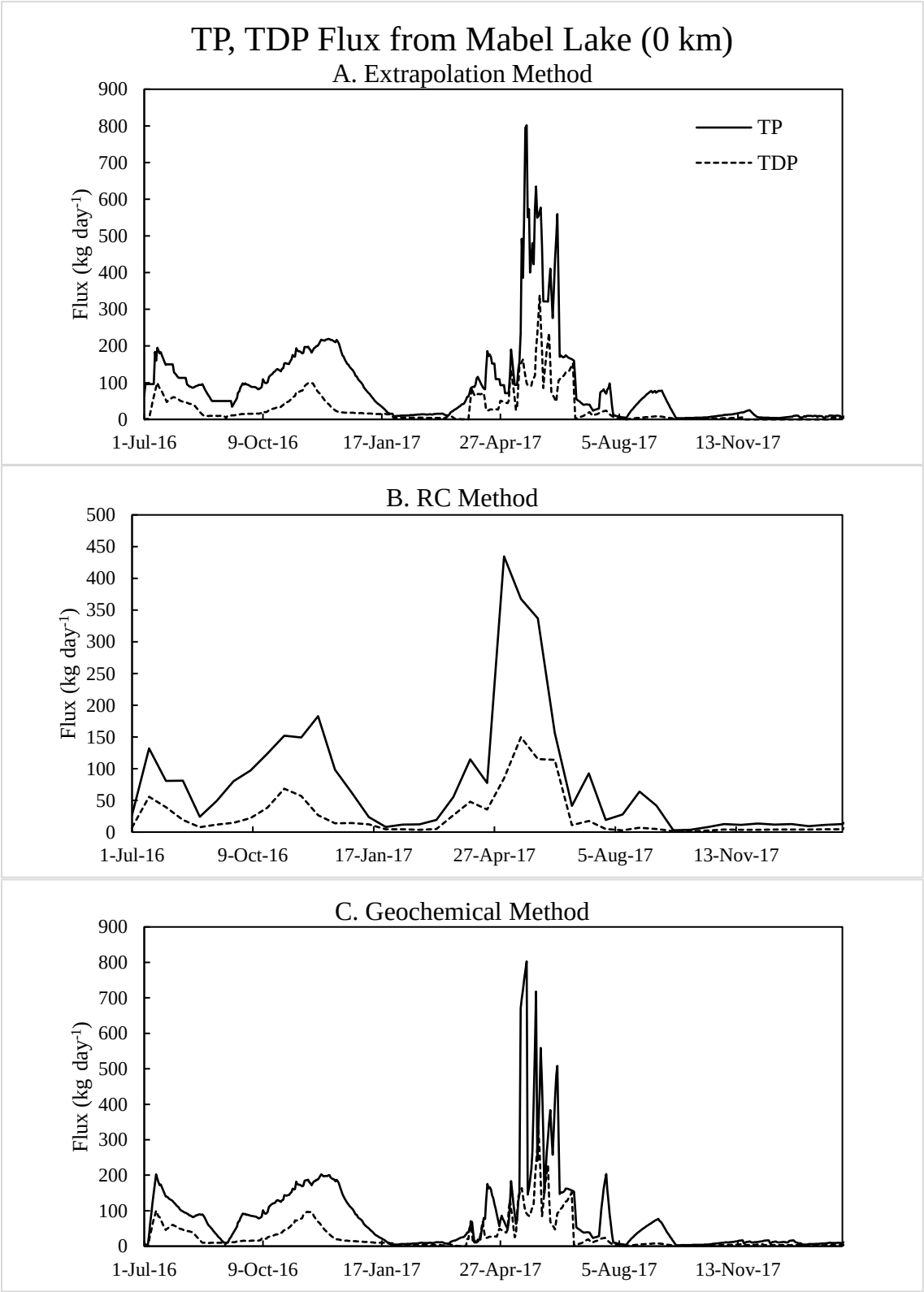

Figure 27*: TP and TDP flux from Mabel Lake (0 km) into the Shuswap River*

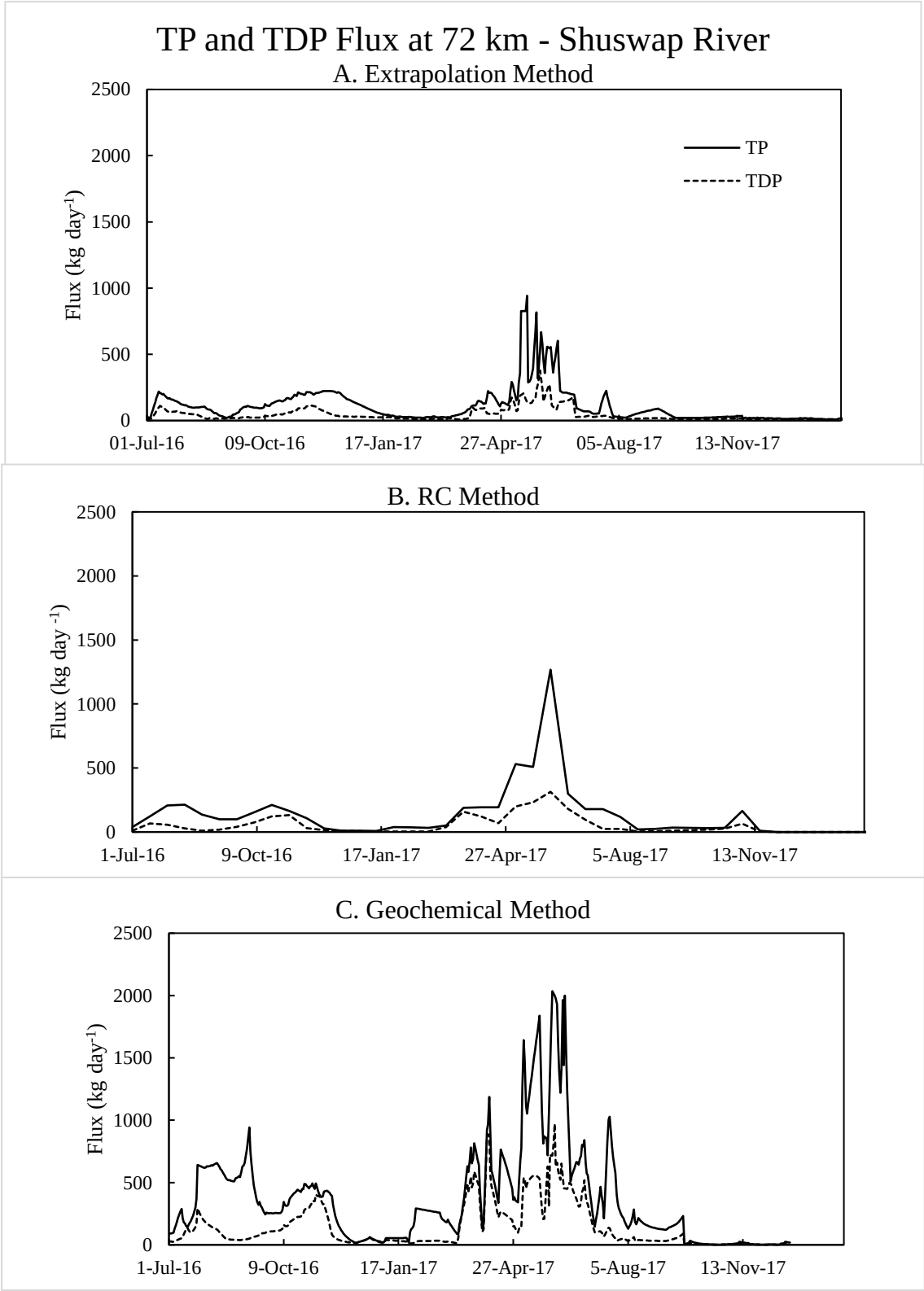

Figure 28: *TP and TDP flux at 72 km on the Shuswap River*

__Table 7:__ TP and TDP flux contribution by source into the Shuswap River

		Extrapolation		RC Method		Geochemical	
	Source	**Annual Flux (kg y^{-1})**	**% of Total Flux**	**Annual Flux (kg y^{-1})**	**% of Total Flux**	**Annual Flux (kg y^{-1})**	**% of Total Flux**
TP	Tributaries	4.09E+03	10.10%	4.09E+03	9.87%	4.09E+03	2.21%
	IFSW	7.12E+03	17.29%	4.75E+04	51.30%	2.92E+04	48.17%
	Mabel Lake	2.95E+04	72.70%	2.86E+04	39.12%	3.02E+04	49.62%
TDP	Tributaries	1.24E+03	3.41%	1.24E+03	14.57%	1.24E+03	3.81%
	IFSW	4.15E+03	29.40%	1.19E+04	23.00%	7.63E+04	37.20%
	Mabel Lake	1.00E+04	67.20%	9.38E+03	62.43%	9.67E+03	59.00%

4.4.2 RC Method

The TP and TDP flux from IFSW graphs (Fig. 26B) were smoothed using a one-week average in order to eliminate false peaks created by large daily precipitation. Smoothing lengthens the transit time for precipitation to the river from one day to one week, lessening the effects of heavy rainfall. For both TP and TDP flux, smoothing created a graph typical of a snowmelt hydrological regime. During freshet TP flux was about 6 times greater than during baseflow. The annual TP contribution from IFSW differs from the extrapolation method, estimating a flux that is 12 times greater. The TDP flux was about 8 times greater during freshet than baseflow. Annually, the TDP flux from IFSW for the RC method was 3 times greater than the extrapolation method.

The TP and TDP flux from Mabel Lake (Fig. 27B) followed the trend of a snowmelt hydrological regime. The flux in the fall months of 2016 were greater than others, as the method is affected by rainfall events, as was seen during this time, though the smoothing eliminates maximums occurring from individual daily precipitation events. For the TP flux, Mabel Lake contributed 7 times more during freshet than baseflow. Mabel Lake was not the majority contributor of TP flux, as in the extrapolation method, contributing only 39.1% of the total (Table 5). As compared to the extrapolation method, the RC method predicted the TP flux from Mabel Lake to be similar, differing by about 3%. For TDP, the same trend as TP was followed.

The TDP flux was 6 times greater during freshet than baseflow. For TDP, Mabel Lake was the majority contributor (62.4%), and had similar estimates to the extrapolation method, estimating flux to be slightly greater (less than double, Table 7).

The RC method showed TP and TDP flux through the entire 72 km of the river behaving in the expected way for a snowmelt hydrological regime (Fig. 28B). The TP flux reached a maximum during freshet, the same time as the other methods. During freshet, the TP flux was estimated to be about 5.5 times greater than during baseflow. The TP flux at 72 km for the RC method was 4.5 times greater than the extrapolation method (Table 7). The TDP flux had a greater difference between freshet and baseflow, with daily flux being about 11 times greater during freshet. The TDP flux at 72 km was estimated to be similar to the estimates from the extrapolation method, being just 2.5 times greater. Because all the methods use the same concentration data, greater flux values are attributed to greater discharge estimates.

4.4.3 Geochemical Method

The TP and TDP flux from IFSW follow a typical snowmelt hydrological regime (Fig. 26C). The peak during freshet is better defined than the other methods, as discharge from IFSW was predicted to be much greater at this time. The TP flux during freshet is about 15 times greater than during baseflow. The annual TP flux for this method differs from the extrapolation method, with estimate that is 10 times greater. The TP flux estimate is similar to the RC method, only being 1.5 times greater than RC method. The flux for TDP from IFSW follows the same trend as TP and is 42 times greater during freshet than baseflow. The annual TDP flux is predicted to be somewhat different from the extrapolation method, with an estimate that is 9 times greater, and from the RC method, with an estimate that is 30 times greater. The greater values are due the calculation of discharge, which accounts for runoff in the form of snowmelt and irrigation returns. Despite the greater discharge returns, overall percent contribution is relatively similar to the RC method (Table 7), which estimate IFSW to be a large contributor to the overall TP and TDP flux.

For Mabel Lake (Fig. 27C), the TP and TDP flux follows the same trend of a snowmelt hydrological regime. Mabel Lake discharge is calculated independently and not by difference in the geochemical method, but the same concentration data is used in all three methods. The method still predicts freshet to have the greatest TP fluxes, which are 15 times greater than

during baseflow. Compared to other methods though, the TP values are similar to (less than 2 times difference) extrapolation and RC method. The TDP flux follows the same trend at as TP, with 7 times greater daily flux during freshet than baseflow. For both fluxes, Mabel Lake contributes the majority of the flux, 59% for TP and 49% for TDP. The total TDP flux is similar for all three methods, differing by less than two times.

The total TP and TDP flux as predicted by the geochemical method follows the same pattern as the other methods (Fig. 28C), typical of a snowmelt hydrological regime. For the TP flux, it is about 4 times greater during freshet than in baseflow, with maximum values associated with large discharge predictions. The total TP flux is predicted to be similar for all three methods, with the geochemical estimates being 5 times greater than the extrapolation method, and 2 times greater than the RC method. For TDP, the freshet flux is 165 times greater than in baseflow. The TDP flux predicted by the geochemical method differs from the extrapolation method, with estimates 14 times greater, while it is similar to the RC method, with estimates that are 6 times greater. The large amount of predicted discharge by the geochemical method is due to large amount of discharge predictions, as the same concentration data were used.

4.5 Hydrometric measurements – Salmon River

Discharge in the Salmon River was measured at the outlet into Shuswap Lake (66 km). The discharge in the river (Fig. 29) peaks in the spring months during freshet (May to June) and reaches base flow in the fall months (September to November), following a trend typical of a snowmelt hydrological regime. The Salmon River peaked in May of 2017 at 53.3 m^3s^{-1}, 4 times greater than the mean peak discharge of 13.4 m^3s^{-1}. The time of sampling (spring 2016 – winter 2018) had considerably greater discharge than usual, with the annual discharge being about 1.9 times greater than mean annual discharge (1911-2015, Water Office of Canada).

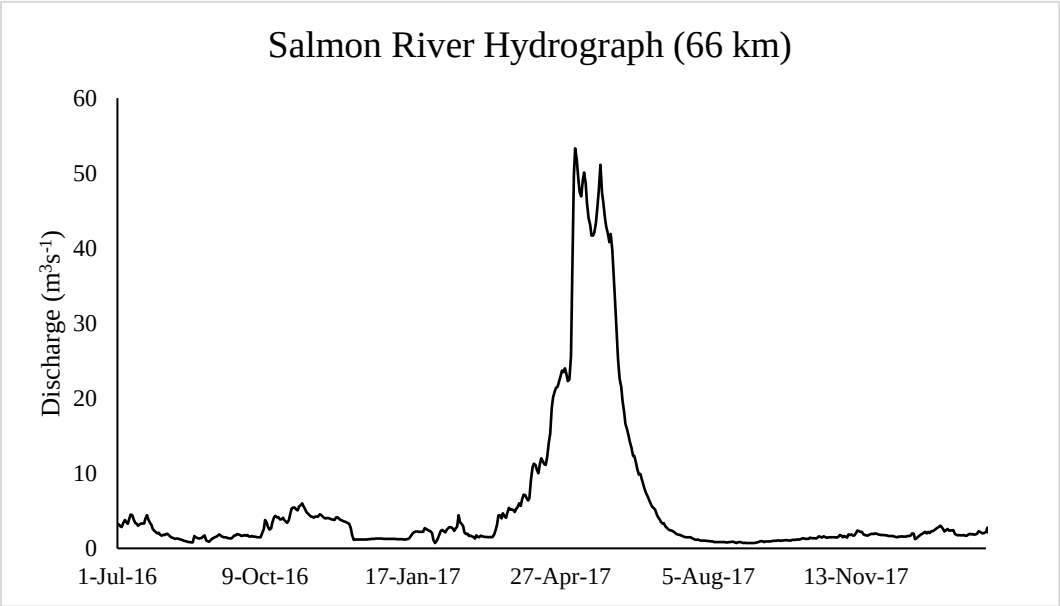

Figure 29: *Discharge from the Salmon River measured at 66 km*

The tributaries (e.g. Bolean Creek, Fig. 30) follow the same trend as the Salmon River at 66 km, typical of a snowmelt hydrological regime. No tributaries ran dry in the Salmon River but had a minimum discharge in summer 2017 of 0.124 m^3s^{-1} (discharge of Bolean Creek) or less. All tributary hydrographs can be found in Appendix C. The tributaries contribute 25,900,000 m^3y^{-1} (Table 8), or 12.3% of the total discharge (Table 9). The annual discharge yield for tributaries is positively correlated with elevation (Fig. 31), and the relationship is considered significant despite the small samples size (R^2= 0.999).

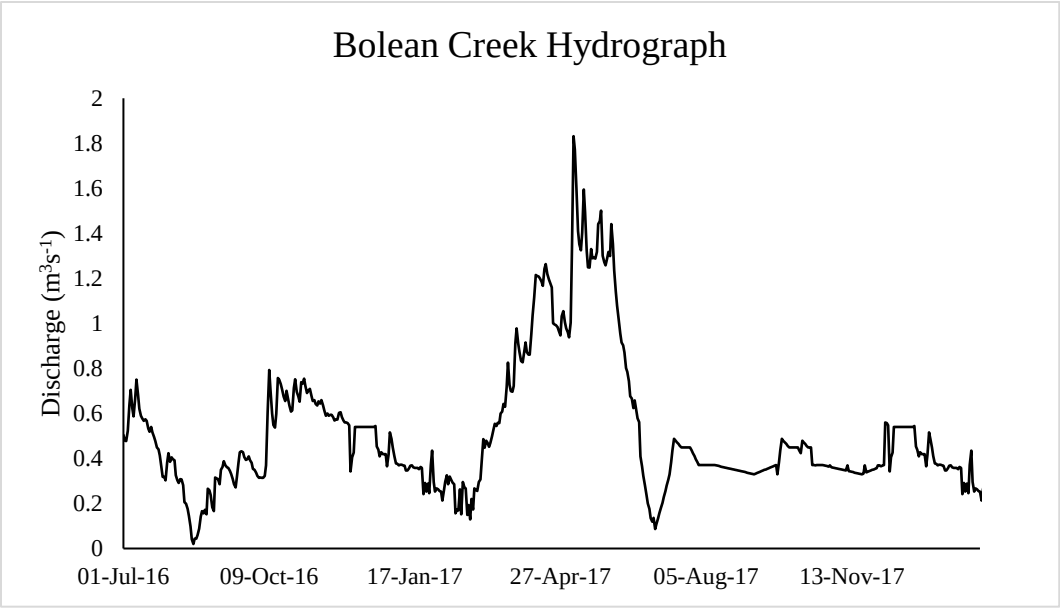

***Figure 30**: Discharge from Bolean Creek, a tributary of the Salmon River*

***Table 8:** Discharge characteristics of tributaries on the Salmon River*

Tributary	Watershed Area (Ha)	Watershed Mean Elevation (m)	Annual Discharge ($m^3 year^{-1}$)	Yield (mm $year^{-1}$)
Bolean Creek	13,300	992	17,200,000	129
Spa Creek	1,370	1,050	4,990,000	364
Silver Creek	2,580	1,000	3,750,000	145
Tributary Total	17,300	1,010	25,900,000	213

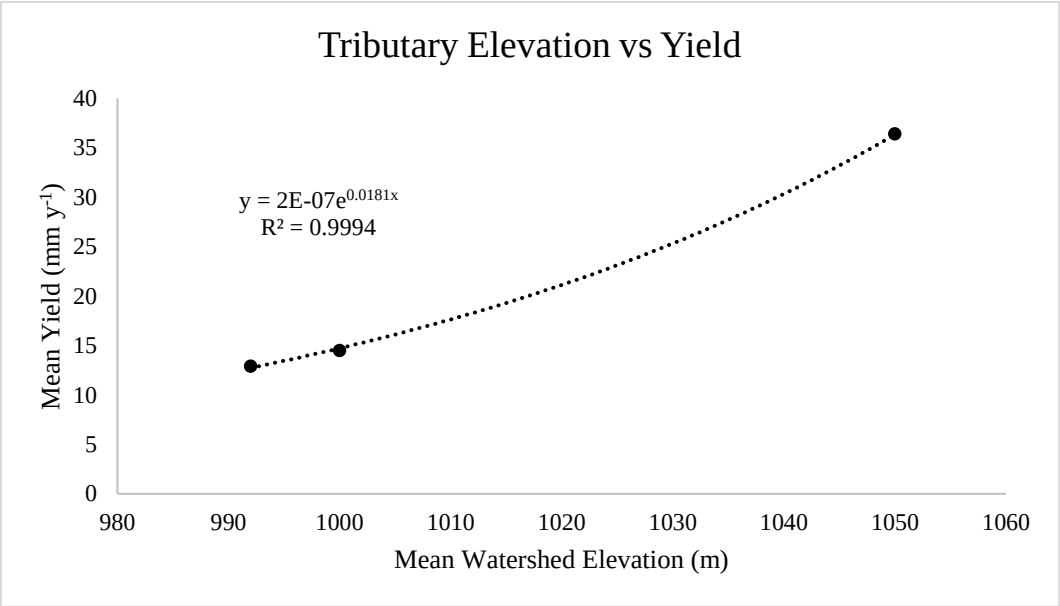

Figure 31: *Elevation and discharge yield correlation for tributaries in the Salmon River*

4.6 Calculated Discharge Estimates

4.6.1 Extrapolation Method

The hydrograph for IFSW, as estimated by the extrapolation method, uses the average discharge yield from metered tributary sub-watershed. Because there are only three metered tributaries along the Salmon River, all were used for the final analyses. The hydrograph (Fig. 32A) for IFSW appears similar to the 66 km hydrograph. Overall the discharge from incremental flows was predicted to be very small, never exceeding 0.08 m^3s^{-1}. Note that because the discharge rates are so low, the scale is different than the RC and geochemical methods to show seasonality.

For the 0 km site at Falkland, the discharge was calculated by difference, subtracting the sum of the discharge from IFSW and tributaries from the measured discharge at 66 km. Inputs from incremental flows and tributaries were small, therefore the hydrograph (Fig. 33A) appears nearly identical to the hydrograph for 66 km, with discharge differing by only about 10% between 0 and 66 km.

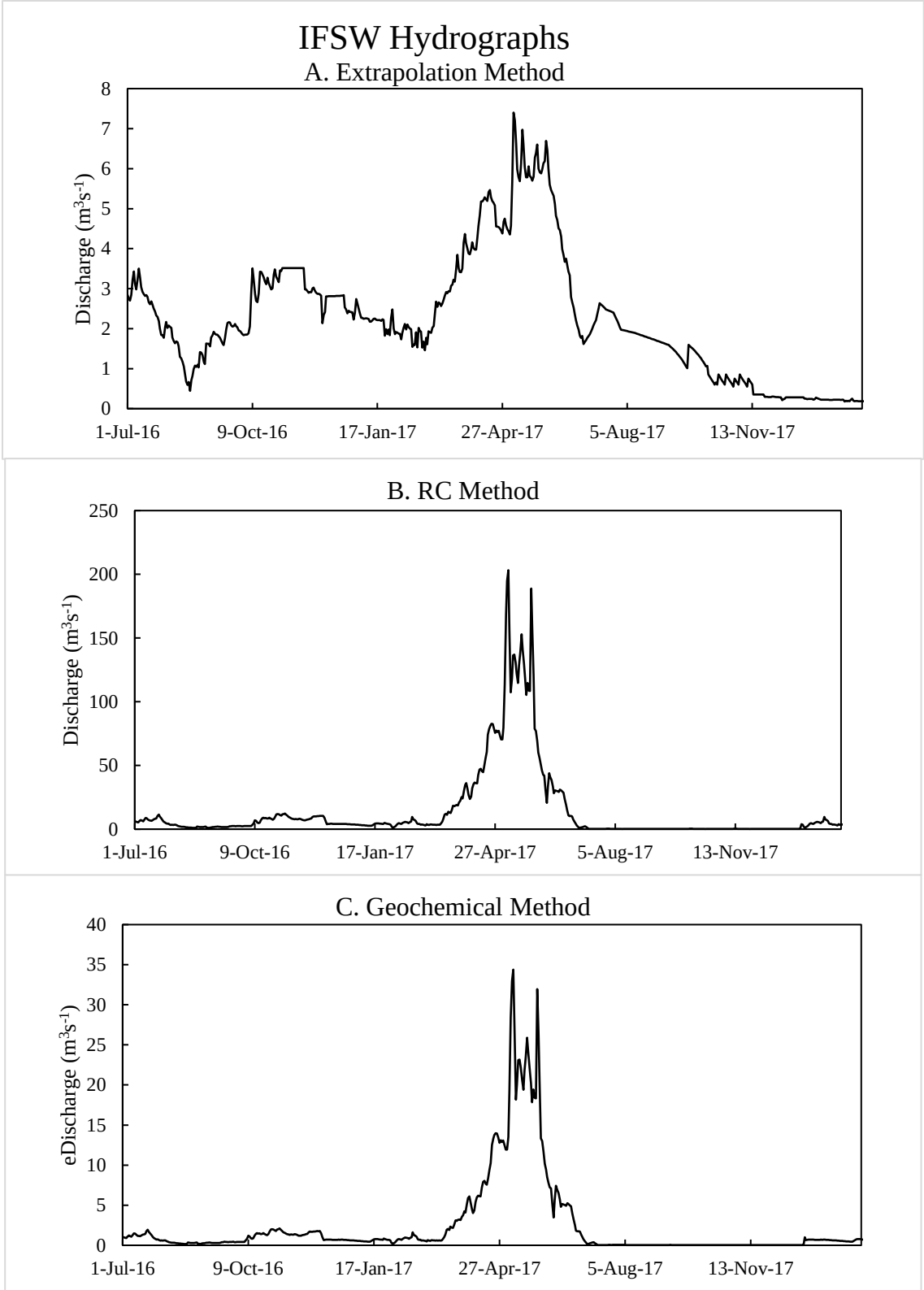

Figure 32*: Discharge from IFSW in the Salmon River*

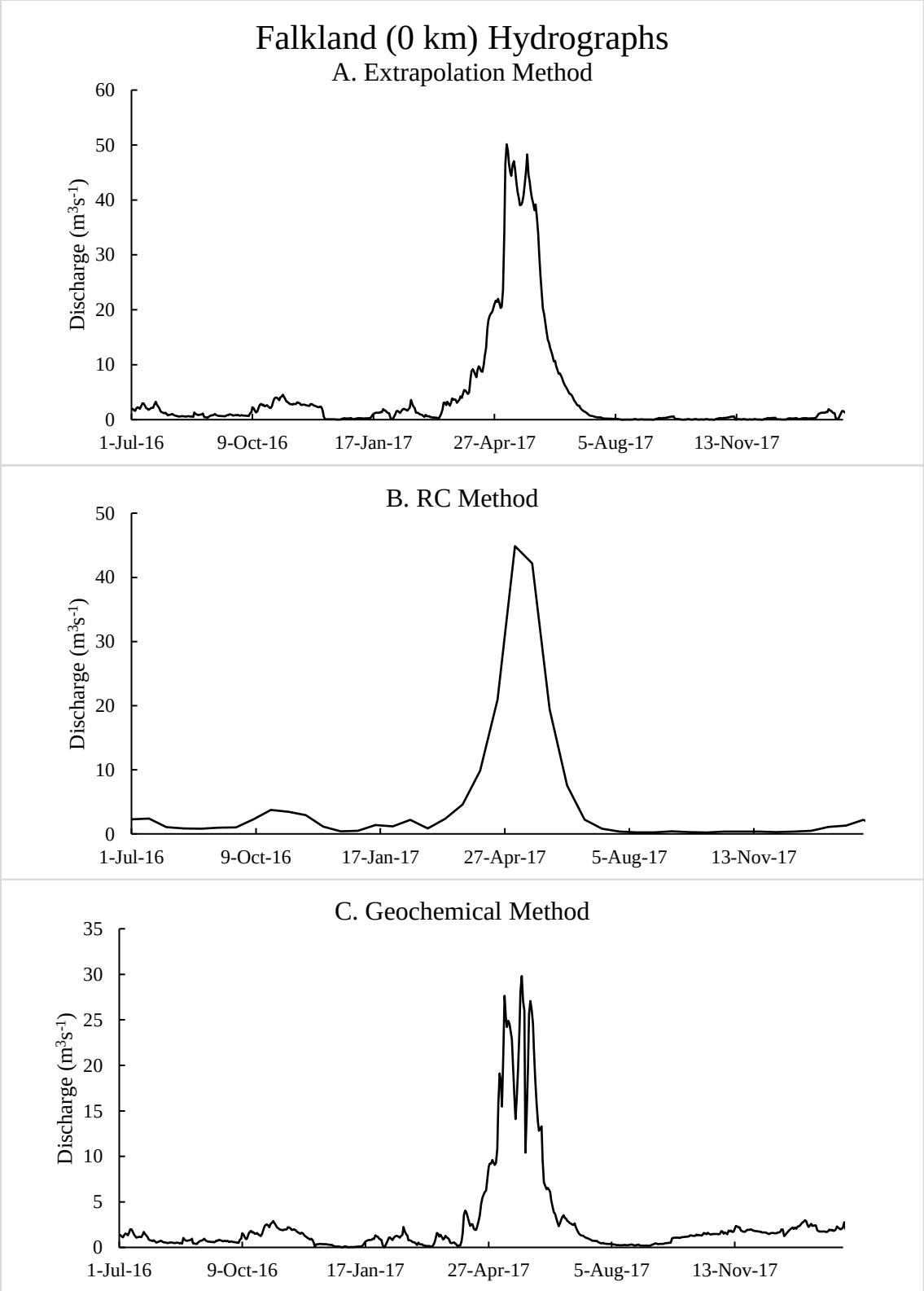

Figure 33*: Discharge from the 0 km site on the Salmon River*

Table 9: Contribution by source into the Salmon River

	Extrapolation		RC Method		Geochemical	
Source	**Annual Q (m^3y^{-1})**	**Percent Contribution**	**Annual Q (m^3y^{-1})**	**Percent Contribution**	**Annual Q (m^3y^{-1})**	**Percent Contribution**
Tributaries	2.6E07	12.3%	2.6E07	12.3%	2.6E07	12.3%
IFSW	3.87E07	18.3%	6.58E08	45%	6.84E07	32.3%
0 km Site	1.46E08	68.4%	1.39E08	42.7%	1.17E08	55.4%

4.6.2 RC Method

The RC method uses daily precipitation data paired with runoff coefficients to estimate discharge from IFSW, as outlined in the methods chapter (Chapter 3). The data were smoothed using a one-week average to account for transit time for precipitation to reach the river. The resultant hydrograph for IFSW (Fig. 32B) is one typical of a snowmelt hydrological regime, with maximum flux during freshet. The method assumes a transit time of one week when using the smoothed data, yet the discharge was less affected by daily precipitation events than expected, with no false peaks, even in the known rainy period of Fall 2016. The IFSW annual discharge was similar to the extrapolation method, with annual discharge estimates that were 1.7 times greater than the estimates from the extrapolation method (Table 9).

The RC method also estimates discharge from the 0 km site by difference, and the hydrograph (Fig. 33B) is similar to the 72 km hydrograph. The difference between 0 and 72 km is about 23%, due to the small inputs from IFSW and tributaries. The RC method estimates a similar discharge to the extrapolation method, with discharge being 1.5 times lesser, as the IFSW inputs are greater (Table 9).

4.6.3 Geochemical Method

EMMA was used to determine the discharge of IFSW and the discharge at 0 km. EMMA was performed for all six chemical end-members on a reach by reach basis. End-members were tested for significant differences in mixing behavior using ANOVA. For the Salmon River, significant differences existed between different models on different reaches of the river. The discharge estimates that were not significantly different for each model type (p-value > 0.05)

were averaged and used for the final analyses (see Appendices for ANOVA results for individual models).

The hydrograph for IFSW (Fig. 32C) followed the expected trend of a snowmelt hydrological regime. The discharge during freshet was about 16 times greater than during baseflow. Overall, the discharge predicted by the geochemical method from IFSW similar to both methods, with estimates being about 1.7 times greater than the extrapolation method and 1.3 times lesser than the RC method (Table 9). Geochemical methods will capture groundwater contribution and losses, which likely play a big role in the Salmon River. In addition, the method will count irrigation returns as inputs of IFSW.

The discharge for the 0 km site (Fig. 33C) was calculated independently using EMMA. The method predicted a gain of about 148% between 0 and 72 km. The method estimated somewhat similar discharge at the site (Table 9), with the site having lesser discharge than what was predicted by the extrapolation and RC methods (1.2 and 7.8 times, respectively).

4.7 Phosphorous Mass Balance Results – Salmon River

4.7.1 Phosphorous measurements

The TP concentration at main-stem sites did not generally increase downstream as would be expected (Fig. 34). The greater concentrations at upstream sites suggest that dilution or loss of P happens between 0 and 66 km. The TP concentration was relatively stable through the year with an appreciable peak in fall of 2016, where all sites had high concentrations due large amounts of rainfall. Another small peak occurred during freshet. There were no undetectable concentrations of TP at any site throughout sampling.

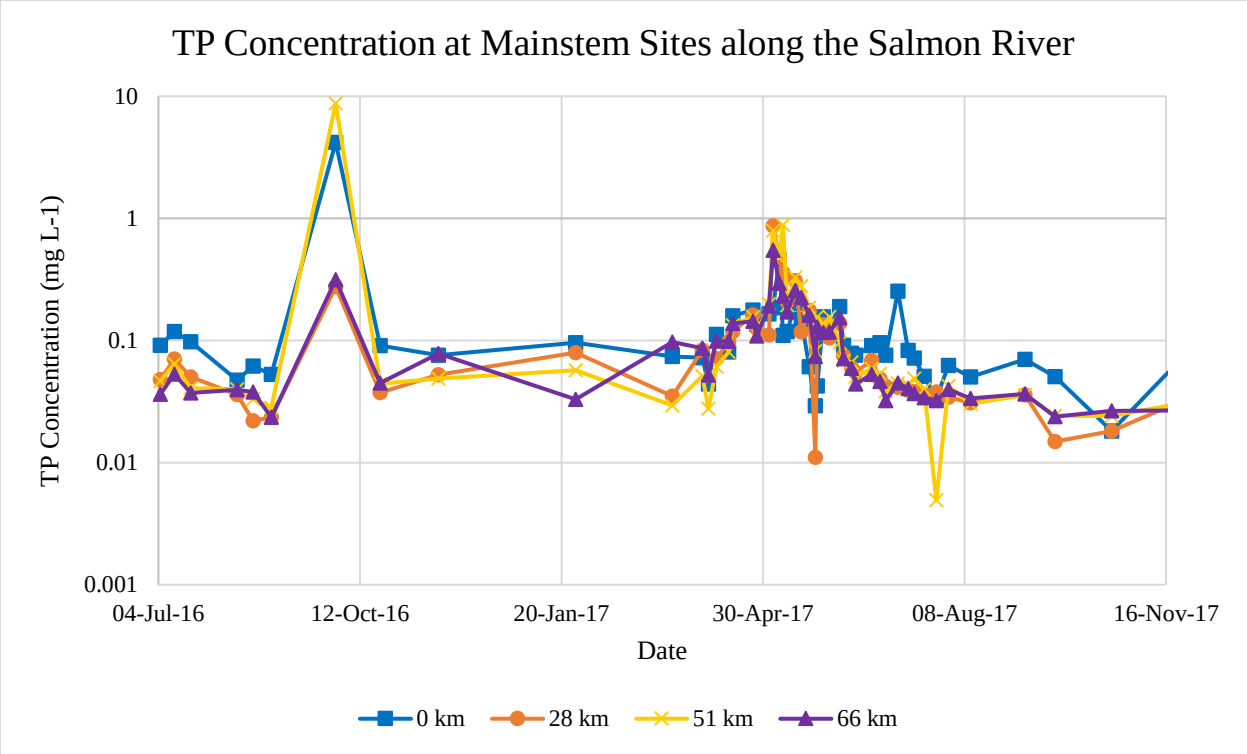

Figure 34: *Seasonality of TP concentration in mainstem sites along the Salmon River*

The TDP concentrations did not increase downstream, many times with the 0 km site having the greatest concentration of TDP (Fig. 35). The concentrations were consistent throughout thee year, with low points in fall/winter of 2017. Again, the greater concentrations in fall of 2016 was likely due to high rainfall, but general confidence in these points are lower than rest of the dataset, as sample intervals were less frequent. Some data points in the series had undetectable amounts of TDP and were set at the MDL of 0.0013 mg L^{-1}.

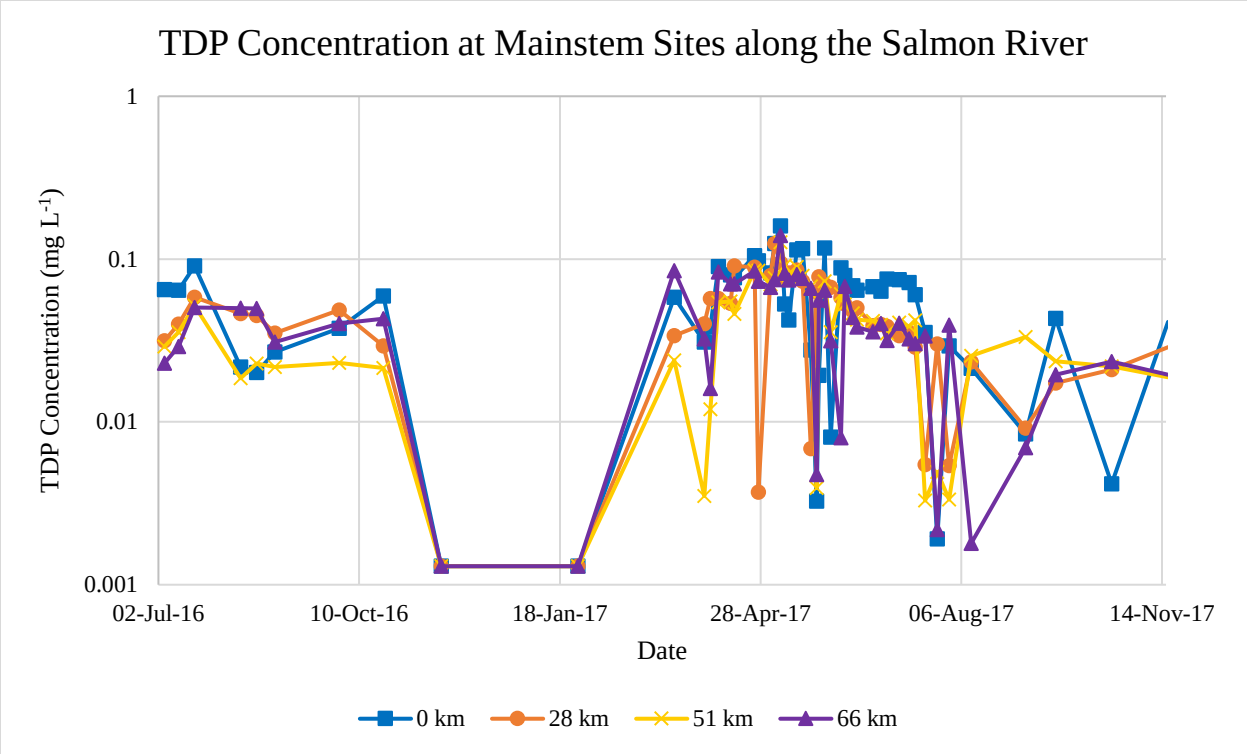

Figure 35*: Seasonality of TDP concentration in mainstem sites along the Salmon River*

There is a positive correlation for both TP and TDP with discharge (Fig. 36A, B) The correlation is weak (R^2 =0.399 for TP and 0.319 for TDP), but due to the large sample size, is considered significant, with correlations for TP and TDP having a p-value less than 0.05. The concentration of each is therefor considered to be dependent on discharge.

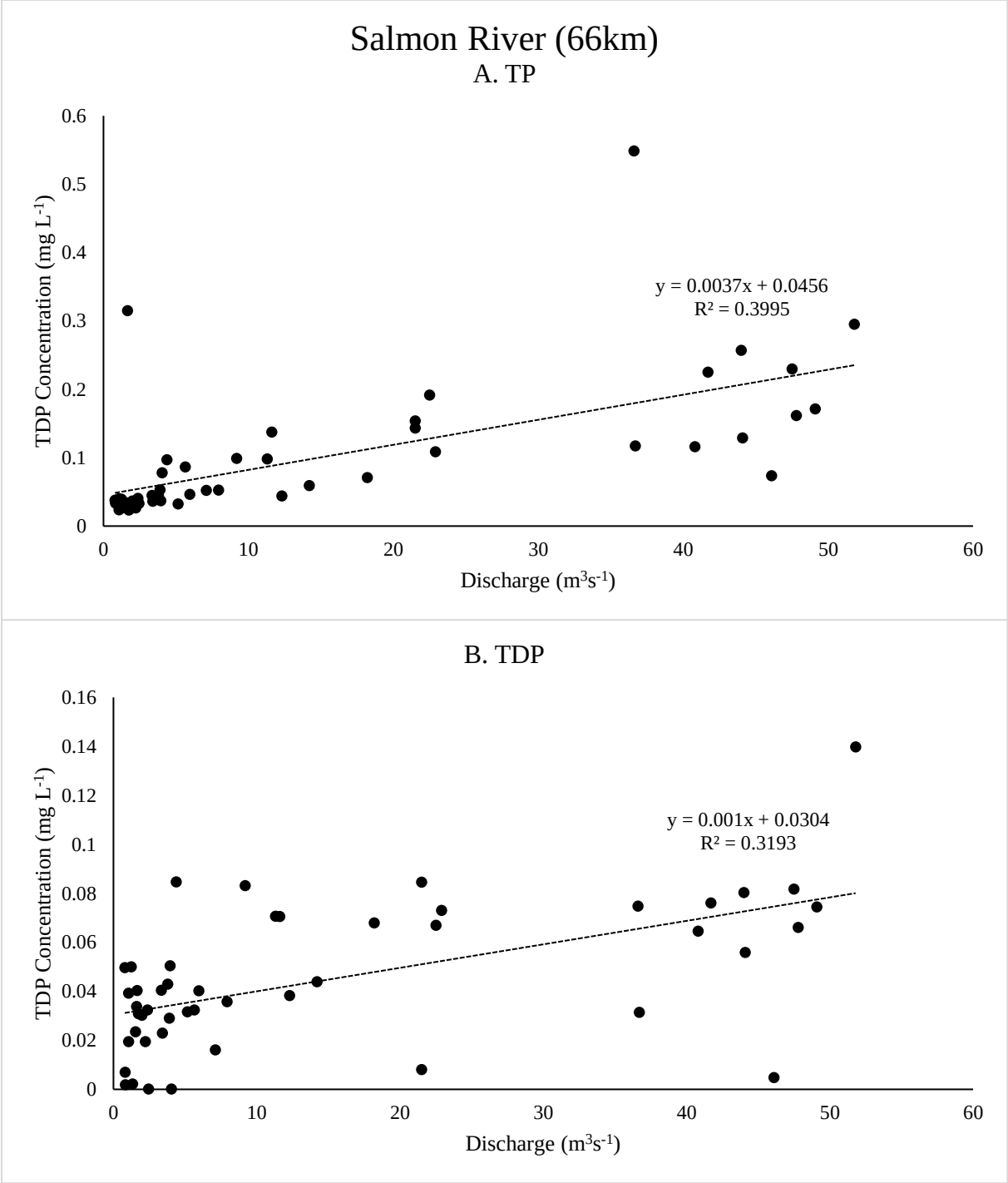

Figure 36*: Correlation plot for discharge and concentration at 66 km*

The flux at 66 km is a measured parameter (Fig. 37). The TP and TDP flux were dependent on discharge, and followed a snowmelt hydrological regime, peaking in spring months during freshet. The TDP flux is just over 50% of the TP flux, similar to the Shuswap River. The flux of both TP and TDP was about 7 times greater in freshet than in the months during baseflow. During baseflow, the discharge became small enough in the Salmon River such that TP and TDP flux is negligible.

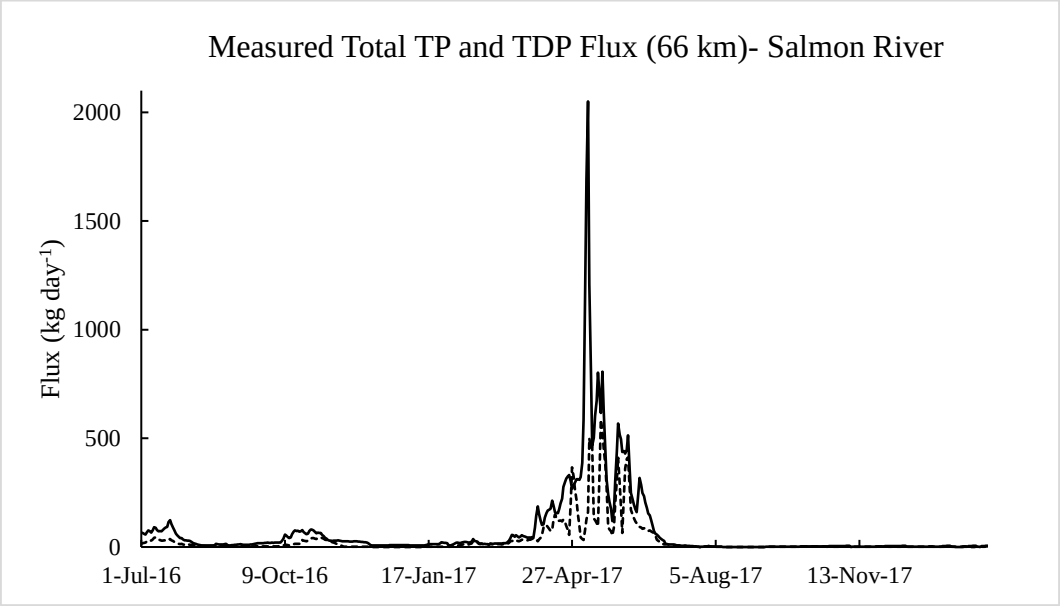

Figure 37*: Measured TP and TDP flux at 66 km at Salmon River*

The TP concentrations in the tributaries reached a maximum during freshet (e.g. Bolean Creek, Fig. 38), similar to the main stem sites. Throughout the rest of year, the concentrations stayed relatively stable. The mean concentration for all the creeks 0.0215 mg L^{-1} (Table 10).

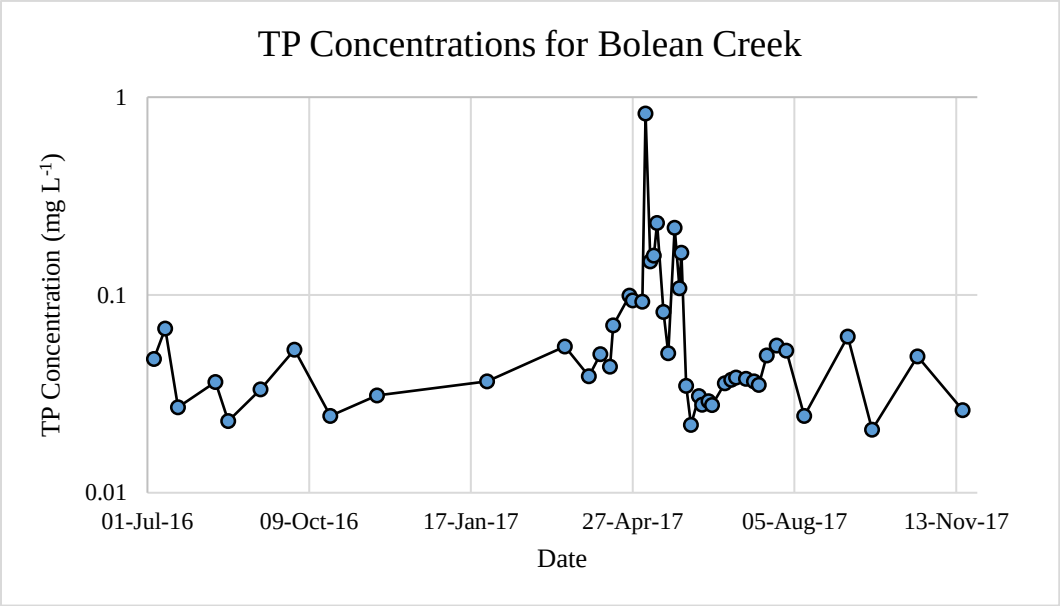

Figure 38*: Seasonality of TP concentration in Bolean Creek, a tributary of the Salmon River*

Table 10: *Watershed characteristics and tributary TDP contributions for the Salmon River*

Tributary/Source	Watershed Area (Ha)	Average [TP] (mg L^{-1})	Annual flux (kg $year^{-1}$)	Yield (kg ha^{-1} $year^{-1}$)
Bolean Creek	13,300	0.3623	4,660	0.35
Spa Creek	1,370	0.0396	186	0.135
Silver Creek	2,580	0.0288	101	0.039
Tributary Total	17,200	0.143	4,940	0.287
Incremental Flows	77,000	0.0684	7,040-44,900	0.091-0.583

The TDP concentration within the tributaries reached a maximum in fall months of 2016, a time of high rainfall, and again during freshet (e.g. Bolean Creek, Fig. 39). In the winter months, the TDP concentration was undetectable and the concentration was set at the MDL. The average concentration was low (0.0215 mg L-1). Just as in the Shuswap River, the tributary TP and TDP yield can be considered close to background levels, as the watersheds are not greatly influenced by anthropogenic activities (Table 11).

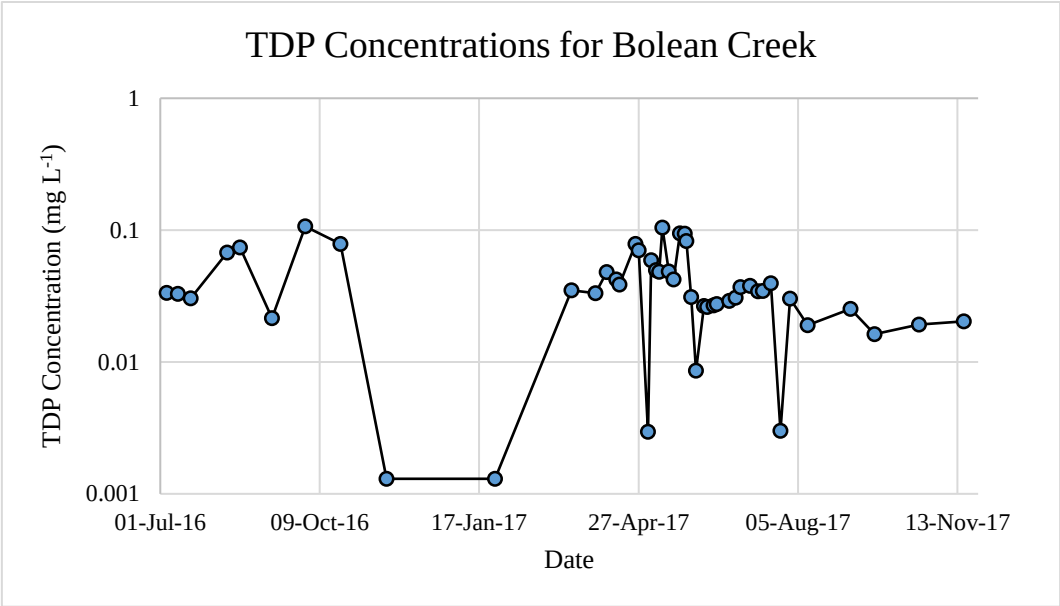

Figure 39*: Seasonality of TDP concentration in Bolean Creek, a tributary of the Salmon River*

Table 11*: Watershed characteristics and tributary TDP contributions for the Salmon River*

Tributary/Source	Watershed Area (Ha)	Average [TDP] (mg L^{-1})	Annual flux (kg $year^{-1}$)	Yield (kg ha^{-1} $year^{-1}$)
Bolean Creek	13,300	0.0432	795	0.06
Spa Creek	1,370	0.0114	53.9	0.039
Silver Creek	2,580	0.0099	36.9	0.014
Tributary Total	17,200	0.0215	886	0.051
Incremental Flows	77,000	0.0404	4,160-8,950	0.054-0.116

The TP flux from tributaries did not follow the expected pattern for a snowmelt hydrological regime (Fig. 40). The main TP flux peak was in fall of 2016, coinciding with heavy rainfall. The TDP flux did not peak at the same time, indicating that the majority of the flux was from particulate P that was transported from runoff. The TP flux then had a second peak during freshet.

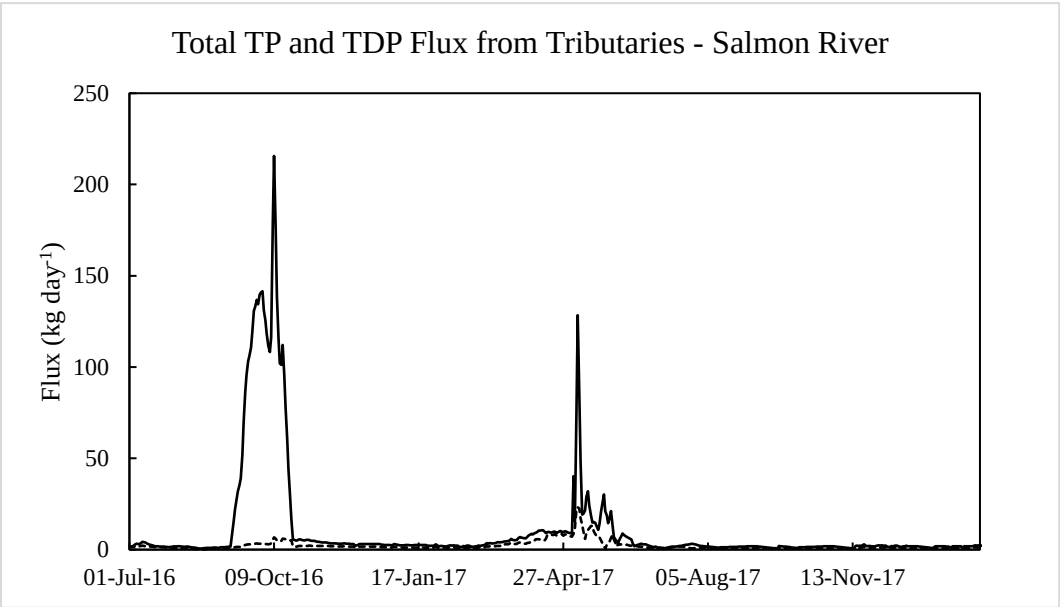

Figure 40*: TP and TDP flux from all the tributaries in the Salmon River*

For IFSW, TP and TDP concentrations were the same for the Shuswap and Salmon River watershed, as the concentration values were similar across the two study areas (Figure 25A, B). The average TP and TDP concentrations for IFSW were about double that of the concentrations for the tributaries.

4.8 P Loadings from IFSW and 0 km

4.8.1 Extrapolation Method

The IFSW flux followed the expected trend of snowmelt hydrological regime (Fig. 41A), reaching a maximum during freshet. The flux during freshet was about 3.5 times greater than during baseflow for both TP and TDP. Note that the scale for figure 31 are not all the same, in order to observe seasonality of the fluxes. The magnitude of the flux from IFSW is much less than the RC or geochemical method.

Because the method predicts low inputs from IFSW, and the 0 km site is solved by difference, the 0 km site thus has greater TP and TDP flux than the other methods (Fig. 42A). The TP and TDP flux from the 0 km site follow the expected trend of a snowmelt hydrological regime, with flux in freshet being about 40 times greater than during baseflow. The 0 km site is said to contribute more than 100% of the total TP and TDP flux (Table 12), than what is present at the 66 km site. This is due to the lesser concentrations at 66 km, suggesting retention, dilution or hyporheic exchange within the river that contributes to the loss of nutrients downstream.

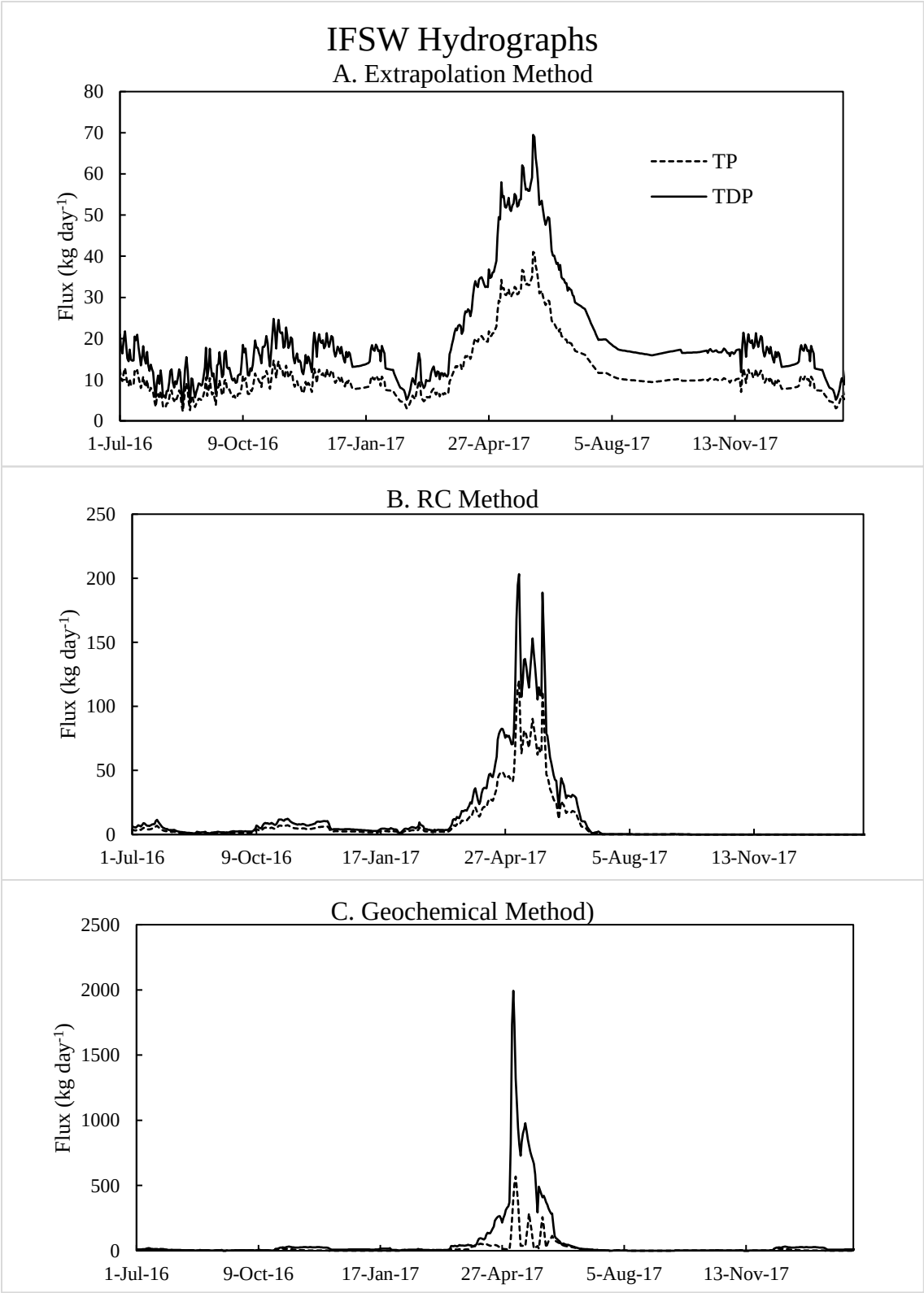

Figure 41*: TP and TDP flux from IFSW in the Salmon River*

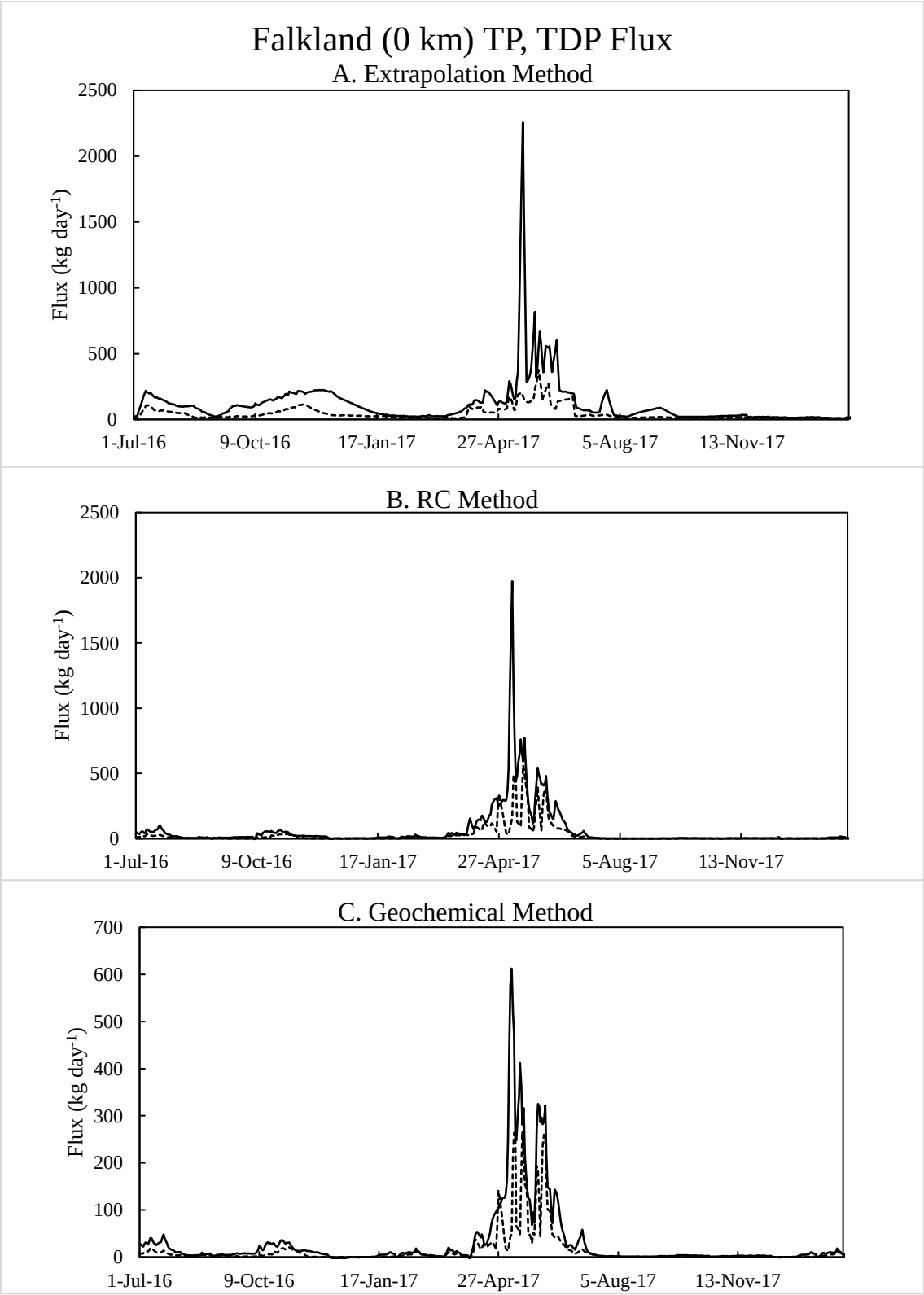

Figure 42: *TP and TDP flux from the 0 km site on the Salmon River*

__Table 12:__ Contribution of TP and TDP flux by source in the Salmon River.

		Extrapolation		RC Method		Geochemical	
	Source	**Annual Flux (kg y^{-1})**	**% of Total Flux**	**Annual Flux (kg y^{-1})**	**% of Total Flux**	**Annual Flux (kg y^{-1})**	**% of Total Flux**
TP	Tributaries	3,820	17.2%	3,820	17.2%	3,820	17.2%
	IFSW	7,040	31.7%	44,900	>100%	30,700	>100%
	0 km Site	19,600	88.2%	4,200	18.9%	10,200	45.7%
TDP	Tributaries	733	12.9%	733	12.9%	733	12.9%
	IFSW	4,160	73.4%	8,950	>100%	5,200	91.6%
	0 km Site	8,760	>100%	1,780	31.8%	4,360	76.7%

4.8.2 RC Method

The TP and TDP flux from IFSW as estimated by the RC method followed a trend expected of a snowmelt hydrological regime (Fig. 41B). The maximum flux during freshet was about 35 times greater than during baseflow for both TP and TDP. The RC method predicts yearly flux to be similar to the extrapolation method, with a flux about 6 times greater for TP and 2 times greater for TDP, as compared to the extrapolation method. The RC method predicts that that IFSW contribute more of the TP and TDP flux than is measured at the 72 km site, suggesting some form or retention of nutrients or hyporheic exchange within the river.

The flux at the 0 km site followed the same trend as expected of a snowmelt regime (Fig. 42B). The daily flux during freshet was about 11 times greater than during baseflow. The magnitude of the flux was smaller than the extrapolation method, as the RC method predicted larger inputs by IFSW, thus reducing the discharge from the 0 km site when solving by difference. Overall, the annual TP and TDP flux was similar to the extrapolation method, with annual flux estimates that were about 5 times lesser (Table 12).

4.8.3 Geochemical Method

The geochemical method estimates for IFSW followed the same trend as the extrapolation and RC methods, typical of a snowmelt hydrological regime (Fig. 41C). The TP and TDP flux are about 25 times greater during freshet than baseflow. Compared to the other methods (Table 12), the annual TP flux is similar, being about 4.5 times greater than estimated by the extrapolation method and 1.5 times less than the RC method. The TDP annual flux is also

similar to the other methods, being about 1.25 greater than the extrapolation and 1.7 times less than the RC method. The TP and TDP flux from IFSW are predicted to be close to or greater than the total flux measured at the 66 km site, once again suggesting some form of nutrient retention or exchange.

For the 0 km site, the expected trend for snowmelt hydrological regime was followed (Fig. 42C). The TP and TDP flux were about 16 times greater in freshet than baseflow. Compared to the extrapolation method, both the TP and TDP flux was similar, and was about 2.5 times greater (Table 12). When compared to the RC method, the TP and TDP flux was also similar, being about 2 times lesser. The geochemical method predicted that the flux from 0 km, IFSW, and tributaries summed exceeds the total flux. Using EMMA, the 0 km site consisted of 12.8% groundwater, and this proportion grew to 31.7% by 72 km. Besides certain times of the year, there was no loss of water between 0 and 72 km, suggesting hyporheic exchange of groundwater. The groundwater generally has lesser concentrations of TP and TDP than the 0 km site, which would explain the loss of nutrients.

4.9 Phosphorous Export Coefficients

IFSW were sub-divided using EMMA into upland and valley watersheds (Table 13). For the Shuswap River, the TP yield for incremental flows is 14.8 kg/ha/year and 0.083 kg/ha/year for upland flows. For the Salmon River, valley incremental flows have a TP yield of 0.87 kg/ha/year and 0.013 kg/ha/year for upland flows. For TDP, valley flows in the Shuswap have an average yield of 5.3 kg/ha/year and upland flows have a yield of 0.08 kg/ha/year. The Salmon River Valley incremental flows have an average TDP yield of 0.45 kg/ha/year and upland flows have a yield of 0.002 kg/ha/year TDP.

Table 13*:Annual yield from incremental flows originating from valley or upland sources in the Shuswap and Salmon Rivers*

	Location	TP (kg/ha/year)	TDP (kg/ha/year)
Shuswap River	Valley	14.8	0.83
	Upland	5.3	0.08
Salmon River	Valley	8.7	0.45
	Upland	0.13	0.002

The homogenous distribution of land use along the Salmon River did not allow for enough distinction between reaches to perform a regression. Therefore, the Salmon and Shuswap

Rivers were grouped together to perform the regression. The forested export coefficient was set to be the average of the tributary yields, while urban and agriculture were considered free parameters. For both TDP (Table 14) and TP (Table 15), the agriculture land use category had a greater export than urban land use. The urban land use TDP export was about three times less than the agriculture export, and the TP export for urban was about 3.5 times less than the agriculture.

Table 14: *TDP export coefficients for Shuswap and Salmon Rivers for different land uses*

Land Use	TP Export (**kg ha^{-1} year^{-1}**)	SE Estimate
Urban	3.83	6.85
Agriculture	13.5	7.50
Forested	0.035	---

Table 15*: TDP export coefficients for Shuswap and Salmon Rivers for different land uses*

Land Use	TDP Export (**kg ha^{-1} year^{-1}**)	SE Estimate
Urban	1.16	2.48
Agriculture	3.75	2.72
Forested	0.008	---

5 Discussion

The aim of the project was to quantify the total phosphorous (TP) and total dissolved phosphorous (TDP) flux from different categories of sources into the lower reaches of the Shuswap and Salmon Rivers. The sources of TP and TDP included tributary sub-watersheds, incremental flow sub-watersheds (IFSW) and the river upstream of the study area (0 km sites e.g. Mabel Lake). The aim of the project was achieved through field sampling of water in tributaries, IFSWs and upstream sites, as well as hydrometric monitoring for major tributaries and the main-stem rivers.

Three discharge modelling techniques were used to estimate hydrometric discharge for IFSWs and unmetered reaches on the mainstem river. The techniques applied were extrapolation, runoff coefficients (RC), and geochemical methods, as outlined in Chapter 3. Temporally interpolated TP and TDP concentrations were multiplied by measured or estimated discharge to determine TP and TDP flux from the three sources (Equation 11, Chapter 3). The TP and TDP flux from sub watersheds were then regressed with land use areas within the watersheds to determine the proportion of the TP and TDP exported from forested, agriculture, and urban land uses. As hypothesized in Chapter 2, IFSWs were the greatest contributor of TP and TDP into the rivers. This is because agriculture and urban land uses, which are known to have greater P exports, are generally within IFSWs.

5.1 Hydrometric Measurements

The Shuswap and Salmon Rivers were consistent with the regime classification descriptions of the North Columbian Mountain Hydrologic Zone and Fraser Plateau Hydrologic zones in which they lie. The seasonality of the discharge from the Shuswap and Salmon Rivers would be considered normal for their hydrologic zones, because they reached maximum discharge during freshet, and minimum discharge in the fall and winter months (Whitfield and Cannon 2000). The Shuswap River differs from other rivers in the regions, as Mabel Lake attenuates flow of the upper Shuswap River. The Salmon River hydrology is also modified slightly from attenuation as water flows through surficial aquifers near Westwold, BC, just above the 0 km sample site.

The magnitude of seasonal discharge during my study within the Shuswap and Salmon Rivers was atypical, due to the uncommon climatic conditions for the area during the time of the

study. The summer and fall of 2016 received much greater rain than usual, increasing discharge in the rivers by about 2.5 times of mean discharge from 1911 to 2015 (Water Office of Canada 2016-2018). The greater rainfall saturated the soils before the onset of a particularly cold winter, with temperatures being 3°C lower than average (Environment Canada Climate Data 2016-2017). In April 2017, the snow pack within the Shuswap and Salmon River watersheds was below average, between 56-80% (River Forecast Center of BC 2016-2018). Despite the small snowpack, come freshet, the melting snowpack could not infiltrate due to the saturation of the soils in the fall months, creating a flood event. The discharge reached a maximum in June 2017, with discharge being 58% greater than average in the Shuswap River for this period, and 115% greater than average from 1911 to 2015 for the Salmon River.

The flood event was followed by an abnormally dry summer and fall, with the rivers reaching a minimum discharge just shy of the lowest recorded discharge for the area (Water Office of Canada 2016-2018). The discharge trend seen within the Shuswap and Salmon Rivers was similar to that of other rivers in the area, according to other Water Office of Canada hydrometric stations (Adams River, Eagle River, South Thompson River, and Seymour River, Water Office of Canada 2016-2018). All rivers exceeded the mean maximum discharge in spring of 2017 and were near the minimum discharge recorded in the fall of 2017.

5.2 Phosphorous Measurements

The majority of the TP samples from the Shuswap River (93.7%) had a concentration of TP less than 0.035 mg L^{-1}, or within the reference range for TP concertation (0-0.035 mg L^{-1}) defined by Environment Canada (2009) to be indicative of an undisturbed watershed. Background contribution of P in the watershed is very low, and even with anthropogenic activities, concentrations were similar to that of an undisturbed watershed. This contributes to the idea that the Shuswap Watershed is a sensitive watershed, meaning that small P additions could potentially result in proportionally large changes in P concentrations.

The Salmon River had a smaller proportion of TP samples within the concentration reference range of 0.-0.035 mg L^{-1} (15.2%). Water bodies with concentrations of TP above 0.1 mg L^{-1} are considered at risk of eutrophication (Environment Canada 2009). Only one TP sample in the Shuswap River had a concentration above the 0.1 mg L^{-1} threshold, while 33.5% of the TP samples in the Salmon River had a concentration above 0.1 mg L^{-1}. The inherent effects

of high TP concentration vary by region and are greatly dependent of physical factors such as size, hydrology, depth, and flushing rate (Wolf and Klaiber 2017).

Many of the samples above 0.1 mg L^{-1} in the Salmon River were at the 0 km site, and the concentration generally decreased before it reached the outlet into Shuswap Lake. The high concentrations were likely due to P being mobilized from the sediments in which the Salmon River through in the Westwold Aquifer. The TP rich water would be more of a concern if it stayed at greater concentrations as traveled downstream and entered the lake system, but it was diluted to a concentration that is not considered at risk for eutrophication upon entering Shuswap Lake.

The median concentrations of TP and TDP in the Shuswap River are 0.0091 mg L^{-1} and 0.0047 mg L^{-1}, respectively, while the Salmon River had a median TP concentration of 0.0706 mg L^{-1} and a median TDP concentration of 0.0419 mg L^{-1}. The median concentrations for TP and TDP within the Environment Canada P inventory (Environment Canada 2009) were 0.014 mg L^{-1} and 0.005 mg L^{-1}, respectively. Therefore, the median concentration of TP and TDP in the Shuswap River and TP concentration in the Salmon River are less than the survey median, while the median TDP concentration in the Salmon River is greater than the survey median. The lower concentrations found in the Shuswap and Salmon Rivers affirm the idea that despite anthropogenic activities, the background release of P from the watershed is very low. The greater median concentration of TDP in the Salmon is likely due to greater concentration of TDP found in the waters exiting the Westwold aquifer (0 km site, Fig. 35), mobilizing P rich sediments, and increasing the median concentration to a greater value. TDP concentrations downstream generally decreased before reaching the outlet into Shuswap Lake.

The Shuswap and Salmon Rivers have a TDP:TP ratio of 25-50%, placing them in the moderate range according to the Environment Canada Survey (2009). The moderate ratio range indicates that a moderate amount of the P is in the form of TDP which is readily available to plants. The majority of the rivers in the Environment Canada Survey had a moderate TDP:TP ratio, and the TDP:TP ratio in the Shuswap and Salmon Rivers was similar to other rivers across BC and within the region, which had a ratio between 20% and 60% (Environment and Climate Change Canada 2018).

For the Shuswap River, TP and TDP concentrations generally increased downstream, with the greater TP and TDP concentrations seen at the 51 km site. The TP and TDP concentration increasing downstream is similar to that found in Environment Canada's Phosphorous survey, where the majority of the rivers had greater TP and TDP concentrations downstream, as the effects of anthropogenic land use tend to accumulate downstream (Environment Canada 2009).

For the Salmon River, the greatest TP and TDP concentrations were at the 0 km site and decreased downstream. This was inconsistent with the trend of increasing P concentrations downstream in the rivers surveyed by Environment Canada (2009). The decrease in P downstream is likely because the water coming from upstream of the 0 km site has the greatest P concentrations, and all the water gained downstream of the 0 km site had lesser P concentrations, ultimately diluting the river water.

The magnitude of the concentrations of TP and TDP followed the expected seasonal dynamics for the region in the Salmon River, reaching a maximum concentration in spring during freshet, and a minimum concentration in the late fall and winter months. The seasonal trends in magnitude of TP concentrations are similar to the TP trend studied for multiple years in the Columbia River near Revelstoke, BC, which also sits in the Northern Columbian Mountain Hydrologic Zone (Environment Canada 2009). The observed seasonal magnitude of the TP concentration Columbia River as well as the Salmon River is considered typical of a snowmelt hydrological regime, with the maximum TP and TDP concentrations observed in May and June during freshet, and the minimum concentrations observed during the winter months (Whitfield and MacLeod 1996). Concentration of P is expected to increase with discharge, which increases the transport of P into the rivers (Hatch et al 1999).

The trend of increasing TP and TDP concentration during freshet, and lower concentrations of TP and TDP during the fall months exhibited in the Salmon River was absent in the Shuswap River. The lack of dependence of TP and TDP concentration on discharge in the Shuswap River may be attributed to hysteresis, or the response of P concentrations lagging behind a change in discharge. This is visible during freshet when connecting the points from the discharge and concentration graph (Fig. 43A, B). Within the Shuswap River, the ascending limb of the hydrograph tends to have greater concentration of P than on the descending limb. The

increased P concentrations are likely because sediment is more easily mobilized in the first part of freshet and are scoured and less mobile in the later part of freshet as discharge lessens. In addition, the discharge of the river on the descending limb is dominated by Mabel Lake (0 km) inputs, which has low P concentrations. The P concentrations from Mabel Lake are low because Mabel Lake acts as a P sink, reducing the velocity of the flow of the Upper Shuswap and allowing for settlement and uptake of P, ultimately attenuating the signal. Hysteresis can also be attributed to the groundwater inputs that have different concentrations of P compared to the river water, masking the signal, but this is not likely the case in the Shuswap River, as there isn't significant groundwater interaction (Hatch et al. 1999).

The hysteresis is limited to times of freshet though and is not apparent in other parts of the year. The lack of apparent hysteresis and seemingly random distribution of the concentration measurements when discharge is lower is likely storm event driven. A storm event can mobilize P and cause increases in P concentrations in the river. A small storm event could then be followed by a much larger event, but because much of the sediment was already mobilized in the smaller event, it could result in only a very small increase in P concentrations (Wolf 2017). This can create a data series in which the discharge and concentration of P have no correlation but do no seem to show hysteresis either.

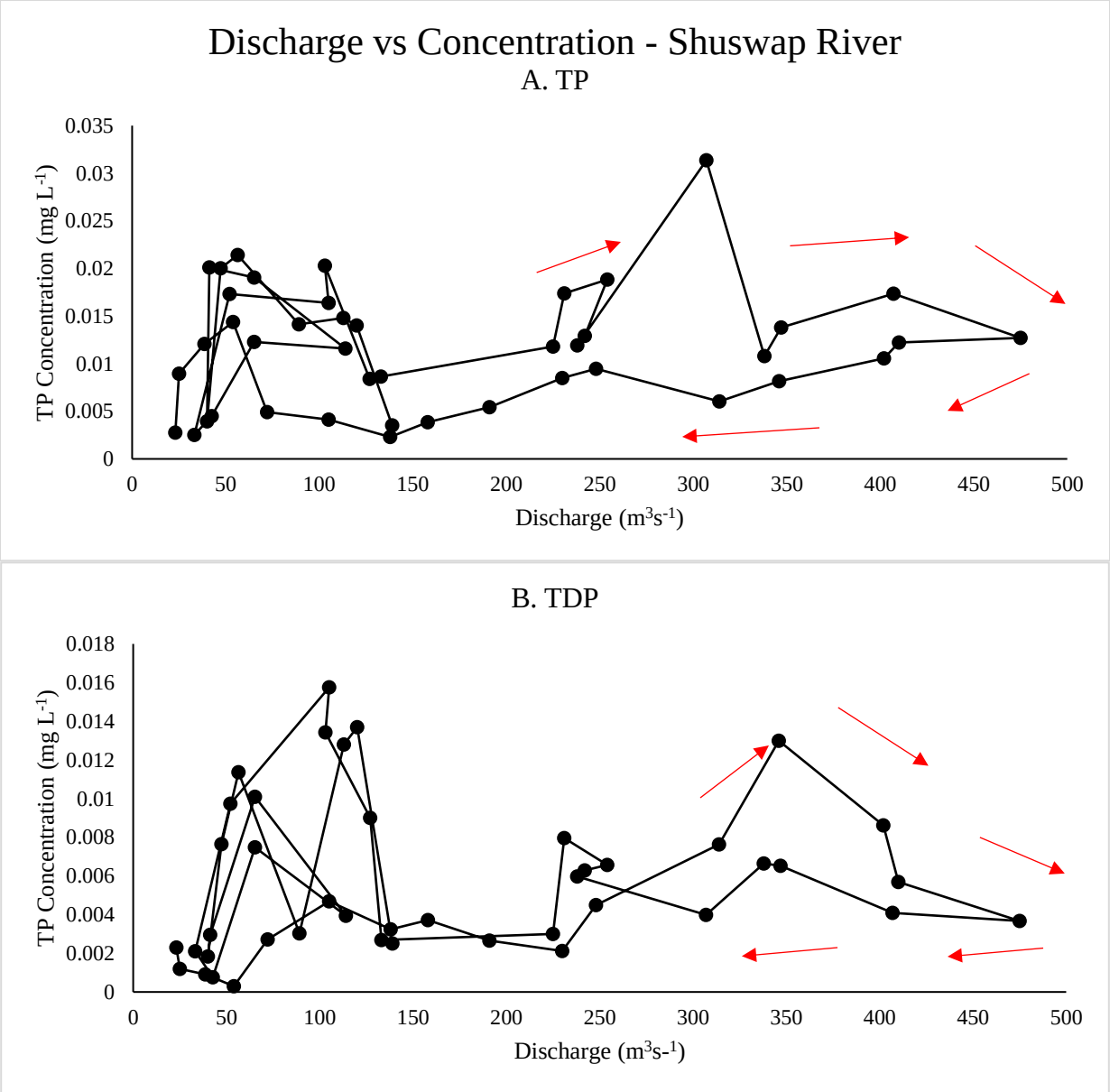

Figure 43*: Discharge vs concentration plots for the Shuswap River. Points are connected to show hysteresis, represented by red arrows.*

5.3 TP and TDP Flux and Yield

Total flux from the Shuswap River was calculated by my study to be between 11,100-72,770 kg y^{-1}, depending on the method used to estimate discharge of unmetered portions of the river and watersheds. My results varied for the Shuswap River when compared to the estimates from the study undertaken by TriStar (2014), which estimated the TP flux of the Shuswap River to be 39,900 kg y^{-1}, approximately the median of the mean annual TP fluxes of the three methods

in my study. The method used by the TriStar study to determine TP flux was the same as the RC method (Chapter 3), except a single concentration value was used for the entire year, whereas my study used measured TP concentrations that changed for each sample date. The lack of changing TP concentration would mean there would be potential for both underestimation and overestimation in certain times of the year. The Tri-Star method also used daily rainfall data paired with export coefficients, and likely did not account for the transport of nutrients via snowmelt, the same issue that is seen within the RC method of my study. This lack of ability to account for storage and transport via snowmelt makes the RC method less suitable for areas like the Salmon and Shuswap, which have a hydrological regime that is driven by snowmelt.

Total TP flux in the Salmon River was measured to be 23,900 kg y^{-1}, and does not change between methods, as total discharge is measured at the outlet into Shuswap Lake (66 km). My results were consistent with the estimates of TP flux from the TriStar 2014 study, which estimated the Salmon River to contribute 22,200 kg y^{-1} TP. When comparing my study and the TriStar study, the annual TP fluxes were similar, differing by about 8%. The predictions of annual TP flux by both studies may be considered large in a year of normal rainfall, as there is a substantial loss of P through the exchange of groundwater, which the RC method cannot account for. Without this loss, the method would likely overestimate the TP flux by a large amount. The seasonal magnitude of TP, as well as an estimation for TDP flux was not included within the study (TriStar 2014).

Contribution of TP from undisturbed forested land in the Shuswap and Salmon River watersheds was calculated to have an export yield of 0.035 kg $ha^{-1}y^{-1}$ TP. A typical TP yield for undisturbed forested watersheds ranges from 0.03-0.07 kg $ha^{-1}y^{-1}$ (Drewry et al. 2006). The TP yield from the undisturbed forested lands in the Shuswap and Salmon River watersheds is near the lesser end of the range from literature. The undisturbed portions of the two watersheds thus only contributes about 10% of the total TP to the Shuswap and Salmon Rivers, which can be considered the background P export.

The small background P export can be attributed to geology and climate. First, the geology plays a significant role, as the watershed is mostly comprised of crystalline bedrock from igneous origins. It has been shown in previous studies that igneous watersheds release about half the amount of phosphorous as sedimentary bedrock. Sedimentary rock not only has

greater P content but is more easily eroded (Dillon and Kirchner 1974). Second, the climate in the watersheds doesn't make the area susceptible to P transport via overland flow. Large rainfall events that lead to large runoff events are uncommon, as the watersheds receives small amounts of rainfall, as the dominant form of precipitation is snowfall. The majority of P transport happens when the snow melts, which is contained in one period of the year, and a large portion of the snowmelt will typically infiltrate due to the low soil moisture from the preceding summer and fall months.

The small background export of P is what makes the Shuswap and Salmon Rivers a sensitive system. The small background release of P results in low TP and TDP concentrations in the rivers and ultimately the lakes. The low concentrations, in turn, make the river sensitive to small additions of P. This returns to the idea introduced in Fig.1, that increases in P can lead to proportional increases in chlorophyll *a*. Chlorophyll *a* is the pigment found within in algae and the main driver in the reduction of water clarity in rates. Chlorophyll *a* and water clarity, as measure by a Secchi disk, have an inverse log-linear relationship, with clarity being reduced with increases in chlorophyll *a*. Water clarity is one of the most common measures of water quality related to eutrophication, and an acceptable level of degradation should be determined to use for management purposes.

My regression used to estimate annual TP export from urban and agricultural land uses (Chapter 4) estimated TP export from agriculture land use to be 13.5 kg $ha^{-1}y^{-1}$, and urban land use TP export to be 3.83 kg $ha^{-1}y^{-1}$. The yield range for agriculture land use is dependent on agriculture type but is usually within the range of 0.5-15.6 kg $ha^{-1}y^{-1}$ (Reckhow et al., 1980; Johnes, 1996; Worrall & Burt, 1999; Bernald et al., 2003). My estimates for agriculture TP export were on the upper end of the range, which may be due to the large part of the land classified as agriculture being used for livestock production, which typically contributes greater amounts of phosphorous than other forms of agriculture such as growing crops (ibid.). Urban land use also varies by type, with a typical TP export range of 0.5-20.8 kg $ha^{-1}y^{-1}$ (ibid.). My estimates were on the lower end of the TP export range, likely due to the non-intensive urban land use in the area. Most of the land use classified as urban is small towns where the majority of housing is in the form of single-family dwellings, which do not have large impermeable areas.

The TDP flux and TDP export yields are not usually calculated in most studies. Instead, TDP is measured as a proportion of TP and the ratio is applied to the flux and yield values. Therefore, TPD average flux and yield values are dependent on the TDP:TP ratio within individual watersheds, which in our case ranges from 25-50%. The TDP:TP ratio is similar to rivers within the region (20-60%, Environment Canada 2009).

Neither the urban or agriculture land uses export abnormally large amounts of TP or TDP to the rivers. This indicates that management in the system is on par with other rivers with acceptable water quality. This again returns to the idea that the algae blooms of 2008 and 2010 were because the rivers have low background and are sensitive to even small addition of P. Management practices that are were considered successful in similar watersheds may need to be adapted to retain more P in the Shuswap and Salmon River watersheds in order to reduce P loadings to a level that is considered acceptable in these sensitive rivers.

The low P export of the Shuswap and Salmon Rivers is affirmed when looking at the total watershed TP yield (background and anthropogenic land use), which is less than the average from literature. Watershed TP yield was 0.11 kg $ha^{-1}y^{-1}$ for the Shuswap River and 0.236 kg $ha^{-1}y^{-1}$ for the Salmon River. When the TP yield is compared to the mean TP yield of 35 rivers throughout Canada (Environment Canada 2009), the mean yields for the Shuswap and Salmon Rivers were in the lower quartile (25th, Fig. 44). The mean TP yields estimated by my study for the Shuswap and Salmon Rivers were 10 and 20 times less than the mean TP yield for 35 rivers throughout Canada, respectively. The small watershed TP yield is due to the large percentage of the land being forested (86%), which can be considered the background TP yield, and is very small (0.035 kg $ha^{-1}y^{-1}$)

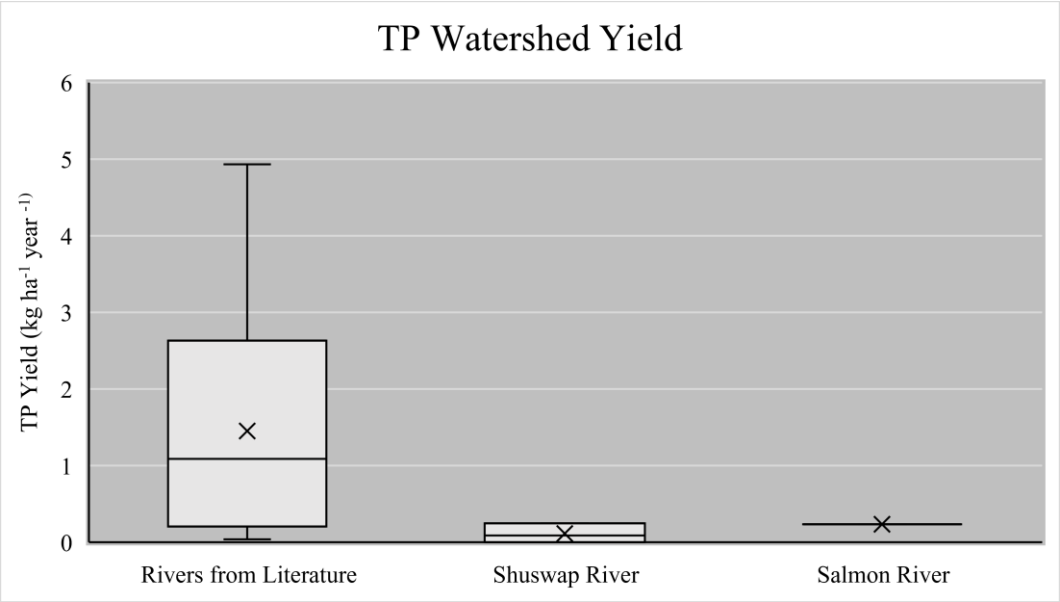

Figure 44: *TP watershed of the Shuswap and Salmon Rivers as compared to 35 rivers from literature*

5.4 Comparison of Discharge and Flux Results to Years with Mean Discharge

The percent difference between the measured discharge of the study period and mean discharge at the hydrometric stations along the rivers was applied to the surrounding tributaries and all unmetered sites including IFSW to correct discharge to what would be considered a mean year. Despite the abnormal seasonal magnitude in discharge during the time of the study, the annual discharge was similar to mean discharge in the two rivers. The measured annual discharge for the sample period in the Shuswap River was 7.5% less than the mean annual discharge, and 7% more than the mean annual discharge in the Salmon River. The 7-7.5% differences in discharge can then been applied to calculated TP and TDP flux for each source in a mean discharge year, though 7 % would be considered a small difference.

For the Salmon River, mean annual TP and TDP flux can be estimated using the relationship between discharge and concentration. Using the relationship defined in Figure 36 with the mean daily discharge, the Salmon River was estimated to have similar flux to a year with mean discharge, with TP flux being 41% greater and TDP flux being 9% less. This

indicates, that once again, even with the uncharacteristic weather, the annual flux was likely similar to an average year.

The relationship between discharge and TP and TDP concentration was absent in the Shuswap River (Fig. 20), and therefore cannot be used to estimate flux in a mean discharge year. The absence of the discharge and concertation relationship in the Shuswap River allows for estimation of TP and TDP flux using an average concentration for the year and daily discharge. This results in an estimate for the TP flux that 1.5 greater than the mean calculated TP flux from my study, and a TDP flux 1.2 times greater.

The similar annual export of P in years of mean discharge might be in spite of the abnormal weather, and not despite of it. The fall of 2016 had large amounts of rainfall which mobilized large amounts of sediments, preceding the flood event of 2017. This may have lessened the magnitude of the P flux during flooding, as much of the manure spread in the fall after crop harvest, was mobilized with the rain events in the fall rather than in spring runoff. Because of the high P flux in fall of 2016 and spring of 2017, much of the easily transported P was scoured from the land, reducing easy mobilization for the remainder of the study (from spring of 2017 on), possibly reducing the annual P flux so it was similar to an average year.

5.5 Measurable Uncertainties

5.5.1 Uncertainties in Hydrometric Measurements

The hydrometric measurements of discharge from the Water Office of Canada are held to high standard of quality and are said to have negligible levels of uncertainty. For discharge, the gauging of discharge within tributaries would be the only quantifiable uncertainty.

The uncertainty within tributary gauging exists in two forms; measurement uncertainty and natural uncertainty. First, measurement uncertainty can be related to the physical measurement of stage height and discharge. Stage height measurement errors are very small, and usually can be concerned negligible. Errors are typically related to the measurement of discharge using flows meters and are random and instrumental errors. Second, natural uncertainty exists within any natural stream system. Natural uncertainty is related to changes in channel conditions and unsteady channel flow. Both can be difficult to recognize or account for.

Uncertainties within tributary discharge can be quantified by confidence limits of the rating curves. In my data set, the average confidence limit for a tributary rating curve was 9%. This means that discharge can differ by up to 9% than what is estimated by the curve, ultimately changing the P flux from tributaries by up to 9%.

5.5.1 Uncertainties in P Measurements

Uncertainties also exist in the measurement of P within the lab. Human error in collection, storage, and general care of water samples exist, but is not quantifiable. For the determination of P, the only quantifiable source of error would be instrumental error. Calibration curves, replication, and other control factors can work to reduce these errors, yet spectrophotometers have been shown to have an instrumental error of between 1-2% in previous studies (Lommer 1989).

When combined, the quantifiable uncertainties come out to about 10% for the entire study. This means that independent of the method used, the results for discharge and P flux can be 10% greater or lesser than the results given. The remaining uncertainty is related to the method used to quantify discharge from IFSW and upper reaches, and is difficult, if not impossible, to quantify, and only strengths and weaknesses of each can be assessed.

5.6 Method Strengths and Weaknesses

5.6.1 Extrapolation Method

The extrapolation method is the simplest method to estimate discharge from ungauged sites such as IFSW. The mean discharge yield is taken from the surrounding tributaries and applies the yield to the IFSW. For the unmetered portions of the river, mass balance techniques are then used to estimate discharge, subtracting or adding IFSW and tributary discharge from measured discharge from a Water Office of Canada hydrometric site. This method only requires monitoring of the tributaries and doesn’t require extensive knowledge of the watershed. To get seasonal dynamics, a small time step would be needed to observe discharge changes, which can be limiting or inaccurate without the use of some sort of continuous monitoring system. It also assumes that IFSW discharge yield is the same as the tributary discharge yield, yet IFSW typically sit at lower elevations and have different land uses, changing runoff and infiltration rates, which likely results in an overestimation of discharge by the extrapolation method. In addition, extrapolation can not capture the amount of water being contributed by groundwater,

and thus likely underestimates discharge in rivers like the Salmon Rivers, where groundwater plays a significant role.

The extrapolation method is commonly used by the United States Geological Survey (USGS) to estimate discharge in ungauged areas (Templin et al 1980). The method has also been successfully applied in numerous studies, including one by Gong (2014) used to estimate sub watershed discharge that flows into the Baltic Sea. Using measured discharge from just 5% of the watershed, discharge was successfully estimated in ungauged regions of the watershed with an error of as small as 6% (Gong 2014). The watershed had a relatively homogenous landscape compared to the Shuswap and Salmon Rivers, which likely played into the success of the technique for the when applied to the watersheds within the studies (ibid.).

5.6.2 RC Method

The RC method uses runoff coefficients from literature to estimate the contribution of discharge from ungauged areas based on land use type. The method could be performed without the monitoring of any part of the watershed for discharge, with just the knowledge of land use areas within the watershed. The method uses precipitation data, and without an extensive monitoring network, it can assume the same precipitation across large portions of the watershed. In my study, the precipitation data was taken from a low elevation site which receives less precipitation than other areas, resulting in discharge estimates of IFSW that are likely smaller than actual discharge. The method also uses total precipitation and does not have a way to estimate snow accumulation and melt rates, which can alter the timing of runoff from precipitation events reaching the surrounding water body. Timing of runoff is further altered by the assumption of a transit time of one day, but this can be increased by smoothing discharge estimates using an average of a specified amount of time that correlates with real life transit time. Just as the extrapolation method, groundwater is not able to be accounted for as a separate source and assumes all discharge contribution is from surface waters.

The RC method was originally developed with the purpose of estimating runoff from small urban watersheds. The method was not intended to be used in areas over 50 acres, but has been applied successfully on larger scales, particularly in areas that don’t experience large amounts of rainfall (Pilgrim and Cordery 1993), such as the Shuswap and Salmon Rivers. Overall, it is one of the most commonly used methods in runoff prediction due to its simplicity

and effectiveness (Grimaldi and Petroselli 2015). This was the method used in the TriStar estimates of TP flux (TriStar 2014). The RC method predictions from TriStar 2014 of TP flux differed greatly in the Shuswap River, and produced similar results in the Salmon River.

5.6.3 Geochemical Method

The geochemical method uses end-member mixing analysis (EMMA) which uses changes in chemical signatures between end-members to determine the relative proportions of the end-members in mixed waters. The method can calculate the exchange of groundwater, which is essential in Salmon River, and can estimate flows at ungauged sites independent of the IFSW and tributaries measurements used in mass balance techniques. In my study, this approach was also the most robust, as it used the average of the results of seven different models (5 element models, CDOM and nitrate), which typically produced similar estimates (Appendix E).

This method is likely the most affected by storm events, which is apparent in Figure 26C, where discharge from IFSW is estimated to be 400 m^3s^{-1} during the peak of freshet. Sampling occurred following a rain on snow event, which created high discharge. There was little difference in the concentration of tracers between end-members in this estimation, which created what is believed to be an overestimation in discharge. This also speaks to how sampling can create a snapshot, and continuous monitoring during freshet would allow for better estimates.

The method also can overestimate inputs from IFSW, as it calculates irrigation returns, which originate from the river, as IFSW discharge. Irrigation returns are not counted as part of IFSW in other methods, as they assume IFSW contributions are only from runoff. The method can also sometimes produce negative proportions and proportions that exceed 100% of the total if concentrations of geochemical tracers are not distinct between end-members (Kendall and McDonnell 1998).

Overall, geochemical methods using EMMA are one of the more commonly used techniques to quantify discharge contribution (Kendall and McDonnell 1998) from different water sources and can be used in watersheds of varying types and sizes, so long as there is a distinct difference in concentration between end-members. An example of successful application in varying watershed types was exhibited in James and Roulet 2006, which used the model to successfully predict groundwater discharge inputs in eight unique catchments.

5.7 Use of Novel Tracers in EMMA

If a conservative geochemical tracer, including CDOM and nitrate, had distinct concentrations between end-members and reaction time was less than residence time, EMMA could be applied successfully (James and Roulet 2006). I found that the majority of the time, CDOM and nitrate produced estimates that were not significantly different from the results of the element tracers (Appendix E). Both CDOM and nitrate can be measured in-situ and near continuously, which could create near continuous estimates of discharge characteristics in the rivers. CDOM, which is more easily measured than nitrate, can be monitored using low-cost optical sensors. Sensors could be placed at upstream and downstream sites in the mainstem of the rivers, and averages from the tributaries and IFSW could be used in EMMA for discharge estimates. This would be an alternative to sampling to determine discharge estimates along the rivers.

6 Conclusion

6.1 Significance

Quantifying phosphorous (P) sources within the watershed is important for managing water quality in the Shuswap and Salmon Rivers. P loadings were estimated for tributary sub-watersheds, upper reaches, and incremental flow sub-watersheds (IFSW), and P export coefficients were estimated for forested, urban and agriculture land uses within the watershed. The P loading estimates showed that IFSWs had the greatest P contribution into the rivers (Tables 6,7,10,11). The large P loadings from IFSWs was due to the anthropogenic activities, such as urban and agriculture land uses, that take place in IFSW.

The Shuswap and Salmon rivers can be considered sensitive to changes in P loading, because TP and TDP concentrations are very low, and small additions of P can cause large proportional changes. The log-log relationship between P and chlorophyll *a* (Fig. 1) means that increased loadings of P will result in an increase of chlorophyll *a*, and thus a decrease in water clarity (Rast and Lee 1978). Because background inputs of P are small and make up only 10% of the total P loadings, small increases in P will result in large proportional changes. Anthropogenic activities account for around 90% of total P loadings, as found in the land use export regression, increasing background loadings by almost nine times. The nine times increase in P loadings thus results in 9 times increase in chlorophyll *a*, and nine times decrease in transparency. For management purposes, it must be determined what an acceptable level of degradation in transparency is acceptable, thus determining the limits of for P loads.

6.2 Management

The understanding of the quantity of P being contributed into the Shuswap and Salmon Rivers by individual sources can be used to inform management decisions that work towards the reduction of P loadings. Because the study concluded IFSWs with anthropogenic land uses are the largest contributor of P, mitigation efforts would be most effective there. The possible mitigation efforts should focus on reduction of P rich waters entering the rivers from agriculture and urban runoff.

Remediation of anthropogenic P loading can be achieved using best management practices (BMPs). There are four BMPs that could possibly be effective in reducing P loadings in

the Shuswap and Salmon River watersheds; riparian wetlands, changing irrigation practice, wastewater treatment, and manure management.

First, runoff having high P concentrations could be directed through riparian wetlands to allow for P reduction before entering the surrounding water bodies. This has been shown to reduce P concentration by up to 93% under ideal conditions (Hoffman et al 2009). Ideal conditions would mean that residence time was long enough to allow for settlement and uptake of P, and the weather was appropriate to sustain plant growth.

Riparian wetlands would likely be effective in the Shuswap and Salmon Rivers, as the majority of the P enters the rivers during freshet. Riparian wetlands would not only slow these waters, allowing for settlement and uptake of P, but could also act as storage for flood waters, potentially reducing discharge in rivers and tributaries, thus reducing erosion and P transport via erosion. In years of large-scale flood events during freshet, riparian wetlands could potentially release P rich sediment. The flood waters could mobilize the P rich sediment, transporting it into the water body. Care would need to be taken to design the wetlands to handle flooding. Riparian wetlands in the study areas will also not be effective in the winter months, as the soils freeze from mid-November to mid-March, hindering plant growth, and therefore P uptake by the plants (Hoffman et al 2009). This should not be an issue though, as there is little to runoff during this time in the Shuswap and Salmon River watersheds, and therefore little to no transport of P into the rivers.

Second, changing irrigation techniques to use water from IFSW rather than the river would be effective in intercepting nutrient rich waters. Intercepting these waters for irrigation would capture P rich runoff before it reaches the river, allowing for uptake by crops. Because the water is rich in nutrients, it could also mean a reduction in need for fertilizer, as well a reduction of P entering the river system. This technique can reduce P concentration by about 55-90% (Hoffman et al 2009). Because the period of large amount of run off coincides with low irrigation rates in the Shuswap and Salmon Rivers, this method may not be very effective. Most of the P enters the rivers during freshet, when the ground is typically saturated and does not need additional irrigation. Irrigation in the region typically occurs in the summer and fall months, when discharge from runoff is small, thus limiting the irrigation from IFSW to groundwater. Groundwater carries less P in the particulate form than runoff, therefore effectiveness would be

limited to plant uptake of dissolved forms of P. Effectiveness could increase if P rich runoff could be collected and stored until needed for irrigation but may require infrastructure that would not be economically feasible in the area.

Third, tertiary treatment could be added to the Enderby waste water treatment plant (WWTP). The impact of this would be nominal, as the WWTP only contributes 2,040 kg y^{-1} TP annually, less than 1% of the of total TP flux (TriStar 2014). Similarly, septic tanks within the watersheds likely contribute less than 1% of the total TP (426 kg y^{-1}, ibid.). Therefore, even if all the septic tanks in the Shuswap and Salmon River Valleys and the Enderby WWTP were treated through tertiary treatment with the greatest efficiency (90-95%, Hoffman et al 2009), the reduction of P would be less than 2% of the overall flux into the Shuswap and Salmon Rivers.

Finally, livestock manure management would focus on nutrient recovery in areas were manure nutrients exceed crop requirements. Nutrient recovery technologies (NRTs) include systems such as centrifuges, membranes, flocculation and other processes to reduce P and N from manure (Mesinger and Jokela 200). NRTs would work towards matching nutrient land application rates with crop nutrient requirements. Many NRTs are in development, and retention and recovery rates have not been widely studied (ibid.) NRTs vary in cost and capabilities, which may not make them economically feasible for areas in the Shuswap and Salmon Rivers.

Moreover, knowledge gained from this study can be used to estimate loadings into the Shuswap and Salmon River in future years using export coefficients and discharge concentration correlation (Salmon River only). P export coefficients can predict the amount of TP and TDP that will be transported into the rivers annually based on land use densities. The coefficients can also be applied to other watersheds within the greater Shuswap and Mara Lake watershed to estimate total loadings without direct estimates. For the Salmon River, loadings can also be estimated using the discharge and concentration correlation to estimate total loadings using the measured discharge from the Water Office of Canada hydrometric station at 66 km. The coefficients and discharge correlation will be valuable in estimating loadings without the use of field measurements.

6.3 Further Research

If my research were to continue on the Shuswap and Salmon Rivers, I would simplify it and use only the geochemical method in the estimates of discharge. The geochemical method

had the most robust approach, using the results from seven individual models of EMMA. Compared to the extrapolation and RC methods, it can estimate inflows from groundwater, and does not rely on precipitation or tributary data to estimate flow from IFSW or upper reaches. Continuous estimates without field sampling could be achieved by using optical sensors to measure colored dissolved organic matter (CDOM) in situ along the river. These sensors could be placed periodically along the mainstem of the rivers and EMMA could be used in conjunction with CDOM values of IFSW and tributaries to determine the flow characteristics in the area. More continuous estimates would be useful to reduce interpolation between sample dates, which adds a large amount of uncertainty to the data, especially during times of greater discharge.

I would also recommend to establish an estimate of the historical background levels of P by examining sediment cores in Shuswap or Mara Lake. Background levels can be estimated by examining the P content in different sediment layers, as well as determining relative abundance of plankton based on fossils within the sediment profile. Knowing historical levels would allow for a better idea of what the actual background or natural P levels were in the watershed, and how they have changed with increase of anthropogenic activities in the area. This is important to establish how sensitive the system is and determine what is acceptable in terms of P loadings.

Bibliography

Bruland, K. W., Lohan, M.C., Aguilar-Islas, A.M., Smith, G.J., Sohst, B., and Baptista, A**.** "Factors Influencing the Chemistry of the Near-Field Columbia River Plume: Nitrate, Silicic Acid, Dissolved Fe, and Dissolved Mn." *Journal of Geophysical Research - Oceans*, vol. 113.

Bernal, S., A. Butturini, E. Nin, F. Sabater, and S. Sabater. 2003. Leaf litter dynamics and nitrous oxide emission in a Mediterranean riparian forest: Implications for soil nitrogen dynamics. Journal of Environmental Quality 32:191-197.

Buda, A. R., Klienman, P.J.A., Srinivasan, M.S., Bryant, R.B., and Feyereisen, G.W. "Effects of Hydrology and Field Management on Phosphorus Transport in Surface Runoff." *Journal of Environmental Quality*, vol. 38, no. 6, 2009, pp. 2273-2284.

Chen, H., Yanguo T., and Jinsheng W. "Load Estimation and Source Apportionment of Nonpoint Source Nitrogen and Phosphorus Based on Integrated Application of SLURP Model, ECM, and RUSLE: A Case Study in the Jinjiang River, China." *Environmental Monitoring and Assessment*, vol. 185, no. 2, 2013, pp. 2009-2021.

Chen, Z., Doering, P.H., Ashton, M., and Orlando, B.A. "Mixing Behavior of Colored Dissolved Organic Matter and its Potential Ecological Implication in the Caloosahatchee River Estuary, Florida." *Estuaries and Coasts*, vol. 38, no. 5, 2014, pp. 1706-1718.

Delkash, M., Al-Faraj, F.A.M., and Scholz, M.. "Comparing the Export Coefficient Approach with the Soil and Water Assessment Tool to Predict Phosphorous Pollution: The Kan Watershed Case Study." *Water, Air, & Soil Pollution*, vol. 225, no. 10, 2014a, pp. 1-17.

Dillon, P. J., and Kirchner, W. B. "The Effects of Geology and Land use on the Export of Phosphorus from Watersheds." *Water Research*, vol. 9, no. 2, 1975a, pp. 135-148.

Dupas, R., Delmas, M., Dorioz, J., Garnier, J., Moatar, F., and Gascuel-Odoux, C. "Assessing the Impact of Agricultural Pressures on N and P Loads and Eutrophication Risk." *Ecological Indicators*, vol. 48, 2015, pp. 396-407.

Drewry, J. J., Newham, L. T. H., Greene, R. S. B., Jakeman, A. J., & Croke, B. F. W. (2006). A review of nitrogen and phosphorus export to waterways: context for catchment modelling. *Marine and Freshwater Research*, *57*(8), 757-774. DOI: 10.1071/MF05166

Eberts, S.M., Thomas, M.A., and Jagucki, M.L., 2013, The quality of our Nation's waters—Factors affecting public-supply-well vulnerability to contamination—Understanding observed water quality and anticipating future water quality: U.S. Geological Survey Circular 1385, 120 p.

Environnement Canada. 2009. Canadian Environmental Sustainability Indicators - Annual Report. Ottawa. ON. Accessed on June 21, 2010. www.ec.gc.ca/indicateurs-indicators.

Fogg, D. N., and Wilkinson, N. T. "The Colorimetric Determination of Phosphorus." *The Analyst*, vol. 83, no. 988, 1958, pp. 406,

Gong, L. "Data-driven scale extrapolation: estimating yearly discharge for a large region by small sub-basins." *Hydrology and Earth System Sciences*, vol. 18, 2014, doi: 10.5194/hess-18-343-2014

Harris, N.M., Gurnell, A.M., Hannah, D.M., and Petts, G.E. "Classification of River Regimes: A Context for Hydroecology." *Hydrological Processes*, vol. 14, no. 16-17, 2000, pp. 2831-2848.

Havens, K.E, & Nürnberg, G.K The Phosphorus-Chlorophyll Relationship in Lakes: Potential Influences of Color and Mixing Regime, Lake and Reservoir Management, 20:3, 188-196, 2004 .

Hoffmann, C.C., Kjaergaard, C., Uusi-Kamppa, J., Hansen, H.C.B., and Kronvang, B**.** "Phosphorus Retention in Riparian Buffers: Review of their Efficiency." *Journal of Environmental Quality*, vol. 38, no. 5, 2009, pp. 1942-1955.

James, April L. "Investigating the Applicability of End-Member Mixing Analysis (EMMA) Across Scale: A Study of Eight Small, Nested Catchments in a Temperate Forested Watershed." *Water Resources Research*, vol. 42, no. 8, 08/2006, doi:10.1029/2005WR004419

Johnes, P. J. "Evaluation and Management of the Impact of Land use Change on the Nitrogen and Phosphorus Load Delivered to Surface Waters: The Export Coefficient Modelling Approach." *Journal of Hydrology*, vol. 183, no. 3, 1996, pp. 323-349.

Jihoon, K., Hesterberg, D., and Osmond, D.L., "Soil Organic Matter Effects on Phosphorus Sorption: A Path Analysis." *Soil Science Society of America Journal*, vol. 73, no. 2, 2009, pp. 360

Kelln, B., Lardner, H., Schoenau, J., and King, T. "Effects of Beef Cow Winter Feeding Systems, Pen Manure and Compost on Soil Nitrogen and Phosphorous Amounts and Distribution, Soil Density, and Crop Biomass." *Nutrient Cycling in Agroecosystems*, vol. 92, no. 2, 2012, pp. 183-194.

Kendall, C., and McDonnell, J.J. *Isotope Tracers in Catchment Hydrology.* Elsevier Science, Amsterdam, 1999.

Kowalenko, C.G., Schmidt, O., Kenney, E., Nielsen D., and Poon, D. 2009. Okanagan Agricultural Soil Study (2007). B.C. Ministry of Agriculture. www.agf.gov.bc.ca/resmgmt/EnviroFarmPlanning/OK_AgricSoilStudy2007/Okanagan_Soil

Kozlov, George. *Road Surface Drainage Design, Construction And Maintenance Guide for Pavements* Division of Research and Development, New Jersey Dept. of Transportation, 1981.

Kronvang, B.,Bechmann, M., Lundekvam, H., Behrendt, H., Rubaek, G.H., Schoumans, O.F., Syversen, N., Andersen, H.E. and Hoffmann, C.C. "Phosphorus Losses from Agricultural Areas in River Basins: Effects and Uncertainties of Targeted Mitigation Measures." *Journal of Environmental Quality*, vol. 34, no. 6, 2005, pp. 2129-2144.

Lin, J.P. *Review of Published Export Coefficient and Event Mean Concentration (EMC) Data.* Wetland Regulatory Assistance Program, 2004.

Maguire, R.O., Rubaek, G.H., Haggard, B.E., and Foy, B.H. "Critical Evaluation of the Implementation of Mitigation Options for Phosphorus from Field to Catchment Scales." *Journal of Environmental Quality*, vol. 38, no. 5, 2009, pp. 1989-1997

Meals, D.W., Dressing, S.A., and Davenport, T.E. "Lag Time in Water Quality Response to Best Management Practices: A Review." *Journal of Environmental Quality*, vol. 39, no. 1, 2009, pp. 85-96

Meisinger, J., and Jokela, W. (2000). Ammonia volatilization from dairy and poultry manure. Managing Nutrients and Pathogens from Animal Agriculture. 28–30 March: p. 334–354.

Miranda, K.M., Espey, M.G. and Wink, D.A. "A Rapid, Simple Spectrophotometric Method for Simultaneous Detection of Nitrate and Nitrite." *Nitric Oxide*, vol. 5, no. 1, 2001a, pp. 62-71

Mockler, E.M., O'Loughlin, F., and Bruen, M. "Understanding Hydrological Flow Paths in Conceptual Catchment Models using Uncertainty and Sensitivity Analysis.", May 2016.

Murphy, J., and Riley, J.P. "A Modified Single Solution Method for the Determination of Phosphate in Natural Waters." *Analytical Chemical Acta*, vol. 27, 1962, pp. 31-36.

Nam, S., Krasner, S.W., and. Amy, G.L. *Differentiating Effluent Organic Matter (EfOM) from Natural Organic Matter (NOM Impact of EfOM on Drinking Water Sources.* 2008.

Nellesen, S., Kovar, J., Hann, M. and Russel, J."Grazing Management Effects on Stream Bank Erosion and Phosphorus Delivery to a Pasture Stream."*Canadian Journal of Soil Science*, vol. 91, no. 3, 2011, pp. 385-395,

Paces, T. "Mass-Balance Approach to the Understanding of Geochemical Processes in Aqueous Systems." *Mass-balance Studies in Aqueous Systems*. Pague, Czechoslovakia: Geological Survey, 1972. 223-35.

Pilgrim, D.H. and Cordery, I., 1993. Flood runoff. In: D.R. Maidment, ed. Handbook of hydrology. New York: McGraw-Hill, 9.1–9.42.

Kleinman, P.J.A., Allen, A.L., Needelman, B.A., Sharpley, A.N., Vadas, P.A. Saporito, L.S., Folmar, G.J., and Bryant, R.B. "Dynamics of Phosphorus Transfers from Heavily Manured Coastal Plain Soils to Drainage Ditches." *Journal of Soil and Water Conservation*, vol. 62, no. 4, 2007, pp. 225

Rahman, K., Besacier-Monbertrand, A., Castella, E., Lods-Crozet, B., Ilg, G., and Beguin, O. "Quantification of the Daily Dynamics of Streamflow Components in a Small Alpine Watershed in Switzerland using End Member Mixing Analysis." *Environmental Earth Sciences*, vol. 74, no. 6, 2015, pp. 4927-4937

Rast, W. and G. F. Lee. 1978. Summary analysis of the North American (US Portion) OECD eutrophication project: nutrient loading-lake response relationships and trophic state indices., EPA 600/3-78-008, US EPA, Corvallis, OR.

Reche, I., Pace,M.L., and Cole, J.J.. "Modeled Effects of Dissolved Organic Carbon and Solar Spectra on Photobleaching in Lake Ecosystems." *Ecosystems*, vol. 3, no. 5, 2000, pp. 419-432.\

Reckhow, K.H., M.N. Beaulac, and J.T. Simpson. 1980. Modeling Phosphorus Loading and Lake Response under Uncertainty: A Manual and Compilation of Export Coefficients, Eat Lansing, Michigan, Michigan State University.

Retamal, L., Vincent, W.F., Martineau, C., and Osburn, C.L. "Comparison of the Optical Properties of Dissolved Organic Matter in Two River-Influenced Coastal Regions of the Canadian Arctic." *Estuarine, Coastal and Shelf Science*, vol. 72, no. 1, 2007, pp. 261-272.

Salvatore Grimaldi & Andrea Petroselli (2015) Do we still need the Rational Formula? An alternative empirical procedure for peak discharge estimation in small and ungauged basins, Hydrological Sciences Journal, 60:1, 67-77, DOI: 10.1080/02626667.2014.880546

Sharpley, A., Daniel, T., Gibson, G., Bundy, L., Cabrera, M., Sims, T., Stevens, R., Lemunyon, J., and Kleinman, P. "Best Management Practices to Minimize Agricultural Phosphorus Impacts on Water Quality. U.S. Department of Agriculture Agricultural Research Service" *U.S. Department of Agriculture Agricultural Research Service*, no. ARS-163, 2006,

Sharpley, A., Herron, S. and Daniel, T. "Overcoming the Challenges of Phosphorus-Based Management in Poultry Farming." *Journal of Soil and Water Conservation*, vol. 62, no. 6, 2007, pp. 375

Sharpley, A., and Withers P.. "The Environmentally-Sound Management of Agricultural Phosphorus." *Fertilizer Research*, vol. 39, no. 2, 1994, pp. 133-146..

Shaw, R. D., Trimbee, A.M., Minty, A., Fricker, H., and Prepas, E.E. "Atmospheric Deposition of Phosphorus and Nitrogen in Central Alberta with Emphasis on Narrow Lake." *Water Air and Soil Pollution*, vol. 43, no. 1-2, 1989, pp. 119-134.

Sims, J. T., Simard, R. R., and Joern, B. C. "Phosphorus Loss in Agricultural Drainage: Historical Perspective and Current Research." *Journal of Environment Quality*, vol. 27, no. 2, 1998, pp. 277.

Stedmon, C. A., and Markager, S. "Behaviour of the Optical Properties of Coloured Dissolved Organic Matter Under Conservative Mixing." *Estuarine, Coastal and Shelf Science*, vol. 57, no. 5-6, 8, pp. 979; 979.

Stedmon, C.A., Osburn, C.L. and Kragh, T. *Tracing Water Mass Mixing in the Baltic–North Sea Transition Zone using the Optical Properties of Coloured Dissolved Organic Matter.* vol. 87,2010,

Tesoriero, A. J. "Identifying Pathways and Processes Affecting Nitrate and Orthophosphate Inputs to Streams in Agricultural Watersheds." *Journal of Environmental Quality*, vol. 38, 2009, pp. 1892-1900.

Templin, William & Herbert, R.A. & Stalnaker, C.B. & Horn, M & W.B. Solley, and. (1980). Water Use Chapter 11 of National Handbook of Recommended Methods for Water Data Acquisition.

Tiessen, K., Elliot, J., Staintion, M., Yarotski, J., Flaten, D., and Lobb, D. "The Effectiveness of Smallscale Headwater Storage Dams and Reservoirs on Stream Water Quality in the Canadian Prairies." *Jouranl of Soil and Water Conservation*, vol. 66, no. 3, 2011, pp. 158-171.

Tipping, E., Benham, S., Boyle, J.F., and Crow, P. "Atmospheric Deposition of Phosphorus to Land and Freshwater." *Environmental Science--Processes & Impacts*, vol. 16, no. 7, 2014, pp. 1608-1617.

Tri-Star Environmental Consulting. 2014. SLIPP Water Quality Report: Sources of Nutrients 2014. Prepared for the Shuswap Lake Integrated Planning Process and Fraser Basin Council. 31 March 2014

Tong, S.T.Y., and Chen, W. "Modeling the Relationship between Land use and Surface Water Quality." *Journal of Environmental Management*, vol. 66, no. 4, 2002, pp. 377-393.

Wolf, D., and Klaiber, H.A. "Bloom and Bust: Toxic Algae's Impact on Nearby Property Values." *Ecological Economics*, vol. 135, 5, pp. 209-221.

Worrall, F & Burt, Tim. (1999). The Impact of Land-Use Change on Water Quality at the Catchment Scale: The Use of Export Coefficient and Structural Models. Journal of Hydrology. 221. 75-90. 10.1016/S0022-1694(99)00084-0.

Yuan, Y., Locke, M.A., Binger, R.L, and Rebich, R.A. "Phosphorus Losses from Agricultural Watersheds in the Mississippi Delta." *Journal of Environmental Management*, vol. 115, 2013, pp. 14-20

Zhou, B., Xu, Y., Vogt, R.D., Lu, X., Li, X. Deng, X., Yue, A., and Zhu, L. "Effects of Land use Change on Phosphorus Levels in Surface Waters—a Case Study of a Watershed Strongly Influenced by Agriculture." *Water, Air, & Soil Pollution*, vol. 227, no. 5, 2016, pp. 1-14.

Appendices

Appendix A: Discharge Data

Table 16: *Measured discharge data for the mainstem of the Shuswap River and its Tributaries. The 29 km discharge data was from the Water Office of Canada. All measurements are in* m^3s^{-1}.

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
01-Jul-16	150	3.016	2.093	0.124	0.300	0.119	0.187	0.143
02-Jul-16	146	2.808	1.523	0.123	0.298	0.125	0.151	0.131
03-Jul-16	141	2.718	1.360	0.123	0.297	0.132	0.145	0.126
04-Jul-16	139	2.860	1.879	0.122	0.295	0.138	0.192	0.134
05-Jul-16	139	2.926	2.196	0.122	0.294	0.145	0.223	0.138
06-Jul-16	136	2.781	1.691	0.122	0.294	0.152	0.208	0.130
07-Jul-16	134	2.536	1.143	0.121	0.294	0.160	0.155	0.116
08-Jul-16	130	2.471	1.061	0.121	0.294	0.158	0.138	0.113
09-Jul-16	130	2.635	1.563	0.120	0.295	0.118	0.174	0.122
10-Jul-16	128	2.460	1.120	0.120	0.295	0.149	0.159	0.112
11-Jul-16	124	2.382	1.087	0.119	0.295	0.161	0.162	0.108
12-Jul-16	120	2.381	1.124	0.119	0.295	0.141	0.171	0.108
13-Jul-16	119	2.661	1.894	0.117	0.296	0.210	0.280	0.123
14-Jul-16	117	2.625	1.738	0.116	0.297	0.219	0.272	0.121
15-Jul-16	123	2.923	1.891	0.114	0.298	0.228	0.250	0.138
16-Jul-16	120	2.620	1.434	0.112	0.298	0.238	0.230	0.121
17-Jul-16	119	2.465	1.205	0.111	0.299	0.210	0.220	0.113
18-Jul-16	116	2.256	0.842	0.109	0.300	0.210	0.180	0.101
19-Jul-16	114	2.337	1.192	0.108	0.301	0.210	0.234	0.106
20-Jul-16	113	2.551	1.569	0.106	0.301	0.188	0.266	0.117
21-Jul-16	108	2.326	1.174	0.105	0.089	0.199	0.245	0.105
22-Jul-16	103	2.196	0.994	0.104	0.103	0.193	0.225	0.098
23-Jul-16	100	2.424	1.394	0.103	0.119	0.190	0.280	0.110
24-Jul-16	96	2.165	0.955	0.102	0.137	0.186	0.225	0.097
25-Jul-16	92.2	2.008	0.776	0.101	0.157	0.182	0.190	0.088
26-Jul-16	89.1	2.022	0.903	0.100	0.649	0.175	0.206	0.089
27-Jul-16	86.4	2.022	1.025	0.097	0.425	0.000	0.221	0.089
28-Jul-16	83.1	1.952	0.988	0.094	0.281	0.000	0.212	0.086
29-Jul-16	80.3	1.644	0.447	0.092	0.495	0.000	0.130	0.070
30-Jul-16	77.4	1.369	0.101	0.089	0.606	0.000	0.082	0.056
31-Jul-16	74.5	1.665	0.564	0.086	0.610	0.000	0.143	0.071
01-Aug-16	72	1.796	0.909	0.084	0.356	0.000	0.187	0.078
02-Aug-16	70.2	1.669	0.623	0.081	0.375	0.000	0.149	0.071
03-Aug-16	69.2	1.929	1.077	0.078	0.407	0.000	0.212	0.084

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
04-Aug-16	67.1	1.697	0.787	0.076	0.522	0.000	0.165	0.073
05-Aug-16	65.4	1.336	0.234	0.073	0.368	0.000	0.091	0.055
06-Aug-16	63.9	1.351	0.260	0.071	0.435	0.000	0.095	0.055
07-Aug-16	62.7	1.244	0.156	0.068	0.662	0.000	0.078	0.050
08-Aug-16	60.8	1.358	0.340	0.065	0.885	0.000	0.100	0.056
09-Aug-16	59.9	1.352	0.369	0.063	0.822	0.000	0.105	0.056
10-Aug-16	58.6	1.516	0.696	0.060	0.783	0.000	0.151	0.064
11-Aug-16	57.6	1.696	1.103	0.058	0.682	0.000	0.210	0.072
12-Aug-16	56.4	1.722	1.214	0.055	0.543	0.000	0.212	0.074
13-Aug-16	55.3	1.615	0.754	0.052	0.433	0.000	0.147	0.068
14-Aug-16	54.5	1.511	0.541	0.050	0.672	0.000	0.117	0.063
15-Aug-16	53.1	1.628	0.775	0.047	0.629	0.000	0.143	0.069
16-Aug-16	52.4	1.597	0.703	0.044	0.524	0.000	0.132	0.068
17-Aug-16	51	1.677	0.885	0.042	0.670	0.000	0.152	0.072
18-Aug-16	49.6	1.801	1.195	0.039	0.754	0.000	0.189	0.078
19-Aug-16	48.6	1.790	1.166	0.036	0.467	0.000	0.181	0.077
20-Aug-16	47.3	1.455	0.432	0.034	0.515	0.000	0.093	0.061
21-Aug-16	46.1	1.130	0.022	0.037	0.552	0.000	0.045	0.045
22-Aug-16	45.1	1.523	0.587	0.040	0.438	0.000	0.109	0.064
23-Aug-16	44.5	1.843	1.321	0.043	0.355	0.000	0.197	0.080
24-Aug-16	43.3	1.993	1.783	0.047	0.126	0.000	0.253	0.088
25-Aug-16	42.6	1.819	1.269	0.050	0.160	0.000	0.182	0.079
26-Aug-16	41.8	1.501	0.537	0.053	0.544	0.000	0.098	0.063
27-Aug-16	41	1.202	0.076	0.057	0.421	0.000	0.057	0.048
28-Aug-16	42.1	1.651	0.877	0.060	0.515	0.000	0.157	0.070
29-Aug-16	41.3	1.642	0.849	0.063	0.582	0.000	0.140	0.070
30-Aug-16	40.7	1.489	0.530	0.066	0.290	0.000	0.100	0.062
31-Aug-16	40.2	1.348	0.278	0.070	0.216	0.000	0.073	0.055
01-Sep-16	38.3	1.448	0.449	0.073	0.261	0.000	0.090	0.060
02-Sep-16	39.7	1.632	0.465	0.076	0.255	0.000	0.138	0.069
03-Sep-16	40.7	1.619	0.661	0.080	0.309	0.000	0.173	0.069
04-Sep-16	39.6	1.540	0.696	0.083	0.264	0.000	0.148	0.065
05-Sep-16	38.7	1.497	0.589	0.086	0.465	0.000	0.125	0.063
06-Sep-16	39.3	1.578	0.592	0.090	0.518	0.000	0.128	0.067
07-Sep-16	39.7	1.778	0.840	0.093	0.498	0.000	0.171	0.077
08-Sep-16	40.1	1.965	1.172	0.096	0.311	0.000	0.225	0.086
09-Sep-16	40	2.156	1.902	0.100	0.244	0.000	0.333	0.096
10-Sep-16	39.4	1.673	0.823	0.100	0.303	0.000	0.164	0.071
11-Sep-16	40.5	1.968	1.146	0.100	0.274	0.000	0.218	0.086
12-Sep-16	39.4	2.077	1.862	0.101	0.375	0.000	0.315	0.092

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
13-Sep-16	38.6	1.764	1.204	0.101	0.536	0.000	0.209	0.076
14-Sep-16	38.3	1.617	0.876	0.102	0.521	0.000	0.161	0.069
15-Sep-16	37.8	1.676	1.053	0.102	0.238	0.000	0.181	0.071
16-Sep-16	37.3	1.548	0.677	0.103	0.153	0.000	0.133	0.065
17-Sep-16	37.9	1.382	0.220	0.103	0.560	0.000	0.086	0.057
18-Sep-16	43.5	2.186	1.088	0.104	0.744	0.000	0.172	0.098
19-Sep-16	41.9	2.102	1.090	0.104	0.925	0.000	0.219	0.093
20-Sep-16	43.1	2.313	1.550	0.105	0.623	0.000	0.303	0.104
21-Sep-16	42.6	2.134	1.151	0.105	0.349	0.000	0.255	0.095
22-Sep-16	41.8	1.857	0.801	0.105	0.255	0.000	0.184	0.081
23-Sep-16	41.3	1.717	0.691	0.106	0.641	0.113	0.165	0.074
24-Sep-16	43	2.279	1.261	0.107	0.562	0.119	0.360	0.103
25-Sep-16	41.8	2.325	1.308	0.107	0.419	0.125	0.437	0.105
26-Sep-16	41.2	1.936	0.926	0.108	0.274	0.132	0.255	0.085
27-Sep-16	40.9	1.848	0.847	0.109	0.438	0.138	0.235	0.080
28-Sep-16	40.5	1.839	0.839	0.109	0.531	0.145	0.254	0.080
29-Sep-16	39.8	1.638	0.668	0.110	0.620	0.152	0.187	0.070
30-Sep-16	39.5	1.453	0.523	0.111	0.599	0.160	0.147	0.060
01-Oct-16	39.5	1.505	0.563	0.111	0.598	0.168	0.026	0.063
02-Oct-16	39.6	1.583	0.624	0.112	0.593	0.175	0.026	0.067
03-Oct-16	39.1	1.351	0.448	0.113	0.732	0.184	0.026	0.055
04-Oct-16	38.6	1.326	0.430	0.113	0.845	0.192	0.026	0.054
05-Oct-16	38.3	1.473	0.538	0.114	1.289	0.201	0.026	0.061
06-Oct-16	38.1	1.659	0.685	0.115	0.681	0.210	0.026	0.071
07-Oct-16	39.3	1.617	0.651	0.115	0.794	0.219	0.026	0.069
08-Oct-16	41.3	1.919	0.910	0.116	1.222	0.228	0.026	0.084
09-Oct-16	50.7	2.588	1.595	0.117	0.930	0.238	0.026	0.119
10-Oct-16	46.9	2.387	1.374	0.117	0.681	0.248	0.026	0.108
11-Oct-16	46	2.492	1.487	0.118	0.700	0.258	0.026	0.114
12-Oct-16	45.8	2.145	1.125	0.119	0.587	0.269	0.026	0.096
13-Oct-16	46.9	1.613	0.648	0.119	0.376	0.280	0.026	0.068
14-Oct-16	53.5	1.529	0.581	0.120	0.518	0.291	0.026	0.064
15-Oct-16	55.6	1.736	0.750	0.121	0.783	0.302	0.026	0.075
16-Oct-16	57.3	1.576	0.618	0.121	0.963	0.314	0.026	0.067
17-Oct-16	59.1	1.789	0.795	0.122	0.954	0.326	0.026	0.077
18-Oct-16	60.7	2.304	1.286	0.123	0.732	0.339	0.026	0.104
19-Oct-16	61.7	2.667	1.685	0.123	0.526	0.351	0.026	0.124
20-Oct-16	63.6	2.432	1.421	0.124	0.501	0.364	0.026	0.111
21-Oct-16	65.6	2.363	1.348	0.125	0.707	0.378	0.026	0.107
22-Oct-16	65.2	2.211	1.191	0.125	0.529	0.391	0.026	0.099

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
23-Oct-16	64.4	2.194	1.174	0.124	0.231	0.380	0.026	0.098
24-Oct-16	63.9	1.890	0.884	0.123	0.512	0.368	0.026	0.082
25-Oct-16	67.7	2.489	1.484	0.122	0.375	0.357	0.027	0.114
26-Oct-16	68.8	2.545	1.546	0.121	0.191	0.346	0.027	0.117
27-Oct-16	76.2	2.627	1.639	0.120	0.125	0.336	0.027	0.121
28-Oct-16	77.4	2.878	1.937	0.119	0.274	0.325	0.027	0.135
29-Oct-16	77.2	2.706	1.730	0.117	0.209	0.315	0.027	0.126
30-Oct-16	77.7	2.306	1.288	0.116	0.158	0.305	0.027	0.104
31-Oct-16	77.9	1.991	0.977	0.115	0.060	0.295	0.027	0.088
01-Nov-16	82.7	2.528	1.527	0.114	0.112	0.286	0.027	0.116
02-Nov-16	86.6	3.083	2.195	0.113	0.059	0.276	0.027	0.147
03-Nov-16	93.4	3.445	2.685	0.112	0.128	0.267	0.027	0.167
04-Nov-16	92.6	3.129	2.256	0.111	0.080	0.258	0.027	0.149
05-Nov-16	92.9	2.615	1.625	0.110	0.192	0.250	0.027	0.121
06-Nov-16	107	3.190	2.335	0.109	0.403	0.241	0.027	0.152
07-Nov-16	105	3.405	2.629	0.107	0.421	0.233	0.027	0.165
08-Nov-16	104	3.140	2.270	0.106	0.125	0.225	0.028	0.150
09-Nov-16	105	3.128	2.254	0.105	0.000	0.217	0.028	0.149
10-Nov-16	105	3.170	2.309	0.104	0.001	0.209	0.028	0.151
11-Nov-16	104	2.737	1.767	0.103	0.001	0.201	0.028	0.127
12-Nov-16	106	2.786	1.825	0.102	0.001	0.194	0.028	0.130
13-Nov-16	117	3.312	2.501	0.101	0.094	0.187	0.028	0.159
14-Nov-16	119	3.057	2.162	0.100	0.392	0.180	0.028	0.145
15-Nov-16	120	2.695	1.717	0.099	0.390	0.173	0.028	0.125
16-Nov-16	122	2.825	1.872	0.098	0.264	0.166	0.028	0.132
17-Nov-16	120	3.053	2.157	0.096	0.195	0.160	0.028	0.145
18-Nov-16	119	3.013	2.105	0.095	0.229	0.154	0.028	0.143
19-Nov-16	116	2.468	1.461	0.094	0.226	0.147	0.028	0.113
20-Nov-16	114	2.310	1.293	0.093	0.120	0.141	0.028	0.104
21-Nov-16	112	2.445	1.436	0.092	0.304	0.143	0.029	0.112
22-Nov-16	108	2.608	1.617	0.091	0.192	0.144	0.029	0.120
23-Nov-16	105	2.343	1.327	0.089	0.192	0.146	0.029	0.106
24-Nov-16	101	2.356	1.341	0.088	0.331	0.147	0.029	0.107
25-Nov-16	99.3	2.308	1.291	0.087	0.257	0.148	0.029	0.104
26-Nov-16	97.8	2.043	1.026	0.086	0.068	0.150	0.029	0.090
27-Nov-16	96.9	1.941	0.931	0.085	0.082	0.151	0.029	0.085
28-Nov-16	93.3	2.135	1.115	0.083	0.242	0.153	0.029	0.095
29-Nov-16	89.9	2.519	1.518	0.082	0.430	0.154	0.029	0.116
30-Nov-16	87	2.214	1.194	0.081	0.594	0.156	0.029	0.099
01-Dec-16	85	2.475	1.468	0.080	0.383	0.157	0.029	0.113

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
02-Dec-16	82.3	2.441	1.432	0.079	0.165	0.159	0.029	0.111
03-Dec-16	80.4	2.178	1.158	0.077	0.366	0.160	0.029	0.097
04-Dec-16	78.3	1.904	0.897	0.076	0.612	0.162	0.030	0.083
05-Dec-16	75.2	1.949	2.195	0.075	0.457	0.163	0.030	0.086
06-Dec-16	73.3	1.994	2.685	0.074	0.617	0.165	0.030	0.088
07-Dec-16	70.5	2.038	2.256	0.072	0.579	0.166	0.030	0.091
08-Dec-16	67.6	2.083	1.625	0.071	0.316	0.168	0.030	0.093
09-Dec-16	65.3	2.128	2.335	0.070	0.278	0.169	0.030	0.095
10-Dec-16	65.7	2.172	2.629	0.069	0.363	0.171	0.030	0.097
11-Dec-16	65.3	2.217	2.270	0.068	0.282	0.173	0.030	0.100
12-Dec-16	64.9	2.262	2.254	0.068	0.134	0.174	0.030	0.102
13-Dec-16	62.8	2.307	2.309	0.068	0.330	0.176	0.030	0.104
14-Dec-16	61.7	2.352	1.767	0.068	0.839	0.177	0.030	0.106
15-Dec-16	59.5	2.397	1.825	0.068	0.969	0.179	0.030	0.108
16-Dec-16	59.4	2.442	2.501	0.068	0.551	0.181	0.030	0.110
17-Dec-16	57.7	2.486	2.162	0.068	0.438	0.182	0.031	0.112
18-Dec-16	57.3	2.531	1.717	0.069	0.944	0.184	0.031	0.113
19-Dec-16	57.4	2.576	1.872	0.069	1.240	0.186	0.031	0.115
20-Dec-16	57.3	2.622	2.157	0.069	1.042	0.187	0.031	0.117
21-Dec-16	56.9	2.667	2.105	0.069	0.947	0.189	0.031	0.119
22-Dec-16	56.4	2.712	1.461	0.069	0.908	0.191	0.031	0.121
23-Dec-16	56.3	2.757	1.293	0.069	0.526	0.192	0.031	0.122
24-Dec-16	56.1	2.802	1.436	0.069	0.490	0.194	0.031	0.119
25-Dec-16	55.3	2.847	1.617	0.070	0.851	0.196	0.031	0.131
26-Dec-16	54.5	2.892	1.327	0.070	1.405	0.197	0.031	0.136
27-Dec-16	54.8	2.567	1.341	0.070	1.036	0.199	0.031	0.118
28-Dec-16	54.1	3.125	1.291	0.070	1.545	0.201	0.031	0.149
29-Dec-16	53.8	2.959	1.026	0.070	1.500	0.203	0.032	0.140
30-Dec-16	53.4	2.803	0.931	0.070	1.135	0.204	0.032	0.131
31-Dec-16	52.6	2.155	1.115	0.070	0.810	0.206	0.032	0.129
01-Jan-17	52.2	2.064	1.518	0.071	1.206	0.208	0.032	0.126
02-Jan-17	50.5	2.024	1.194	0.071	1.538	0.210	0.032	0.123
03-Jan-17	49.8	1.983	1.468	0.071	1.444	0.212	0.032	0.121
04-Jan-17	49.4	1.942	1.432	0.071	1.354	0.214	0.032	0.118
05-Jan-17	48.8	1.901	1.158	0.071	1.267	0.215	0.032	0.115
06-Jan-17	48.7	1.860	0.897	0.071	1.183	0.217	0.032	0.113
07-Jan-17	48.2	1.820	0.937	0.071	1.103	0.219	0.032	0.110
08-Jan-17	47.6	1.779	0.976	0.072	1.026	0.221	0.032	0.107
09-Jan-17	46.6	1.738	1.017	0.072	0.952	0.223	0.032	0.103
10-Jan-17	45.5	1.697	1.058	0.072	0.881	0.225	0.033	0.100

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
11-Jan-17	44	1.657	1.100	0.072	0.813	0.227	0.033	0.097
12-Jan-17	43.2	1.616	1.142	0.072	0.748	0.228	0.033	0.093
13-Jan-17	43.3	1.576	1.185	0.072	0.687	0.230	0.033	0.090
14-Jan-17	43.4	1.535	1.229	0.072	0.628	0.232	0.033	0.086
15-Jan-17	43.6	1.495	1.273	0.073	0.572	0.234	0.033	0.082
16-Jan-17	43.7	1.454	1.318	0.073	0.520	0.236	0.033	0.078
17-Jan-17	43.6	1.414	1.363	0.073	0.470	0.238	0.033	0.073
18-Jan-17	43.9	1.374	1.410	0.073	0.423	0.240	0.033	0.068
19-Jan-17	44	1.333	1.456	0.073	0.379	0.242	0.033	0.063
20-Jan-17	44	1.293	1.504	0.073	0.519	0.244	0.033	0.057
21-Jan-17	44	1.253	1.552	0.073	2.366	0.246	0.033	0.051
22-Jan-17	43.6	1.331	1.601	0.074	2.702	0.248	0.034	0.055
23-Jan-17	43.5	1.369	1.650	0.074	1.709	0.250	0.034	0.056
24-Jan-17	43.3	1.655	1.700	0.074	1.021	0.252	0.034	0.070
25-Jan-17	43.1	2.146	1.751	0.074	1.218	0.254	0.034	0.096
26-Jan-17	42.7	2.188	1.803	0.074	0.712	0.256	0.034	0.098
27-Jan-17	42.6	2.491	1.855	0.024	1.228	0.000	0.034	0.114
28-Jan-17	42.2	2.497	1.954	0.024	1.032	0.000	0.034	0.112
29-Jan-17	41.9	2.039	1.571	0.024	1.146	0.000	0.034	0.111
30-Jan-17	41.5	2.010	2.250	0.024	1.267	0.000	0.034	0.109
31-Jan-17	40.7	1.981	2.037	0.024	1.395	0.000	0.034	0.107
01-Feb-17	41.4	1.952	1.846	0.024	1.530	0.000	0.034	0.105
02-Feb-17	42.8	1.923	1.135	0.024	1.672	0.000	0.034	0.104
03-Feb-17	42.5	1.894	1.081	0.023	1.821	0.000	0.035	0.102
04-Feb-17	40.7	1.865	1.027	0.023	1.978	0.000	0.035	0.100
05-Feb-17	40	1.836	0.975	0.023	2.142	0.000	0.035	0.098
06-Feb-17	40.5	1.807	0.923	0.023	2.314	0.000	0.035	0.096
07-Feb-17	39.6	1.778	0.873	0.023	2.494	0.000	0.035	0.094
08-Feb-17	42.1	1.749	0.824	0.023	2.681	0.000	0.035	0.092
09-Feb-17	37.9	1.720	0.776	0.023	2.346	0.000	0.035	0.090
10-Feb-17	40.5	1.691	0.729	0.023	2.036	0.000	0.035	0.088
11-Feb-17	39	1.662	0.683	0.023	1.752	0.000	0.035	0.085
12-Feb-17	38.8	1.633	0.639	0.023	1.491	0.000	0.035	0.083
13-Feb-17	38.2	1.604	0.595	0.023	1.254	0.000	0.035	0.081
14-Feb-17	37.9	1.576	0.552	0.023	1.040	0.000	0.035	0.078
15-Feb-17	37.9	1.547	0.511	0.023	1.130	0.000	0.036	0.076
16-Feb-17	38.8	1.518	0.470	0.023	1.203	0.000	0.036	0.049
17-Feb-17	39.2	1.489	0.431	0.023	1.204	0.000	0.036	0.062
18-Feb-17	38.7	1.081	0.392	0.023	1.201	0.000	0.036	0.043
19-Feb-17	38.6	1.071	0.355	0.022	0.438	0.000	0.036	0.042

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
20-Feb-17	38.2	1.248	0.319	0.022	0.613	0.000	0.036	0.051
21-Feb-17	37.9	1.529	0.284	0.022	0.953	0.000	0.036	0.064
22-Feb-17	37.5	1.932	0.250	0.022	1.333	0.000	0.036	0.085
23-Feb-17	37	1.996	0.379	0.022	2.014	0.000	0.036	0.088
24-Feb-17	36.5	1.991	0.434	0.022	2.436	0.000	0.036	0.088
25-Feb-17	35.7	1.809	0.461	0.022	2.043	0.000	0.036	0.078
26-Feb-17	36.1	1.440	0.682	0.022	1.293	0.000	0.036	0.060
27-Feb-17	35.4	1.285	1.126	0.022	1.594	0.000	0.037	0.052
28-Feb-17	34.7	1.559	1.168	0.022	2.679	0.000	0.037	0.066
01-Mar-17	35.1	1.971	1.486	0.022	2.814	0.000	0.037	0.087
02-Mar-17	34.9	1.994	1.493	0.022	1.695	0.000	0.037	0.088
03-Mar-17	34.4	1.329	1.022	0.022	0.820	0.000	0.037	0.054
04-Mar-17	35	1.141	0.961	0.022	0.662	0.000	0.037	0.045
05-Mar-17	34.6	1.006	0.936	0.022	0.413	0.000	0.037	0.039
06-Mar-17	34.3	1.252	0.911	0.022	0.566	0.000	0.037	0.051
07-Mar-17	33.9	1.600	0.887	0.022	1.121	0.000	0.037	0.068
08-Mar-17	33.4	1.673	0.862	0.021	0.932	0.000	0.037	0.071
09-Mar-17	33.1	1.846	0.838	0.021	0.238	0.113	0.037	0.080
10-Mar-17	33.3	1.723	0.815	0.000	0.565	0.118	0.038	0.074
11-Mar-17	33.1	1.776	0.791	0.003	1.796	0.123	0.038	0.077
12-Mar-17	33.9	2.211	0.768	0.005	1.960	0.128	0.038	0.099
13-Mar-17	37.6	2.608	0.745	0.008	1.851	0.133	0.041	0.120
14-Mar-17	40.9	2.568	0.723	0.011	1.081	0.139	0.045	0.118
15-Mar-17	42.9	2.544	0.700	0.013	0.387	0.144	0.049	0.117
16-Mar-17	54.5	3.350	0.678	0.016	0.156	0.150	0.054	0.162
17-Mar-17	53.6	3.168	0.656	0.019	0.301	0.156	0.058	0.151
18-Mar-17	52.7	2.384	0.634	0.022	0.120	0.162	0.063	0.108
19-Mar-17	53.6	3.109	0.613	0.024	0.169	0.168	0.068	0.148
20-Mar-17	52.4	3.033	0.592	0.027	0.246	0.175	0.073	0.144
21-Mar-17	52.1	2.454	0.571	0.030	0.479	0.185	0.078	0.112
22-Mar-17	54.5	2.424	0.550	0.033	0.897	0.195	0.084	0.110
23-Mar-17	57.1	2.775	0.267	0.036	0.958	0.206	0.089	0.129
24-Mar-17	57.3	2.592	0.260	0.039	1.027	0.217	0.089	0.119
25-Mar-17	59.6	2.820	0.375	0.041	0.712	0.228	0.089	0.132
26-Mar-17	60.1	2.705	1.369	0.044	0.428	0.240	0.089	0.126
27-Mar-17	60.1	2.799	1.369	0.047	0.788	0.253	0.118	0.131
28-Mar-17	63.7	3.353	1.369	0.050	0.722	0.265	0.150	0.162
29-Mar-17	70.6	3.125	1.568	0.053	0.909	0.278	0.187	0.149
30-Mar-17	78	3.307	1.755	0.056	0.859	0.292	0.228	0.159
31-Mar-17	76.4	3.550	2.015	0.058	0.332	0.306	0.200	0.173

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
01-Apr-17	84	3.394	2.015	0.061	0.225	0.324	0.174	0.164
02-Apr-17	92	3.277	2.256	0.070	0.145	0.342	0.150	0.157
03-Apr-17	86.9	3.171	2.256	0.078	0.372	0.361	0.128	0.151
04-Apr-17	82.2	2.839	2.098	0.087	0.773	0.423	0.108	0.133
05-Apr-17	80.8	2.663	1.755	0.080	0.684	0.491	0.089	0.123
06-Apr-17	85.8	2.700	1.568	0.074	0.942	0.567	0.211	0.125
07-Apr-17	101	2.408	2.098	0.068	0.739	0.650	0.389	0.110
08-Apr-17	103	2.769	2.256	0.061	0.790	0.621	0.373	0.129
09-Apr-17	101	3.056	2.098	0.066	0.947	0.594	0.357	0.145
10-Apr-17	100	2.950	2.098	0.070	1.763	0.567	0.342	0.139
11-Apr-17	99	2.964	2.098	0.074	1.648	0.541	0.327	0.140
12-Apr-17	97.9	2.750	1.931	0.078	1.796	0.516	0.313	0.128
13-Apr-17	101	2.576	1.931	0.082	3.123	0.491	0.299	0.119
14-Apr-17	105	2.916	1.931	0.087	3.328	0.789	0.285	0.137
15-Apr-17	104	3.131	1.931	0.103	2.419	1.189	0.271	0.149
16-Apr-17	103	2.997	1.931	0.119	3.380	1.150	0.258	0.142
17-Apr-17	103	2.632	1.931	0.119	3.410	1.112	0.246	0.122
18-Apr-17	113	3.058	1.931	0.119	2.762	1.075	0.264	0.145
19-Apr-17	118	3.269	2.256	0.119	2.678	1.039	0.283	0.157
20-Apr-17	118	3.192	2.256	0.119	3.249	1.004	0.276	0.153
21-Apr-17	123	3.597	2.256	0.119	3.091	0.969	0.270	0.176
22-Apr-17	123	3.035	2.256	0.119	3.521	0.936	0.264	0.144
23-Apr-17	125	2.732	2.256	0.119	3.547	0.903	0.258	0.127
24-Apr-17	126	2.541	2.256	0.119	3.449	0.871	0.252	0.117
25-Apr-17	126	2.653	2.098	0.119	4.116	0.839	0.246	0.123
26-Apr-17	127	2.431	2.098	0.119	4.308	0.491	0.748	0.111
27-Apr-17	132	2.747	2.098	0.122	4.895	0.257	1.546	0.128
28-Apr-17	133	3.215	1.931	0.125	4.915	0.333	1.071	0.154
29-Apr-17	131	3.111	1.931	0.124	4.825	0.423	1.044	0.148
30-Apr-17	134	3.101	1.931	0.123	5.341	0.528	0.938	0.148
01-May-17	134	3.149	1.931	0.122	4.959	0.650	0.875	0.150
02-May-17	132	3.128	1.931	0.121	4.588	0.789	1.023	0.149
03-May-17	134	3.246	1.931	0.120	4.387	0.947	1.039	0.156
04-May-17	141	3.239	2.098	0.119	4.306	1.532	1.053	0.155
05-May-17	176	3.532	2.098	0.187	4.762	1.969	0.882	0.172
06-May-17	223	4.241	3.064	0.256	4.992	0.926	0.964	0.213
07-May-17	223	3.894	4.822	0.256	4.921	0.818	1.218	0.193
08-May-17	227	3.777	4.392	0.256	4.673	0.793	1.130	0.186
09-May-17	225	3.495	4.313	0.256	4.619	0.700	1.482	0.170
10-May-17	226	3.366	4.233	0.249	4.390	0.645	1.300	0.162

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
11-May-17	231	3.423	4.313	0.243	4.239	0.775	1.042	0.166
12-May-17	249	3.763	4.233	0.289	4.578	0.789	0.934	0.185
13-May-17	254	3.500	4.468	0.342	4.609	0.802	0.936	0.170
14-May-17	253	3.396	4.392	0.295	4.638	0.651	0.872	0.164
15-May-17	248	3.144	4.392	0.249	4.257	0.723	0.986	0.150
16-May-17	247	2.695	4.233	0.216	4.451	0.954	1.187	0.125
17-May-17	242	3.100	4.233	0.207	4.941	0.872	1.159	0.147
18-May-17	238	3.376	4.233	0.203	4.787	1.208	1.022	0.163
19-May-17	236	3.359	4.233	0.197	5.336	1.032	1.069	0.162
20-May-17	238	3.561	4.233	0.193	5.075	0.792	0.985	0.174
21-May-17	245	3.935	4.233	0.289	4.616	0.697	0.953	0.195
22-May-17	257	4.120	4.313	0.322	4.382	0.698	1.042	0.206
23-May-17	279	3.871	4.392	0.342	4.387	0.643	1.096	0.192
24-May-17	307	3.932	4.468	0.375	4.231	0.742	2.236	0.195
25-May-17	317	3.581	4.392	0.335	4.499	0.925	2.087	0.175
26-May-17	328	3.701	4.392	0.282	4.889	0.898	1.574	0.182
27-May-17	338	4.086	4.392	0.256	4.838	0.774	1.308	0.204
28-May-17	347	4.413	4.392	0.348	4.576	0.816	1.048	0.223
29-May-17	358	4.503	4.392	0.352	4.671	0.741	1.006	0.229
30-May-17	381	4.399	4.468	0.345	4.497	0.713	1.081	0.223
31-May-17	407	4.693	4.542	0.342	4.425	0.792	1.134	0.240
01-Jun-17	448	5.743	4.542	0.335	4.616	0.841	0.931	0.305
02-Jun-17	467	5.969	4.542	0.322	4.723	2.007	0.943	0.319
03-Jun-17	475	5.669	4.542	0.315	6.124	1.842	0.844	0.300
04-Jun-17	473	5.509	4.542	0.312	5.995	1.301	0.835	0.290
05-Jun-17	461	5.620	4.468	0.302	5.455	1.039	0.981	0.297
06-Jun-17	440	5.337	4.392	0.302	5.087	0.798	1.016	0.280
07-Jun-17	422	4.978	4.392	0.305	4.629	0.759	0.369	0.258
08-Jun-17	410	4.832	4.542	0.295	4.540	0.827	0.297	0.249
09-Jun-17	413	4.744	4.542	0.299	4.693	0.876	0.316	0.243
10-Jun-17	402	4.222	4.614	0.289	4.794	0.694	0.288	0.212
11-Jun-17	392	4.198	4.392	0.295	4.375	0.704	0.212	0.211
12-Jun-17	377	3.923	4.313	0.302	4.403	0.618	0.229	0.195
13-Jun-17	360	4.258	4.392	0.309	4.158	0.611	0.243	0.214
14-Jun-17	346	4.485	4.313	0.315	4.135	0.738	0.238	0.228
15-Jun-17	327	4.105	4.313	0.309	4.488	0.768	0.195	0.205
16-Jun-17	314	4.299	4.313	0.302	4.562	0.247	0.201	0.217
17-Jun-17	308	4.565	4.313	0.303	2.055	0.197	0.192	0.233
18-Jun-17	293	4.396	4.313	0.303	1.366	0.209	0.185	0.222
19-Jun-17	284	4.348	4.313	0.304	1.566	0.190	0.179	0.220

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
20-Jun-17	279	4.318	4.313	0.305	1.258	0.140	0.176	0.218
21-Jun-17	277	4.664	4.313	0.305	0.079	0.151	0.173	0.238
22-Jun-17	267	4.623	4.313	0.306	0.403	0.160	0.137	0.236
23-Jun-17	256	4.530	4.233	0.308	0.631	0.000	0.112	0.230
24-Jun-17	248	4.594	4.233	0.309	1.258	0.000	0.124	0.234
25-Jun-17	243	4.410	4.233	0.249	0.079	0.001	0.129	0.223
26-Jun-17	239	4.078	4.233	0.223	0.403	0.001	0.134	0.204
27-Jun-17	235	3.966	4.233	0.203	0.631	0.001	0.137	0.197
28-Jun-17	230	3.852	4.233	0.184	0.403	0.000	0.134	0.190
29-Jun-17	227	4.062	4.151	0.158	0.631	0.000	0.126	0.203
30-Jun-17	224	3.973	4.067	0.132	0.079	0.000	0.124	0.197
01-Jul-17	217	3.532	4.052	0.128	0.337	0.001	0.344	0.197
02-Jul-17	212	3.486	4.036	0.123	0.336	0.001	0.344	0.093
03-Jul-17	209	3.439	4.021	0.119	0.335	0.001	0.344	0.093
04-Jul-17	202	2.839	4.005	0.115	0.334	0.001	0.344	0.093
05-Jul-17	196	2.793	3.989	0.111	0.332	0.001	0.344	0.093
06-Jul-17	191	2.050	3.974	0.107	0.331	0.001	0.344	0.093
07-Jul-17	184	2.017	3.958	0.103	0.330	0.001	0.344	0.093
08-Jul-17	179	1.984	3.942	0.099	0.329	0.001	0.344	0.093
09-Jul-17	172	1.951	3.926	0.095	0.327	0.001	0.344	0.093
10-Jul-17	165	1.918	3.910	0.090	0.326	0.001	0.344	0.093
11-Jul-17	158	1.885	3.894	0.086	0.325	0.001	0.344	0.093
12-Jul-17	151	1.852	3.878	0.082	0.323	0.001	0.344	0.093
13-Jul-17	144	1.819	3.861	0.078	0.322	0.001	0.344	0.093
14-Jul-17	138	1.786	3.845	0.074	0.320	0.001	0.344	0.093
15-Jul-17	131	1.786	3.742	0.069	0.319	0.000	0.336	0.093
16-Jul-17	122	1.786	3.636	0.064	0.318	0.000	0.327	0.095
17-Jul-17	114	1.786	3.526	0.059	0.317	0.000	0.319	0.097
18-Jul-17	110	1.786	3.411	0.054	0.316	0.000	0.311	0.098
19-Jul-17	105	1.786	3.292	0.049	0.315	0.000	0.303	0.100
20-Jul-17	99.5	1.685	3.218	0.047	0.315	0.000	0.296	0.102
21-Jul-17	93.4	1.585	3.142	0.045	0.314	0.000	0.289	0.101
22-Jul-17	87	1.485	3.064	0.042	0.314	0.000	0.283	0.101
23-Jul-17	81.9	1.385	2.984	0.040	0.314	0.000	0.276	0.100
24-Jul-17	76.5	1.285	2.902	0.038	0.313	0.000	0.270	0.099
25-Jul-17	72.1	1.185	2.817	0.036	0.313	0.000	0.264	0.098
26-Jul-17	68	1.185	2.839	0.035	0.310	0.000	0.252	0.098
27-Jul-17	64.7	1.185	2.860	0.034	0.308	0.000	0.240	0.096
28-Jul-17	61.6	1.185	2.881	0.033	0.306	0.000	0.228	0.094
29-Jul-17	58.8	1.185	2.902	0.032	0.303	0.000	0.217	0.093

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
30-Jul-17	56.1	1.185	2.923	0.031	0.301	0.000	0.206	0.091
31-Jul-17	53.9	1.185	2.943	0.030	0.298	0.000	0.195	0.089
01-Aug-17	51.9	1.178	2.925	0.029	0.298	0.000	0.167	0.088
02-Aug-17	50	1.171	2.906	0.028	0.298	0.000	0.141	0.084
03-Aug-17	48.2	1.165	2.887	0.027	0.298	0.000	0.118	0.080
04-Aug-17	46.6	1.158	2.868	0.026	0.297	0.000	0.097	0.076
05-Aug-17	45.2	1.152	2.849	0.024	0.297	0.000	0.078	0.071
06-Aug-17	44.2	1.145	2.830	0.023	0.297	0.000	0.061	0.066
07-Aug-17	42.7	1.139	2.811	0.022	0.296	0.000	0.047	0.061
08-Aug-17	41.8	1.132	2.792	0.021	0.296	0.000	0.034	0.055
09-Aug-17	40.7	1.126	2.772	0.020	0.296	0.000	0.024	0.048
10-Aug-17	39.7	1.119	2.753	0.019	0.296	0.000	0.015	0.039
11-Aug-17	38.6	1.112	2.743	0.018	0.295	0.000	0.009	0.028
12-Aug-17	37.5	1.112	2.734	0.017	0.295	0.000	0.010	0.023
13-Aug-17	36.9	1.111	2.724	0.016	0.295	0.000	0.011	0.013
14-Aug-17	36.1	1.110	2.715	0.016	0.296	0.000	0.012	0.019
15-Aug-17	35.2	1.109	2.705	0.015	0.296	0.000	0.013	0.023
16-Aug-17	34.2	1.108	2.696	0.014	0.296	0.000	0.014	0.026
17-Aug-17	33.5	1.107	2.686	0.014	0.296	0.000	0.015	0.029
18-Aug-17	32.8	1.106	2.677	0.013	0.296	0.000	0.016	0.031
19-Aug-17	32.2	1.105	2.667	0.012	0.296	0.000	0.018	0.034
20-Aug-17	31.4	1.104	2.657	0.012	0.296	0.000	0.019	0.036
21-Aug-17	31	1.104	2.648	0.011	0.296	0.000	0.020	0.038
22-Aug-17	30.3	1.103	2.638	0.010	0.297	0.000	0.022	0.040
23-Aug-17	29.9	1.102	2.628	0.010	0.297	0.000	0.023	0.042
24-Aug-17	29.3	1.101	2.619	0.009	0.297	0.000	0.025	0.043
25-Aug-17	29.1	1.100	2.609	0.008	0.297	0.000	0.026	0.045
26-Aug-17	28.5	1.099	2.599	0.008	0.297	0.000	0.028	0.047
27-Aug-17	28.2	1.098	2.589	0.007	0.297	0.000	0.030	0.048
28-Aug-17	28	1.097	2.579	0.006	0.297	0.000	0.032	0.050
29-Aug-17	27.4	1.096	2.569	0.006	0.297	0.000	0.033	0.051
30-Aug-17	27.1	1.096	2.559	0.005	0.297	0.000	0.035	0.052
31-Aug-17	26.7	1.095	2.549	0.004	0.298	0.000	0.037	0.054
01-Sep-17	26.4	1.094	2.539	0.004	0.298	0.000	0.039	0.055
02-Sep-17	26.3	1.093	2.529	0.003	0.298	0.000	0.041	0.056
03-Sep-17	26	1.092	2.519	0.002	0.298	0.000	0.043	0.058
04-Sep-17	25.9	1.091	2.509	0.002	0.298	0.000	0.046	0.059
05-Sep-17	25.5	1.090	2.499	0.001	0.298	0.000	0.048	0.060
06-Sep-17	25.1	1.089	2.489	0.001	0.298	0.000	0.050	0.061
07-Sep-17	25.1	1.088	2.478	0.000	0.298	0.000	0.052	0.062

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
08-Sep-17	24.8	1.087	2.488	0.000	0.299	0.000	0.056	0.063
09-Sep-17	25.4	1.085	2.498	0.000	0.299	0.000	0.059	0.061
10-Sep-17	25.8	1.084	2.507	0.000	0.299	0.000	0.062	0.059
11-Sep-17	25.2	1.082	2.516	0.000	0.299	0.000	0.066	0.057
12-Sep-17	25.2	1.080	2.526	0.000	0.299	0.000	0.069	0.055
13-Sep-17	24.8	1.079	2.535	0.000	0.300	0.000	0.073	0.052
14-Sep-17	24.5	1.077	2.545	0.000	0.300	0.000	0.077	0.050
15-Sep-17	24.3	1.076	2.554	0.000	0.300	0.000	0.081	0.047
16-Sep-17	24.1	1.074	2.563	0.000	0.300	0.000	0.085	0.044
17-Sep-17	23.8	1.072	2.573	0.000	0.300	0.000	0.089	0.041
18-Sep-17	23.8	1.071	2.582	0.000	0.301	0.000	0.093	0.038
19-Sep-17	23.7	1.069	2.591	0.000	0.301	0.000	0.098	0.034
20-Sep-17	23.5	1.068	2.600	0.000	0.301	0.000	0.102	0.030
21-Sep-17	23.4	1.066	2.609	0.000	0.301	0.000	0.107	0.025
22-Sep-17	23.1	1.064	2.619	0.000	0.301	0.000	0.112	0.018
23-Sep-17	23.1	1.064	2.619	0.001	0.300	0.000	0.118	0.017
24-Sep-17	23.1	1.064	2.619	0.001	0.298	0.000	0.124	0.012
25-Sep-17	22.9	1.064	2.619	0.002	0.296	0.000	0.130	0.017
26-Sep-17	22.9	1.064	2.619	0.002	0.296	0.000	0.137	0.021
27-Sep-17	22.8	1.064	2.619	0.003	0.296	0.000	0.143	0.024
28-Sep-17	22.7	1.064	2.619	0.004	0.297	0.000	0.150	0.026
29-Sep-17	22.65	1.064	2.619	0.004	0.298	0.000	0.157	0.029
30-Sep-17	22.6	1.064	2.619	0.005	0.298	0.000	0.164	0.031
01-Oct-17	22.7	1.064	2.619	0.006	0.298	0.000	0.025	0.033
02-Oct-17	22.65	1.064	2.619	0.006	0.298	0.000	0.025	0.038
03-Oct-17	22.6	1.064	2.619	0.007	0.298	0.000	0.025	0.042
04-Oct-17	22.6	1.064	2.619	0.007	0.298	0.000	0.025	0.045
05-Oct-17	22.7	1.064	2.619	0.008	0.298	0.000	0.025	0.049
06-Oct-17	22.7	1.064	2.619	0.009	0.299	0.000	0.025	0.052
07-Oct-17	22.7	1.064	2.619	0.009	0.299	0.000	0.025	0.051
08-Oct-17	22.7	1.064	2.619	0.010	0.299	0.000	0.027	0.051
09-Oct-17	22.6	1.064	2.619	0.011	0.299	0.000	0.029	0.050
10-Oct-17	22.65	1.064	2.619	0.011	0.299	0.000	0.030	0.050
11-Oct-17	22.7	1.064	2.619	0.012	0.299	0.000	0.032	0.049
12-Oct-17	22.8	1.064	2.619	0.013	0.298	0.000	0.034	0.049
13-Oct-17	23.3	1.064	2.619	0.013	0.297	0.000	0.035	0.048
14-Oct-17	22.9	1.064	2.619	0.014	0.296	0.000	0.037	0.047
15-Oct-17	23.1	1.064	2.619	0.014	0.297	0.000	0.039	0.047
16-Oct-17	23.3	1.064	2.619	0.015	0.297	0.000	0.046	0.049
17-Oct-17	24.4	1.064	2.619	0.016	0.298	0.000	0.053	0.051

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
18-Oct-17	24.6	1.064	2.619	0.016	0.300	0.000	0.061	0.054
19-Oct-17	24.8	1.064	2.619	0.017	0.302	0.000	0.070	0.056
20-Oct-17	25.9	1.064	2.619	0.018	0.304	0.000	0.079	0.058
21-Oct-17	25.5	1.064	2.639	0.018	0.303	0.000	0.066	0.060
22-Oct-17	26.5	1.064	2.549	0.019	0.301	0.000	0.055	0.059
23-Oct-17	26.4	1.064	2.686	0.020	0.299	0.000	0.044	0.059
24-Oct-17	26.3	1.064	2.753	0.020	0.299	0.000	0.035	0.058
25-Oct-17	26.4	1.064	2.673	0.021	0.298	0.000	0.027	0.058
26-Oct-17	26.6	1.064	2.632	0.022	0.298	0.000	0.030	0.058
27-Oct-17	26.3	1.064	2.639	0.022	0.297	0.000	0.034	0.057
28-Oct-17	26.3	1.064	2.673	0.023	0.297	0.000	0.037	0.057
29-Oct-17	26.1	1.064	2.680	0.024	0.297	0.000	0.034	0.056
30-Oct-17	26.1	1.064	2.612	0.024	0.297	0.000	0.031	0.054
31-Oct-17	26	1.064	2.586	0.025	0.298	0.000	0.028	0.053
01-Nov-17	26	1.064	2.609	0.026	0.298	0.000	0.025	0.052
02-Nov-17	27.3	1.064	2.588	0.026	0.298	0.000	0.022	0.050
03-Nov-17	26.9	1.064	2.659	0.027	0.299	0.000	0.025	0.049
04-Nov-17	25.9	1.064	2.767	0.028	0.299	0.000	0.028	0.047
05-Nov-17	25.4	1.064	2.720	0.028	0.298	0.000	0.031	0.046
06-Nov-17	25.2	1.064	2.632	0.029	0.298	0.000	0.034	0.045
07-Nov-17	24.7	1.064	2.542	0.030	0.297	0.000	0.032	0.043
08-Nov-17	24.9	1.064	2.549	0.030	0.296	0.000	0.031	0.042
09-Nov-17	24.8	1.064	2.406	0.031	0.296	0.000	0.030	0.040
10-Nov-17	25.6	1.064	2.570	0.032	0.297	0.000	0.029	0.047
11-Nov-17	25.3	1.064	2.570	0.032	0.297	0.000	0.027	0.053
12-Nov-17	25.5	1.064	2.500	0.033	0.297	0.000	0.025	0.058
13-Nov-17	26.3	1.064	2.549	0.034	0.297	0.000	0.024	0.063
14-Nov-17	27	1.064	2.659	0.034	0.301	0.000	0.024	0.067
15-Nov-17	2.26	1.064	2.680	0.035	0.305	0.000	0.025	0.071
16-Nov-17	2.29	1.064	2.686	0.036	0.309	0.000	0.025	0.075
17-Nov-17	2.05	1.064	2.686	0.036	0.313	0.000	0.026	0.079
18-Nov-17	26.7	1.904	0.897	0.076	0.612	0.162	0.030	0.083
19-Nov-17	27.2	1.949	2.195	0.075	0.457	0.163	0.030	0.086
20-Nov-17	27.2	1.994	2.685	0.074	0.617	0.165	0.030	0.088
21-Nov-17	26.9	2.038	2.256	0.072	0.579	0.166	0.030	0.091
22-Nov-17	26.7	2.083	1.625	0.071	0.316	0.168	0.030	0.093
23-Nov-17	26.7	2.128	2.335	0.070	0.278	0.169	0.030	0.095
24-Nov-17	26.6	2.172	2.629	0.069	0.363	0.171	0.030	0.097
25-Nov-17	26.9	2.217	2.270	0.068	0.282	0.173	0.030	0.100
26-Nov-17	28.2	2.262	2.254	0.068	0.134	0.174	0.030	0.102

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
27-Nov-17	30.4	2.307	2.309	0.068	0.330	0.176	0.030	0.104
28-Nov-17	29.9	2.352	1.767	0.068	0.839	0.177	0.030	0.106
29-Nov-17	29.9	2.397	1.825	0.068	0.969	0.179	0.030	0.108
30-Nov-17	31.8	2.442	2.501	0.068	0.551	0.181	0.030	0.110
01-Dec-17	31.7	2.486	2.162	0.068	0.438	0.182	0.031	0.112
02-Dec-17	31.9	2.531	1.717	0.069	0.944	0.184	0.031	0.113
03-Dec-17	31.7	2.576	1.872	0.069	1.240	0.186	0.031	0.115
04-Dec-17	32.5	2.622	2.157	0.069	1.042	0.187	0.031	0.117
05-Dec-17	32.9	2.667	2.105	0.069	0.947	0.189	0.031	0.119
06-Dec-17	32.8	2.712	1.461	0.069	0.908	0.191	0.031	0.121
07-Dec-17	32.3	2.757	1.293	0.069	0.526	0.192	0.031	0.122
08-Dec-17	32.1	2.802	1.436	0.069	0.490	0.194	0.031	0.119
09-Dec-17	31.8	2.847	1.617	0.070	0.851	0.196	0.031	0.131
10-Dec-17	31.5	2.892	1.327	0.070	1.405	0.197	0.031	0.136
11-Dec-17	31.1	2.567	1.341	0.070	1.036	0.199	0.031	0.118
12-Dec-17	30.9	3.125	1.291	0.070	1.545	0.201	0.031	0.149
13-Dec-17	30.5	2.959	1.026	0.070	1.500	0.203	0.032	0.140
14-Dec-17	30.2	2.803	0.931	0.070	1.135	0.204	0.032	0.131
15-Dec-17	29.7	2.155	1.115	0.070	0.810	0.206	0.032	0.129
16-Dec-17	29.5	2.064	1.518	0.071	1.206	0.208	0.032	0.126
17-Dec-17	29.3	2.024	1.194	0.071	1.538	0.210	0.032	0.123
18-Dec-17	29.3	1.983	1.468	0.071	1.444	0.212	0.032	0.121
19-Dec-17	29.0	1.942	1.432	0.071	1.354	0.214	0.032	0.118
20-Dec-17	29.4	1.901	1.158	0.071	1.267	0.215	0.032	0.115
21-Dec-17	30.0	1.860	0.897	0.071	1.183	0.217	0.032	0.113
22-Dec-17	29.7	1.820	0.937	0.071	1.103	0.219	0.032	0.110
23-Dec-17	30.1	1.779	0.976	0.072	1.026	0.221	0.032	0.107
24-Dec-17	29.2	1.738	1.017	0.072	0.952	0.223	0.032	0.103
25-Dec-17	29.1	1.697	1.058	0.072	0.881	0.225	0.033	0.100
26-Dec-17	29.0	1.657	1.100	0.072	0.813	0.227	0.033	0.097
27-Dec-17	28.4	1.616	1.142	0.072	0.748	0.228	0.033	0.093
28-Dec-17	27.9	1.576	1.185	0.072	0.687	0.230	0.033	0.090
29-Dec-17	27.5	1.535	1.229	0.072	0.628	0.232	0.033	0.086
30-Dec-17	27.4	1.495	1.273	0.073	0.572	0.234	0.033	0.082
31-Dec-17	27.6	1.454	1.318	0.073	0.520	0.236	0.033	0.078
01-Jan-18	27.9	1.414	1.363	0.073	0.470	0.238	0.033	0.073
02-Jan-18	28.4	1.374	1.410	0.073	0.423	0.240	0.033	0.068
03-Jan-18	27.8	1.333	1.456	0.073	0.379	0.242	0.033	0.063
04-Jan-18	27.5	1.293	1.504	0.073	0.519	0.244	0.033	0.057
05-Jan-18	27.6	1.253	1.552	0.073	2.366	0.246	0.033	0.051

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
06-Jan-18	27.1	1.331	1.601	0.074	2.702	0.248	0.034	0.055
07-Jan-18	27.0	1.369	1.650	0.074	1.709	0.250	0.034	0.056
08-Jan-18	27.0	1.655	1.700	0.074	1.021	0.252	0.034	0.070
09-Jan-18	27.3	2.146	1.751	0.074	1.218	0.254	0.034	0.096
10-Jan-18	27.6	2.188	1.803	0.074	0.712	0.256	0.034	0.098
11-Jan-18	27.9	2.491	1.855	0.024	1.228	0.000	0.034	0.114
12-Jan-18	28.7	2.497	1.954	0.024	1.032	0.000	0.034	0.112
13-Jan-18	29.2	2.039	1.571	0.024	1.146	0.000	0.034	0.111
14-Jan-18	29.0	2.010	2.250	0.024	1.267	0.000	0.034	0.109
15-Jan-18	28.8	1.981	2.037	0.024	1.395	0.000	0.034	0.107
16-Jan-18	29.2	1.952	1.846	0.024	1.530	0.000	0.034	0.105
17-Jan-18	28.9	1.923	1.135	0.024	1.672	0.000	0.034	0.104
18-Jan-18	28.7	1.894	1.081	0.023	1.821	0.000	0.035	0.102
19-Jan-18	28.6	1.865	1.027	0.023	1.978	0.000	0.035	0.100
20-Jan-18	29.0	1.836	0.975	0.023	2.142	0.000	0.035	0.098
21-Jan-18	29.3	1.807	0.923	0.023	2.314	0.000	0.035	0.096
22-Jan-18	29.2	1.778	0.873	0.023	2.494	0.000	0.035	0.094
23-Jan-18	29.5	1.749	0.824	0.023	2.681	0.000	0.035	0.092
24-Jan-18	29.2	1.720	0.776	0.023	2.346	0.000	0.035	0.090
25-Jan-18	29.3	1.691	0.729	0.023	2.036	0.000	0.035	0.088
26-Jan-18	29.2	1.662	0.683	0.023	1.752	0.000	0.035	0.085
27-Jan-18	29.3	1.633	0.639	0.023	1.491	0.000	0.035	0.083
28-Jan-18	30.0	1.604	0.595	0.023	1.254	0.000	0.035	0.081
29-Jan-18	29.9	1.576	0.552	0.023	1.040	0.000	0.035	0.078
30-Jan-18	29.7	1.547	0.511	0.023	1.130	0.000	0.036	0.076
31-Jan-18	30.0	1.518	0.470	0.023	1.203	0.000	0.036	0.049
01-Feb-18	30.8	1.489	0.431	0.023	1.204	0.000	0.036	0.062
02-Feb-18	31.1	1.081	0.392	0.023	1.201	0.000	0.036	0.043
03-Feb-18	30.8	1.071	0.355	0.022	0.438	0.000	0.036	0.042
04-Feb-18	30.7	1.248	0.319	0.022	0.613	0.000	0.036	0.051
05-Feb-18	30.8	1.529	0.284	0.022	0.953	0.000	0.036	0.064
06-Feb-18	30.7	1.932	0.250	0.022	1.333	0.000	0.036	0.085
07-Feb-18	32.2	1.996	0.379	0.022	2.014	0.000	0.036	0.088
08-Feb-18	32.9	1.991	0.434	0.022	2.436	0.000	0.036	0.088
09-Feb-18	32.5	1.809	0.461	0.022	2.043	0.000	0.036	0.078
10-Feb-18	32.5	1.440	0.682	0.022	1.293	0.000	0.036	0.060
11-Feb-18	32.2	1.285	1.126	0.022	1.594	0.000	0.037	0.052
12-Feb-18	33.5	1.559	1.168	0.022	2.679	0.000	0.037	0.066
13-Feb-18	33.3	1.971	1.486	0.022	2.814	0.000	0.037	0.087
14-Feb-18	32.0	1.994	1.493	0.022	1.695	0.000	0.037	0.088

Date	29 km	Kingfisher Creek	Cooke Creek	Fall Creek	Trinity Creek	Ashton Creek	Brash Creek	Fortune Creek
15-Feb-18	31.9	1.329	1.022	0.022	0.820	0.000	0.037	0.054
16-Feb-18	31.5	1.141	0.961	0.022	0.662	0.000	0.037	0.045
17-Feb-18	31.9	1.006	0.936	0.022	0.413	0.000	0.037	0.039
18-Feb-18	31.9	1.252	0.911	0.022	0.566	0.000	0.037	0.051
19-Feb-18	31.4	1.600	0.887	0.022	1.121	0.000	0.037	0.068
20-Feb-18	31.1	1.673	0.862	0.021	0.932	0.000	0.037	0.071
21-Feb-18	31.4	1.846	0.838	0.021	0.238	0.113	0.037	0.080
22-Feb-18	30.3	1.723	0.815	0.000	0.565	0.118	0.038	0.074
23-Feb-18	29.7	1.776	0.791	0.003	1.796	0.123	0.038	0.077
24-Feb-18	29.3	2.211	0.768	0.005	1.960	0.128	0.038	0.099
25-Feb-18	29.4	2.608	0.745	0.008	1.851	0.133	0.041	0.120
26-Feb-18	28.8	2.568	0.723	0.011	1.081	0.139	0.045	0.118
27-Feb-18	30.8	2.544	0.700	0.013	0.387	0.144	0.049	0.117
28-Feb-18	28.8	3.350	0.678	0.016	0.156	0.150	0.054	0.162

Table 17*: Measured discharge data for the mainstem of the Salmon River and its Tributaries. The 29 km discharge data was from the Water Office of Canada. All measurements are in* m^3s^{-1}

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
01-Jul-16	3.23	0.504	0.149	0.183
02-Jul-16	3.17	0.479	0.149	0.183
03-Jul-16	2.94	0.477	0.149	0.168
04-Jul-16	2.85	0.522	0.149	0.164
05-Jul-16	3.41	0.639	0.149	0.160
06-Jul-16	3.77	0.704	0.149	0.155
07-Jul-16	3.54	0.623	0.149	0.149
08-Jul-16	3.26	0.586	0.148	0.142
09-Jul-16	3.87	0.665	0.148	0.134
10-Jul-16	4.52	0.750	0.148	0.132
11-Jul-16	4.4	0.684	0.147	0.130
12-Jul-16	3.9	0.621	0.147	0.126
13-Jul-16	3.41	0.590	0.147	0.121
14-Jul-16	3.26	0.578	0.147	0.117
15-Jul-16	3.03	0.566	0.146	0.116
16-Jul-16	3.18	0.574	0.146	0.114
17-Jul-16	3.31	0.566	0.146	0.110
18-Jul-16	3.33	0.532	0.146	0.105
19-Jul-16	3.3	0.518	0.145	0.104

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
20-Jul-16	3.95	0.540	0.145	0.102
21-Jul-16	4.4	0.516	0.145	0.100
22-Jul-16	3.88	0.496	0.145	0.097
23-Jul-16	3.45	0.477	0.144	0.095
24-Jul-16	3.09	0.450	0.144	0.092
25-Jul-16	2.57	0.441	0.144	0.089
26-Jul-16	2.32	0.413	0.144	0.086
27-Jul-16	2.14	0.361	0.144	0.084
28-Jul-16	1.97	0.318	0.144	0.080
29-Jul-16	2.06	0.318	0.144	0.077
30-Jul-16	1.82	0.302	0.144	0.075
31-Jul-16	1.68	0.383	0.143	0.072
01-Aug-16	1.81	0.424	0.143	0.069
02-Aug-16	1.78	0.385	0.143	0.066
03-Aug-16	1.91	0.405	0.143	0.064
04-Aug-16	1.94	0.396	0.143	0.061
05-Aug-16	1.74	0.391	0.143	0.059
06-Aug-16	1.53	0.325	0.143	0.056
07-Aug-16	1.44	0.302	0.143	0.053
08-Aug-16	1.36	0.290	0.142	0.047
09-Aug-16	1.28	0.309	0.142	0.043
10-Aug-16	1.32	0.307	0.142	0.041
11-Aug-16	1.3	0.281	0.142	0.037
12-Aug-16	1.23	0.205	0.142	0.033
13-Aug-16	1.16	0.198	0.142	0.030
14-Aug-16	1.1	0.176	0.142	0.027
15-Aug-16	1.01	0.144	0.142	0.024
16-Aug-16	0.983	0.099	0.142	0.021
17-Aug-16	0.937	0.041	0.142	0.017
18-Aug-16	0.858	0.020	0.142	0.013
19-Aug-16	0.819	0.044	0.142	0.010
20-Aug-16	0.792	0.044	0.142	0.007
21-Aug-16	0.792	0.060	0.142	0.007
22-Aug-16	1.66	0.088	0.143	0.007
23-Aug-16	1.47	0.142	0.143	0.007
24-Aug-16	1.38	0.166	0.143	0.007
25-Aug-16	1.3	0.156	0.143	0.007
26-Aug-16	1.36	0.171	0.143	0.007
27-Aug-16	1.39	0.152	0.143	0.007
28-Aug-16	1.57	0.265	0.143	0.007

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
29-Aug-16	1.74	0.258	0.144	0.010
30-Aug-16	1.03	0.237	0.144	0.013
31-Aug-16	0.986	0.184	0.144	0.015
01-Sep-16	0.889	0.166	0.144	0.018
02-Sep-16	1.07	0.316	0.144	0.020
03-Sep-16	1.26	0.311	0.145	0.022
04-Sep-16	1.38	0.309	0.145	0.024
05-Sep-16	1.47	0.286	0.145	0.027
06-Sep-16	1.58	0.350	0.145	0.029
07-Sep-16	1.69	0.363	0.145	0.030
08-Sep-16	1.88	0.387	0.145	0.032
09-Sep-16	1.67	0.370	0.146	0.034
10-Sep-16	1.56	0.361	0.146	0.037
11-Sep-16	1.48	0.358	0.146	0.039
12-Sep-16	1.48	0.345	0.146	0.041
13-Sep-16	1.42	0.332	0.146	0.042
14-Sep-16	1.37	0.309	0.146	0.045
15-Sep-16	1.37	0.286	0.147	0.047
16-Sep-16	1.31	0.272	0.147	0.049
17-Sep-16	1.46	0.318	0.147	0.051
18-Sep-16	1.71	0.383	0.147	0.052
19-Sep-16	1.74	0.428	0.147	0.054
20-Sep-16	1.91	0.433	0.147	0.056
21-Sep-16	1.85	0.428	0.147	0.058
22-Sep-16	1.78	0.407	0.148	0.059
23-Sep-16	1.66	0.394	0.148	0.061
24-Sep-16	1.71	0.396	0.148	0.062
25-Sep-16	1.77	0.409	0.148	0.065
26-Sep-16	1.71	0.391	0.148	0.067
27-Sep-16	1.76	0.381	0.148	0.069
28-Sep-16	1.6	0.354	0.149	0.071
29-Sep-16	1.57	0.350	0.149	0.073
30-Sep-16	1.65	0.336	0.149	0.074
01-Oct-16	1.57	0.323	0.149	0.076
02-Oct-16	1.55	0.313	0.149	0.077
03-Oct-16	1.53	0.316	0.149	0.079
04-Oct-16	1.48	0.313	0.149	0.081
05-Oct-16	1.49	0.313	0.150	0.082
06-Oct-16	1.49	0.323	0.150	0.084
07-Oct-16	2.04	0.370	0.150	0.085

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
08-Oct-16	2.6	0.606	0.150	0.087
09-Oct-16	3.79	0.792	0.150	0.088
10-Oct-16	3.46	0.702	0.150	0.090
11-Oct-16	2.86	0.600	0.150	0.091
12-Oct-16	2.51	0.548	0.151	0.093
13-Oct-16	2.67	0.536	0.151	0.095
14-Oct-16	3.49	0.598	0.151	0.096
15-Oct-16	4.13	0.757	0.152	0.098
16-Oct-16	4.35	0.750	0.152	0.102
17-Oct-16	4.11	0.730	0.152	0.106
18-Oct-16	4.15	0.708	0.152	0.106
19-Oct-16	3.85	0.674	0.152	0.107
20-Oct-16	3.85	0.656	0.152	0.108
21-Oct-16	4.08	0.701	0.152	0.109
22-Oct-16	3.78	0.663	0.153	0.111
23-Oct-16	3.56	0.635	0.153	0.115
24-Oct-16	3.4	0.608	0.153	0.116
25-Oct-16	3.75	0.614	0.153	0.117
26-Oct-16	4.62	0.713	0.153	0.118
27-Oct-16	5.33	0.752	0.153	0.120
28-Oct-16	5.45	0.697	0.153	0.121
29-Oct-16	5.45	0.674	0.153	0.123
30-Oct-16	5.19	0.652	0.154	0.124
31-Oct-16	5.04	0.739	0.154	0.124
01-Nov-16	5.56	0.732	0.154	0.124
02-Nov-16	5.76	0.755	0.154	0.124
03-Nov-16	6.01	0.723	0.154	0.124
04-Nov-16	5.61	0.691	0.154	0.124
05-Nov-16	5.25	0.702	0.154	0.124
06-Nov-16	4.83	0.710	0.155	0.124
07-Nov-16	4.63	0.678	0.155	0.124
08-Nov-16	4.41	0.656	0.155	0.124
09-Nov-16	4.25	0.659	0.155	0.125
10-Nov-16	4.2	0.642	0.155	0.125
11-Nov-16	4.09	0.635	0.155	0.125
12-Nov-16	4.25	0.654	0.155	0.125
13-Nov-16	4.22	0.644	0.156	0.125
14-Nov-16	4.27	0.659	0.156	0.125
15-Nov-16	4.53	0.637	0.156	0.125
16-Nov-16	4.42	0.614	0.156	0.125

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
17-Nov-16	4.27	0.590	0.156	0.125
18-Nov-16	4.02	0.600	0.156	0.125
19-Nov-16	4	0.590	0.156	0.125
20-Nov-16	4.04	0.594	0.157	0.125
21-Nov-16	4.04	0.594	0.157	0.125
22-Nov-16	3.93	0.582	0.157	0.125
23-Nov-16	3.85	0.568	0.157	0.125
24-Nov-16	3.83	0.574	0.157	0.125
25-Nov-16	3.77	0.572	0.157	0.126
26-Nov-16	4.14	0.602	0.157	0.126
27-Nov-16	4.15	0.606	0.157	0.126
28-Nov-16	3.96	0.584	0.158	0.126
29-Nov-16	3.79	0.568	0.158	0.126
30-Nov-16	3.73	0.560	0.158	0.126
01-Dec-16	3.62	0.560	0.158	0.126
02-Dec-16	3.57	0.556	0.158	0.126
03-Dec-16	3.48	0.546	0.158	0.126
04-Dec-16	3.34	0.343	0.158	0.126
05-Dec-16	3.28	0.405	0.158	0.126
06-Dec-16	2.66	0.426	0.159	0.126
07-Dec-16	1.78	0.540	0.159	0.126
08-Dec-16	1.15	0.540	0.159	0.126
09-Dec-16	1.17	0.540	0.159	0.126
10-Dec-16	1.17	0.540	0.159	0.127
11-Dec-16	1.17	0.540	0.159	0.127
12-Dec-16	1.17	0.540	0.159	0.127
13-Dec-16	1.17	0.540	0.160	0.127
14-Dec-16	1.17	0.540	0.160	0.127
15-Dec-16	1.17	0.540	0.161	0.127
16-Dec-16	1.17	0.540	0.161	0.127
17-Dec-16	1.19	0.540	0.161	0.127
18-Dec-16	1.21	0.540	0.161	0.127
19-Dec-16	1.23	0.540	0.162	0.128
20-Dec-16	1.25	0.540	0.162	0.128
21-Dec-16	1.26	0.544	0.162	0.128
22-Dec-16	1.28	0.454	0.162	0.128
23-Dec-16	1.3	0.439	0.162	0.128
24-Dec-16	1.3	0.409	0.163	0.128
25-Dec-16	1.29	0.428	0.162	0.128
26-Dec-16	1.29	0.420	0.162	0.128

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
27-Dec-16	1.29	0.420	0.161	0.128
28-Dec-16	1.28	0.420	0.161	0.128
29-Dec-16	1.28	0.365	0.162	0.128
30-Dec-16	1.28	0.418	0.162	0.128
31-Dec-16	1.28	0.516	0.162	0.128
01-Jan-17	1.28	0.487	0.162	0.128
02-Jan-17	1.27	0.449	0.162	0.128
03-Jan-17	1.27	0.410	0.162	0.128
04-Jan-17	1.26	0.378	0.162	0.128
05-Jan-17	1.25	0.376	0.162	0.128
06-Jan-17	1.24	0.370	0.163	0.128
07-Jan-17	1.23	0.372	0.163	0.128
08-Jan-17	1.23	0.372	0.164	0.128
09-Jan-17	1.22	0.370	0.164	0.129
10-Jan-17	1.21	0.367	0.163	0.129
11-Jan-17	1.2	0.347	0.163	0.129
12-Jan-17	1.19	0.347	0.163	0.129
13-Jan-17	1.22	0.356	0.163	0.129
14-Jan-17	1.25	0.367	0.164	0.129
15-Jan-17	1.46	0.370	0.164	0.129
16-Jan-17	1.74	0.361	0.164	0.129
17-Jan-17	2.04	0.358	0.164	0.129
18-Jan-17	2.14	0.358	0.164	0.129
19-Jan-17	2.23	0.358	0.164	0.129
20-Jan-17	2.24	0.352	0.164	0.129
21-Jan-17	2.22	0.363	0.164	0.129
22-Jan-17	2.21	0.358	0.165	0.129
23-Jan-17	2.19	0.241	0.165	0.129
24-Jan-17	2.22	0.290	0.165	0.129
25-Jan-17	2.72	0.253	0.165	0.129
26-Jan-17	2.57	0.288	0.165	0.130
27-Jan-17	2.45	0.246	0.165	0.130
28-Jan-17	2.33	0.370	0.165	0.130
29-Jan-17	2.28	0.435	0.165	0.130
30-Jan-17	2.05	0.295	0.165	0.130
31-Jan-17	1.13	0.253	0.166	0.130
01-Feb-17	0.73	0.267	0.166	0.130
02-Feb-17	0.979	0.263	0.166	0.130
03-Feb-17	1.35	0.256	0.166	0.130
04-Feb-17	1.85	0.253	0.166	0.130

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
05-Feb-17	2.32	0.213	0.166	0.130
06-Feb-17	2.44	0.258	0.166	0.130
07-Feb-17	2.27	0.297	0.166	0.130
08-Feb-17	2.12	0.325	0.167	0.130
09-Feb-17	2.48	0.286	0.167	0.130
10-Feb-17	2.73	0.320	0.167	0.131
11-Feb-17	2.85	0.304	0.167	0.131
12-Feb-17	2.78	0.293	0.167	0.131
13-Feb-17	2.66	0.286	0.167	0.131
14-Feb-17	2.34	0.156	0.167	0.131
15-Feb-17	2.67	0.174	0.167	0.131
16-Feb-17	2.87	0.169	0.168	0.131
17-Feb-17	4.43	0.263	0.168	0.131
18-Feb-17	3.48	0.152	0.168	0.131
19-Feb-17	3.27	0.295	0.168	0.131
20-Feb-17	2.95	0.272	0.168	0.131
21-Feb-17	2.1	0.267	0.168	0.131
22-Feb-17	1.92	0.149	0.168	0.131
23-Feb-17	1.93	0.193	0.168	0.131
24-Feb-17	1.65	0.129	0.168	0.131
25-Feb-17	1.71	0.220	0.169	0.131
26-Feb-17	1.61	0.174	0.169	0.132
27-Feb-17	1.53	0.267	0.169	0.132
28-Feb-17	1.32	0.260	0.169	0.132
01-Mar-17	1.73	0.256	0.169	0.132
02-Mar-17	1.54	0.295	0.169	0.132
03-Mar-17	1.48	0.307	0.169	0.132
04-Mar-17	1.67	0.387	0.169	0.132
05-Mar-17	1.62	0.485	0.170	0.132
06-Mar-17	1.56	0.447	0.170	0.132
07-Mar-17	1.53	0.479	0.170	0.132
08-Mar-17	1.54	0.471	0.170	0.132
09-Mar-17	1.47	0.452	0.170	0.132
10-Mar-17	1.53	0.469	0.170	0.132
11-Mar-17	1.49	0.498	0.170	0.132
12-Mar-17	1.51	0.530	0.171	0.133
13-Mar-17	1.88	0.554	0.171	0.133
14-Mar-17	2.38	0.544	0.342	0.133
15-Mar-17	3.17	0.558	0.342	0.133
16-Mar-17	4.37	0.556	0.342	0.133

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
17-Mar-17	4.44	0.600	0.342	0.133
18-Mar-17	4	0.608	0.343	0.133
19-Mar-17	4.68	0.642	0.343	0.133
20-Mar-17	4.31	0.629	0.343	0.133
21-Mar-17	4.06	0.717	0.343	0.133
22-Mar-17	4.7	0.826	0.344	0.133
23-Mar-17	5.42	0.726	0.344	0.133
24-Mar-17	5.14	0.699	0.344	0.133
25-Mar-17	5.18	0.697	0.344	0.133
26-Mar-17	5.11	0.723	0.345	0.134
27-Mar-17	4.86	0.912	0.345	0.134
28-Mar-17	5.28	0.978	0.345	0.134
29-Mar-17	5.48	0.912	0.345	0.134
30-Mar-17	5.99	0.873	0.346	0.134
31-Mar-17	5.65	0.832	0.346	0.134
01-Apr-17	6.49	0.827	0.346	0.134
02-Apr-17	7.15	0.865	0.347	0.134
03-Apr-17	7.1	0.915	0.347	0.134
04-Apr-17	6.71	0.873	0.347	0.134
05-Apr-17	6.4	0.861	0.347	0.134
06-Apr-17	6.7	0.861	0.347	0.134
07-Apr-17	9.19	0.952	0.347	0.134
08-Apr-17	10.8	1.034	0.347	0.134
09-Apr-17	11.3	1.116	0.347	0.130
10-Apr-17	11.1	1.215	0.548	0.125
11-Apr-17	10.5	1.211	0.581	0.118
12-Apr-17	10	1.208	0.613	0.124
13-Apr-17	11.3	1.199	0.663	0.132
14-Apr-17	12	1.185	0.639	0.141
15-Apr-17	11.6	1.167	0.613	0.155
16-Apr-17	11.2	1.242	0.582	0.155
17-Apr-17	11.1	1.263	0.565	0.155
18-Apr-17	12.3	1.219	0.546	0.155
19-Apr-17	13.9	1.195	0.528	0.155
20-Apr-17	15.3	1.179	0.534	0.155
21-Apr-17	18.8	1.159	0.540	0.155
22-Apr-17	20.1	1.000	0.536	0.160
23-Apr-17	20.9	0.995	0.534	0.164
24-Apr-17	21.4	0.992	0.532	0.165
25-Apr-17	21.5	0.983	0.531	0.166

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
26-Apr-17	22.3	0.967	0.529	0.166
27-Apr-17	22.9	0.946	0.527	0.167
28-Apr-17	23.7	1.031	0.528	0.167
29-Apr-17	23.5	1.054	0.525	0.168
30-Apr-17	24	1.005	0.523	0.167
01-May-17	23.2	0.978	0.521	0.168
02-May-17	22.3	0.960	0.521	0.169
03-May-17	22.5	0.938	0.521	0.169
04-May-17	25.6	1.003	0.526	0.167
05-May-17	36.6	1.327	0.530	0.164
06-May-17	49.7	1.832	0.531	0.167
07-May-17	53.3	1.773	0.534	0.169
08-May-17	51.8	1.598	0.715	0.170
09-May-17	49.2	1.410	0.718	0.171
10-May-17	47.5	1.352	0.711	0.172
11-May-17	46.9	1.325	0.694	0.174
12-May-17	49.1	1.403	0.800	0.198
13-May-17	50.1	1.595	0.803	0.255
14-May-17	48.6	1.493	0.787	0.255
15-May-17	46	1.325	0.787	0.255
16-May-17	44	1.249	0.787	0.255
17-May-17	43.1	1.248	0.787	0.255
18-May-17	41.7	1.330	0.787	0.255
19-May-17	41.7	1.289	0.697	0.249
20-May-17	42.1	1.291	0.702	0.234
21-May-17	43.4	1.287	0.726	0.207
22-May-17	45.7	1.317	0.718	0.208
23-May-17	47.8	1.441	0.762	0.215
24-May-17	51.1	1.454	0.833	0.213
25-May-17	47.4	1.500	0.854	0.228
26-May-17	46.1	1.301	0.832	0.254
27-May-17	44.1	1.273	0.810	0.262
28-May-17	42.9	1.258	0.779	0.276
29-May-17	42	1.289	0.718	0.288
30-May-17	40.8	1.317	0.735	0.304
31-May-17	41.9	1.299	0.756	0.330
01-Jun-17	39.8	1.441	0.741	0.342
02-Jun-17	36.7	1.353	0.741	0.358
03-Jun-17	32.7	1.236	0.736	0.346
04-Jun-17	28.5	1.141	0.728	0.324

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
05-Jun-17	25.2	1.078	0.720	0.349
06-Jun-17	22.6	1.017	0.738	0.383
07-Jun-17	21.5	0.956	0.786	0.413
08-Jun-17	19.7	0.915	0.590	0.392
09-Jun-17	18.2	0.902	0.584	0.322
10-Jun-17	16.6	0.872	0.588	0.319
11-Jun-17	15.9	0.801	0.606	0.323
12-Jun-17	15	0.784	0.623	0.320
13-Jun-17	14.2	0.743	0.640	0.307
14-Jun-17	13.4	0.676	0.607	0.294
15-Jun-17	12.3	0.667	0.556	0.278
16-Jun-17	12.3	0.623	0.551	0.271
17-Jun-17	11.4	0.658	0.549	0.262
18-Jun-17	10.6	0.614	0.544	0.254
19-Jun-17	9.83	0.578	0.540	0.249
20-Jun-17	9.91	0.561	0.360	0.240
21-Jun-17	9.23	0.409	0.179	0.232
22-Jun-17	8.53	0.365	0.179	0.235
23-Jun-17	7.93	0.323	0.179	0.240
24-Jun-17	7.32	0.281	0.179	0.237
25-Jun-17	6.89	0.237	0.179	0.232
26-Jun-17	6.48	0.201	0.179	0.230
27-Jun-17	5.95	0.176	0.179	0.227
28-Jun-17	5.53	0.134	0.179	0.223
29-Jun-17	5.42	0.119	0.179	0.223
30-Jun-17	5.15	0.137	0.178	0.220
01-Jul-17	4.62	0.086	0.177	0.213
02-Jul-17	4.18	0.110	0.175	0.205
03-Jul-17	3.86	0.133	0.174	0.198
04-Jul-17	3.54	0.157	0.172	0.190
05-Jul-17	3.33	0.180	0.170	0.182
06-Jul-17	3.34	0.203	0.169	0.174
07-Jul-17	2.94	0.229	0.167	0.172
08-Jul-17	2.72	0.255	0.164	0.170
09-Jul-17	2.55	0.280	0.162	0.168
10-Jul-17	2.43	0.305	0.160	0.166
11-Jul-17	2.37	0.330	0.157	0.164
12-Jul-17	2.27	0.384	0.153	0.158
13-Jul-17	2.15	0.436	0.149	0.151
14-Jul-17	1.98	0.487	0.144	0.145

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
15-Jul-17	1.88	0.479	0.144	0.144
16-Jul-17	1.82	0.472	0.143	0.143
17-Jul-17	1.77	0.464	0.142	0.142
18-Jul-17	1.68	0.456	0.141	0.141
19-Jul-17	1.61	0.449	0.141	0.140
20-Jul-17	1.53	0.449	0.141	0.135
21-Jul-17	1.48	0.449	0.142	0.131
22-Jul-17	1.48	0.449	0.142	0.127
23-Jul-17	1.46	0.449	0.143	0.122
24-Jul-17	1.48	0.449	0.144	0.117
25-Jul-17	1.33	0.449	0.144	0.113
26-Jul-17	1.25	0.436	0.142	0.107
27-Jul-17	1.19	0.423	0.141	0.101
28-Jul-17	1.15	0.410	0.139	0.096
29-Jul-17	1.17	0.397	0.137	0.090
30-Jul-17	1.08	0.384	0.135	0.084
31-Jul-17	1.05	0.370	0.133	0.077
01-Aug-17	1.02	0.370	0.132	0.076
02-Aug-17	1.03	0.370	0.132	0.074
03-Aug-17	1	0.370	0.131	0.072
04-Aug-17	1.01	0.370	0.131	0.070
05-Aug-17	0.979	0.370	0.131	0.069
06-Aug-17	0.95	0.370	0.130	0.067
07-Aug-17	0.944	0.370	0.130	0.065
08-Aug-17	0.909	0.370	0.130	0.063
09-Aug-17	0.846	0.370	0.129	0.062
10-Aug-17	0.857	0.370	0.129	0.060
11-Aug-17	0.829	0.370	0.128	0.058
12-Aug-17	0.834	0.369	0.128	0.056
13-Aug-17	0.817	0.367	0.128	0.055
14-Aug-17	0.829	0.366	0.128	0.053
15-Aug-17	0.84	0.364	0.128	0.052
16-Aug-17	0.834	0.363	0.127	0.050
17-Aug-17	0.801	0.361	0.127	0.049
18-Aug-17	0.812	0.360	0.127	0.047
19-Aug-17	0.823	0.358	0.127	0.046
20-Aug-17	0.851	0.357	0.127	0.044
21-Aug-17	0.886	0.355	0.127	0.043
22-Aug-17	0.863	0.354	0.126	0.041
23-Aug-17	0.806	0.352	0.126	0.040

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
24-Aug-17	0.73	0.351	0.126	0.038
25-Aug-17	0.806	0.349	0.126	0.036
26-Aug-17	0.817	0.348	0.126	0.035
27-Aug-17	0.829	0.346	0.126	0.033
28-Aug-17	0.762	0.345	0.125	0.032
29-Aug-17	0.719	0.343	0.125	0.030
30-Aug-17	0.746	0.342	0.125	0.028
31-Aug-17	0.698	0.340	0.125	0.027
01-Sep-17	0.708	0.339	0.125	0.025
02-Sep-17	0.73	0.337	0.125	0.024
03-Sep-17	0.714	0.336	0.124	0.022
04-Sep-17	0.708	0.334	0.124	0.020
05-Sep-17	0.708	0.333	0.124	0.019
06-Sep-17	0.74	0.331	0.124	0.017
07-Sep-17	0.806	0.330	0.124	0.015
08-Sep-17	0.851	0.333	0.124	0.005
09-Sep-17	0.914	0.335	0.124	0.005
10-Sep-17	0.962	0.338	0.124	0.005
11-Sep-17	0.909	0.341	0.124	0.022
12-Sep-17	0.857	0.343	0.124	0.020
13-Sep-17	0.909	0.346	0.124	0.019
14-Sep-17	0.91	0.349	0.124	0.017
15-Sep-17	0.912	0.351	0.124	0.005
16-Sep-17	0.914	0.354	0.124	0.022
17-Sep-17	0.962	0.357	0.124	0.020
18-Sep-17	0.997	0.360	0.124	0.019
19-Sep-17	1	0.362	0.124	0.017
20-Sep-17	1.02	0.365	0.124	0.005
21-Sep-17	1.03	0.368	0.124	0.005
22-Sep-17	1.06	0.370	0.124	0.005
23-Sep-17	1.02	0.330	0.157	0.164
24-Sep-17	1.03	0.384	0.153	0.158
25-Sep-17	1.06	0.436	0.149	0.151
26-Sep-17	1.08	0.487	0.144	0.145
27-Sep-17	1.08	0.479	0.144	0.144
28-Sep-17	1.06	0.472	0.143	0.143
29-Sep-17	1.05	0.464	0.142	0.142
30-Sep-17	1.06	0.456	0.141	0.141
01-Oct-17	1.12	0.449	0.141	0.140
02-Oct-17	1.14	0.449	0.141	0.135

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
03-Oct-17	1.15	0.449	0.142	0.131
04-Oct-17	1.17	0.449	0.142	0.127
05-Oct-17	1.19	0.449	0.143	0.122
06-Oct-17	1.19	0.449	0.144	0.117
07-Oct-17	1.25	0.449	0.144	0.113
08-Oct-17	1.33	0.436	0.142	0.107
09-Oct-17	1.31	0.423	0.141	0.101
10-Oct-17	1.27	0.479	0.144	0.144
11-Oct-17	1.26	0.472	0.143	0.143
12-Oct-17	1.27	0.464	0.142	0.142
13-Oct-17	1.42	0.456	0.141	0.141
14-Oct-17	1.33	0.449	0.141	0.140
15-Oct-17	1.35	0.449	0.141	0.135
16-Oct-17	1.33	0.449	0.142	0.131
17-Oct-17	1.3	0.370	0.131	0.070
18-Oct-17	1.42	0.370	0.131	0.069
19-Oct-17	1.6	0.369	0.128	0.056
20-Oct-17	1.53	0.370	0.130	0.065
21-Oct-17	1.44	0.370	0.130	0.063
22-Oct-17	1.62	0.370	0.129	0.062
23-Oct-17	1.51	0.370	0.129	0.060
24-Oct-17	1.44	0.370	0.128	0.058
25-Oct-17	1.42	0.369	0.128	0.056
26-Oct-17	1.47	0.367	0.128	0.055
27-Oct-17	1.47	0.366	0.128	0.053
28-Oct-17	1.48	0.364	0.128	0.052
29-Oct-17	1.47	0.369	0.128	0.056
30-Oct-17	1.47	0.361	0.127	0.049
31-Oct-17	1.45	0.360	0.127	0.047
01-Nov-17	1.5	0.358	0.127	0.046
02-Nov-17	1.79	0.357	0.127	0.044
03-Nov-17	1.75	0.355	0.127	0.043
04-Nov-17	1.49	0.354	0.126	0.041
05-Nov-17	1.64	0.352	0.126	0.040
06-Nov-17	1.55	0.351	0.126	0.038
07-Nov-17	1.44	0.349	0.126	0.036
08-Nov-17	1.85	0.348	0.126	0.035
09-Nov-17	1.79	0.346	0.126	0.033
10-Nov-17	1.85	0.369	0.128	0.056
11-Nov-17	1.7	0.343	0.125	0.030

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
12-Nov-17	1.72	0.342	0.125	0.028
13-Nov-17	2.06	0.340	0.125	0.027
14-Nov-17	2.37	0.339	0.125	0.025
15-Nov-17	2.29	0.337	0.125	0.024
16-Nov-17	2.19	0.336	0.124	0.022
17-Nov-17	2.22	0.334	0.124	0.020
18-Nov-17	1.87	0.333	0.124	0.019
19-Nov-17	1.79	0.331	0.124	0.017
20-Nov-17	1.74	0.330	0.124	0.015
21-Nov-17	1.7	0.333	0.124	0.005
22-Nov-17	1.8	0.369	0.128	0.056
23-Nov-17	1.92	0.338	0.124	0.005
24-Nov-17	1.93	0.341	0.124	0.022
25-Nov-17	1.92	0.343	0.124	0.020
26-Nov-17	1.99	0.346	0.124	0.019
27-Nov-17	1.94	0.349	0.124	0.017
28-Nov-17	1.85	0.351	0.124	0.005
29-Nov-17	1.81	0.354	0.124	0.022
30-Nov-17	1.78	0.357	0.124	0.020
01-Dec-17	1.79	0.369	0.128	0.056
02-Dec-17	1.77	0.369	0.128	0.056
03-Dec-17	1.74	0.365	0.124	0.005
04-Dec-17	1.74	0.368	0.124	0.005
05-Dec-17	1.63	0.370	0.124	0.005
06-Dec-17	1.64	0.560	0.158	0.126
07-Dec-17	1.64	0.556	0.158	0.126
08-Dec-17	1.64	0.546	0.158	0.126
09-Dec-17	1.58	0.343	0.158	0.126
10-Dec-17	1.5	0.405	0.158	0.126
11-Dec-17	1.48	0.426	0.159	0.126
12-Dec-17	1.55	0.540	0.159	0.126
13-Dec-17	1.58	0.540	0.159	0.126
14-Dec-17	1.6	0.540	0.159	0.126
15-Dec-17	1.55	0.540	0.159	0.127
16-Dec-17	1.55	0.540	0.159	0.127
17-Dec-17	1.56	0.540	0.159	0.127
18-Dec-17	1.65	0.540	0.160	0.127
19-Dec-17	1.63	0.540	0.160	0.127
20-Dec-17	2.06	0.540	0.161	0.127
21-Dec-17	2.11	0.540	0.161	0.127

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
22-Dec-17	2.11	0.540	0.161	0.127
23-Dec-17	1.68	0.540	0.161	0.127
24-Dec-17	1.65	0.540	0.162	0.128
25-Dec-17	1.56	0.540	0.162	0.128
26-Dec-17	1.57	0.544	0.162	0.128
27-Dec-17	1.56	0.454	0.162	0.128
28-Dec-17	1.57	0.439	0.162	0.128
29-Dec-17	1.58	0.409	0.163	0.128
30-Dec-17	1.52	0.428	0.162	0.128
31-Dec-17	1.47	0.420	0.162	0.128
01-Jan-18	1.23	0.420	0.161	0.128
02-Jan-18	1.78	0.420	0.161	0.128
03-Jan-18	1.69	0.365	0.162	0.128
04-Jan-18	1.71	0.418	0.162	0.128
05-Jan-18	1.65	0.516	0.162	0.128
06-Jan-18	1.65	0.487	0.162	0.128
07-Jan-18	1.62	0.449	0.162	0.128
08-Jan-18	1.91	0.410	0.162	0.128
09-Jan-18	1.99	0.378	0.162	0.128
10-Jan-18	1.84	0.376	0.162	0.128
11-Jan-18	1.78	0.370	0.163	0.128
12-Jan-18	1.74	0.372	0.163	0.128
13-Jan-18	1.84	0.372	0.164	0.128
14-Jan-18	1.59	0.370	0.164	0.129
15-Jan-18	1.32	0.367	0.163	0.129
16-Jan-18	2.1	0.347	0.163	0.129
17-Jan-18	2.31	0.347	0.163	0.129
18-Jan-18	1.99	0.356	0.163	0.129
19-Jan-18	1.87	0.367	0.164	0.129
20-Jan-18	1.75	0.370	0.164	0.129
21-Jan-18	1.6	0.361	0.164	0.129
22-Jan-18	1.72	0.358	0.164	0.129
23-Jan-18	1.63	0.358	0.164	0.129
24-Jan-18	1.92	0.358	0.164	0.129
25-Jan-18	1.48	0.352	0.164	0.129
26-Jan-18	2.37	0.363	0.164	0.129
27-Jan-18	2.01	0.358	0.165	0.129
28-Jan-18	2.2	0.241	0.165	0.129
29-Jan-18	2.29	0.290	0.165	0.129
30-Jan-18	2.35	0.253	0.165	0.129

Date	66 km	Bolean Creek	Spa Creek	Silver Creek
31-Jan-18	2.3	0.288	0.165	0.130
01-Feb-18	1.65	0.246	0.165	0.130
02-Feb-18	1.62	0.370	0.165	0.130
03-Feb-18	1.91	0.435	0.165	0.130
04-Feb-18	1.99	0.295	0.165	0.130
05-Feb-18	1.84	0.253	0.166	0.130
06-Feb-18	1.78	0.267	0.166	0.130
07-Feb-18	1.74	0.263	0.166	0.130
08-Feb-18	1.84	0.256	0.166	0.130
09-Feb-18	1.59	0.253	0.166	0.130
10-Feb-18	1.32	0.213	0.166	0.130
11-Feb-18	2.1	0.258	0.166	0.130
12-Feb-18	2.31	0.297	0.166	0.130
13-Feb-18	1.99	0.325	0.167	0.130
14-Feb-18	1.87	0.286	0.167	0.130
15-Feb-18	1.75	0.320	0.167	0.131
16-Feb-18	1.6	0.304	0.167	0.131
17-Feb-18	1.72	0.293	0.167	0.131
18-Feb-18	1.63	0.286	0.167	0.131
19-Feb-18	1.92	0.156	0.167	0.131
20-Feb-18	1.48	0.174	0.167	0.131
21-Feb-18	2.37	0.169	0.168	0.131
22-Feb-18	1.84	0.263	0.168	0.131
23-Feb-18	1.59	0.152	0.168	0.131
24-Feb-18	1.32	0.295	0.168	0.131
25-Feb-18	2.1	0.272	0.168	0.131
26-Feb-18	1.59	0.267	0.168	0.131
27-Feb-18	1.32	0.149	0.168	0.131
28-Feb-18	2.1	0.193	0.168	0.131

Appendix B: Rating Curves

***Table 18**: Stage height and measured discharge for tributary rating curves*

Kingfisher Creek		**Cooke Creek**		**Fall Creek**	
Stage(cm)	Discharge (m^3s^{-1})	Stage (cm)	Discharge (m^3s^{-1})	Stage (cm)	Discharge (m^3s^{-1})
39.4	1.718	34	1.860	18.5	0.293
60.1	2.658	23.5	0.671	15	0.238
19.4	0.821	30	1.210	19	0.299
42.8	1.980	50	2.076	17	0.269
7.0	0.050	0	0.050	5	0.010
33.0	1.100	10.5	0.450	11	0.120
Trinity Creek		**Ashton Creek**		**Brash Creek**	
Stage (cm)	Discharge (m^3s^{-1})	Stage (cm)	Discharge (m^3s^{-1})	Stage (cm)	Discharge (m^3s^{-1})
29.8	0.313	15	0.338	15.5	0.255
20.7	0.278	17	0.258	11	0.150
67.0	3.650	25	0.803	26	0.684
55.0	1.260	26	0.985	29.5	1.387
71.8	2.360	7	0.180	3.8	0.013
		24.6	0.360	20.5	0.593
		0	0.000	11.3	0.286
Fortune Creek		**Bolean Creek**		**Spa Creek**	
Stage (cm)	Discharge (m^3s^{-1})	Stage (cm)	Discharge (m^3s^{-1})	Stage (cm)	Discharge (m^3s^{-1})
6	0.052	39.5	0.099	11	4.884
12	0.094	46	0.371	4	0.378
21	0.529	40	0.103	13	12.675
22	0.614	43.5	0.187	8	6.340
14	0.386	45	**0.237**	4.5	3.340
10.5	0.289	41	0.111	6.5	3.890
Silver Creek					
Stage (cm)	Discharge (m^3s^{-1})				
31	1.430				
20	0.150				
21	0.290				
30	1.100				
15	0.100				
26	0.530				

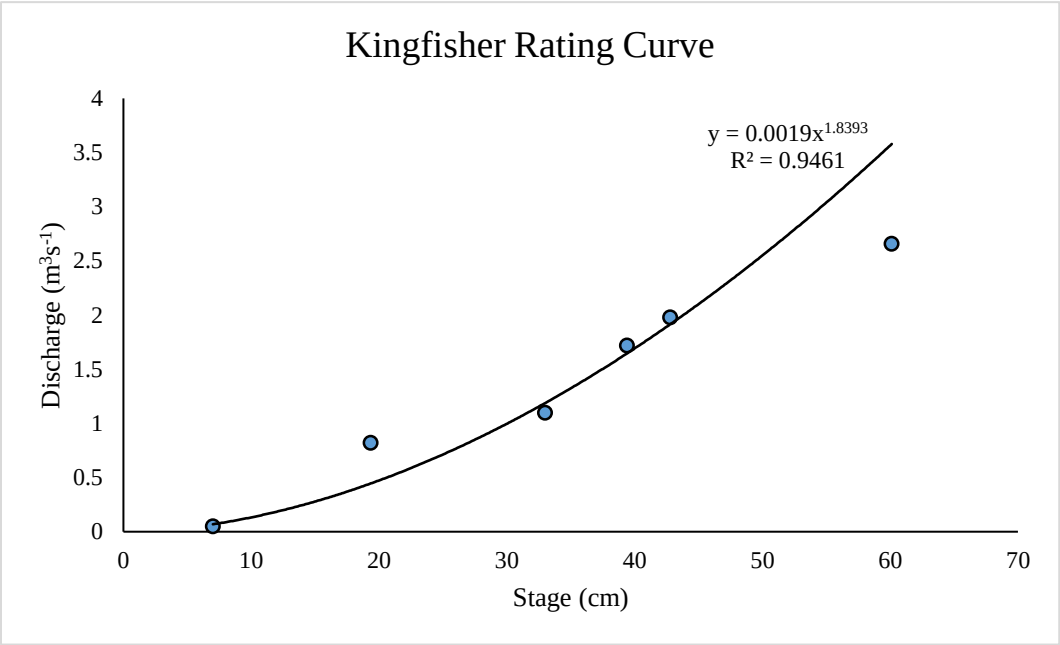

Figure 45: *Discharge rating curve for Kingfisher Creek, a tributary on the Shuswap River*

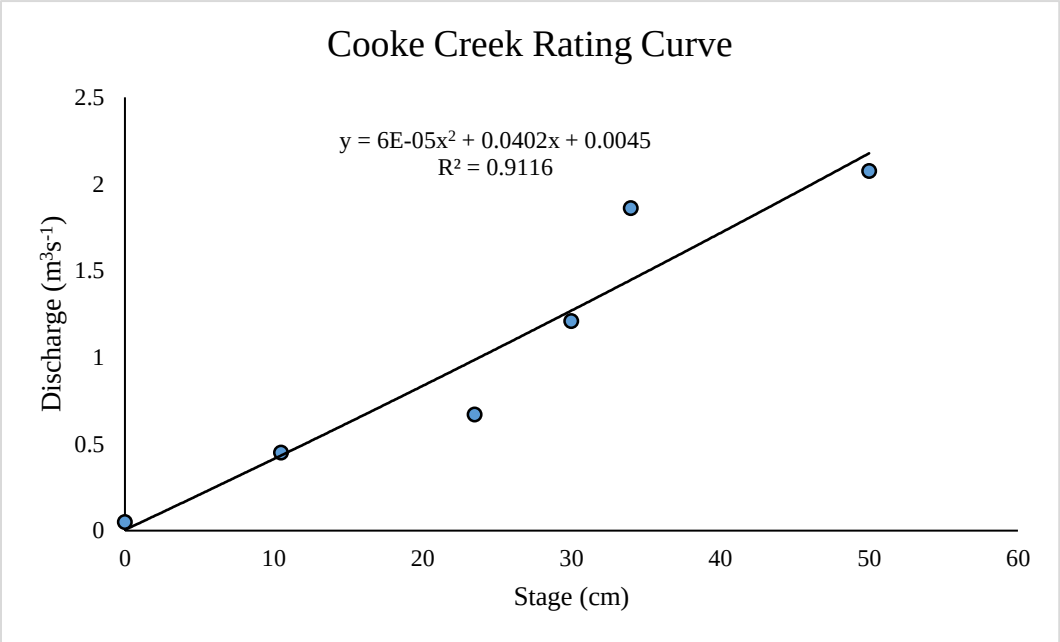

Figure 46*: Discharge rating curve for Cooke Creek, a tributary on the Shuswap River*

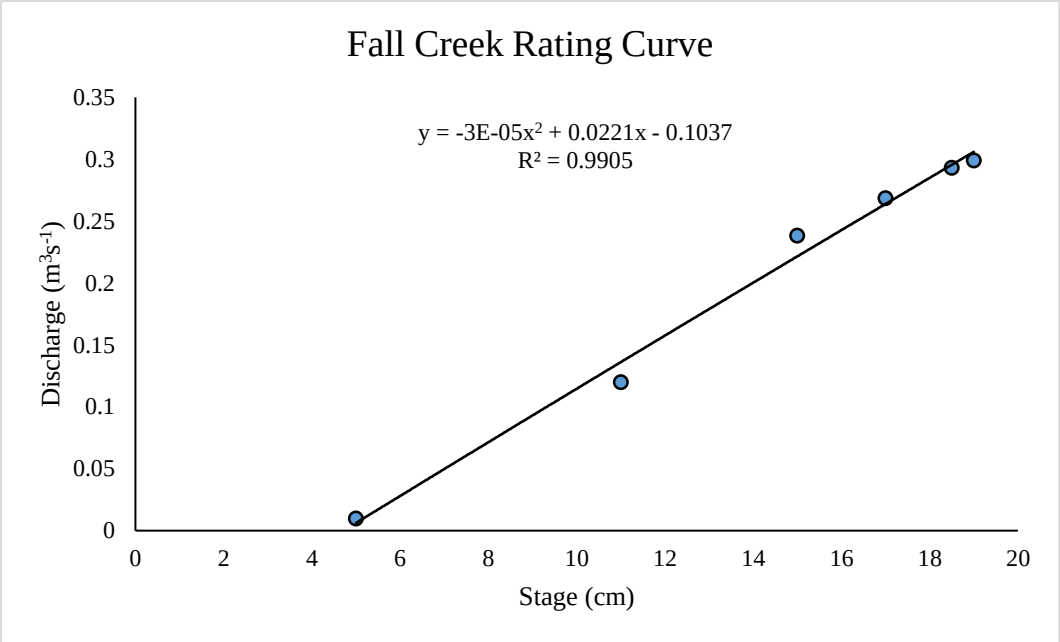

Figure 47*: Discharge rating curve for Fall Creek, a tributary on the Shuswap River*

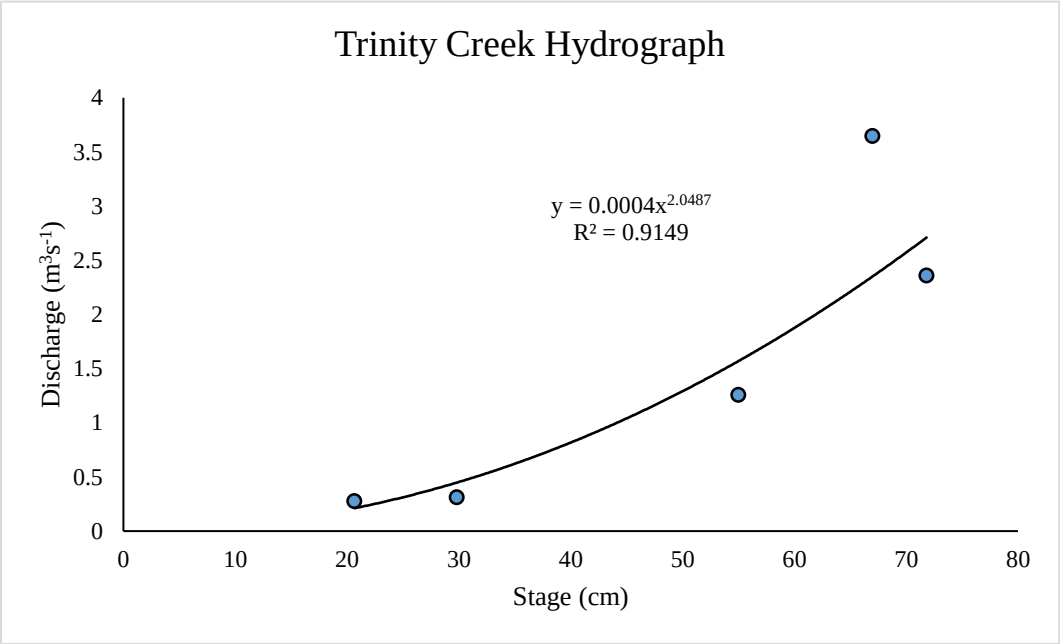

Figure 48: *Discharge rating curve for Trinity Creek, a tributary on the Shuswap River*

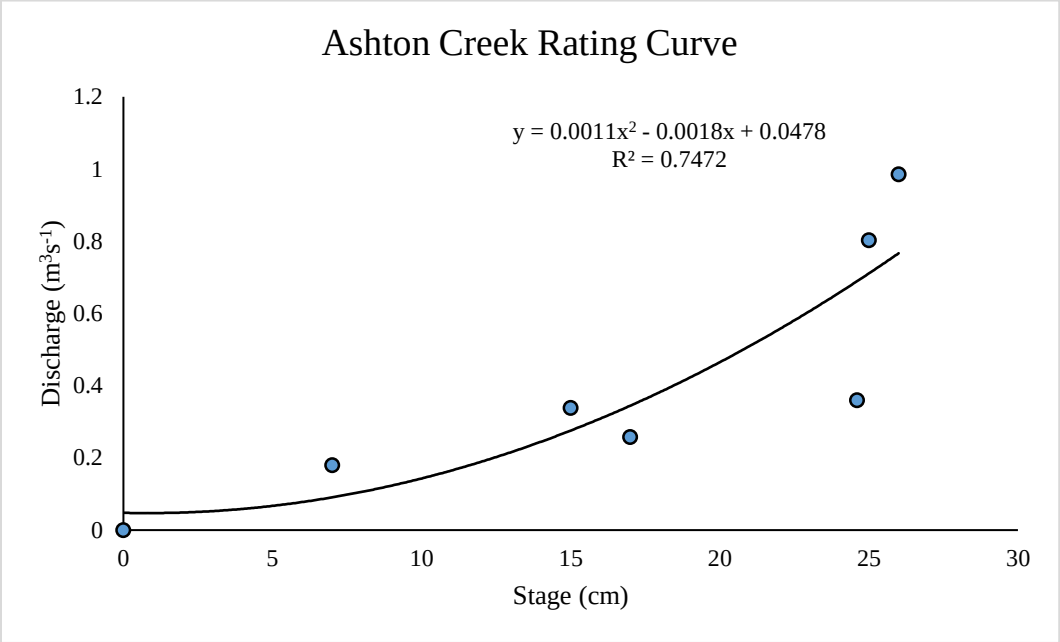

Figure 49*: Discharge rating curve for Ashton Creek, a tributary on the Shuswap RiveR*

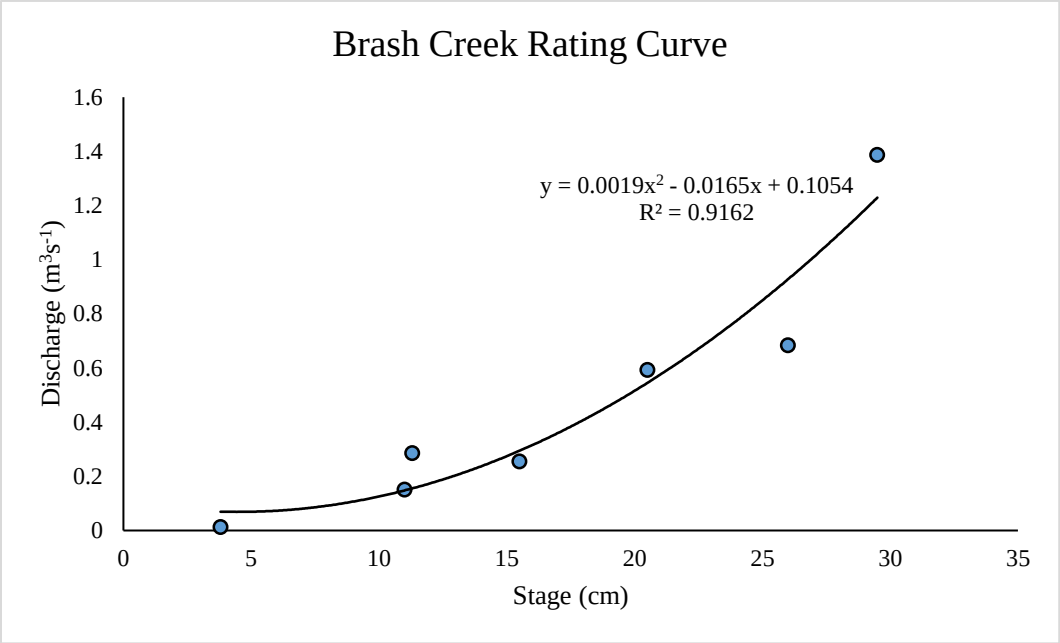

Figure 50: *Discharge rating curve for Brash Creek, a tributary on the Shuswap River*

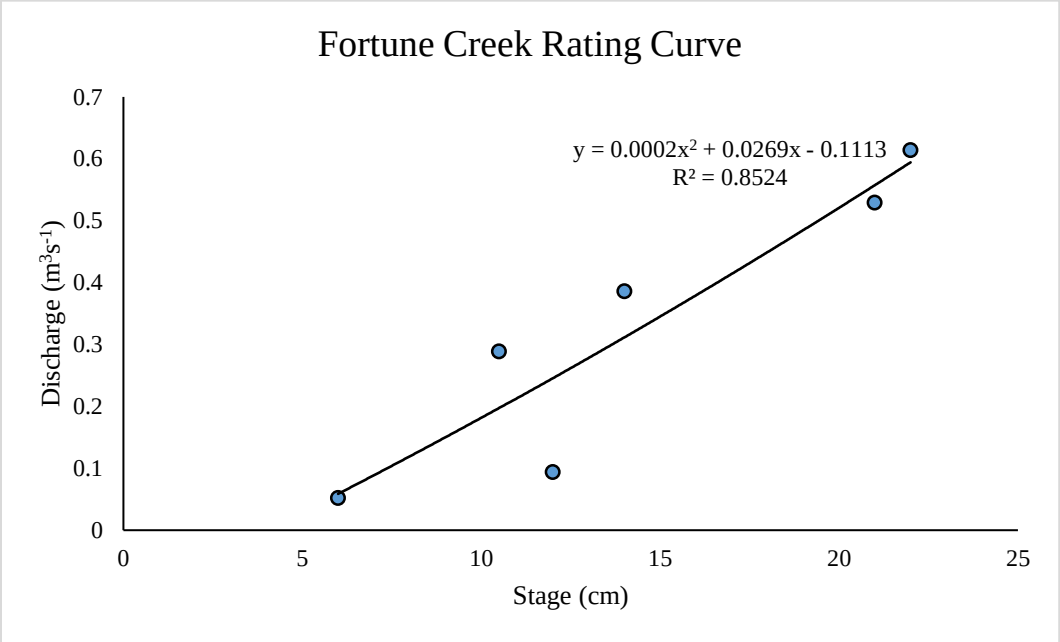

Figure 51: *Discharge rating curve for Fortune Creek, a tributary on the Shuswap River*

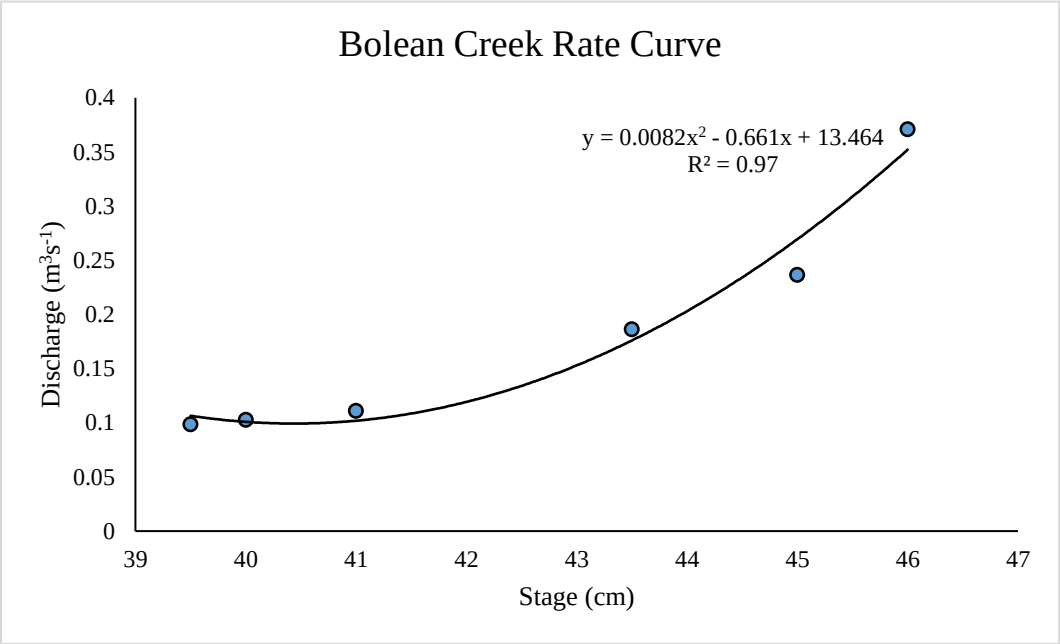

***Figure 52**: Discharge rating curve for Bolean Creek, a tributary on the Salmon River*

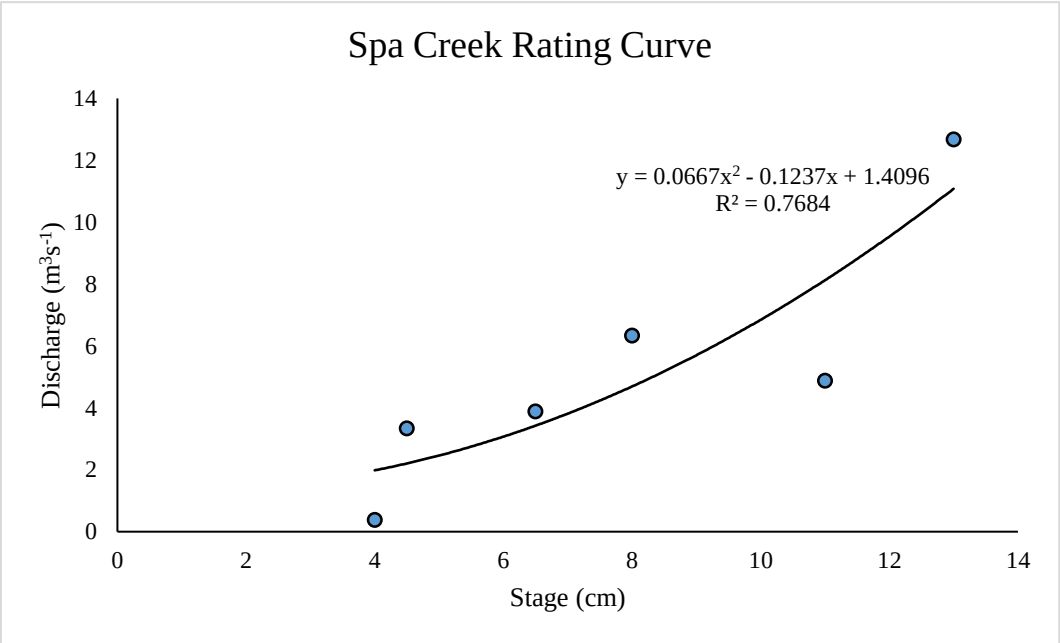

Figure 53: *Discharge rating curve for Bolean Creek, a tributary on the Salmon River*

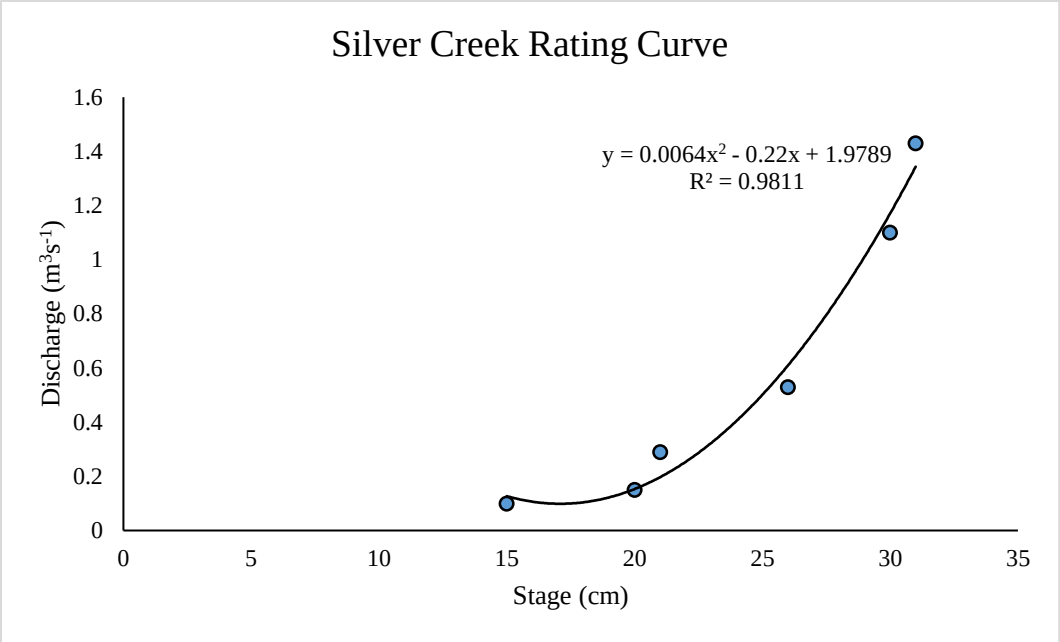

Figure 54*: Discharge rating curve for Silver Creek, a tributary on the Salmon River*

Appendix C: Tributary Hydrographs

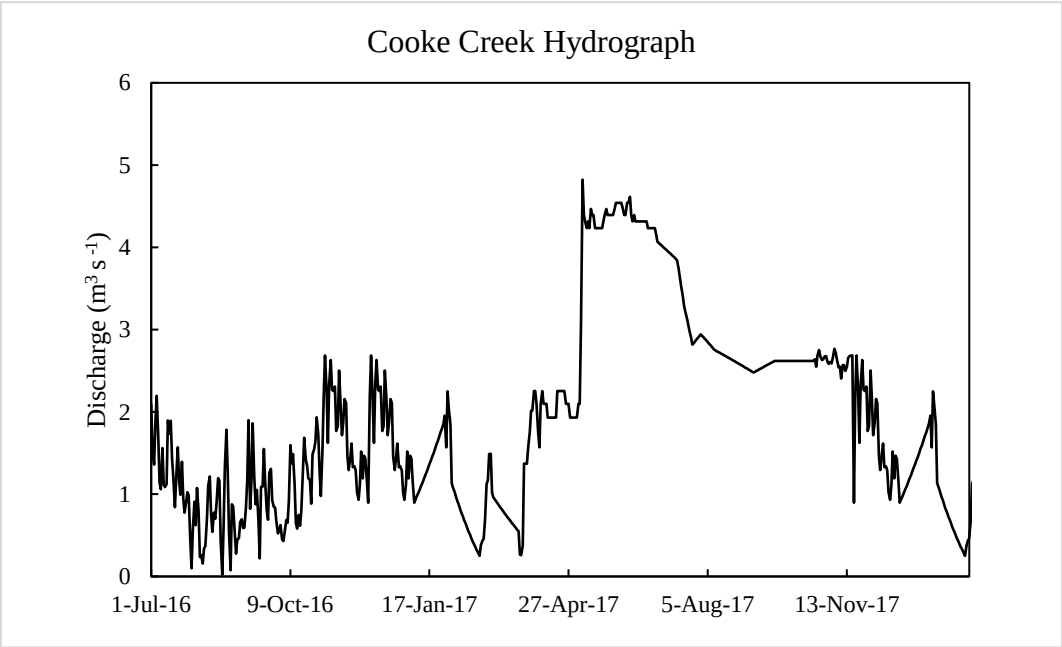

Figure 55: *Discharge hydrograph for Cooke Creek, a tributary along the Shuswap River*

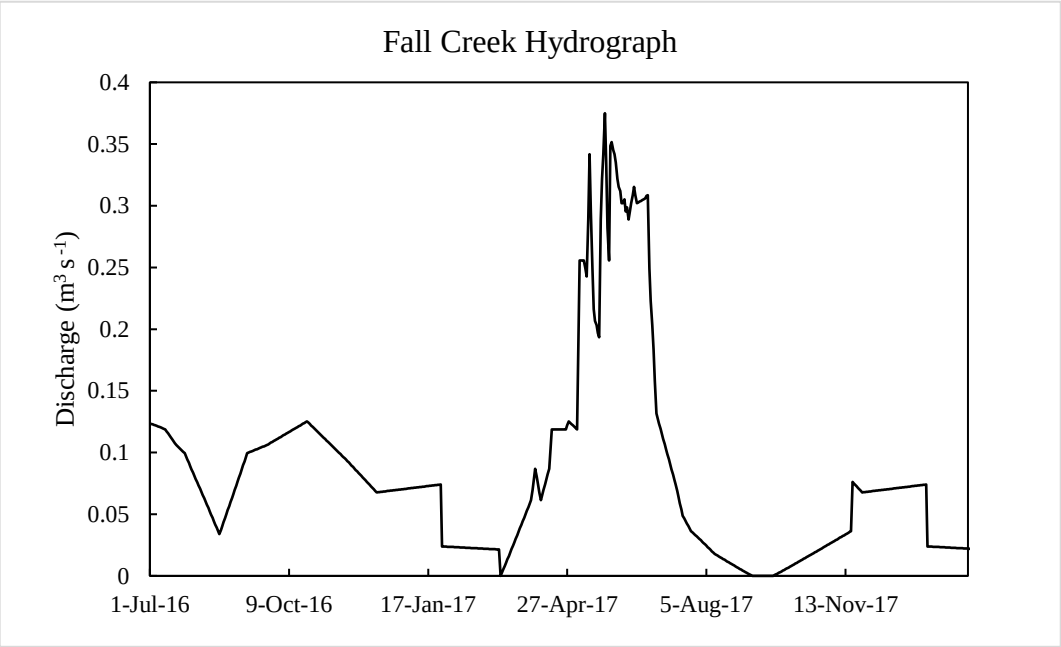

Figure 56: *Discharge hydrograph for Fall Creek, a tributary along the Shuswap River*

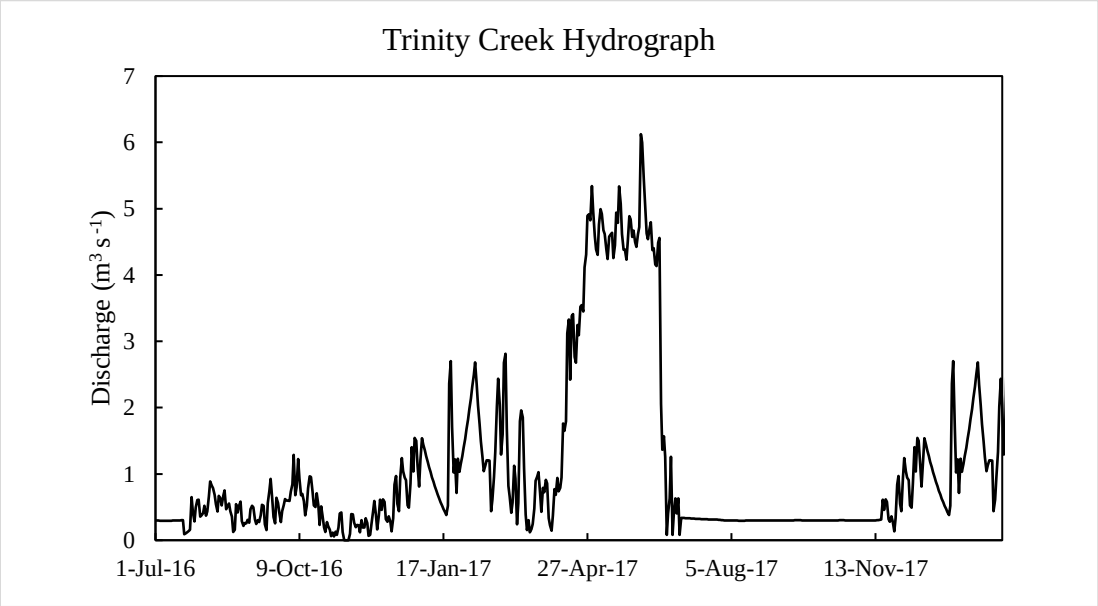

Figure 57: *Discharge hydrograph for Trinity Creek, a tributary along the Shuswap River*

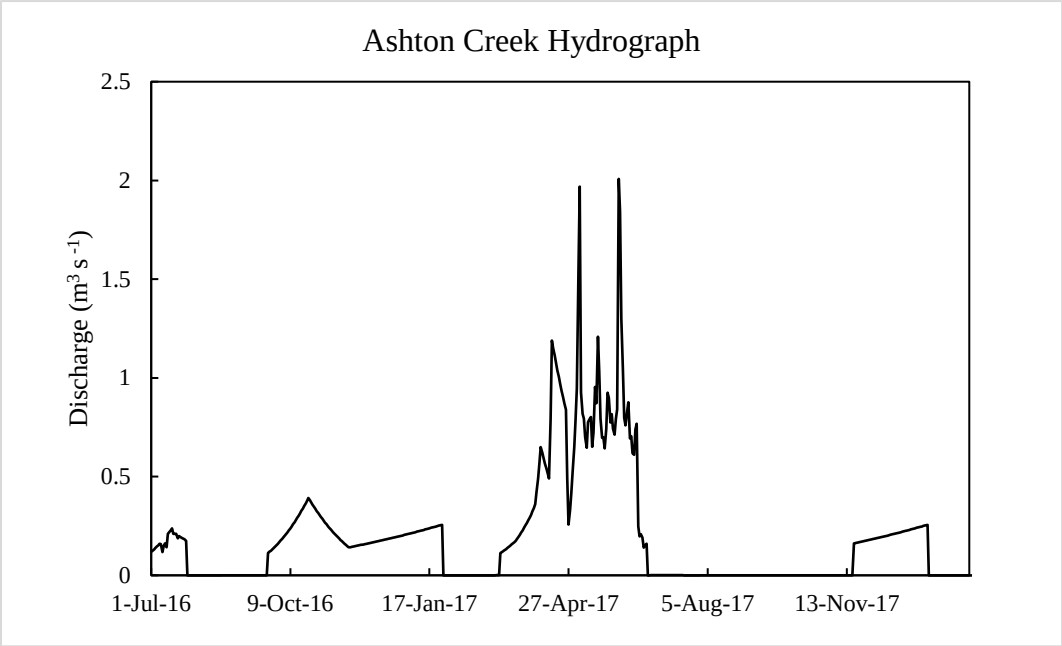

Figure 58*: Discharge hydrograph for Ashton Creek, a tributary along the Shuswap River*

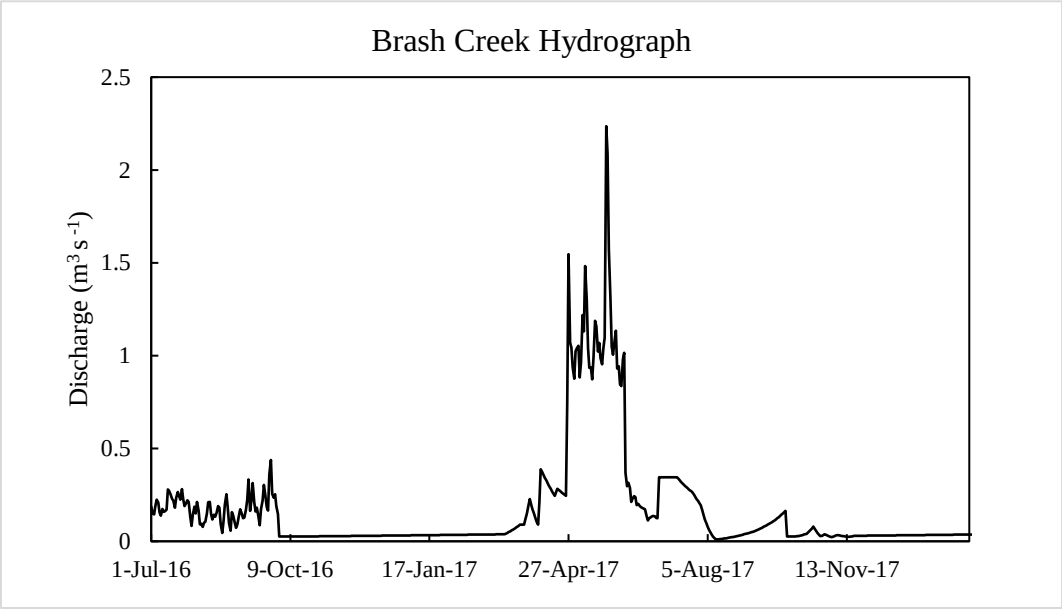

Figure 59: *Discharge hydrograph for Brash Creek, a tributary along the Shuswap River*

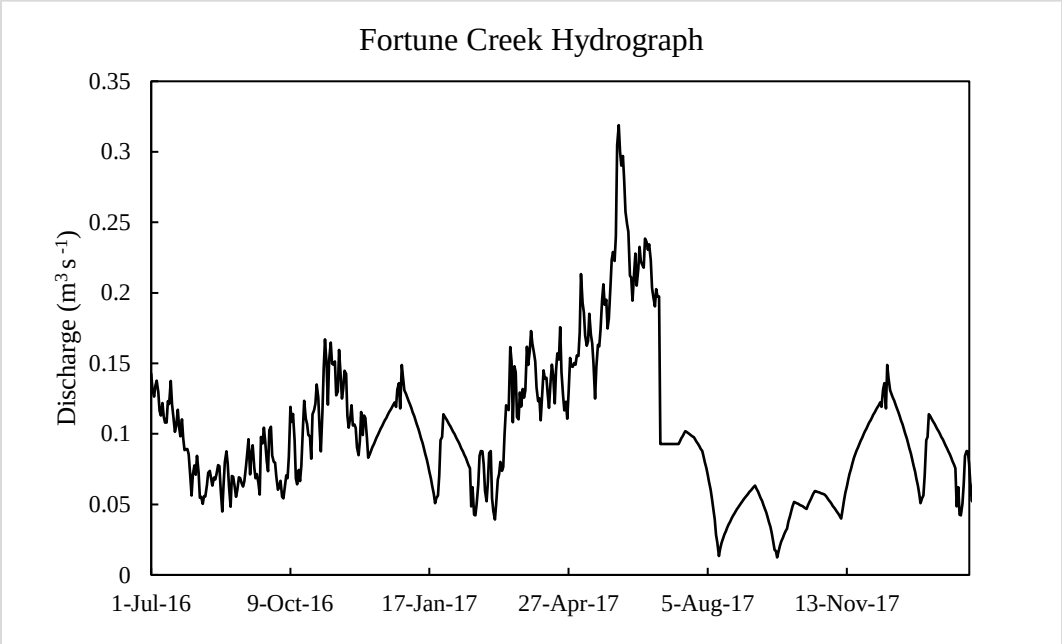

Figure 60: *Discharge hydrograph for Fortune Creek, a tributary along the Shuswap River*

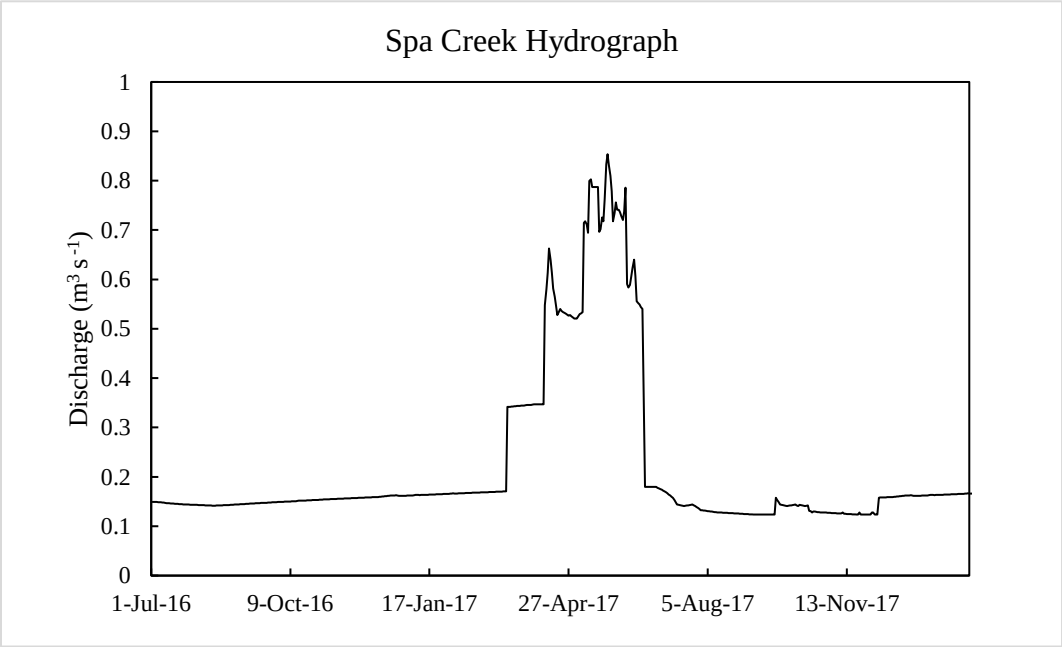

Figure 61*: Discharge hydrograph for Spa Creek, a tributary along the Salmon River*

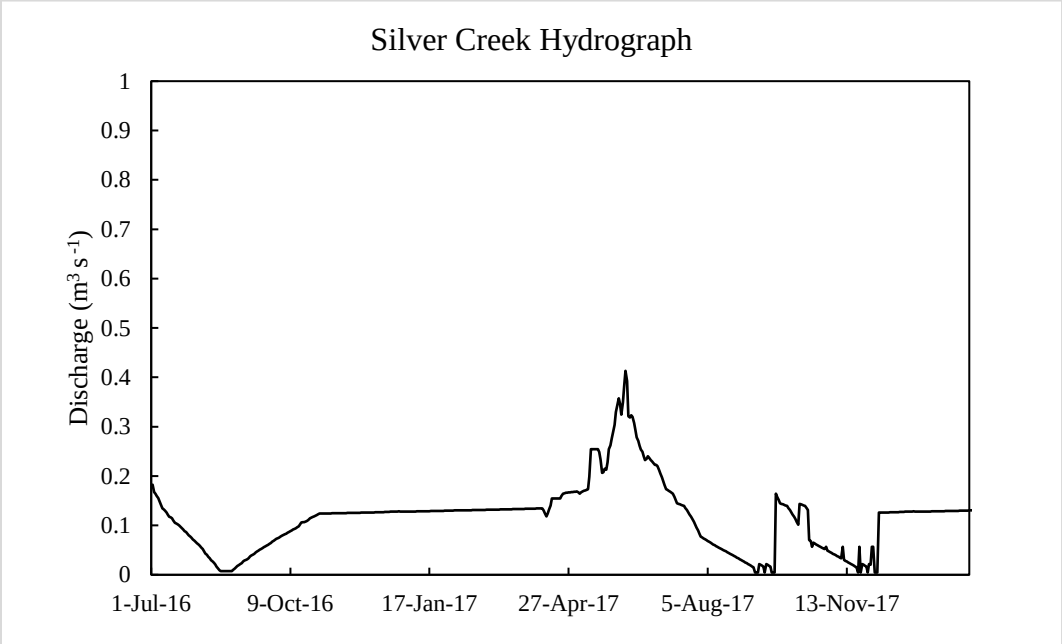

Figure 62*: Discharge hydrograph for Silver Creek, a tributary along the Salmon River*

Appendix D: Tributary Yield

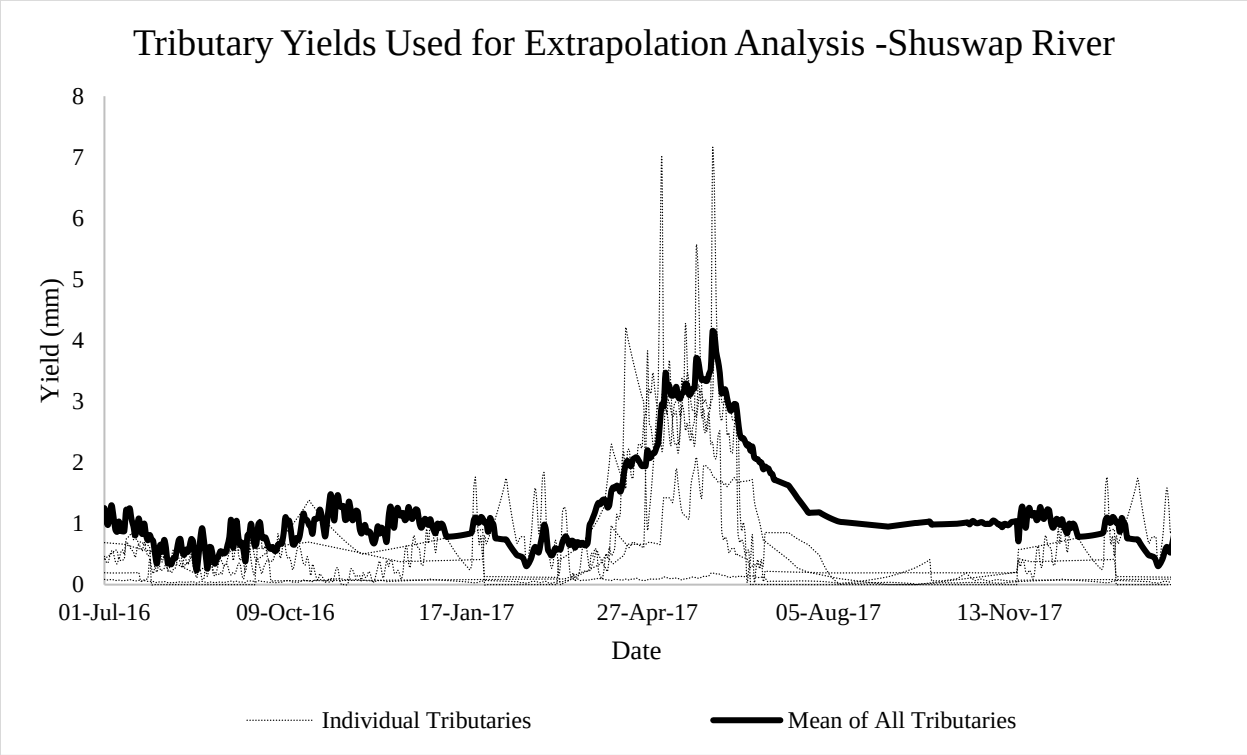

Figure 63: *Mean tributary yield used in the extrapolation method - Shuswap River*

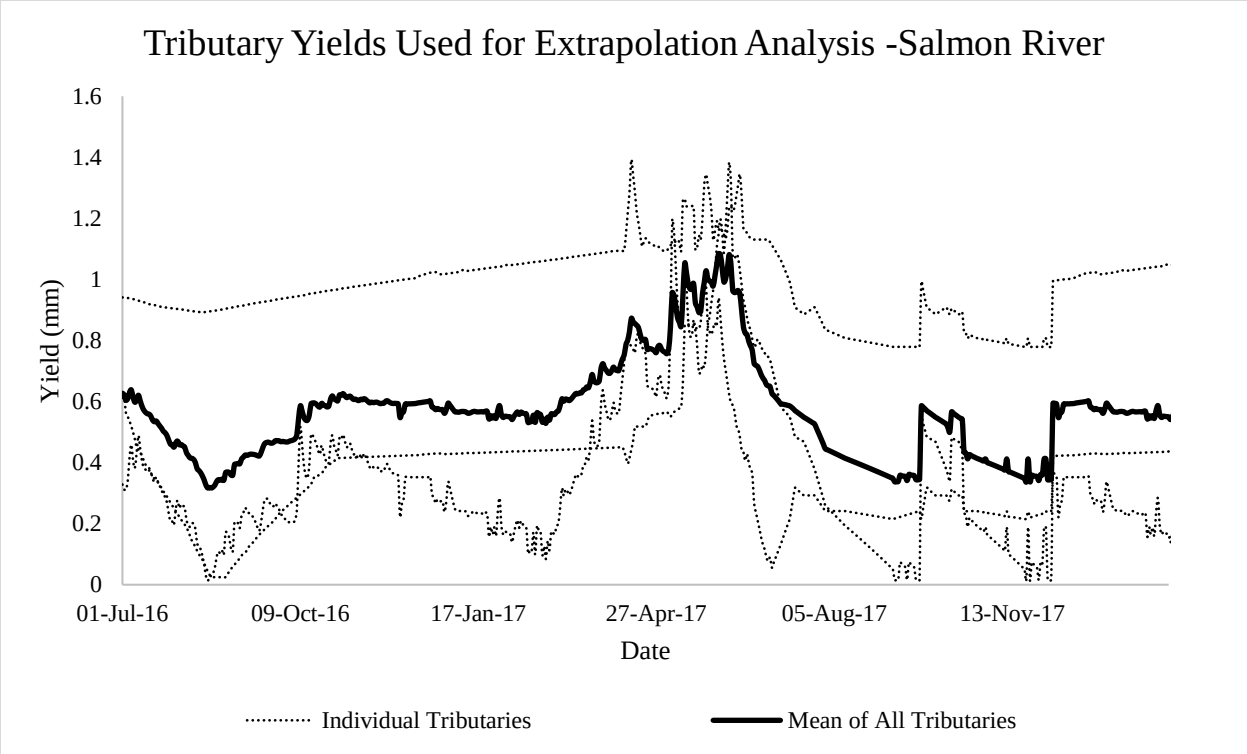

Figure 64*: Mean tributary yield used in the extrapolation method - Salmon River*

Appendix E: EMMA ANOVA Results

End-member mixing analysis was performed on a reach by reach basis with the rivers. The model variance between the model estimates was then tested using analysis of variance (ANOVA). The colored dissolved organic matter (CDOM) and nitrate models were then tested for variance against the element models.

Shuswap River 0 km to 29 km

All element tracers except Mg met the assumptions (Chapter 1) needed to perform an EMMA between 0 km and 29km on the Shuswap River. Mg did not have a great enough difference in concentration between the two sites to be used in a mixing model. The individual EMMAs for Ca, Na, Sr, and K produced results that were not significantly different from each other according ANOVA. The ANOVA produced a p-value of 0.7746, greater than the alpha of 0.05, allowing acceptation of the null hypothesis and conclude that there was no significant difference among output values.

For the CDOM EMMAS, all wavelengths except 440 nm met the assumption needed to run the model. The 440 nm wavelength did not have large enough difference in absorption values to be used in a mixing model. The individual EMMAs for the wavelengths of 240, 310, 335, 340, and 350 nm produced outputs that were determined to not have significant differences according to ANOVA. The p-value was 0.8700, greater than the alpha of 0.05.

The averages of all the element EMMAs and the CDOM EMMAs outputs were then tested for significant difference against each other using ANOVA. The p-value in this reach was 0.3867, once again, showing that the variance was not significant between the two models.

Table 19: *ANOVA results for EMMAs in the reach between 0 km and 29 km*

Tracer Models Tested for variance	p-value
Elements: Ca, K, Na, Sr	0.7747
Wavelengths (nm): 240, 310, 335, 340, 350	0.87
Average of elements vs Average of CDOM wavelengths	0.3867
Average of elements vs nitrate	0.973

Shuswap River 29km to 57km

All element tracers met the assumptions needed to perform an EMMA in the reach between 29km and 57km. The model outputs for Ca, Na, Sr, Mg, and K were determined to have insignificant variance between them based on the p-value of the ANOVA (p-value 0.9858). As with the elements, every wavelength was able to be used for the CDOM models and no significant differences existed between the individual model estimates (p-value 0.2815). The average of the element model results also showed no significant difference between the CDOM models or the nitrate models.

Table 20 : *ANOVA results for EMMAs in the reach between 29 km and 57 km*

Tracer Models Tested for variance	p-value
Elements: Ca, K, Mg, Na, Sr	0.9858
Wavelengths (nm): 240, 310, 335, 340, 350, 340	0.2815
Average of elements vs Average of CDOM wavelengths	0.7240
Average of elements vs nitrate	0.8223

Shuswap River 57km to 73km

From 57 km to 73 km, Mg, Na, and Ca exhibited the characteristics to be used in a mixing model. K and Sr failed to have large enough differences in concentrations between end-members 40% of the time and were only used to create models on sample days in which they met the assumptions. Model outputs for Na, Sr, Mg, K, and Ca were compared using ANOVA, producing a p-value of 0.0525. The p-value was greater than 0.05, therefore the difference between all these EMMA outputs were considered insignificant.

In this reach, all CDOM wavelengths were used except 340 nm. As with K and Sr, this wavelength did not exhibit enough change between end-members to be deemed a viable tracer. The 240, 310, 335, 340, and 440 nm wavelength outputs were compared and incremental flow estimate variance between them was insignificant according to ANOVA (p-value of 0.2810).

When comparing the element model estimates to that of the CDOM and nitrate models, not significant difference was detected.

***Table 21**: ANOVA results for EMMAs in the reach between 57km and 73 km*

Tracer Models Tested for variance	p-value
Elements: Ca, Mg, Na, Sr	0.0525
Wavelengths (nm): 240, 310, 335, 350	0.2810
Average of elements vs Average of CDOM wavelengths	0.8223
Average of elements vs nitrate	0.1853

Salmon River 0km to 28km

In the reach of the Salmon River from 0 km to 28km, only the nitrate model exhibited enough variation between end-members to be used. Therefore, there were no ANOVA results.

Salmon River 28km to 51km

All elements except K were used in EMMA. K did not exhibit enough difference between end-members to be used. Between the four remaining element models, there was determined to be no significant difference between estimates (p-value 0.8384, Table).

For CDOM, only 3 of the wavelengths had enough of a difference between end-members to be used in EMMA. Between the 3 model outputs, there was considered to be no significant difference in estimates (p-value 0.09844, table). The CDOM model was then tested for variance against the average of the element models, and once again, no significant difference was found between the two.

The average of the element models was compared to the nitrate model estimates, and no significant difference existed (0.0572, table).

***Table 22**:ANOVA results for EMMAs in the reach between 28 km and 51 km*

Tracer Models Tested for variance	p-value
Elements: Ca, Mg, Na, Sr	0.8384
Wavelengths (nm): 240, 310, 340	0.9844
Average of elements vs Average of CDOM wavelengths	0.5828
Average of elements vs nitrate	0.0572

Salmon River 51km to 66km

All elements exhibited the characteristics to be used in EMMA. No significant difference existed between the estimates of each individual model (p-value 0.0607). For CDOM, only three wavelengths had distinct enough differences between end-members to be used, and no significant differences existed between the 3 model estimates.

When the element model estimates were tested against the CDOM and nitrate models, significant differences existed, with p-values being less than 0.05.

***Table 23**:ANOVA results for EMMAs in the reach between 51 km and 66 km*

Tracer Models Tested for variance	p-value
Elements: Ca, Mg, Na, Sr, K	0.0607
Wavelengths (nm): 240, 310, 340	0.9994
Average of elements vs Average of CDOM wavelengths	0.0036
Average of elements vs nitrate	0.0022

Appendix F: Precipitation Data

***Table 24**: Precipitation date from Salmon Arm (Ministry of the Environment 2016-2018) used in the RC method*

Date	PPT (mm)	Date	PPT (mm)	Date	PPT (mm)	Date	PPT (mm)
01-Jul-16	0.2	03-Jan-17	0	08-Jul-17	0	10-Jan-18	0
02-Jul-16	0.2	04-Jan-17	0	09-Jul-17	0	11-Jan-18	0.2
03-Jul-16	4.5	05-Jan-17	0.7	10-Jul-17	0	12-Jan-18	3.4
04-Jul-16	4.3	06-Jan-17	0.7	11-Jul-17	0	13-Jan-18	1.3
05-Jul-16	2.7	07-Jan-17	0	12-Jul-17	0	14-Jan-18	0
06-Jul-16	0.2	08-Jan-17	6.1	13-Jul-17	0	15-Jan-18	0
07-Jul-16	0	09-Jan-17	5.6	14-Jul-17	0	16-Jan-18	4.8
08-Jul-16	5.8	10-Jan-17	0	15-Jul-17	0	17-Jan-18	5.9
09-Jul-16	9	11-Jan-17	0	16-Jul-17	0	18-Jan-18	0.3
10-Jul-16	0	12-Jan-17	0	17-Jul-17	0	19-Jan-18	0.5
11-Jul-16	0	13-Jan-17	0	18-Jul-17	0	20-Jan-18	1.7
12-Jul-16	0.6	14-Jan-17	0	19-Jul-17	0	21-Jan-18	0.2
13-Jul-16	0.2	15-Jan-17	0.2	20-Jul-17	0.2	22-Jan-18	0.6
14-Jul-16	0.5	16-Jan-17	0	21-Jul-17	0	23-Jan-18	3.3
15-Jul-16	0.7	17-Jan-17	0.4	22-Jul-17	0	24-Jan-18	10.4
16-Jul-16	2.6	18-Jan-17	2.4	23-Jul-17	0	25-Jan-18	2.9
17-Jul-16	0	19-Jan-17	1.5	24-Jul-17	0	26-Jan-18	0.6
18-Jul-16	0	20-Jan-17	0.2	25-Jul-17	0	27-Jan-18	15
19-Jul-16		21-Jan-17	0	26-Jul-17	0	28-Jan-18	5
20-Jul-16	0.2	22-Jan-17	0.2	27-Jul-17	0.2	29-Jan-18	2.5
21-Jul-16	0	23-Jan-17	0.3	28-Jul-17	0	30-Jan-18	0
22-Jul-16	1.1	24-Jan-17	0	29-Jul-17	0	31-Jan-18	0
23-Jul-16	0	25-Jan-17	0	30-Jul-17	0	01-Feb-18	2.4
24-Jul-16	0.2	26-Jan-17	0	31-Jul-17	0.2	02-Feb-18	1.6
25-Jul-16	0	27-Jan-17	0	01-Aug-17	0	03-Feb-18	1.3
26-Jul-16	0	28-Jan-17	0	02-Aug-17	0	04-Feb-18	6
27-Jul-16	0	29-Jan-17	0	03-Aug-17	0	05-Feb-18	0.5
28-Jul-16	0	30-Jan-17	0	04-Aug-17	0	06-Feb-18	1.7
29-Jul-16	0	31-Jan-17	0	05-Aug-17	0.2	07-Feb-18	1.7
30-Jul-16	1.3	01-Feb-17	0	06-Aug-17	0	08-Feb-18	0.8
31-Jul-16	0.8	02-Feb-17	0	07-Aug-17	0	09-Feb-18	0
01-Aug-16	0.2	03-Feb-17	6	08-Aug-17	0	10-Feb-18	3.1
02-Aug-16	1.8	04-Feb-17	8.6	09-Aug-17	0	11-Feb-18	
03-Aug-16	0.2	05-Feb-17	2.2	10-Aug-17	0.2	12-Feb-18	
04-Aug-16	0.7	06-Feb-17	0.7	11-Aug-17	0	13-Feb-18	
05-Aug-16	0.2	07-Feb-17	0.7	12-Aug-17	0	14-Feb-18	
06-Aug-16	0.2	08-Feb-17	0.6	13-Aug-17	0.5	15-Feb-18	

Date	PPT (mm)	Date	PPT (mm)	Date	PPT (mm)	Date	PPT (mm)
08-Aug-16	0	10-Feb-17	0.5	15-Aug-17	0	17-Feb-18	13.8
09-Aug-16	1	11-Feb-17	0	16-Aug-17	0	18-Feb-18	0
10-Aug-16	3.1	12-Feb-17	0	17-Aug-17	0	19-Feb-18	0
11-Aug-16	0.2	13-Feb-17	0	18-Aug-17	0	20-Feb-18	0
12-Aug-16	0	14-Feb-17	0	19-Aug-17	0	21-Feb-18	0
13-Aug-16	0	15-Feb-17	4.2	20-Aug-17	0	22-Feb-18	0
14-Aug-16	0	16-Feb-17	0.2	21-Aug-17	0	23-Feb-18	4.5
15-Aug-16	0	17-Feb-17	0	22-Aug-17	0	24-Feb-18	1.4
16-Aug-16	0	18-Feb-17	1.8	23-Aug-17	0	25-Feb-18	2.6
17-Aug-16	0	19-Feb-17	3.7	24-Aug-17	1.3	26-Feb-18	0
18-Aug-16	0	20-Feb-17	0.6	25-Aug-17	0.2	27-Feb-18	1.7
19-Aug-16	0	21-Feb-17	0	26-Aug-17	0	28-Feb-18	0
20-Aug-16	0	22-Feb-17	0	27-Aug-17	0	01-Mar-18	0.2
21-Aug-16	0	23-Feb-17	0	28-Aug-17	0	02-Mar-18	11
22-Aug-16	0	24-Feb-17	0	29-Aug-17	0		
23-Aug-16	0	25-Feb-17	0.5	30-Aug-17	0		
24-Aug-16	0	26-Feb-17	1.1	31-Aug-17	0		
25-Aug-16	0	27-Feb-17	0	01-Sep-17	0		
26-Aug-16	0	28-Feb-17	0	02-Sep-17	0		
27-Aug-16	7.1	01-Mar-17	3.1	03-Sep-17	0		
28-Aug-16	0.4	02-Mar-17	1.4	04-Sep-17	0.2		
29-Aug-16	0.2	03-Mar-17	0.2	05-Sep-17	0.2		
30-Aug-16	0	04-Mar-17	1.5	06-Sep-17	0		
31-Aug-16	0	05-Mar-17	2.7	07-Sep-17	0		
01-Sep-16	1.1	06-Mar-17	0.7	08-Sep-17	0		
02-Sep-16	9	07-Mar-17		09-Sep-17	3.1		
03-Sep-16	0.2	08-Mar-17	1.7	10-Sep-17	0		
04-Sep-16	0.5	09-Mar-17	5	11-Sep-17	0		
05-Sep-16	5.4	10-Mar-17	3.2	12-Sep-17	0		
06-Sep-16	9.3	11-Mar-17	5.1	13-Sep-17	0		
07-Sep-16	1.1	12-Mar-17	0.9	14-Sep-17	0		
08-Sep-16	1	13-Mar-17	2.2	15-Sep-17	0		
09-Sep-16	0.2	14-Mar-17	5.3	16-Sep-17	0		
10-Sep-16	0.3	15-Mar-17	5.4	17-Sep-17	0		
11-Sep-16	0.2	16-Mar-17	1.2	18-Sep-17	1		
12-Sep-16	0	17-Mar-17	2.6	19-Sep-17	0.2		
13-Sep-16	0	18-Mar-17	2.7	20-Sep-17	0		
14-Sep-16	0	19-Mar-17	0	21-Sep-17	0		
15-Sep-16	0	20-Mar-17	0	22-Sep-17	0		
16-Sep-16	0	21-Mar-17	6.4	23-Sep-17	0		

Date	PPT (mm)	Date	PPT (mm)	Date	PPT (mm)	Date	PPT (mm)
17-Sep-16	8.4	22-Mar-17	0.3	24-Sep-17	0		
18-Sep-16	2.4	23-Mar-17	0	25-Sep-17	0.3		
19-Sep-16	2.9	24-Mar-17	2.5	26-Sep-17	0		
20-Sep-16	1.6	25-Mar-17	0	27-Sep-17	0		
21-Sep-16	0	26-Mar-17	0	28-Sep-17	0		
22-Sep-16	0	27-Mar-17	1.9	29-Sep-17	0		
23-Sep-16	0.8	28-Mar-17	4.8	30-Sep-17	7.7		
24-Sep-16	0	29-Mar-17	7.3	01-Oct-17	0		
25-Sep-16	0	30-Mar-17	0	02-Oct-17	0		
26-Sep-16	0.2	31-Mar-17	0	03-Oct-17	0.2		
27-Sep-16	0	01-Apr-17	7.6	04-Oct-17	0		
28-Sep-16	0.2	02-Apr-17	0	05-Oct-17	0		
29-Sep-16	0	03-Apr-17	0	06-Oct-17	0.2		
30-Sep-16	0	04-Apr-17	0	07-Oct-17	0.7		
01-Oct-16	0	05-Apr-17	2.1	08-Oct-17	0.2		
02-Oct-16	0.2	06-Apr-17	13.1	09-Oct-17	0		
03-Oct-16	0	07-Apr-17	4.6	10-Oct-17	0		
04-Oct-16	0	08-Apr-17	0.2	11-Oct-17	0.3		
05-Oct-16	0.2	09-Apr-17	0.2	12-Oct-17	0		
06-Oct-16	3.1	10-Apr-17	0.2	13-Oct-17	7.3		
07-Oct-16	25.5	11-Apr-17	0	14-Oct-17	0.4		
08-Oct-16	22.2	12-Apr-17	7.5	15-Oct-17	1		
09-Oct-16	0.2	13-Apr-17	6.6	16-Oct-17	0		
10-Oct-16	0	14-Apr-17	0	17-Oct-17	3		
11-Oct-16	0.2	15-Apr-17	0	18-Oct-17	3.1		
12-Oct-16	0	16-Apr-17	0	19-Oct-17	0.2		
13-Oct-16	7.2	17-Apr-17	4.7	20-Oct-17	1		
14-Oct-16		18-Apr-17	3.3	21-Oct-17	22.3		
15-Oct-16	4.4	19-Apr-17	0	22-Oct-17	0.2		
16-Oct-16	1.3	20-Apr-17	15.7	23-Oct-17	0		
17-Oct-16	1	21-Apr-17	0	24-Oct-17	0		
18-Oct-16	0	22-Apr-17	0.3	25-Oct-17	1.1		
19-Oct-16	0	23-Apr-17	0	26-Oct-17	0		
20-Oct-16	3.9	24-Apr-17	0	27-Oct-17	0		
21-Oct-16	0	25-Apr-17	0	28-Oct-17	0		
22-Oct-16	0	26-Apr-17	3.6	29-Oct-17	0		
23-Oct-16	0	27-Apr-17	0.9	30-Oct-17	0		
24-Oct-16	0	28-Apr-17	0	31-Oct-17	1		
25-Oct-16	3.6	29-Apr-17	2.7	01-Nov-17	0		
26-Oct-16	2.7	30-Apr-17	0.9	02-Nov-17	20.4		

Date	PPT (mm)	Date	PPT (mm)	Date	PPT (mm)	Date	PPT (mm)
27-Oct-16	4.3	01-May-17	0	03-Nov-17	1.2		
28-Oct-16	0	02-May-17	0	04-Nov-17	0		
29-Oct-16	0.2	03-May-17	9.9	05-Nov-17	0.2		
30-Oct-16	0	04-May-17	0	06-Nov-17	0		
31-Oct-16	5.1	05-May-17	22.8	07-Nov-17	0		
01-Nov-16	2.6	06-May-17	0	08-Nov-17	0		
02-Nov-16	4.2	07-May-17	0	09-Nov-17	10.1		
03-Nov-16	0.2	08-May-17	0.2	10-Nov-17	3.4		
04-Nov-16	0	09-May-17	0	11-Nov-17	1.3		
05-Nov-16	1.3	10-May-17	0	12-Nov-17	5.2		
06-Nov-16	2.2	11-May-17	11.3	13-Nov-17	7.2		
07-Nov-16	0	12-May-17	3.1	14-Nov-17	2.2		
08-Nov-16	0	13-May-17	0	15-Nov-17	7.7		
09-Nov-16	0.4	14-May-17	0	16-Nov-17	0		
10-Nov-16	0	15-May-17	9.9	17-Nov-17	1.5		
11-Nov-16	0	16-May-17	6.6	18-Nov-17	0		
12-Nov-16	5.3	17-May-17	0.2	19-Nov-17	0		
13-Nov-16	1.7	18-May-17	0.4	20-Nov-17	0		
14-Nov-16	1.2	19-May-17	0	21-Nov-17	4.9		
15-Nov-16	8.7	20-May-17	0	22-Nov-17	0.7		
16-Nov-16	0	21-May-17	0	23-Nov-17	0.8		
17-Nov-16	3.5	22-May-17	0	24-Nov-17	0		
18-Nov-16	0	23-May-17	0	25-Nov-17	4.1		
19-Nov-16	3.4	24-May-17	0	26-Nov-17	2.2		
20-Nov-16	1.7	25-May-17	0	27-Nov-17	0		
21-Nov-16	0	26-May-17	0	28-Nov-17	1.3		
22-Nov-16	0	27-May-17	0	29-Nov-17	0.2		
23-Nov-16	1.2	28-May-17	0.2	30-Nov-17	3.3		
24-Nov-16	3.7	29-May-17	0	01-Dec-17	0		
25-Nov-16	1.9	30-May-17	0	02-Dec-17	1.7		
26-Nov-16	13.5	31-May-17	11.7	03-Dec-17	0.3		
27-Nov-16	0.7	01-Jun-17	4.7	04-Dec-17	0		
28-Nov-16	0.2	02-Jun-17	0	05-Dec-17	0		
29-Nov-16	0	03-Jun-17	0	06-Dec-17	0		
30-Nov-16	2	04-Jun-17	0	07-Dec-17	0		
01-Dec-16	0.6	05-Jun-17	0	08-Dec-17	0		
02-Dec-16	3.7	06-Jun-17	0	09-Dec-17	0		
03-Dec-16	0	07-Jun-17	0	10-Dec-17	0		
04-Dec-16	0.3	08-Jun-17	0.7	11-Dec-17	0		
05-Dec-16	0	09-Jun-17	0.2	12-Dec-17	0		

Date	PPT (mm)	Date	PPT (mm)	Date	PPT (mm)	Date	PPT (mm)
06-Dec-16	0	10-Jun-17	0	13-Dec-17	0.4		
07-Dec-16	0	11-Jun-17	0	14-Dec-17	0		
08-Dec-16	0	12-Jun-17	0	15-Dec-17	0.2		
09-Dec-16	0.9	13-Jun-17	0	16-Dec-17	0.7		
10-Dec-16	1.7	14-Jun-17	0.4	17-Dec-17	6.2		
11-Dec-16	3.4	15-Jun-17	3.5	18-Dec-17	2.7		
12-Dec-16	0	16-Jun-17	1.1	19-Dec-17	6.8		
13-Dec-16	0	17-Jun-17	0	20-Dec-17	0.6		
14-Dec-16	0	18-Jun-17	0	21-Dec-17	7		
15-Dec-16	0	19-Jun-17	0.8	22-Dec-17	0		
16-Dec-16	0	20-Jun-17	0.2	23-Dec-17	0.2		
17-Dec-16	0	21-Jun-17	0	24-Dec-17	0		
18-Dec-16	2.3	22-Jun-17	0	25-Dec-17	0		
19-Dec-16	2	23-Jun-17	0	26-Dec-17	0		
20-Dec-16	4.6	24-Jun-17	0	27-Dec-17	1.5		
21-Dec-16	0.2	25-Jun-17	0	28-Dec-17	5.2		
22-Dec-16	0	26-Jun-17	0	29-Dec-17	6.9		
23-Dec-16	11.4	27-Jun-17	0	30-Dec-17	3.4		
24-Dec-16	0.9	28-Jun-17	0.8	31-Dec-17	0		
25-Dec-16	0	29-Jun-17	0	01-Jan-18	0		
26-Dec-16	6	30-Jun-17	0	02-Jan-18	0		
27-Dec-16	0.7	01-Jul-17	0	03-Jan-18	0		
28-Dec-16	0	02-Jul-17	0	04-Jan-18	0		
29-Dec-16	1.4	03-Jul-17	0	05-Jan-18	0.2		
30-Dec-16	0	04-Jul-17	0.2	06-Jan-18	3		
31-Dec-16	1.8	05-Jul-17	0	07-Jan-18	3.1		
01-Jan-17	0	06-Jul-17	0	08-Jan-18	4		
02-Jan-17	0	07-Jul-17	0	09-Jan-18	6.1		

Appendix G: Chemical Data

Table 22: *Chemical data for samples taken along the Shuswap River. All data is in mg L^{-1}*

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
05-Jul-16	Mabel Lake	0.0001	0.0001	0.0402	12.90	0.9965	1.459	0.955	0.0587
12-Jul-16	Mabel Lake	0.0100	0.0196	0.0409	13.00	0.7723	1.469	0.937	0.0598
20-Jul-16	Mabel Lake	0.0051	0.0153	0.0652	13.30	0.7084	1.581	0.967	0.0610
26-Jul-16	Mabel Lake	0.0083	0.0456	0.0001	13.00	0.7551	1.482	0.920	0.0599
09-Aug-16	Mabel Lake	0.0032	0.0001	0.0390	13.70	0.7796	1.577	1.011	0.0634
12-Aug-16	Mabel Lake	0.0086	0.0201	0.0736	14.00	0.9740	1.608	1.042	0.0644
20-Aug-16	Mabel Lake	0.0026	0.0236	0.0475	14.20	0.9198	1.644	1.066	0.0658
23-Sep-16	Mabel Lake	2.0189	0.0001	0.0625	14.30	0.8181	1.628	1.093	0.0651
22-Oct-16	Mabel Lake	0.0065	0.0250	0.0443	14.60	0.8039	1.719	1.259	0.0673
20-Nov-16	Mabel Lake	0.0103	0.0183	0.1497	14.70	0.6976	1.738	1.295	0.0684
11-Dec-16	Mabel Lake	0.0040	0.0001	0.0013	14.60	1.3100	1.812	1.390	0.0696
27-Jan-17	Mabel Lake	0.0016	0.0001	ND	36.70	2.2200	4.650	3.560	0.1750
09-Mar-17	Mabel Lake	0.0010	0.0001	0.3585	15.50	0.8730	1.939	1.450	0.0740
20-Mar-17	Mabel Lake	0.0067	0.0003	0.2929	40.40	2.4600	5.130	3.930	0.1890
31-Mar-17	Mabel Lake	0.0099	0.0001	0.2749	15.10	0.8055	1.851	1.355	0.0701
03-Apr-17	Mabel Lake	0.0128	0.0123	0.2929	15.80	0.7806	1.947	1.512	0.0742
07-Apr-17	Mabel Lake	0.0134	0.0082	0.2830	14.70	0.7737	1.837	1.433	0.0698
13-Apr-17	Mabel Lake	0.0096	0.0090	0.0409	15.40	0.9020	1.896	1.379	0.0734
15-Apr-17	Mabel Lake	0.0225	0.0031	0.2671	15.20	0.8180	1.826	1.347	0.0708
25-Apr-17	Mabel Lake	0.0058	0.0027	0.2415	16.20	1.0580	1.974	1.485	0.0771
27-Apr-17	Mabel Lake	0.0087	0.0049	0.2250	15.00	0.9106	1.865	1.367	0.0713
03-May-17	Mabel Lake	0.0046	0.0042	0.1738	15.00	0.8791	1.856	1.351	0.0704
05-May-17	Mabel Lake	0.0104	0.0087	0.1959	14.30	0.7700	1.770	1.400	0.0686
08-May-17	Mabel Lake	0.0051	0.0047	0.1873	14.30	0.8714	1.777	1.373	0.0677
10-May-17	Mabel Lake	0.0018	0.0014	0.2133	15.20	0.9688	1.897	1.390	0.0721
12-May-17	Mabel Lake	0.0073	0.0066	0.1966	15.00	0.8368	1.897	1.361	0.0718
16-May-17	Mabel Lake	0.1113	0.0081	0.1496	15.20	0.8687	1.925	1.369	0.0733
19-May-17	Mabel Lake	0.0077	0.0051	0.1630	14.90	0.9325	1.850	1.313	0.0709
23-May-17	Mabel Lake	0.0110	0.0040	0.2352	19.40	1.2500	3.100	2.490	0.1260
26-May-17	Mabel Lake	0.0260	0.0044	0.1125	15.30	0.9570	1.940	1.280	0.0660
27-May-17	Mabel Lake	0.0085	0.0069	0.1162	14.90	0.9370	1.850	1.230	0.0620
30-May-17	Mabel Lake	0.0168	0.0107	0.0722	13.80	0.7630	1.650	1.230	0.0640
02-Jun-17	Mabel Lake	0.0039	0.0022	0.0796	14.60	0.8170	1.770	1.310	0.0680
07-Jun-17	Mabel Lake	0.0118	0.0067	0.1267	11.30	5.8900	5.070	2.280	0.0520
09-Jun-17	Mabel Lake	0.0081	0.0021	0.0516	15.00	1.4400	2.050	1.420	0.0700
13-Jun-17	Mabel Lake	0.0192	0.0016	0.0842	14.70	2.6200	3.450	1.700	0.0660

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
15-Jun-17	Mabel Lake	0.0064	0.0040	0.0873	11.80	0.6350	1.410	1.070	0.0560
23-Jun-17	Mabel Lake	0.0079	0.0061	0.1315	13.70	0.7070	1.580	1.190	0.0630
27-Jun-17	Mabel Lake	0.0081	0.0078	0.0834	13.80	0.7720	1.630	1.240	0.0650
30-Jun-17	Mabel Lake	0.0003	0.0000	0.0859	12.50	0.7150	1.460	1.140	0.0590
06-Jul-17	Mabel Lake	0.0024	0.0006	0.0794	11.80	0.6500	1.370	1.060	0.0550
11-Jul-17	Mabel Lake	0.0030	0.0015	0.0971	12.70	0.7610	1.460	1.120	0.0570
14-Jul-17	Mabel Lake	0.0020	0.0009	0.0189	12.00	0.7600	1.370	1.040	0.0550
19-Jul-17	Mabel Lake	0.0033	0.0019	0.1330	11.60	0.6740	1.310	1.010	0.0530
25-Jul-17	Mabel Lake	0.0350	0.0041	0.0461	12.40	0.7970	1.400	1.080	0.0570
31-Jul-17	Mabel Lake	0.0026	0.0015	0.1510	13.50	0.7820	1.480	1.140	0.0600
11-Aug-17	Mabel Lake	0.0013	0.0000	0.0677	14.20	0.8010	1.630	1.300	0.0640
07-Sep-17	Mabel Lake	0.0444	0.0047	0.0066	34.80	1.7900	4.120	3.000	0.1670
22-Sep-17	Mabel Lake	0.0016	0.0009	0.0830	38.00	1.9200	4.520	3.260	0.1710
20-Oct-17	Mabel Lake	0.0028	0.0009	0.3882	34.10	2.2200	4.100	3.130	0.1570
17-Nov-17	Mabel Lake	0.0084	0.0027	0.0196	37.40	1.9600	4.590	3.000	0.1750
05-Jul-16	Kingfisher Crk	0.0039	0.0003	0.0452	7.37	0.6369	0.806	0.619	0.0450
12-Jul-16	Kingfisher Crk	0.0092	0.0099	0.0492	8.90	0.5734	0.951	0.740	0.0527
20-Jul-16	Kingfisher Crk	0.0091	0.0132	0.0536	9.06	0.6453	0.990	0.759	0.0539
26-Jul-16	Kingfisher Crk	0.0077	0.0148	0.0443	11.00	0.6850	1.200	0.926	0.0649
12-Aug-16	Kingfisher Crk	0.0075	0.0193	0.1041	14.10	0.9849	1.594	1.323	0.0835
20-Aug-16	Kingfisher Crk	0.0001	0.0225	0.1166	16.00	1.0440	1.853	1.562	0.0948
09-Aug-16	Kingfisher Crk	0.0003	0.0001	0.0841	12.10	0.8125	1.396	1.119	0.0714
23-Sep-16	Kingfisher Crk	0.7386	0.0188	0.0600	11.30	0.6111	1.287	1.097	0.0654
22-Oct-16	Kingfisher Crk	0.0088	0.0209	0.0827	10.40	0.6443	1.158	1.179	0.0566
20-Nov-16	Kingfisher Crk	0.0130	0.0217	0.2209	10.40	0.9706	1.150	1.185	0.0554
11-Dec-16	Kingfisher Crk	0.0019	0.0001	0.0013	13.50	0.9403	1.558	1.494	0.0723
27-Jan-17	Kingfisher Crk	0.0065	0.0001	0.3472	15.50	0.9289	1.801	1.777	0.0836
09-Mar-17	Kingfisher Crk	0.0006	0.0001	0.6313	14.60	0.7526	1.669	1.737	0.0752
20-Mar-17	Kingfisher Crk	0.0088	0.0020	0.0754	11.30	0.7171	1.267	1.408	0.0526
31-Mar-17	Kingfisher Crk	0.0082	0.0020	0.0551	10.90	0.7367	1.183	1.337	0.0477
03-Apr-17	Kingfisher Crk	0.0128	0.0099	0.2396	10.20	0.9438	1.273	1.322	0.0451
07-Apr-17	Kingfisher Crk	0.0239	0.0137	0.0861	8.48	0.6034	0.932	1.109	0.0380
13-Apr-17	Kingfisher Crk	0.0073	0.0073	0.0333	16.90	0.8212	1.885	1.651	0.0733
15-Apr-17	Kingfisher Crk	0.0174	0.0054	0.0455	9.17	0.6708	1.014	1.134	0.0438
25-Apr-17	Kingfisher Crk	0.0077	0.0042	0.1076	9.54	0.6521	1.015	1.152	0.0466
27-Apr-17	Kingfisher Crk	0.0106	0.0034	0.0941	9.37	0.7381	1.013	1.124	0.0461
03-May-17	Kingfisher Crk	0.0053	0.0049	0.0670	9.81	0.7115	1.106	1.156	0.0488
05-May-17	Kingfisher Crk	0.0155	0.0098	0.2321	6.66	0.5290	0.724	1.108	0.0335
08-May-17	Kingfisher Crk	0.0069	0.0044	0.1810	12.40	0.7827	1.486	1.361	0.0597

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
10-May-17	Kingfisher Crk	0.0127	0.0045	0.2593	11.70	1.0190	1.328	1.114	0.0544
12-May-17	Kingfisher Crk	0.0126	0.0066	0.1923	7.27	0.7193	0.817	0.814	0.0381
16-May-17	Kingfisher Crk	0.0084	0.0074	0.1713	8.33	0.6320	0.923	0.896	0.0447
19-May-17	Kingfisher Crk	0.0062	0.0048	0.2130	9.65	0.6637	1.143	1.029	0.0514
23-May-17	Kingfisher Crk	0.0206	0.0059	0.2471	5.03	0.5322	0.563	0.594	0.0283
26-May-17	Kingfisher Crk	0.0057	0.0041	0.1470	8.03	0.5410	0.909	0.775	0.0390
27-May-17	Kingfisher Crk	0.0114	0.0036	0.1275	6.13	0.6210	0.776	0.534	0.0310
30-May-17	Kingfisher Crk	0.0372	0.0138	0.0895	4.96	0.4100	0.532	0.612	0.0280
02-Jun-17	Kingfisher Crk	0.0954	0.0036	0.0872	6.12	0.4600	0.619	0.677	0.0330
07-Jun-17	Kingfisher Crk	0.0243	0.0073	0.1133	6.02	6.6100	5.030	2.250	0.0330
09-Jun-17	Kingfisher Crk	0.0096	0.0024	0.0705	5.88	3.5700	2.260	1.490	0.0330
13-Jun-17	Kingfisher Crk	0.0082	0.0029	0.0748	6.09	1.5400	1.550	0.970	0.0350
15-Jun-17	Kingfisher Crk	0.0069	0.0045	0.0793	5.69	0.3660	0.633	0.658	0.0330
23-Jun-17	Kingfisher Crk	0.0097	0.0036	0.0626	5.66	0.3460	0.618	0.632	0.0330
27-Jun-17	Kingfisher Crk	0.0119	0.0103	0.0620	5.60	0.3470	0.611	0.621	0.0330
30-Jun-17	Kingfisher Crk	0.0000	0.0000	0.0412	5.29	0.3810	0.560	0.615	0.0310
06-Jul-17	Kingfisher Crk	0.0036	0.0003	0.0521	5.28	0.4320	0.570	0.615	0.0320
11-Jul-17	Kingfisher Crk	0.0027	0.0021	0.0505	7.05	0.5910	0.788	0.764	0.0420
14-Jul-17	Kingfisher Crk	0.0017	0.0014	0.0523	7.93	0.5980	0.868	0.789	0.0480
19-Jul-17	Kingfisher Crk	0.0027	0.0022	0.0710	10.00	0.6160	1.130	1.030	0.0610
25-Jul-17	Kingfisher Crk	0.0612	0.0041	0.1002	11.90	0.8640	1.340	1.230	0.0700
31-Jul-17	Kingfisher Crk	0.0021	0.0021	0.3462	13.10	0.9700	1.470	1.320	0.0780
11-Aug-17	Kingfisher Crk	0.0005	0.0003	0.0775	14.90	0.9390	1.700	1.560	0.0870
07-Sep-17	Kingfisher Crk	0.0176	0.0027	0.0124	43.10	2.4400	5.080	4.920	0.2490
22-Sep-17	Kingfisher Crk	0.0001	0.0001	0.0158	44.90	2.4500	5.580	5.280	0.2650
20-Oct-17	Kingfisher Crk	0.0031	0.0024	0.0623	36.90	2.1000	4.380	3.880	0.2120
17-Nov-17	Kingfisher Crk	0.0092	0.0020	0.1989	35.70	1.8700	4.230	3.930	0.1920
05-Jul-16	4km	0.0020	0.0014	0.0864	12.20	0.9189	1.382	0.904	0.0562
12-Jul-16	4km	0.0096	0.0132	0.0458	12.40	0.7541	1.395	0.919	0.0569
20-Jul-16	4km	0.0088	0.0129	0.0416	13.10	0.9380	1.526	0.936	0.0601
26-Jul-16	4km	0.0089	0.0142	0.0117	13.00	0.7414	1.462	0.931	0.0596
09-Aug-16	4km	0.0011	0.0001	0.0436	14.40	0.7758	1.653	1.089	0.0668
12-Aug-16	4km	0.0100	0.0199	0.0747	14.30	0.7526	1.520	1.001	0.0615
20-Aug-16	4km	0.0003	0.0174	0.0492	14.50	0.9728	1.677	1.100	0.0680
23-Sep-16	4km	0.9947	0.0201	0.0615	14.40	0.7706	1.659	1.080	0.0672
22-Oct-16	4km	0.0079	0.0140	0.0360	14.30	0.7850	1.654	1.268	0.0659
20-Nov-16	4km	0.0136	0.0228	0.1481	14.20	1.0170	1.656	1.316	0.0658
11-Dec-16	4km	0.0010	0.0001	0.0013	14.90	0.9043	1.813	1.417	0.0715
27-Jan-17	4km	0.0036	0.0001	0.3256	15.50	1.0670	1.903	1.472	0.0737

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
09-Mar-17	4km	0.0006	0.0001	0.7992	16.20	0.8407	1.987	1.491	0.0764
20-Mar-17	4km	0.0064	0.0012	0.4313	15.60	0.8619	1.893	1.493	0.0730
31-Mar-17	4km	0.0082	0.0001	0.2317	14.80	0.8067	1.824	1.477	0.0703
03-Apr-17	4km	0.0105	0.0093	0.0712	14.40	1.1260	1.765	1.474	0.0681
07-Apr-17	4km	0.0840	0.0082	0.2315	13.70	0.7656	1.676	1.439	0.0648
13-Apr-17	4km	0.0105	0.0064	0.0294	10.00	0.8828	1.076	1.194	0.0464
15-Apr-17	4km	0.0232	0.0023	0.2511	15.40	0.8350	1.869	1.465	0.0732
25-Apr-17	4km	0.0046	0.0046	0.2330	15.40	1.1490	1.838	1.443	0.0720
27-Apr-17	4km	0.0114	0.0061	0.2093	14.70	0.9969	1.812	1.415	0.0701
03-May-17	4km	0.0049	0.0008	0.1956	14.70	0.8130	1.807	1.357	0.0699
05-May-17	4km	0.1765	0.0069	0.2049	12.90	0.7220	1.565	1.353	0.0616
08-May-17	4km	0.0047	0.0047	0.1822	13.80	0.8036	1.652	1.318	0.0645
10-May-17	4km	0.0058	0.0014	0.1717	14.30	0.9805	1.929	1.380	0.0694
12-May-17	4km	0.0080	0.0066	0.1818	14.70	0.8739	1.792	1.334	0.0714
16-May-17	4km	0.0098	0.0064	0.1440	14.90	1.3710	1.866	1.370	0.0721
19-May-17	4km	0.0059	0.0048	0.2020	14.00	0.8931	1.758	1.270	0.0672
23-May-17	4km	0.0121	0.0044	0.2478	13.50	0.7725	1.677	1.221	0.0654
26-May-17	4km	0.0086	0.0048	0.1193	14.70	0.8860	1.830	1.220	0.0640
27-May-17	4km	0.0075	0.0036	0.1423	14.30	0.9110	1.820	1.190	0.0610
30-May-17	4km	0.0220	0.0176	0.0923	13.10	0.7520	1.580	1.170	0.0620
02-Jun-17	4km	0.0063	0.0052	0.1026	14.00	0.7000	1.660	1.300	0.0650
07-Jun-17	4km	0.0139	0.0070	0.1237	11.60	3.0500	2.660	1.900	0.0530
09-Jun-17	4km	0.0063	0.0027	0.0664	13.80	3.4200	3.000	1.970	0.0650
13-Jun-17	4km	0.0098	0.0035	0.1090	13.30	1.7500	2.280	1.430	0.0630
15-Jun-17	4km	0.0057	0.0042	0.0968	11.70	0.6420	1.400	1.070	0.0550
23-Jun-17	4km	0.0115	0.0036	0.1360	12.90	0.7130	1.500	1.140	0.0600
27-Jun-17	4km	0.0116	0.0070	0.0946	13.40	1.0400	1.920	1.320	0.0630
30-Jun-17	4km	0.0018	0.0000	0.0483	11.50	0.9140	1.330	1.050	0.0540
06-Jul-17	4km	0.0030	0.0012	0.0611	12.00	0.6920	1.380	1.080	0.0570
11-Jul-17	4km	0.0036	0.0015	0.0953	12.30	0.7620	1.400	1.090	0.0570
14-Jul-17	4km	0.0023	0.0009	0.0246	12.20	0.6390	1.390	1.060	0.0560
19-Jul-17	4km	0.0038	0.0016	0.1026	12.20	0.8270	1.420	1.130	0.0570
25-Jul-17	4km	0.0328	0.0027	0.0400	12.30	0.9630	1.430	1.180	0.0580
31-Jul-17	4km	0.0031	0.0026	0.2133	13.00	0.7640	1.470	1.130	0.0600
11-Aug-17	4km	0.0008	0.0008	0.0584	12.90	0.7690	1.490	1.150	0.0600
07-Sep-17	4km	0.0097	0.0030	0.0009	34.30	1.8100	4.040	2.920	0.1620
22-Sep-17	4km	0.0021	0.0011	0.0123	34.90	1.8100	4.160	3.020	0.1630
20-Oct-17	4km	0.0020	0.0020	0.0009	35.20	1.8500	4.230	3.140	0.1640
17-Nov-17	4km	0.0091	0.0018	0.2059	36.30	1.9300	4.410	2.970	0.1690

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
05-Jul-16	Cooke Crk	0.0024	0.0014	0.0304	6.56	0.7093	0.650	0.630	0.0389
12-Jul-16	Cooke Crk	0.0081	0.0204	0.0411	7.80	0.5927	0.792	0.761	0.0480
20-Jul-16	Cooke Crk	0.0299	0.0172	0.0247	7.92	1.6320	0.905	0.788	0.0487
26-Jul-16	Cooke Crk	0.0100	0.0132	0.0177	10.10	0.8657	1.075	1.018	0.0653
09-Aug-16	Cooke Crk	0.0062	0.0001	0.0552	12.00	1.1840	1.336	1.328	0.0799
12-Aug-16	Cooke Crk	0.0083	0.0188	0.0719	12.70	1.1670	1.407	1.378	0.0854
20-Aug-16	Cooke Crk	0.0040	0.0172	0.0461	14.40	1.0880	1.664	1.575	0.0999
23-Sep-16	Cooke Crk	2.0189	0.0228	0.0395	10.30	0.8361	1.134	1.138	0.0680
22-Oct-16	Cooke Crk	0.0270	0.0228	0.0692	8.95	0.6452	1.034	1.280	0.0585
20-Nov-16	Cooke Crk	0.0136	0.0001	0.1656	8.76	0.7587	1.019	1.270	0.0566
11-Dec-16	Cooke Crk	0.0027	0.0001	0.0013	10.90	0.7767	1.343	1.595	0.0735
27-Jan-17	Cooke Crk	0.0016	0.0001	0.2760	13.60	0.9801	1.678	1.847	0.0936
09-Mar-17	Cooke Crk	0.0008	0.0001	0.5641	13.60	0.9101	1.770	1.917	0.0951
20-Mar-17	Cooke Crk	0.0088	0.0023	0.1421	9.64	0.9113	1.380	1.616	0.0686
31-Mar-17	Cooke Crk	0.0090	0.0041	0.0436	9.61	0.7930	1.230	1.375	0.0621
03-Apr-17	Cooke Crk	0.0225	0.0076	0.1331	8.27	0.7381	1.196	1.385	0.0579
07-Apr-17	Cooke Crk	0.0117	0.0114	0.0605	8.11	0.7917	1.128	1.377	0.0580
13-Apr-17	Cooke Crk	0.0155	0.0088	0.0396	8.04	0.8055	1.096	1.298	0.0564
15-Apr-17	Cooke Crk	0.0093	0.0058	0.0402	7.16	0.7614	0.954	1.188	0.0482
25-Apr-17	Cooke Crk	0.0315	0.0065	0.0764	8.14	0.7632	1.074	1.295	0.0550
27-Apr-17	Cooke Crk	0.0144	0.0118	0.0786	8.45	0.7702	1.062	1.302	0.0549
03-May-17	Cooke Crk	0.0122	0.0053	0.0553	7.53	0.6707	0.992	1.214	0.0520
05-May-17	Cooke Crk	0.0440	0.0120	0.2466	5.76	0.7489	0.709	1.157	0.0372
08-May-17	Cooke Crk	0.0116	0.0058	0.1262	6.34	0.6741	0.768	1.049	0.0419
10-May-17	Cooke Crk	0.0174	0.0059	0.1059	6.37	1.0490	0.852	0.986	0.0423
12-May-17	Cooke Crk	0.0143	0.0098	0.1225	5.55	0.6098	0.658	0.815	0.0366
16-May-17	Cooke Crk	0.0138	0.0074	0.0631	6.92	2.7380	0.844	1.016	0.0460
19-May-17	Cooke Crk	0.0059	0.0051	0.1252	6.68	0.5810	0.794	0.936	0.0447
23-May-17	Cooke Crk	0.0275	0.0077	0.1856	4.30	0.4819	0.477	0.635	0.0273
26-May-17	Cooke Crk	0.0684	0.0048	0.0720	5.63	0.5550	0.650	0.755	0.0330
27-May-17	Cooke Crk	0.0134	0.0056	0.1372	5.16	1.0800	0.559	0.529	0.0280
30-May-17	Cooke Crk	0.0356	0.0135	0.0499	4.04	0.5740	0.427	0.653	0.0240
02-Jun-17	Cooke Crk	0.0287	0.0036	0.0393	4.44	0.4730	0.469	0.659	0.0260
07-Jun-17	Cooke Crk	0.0275	0.0082	0.0694	4.56	4.9400	3.510	2.000	0.0260
09-Jun-17	Cooke Crk	0.0081	0.0030	0.0537	ND	0.0100	0.000	0.013	0.0000
13-Jun-17	Cooke Crk	0.0093	0.0035	0.0511	5.41	4.9900	3.770	1.830	0.0300
15-Jun-17	Cooke Crk	0.0064	0.0052	0.0509	4.60	0.2830	0.477	0.658	0.0280
23-Jun-17	Cooke Crk	0.0073	0.0054	0.0385	4.63	0.3740	0.471	0.644	0.0280
27-Jun-17	Cooke Crk	0.0113	0.0095	0.0393	4.55	0.3200	0.456	0.613	0.0260
30-Jun-17	Cooke Crk	0.0003	0.0000	0.1606	4.04	0.4250	0.392	0.556	0.0230

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
06-Jul-17	Cooke Crk	0.0036	0.0012	0.1799	4.70	0.3610	0.455	0.638	0.0280
11-Jul-17	Cooke Crk	0.0021	0.0021	0.4208	7.50	0.5630	0.753	0.905	0.0440
14-Jul-17	Cooke Crk	0.0020	0.0009	0.0284	8.17	0.7190	0.858	0.959	0.0510
19-Jul-17	Cooke Crk	0.0027	0.0025	0.0617	9.94	0.7430	1.110	1.240	0.0660
25-Jul-17	Cooke Crk	0.0085	0.0041	0.0516	12.10	1.1500	1.500	1.580	0.0870
31-Jul-17	Cooke Crk	0.0023	0.0015	0.2757	12.90	1.0800	1.440	1.550	0.0860
11-Aug-17	Cooke Crk	0.0013	0.0000	0.0547	14.30	1.1800	1.680	1.770	0.0990
07-Sep-17	Cooke Crk	0.0045	0.0037	0.0009	43.00	3.1700	5.240	5.320	0.3050
22-Sep-17	Cooke Crk	0.0007	0.0002	0.0080	44.30	2.8100	5.380	5.290	0.3010
20-Oct-17	Cooke Crk	0.0013	0.0013	0.0577	35.40	2.3200	4.360	4.790	0.2430
17-Nov-17	Cooke Crk	0.0092	0.0024	0.1960	35.00	2.1100	4.400	4.460	0.2440
05-Jul-16	Falls Crk	0.0005	0.0022	0.0371	5.20	0.4512	0.506	0.530	0.0262
12-Jul-16	Falls Crk	0.0103	0.0150	0.0426	6.46	0.3411	0.662	0.615	0.0334
20-Jul-16	Falls Crk	0.0331	0.0156	0.0310	6.93	1.0280	0.799	0.643	0.0351
26-Jul-16	Falls Crk	0.0094	0.0126	0.0264	9.55	1.5790	0.944	0.797	0.0493
09-Aug-16	Falls Crk	0.0011	0.0001	0.0534	8.71	0.6986	0.864	0.745	0.0447
12-Aug-16	Falls Crk	0.0150	0.0199	0.0868	12.70	0.7141	1.215	1.014	0.0667
20-Aug-16	Falls Crk	0.0033	0.0153	0.1166	19.60	1.0360	1.897	1.514	0.1059
23-Sep-16	Falls Crk	2.2750	0.0234	0.0468	8.40	0.5003	0.814	0.712	0.0416
22-Oct-16	Falls Crk	0.0133	0.0234	0.0256	6.72	2.4830	0.687	0.822	0.0321
20-Nov-16	Falls Crk	0.0124	0.0001	0.1076	7.09	0.4756	0.711	0.820	0.0337
11-Dec-16	Falls Crk	0.0028	0.0001	0.0013	10.20	0.7609	1.048	1.083	0.0510
27-Jan-17	Falls Crk	0.0093	0.0001	0.4643	14.90	2.0030	1.937	1.722	0.0782
09-Mar-17	Falls Crk	0.0002	0.0001	0.8109	18.30	0.7261	1.861	1.764	0.0981
20-Mar-17	Falls Crk	0.0064	0.0001	0.1619	20.10	1.0420	2.074	1.726	0.1013
31-Mar-17	Falls Crk	0.0073	0.0029	0.0875	21.70	1.0180	2.180	1.731	0.1072
03-Apr-17	Falls Crk	0.0160	0.0085	0.3401	20.40	1.7610	2.184	1.703	0.0997
07-Apr-17	Falls Crk	0.0070	0.0070	0.1218	18.70	1.1360	1.888	1.549	0.0910
13-Apr-17	Falls Crk	0.0074	0.0073	0.0256	17.50	1.0850	1.798	1.467	0.0860
15-Apr-17	Falls Crk	0.0279	0.0035	0.1794	15.20	0.7999	1.424	1.203	0.0689
25-Apr-17	Falls Crk	0.0061	0.0046	0.1298	13.30	0.6990	1.303	1.139	0.0630
27-Apr-17	Falls Crk	0.0072	0.0064	0.1202	13.20	1.1020	1.490	1.250	0.0628
03-May-17	Falls Crk	0.0061	0.0019	0.0899	12.00	0.6054	1.214	1.034	0.0579
05-May-17	Falls Crk	0.5236	0.0087	0.1383	6.27	0.5434	0.670	0.835	0.0303
08-May-17	Falls Crk	0.0127	0.0113	0.0486	5.88	0.6407	0.628	0.750	0.0289
10-May-17	Falls Crk	0.0127	0.0105	0.0441	6.07	0.9456	0.701	0.730	0.0296
12-May-17	Falls Crk	0.0178	0.0101	0.0356	5.32	0.4570	0.578	0.603	0.0256
16-May-17	Falls Crk	0.0098	0.0084	0.0102	6.73	0.6567	0.699	0.710	0.0323
19-May-17	Falls Crk	0.0173	0.0077	0.0563	6.43	0.4092	0.680	0.674	0.0319

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
23-May-17	Falls Crk	0.0250	0.0066	0.0867	3.80	0.3443	0.413	0.509	0.0189
26-May-17	Falls Crk	0.0631	0.0054	0.0294	4.98	0.3600	0.518	0.562	0.0210
27-May-17	Falls Crk	0.0121	0.0059	0.0675	4.04	0.5390	0.451	0.525	0.0170
30-May-17	Falls Crk	0.0179	0.0119	0.0253	3.54	0.6000	0.375	0.620	0.0170
02-Jun-17	Falls Crk	0.0080	0.0036	0.0196	25.40	1.1000	3.760	2.170	0.1560
07-Jun-17	Falls Crk	0.0133	0.0085	0.0587	3.59	4.3300	2.740	1.520	0.0170
09-Jun-17	Falls Crk	0.0039	0.0030	0.0494	3.85	4.5100	3.240	1.740	0.0200
13-Jun-17	Falls Crk	0.0096	0.0037	0.0461	3.27	0.5560	0.583	0.607	0.0160
15-Jun-17	Falls Crk	0.0072	0.0055	0.0496	3.18	0.2160	0.354	0.512	0.0160
23-Jun-17	Falls Crk	0.0097	0.0067	0.0403	3.51	0.2230	0.361	0.537	0.0180
27-Jun-17	Falls Crk	0.0151	0.0076	0.0415	3.82	0.2320	0.389	0.568	0.0200
30-Jun-17	Falls Crk	0.0051	0.0021	0.0585	3.77	0.2910	0.397	0.600	0.0200
06-Jul-17	Falls Crk	0.0039	0.0018	0.0772	6.15	0.4810	0.610	0.731	0.0330
11-Jul-17	Falls Crk	0.0024	0.0021	0.0768	9.31	0.6200	0.913	1.000	0.0500
14-Jul-17	Falls Crk	0.0256	0.0043	0.1362	11.50	0.5930	1.110	1.190	0.0610
19-Jul-17	Falls Crk	0.0049	0.0019	0.1556	15.60	0.9010	1.530	1.370	0.0840
25-Jul-17	Falls Crk	0.0399	0.0074	0.1701	18.30	1.0600	1.780	1.580	0.0990
31-Jul-17	Falls Crk	0.0046	0.0023	0.5590	23.60	1.3800	2.300	2.010	0.1290
11-Aug-17	Falls Crk	0.0026	0.0013	0.0706	27.70	1.3000	2.710	2.340	0.1490
20-Oct-17	Falls Crk	0.0026	0.0011	0.0431	40.30	2.1000	3.910	3.650	0.2220
17-Nov-17	Falls Crk	0.0082	0.0017	0.2031	47.60	2.0100	4.780	3.770	0.2620
05-Jul-16	Trinity Crk	0.0020	0.0014	0.0802	37.80	1.7670	6.502	2.986	0.2519
12-Jul-16	Trinity Crk	0.0163	0.0115	0.0853	36.80	1.7810	6.394	2.959	0.2470
20-Jul-16	Trinity Crk	0.0437	0.0126	0.0597	34.70	1.8610	6.542	2.911	0.2392
26-Jul-16	Trinity Crk	0.0072	0.0137	0.0665	37.70	2.6590	6.371	3.022	0.2519
09-Aug-16	Trinity Crk	0.0062	0.0001	0.1564	39.50	1.8430	6.839	3.369	0.2670
12-Aug-16	Trinity Crk	0.0152	0.0215	0.1440	39.70	2.0430	6.884	3.328	0.2742
20-Aug-16	Trinity Crk	0.0100	0.0209	0.2268	39.00	1.9160	6.619	3.338	0.2601
23-Sep-16	Trinity Crk	1.6775	0.0207	0.1304	39.10	1.7910	6.743	3.251	0.2622
22-Oct-16	Trinity Crk	0.0199	0.0075	0.0498	40.40	1.9630	7.066	3.391	0.2642
20-Nov-16	Trinity Crk	0.0174	0.0389	0.3344	37.00	1.9430	6.406	3.119	0.2378
27-Jan-17	Trinity Crk	0.0130	0.0001	0.4359	40.70	1.8690	7.359	3.528	0.2683
09-Mar-17	Trinity Crk	0.0001	0.0001	0.6982	16.60	0.9648	2.142	1.657	0.0814
20-Mar-17	Trinity Crk	0.0090	0.0009	0.4116	18.30	1.0220	2.514	1.890	0.0933
31-Mar-17	Trinity Crk	0.0082	0.0038	0.0473	29.80	1.8090	3.561	1.964	0.1163
03-Apr-17	Trinity Crk	0.0195	0.0099	0.2574	27.80	1.6730	5.440	3.044	0.1809
07-Apr-17	Trinity Crk	0.0840	0.0219	0.4505	27.50	1.5080	5.276	3.078	0.1800
13-Apr-17	Trinity Crk	0.0260	0.0186	0.0626	27.20	1.6380	5.111	2.940	0.1778
15-Apr-17	Trinity Crk	0.0151	0.0027	0.1463	26.40	1.3580	4.783	2.699	0.1690

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
25-Apr-17	Trinity Crk	0.0161	0.0138	0.0915	27.60	1.4870	4.887	2.597	0.1791
27-Apr-17	Trinity Crk	0.0216	0.0121	0.1004	26.60	1.4900	4.709	2.599	0.1712
03-May-17	Trinity Crk	0.0441	0.0118	0.0628	28.40	1.3000	4.947	2.542	0.1817
05-May-17	Trinity Crk	0.0585	0.0276	0.1376	20.90	1.1890	3.830	3.281	0.1412
08-May-17	Trinity Crk	0.0632	0.0160	0.1118	27.80	1.5560	4.564	2.483	0.1697
10-May-17	Trinity Crk	0.3488	0.0120	0.0918	27.30	1.5380	4.505	2.430	0.1703
12-May-17	Trinity Crk	0.1083	0.0171	0.0853	25.40	1.3780	4.237	2.242	0.1591
16-May-17	Trinity Crk	0.2122	0.0138	0.0951	27.20	1.5380	4.554	2.315	0.1716
19-May-17	Trinity Crk	0.1366	0.0129	0.1310	27.70	1.2480	4.586	2.212	0.1740
23-May-17	Trinity Crk	0.0606	0.0114	0.1361	24.60	1.1660	3.776	1.791	0.1542
26-May-17	Trinity Crk	0.0117	0.0057	0.0643	27.30	1.2100	4.320	1.860	0.1540
27-May-17	Trinity Crk	0.0601	0.0095	0.0306	27.60	1.3900	4.220	1.780	0.1520
30-May-17	Trinity Crk	0.0579	0.0243	0.0528	24.40	1.1200	3.500	1.670	0.1500
02-Jun-17	Trinity Crk	0.3762	0.0069	0.0800	3.59	0.2880	0.372	0.511	0.0170
07-Jun-17	Trinity Crk	0.0788	0.0130	0.1232	13.30	4.6200	5.900	2.890	0.1350
09-Jun-17	Trinity Crk	0.0202	0.0055	0.0834	23.90	1.6800	4.700	2.230	0.1680
13-Jun-17	Trinity Crk	0.0210	0.0072	0.0880	6.93	2.5600	5.680	2.630	0.1230
15-Jun-17	Trinity Crk	0.0233	0.0072	0.1139	30.80	1.1700	4.950	2.300	0.2020
23-Jun-17	Trinity Crk	0.0290	0.0079	0.1257		0.0480		0.024	0.0000
27-Jun-17	Trinity Crk	0.0286	0.0108	0.1683	34.60	1.4100	5.710	2.630	0.2290
30-Jun-17	Trinity Crk	0.0057	0.0036	0.0771	37.00	1.5100	6.080	2.800	0.2470
06-Jul-17	Trinity Crk	0.0078	0.0042	0.0529	36.40	1.5500	6.050	2.840	0.2440
11-Jul-17	Trinity Crk	0.0071	0.0039	0.1706	37.80	1.6500	6.310	2.990	0.2540
14-Jul-17	Trinity Crk	0.0035	0.0014	0.1930	38.60	2.1600	6.520	3.030	0.2640
19-Jul-17	Trinity Crk	0.0066	0.0019	0.1762	39.10	1.8900	6.480	3.210	0.2590
25-Jul-17	Trinity Crk	0.0388	0.0000	0.2229	37.80	1.6900	6.390	3.190	0.2540
31-Jul-17	Trinity Crk	0.0067	0.0018	0.4292	38.60	1.8300	6.570	3.370	0.2600
11-Aug-17	Trinity Crk	0.0033	0.0005	0.1579	36.30	1.8500	6.420	3.430	0.2530
07-Sep-17	Trinity Crk	0.0080	0.0065	0.5743	101.00	4.8300	17.700	9.290	0.7000
22-Sep-17	Trinity Crk	0.0060	0.0046	0.4535	96.50	4.6000	17.400	9.090	0.6690
20-Oct-17	Trinity Crk	0.0039	0.0013	0.1901	91.60	4.4500	16.600	8.810	0.6230
17-Nov-17	Trinity Crk	0.0099	0.0029	0.1932	102.00	4.0700	18.000	7.890	0.6770
05-Jul-16	29km	0.0035	0.0006	0.0574	12.90	1.1430	1.490	1.008	0.0596
12-Jul-16	29km	0.0137	0.0142	0.0639	13.10	0.7886	1.505	0.967	0.0614
20-Jul-16	29km	0.0148	0.0156	0.0309	13.70	1.1930	1.656	1.040	0.0632
26-Jul-16	29km	0.0030	0.0166	0.0139	13.20	1.3710	1.510	0.992	0.0614
09-Aug-16	29km	0.0003	0.0001	0.0525	14.80	1.0190	1.724	1.315	0.0701
12-Aug-16	29km	0.0114	0.0220	0.0744	14.20	1.0700	1.659	1.115	0.0671
20-Aug-16	29km	0.0076	0.0199	0.0330	14.70	1.0370	1.715	1.194	0.0696

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
23-Sep-16	29km	1.7629	0.0201	0.0448	14.80	0.8185	1.770	1.134	0.0713
22-Oct-16	29km	0.0085	0.0196	0.0322	14.50	0.9697	1.741	1.297	0.0699
20-Nov-16	29km	0.0109	0.0038	0.1507	14.70	0.9056	1.808	1.431	0.0709
11-Dec-16	29km	0.0116	0.0001	0.0013	18.40	1.3070	3.122	3.034	0.0905
27-Jan-17	29km	0.0008	0.0001	0.3352	16.60	1.0900	2.097	1.602	0.0801
09-Mar-17	29km	0.0006	0.0001	0.7281	41.90	1.6080	7.599	3.643	0.2778
20-Mar-17	29km	0.0172	0.0090	0.8234	32.10	1.6000	6.474	3.445	0.2114
31-Mar-17	29km	0.0184	0.0128	0.7298	27.80	1.5150	5.454	2.984	0.1813
03-Apr-17	29km	0.0613	0.0172	1.2413	16.60	1.1840	2.297	1.738	0.0850
07-Apr-17	29km	0.0371	0.0096	0.2670	17.60	0.9982	2.457	1.846	0.0912
13-Apr-17	29km	0.0111	0.0077	0.0269	16.80	0.9361	2.278	1.654	0.0851
15-Apr-17	29km	0.0217	0.0027	0.1843	16.20	0.9735	2.164	1.537	0.0822
25-Apr-17	29km	0.0077	0.0042	0.1972	16.40	0.9374	2.146	1.555	0.0823
27-Apr-17	29km	0.0091	0.0080	0.1857	15.90	1.2140	2.132	1.644	0.0798
03-May-17	29km	0.0065	0.0038	0.1262	16.00	0.8806	2.155	1.634	0.0818
05-May-17	29km	0.0555	0.0063	0.1548	14.00	0.8527	1.864	1.737	0.0724
08-May-17	29km	0.0094	0.0058	0.1751	14.50	0.9091	1.867	1.423	0.0710
10-May-17	29km	0.0142	0.0040	0.1692	15.00	1.1380	1.947	1.438	0.0745
12-May-17	29km	0.0206	0.0066	0.1355	14.20	0.8790	1.848	1.329	0.0720
16-May-17	29km	0.0135	0.0064	0.1619	15.00	0.9515	1.951	1.395	0.0744
19-May-17	29km	0.0118	0.0029	0.1974	15.00	0.8354	1.962	1.388	0.0749
23-May-17	29km	0.0125	0.0044	0.1909	14.20	0.8412	1.786	1.290	0.0702
26-May-17	29km	0.0691	0.0063	0.1223	15.20	1.1400	1.950	1.330	0.0660
27-May-17	29km	0.0108	0.0042	0.1270	14.00	1.3100	1.780	1.180	0.0600
30-May-17	29km	0.0198	0.0174	0.0975	13.50	1.2300	1.670	1.350	0.0660
02-Jun-17	29km	0.0124	0.0028	0.0715	13.80	0.8460	1.710	1.250	0.0670
07-Jun-17	29km	0.0139	0.0071	0.0902	12.40	2.5100	2.250	1.650	0.0590
09-Jun-17	29km	0.0105	0.0021	0.0824	13.40	3.1800	2.620	1.790	0.0630
13-Jun-17	29km	0.0106	0.0032	0.0932	13.80	2.4000	3.180	1.680	0.0660
15-Jun-17	29km	0.0057	0.0037	0.0976	11.80	0.6690	1.410	1.110	0.0570
23-Jun-17	29km	0.0085	0.0018	0.1305	12.60	0.7050	1.520	1.140	0.0600
27-Jun-17	29km	0.0124	0.0076	0.0865	12.70	0.7590	1.550	1.210	0.0610
30-Jun-17	29km	0.0006	0.0003	0.0471	12.20	0.6960	1.420	1.130	0.0580
06-Jul-17	29km	0.0054	0.0009	0.0737	11.80	0.7980	1.380	1.120	0.0560
11-Jul-17	29km	0.0039	0.0012	0.0962	12.80	0.7820	1.480	1.130	0.0590
14-Jul-17	29km	0.0023	0.0023	0.0551	13.00	0.7860	1.510	1.130	0.0610
19-Jul-17	29km	0.0041	0.0027	0.0724	12.20	0.7400	1.390	1.110	0.0570
25-Jul-17	29km	0.0049	0.0041	0.0643	13.40	0.9020	1.610	1.290	0.0640
31-Jul-17	29km	0.0144	0.0044	0.4466	13.70	1.2600	1.770	1.340	0.0640
11-Aug-17	29km	0.0121	0.0015	0.0716	13.80	0.8920	1.600	1.270	0.0640

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
07-Sep-17	29km	0.0089	0.0052	0.0121	35.90	2.4100	4.330	3.330	0.1740
22-Sep-17	29km	0.0027	0.0025	0.0242	36.10	2.1900	4.450	3.200	0.1720
20-Oct-17	29km	0.0026	0.0015	0.2663	37.10	1.9600	4.600	3.340	0.1790
17-Nov-17	29km	0.0087	0.0017	0.1946	38.20	2.1100	4.810	3.310	0.1850
05-Jul-16	Ashton Crk	0.0039	0.0006	0.0431	12.30	0.9264	1.231	0.811	0.0506
12-Jul-16	Ashton Crk	0.0118	0.0156	0.0449	13.80	1.2620	1.410	0.900	0.0578
20-Jul-16	Ashton Crk	0.0199	0.0126	0.0123	13.30	1.7230	1.435	0.894	0.0571
26-Jul-16	Ashton Crk	0.0077	0.0150	0.0022	17.10	1.7750	1.794	1.104	0.0723
12-Aug-16	Ashton Crk	0.0166	0.0201	0.0980	20.40	2.2540	2.124	1.302	0.0853
20-Aug-16	Ashton Crk	0.0063	0.0201	0.1222	21.50	1.5310	2.170	1.338	0.0883
23-Sep-16	Ashton Crk	2.2750	0.0207	0.0503	18.30	1.4890	1.932	1.134	0.0765
22-Oct-16	Ashton Crk	0.0168	0.0228	0.0656	13.30	0.9189	1.453	1.139	0.0575
20-Nov-16	Ashton Crk	0.0127	0.0001	0.3629	14.20	0.7498	1.536	1.177	0.0608
27-Jan-17	Ashton Crk	0.0048	0.0001	0.4683	24.90	2.4910	3.908	2.023	0.1057
09-Mar-17	Ashton Crk	0.0014	0.0001	0.7033	28.20	1.4350	3.395	1.947	0.1165
20-Mar-17	Ashton Crk	0.0082	0.0006	0.0786	30.10	1.6310	3.723	2.043	0.1223
31-Mar-17	Ashton Crk	0.0090	0.0015	0.3239	18.30	1.0050	2.558	1.884	0.0931
03-Apr-17	Ashton Crk	0.0572	0.0265	0.0653	28.00	1.8150	3.482	2.004	0.1121
07-Apr-17	Ashton Crk	0.0195	0.0120	0.2203	25.50	1.5800	3.164	1.897	0.1015
13-Apr-17	Ashton Crk	0.0155	0.0097	0.0333	26.50	1.8340	3.336	1.932	0.1041
15-Apr-17	Ashton Crk	0.0194	0.0115	0.2455	19.40	1.3280	2.418	1.693	0.0775
25-Apr-17	Ashton Crk	0.0296	0.0088	0.1193	19.10	1.2540	2.340	1.474	0.0769
27-Apr-17	Ashton Crk	0.0265	0.0121	0.1076	18.20	1.2530	2.292	1.498	0.0726
03-May-17	Ashton Crk	0.0217	0.0034	0.0305	17.90	1.1950	2.245	1.385	0.0726
05-May-17	Ashton Crk	0.1347	0.0189	0.1884	9.79	0.7887	1.168	1.453	0.0418
08-May-17	Ashton Crk	0.0221	0.0123	0.2865	12.60	1.0270	1.466	1.128	0.0512
10-May-17	Ashton Crk	0.0218	0.0102	0.2208	12.50	1.1100	1.440	1.040	0.0498
12-May-17	Ashton Crk	0.0227	0.0122	0.2744	9.08	0.7720	1.075	0.860	0.0391
16-May-17	Ashton Crk	0.0206	0.0101	0.1621	13.00	0.9339	1.523	1.075	0.0536
19-May-17	Ashton Crk	0.0103	0.0095	0.2096	10.90	0.8801	1.288	0.945	0.0460
23-May-17	Ashton Crk	0.0272	0.0084	0.3285	7.66	0.6025	0.799	0.744	0.0322
26-May-17	Ashton Crk	0.0234	0.0067	0.1506	9.38	0.7370	1.020	0.820	0.0350
27-May-17	Ashton Crk	0.0209	0.0072	0.0273	7.75	0.8990	0.829	0.697	0.0290
30-May-17	Ashton Crk	0.0298	0.0116	0.2836	6.22	0.5390	0.630	0.644	0.0260
02-Jun-17	Ashton Crk	0.0234	0.0055	0.1974	7.80	0.6270	0.816	0.757	0.0320
07-Jun-17	Ashton Crk	0.0151	0.0127	0.3245	7.90	2.4400	3.120	1.330	0.0320
09-Jun-17	Ashton Crk	0.0054	0.0033	0.2201	7.76	3.8900	2.390	1.660	0.0320
13-Jun-17	Ashton Crk	0.0154	0.0040	0.2452	7.27	1.6300	1.290	0.829	0.0300
15-Jun-17	Ashton Crk	0.0062	0.0045	0.1966	9.24	8.3500	9.030	3.440	0.0340

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
23-Jun-17	Ashton Crk	0.0085	0.0067	0.0742	ND	0.0660	ND	0.020	0.0000
27-Jun-17	Ashton Crk	0.0081	0.0081	0.0561	10.20	0.6410	0.997	0.805	0.0410
30-Jun-17	Ashton Crk	0.0024	0.0009	0.0606	11.20	0.7740	1.090	0.861	0.0450
06-Jul-17	Ashton Crk	0.0030	0.0015	0.0000	15.10	0.9930	1.560	1.070	0.0620
11-Jul-17	Ashton Crk	0.0033	0.0027	0.0523	19.00	1.3000	2.040	1.300	0.0770
14-Jul-17	Ashton Crk	0.0164	0.0164	0.0046	21.00	1.3000	2.210	1.380	0.0840
19-Jul-17	Ashton Crk	0.0143	0.0052	0.1463	21.70	1.5300	2.260	1.520	0.0880
25-Jul-17	Ashton Crk	0.0437	0.0153	0.2273	21.40	1.5700	2.180	1.500	0.0870
Note: Ashton Creek Ran dry from August 2017-March 2018									
05-Jul-16	Brash Crk	0.0122	0.0251	0.0383	14.30	1.3400	2.136	1.830	0.0696
12-Jul-16	Brash Crk	0.0252	0.0169	0.0165	14.00	1.0490	2.117	1.860	0.0696
20-Jul-16	Brash Crk	0.0231	0.0158	0.0140	13.20	1.1650	2.001	1.772	0.0664
26-Jul-16	Brash Crk	0.0139	0.0123	0.0279	15.00	2.0590	2.274	2.034	0.0745
09-Aug-16	Brash Crk	0.0117	0.0001	0.0314	17.50	1.1910	2.662	2.215	0.0864
12-Aug-16	Brash Crk	0.0214	0.0188	0.0657	19.20	1.4420	2.912	2.476	0.0954
20-Aug-16	Brash Crk	0.0177	0.0193	0.0483	23.20	1.4960	3.495	2.914	0.1130
23-Sep-16	Brash Crk	3.4699	0.0204	0.0680	16.70	1.0310	2.590	2.150	0.0835
22-Oct-16	Brash Crk	0.0432	0.0209	0.1409	11.20	1.5160	1.815	2.002	0.0580
20-Nov-16	Brash Crk	0.0328	0.0001	0.3269	13.10	0.8327	2.158	2.421	0.0655
11-Dec-16	Brash Crk	0.0009	0.0001	0.0013	15.60	2.7260	1.909	1.548	0.0751
27-Jan-17	Brash Crk	0.0167	0.0001	0.3874	22.50	2.1880	4.615	3.416	0.1076
09-Mar-17	Brash Crk	0.0074	0.0001	0.5515	25.10	1.1780	4.063	3.495	0.1218
20-Mar-17	Brash Crk	0.0385	0.0001	0.0238	21.40	1.2240	3.651	3.704	0.1025
31-Mar-17	Brash Crk	0.0531	0.0061	0.0144	17.70	0.8889	2.927	3.222	0.0830
03-Apr-17	Brash Crk	0.0195	0.0128	0.4031	16.00	0.9154	2.813	3.199	0.0780
07-Apr-17	Brash Crk	0.1079	0.0376	0.0653	14.50	0.9394	2.603	3.048	0.0715
13-Apr-17	Brash Crk	0.0586	0.0527	0.1750	16.20	1.2250	2.812	3.102	0.0787
15-Apr-17	Brash Crk	0.0705	0.0626	0.0086	11.40	0.9045	2.107	2.576	0.0585
25-Apr-17	Brash Crk	0.0673	0.0553	0.0057	12.40	0.8114	2.185	2.641	0.0629
27-Apr-17	Brash Crk	0.0713	0.0519	0.0358	11.30	1.4880	2.040	2.570	0.0574
03-May-17	Brash Crk	0.0552	0.0461	0.0009	12.10	0.9115	2.067	2.380	0.0596
05-May-17	Brash Crk	0.0381	0.0292	0.1108	7.31	0.6681	1.201	2.140	0.0388
08-May-17	Brash Crk	0.0603	0.0338	0.4387	9.32	0.8065	1.518	1.990	0.0508
10-May-17	Brash Crk	0.0617	0.0294	0.2480	9.85	1.0990	2.089	1.893	0.0543
12-May-17	Brash Crk	0.0716	0.0280	0.2729	7.92	0.7209	1.270	1.507	0.0454
16-May-17	Brash Crk	0.0530	0.0294	0.2469	10.50	0.8653	1.657	1.832	0.0557
19-May-17	Brash Crk	0.0492	0.0231	0.2586	9.49	0.7650	1.474	1.597	0.0496
23-May-17	Brash Crk	0.0720	0.0202	0.3907	6.78	0.6225	1.007	1.158	0.0377
26-May-17	Brash Crk	0.0070	0.0051	0.2127	8.76	0.8070	1.290	1.330	0.0400

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
27-May-17	Brash Crk	0.0255	0.0144	0.0242	7.57	0.8000	1.120	1.140	0.0350
30-May-17	Brash Crk	0.0480	0.0248	0.2357	6.20	0.6300	0.863	1.000	0.0320
02-Jun-17	Brash Crk	0.0265	0.0094	0.2240	7.04	0.6280	0.977	1.160	0.0350
07-Jun-17	Brash Crk	0.0204	0.0145	0.1732	8.72	0.8570	1.280	1.350	0.0430
09-Jun-17	Brash Crk	0.0093	0.0058	0.1152	9.28	3.9900	2.280	2.100	0.0460
13-Jun-17	Brash Crk	0.0125	0.0090	0.0245	11.20	1.3600	1.990	1.710	0.0550
15-Jun-17	Brash Crk	0.0109	0.0089	0.0576	11.30	2.2100	2.900	2.010	0.0570
23-Jun-17	Brash Crk	0.0127	0.0097	0.0448	ND	0.0900	ND	0.018	0.0000
27-Jun-17	Brash Crk	0.0154	0.0130	0.0531	15.70	1.0900	2.340	2.160	0.0790
30-Jun-17	Brash Crk	0.0075	0.0060	0.0936	16.90	1.1800	2.520	2.310	0.0850
06-Jul-17	Brash Crk	0.0154	0.0136	0.0867	18.70	1.3600	2.830	2.530	0.0950
11-Jul-17	Brash Crk	0.0152	0.0152	0.0649	20.20	1.4800	3.030	2.680	0.1010
14-Jul-17	Brash Crk	0.0000	0.0000	0.0000	21.00	1.5400	3.210	2.820	0.1050
19-Jul-17	Brash Crk	0.0140	0.0038	0.0709	21.60	1.3900	3.290	2.870	0.1070
25-Jul-17	Brash Crk	0.0167	0.0025	0.0791	21.50	1.3800	3.320	2.920	0.1080
31-Jul-17	Brash Crk	0.0167	0.0015	0.3470	22.60	1.5600	3.510	3.090	0.1110
11-Aug-17	Brash Crk	0.0086	0.0049	0.0544	21.40	1.3400	3.390	2.920	0.1050
07-Sep-17	Brash Crk	0.0137	0.0057	0.0046	58.10	3.5000	9.260	7.520	0.2860
22-Sep-17	Brash Crk	0.0128	0.0078	0.0215	57.70	3.2800	9.410	7.560	0.2840
20-Oct-17	Brash Crk	0.0110	0.0077	0.0611	59.70	3.6100	9.610	7.700	0.2940
17-Nov-17	Brash Crk	0.0138	0.0079	0.2010	55.90	3.0700	9.000	7.100	0.2710
09-Jun-17	Fortune Crk	0.0485	0.0355	0.0358	21.40	6.5700	5.700	3.440	0.1030
05-Jul-16	Fortune Crk	0.0607	0.0086	0.0665	34.20	2.8120	4.832	3.985	0.1853
12-Jul-16	Fortune Crk	0.0651	0.0295	0.0373	31.90	3.3080	4.400	3.631	0.1713
20-Jul-16	Fortune Crk	0.0508	0.0169	0.0009	31.00	2.3010	4.597	3.787	0.1733
26-Jul-16	Fortune Crk	0.0261	0.0201	0.0055	34.80	2.5450	5.459	4.717	0.2006
09-Aug-16	Fortune Crk	0.0216	0.0001	0.1010	47.50	5.1980	10.450	9.584	0.3446
12-Aug-16	Fortune Crk	0.0161	0.0285	0.1617	28.90	2.3930	2.184	1.609	0.1187
20-Aug-16	Fortune Crk	0.0451	0.0204	0.0725	37.90	3.2450	7.884	6.970	0.2719
23-Sep-16	Fortune Crk	6.7132	0.0236	0.0387	53.60	5.6930	13.240	12.230	0.4122
22-Oct-16	Fortune Crk	0.0304	0.0244	0.0898	38.60	3.7860	6.425	5.845	0.2233
20-Nov-16	Fortune Crk	0.0269	0.0001	0.3320	31.10	3.0040	4.849	4.754	0.1714
27-Jan-17	Fortune Crk	0.0040	0.0001	0.4357	18.20	2.0580	3.287	2.308	0.0948
09-Mar-17	Fortune Crk	0.0059	0.0001	1.3425	38.10	2.9410	3.669	2.926	0.1642
20-Mar-17	Fortune Crk	0.0371	0.0286	1.8583	46.80	4.0290	8.352	8.552	0.5801
31-Mar-17	Fortune Crk	0.0899	0.0061	2.8862	36.40	5.5250	10.510	12.170	0.2639
03-Apr-17	Fortune Crk	0.0653	0.0076	2.5041	31.20	5.0260	9.069	10.400	0.2236
07-Apr-17	Fortune Crk	0.0919	0.0639	1.5923	29.50	5.1990	8.520	10.260	0.2085
13-Apr-17	Fortune Crk	0.0630	0.0577	0.1916	25.60	4.3320	6.301	7.025	0.1601

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
15-Apr-17	Fortune Crk	0.0430	0.0372	0.1731	20.80	3.3250	4.606	5.159	0.1216
25-Apr-17	Fortune Crk	0.0246	0.0223	0.0431	22.00	2.8710	4.325	4.694	0.1255
27-Apr-17	Fortune Crk	0.0781	0.0451	0.1387	22.90	3.6960	5.014	5.597	0.1315
03-May-17	Fortune Crk	0.0350	0.0225	0.0174	25.20	3.6340	4.577	4.668	0.1376
05-May-17	Fortune Crk	0.1066	0.0131	0.0509	20.50	3.2500	4.003	4.828	0.1164
08-May-17	Fortune Crk	0.1165	0.0722	0.1845	20.90	3.1900	3.527	3.768	0.1097
10-May-17	Fortune Crk	0.0762	0.0398	0.2256	24.40	3.0550	3.864	4.037	0.1262
12-May-17	Fortune Crk	0.1286	0.0650	0.3593	23.40	3.1020	3.792	3.932	0.1209
16-May-17	Fortune Crk	0.0530	0.0371	0.0454	25.60	2.6750	3.924	4.028	0.1321
19-May-17	Fortune Crk	0.0404	0.0264	0.0426	21.30	2.3600	3.200	3.107	0.1084
23-May-17	Fortune Crk	0.0386	0.0305	1.1929	18.70	1.8890	2.325	2.110	0.0899
26-May-17	Fortune Crk	0.0285	0.0051	0.0246	20.20	2.2800	2.500	2.100	0.0860
27-May-17	Fortune Crk	0.0301	0.0284	0.0780	21.10	2.3800	2.560	2.100	0.0890
30-May-17	Fortune Crk	0.0521	0.0408	0.0007	19.50	1.8200	2.170	2.020	0.0890
02-Jun-17	Fortune Crk	0.0234	0.0028	0.0368	14.50	0.9360	1.060	0.921	0.0610
07-Jun-17	Fortune Crk	0.0506	0.0391	0.0474	18.70	5.1500	4.110	2.700	0.0860
13-Jun-17	Fortune Crk	0.0535	0.0239	0.0363	22.90	4.0800	5.850	3.180	0.1110
15-Jun-17	Fortune Crk	0.0541	0.0389	0.0490	24.10	2.3500	3.160	2.870	0.1200
23-Jun-17	Fortune Crk	0.0533	0.0345	0.0428	27.40	2.4800	3.680	3.410	0.1380
30-Jun-17	Fortune Crk	0.0621	0.0517	0.0605	31.00	2.7500	4.110	3.760	0.1600
06-Jul-17	Fortune Crk	0.0893	0.0649	0.0608	36.20	3.3900	5.150	4.750	0.1910
11-Jul-17	Fortune Crk	0.1227	0.0680	0.0489	40.10	3.3500	6.450	5.990	0.2340
14-Jul-17	Fortune Crk	0.0780	0.0512	0.0281	43.10	3.4700	7.730	7.280	0.2710
19-Jul-17	Fortune Crk	0.0598	0.0019	0.0611	49.10	3.9100	10.600	10.300	0.3540
25-Jul-17	Fortune Crk	0.0060	0.0016	0.0496	49.50	4.0800	12.900	12.500	0.4120
31-Jul-17	Fortune Crk	0.0924	0.0031	0.5464	49.00	4.1500	14.200	13.800	0.4460
11-Aug-17	Fortune Crk	0.0940	0.0742	0.0838	53.30	4.7800	17.400	17.100	0.5420
17-Nov-17	Fortune Crk	0.0126	0.0124	0.7346		17.6000	47.700	44.800	1.4300
05-Jul-16	42km	0.0039	0.0001	0.0681	12.40	0.7211	1.448	0.954	0.0586
12-Jul-16	42km	0.0059	0.0126	0.0534	13.00	0.7447	1.506	1.003	0.0611
20-Jul-16	42km	0.0071	0.0169	0.2264	13.50	1.7970	1.590	0.996	0.0639
26-Jul-16	42km	0.0075	0.0397	0.0177	13.70	1.4460	1.637	1.089	0.0661
09-Aug-16	42km	0.0011	0.0001	0.0456	14.90	0.9665	1.819	1.292	0.0712
12-Aug-16	42km	0.0094	0.0177	0.0953	14.60	0.9618	1.746	1.217	0.0696
20-Aug-16	42km	0.0016	0.0234	0.0724	14.90	0.9607	1.869	1.309	0.0716
23-Sep-16	42km	1.7629	0.0290	0.0474	14.90	1.2130	1.831	1.253	0.0718
22-Oct-16	42km	0.0065	0.0231	0.0402	15.20	1.3270	1.910	1.501	0.0738
20-Nov-16	42km	0.0124	0.0001	0.2202	15.00	0.8612	1.849	1.379	0.0729
11-Dec-16	42km	0.0013	0.0001	0.0013	15.90	1.6710	1.952	1.539	0.0767

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
27-Jan-17	42km	0.0179	0.0001	1.6434	52.50	5.1220	13.620	14.760	0.3927
09-Mar-17	42km	0.0022	0.0001	0.6975	17.30	1.1360	2.429	1.941	0.0884
20-Mar-17	42km	0.0481	0.0178	1.1256	19.40	1.7200	3.162	2.685	0.1062
31-Mar-17	42km	0.0864	0.0137	0.4168	19.10	1.2280	ND	2.463	0.1100
03-Apr-17	42km	0.0791	0.0216	0.9610	17.60	1.7370	2.764	2.226	0.0963
07-Apr-17	42km	0.0271	0.0123	0.3363	17.50	1.1930	2.657	2.178	0.0943
13-Apr-17	42km	0.0120	0.0114	0.0409	18.10	1.4190	2.612	1.976	0.0939
15-Apr-17	42km	0.0147	0.0088	0.2032	16.40	1.0430	2.423	1.824	0.0890
25-Apr-17	42km	0.0073	0.0046	0.1829	16.30	1.0060	2.275	1.791	0.0838
27-Apr-17	42km	0.0136	0.0114	0.1064	16.50	1.4680	2.352	1.860	0.0860
03-May-17	42km	0.0095	0.0049	0.1534	16.10	1.0190	2.225	1.662	0.0814
05-May-17	42km	0.0111	0.0104	0.1620	14.70	0.9754	2.039	1.693	0.0774
08-May-17	42km	0.0236	0.0091	0.2350	14.70	1.0670	1.992	1.660	0.0751
10-May-17	42km	0.0203	0.0058	0.1843	15.60	1.3700	2.089	1.606	0.0790
12-May-17	42km	0.0241	0.0077	0.1794	15.00	1.1190	2.000	1.508	0.0746
16-May-17	42km	0.0189	0.0094	0.1647	15.10	0.9741	2.002	1.499	0.0759
19-May-17	42km	0.0121	0.0081	0.1870	14.20	0.9275	1.899	1.385	0.0725
23-May-17	42km	0.0118	0.0040	0.1683	15.60	1.0000	1.970	1.420	0.0740
26-May-17	42km	0.0171	0.0143	0.1177	15.30	0.9930	1.980	1.350	0.0670
27-May-17	42km	0.0134	0.0065	0.1255	14.70	0.9250	1.850	1.230	0.0630
30-May-17	42km	0.0207	0.0146	0.0776	14.20	0.9150	1.750	1.300	0.0700
02-Jun-17	42km	0.0198	0.0058	0.0863	13.80	0.9000	1.730	1.310	0.0670
07-Jun-17	42km	0.0163	0.0071	0.0989	12.40	4.7200	4.800	2.110	0.0650
09-Jun-17	42km	0.0081	0.0027	0.0846	13.50	3.2300	2.690	1.890	0.0650
13-Jun-17	42km	0.0130	0.0032	0.1148	13.60	3.3500	3.510	1.920	0.0650
15-Jun-17	42km	0.0067	0.0062	0.0970	13.70	9.0300	10.700	3.580	0.0620
23-Jun-17	42km	0.0091	0.0042	0.1058	ND	0.0750	0.000	0.037	0.0010
27-Jun-17	42km	0.0132	0.0078	0.0901	12.30	0.7400	1.470	1.140	0.0590
30-Jun-17	42km	0.0018	0.0003	0.1090	12.50	1.2700	1.480	1.150	0.0600
06-Jul-17	42km	0.0042	0.0018	0.1081	12.40	0.8190	1.510	1.170	0.0590
11-Jul-17	42km	0.0051	0.0012	0.1039	13.00	0.7240	1.500	1.180	0.0600
14-Jul-17	42km	0.0023	0.0009	0.0477	12.60	0.7980	1.490	1.150	0.0600
19-Jul-17	42km	0.0038	0.0036	0.0698	12.70	0.9710	1.570	1.220	0.0620
25-Jul-17	42km	0.0033	0.0027	0.0744	13.00	0.8020	1.570	1.280	0.0620
31-Jul-17	42km	0.0054	0.0023	0.2432	13.70	0.8320	1.680	1.340	0.0650
11-Aug-17	42km	0.0362	0.0076	0.0807	14.10	0.8620	1.870	1.530	0.0700
07-Sep-17	42km	0.0124	0.0057	0.0706	38.40	2.0800	5.030	3.880	0.1820
22-Sep-17	42km		0.0032	0.0210	36.50	2.0300	4.670	3.590	0.1740
20-Oct-17	42km	0.0028	0.0024	0.1917	37.60	1.9500	4.830	3.670	0.1820
17-Nov-17	42km	0.0094	0.0024	0.1967	38.80	2.1500	5.120	3.570	0.1890

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
05-Jul-16	57km	0.0016	0.0008	0.0596	13.70	0.7742	1.626	1.196	0.0687
12-Jul-16	57km	0.0126	0.0134	0.0401	14.00	0.8898	1.685	1.251	0.0725
20-Jul-16	57km	0.0028	0.0172	0.0419	13.80	2.7020	1.684	1.165	0.0704
26-Jul-16	57km	0.0055	0.0212	0.0168	13.80	1.0070	1.651	1.148	0.0675
09-Aug-16	57km	0.0011	0.0001	0.4344	16.00	1.4070	2.184	1.653	0.0849
12-Aug-16	57km	0.0080	0.0225	0.0962	15.20	0.8957	1.922	1.402	0.0786
20-Aug-16	57km	0.0016	0.0215	0.0636	15.20	0.9893	2.032	1.496	0.0797
23-Sep-16	57km	0.5679	0.0228	0.0415	15.40	0.8723	1.968	1.397	0.0782
22-Oct-16	57km	0.0102	0.0220	0.0653	15.10	1.1040	1.928	1.582	0.0802
20-Nov-16	57km	0.0133	0.0001	0.2339	17.40	1.1580	2.258	2.036	0.1091
11-Dec-16	57km	0.0024	0.0001	0.0013	17.20	1.4460	2.313	2.016	0.1024
27-Jan-17	57km	0.0028	0.0001	0.3437	16.50	2.3450	2.698	2.124	0.0818
09-Mar-17	57km	0.0020	0.0001	0.8582	24.00	1.4870	3.532	3.305	0.1786
20-Mar-17	57km	0.0971	0.0829	2.3617	23.90	2.1190	3.942	3.495	0.1397
31-Mar-17	57km	0.0359	0.0055	1.9773	41.30	3.1280	6.267	6.202	0.4335
03-Apr-17	57km	0.0645	0.0120	2.5045	33.50	2.6520	5.035	4.941	0.3366
07-Apr-17	57km	0.0779	0.0137	0.6505	29.40	1.8970	4.403	4.323	0.2742
13-Apr-17	57km	0.0134	0.0076	0.0345	28.50	1.7910	4.305	4.022	0.2560
15-Apr-17	57km	0.0128	0.0081	0.2722	25.50	1.7270	3.827	3.576	0.2255
25-Apr-17	57km	0.0123	0.0061	0.1845	23.30	1.4760	3.452	3.116	0.1937
27-Apr-17	57km	0.0186	0.0144	0.1792	24.30	1.7350	3.623	3.260	0.2010
03-May-17	57km	0.0118	0.0038	0.1707	22.40	1.3810	3.252	2.887	0.1835
05-May-17	57km	0.0329	0.0133	0.1612	22.60	1.6160	3.399	3.311	0.1976
08-May-17	57km	0.0236	0.0156	0.3129	20.40	1.4320	2.959	2.748	0.1614
10-May-17	57km	0.0218	*0.0102*	0.1378	20.10	1.4390	2.865	2.485	0.1477
12-May-17	57km	0.0262	0.0091	0.2142	19.10	1.3240	2.638	2.325	0.1356
16-May-17	57km	0.0216	0.0088	0.1809	20.10	1.4380	2.798	2.418	0.1490
19-May-17	57km	0.0198	0.0070	0.1869	16.90	1.0460	2.366	1.930	0.1137
23-May-17	57km	0.0338	0.0099	0.1644	19.40	1.1700	3.080	2.370	0.1170
26-May-17	57km	0.0808	0.0035	0.0576	16.30	2.0800	5.710	5.130	0.1220
27-May-17	57km	0.0154	0.0046	0.1311	15.40	1.1300	2.010	1.420	0.0770
30-May-17	57km	0.0209	0.0149	0.0926	10.40	0.6700	1.350	0.945	0.0500
02-Jun-17	57km	0.0270	0.0052	0.0900	14.70	0.9640	1.870	1.490	0.0850
07-Jun-17	57km	0.0213	0.0092	0.1103	14.20	2.8700	2.940	2.070	0.0800
09-Jun-17	57km	0.0114	0.0030	0.0837	13.10	3.9500	4.180	2.060	0.0660
13-Jun-17	57km	0.0128	0.0043	0.1073	14.50	1.3700	1.940	1.430	0.0700
15-Jun-17	57km	0.0084	0.0057	0.1240	12.50	0.7120	1.540	1.210	0.0610
23-Jun-17	57km	0.0163	0.0061	0.1215	13.00	0.9420	1.660	1.350	0.0710
27-Jun-17	57km	0.0116	0.0062	0.0942	13.70	0.8020	1.710	1.480	0.0760
30-Jun-17	57km	0.0012	0.0006	0.0901	12.80	0.8580	1.530	1.220	0.0610

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
06-Jul-17	57km	0.0051	0.0024	0.1454	12.20	0.7470	1.470	1.200	0.0610
11-Jul-17	57km	0.0065	0.0015	0.1068	12.90	0.8010	1.580	1.270	0.0650
14-Jul-17	57km	0.0052	0.0014	0.0677	14.20	0.8470	1.740	1.400	0.0710
19-Jul-17	57km	0.0052	0.0030	0.0938	13.10	0.7540	1.630	1.380	0.0680
25-Jul-17	57km	0.0074	0.0055	0.0843	14.40	0.8630	1.850	1.590	0.0770
31-Jul-17	57km	0.0051	0.0041	0.3989	14.30	0.8460	1.950	1.850	0.0770
11-Aug-17	57km	0.0028	0.0010	0.0792	37.80	1.9800	5.310	4.490	0.2030
07-Sep-17	57km	0.0082	0.0037	0.0336	40.70	2.2300	6.280	5.210	0.2280
22-Sep-17	57km	0.0034	0.0027	0.0596	40.00	2.0300	5.780	4.700	0.2150
20-Oct-17	57km	0.0046	0.0013	0.1361	47.90	2.6400	7.890	7.670	0.3230
17-Nov-17	57km	0.0104	0.0020	0.1996	44.50	2.8100	6.660	5.220	0.2280
05-Jul-16	73km	0.0032	0.0008	0.0436	13.10	0.9494	1.548	1.043	0.0618
12-Jul-16	73km	0.0107	0.0019	0.0335	13.30	0.7168	1.588	1.083	0.0635
20-Jul-16	73km	0.0059	0.0115	0.0591	13.40	1.3790	1.693	1.084	0.0642
26-Jul-16	73km	0.0097	0.0193	0.0166	14.20	1.0580	1.770	1.222	0.0677
09-Aug-16	73km	0.0016	0.0446	0.0567	17.40	1.3620	2.366	1.812	0.0845
12-Aug-16	73km	0.0094	0.0489	0.0820	14.70	1.1260	1.912	1.376	0.0753
20-Aug-16	73km	0.0043	0.0537	0.0455	16.70	1.2770	2.260	1.721	0.0812
23-Sep-16	73km	2.5310	0.0252	0.0485	16.40	0.9275	2.076	1.489	0.0784
22-Oct-16	73km	0.0204	0.0400	0.0689	16.30	1.5250	2.077	1.654	0.0794
20-Nov-16	73km	0.0139	0.0001	0.2599	15.70	1.0250	1.991	1.571	0.0783
11-Dec-16	73km	0.0024	0.0001	0.0013	16.70	1.0950	2.184	1.744	0.0826
27-Jan-17	73km	0.0114	0.0001	0.4364	19.80	1.1730	2.822	2.514	0.1293
09-Mar-17	73km	0.0039	0.0001	0.8072	19.10	1.0960	2.801	2.367	0.1015
20-Mar-17	73km	0.0195	0.0137	1.0162	38.10	2.6300	3.842	2.711	0.1618
31-Mar-17	73km	0.0178	0.0137	0.9831	21.50	1.3690	3.379	2.770	0.1250
03-Apr-17	73km	0.0691	0.0645	0.7252	20.60	1.3800	3.348	2.679	0.1205
07-Apr-17	73km	0.0222	0.0175	0.5715	20.00	1.2920	3.046	2.528	0.1127
13-Apr-17	73km	0.0111	0.0073	0.0333	20.10	1.3420	3.079	2.420	0.1113
15-Apr-17	73km	0.0244	0.0085	0.3344	21.20	1.2450	2.903	2.381	0.1079
25-Apr-17	73km	0.0123	0.0054	0.2101	18.10	1.0030	2.568	2.031	0.0970
27-Apr-17	73km	0.0182	0.0072	0.2141	18.20	1.1230	2.610	2.085	0.0992
03-May-17	73km	0.0202	0.0038	0.1979	17.60	1.0140	2.464	1.877	0.0945
05-May-17	73km	0.0374	0.0122	0.2659	15.90	1.1890	2.425	2.091	0.0956
08-May-17	73km	0.0258	0.0120	0.3164	16.20	1.0760	2.218	1.873	0.0878
19-May-17	73km	0.0242	0.0070	0.2250	15.60	0.8804	2.101	1.598	0.0818
23-May-17	73km	0.0169	0.0040	0.1831	15.60	1.1100	2.000	1.460	0.0720
26-May-17	73km	0.0101	0.0089	0.1210	15.70	1.0700	2.070	1.410	0.0710
27-May-17	73km	0.0147	0.0042	0.0642	14.40	0.8910	1.860	1.250	0.0630

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
30-May-17	73km	0.0265	0.0209	0.0894	13.90	0.9740	1.810	1.240	0.0610
02-Jun-17	73km	0.0243	0.0077	0.0828	13.70	0.9180	1.690	1.300	0.0670
07-Jun-17	73km	0.0192	0.0089	0.1221	13.60	3.4000	3.650	1.900	0.0660
09-Jun-17	73km	0.0903	0.0064	0.0920	12.70	4.0600	3.480	2.150	0.0600
13-Jun-17	73km	0.0136	0.0067	0.1098	16.30	1.9800	2.430	1.770	0.0880
15-Jun-17	73km	0.0077	0.0074	0.1114	13.90	4.4200	5.640	2.370	0.0730
23-Jun-17	73km	0.0163	0.0073	0.1009	12.40	0.6760	1.590	1.260	0.0630
27-Jun-17	73km	0.0149	0.0092	0.0957	13.50	0.7660	1.650	1.320	0.0660
30-Jun-17	73km	0.0039	0.0033	0.1292	14.40	0.9360	1.890	1.690	0.0760
06-Jul-17	73km	0.0048	0.0033	0.1325	12.70	0.8500	1.600	1.310	0.0630
11-Jul-17	73km	0.0116	0.0027	0.1002	13.70	0.8860	1.810	1.510	0.0680
14-Jul-17	73km	0.0046	0.0014	0.0621	13.10	0.8830	1.560	1.280	0.0620
19-Jul-17	73km	0.0296	0.0038	0.1030	13.80	0.8450	1.800	1.570	0.0680
25-Jul-17	73km	0.0339	0.0027	0.0673	14.40	0.9110	1.920	1.660	0.0730
31-Jul-17	73km	0.0308	0.0077	0.3350	15.30	0.9670	2.140	1.840	0.0790
11-Aug-17	73km	0.0045	0.0008	0.0729	37.70	2.3700	5.400	4.870	0.1890
07-Sep-17	73km	0.0114	0.0030	0.0161	44.30	3.1100	6.590	6.050	0.2230
22-Sep-17	73km	0.0098	0.0039	0.0729	48.50	3.8800	7.940	6.660	0.2460
20-Oct-17	73km	0.0033	0.0031	0.1575	42.40	2.4500	6.190	5.190	0.2210
17-Nov-17	73km	0.0138	0.0045	0.2116	64.80	4.1700	10.900	12.400	0.5630

Table 25: *Chemical data for samples taken along the Salmon River. All data is in mg L^{-1}*

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
05-Jul-16	0km	0.0912	0.0649	0.4216	33.5	3.049	14.11	15.65	0.2572
12-Jul-16	0km	0.1187	0.0644	0.2267	27.5	2.627	11.81	13.13	0.2091
20-Jul-16	0km	0.0977	0.0907	0.1324	22	2.456	9.253	9.418	0.1584
12-Aug-16	0km	0.0475	0.0217	0.1301	25.6	3.132	16.47	20.12	0.2591
20-Aug-16	0km	0.0616	0.0201	0.3656	40.5	3.899	16.74	20.04	0.3021
09-Aug-16	0km	0.0528	0.0268	0.5732	18.8	3.299	16.4	20.65	0.2446
30-Sep-16	0km	4.1851	0.0376	0.5114	40.8	3.435	16.92	20.73	0.3048
22-Oct-16	0km	0.0906	0.0593	0.4179	35.8	3.266	14.98	18.37	0.2695
20-Nov-16	0km	0.0757	0.0001	0.8896	30.3	2.764	13	15.06	0.2274
27-Jan-16	0km	0.0961	0.0001	1.7680	40.7	4.396	17.85	21.14	0.3043
16-Mar-17	0km	0.0738	0.0583	1.2015	35.8	3.641	15.73	18.16	0.2792
31-Mar-17	0km	0.0724	0.0309	0.8862	31.8	2.843	13.68	15.67	0.2427
03-Apr-17	0km	0.0441	0.0382	0.8040	21.6	2.425	9.493	10.04	0.1614
07-Apr-17	0km	0.1123	0.0899	0.4343	34	2.463	11	9.857	0.3973
13-Apr-17	0km	0.0805	0.0799	0.3525	21.4	2.259	9.359	9.583	0.1601
15-Apr-17	0km	0.1588	0.0767	0.2509	16.4	1.991	7.016	7.048	0.1202
25-Apr-17	0km	0.1779	0.1050	0.0031	17.4	2.244	7.628	7.605	0.132
27-Apr-17	0km	0.1353	0.0974	0.0144	17.2	2.324	8.043	7.699	0.1388
03-May-17	0km	0.1656	0.0821	0.0169	16.7	2.017	7.499	7.468	0.1284
05-May-17	0km	0.1846	0.1247	0.0036	19	2.559	8.424	8.363	0.1511
08-May-17	0km	0.4581	0.1597	0.1806	17.8	2.954	7.324	6.462	0.1449
10-May-17	0km	0.1104	0.0530	0.2489	15.1	1.483	4.228	4.407	0.1492
12-May-17	0km	0.1184	0.0422	0.2150	13.4	1.433	3.586	3.967	0.1265
16-May-17	0km	0.2018	0.1138	0.0938	15.2	2.154	6.245	6.497	0.1176
19-May-17	0km	0.1476	0.1160	0.0927	16.1	2.184	6.831	6.931	0.1287
23-May-17	0km	0.0610	0.0276	0.2438	10.4	1.16	2.49	2.63	0.086
26-May-17	0km	0.0292	0.0033	0.1187	12.4	1.19	3.12	3.1	0.104
27-May-17	0km	0.0425	0.0193	0.0813	10.5	1.13	2.41	2.54	0.085
30-May-17	0km	0.1566	0.1169	0.0032	14	2.14	5.84	5.33	0.096
02-Jun-17	0km	0.1271	0.0081	0.0138	13.7	1.76	5.54	5.7	0.104
07-Jun-17	0km	0.1892	0.0882	0.1439	17.7	2.02	7.48	7.68	0.135
09-Jun-17	0km	0.0915	0.0794	0.1575	17	6.54	9.61	8.71	0.125
13-Jun-17	0km	0.0787	0.0686	0.1950	20.4	4.4	10.1	10.1	0.157
15-Jun-17	0km	0.0757	0.0642	0.2831	22.1	2.7	10.2	10.8	0.178
23-Jun-17	0km	0.0908	0.0678	0.2501	24.4	2.31	10.6	11.3	0.192
27-Jun-17	0km	0.0959	0.0635	0.4480	29.6	2.63	12.5	14.3	0.24
30-Jun-17	0km	0.0756	0.0753	0.0372	32	2.87	13.7	15.7	0.254
06-Jul-17	0km	0.2535	0.0748	0.0884	35.6	3.02	15.1	18.7	0.275
11-Jul-17	0km	0.0829	0.0719	0.7581	39	3.03	16.5	21.2	0.301

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
14-Jul-17	0km	0.0720	0.0604	0.6299	37.1	2.89	15.8	20	0.285
19-Jul-17	0km	0.0510	0.0354	0.4398	36.5	2.92	15.8	20.3	0.282
25-Jul-17	0km	0.0336	0.0019	0.4738	37.9	3.04	16.4	21.1	0.295
31-Jul-17	0km	0.0624	0.0293	1.2767	37.1	3.04	16.3	20.6	0.289
11-Aug-17	0km	0.0502	0.0213	0.2282	96	7.27	40.6	50.8	0.739
07-Sep-17	0km	0.0701	0.0084	0.7147	98.1	7.45	42.2	52.7	0.756
22-Sep-17	0km	0.0506	0.0433	0.6424	98.1	7.54	41.8	52.3	0.764
20-Oct-17	0km	0.0182	0.0042	2.4479	96.4	8.75	41.5	51.8	0.755
17-Nov-17	0km	0.0547	0.0411	0.2236	96.5	8.54	42.2	54.2	0.752
05-Jul-16	Bolean Creek	0.0476	0.0334	0.0912	30.9	2.662	8.182	6.904	0.3556
12-Jul-16	Bolean Creek	0.0677	0.0329	0.0447	27.4	2.194	7.543	6.752	0.3068
20-Jul-16	Bolean Creek	0.0271	0.0303	0.0444	22.6	1.787	5.388	4.906	0.235
12-Aug-16	Bolean Creek	0.0364	0.0676	0.0864	42.1	3.24	10.74	8.229	0.5098
20-Aug-16	Bolean Creek	0.0231	0.0738	0.0540	55	3.668	14.38	10.15	0.714
09-Sep-16	Bolean Creek	0.0333	0.0215	0.0963	39.2	2.873	10.36	8.258	0.4613
30-Sep-16	Bolean Creek	5.2909	0.1066	0.0482	44.4	3.135	11.95	9.042	0.5447
22-Oct-16	Bolean Creek	0.0244	0.0784	0.0248	22	1.682	5.242	4.748	0.2274
20-Nov-16	Bolean Creek	0.0310	0.0001	0.0801	26.3	1.727	7.003	6.331	0.2855
27-Jan-17	Bolean Creek	0.0366	0.0001	0.4346	40.9	3.09	11.8	8.926	0.4973
16-Mar-17	Bolean Creek	0.0548	0.0349	0.5118	35.1	3.086	11.12	9.179	0.4143
31-Mar-17	Bolean Creek	0.0388	0.0333	0.2195	40.8	2.936	13.8	12.33	0.497
07-Apr-17	Bolean Creek	0.0502	0.0481	0.4775	30.5	2.274	10.21	9.717	0.3464
13-Apr-17	Bolean Creek	0.0435	0.0423	0.1865	33.5	2.606	ND	11.65	0.4084
15-Apr-17	Bolean Creek	0.0701	0.0387	0.3401	23.6	2.111	8.086	8.337	0.2641
25-Apr-17	Bolean Creek	0.0992	0.0785	0.2050	22	1.928	7.639	8.007	0.241
27-Apr-17	Bolean Creek	0.0940	0.0704	0.1943	25.4	2.274	9.135	8.912	0.2809
03-May-17	Bolean Creek	0.0925	0.0030	0.1476	12.3	1.483	1.277	2.185	0.0858
05-May-17	Bolean Creek	0.8266	0.0592	0.2244	18.1	2.061	3.656	4.584	0.1524
08-May-17	Bolean Creek	0.1481	0.0497	0.2476	16.9	1.616	4.586	5.046	0.1659
10-May-17	Bolean Creek	0.1583	0.0483	0.1390	15.6	2.416	6.227	6.235	0.124
12-May-17	Bolean Creek	0.2309	0.1043	0.1022	14.4	2.266	5.822	5.815	0.1128
16-May-17	Bolean Creek	0.0820	0.0485	0.2021	15.9	1.471	4.781	4.946	0.1635
19-May-17	Bolean Creek	0.0507	0.0422	0.2306	14	1.325	4.033	4.216	0.1385
23-May-17	Bolean Creek	0.2189	0.0948	0.0601	13.8	2.15	5.73	5.48	0.099
26-May-17	Bolean Creek	0.1081	0.0941	0.0230	12.7	1.91	5.38	4.98	0.087
27-May-17	Bolean Creek	0.1634	0.0827	0.0350	13.5	2.01	5.59	5.18	0.091
30-May-17	Bolean Creek	0.0347	0.0311	0.0524	10.7	1.17	2.46	2.56	0.089
02-Jun-17	Bolean Creek	0.0220	0.0086	0.0472	12.4	1.1	2.88	3.13	0.115

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
07-Jun-17	Bolean Creek	0.0308	0.0266	0.0943	16.7	1.38	4.04	4.08	0.165
09-Jun-17	Bolean Creek	0.0279	0.0262	0.0636	18.1	5.52	6.85	5.4	0.176
13-Jun-17	Bolean Creek	0.0290	0.0269	0.0566	23.1	5.66	7.6	6.38	0.244
15-Jun-17	Bolean Creek	0.0278	0.0275	0.0784	23.8	1.96	6.37	5.75	0.258
23-Jun-17	Bolean Creek	0.0357	0.0290	0.0758	28.4	2.12	7.62	6.58	0.322
27-Jun-17	Bolean Creek	0.0373	0.0308	0.1604	35.3	2.62	9.37	7.54	0.415
30-Jun-17	Bolean Creek	0.0382	0.0370	0.6555	39.5	2.91	10.8	9.31	0.469
06-Jul-17	Bolean Creek	0.0377	0.0377	0.0609	46	4	12.2	9.28	0.578
11-Jul-17	Bolean Creek	0.0365	0.0345	0.1368	54.7	3.91	14.7	10.8	0.705
14-Jul-17	Bolean Creek	0.0351	0.0345	0.1484	53.9	3.74	14.6	10.6	0.702
19-Jul-17	Bolean Creek	0.0494	0.0395	0.1298	57.4	4.12	15.9	11.5	0.767
25-Jul-17	Bolean Creek	0.0554	0.0030	0.1350	61.1	4.42	16.9	12.2	0.826
31-Jul-17	Bolean Creek	0.0524	0.0303	0.4047	63.1	4.39	17.7	12.2	0.875
11-Aug-17	Bolean Creek	0.0245	0.0190	0.0664	165	11.3	46.6	30.8	2.35
07-Sep-17	Bolean Creek	0.0616	0.0253	0.0164	ND	11.5	48.5	30.1	2.52
22-Sep-17	Bolean Creek	0.0208	0.0163	0.0416	ND	10	46.9	30	2.37
20-Oct-17	Bolean Creek	0.0488	0.0193	0.1653	152	9.89	45.4	32.4	2.12
17-Nov-17	Bolean Creek	0.0262	0.0203	0.2194	145	8.59	44.5	33.4	1.93
05-Jul-16	28 km	0.0479	0.0315	0.0749	41.9	3.285	15.07	13.52	0.4284
12-Jul-16	28 km	0.0707	0.0398	0.0415	32.8	2.554	11.96	10.92	0.3231
20-Jul-16	28 km	0.0502	0.0583	0.0437	34.4	2.788	12.06	11.94	0.3241
12-Aug-16	28 km	0.0361	0.0462	0.0675	49.3	3.643	18.18	16.73	0.5255
20-Aug-16	28 km	0.0220	0.0451	0.0451	49.7	3.777	19.61	17.37	0.5594
09-Aug-16	28 km	0.0235	0.0352	0.0741	48.2	4.599	17.64	16.15	0.5125
30-Sep-16	28 km	0.2754	0.0486	0.0296	49	3.499	18.84	17.36	0.5239
22-Oct-16	28 km	0.0375	0.0293	0.0875	34.9	2.852	12.26	12.22	0.3371
20-Nov-16	28 km	0.0523	0.0001	0.4252	34.6	2.85	12.53	12.66	0.3254
27-Jan-16	28 km	0.0794	0.0001	1.2180	45	3.936	17.69	17.08	0.4493
16-Mar-17	28 km	0.0351	0.0338	0.7235	45.2	3.666	17.21	16.85	0.4541
31-Mar-17	28 km	0.0834	0.0400	0.0113	42.3	3.306	16.55	16.09	0.4153
07-Apr-17	28 km	0.0709	0.0572	0.3616	31	2.526	11.83	11.81	0.2934
13-Apr-17	28 km	0.0974	0.0572	0.2516	19.2	2.07	2.037	3.153	0.1332
15-Apr-17	28 km	0.1185	0.0535	0.2916	22.7	2.222	8.562	8.287	0.2021
25-Apr-17	28 km	0.1622	0.0910	0.0810	22.6	2.346	8.896	8.931	0.1954
27-Apr-17	28 km	0.1255	0.0891	0.0858	21.5	2.212	8.382	8.135	0.1872
03-May-17	28 km	0.1111	0.0037	0.0546	20.9	2.029	8.233	7.935	0.1848
05-May-17	28 km	0.8665	0.0792	0.2110	21.9	2.364	5.63	5.998	0.1754
08-May-17	28 km	0.4806	0.1245	0.1929	23.8	3.273	7.985	7.67	0.1993
10-May-17	28 km	0.3579	0.0951	0.1552	19.2	2.736	6.343	6.34	0.1569

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
12-May-17	28 km	0.2079	0.0779	0.1516	17.6	2.138	5.694	5.713	0.1462
16-May-17	28 km	0.3084	0.0823	0.1355	17.9	1.992	6.399	6.251	0.1534
19-May-17	28 km	0.1175	0.0856	0.1165	18.4	2.063	6.601	6.407	0.157
23-May-17	28 km	0.1766	0.0732	0.1495	15.9	1.96	5.3	5.09	0.118
26-May-17	28 km	0.0111	0.0069	0.1154	16.7	1.04	2.25	1.58	0.086
27-May-17	28 km	0.1389	0.0628	0.0482	16.8	2.12	5.72	5.03	0.126
30-May-17	28 km	0.1345	0.0780	0.0318	17.1	2.06	5.94	5.4	0.129
02-Jun-17	28 km	0.1053	0.0699	0.0558	16.9	1.72	5.72	5.62	0.142
07-Jun-17	28 km	0.1389	0.0669	0.1606	20.8	1.92	7.31	7.04	0.177
09-Jun-17	28 km	0.0753	0.0579	0.1670	22.1	8.84	11.6	9.42	0.188
13-Jun-17	28 km	0.0599	0.0529	0.1403	26.3	5.99	11.4	10.5	0.24
15-Jun-17	28 km	0.0546	0.0479	0.1839	29.7	4	11.5	10.8	0.273
23-Jun-17	28 km	0.0690	0.0502	0.1025	31.1	2.56	11.6	11.4	0.299
27-Jun-17	28 km	0.0486	0.0389	0.1215	37	2.83	13.7	13.3	0.366
30-Jun-17	28 km	0.0421	0.0397	0.1451	42.1	3.21	15.4	14.6	0.423
06-Jul-17	28 km	0.0413	0.0386	0.8883	49.1	3.53	17.6	16.4	0.506
11-Jul-17	28 km	0.0389	0.0339	0.0329	52.7	3.83	20.6	18.1	0.574
14-Jul-17	28 km	0.0380	0.0354	0.0189	52.4	3.82	19.6	17.6	0.569
19-Jul-17	28 km	0.0359	0.0288	0.0613	53.9	3.85	20.5	17.6	0.6
25-Jul-17	28 km	0.0379	0.0055	0.0750	56.7	4.02	21.5	18.7	0.628
31-Jul-17	28 km	0.0344	0.0300	0.4074	55.6	3.97	21.5	18	0.633
11-Aug-17	28 km	0.0308	0.0054	0.0652	130	10.4	57.6	45.6	1.62
07-Sep-17	28 km	0.0358	0.0234	0.0006	77.6	10.9	57.1	46.6	1.47
22-Sep-17	28 km	0.0149	0.0092	0.0150	145	9.41	57.2	47.8	1.64
20-Oct-17	28 km	0.0182	0.0173	0.1451	132	9.11	52.3	46.3	1.45
17-Nov-17	28 km	0.0287	0.0210	0.2173	130	8.87	52.1	49.7	1.38
05-Jul-16	Silver Creek	0.001	0.001	0.047	39.2	2.798	2.475	1.883	0.2332
12-Jul-16	Silver Creek	0.007	0.002	0.021	34.8	2.215	2.235	1.734	0.2044
20-Jul-16	Silver Creek	0.003	0.008	0.073	32.8	2.305	2.107	1.657	0.1968
09-Aug-16	Silver Creek	0.024	0.02	0.11	43.2	2.646	2.979	2.278	0.2629
12-Aug-16	Silver Creek	0.012	0.02	0.083	40.9	2.693	2.784	2.09	0.2496
20-Aug-16	Silver Creek	1E-04	1E-04	0.072	45.3	2.836	3.207	2.338	0.2761
30-Sep-16	Silver Creek	4.185	0.031	0.036	44.2	2.769	3.103	2.291	0.2648
22-Oct-16	Silver Creek	0.019	0.031	0.024	28.3	1.823	1.833	1.727	0.1633
20-Nov-16	Silver Creek	0.012	1E-04	0.06	32.4	1.997	2.182	2.164	0.1847
11-Dec-16	Silver Creek	0.003	1E-04	0.001	37	2.179	2.613	2.318	0.2153
27-Jan-17	Silver Creek	0.002	1E-04	0.104	39.9	3.507	3.186	2.608	0.2341
16-Mar-17	Silver Creek	0.007	0.004	0.233	41.7	2.407	3.022	2.626	0.2514
31-Mar-17	Silver Creek	0.012	0.008	0.015	40.2	2.53	2.862	2.717	0.2429

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
03-Apr-17	Silver Creek	0.028	0.022	0.061	41.1	3.043	ND	2.818	0.2654
07-Apr-17	Silver Creek	0.018	0.012	0.003	38.3	2.629	2.665	2.464	0.2273
13-Apr-17	Silver Creek	0.108	0.012	0.054	29.7	2.444	11.54	11.37	0.2691
15-Apr-17	Silver Creek	0.003	1E-04	0.01	41.1	2.619	2.732	2.238	0.2438
25-Apr-17	Silver Creek	0.01	0.008	0.005	39.3	2.558	2.651	2.185	0.2357
27-Apr-17	Silver Creek	0.015	ND	0.042	38.3	2.558	2.555	2.05	0.2303
03-May-17	Silver Creek	0.021	0.009	9E-04	35.7	2.373	2.358	1.937	0.2121
05-May-17	Silver Creek	0.038	0.019	9E-04	23.5	1.565	1.332	1.587	0.1222
08-May-17	Silver Creek	0.025	0.004	0.002	21.8	1.588	1.32	1.384	0.117
10-May-17	Silver Creek	0.017	0.011	0.009	22.5	1.766	1.352	1.304	0.121
12-May-17	Silver Creek	0.019	0.016	6E-04	19.2	1.34	1.169	1.222	0.1039
16-May-17	Silver Creek	0.018	0.014	9E-04	24.2	1.616	1.541	1.55	0.1346
19-May-17	Silver Creek	0.017	0.011	0.04	22	1.452	1.338	1.268	0.1197
23-May-17	Silver Creek	0.202	0.019	0.067	18.6	1.25	1.18	1.41	0.086
26-May-17	Silver Creek	0.012	0.003	0.019	17.7	1.21	1.06	1.03	0.082
27-May-17	Silver Creek	0.108	0.012	0.202	14.6	1.01	0.85	1.17	0.064
30-May-17	Silver Creek	0.048	0.02	9E-04	12.6	0.955	0.694	0.828	0.056
02-Jun-17	Silver Creek	0.015	0.008	0.012	17.6	1.09	0.969	1.09	0.088
07-Jun-17	Silver Creek	0.014	0.01	0.036	20.6	6.33	4.03	2.46	0.105
09-Jun-17	Silver Creek	0.0033	0.003	0.027	21.2	4.23	3.23	2.11	0.111
13-Jun-17	Silver Creek	0.006	0.006	0.03	27.2	5.2	3.91	2.52	0.153
15-Jun-17	Silver Creek	0.006	0.005	0.041	24.3	1.91	1.72	1.54	0.148
23-Jun-17	Silver Creek	0.01	0.004	0.037	32.7	2.01	2.03	1.79	0.189
27-Jun-17	Silver Creek	0.008	0.008	0.041	34.5	2.18	2.2	1.83	0.204
30-Jun-17	Silver Creek	0.001	9E-04	0.079	35.4	2.35	2.24	1.94	0.211
06-Jul-17	Silver Creek	0.003	0.003	0.046	39.2	2.56	2.51	2.1	0.237
11-Jul-17	Silver Creek	0.004	0.003	0.039	39.5	2.54	2.61	2.16	0.242
14-Jul-17	Silver Creek	0.006	0.003	0.084	42.8	2.82	3.01	2.44	0.266
19-Jul-17	Silver Creek	0.006	0.002	0.03	42.6	2.7	2.88	2.32	0.261
25-Jul-17	Silver Creek	0.008	0.005	0.036	42	2.71	2.87	2.34	0.26
31-Jul-17	Silver Creek	0.007	0.003	0.238	45	2.86	3.1	2.52	0.28
11-Aug-17	Silver Creek	0.028	8E-04	0.062	112	6.79	8.15	6.49	0.703
07-Sep-17	Silver Creek	0.034	0.006	9E-04	115	7.12	8.58	6.63	0.715
22-Sep-17	Silver Creek	0.002	5E-04	0.011	111	6.28	8.24	6.24	0.68
20-Oct-17	Silver Creek	0.002	9E-04	0.388	110	6.48	8.13	6.22	0.672
17-Nov-17	Silver Creek	0.01	0.003	0.205	110	6.22	8.19	5.88	0.661
05-Jul-16	Spa Creek	0.004	0.019	0.065	12.9	1.405	1.254	1.815	0.0904
12-Jul-16	Spa Creek	0.013	0.002	0.056	12.3	1.216	1.209	1.774	0.0836
20-Jul-16	Spa Creek	0.006	0.024	0.067	11.8	1.248	1.236	1.734	0.0831

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
09-Aug-16	Spa Creek	0.008	0.033	0.105	17.4	1.558	1.788	2.405	0.1209
12-Aug-16	Spa Creek	0.014	0.045	0.139	18.3	1.693	1.849	2.495	0.129
20-Aug-16	Spa Creek	0.003	0.041	0.128	21.3	1.874	2.175	2.848	0.1508
30-Sep-16	Spa Creek	5.054	0.045	0.065	25.5	2.534	2.664	3.36	0.1753
22-Oct-16	Spa Creek	0.013	0.056	0.026	12.8	2.246	1.309	2.066	0.0859
20-Nov-16	Spa Creek	0.022	1E-04	0.071	11	0.993	1.122	1.926	0.0776
27-Jan-17	Spa Creek	0.01	1E-04	0.156	15.5	1.788	1.783	2.585	0.1101
16-Mar-17	Spa Creek	1E-04	1E-04	0.252	15.7	1.28	1.693	2.468	0.1117
31-Mar-17	Spa Creek	0.025	0.024	0.005	19.9	1.912	2.096	3.257	0.1443
03-Apr-17	Spa Creek	0.106	0.089	1.134	20.6	2.132	2.153	3.332	0.1479
07-Apr-17	Spa Creek	0.026	0.023	0.033	17.8	1.871	1.843	2.914	0.1261
13-Apr-17	Spa Creek	0.021	0.02	0.089	28.2	2.376	10.99	10.79	0.2557
15-Apr-17	Spa Creek	0.003	1E-04	0.019	17.1	1.879	1.783	2.707	0.1189
25-Apr-17	Spa Creek	0.013	0.011	0.004	17	1.701	1.764	2.731	0.1202
27-Apr-17	Spa Creek	ND	0.011	0.048	16.8	1.779	1.698	2.586	0.1164
03-May-17	Spa Creek	0.013	0.009	0.015	15.1	1.456	1.538	2.555	0.1049
05-May-17	Spa Creek	0.029	0.027	0.04	12.2	1.456	1.258	2.147	0.0849
08-May-17	Spa Creek	0.044	0.004	0.321	11.3	1.357	1.225	2.029	0.0799
10-May-17	Spa Creek	0.014	0.008	0.03	10.9	1.393	1.13	1.898	0.0773
12-May-17	Spa Creek	0.015	0.01	0.022	9.74	1.236	1.018	1.77	0.0687
16-May-17	Spa Creek	0.019	0.009	0.006	10.6	1.21	1.02	1.766	0.071
19-May-17	Spa Creek	0.009	0.008	0.077	9.28	1.015	0.952	1.654	0.0654
23-May-17	Spa Creek	0.024	0.007	1.009	6.67	0.882	0.674	1.29	0.043
26-May-17	Spa Creek	0.007	0.004	0.032	7.26	0.89	0.714	1.28	0.045
27-May-17	Spa Creek	0.031	0.006	0.12	5.96	0.789	0.589	1.2	0.037
30-May-17	Spa Creek	0.025	0.016	9E-04	5.97	0.883	0.655	1.22	0.038
02-Jun-17	Spa Creek	0.019	0.006	0.015	5.82	0.746	0.565	1.24	0.041
07-Jun-17	Spa Creek	0.014	0.009	0.055	6.98	0.847	0.716	1.37	0.049
09-Jun-17	Spa Creek	0.008	0.006	0.041	7.62	2.19	1.83	1.8	0.051
13-Jun-17	Spa Creek	0.008	0.007	0.055	8.54	3.41	2.49	2.32	0.061
15-Jun-17	Spa Creek	0.007	0.007	0.069	8.75	0.852	0.968	1.64	0.062
23-Jun-17	Spa Creek	0.01	0.007	0.062	9.79	0.929	1.08	1.79	0.069
27-Jun-17	Spa Creek	0.009	0.007	0.069	10.7	0.956	1.13	1.82	0.074
30-Jun-17	Spa Creek	0.005	0.001	0.043	11.7	1.09	1.25	1.97	0.082
06-Jul-17	Spa Creek	0.005	0.005	0.214	13.6	1.38	1.47	2.17	0.096
11-Jul-17	Spa Creek	0.034	0.005	0.118	15.7	2.07	1.73	2.42	0.11
14-Jul-17	Spa Creek	0.005	0.003	0.106	17.7	1.59	1.81	2.51	0.121
19-Jul-17	Spa Creek	0.03	0.005	0.154	22.6	1.92	2.47	3.21	0.158
25-Jul-17	Spa Creek	0.079	0.036	0.143	18	1.72	1.94	2.62	0.125
31-Jul-17	Spa Creek	0.03	0.005	0.774	23.2	1.98	2.49	3.25	0.164

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11-Aug-17	Spa Creek	0.019	1E-05	0.076	66.1	5.4	6.9	9	0.471
07-Sep-17	Spa Creek	0.008	0.006	0.012	73.9	5.85	8.09	10.5	0.523
22-Sep-17	Spa Creek	0.004	0.004	0.01	73.2	5.45	8.45	10.3	0.519
20-Oct-17	Spa Creek	0.009	0.004	0.099	72.7	6.06	8.55	10.3	0.511
17-Nov-17	Spa Creek	0.012	0.004	0.2	71.8	5.73	8.13	9.84	0.498
05-Jul-16	51 km	0.0464	0.0290	0.0929	43.1	3.548	13.71	12.05	0.4164
12-Jul-16	51 km	0.0643	0.0356	0.0446	35.7	2.958	11.38	10.02	0.33
20-Jul-16	51 km	0.0408	0.0518	0.1089	38.2	3.053	12.46	11.23	0.3659
12-Aug-16	51 km	0.0400	0.0185	0.0801	49.5	4.197	16.49	14.35	0.503
20-Aug-16	51 km	0.0331	0.0228	0.0807	54.4	4.837	18.65	15.27	0.5637
09-Aug-16	51 km	0.0283	0.0217	0.0811	44.3	4.097	16.97	14.75	0.4947
30-Sep-16	51 km	8.7266	0.0231	0.0731	51.3	3.934	17.44	15.23	0.5228
22-Oct-16	51 km	0.0443	0.0215	0.0535	40	2.963	12.85	11.8	0.3771
20-Nov-16	51 km	0.0488	0.0001	0.3953	39.5	3.085	13.3	12.4	0.3711
27-Jan-16	51 km	0.0570	0.0001	0.9730	49.5	5.154	17.52	15.67	0.4791
16-Mar-17	51 km	0.0295	0.0239	0.3678	49.3	3.752	16.68	14.75	0.4753
31-Mar-17	51 km	0.0511	0.0035	0.7410	44.6	3.838	14.25	13.01	0.4113
03-Apr-17	51 km	0.0277	0.0120	0.0303	36.9	3.29	11.85	11.05	0.3361
07-Apr-17	51 km	0.0610	0.0543	0.2381	34.6	2.818	10.8	10.22	0.3069
13-Apr-17	51 km	0.0805	0.0548	0.2414	30.7	2.561	9.899	9.175	0.2648
15-Apr-17	51 km	0.1336	0.0461	0.2843	25.3	2.349	7.773	7.419	0.2128
25-Apr-17	51 km	0.1568	0.0853	0.1979	25.1	2.449	8.513	8.605	0.2096
27-Apr-17	51 km	0.1145	0.0849	0.1251	23.5	2.325	8.023	7.696	0.1962
03-May-17	51 km	0.1994	0.0699	0.0952	24.2	2.191	8.343	7.957	0.2058
05-May-17	51 km	0.7918	0.0766	0.2051	21.7	2.38	5.879	6.233	0.1725
08-May-17	51 km	0.4752	0.1271	0.0242	25.2	3.334	7.541	7.512	0.2082
10-May-17	51 km	0.8821	0.0911	0.1682	21.7	2.809	6.36	6.16	0.1738
12-May-17	51 km	0.1939	0.0796	0.1556	20	2.43	5.775	5.722	0.1612
16-May-17	51 km	0.3290	0.0896	0.1525	20.8	2.333	6.392	6.248	0.1667
19-May-17	51 km	0.2798	0.0790	0.1613	19.3	2.053	6.062	5.849	0.1593
23-May-17	51 km	0.1858	0.0678	0.1439	18.2	2.07	5.13	4.86	0.131
26-May-17	51 km	0.0818	0.0039	0.0565	17.8	2.04	5.42	4.85	0.127
27-May-17	51 km	0.1563	0.0548	0.2582	17.8	2.04	5.24	4.81	0.126
30-May-17	51 km	0.1293	0.0730	0.0367	18	2.1	5.28	4.71	0.129
02-Jun-17	51 km	0.1566	0.0355	0.0446	18.6	1.8	5.45	5.26	0.148
07-Jun-17	51 km	0.0959	0.0610	0.1457	23.4	7.39	11.4	8.15	0.189
09-Jun-17	51 km	0.0680	0.0527	0.1682	24.2	5.26	9.1	7.75	0.199
13-Jun-17	51 km	0.0662	0.0466	0.1744	28.1	5.4	11	9.52	0.251
15-Jun-17	51 km	0.0506	0.0424	0.2373	31.9	3.79	11.7	9.93	0.285

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23-Jun-17	51 km	0.0587	0.0418	0.9620	33.3	2.68	11.1	10.2	0.305
27-Jun-17	51 km	0.0535	0.0394	0.1080	39.8	3.1	12.9	12	0.373
30-Jun-17	51 km	0.0382	0.0350	0.0406	42.3	3.41	13.7	12.7	0.402
06-Jul-17	51 km	0.0447	0.0407	0.1204	47.7	3.74	15.2	13.6	0.467
11-Jul-17	51 km	0.0431	0.0386	0.1075	53.3	3.99	17.4	14.9	0.529
14-Jul-17	51 km	0.0489	0.0420	0.0905	52	3.97	16.7	14.5	0.519
19-Jul-17	51 km	0.0401	0.0033	0.1309	54.1	4.16	17.7	14.6	0.544
25-Jul-17	51 km	0.0049	0.0049	0.0832	50.1	3.86	15	12.9	0.489
31-Jul-17	51 km	0.0424	0.0033	0.5621	54	4.36	17.8	14.7	0.556
11-Aug-17	51 km	0.0303	0.0254	0.1003	138	10.9	46.9	37.3	1.45
07-Sep-17	51 km	0.0358	0.0333	0.0665	140	11.2	48.9	38.1	1.49
22-Sep-17	51 km	0.0243	0.0236	0.0347	137	9.86	48.1	38.2	1.45
20-Oct-17	51 km	0.0241	0.0219	0.1351	139	10.1	49.6	41.4	1.45
17-Nov-17	51 km	0.0292	0.0188	0.2158	135	9.43	49	42.6	1.41
05-Jul-16	66 km	0.0363	0.0229	0.0668	33	2.779	9.61	8.472	0.3076
12-Jul-16	66 km	0.0532	0.0290	0.0500	30.8	2.6	9.254	8.149	0.2854
20-Jul-16	66 km	0.0371	0.0505	0.4830	35.8	2.936	10.95	9.773	0.3409
12-Aug-16	66 km	0.0394	0.0499	0.0938	46	3.909	14.46	12.82	0.4607
20-Aug-16	66 km	0.0378	0.0497	0.0502	48.7	4.082	15.09	12.77	0.4871
09-Aug-16	66 km	0.0235	0.0309	0.0714	45.9	3.573	14.5	12.74	0.4577
30-Sep-16	66 km	0.3149	0.0403	0.0485	48.6	3.78	16.17	14.21	0.4984
22-Oct-16	66 km	0.0449	0.0430	0.0464	30.7	2.452	9.425	8.713	0.2878
20-Nov-16	66 km	0.0781	0.0001	0.3634	33.9	2.518	10.68	9.992	0.3158
27-Jan-16	66 km	0.0330	0.0001	0.8289	45.2	3.869	14.53	13.35	0.436
16-Mar-17	66 km	0.0971	0.0847	0.9727	40.8	3.605	12.99	12.03	0.3774
31-Mar-17	66 km	0.0864	0.0324	0.7298	41.1	3.17	12.19	11.54	0.3728
03-Apr-17	66 km	0.0522	0.0160	0.5625	35.9	2.827	10.85	10.32	0.3276
07-Apr-17	66 km	0.0989	0.0831	0.8570	32.2	2.919	9.704	9.285	0.2884
13-Apr-17	66 km	0.0983	0.0706	0.3104	32.1	2.827	9.974	9.427	0.2817
15-Apr-17	66 km	0.1375	0.0705	0.3810	25.6	2.424	7.696	7.533	0.2211
25-Apr-17	66 km	0.1433	0.0845	0.4523	23.7	2.195	7.679	7.613	0.2003
27-Apr-17	66 km	0.1088	0.0731	0.1375	23.2	2.22	7.442	7.29	0.1941
03-May-17	66 km	0.1914	0.0670	0.1058	23.3	2.175	7.572	7.419	0.1981
05-May-17	66 km	0.5487	0.0747	0.1988	19.5	2.28	5.365	5.924	0.163
08-May-17	66 km	0.2951	0.1398	0.2766	23.2	3.204	6.05	6.13	0.1917
10-May-17	66 km	0.2298	0.0817	0.1640	19.9	2.738	5.609	5.732	0.1609
12-May-17	66 km	0.1715	0.0744	0.1427	17.8	2.185	4.961	4.942	0.145
16-May-17	66 km	0.2571	0.0803	0.1417	18.9	2.219	5.582	5.538	0.1541
19-May-17	66 km	0.2251	0.0760	0.1550	18	1.978	5.39	5.455	0.1488

Date	Site	TP	TDP	NO_3^-	Ca	K	Mg	Na	Sr
23-May-17	66 km	0.1616	0.0661	0.1098	16.6	2.13	4.62	4.55	0.126
26-May-17	66 km	0.0738	0.0048	0.0532	16.8	1.97	4.87	4.5	0.122
27-May-17	66 km	0.1288	0.0559	0.0253	15.1	1.83	4.23	3.89	0.106
30-May-17	66 km	0.1160	0.0645	0.0239	14.8	1.72	4.17	3.85	0.107
02-Jun-17	66 km	0.1171	0.0314	0.0371	17	1.61	4.69	4.65	0.135
07-Jun-17	66 km	0.1537	0.0080	0.1412	19.3	5.34	7.9	6.66	0.159
09-Jun-17	66 km	0.0708	0.0679	0.1517	21.5	5.58	7.65	7.02	0.177
13-Jun-17	66 km	0.0591	0.0439	0.1714	26	4.84	9.31	8.18	0.226
15-Jun-17	66 km	0.0442	0.0382	0.2417	26.7	2.15	8.25	7.71	0.239
23-Jun-17	66 km	0.0526	0.0357	0.1351	31.5	2.38	9.46	8.87	0.277
27-Jun-17	66 km	0.0462	0.0403	0.1390	35.4	2.69	11	10.1	0.328
30-Jun-17	66 km	0.0323	0.0317	0.1080	40.4	3.23	12.3	11.6	0.381
06-Jul-17	66 km	0.0450	0.0404	0.0464	43.9	3.47	13.2	11.8	0.418
11-Jul-17	66 km	0.0404	0.0324	0.0896	45.4	3.48	13.5	11.9	0.438
14-Jul-17	66 km	0.0368	0.0302	0.0744	48.9	3.88	14.7	12.9	0.48
19-Jul-17	66 km	0.0340	0.0338	0.1630	49.3	3.77	14.8	12.7	0.482
25-Jul-17	66 km	0.0322	0.0022	0.0894	50.2	3.94	15.3	13.1	0.499
31-Jul-17	66 km	0.0398	0.0393	0.4177	49.1	4	15	12.7	0.491
11-Aug-17	66 km	0.0335	0.0018	0.0806	127	9.73	39.3	32	1.27
07-Sep-17	66 km	0.0365	0.0070	0.0411	128	10	40.6	32.8	1.31
22-Sep-17	66 km	0.0238	0.0195	0.0198	129	9.04	42.4	33.6	1.32
20-Oct-17	66 km	0.0265	0.0234	0.1319	131	9.75	44.4	37.6	1.35
17-Nov-17	66 km	0.0267	0.0195	0.0009	126	9.12	43	37.1	1.28

Appendix H: Colored Dissolved Organic Matter (CDOM) Data

***Table 26**: CDOM data for samples taken along the Shuswap River. All data is in absorbance units*

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
05-Jul-16	Mabel Lake	0.0485	0.0296	0.0246	0.0241	0.0242	0.0158
12-Jul-16	Mabel Lake	0.0433	0.0279	0.0233	0.0226	0.0232	0.0149
20-Jul-16	Mabel Lake	0.0477	0.0287	0.0240	0.0235	0.0240	0.0155
26-Jul-16	Mabel Lake	0.0464	0.0289	0.0241	0.0233	0.0240	0.0158
09-Aug-16	Mabel Lake	0.0367	0.0257	0.0218	0.0214	0.0222	0.0151
12-Aug-16	Mabel Lake	0.0421	0.0266	0.0223	0.0219	0.0227	0.0149
20-Aug-16	Mabel Lake	0.0374	0.0249	0.0209	0.0207	0.0216	0.0149
23-Sep-16	Mabel Lake	0.0399	0.0265	0.0228	0.0222	0.0233	0.0158
22-Oct-16	Mabel Lake	0.0457	0.0285	0.0237	0.0233	0.0235	0.0153
20-Nov-16	Mabel Lake	0.0478	0.0292	0.0242	0.0238	0.0241	0.0150
11-Dec-16	Mabel Lake	0.0513	0.0306	0.0252	0.0245	0.0249	0.0155
27-Jan-17	Mabel Lake	0.0507	0.0294	0.0244	0.0236	0.0245	0.0158
09-Mar-17	Mabel Lake	0.0465	0.0287	0.0240	0.0234	0.0238	0.0154
31-Mar-17	Mabel Lake	0.0447	0.0279	0.0233	0.0227	0.0232	0.0152
03-Apr-17	Mabel Lake	0.0504	0.0302	0.0249	0.0242	0.0245	0.0152
07-Apr-17	Mabel Lake	0.2294	0.1506	0.1506	0.1299	0.1274	0.1024
13-Apr-17	Mabel Lake	0.0490	0.0297	0.0297	0.0240	0.0244	0.0155
15-Apr-17	Mabel Lake	0.0579	0.0312	0.0312	0.0249	0.0253	0.0164
25-Apr-17	Mabel Lake	0.0516	0.0308	0.0251	0.0239	0.0241	0.0151
27-Apr-17	Mabel Lake	0.0485	0.0294	0.0241	0.0234	0.0239	0.0151
03-May-17	Mabel Lake	0.0488	0.0292	0.0242	0.0234	0.0239	0.0150
05-May-17	Mabel Lake	0.1104	0.0494	0.0381	0.0361	0.0343	0.0176
08-May-17	Mabel Lake	0.0600	0.0335	0.0270	0.0262	0.0263	0.0162
10-May-17	Mabel Lake	0.0794	0.0366	0.0299	0.0289	0.0281	0.0163
12-May-17	Mabel Lake	0.0625	0.0345	0.0286	0.0276	0.0276	0.0161
16-May-17	Mabel Lake	0.0675	0.0366	0.0298	0.0287	0.0283	0.0166
19-May-17	Mabel Lake	0.0578	0.0334	0.0271	0.0264	0.0264	0.0162
23-May-17	Mabel Lake	0.0655	0.0374	0.0301	0.0290	0.0287	0.0169
26-May-17	Mabel Lake	0.0685	0.0377	0.0298	0.0290	0.0286	0.0164
27-May-17	Mabel Lake	0.0652	0.0367	0.0295	0.0284	0.0278	0.0165
30-May-17	Mabel Lake	0.0630	0.0351	0.0282	0.0275	0.0273	0.0169
02-Jun-17	Mabel Lake	0.0722	0.0387	0.0306	0.0293	0.0288	0.0166
07-Jun-17	Mabel Lake	0.1466	0.0657	0.0489	0.0465	0.0430	0.0190
09-Jun-17	Mabel Lake	0.0988	0.0547	0.0438	0.0418	0.0398	0.0206
13-Jun-17	Mabel Lake	0.1007	0.0505	0.0391	0.0374	0.0360	0.0184
15-Jun-17	Mabel Lake	0.0683	0.0381	0.0300	0.0293	0.0291	0.0172
23-Jun-17	Mabel Lake	0.0684	0.0380	0.0303	0.0293	0.0291	0.0166
27-Jun-17	Mabel Lake	0.0681	0.0377	0.0300	0.0291	0.0286	0.0166

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
30-Jun-17	Mabel Lake	0.0616	0.0354	0.0286	0.0277	0.0276	0.0163
06-Jul-17	Mabel Lake	0.0553	0.0327	0.0269	0.0259	0.0261	0.0159
11-Jul-17	Mabel Lake	0.0540	0.0326	0.0265	0.0259	0.0258	0.0158
14-Jul-17	Mabel Lake	0.0532	0.0318	0.0260	0.0254	0.0256	0.0158
19-Jul-17	Mabel Lake	0.0527	0.0318	0.0257	0.0254	0.0253	0.0157
25-Jul-17	Mabel Lake	0.0530	0.0313	0.0256	0.0249	0.0251	0.0159
31-Jul-17	Mabel Lake	0.0479	0.0291	0.0241	0.0234	0.0240	0.0156
11-Aug-17	Mabel Lake	0.0452	0.0279	0.0234	0.0229	0.0235	0.0154
07-Sep-17	Mabel Lake	0.0436	0.0272	0.0227	0.0220	0.0227	0.0150
22-Sep-17	Mabel Lake	0.0440	0.0276	0.0230	0.0226	0.0232	0.0153
20-Oct-17	Mabel Lake	0.0556	0.0320	0.0260	0.0255	0.0256	0.0158
05-Jul-16	Kingfisher Creek	0.0480	0.0314	0.0258	0.0255	0.0253	0.0156
12-Jul-16	Kingfisher Creek	0.0421	0.0291	0.0245	0.0242	0.0245	0.0155
20-Jul-16	Kingfisher Creek	0.0640	0.0408	0.0337	0.0330	0.0326	0.0205
26-Jul-16	Kingfisher Creek	0.0434	0.0292	0.0247	0.0240	0.0242	0.0161
12-Aug-16	Kingfisher Creek	0.0337	0.0246	0.0214	0.0210	0.0220	0.0151
20-Aug-16	Kingfisher Creek	0.0305	0.0237	0.0208	0.0203	0.0213	0.0149
09-Aug-16	Kingfisher Creek	0.0645	0.0401	0.0331	0.0321	0.0316	0.0187
23-Sep-16	Kingfisher Creek	0.0515	0.0332	0.0274	0.0266	0.0268	0.0166
22-Oct-16	Kingfisher Creek	0.1276	0.0650	0.0492	0.0464	0.0435	0.0194
20-Nov-16	Kingfisher Creek	0.1095	0.0565	0.0433	0.0411	0.0390	0.0180
11-Dec-16	Kingfisher Creek	0.0750	0.0417	0.0329	0.0314	0.0307	0.0164
27-Jan-17	Kingfisher Creek	0.0580	0.0310	0.0250	0.0244	0.0246	0.0154
09-Mar-17	Kingfisher Creek	0.0563	0.0339	0.0277	0.0269	0.0268	0.0164
20-Mar-17	Kingfisher Creek	0.1324	0.0660	0.0492	0.0468	0.0437	0.0196
31-Mar-17	Kingfisher Creek	0.1529	0.0742	0.0553	0.0526	0.0486	0.0207
03-Apr-17	Kingfisher Creek	0.1670	0.0806	0.0806	0.0567	0.0523	0.0218
07-Apr-17	Kingfisher Creek	0.1797	0.0869	0.0869	0.0612	0.0562	0.0228
13-Apr-17	Kingfisher Creek	0.0600	0.0346	0.0346	0.0273	0.0271	0.0161
15-Apr-17	Kingfisher Creek	0.1681	0.0803	0.0803	0.0566	0.0519	0.0219
25-Apr-17	Kingfisher Creek	0.1385	0.0688	0.0518	0.0491	0.0457	0.0200
27-Apr-17	Kingfisher Creek	0.1351	0.0676	0.0506	0.0481	0.0442	0.0196
03-May-17	Kingfisher Creek	0.1192	0.0615	0.0466	0.0440	0.0415	0.0190
05-May-17	Kingfisher Creek	0.1923	0.0915	0.0676	0.0637	0.0577	0.0222
08-May-17	Kingfisher Creek	0.0940	0.0470	0.0365	0.0348	0.0340	0.0190
10-May-17	Kingfisher Creek	0.1241	0.0617	0.0477	0.0456	0.0427	0.0205
12-May-17	Kingfisher Creek	0.1419	0.0697	0.0539	0.0512	0.0477	0.0219
16-May-17	Kingfisher Creek	0.1059	0.0584	0.0458	0.0437	0.0415	0.0198

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
19-May-17	Kingfisher Creek	0.0884	0.0480	0.0376	0.0362	0.0349	0.0187
23-May-17	Kingfisher Creek	0.1128	0.0598	0.0461	0.0439	0.0413	0.0198
26-May-17	Kingfisher Creek	0.0865	0.0473	0.0369	0.0353	0.0339	0.0180
27-May-17	Kingfisher Creek	0.0885	0.0475	0.0371	0.0357	0.0344	0.0189
30-May-17	Kingfisher Creek	0.1063	0.0561	0.0432	0.0414	0.0390	0.0191
02-Jun-17	Kingfisher Creek	0.1041	0.0550	0.0418	0.0402	0.0379	0.0186
07-Jun-17	Kingfisher Creek	0.1829	0.0781	0.0578	0.0543	0.0495	0.0219
09-Jun-17	Kingfisher Creek	0.1273	0.0648	0.0525	0.0509	0.0502	0.0284
13-Jun-17	Kingfisher Creek	0.1060	0.0526	0.0418	0.0398	0.0382	0.0190
15-Jun-17	Kingfisher Creek	0.0754	0.0430	0.0338	0.0329	0.0318	0.0175
23-Jun-17	Kingfisher Creek	0.0686	0.0402	0.0323	0.0312	0.0305	0.0170
27-Jun-17	Kingfisher Creek	0.0635	0.0381	0.0308	0.0297	0.0293	0.0167
30-Jun-17	Kingfisher Creek	0.0609	0.0374	0.0306	0.0293	0.0292	0.0168
06-Jul-17	Kingfisher Creek	0.0562	0.0355	0.0291	0.0284	0.0283	0.0167
11-Jul-17	Kingfisher Creek	0.0496	0.0324	0.0269	0.0263	0.0264	0.0164
14-Jul-17	Kingfisher Creek	0.0465	0.0315	0.0264	0.0258	0.0259	0.0160
19-Jul-17	Kingfisher Creek	0.0396	0.0280	0.0240	0.0235	0.0241	0.0157
25-Jul-17	Kingfisher Creek	0.0377	0.0274	0.0235	0.0230	0.0237	0.0155
31-Jul-17	Kingfisher Creek	0.0337	0.0257	0.0222	0.0217	0.0225	0.0154
11-Aug-17	Kingfisher Creek	0.0333	0.0253	0.0220	0.0219	0.0229	0.0154
07-Sep-17	Kingfisher Creek	0.0313	0.0245	0.0216	0.0211	0.0221	0.0150
22-Sep-17	Kingfisher Creek	0.0287	0.0237	0.0208	0.0206	0.0214	0.0149
20-Oct-17	Kingfisher Creek	0.0613	0.0378	0.0306	0.0296	0.0291	0.0167
05-Jul-16	4km	0.0448	0.0283	0.0236	0.0234	0.0237	0.0156
12-Jul-16	4km	0.0418	0.0275	0.0231	0.0226	0.0233	0.0149
20-Jul-16	4km	0.0464	0.0284	0.0238	0.0234	0.0237	0.0157
26-Jul-16	4km	0.0396	0.0264	0.0225	0.0221	0.0227	0.0152
09-Aug-16	4km	0.0432	0.0279	0.0237	0.0231	0.0237	0.0158
12-Aug-16	4km	0.0399	0.0259	0.0217	0.0215	0.0221	0.0151
20-Aug-16	4km	0.0399	0.0258	0.0218	0.0213	0.0219	0.0149
23-Sep-16	4km	0.0412	0.0291	0.0253	0.0250	0.0257	0.0182
22-Oct-16	4km	0.0514	0.0312	0.0256	0.0248	0.0250	0.0158
20-Nov-16	4km	0.0502	0.0306	0.0250	0.0246	0.0247	0.0152
11-Dec-16	4km	0.0483	0.0294	0.0245	0.0239	0.0240	0.0153
27-Jan-17	4km	0.0523	0.0299	0.0247	0.0242	0.0246	0.0153
09-Mar-17	4km	0.0452	0.0280	0.0232	0.0227	0.0233	0.0151
20-Mar-17	4km	0.0585	0.0339	0.0273	0.0267	0.0266	0.0161
31-Mar-17	4km	0.0628	0.0355	0.0284	0.0272	0.0270	0.0161

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
03-Apr-17	4km	0.0618	0.0348	0.0348	0.0271	0.0273	0.0168
07-Apr-17	4km	0.0690	0.0383	0.0383	0.0293	0.0287	0.0162
13-Apr-17	4km	0.1409	0.0707	0.0707	0.0508	0.0476	0.0235
15-Apr-17	4km	0.0621	0.0357	0.0357	0.0277	0.0278	0.0165
25-Apr-17	4km	0.0548	0.0319	0.0256	0.0250	0.0247	0.0153
27-Apr-17	4km	0.0555	0.0323	0.0260	0.0251	0.0255	0.0154
03-May-17	4km	0.0503	0.0301	0.0246	0.0240	0.0239	0.0151
05-May-17	4km	0.0727	0.0390	0.0310	0.0298	0.0287	0.0158
08-May-17	4km	0.0941	0.0469	0.0366	0.0350	0.0338	0.0178
10-May-17	4km	0.0781	0.0384	0.0311	0.0300	0.0291	0.0165
12-May-17	4km	0.0700	0.0389	0.0315	0.0304	0.0300	0.0170
16-May-17	4km	0.1091	0.0491	0.0364	0.0352	0.0334	0.0177
19-May-17	4km	0.0613	0.0342	0.0275	0.0272	0.0270	0.0165
23-May-17	4km	0.0733	0.0399	0.0319	0.0305	0.0300	0.0171
26-May-17	4km	0.0687	0.0378	0.0302	0.0291	0.0287	0.0165
27-May-17	4km	0.0669	0.0375	0.0298	0.0290	0.0286	0.0165
30-May-17	4km	0.0689	0.0387	0.0305	0.0298	0.0292	0.0173
02-Jun-17	4km	0.0729	0.0388	0.0306	0.0292	0.0287	0.0162
07-Jun-17	4km	0.1838	0.0600	0.0451	0.0429	0.0404	0.0201
09-Jun-17	4km	0.1125	0.0522	0.0406	0.0387	0.0370	0.0191
13-Jun-17	4km	0.0918	0.0479	0.0378	0.0365	0.0354	0.0188
15-Jun-17	4km	0.0694	0.0389	0.0309	0.0299	0.0294	0.0166
23-Jun-17	4km	0.0676	0.0383	0.0305	0.0298	0.0294	0.0169
27-Jun-17	4km	0.0692	0.0387	0.0308	0.0299	0.0295	0.0167
30-Jun-17	4km	0.0618	0.0356	0.0288	0.0279	0.0280	0.0164
06-Jul-17	4km	0.0568	0.0333	0.0270	0.0263	0.0264	0.0160
11-Jul-17	4km	0.0537	0.0320	0.0263	0.0254	0.0255	0.0159
14-Jul-17	4km	0.0529	0.0317	0.0260	0.0253	0.0256	0.0158
19-Jul-17	4km	0.0518	0.0313	0.0257	0.0252	0.0253	0.0161
25-Jul-17	4km	0.0538	0.0318	0.0261	0.0255	0.0255	0.0158
31-Jul-17	4km	0.0462	0.0286	0.0240	0.0236	0.0240	0.0155
11-Aug-17	4km	0.0435	0.0271	0.0228	0.0224	0.0230	0.0151
07-Sep-17	4km	0.0423	0.0269	0.0225	0.0221	0.0227	0.0153
22-Sep-17	4km	0.0448	0.0279	0.0232	0.0228	0.0234	0.0154
05-Jul-16	Cooke Creek	0.0706	0.0436	0.0357	0.0346	0.0337	0.0204
12-Jul-16	Cooke Creek	0.0566	0.0349	0.0286	0.0276	0.0274	0.0158
20-Jul-16	Cooke Creek	0.0776	0.0424	0.0337	0.0324	0.0314	0.0171

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
26-Jul-16	Cooke Creek	0.0545	0.0342	0.0280	0.0272	0.0271	0.0164
09-Aug-16	Cooke Creek	0.0738	0.0420	0.0338	0.0325	0.0317	0.0174
12-Aug-16	Cooke Creek	0.0456	0.0296	0.0244	0.0240	0.0245	0.0153
20-Aug-16	Cooke Creek	0.0371	0.0263	0.0222	0.0218	0.0225	0.0149
23-Sep-16	Cooke Creek	0.0823	0.0487	0.0395	0.0380	0.0369	0.0209
22-Oct-16	Cooke Creek	0.1464	0.0743	0.0561	0.0531	0.0489	0.0210
20-Nov-16	Cooke Creek	0.1420	0.0729	0.0553	0.0526	0.0487	0.0203
11-Dec-16	Cooke Creek	0.1019	0.0534	0.0410	0.0387	0.0372	0.0178
27-Jan-17	Cooke Creek	0.0679	0.0395	0.0317	0.0306	0.0301	0.0165
09-Mar-17	Cooke Creek	0.0785	0.0440	0.0345	0.0331	0.0321	0.0168
20-Mar-17	Cooke Creek	0.1961	0.0912	0.0668	0.0632	0.0576	0.0235
31-Mar-17	Cooke Creek	0.2029	0.0984	0.0726	0.0687	0.0623	0.0242
03-Apr-17	Cooke Creek	0.2242	0.1094	0.1094	0.0760	0.0688	0.0279
07-Apr-17	Cooke Creek	0.2115	0.1017	0.1017	0.0706	0.0637	0.0256
13-Apr-17	Cooke Creek	0.2068	0.1019	0.1019	0.0717	0.0654	0.0273
15-Apr-17	Cooke Creek	0.2396	0.1134	0.1134	0.0783	0.0709	0.0265
25-Apr-17	Cooke Creek	0.1781	0.0863	0.0637	0.0596	0.0548	0.0219
27-Apr-17	Cooke Creek	0.1920	0.0926	0.0681	0.0647	0.0583	0.0228
03-May-17	Cooke Creek	0.1813	0.0900	0.0673	0.0635	0.0580	0.0239
05-May-17	Cooke Creek	0.2277	0.1068	0.0781	0.0735	0.0661	0.0242
08-May-17	Cooke Creek	0.1896	0.0910	0.0677	0.0640	0.0586	0.0241
10-May-17	Cooke Creek	0.1710	0.0891	0.0685	0.0651	0.0602	0.0267
12-May-17	Cooke Creek	0.1656	0.0821	0.0627	0.0596	0.0548	0.0234
16-May-17	Cooke Creek	0.1913	0.0827	0.0621	0.0587	0.0543	0.0231
19-May-17	Cooke Creek	0.1234	0.0633	0.0482	0.0457	0.0428	0.0200
23-May-17	Cooke Creek	0.1256	0.0639	0.0483	0.0457	0.0426	0.0200
26-May-17	Cooke Creek	0.1135	0.0589	0.0447	0.0428	0.0404	0.0192
27-May-17	Cooke Creek	0.1049	0.0562	0.0438	0.0417	0.0396	0.0209
30-May-17	Cooke Creek	0.1214	0.0619	0.0469	0.0445	0.0416	0.0194
02-Jun-17	Cooke Creek	0.1179	0.0605	0.0458	0.0435	0.0408	0.0190
07-Jun-17	Cooke Creek	0.1774	0.0847	0.0634	0.0598	0.0539	0.0224
09-Jun-17	Cooke Creek	0.1392	0.0702	0.0530	0.0504	0.0469	0.0232
13-Jun-17	Cooke Creek	0.1101	0.0603	0.0471	0.0448	0.0426	0.0203
15-Jun-17	Cooke Creek	0.0947	0.0515	0.0402	0.0386	0.0364	0.0182
23-Jun-17	Cooke Creek	0.0815	0.0464	0.0367	0.0353	0.0343	0.0184
27-Jun-17	Cooke Creek	0.0759	0.0445	0.0355	0.0344	0.0331	0.0183
30-Jun-17	Cooke Creek	0.0698	0.0409	0.0331	0.0318	0.0310	0.0170
06-Jul-17	Cooke Creek	0.0731	0.0435	0.0347	0.0334	0.0326	0.0176
11-Jul-17	Cooke Creek	0.0609	0.0373	0.0304	0.0294	0.0290	0.0169
14-Jul-17	Cooke Creek	0.0558	0.0351	0.0288	0.0279	0.0277	0.0165

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
19-Jul-17	Cooke Creek	0.0480	0.0315	0.0262	0.0257	0.0261	0.0160
25-Jul-17	Cooke Creek	0.0442	0.0298	0.0251	0.0246	0.0252	0.0158
31-Jul-17	Cooke Creek	0.0400	0.0280	0.0240	0.0236	0.0241	0.0156
11-Aug-17	Cooke Creek	0.0392	0.0279	0.0237	0.0234	0.0239	0.0154
07-Sep-17	Cooke Creek	0.0390	0.0277	0.0232	0.0231	0.0235	0.0153
22-Sep-17	Cooke Creek	0.0333	0.0253	0.0216	0.0216	0.0224	0.0149
20-Oct-17	Cooke Creek	0.0604	0.0368	0.0296	0.0288	0.0286	0.0164
05-Jul-16	Falls Creek	0.1503	0.0771	0.0580	0.0549	0.0506	0.0212
12-Jul-16	Falls Creek	0.1072	0.0565	0.0435	0.0411	0.0389	0.0185
20-Jul-16	Falls Creek	0.1239	0.0620	0.0470	0.0449	0.0419	0.0194
26-Jul-16	Falls Creek	0.0917	0.0483	0.0373	0.0357	0.0340	0.0174
09-Aug-16	Falls Creek	0.1672	0.0845	0.0632	0.0599	0.0546	0.0224
12-Aug-16	Falls Creek	0.0797	0.0440	0.0349	0.0335	0.0324	0.0171
20-Aug-16	Falls Creek	0.0499	0.0310	0.0255	0.0250	0.0250	0.0153
23-Sep-16	Falls Creek	0.1165	0.0612	0.0469	0.0447	0.0421	0.0197
22-Oct-16	Falls Creek	0.1576	0.0774	0.0579	0.0546	0.0504	0.0216
20-Nov-16	Falls Creek	0.1183	0.0608	0.0463	0.0439	0.0413	0.0189
11-Dec-16	Falls Creek	0.1045	0.0557	0.0430	0.0409	0.0387	0.0197
27-Jan-17	Falls Creek	0.0763	0.0384	0.0297	0.0286	0.0282	0.0161
09-Mar-17	Falls Creek	0.1127	0.0805	0.0707	0.0692	0.0691	0.0532
20-Mar-17	Falls Creek	0.0980	0.0510	0.0390	0.0374	0.0355	0.0181
31-Mar-17	Falls Creek	0.0956	0.0491	0.0377	0.0360	0.0343	0.0169
03-Apr-17	Falls Creek	0.1104	0.0538	0.0538	0.0393	0.0375	0.0197
07-Apr-17	Falls Creek	0.1064	0.0541	0.0541	0.0393	0.0370	0.0181
13-Apr-17	Falls Creek	0.1026	0.0533	0.0533	0.0391	0.0371	0.0184
15-Apr-17	Falls Creek	0.1315	0.0647	0.0647	0.0458	0.0425	0.0193
25-Apr-17	Falls Creek	0.1404	0.0694	0.0521	0.0493	0.0453	0.0197
27-Apr-17	Falls Creek	0.1427	0.0707	0.0520	0.0491	0.0454	0.0195
03-May-17	Falls Creek	0.1285	0.0642	0.0481	0.0453	0.0424	0.0189
05-May-17	Falls Creek	0.2923	0.1317	0.0937	0.0870	0.0767	0.0259
08-May-17	Falls Creek	0.2638	0.1287	0.0960	0.0903	0.0813	0.0314
10-May-17	Falls Creek	0.2152	0.1074	0.0811	0.0763	0.0695	0.0283
12-May-17	Falls Creek	0.2013	0.0996	0.0746	0.0702	0.0638	0.0254
16-May-17	Falls Creek	0.2106	0.0930	0.0698	0.0657	0.0603	0.0249
19-May-17	Falls Creek	0.1580	0.0778	0.0580	0.0551	0.0501	0.0217
23-May-17	Falls Creek	0.1770	0.0864	0.0639	0.0600	0.0543	0.0231
26-May-17	Falls Creek	0.1529	0.0756	0.0564	0.0533	0.0488	0.0212
27-May-17	Falls Creek	0.1529	0.0765	0.0565	0.0540	0.0494	0.0212

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
30-May-17	Falls Creek	0.1517	0.0746	0.0554	0.0523	0.0481	0.0214
02-Jun-17	Falls Creek	0.1667	0.0820	0.0608	0.0572	0.0521	0.0216
07-Jun-17	Falls Creek	0.1963	0.1024	0.0781	0.0736	0.0665	0.0279
09-Jun-17	Falls Creek	0.1817	0.0889	0.0661	0.0621	0.0570	0.0256
13-Jun-17	Falls Creek	0.1513	0.0786	0.0602	0.0571	0.0531	0.0233
15-Jun-17	Falls Creek	0.1231	0.0636	0.0482	0.0459	0.0427	0.0197
23-Jun-17	Falls Creek	0.1120	0.0591	0.0456	0.0433	0.0408	0.0193
27-Jun-17	Falls Creek	0.1068	0.0574	0.0442	0.0422	0.0398	0.0199
30-Jun-17	Falls Creek	0.1170	0.0629	0.0485	0.0462	0.0430	0.0201
06-Jul-17	Falls Creek	0.1181	0.0628	0.0482	0.0458	0.0430	0.0198
11-Jul-17	Falls Creek	0.0982	0.0532	0.0412	0.0395	0.0377	0.0186
14-Jul-17	Falls Creek	0.0815	0.0457	0.0361	0.0346	0.0334	0.0175
19-Jul-17	Falls Creek	0.0641	0.0379	0.0304	0.0292	0.0290	0.0166
25-Jul-17	Falls Creek	0.0547	0.0335	0.0272	0.0267	0.0266	0.0159
31-Jul-17	Falls Creek	0.0474	0.0305	0.0255	0.0248	0.0252	0.0157
11-Aug-17	Falls Creek	0.0412	0.0285	0.0242	0.0235	0.0242	0.0155
20-Oct-17	Falls Creek	0.0832	0.0466	0.0367	0.0353	0.0341	0.0177
05-Jul-16	Trinity Creek	0.0522	0.0305	0.0247	0.0241	0.0243	0.0155
12-Jul-16	Trinity Creek	0.0523	0.0305	0.0250	0.0244	0.0247	0.0152
20-Jul-16	Trinity Creek	0.1043	0.0388	0.0284	0.0274	0.0267	0.0159
26-Jul-16	Trinity Creek	0.0502	0.0296	0.0244	0.0236	0.0239	0.0155
09-Aug-16	Trinity Creek	0.0408	0.0269	0.0227	0.0222	0.0228	0.0153
12-Aug-16	Trinity Creek	0.0371	0.0250	0.0211	0.0209	0.0216	0.0151
20-Aug-16	Trinity Creek	0.0322	0.0231	0.0203	0.0202	0.0213	0.0152
23-Sep-16	Trinity Creek	0.0364	0.0252	0.0216	0.0211	0.0222	0.0152
22-Oct-16	Trinity Creek	0.0940	0.0473	0.0359	0.0344	0.0330	0.0165
20-Nov-16	Trinity Creek	0.1073	0.0523	0.0392	0.0374	0.0354	0.0168
27-Jan-17	Trinity Creek	0.0550	0.0287	0.0232	0.0227	0.0230	0.0149
09-Mar-17	Trinity Creek	0.0445	0.0280	0.0230	0.0224	0.0231	0.0150
20-Mar-17	Trinity Creek	0.0731	0.0389	0.0307	0.0295	0.0289	0.0162
31-Mar-17	Trinity Creek	0.1608	0.0749	0.0547	0.0517	0.0477	0.0201
03-Apr-17	Trinity Creek	0.2467	0.1093	0.1093	0.0746	0.0680	0.0299
07-Apr-17	Trinity Creek	0.2384	0.1051	0.1051	0.0710	0.0641	0.0237
13-Apr-17	Trinity Creek	0.1967	0.0878	0.0878	0.0601	0.0551	0.0218
15-Apr-17	Trinity Creek	0.2208	0.0982	0.0982	0.0659	0.0595	0.0229
25-Apr-17	Trinity Creek	0.1614	0.0731	0.0526	0.0498	0.0458	0.0189
27-Apr-17	Trinity Creek	0.1718	0.0771	0.0556	0.0529	0.0476	0.0196
03-May-17	Trinity Creek	0.1527	0.0663	0.0482	0.0458	0.0426	0.0183

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
05-May-17	Trinity Creek	0.2552	0.1113	0.0791	0.0743	0.0666	0.0236
08-May-17	Trinity Creek	0.1730	0.0775	0.0568	0.0539	0.0493	0.0213
10-May-17	Trinity Creek	0.1503	0.0654	0.0473	0.0451	0.0418	0.0191
12-May-17	Trinity Creek	0.1734	0.0752	0.0550	0.0524	0.0486	0.0217
16-May-17	Trinity Creek	0.1652	0.0740	0.0549	0.0520	0.0486	0.0220
19-May-17	Trinity Creek	0.1347	0.0653	0.0487	0.0462	0.0434	0.0212
23-May-17	Trinity Creek	0.1171	0.0578	0.0436	0.0415	0.0391	0.0188
26-May-17	Trinity Creek	0.1019	0.0508	0.0384	0.0365	0.0347	0.0175
27-May-17	Trinity Creek	0.0985	0.0502	0.0383	0.0366	0.0350	0.0174
30-May-17	Trinity Creek	0.1022	0.0519	0.0397	0.0380	0.0361	0.0198
02-Jun-17	Trinity Creek	0.1471	0.0689	0.0514	0.0490	0.0456	0.0203
07-Jun-17	Trinity Creek	0.1309	0.0651	0.0483	0.0458	0.0429	0.0203
09-Jun-17	Trinity Creek	0.1068	0.0561	0.0437	0.0416	0.0398	0.0208
13-Jun-17	Trinity Creek	0.1009	0.0478	0.0367	0.0354	0.0342	0.0181
15-Jun-17	Trinity Creek	0.0749	0.0396	0.0311	0.0301	0.0294	0.0162
23-Jun-17	Trinity Creek	0.0688	0.0372	0.0297	0.0285	0.0282	0.0163
27-Jun-17	Trinity Creek	0.0631	0.0350	0.0280	0.0271	0.0268	0.0159
30-Jun-17	Trinity Creek	0.0552	0.0317	0.0256	0.0252	0.0254	0.0155
06-Jul-17	Trinity Creek	0.0507	0.0301	0.0245	0.0240	0.0244	0.0153
11-Jul-17	Trinity Creek	0.0488	0.0296	0.0244	0.0236	0.0241	0.0153
14-Jul-17	Trinity Creek	0.0478	0.0291	0.0240	0.0235	0.0238	0.0153
19-Jul-17	Trinity Creek	0.0535	0.0280	0.0228	0.0223	0.0228	0.0150
25-Jul-17	Trinity Creek	0.0394	0.0258	0.0218	0.0216	0.0222	0.0148
31-Jul-17	Trinity Creek	0.0376	0.0249	0.0213	0.0209	0.0220	0.0150
11-Aug-17	Trinity Creek	0.0356	0.0244	0.0208	0.0208	0.0217	0.0151
07-Sep-17	Trinity Creek	0.0295	0.0220	0.0196	0.0192	0.0202	0.0145
22-Sep-17	Trinity Creek	0.0294	0.0216	0.0189	0.0187	0.0202	0.0146
20-Oct-17	Trinity Creek	0.0461	0.0301	0.0251	0.0245	0.0250	0.0158
05-Jul-16	29km	0.0519	0.0305	0.0249	0.0244	0.0247	0.0153
12-Jul-16	29km	0.0437	0.0282	0.0235	0.0228	0.0236	0.0152
20-Jul-16	29km	0.0478	0.0287	0.0239	0.0234	0.0235	0.0156
26-Jul-16	29km	0.0391	0.0253	0.0217	0.0213	0.0220	0.0150
09-Aug-16	29km	0.0362	0.0249	0.0215	0.0212	0.0219	0.0152
12-Aug-16	29km	0.0388	0.0270	0.0233	0.0231	0.0242	0.0175
20-Aug-16	29km	0.0379	0.0250	0.0213	0.0209	0.0218	0.0148
23-Sep-16	29km	0.0326	0.0241	0.0212	0.0208	0.0219	0.0152
22-Oct-16	29km	0.0535	0.0320	0.0261	0.0253	0.0255	0.0156
20-Nov-16	29km	0.0546	0.0324	0.0264	0.0254	0.0256	0.0153

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
11-Dec-16	29km	0.1078	0.0536	0.0402	0.0382	0.0359	0.0174
27-Jan-17	29km	0.0613	0.0290	0.0230	0.0225	0.0228	0.0150
09-Mar-17	29km	0.0531	0.0298	0.0241	0.0236	0.0237	0.0150
20-Mar-17	29km	0.1886	0.0831	0.0599	0.0561	0.0514	0.0217
31-Mar-17	29km	0.2276	0.0981	0.0695	0.0650	0.0586	0.0215
03-Apr-17	29km	0.0986	0.0503	0.0503	0.0368	0.0353	0.0191
07-Apr-17	29km	0.1032	0.0521	0.0521	0.0384	0.0367	0.0185
13-Apr-17	29km	0.0792	0.0424	0.0424	0.0316	0.0310	0.0170
15-Apr-17	29km	0.0898	0.0459	0.0459	0.0342	0.0329	0.0176
25-Apr-17	29km	0.0708	0.0381	0.0301	0.0288	0.0282	0.0157
27-Apr-17	29km	0.0766	0.0415	0.0317	0.0304	0.0293	0.0160
03-May-17	29km	0.1680	0.0826	0.0639	0.0611	0.0576	0.0357
05-May-17	29km	0.1036	0.0521	0.0395	0.0374	0.0359	0.0172
08-May-17	29km	0.0998	0.0496	0.0387	0.0370	0.0346	0.0177
10-May-17	29km	0.0765	0.0418	0.0333	0.0319	0.0314	0.0176
12-May-17	29km	0.1095	0.0550	0.0455	0.0431	0.0391	0.0183
16-May-17	29km	0.0686	0.0378	0.0300	0.0291	0.0285	0.0169
19-May-17	29km	0.0649	0.0368	0.0296	0.0286	0.0284	0.0170
23-May-17	29km	0.0722	0.0398	0.0317	0.0305	0.0299	0.0172
26-May-17	29km	0.0712	0.0389	0.0309	0.0301	0.0298	0.0169
27-May-17	29km	0.0701	0.0389	0.0310	0.0303	0.0296	0.0172
30-May-17	29km	0.0762	0.0392	0.0309	0.0298	0.0291	0.0175
02-Jun-17	29km	0.0796	0.0425	0.0331	0.0321	0.0310	0.0168
07-Jun-17	29km	0.1296	0.0585	0.0445	0.0422	0.0397	0.0194
09-Jun-17	29km	0.1028	0.0549	0.0429	0.0409	0.0390	0.0217
13-Jun-17	29km	0.0999	0.0504	0.0395	0.0378	0.0364	0.0189
15-Jun-17	29km	0.0689	0.0387	0.0309	0.0299	0.0296	0.0169
23-Jun-17	29km	0.0704	0.0393	0.0313	0.0302	0.0299	0.0168
27-Jun-17	29km	0.0691	0.0385	0.0307	0.0297	0.0292	0.0170
30-Jun-17	29km	0.0593	0.0348	0.0282	0.0272	0.0271	0.0162
06-Jul-17	29km	0.0569	0.0330	0.0267	0.0261	0.0264	0.0163
11-Jul-17	29km	0.0561	0.0329	0.0268	0.0261	0.0260	0.0159
14-Jul-17	29km	0.0549	0.0330	0.0269	0.0262	0.0261	0.0160
19-Jul-17	29km	0.0474	0.0298	0.0248	0.0242	0.0246	0.0157
25-Jul-17	29km	0.0514	0.0308	0.0252	0.0246	0.0248	0.0155
31-Jul-17	29km	0.0467	0.0289	0.0242	0.0237	0.0241	0.0160
11-Aug-17	29km	0.0402	0.0264	0.0223	0.0219	0.0227	0.0154
07-Sep-17	29km	0.0396	0.0258	0.0217	0.0214	0.0223	0.0151
22-Sep-17	29km	0.0429	0.0269	0.0224	0.0222	0.0230	0.0152
20-Oct-17	29km	0.0494	0.0301	0.0250	0.0244	0.0248	0.0156

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
05-Jul-16	Ashton Creek	0.1091	0.0571	0.0435	0.0413	0.0391	0.0183
12-Jul-16	Ashton Creek	0.0874	0.0468	0.0366	0.0350	0.0338	0.0171
20-Jul-16	Ashton Creek	0.1196	0.0596	0.0454	0.0429	0.0404	0.0190
26-Jul-16	Ashton Creek	0.0803	0.0436	0.0342	0.0329	0.0317	0.0180
12-Aug-16	Ashton Creek	0.0501	0.0301	0.0245	0.0240	0.0243	0.0152
20-Aug-16	Ashton Creek	0.0376	0.0253	0.0212	0.0211	0.0217	0.0147
23-Sep-16	Ashton Creek	0.0729	0.0413	0.0329	0.0318	0.0311	0.0173
22-Oct-16	Ashton Creek	0.1583	0.0774	0.0574	0.0543	0.0499	0.0207
20-Nov-16	Ashton Creek	0.1140	0.0585	0.0449	0.0427	0.0402	0.0189
27-Jan-17	Ashton Creek	0.0683	0.0389	0.0308	0.0297	0.0290	0.0165
09-Mar-17	Ashton Creek	0.0529	0.0314	0.0255	0.0249	0.0249	0.0154
20-Mar-17	Ashton Creek	0.1405	0.0647	0.0475	0.0453	0.0420	0.0190
31-Mar-17	Ashton Creek	0.0905	0.0459	0.0352	0.0339	0.0325	0.0168
03-Apr-17	Ashton Creek	0.1724	0.0781	0.0781	0.0532	0.0491	0.0211
07-Apr-17	Ashton Creek	0.1910	0.0904	0.0904	0.0626	0.0572	0.0226
13-Apr-17	Ashton Creek	0.1762	0.0798	0.0798	0.0561	0.0518	0.0244
15-Apr-17	Ashton Creek	0.2347	0.1070	0.1070	0.0723	0.0650	0.0246
25-Apr-17	Ashton Creek	0.1864	0.0866	0.0633	0.0598	0.0544	0.0215
27-Apr-17	Ashton Creek	0.2075	0.0960	0.0703	0.0662	0.0602	0.0241
03-May-17	Ashton Creek	0.1809	0.0852	0.0622	0.0584	0.0529	0.0214
05-May-17	Ashton Creek	0.3058	0.1391	0.0997	0.0932	0.0830	0.0276
08-May-17	Ashton Creek	0.2104	0.0974	0.0715	0.0672	0.0610	0.0241
10-May-17	Ashton Creek	0.1970	0.0941	0.0699	0.0664	0.0606	0.0249
12-May-17	Ashton Creek	0.2132	0.1052	0.0788	0.0739	0.0674	0.0258
16-May-17	Ashton Creek	0.1701	0.0835	0.0627	0.0594	0.0548	0.0243
19-May-17	Ashton Creek	0.1641	0.0821	0.0617	0.0583	0.0531	0.0225
23-May-17	Ashton Creek	0.1596	0.0794	0.0600	0.0570	0.0519	0.0221
26-May-17	Ashton Creek	0.1490	0.0729	0.0546	0.0517	0.0474	0.0209
27-May-17	Ashton Creek	0.1448	0.0718	0.0540	0.0511	0.0474	0.0210
30-May-17	Ashton Creek	0.1478	0.0741	0.0555	0.0525	0.0484	0.0220
02-Jun-17	Ashton Creek	0.1719	0.0842	0.0628	0.0594	0.0543	0.0226
07-Jun-17	Ashton Creek	0.2155	0.0899	0.0668	0.0627	0.0569	0.0228
09-Jun-17	Ashton Creek	0.1901	0.0841	0.0633	0.0602	0.0556	0.0235
13-Jun-17	Ashton Creek	0.1486	0.0721	0.0557	0.0528	0.0496	0.0222
15-Jun-17	Ashton Creek	0.0696	0.0394	0.0314	0.0304	0.0299	0.0170
23-Jun-17	Ashton Creek	0.0928	0.0501	0.0390	0.0371	0.0356	0.0184
27-Jun-17	Ashton Creek	0.0841	0.0468	0.0367	0.0351	0.0338	0.0178
30-Jun-17	Ashton Creek	0.0835	0.0464	0.0366	0.0353	0.0341	0.0178
06-Jul-17	Ashton Creek	0.0722	0.0409	0.0328	0.0315	0.0310	0.0171
11-Jul-17	Ashton Creek	0.0625	0.0364	0.0295	0.0285	0.0282	0.0165

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
14-Jul-17	Ashton Creek	0.0579	0.0345	0.0281	0.0272	0.0270	0.0165
19-Jul-17	Ashton Creek	0.0530	0.0320	0.0265	0.0256	0.0258	0.0156
25-Jul-17	Ashton Creek	0.0486	0.0303	0.0253	0.0246	0.0249	0.0157
Note: Ashton Creek Ran dry from August 2017-March 2018							
05-Jul-16	Brash Creek	0.1064	0.0544	0.0413	0.0396	0.0374	0.0179
12-Jul-16	Brash Creek	0.1006	0.0524	0.0402	0.0385	0.0366	0.0177
20-Jul-16	Brash Creek	0.1204	0.0601	0.0451	0.0429	0.0401	0.0187
26-Jul-16	Brash Creek	0.0900	0.0471	0.0365	0.0350	0.0337	0.0179
09-Aug-16	Brash Creek	0.1046	0.0545	0.0417	0.0399	0.0377	0.0185
12-Aug-16	Brash Creek	0.0685	0.0386	0.0307	0.0297	0.0293	0.0167
20-Aug-16	Brash Creek	0.0503	0.0306	0.0247	0.0240	0.0241	0.0152
23-Sep-16	Brash Creek	0.0805	0.0446	0.0350	0.0339	0.0327	0.0179
22-Oct-16	Brash Creek	0.1784	0.0884	0.0662	0.0628	0.0575	0.0236
20-Nov-16	Brash Creek	0.1505	0.0728	0.0541	0.0515	0.0475	0.0202
11-Dec-16	Brash Creek	0.0526	0.0312	0.0254	0.0247	0.0248	0.0154
27-Jan-17	Brash Creek	0.0883	0.0399	0.0303	0.0291	0.0286	0.0164
09-Mar-17	Brash Creek	0.0613	0.0341	0.0272	0.0263	0.0262	0.0155
20-Mar-17	Brash Creek	0.1973	0.0829	0.0596	0.0560	0.0519	0.0237
31-Mar-17	Brash Creek	0.2212	0.1003	0.0723	0.0680	0.0616	0.0235
03-Apr-17	Brash Creek	0.2463	0.1165	0.1165	0.0802	0.0729	0.0315
07-Apr-17	Brash Creek	0.2937	0.1357	0.1357	0.0925	0.0836	0.0312
13-Apr-17	Brash Creek	0.2243	0.1042	0.1042	0.0723	0.0663	0.0281
15-Apr-17	Brash Creek	0.3115	0.1435	0.1435	0.0971	0.0866	0.0318
25-Apr-17	Brash Creek	0.2382	0.1077	0.0772	0.0729	0.0653	0.0242
27-Apr-17	Brash Creek	0.2530	0.1176	0.0858	0.0805	0.0734	0.0298
03-May-17	Brash Creek	0.2066	0.0983	0.0726	0.0684	0.0627	0.0272
05-May-17	Brash Creek	0.3615	0.1631	0.1166	0.1087	0.0959	0.0310
08-May-17	Brash Creek	0.2565	0.1084	0.0763	0.0718	0.0641	0.0246
10-May-17	Brash Creek	0.2752	0.1103	0.0778	0.0734	0.0667	0.0287
12-May-17	Brash Creek	0.4264	0.1414	0.1035	0.0985	0.0904	0.0340
16-May-17	Brash Creek	0.1865	0.0894	0.0658	0.0625	0.0568	0.0241
19-May-17	Brash Creek	0.1865	0.0882	0.0647	0.0611	0.0557	0.0234
23-May-17	Brash Creek	0.2152	0.1074	0.0817	0.0775	0.0707	0.0324
26-May-17	Brash Creek	0.1789	0.0846	0.0621	0.0585	0.0533	0.0223
27-May-17	Brash Creek	0.1842	0.0882	0.0651	0.0612	0.0562	0.0252
30-May-17	Brash Creek	0.1957	0.0934	0.0693	0.0653	0.0595	0.0262
02-Jun-17	Brash Creek	0.2076	0.0968	0.0706	0.0663	0.0598	0.0231
07-Jun-17	Brash Creek	0.1944	0.0835	0.0602	0.0567	0.0517	0.0220

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
09-Jun-17	Brash Creek	0.1949	0.0866	0.0650	0.0618	0.0576	0.0285
13-Jun-17	Brash Creek	0.3217	0.0867	0.0722	0.0707	0.0686	0.0245
15-Jun-17	Brash Creek	0.4085	0.1003	0.0796	0.0777	0.0752	0.0275
23-Jun-17	Brash Creek	0.1069	0.0541	0.0413	0.0394	0.0374	0.0183
27-Jun-17	Brash Creek	0.0939	0.0485	0.0372	0.0358	0.0344	0.0174
30-Jun-17	Brash Creek	0.0834	0.0442	0.0346	0.0333	0.0321	0.0172
06-Jul-17	Brash Creek	0.0765	0.0417	0.0327	0.0317	0.0307	0.0168
11-Jul-17	Brash Creek	0.0711	0.0394	0.0310	0.0300	0.0296	0.0164
14-Jul-17	Brash Creek	0.0700	0.0388	0.0307	0.0297	0.0292	0.0164
19-Jul-17	Brash Creek	0.0646	0.0364	0.0292	0.0283	0.0279	0.0160
25-Jul-17	Brash Creek	0.0640	0.0368	0.0293	0.0285	0.0282	0.0161
31-Jul-17	Brash Creek	0.0626	0.0357	0.0287	0.0276	0.0275	0.0162
11-Aug-17	Brash Creek	0.0592	0.0346	0.0279	0.0269	0.0266	0.0159
07-Sep-17	Brash Creek	0.0529	0.0319	0.0261	0.0254	0.0255	0.0153
22-Sep-17	Brash Creek	0.0486	0.0301	0.0249	0.0243	0.0247	0.0153
09-Jun-17	Fortune Creek	0.2499	0.0997	0.0721	0.0683	0.0626	0.0266
05-Jul-16	Fortune Creek	0.1120	0.0554	0.0417	0.0399	0.0376	0.0173
12-Jul-16	Fortune Creek	0.1212	0.0588	0.0442	0.0419	0.0395	0.0180
20-Jul-16	Fortune Creek	0.1346	0.0674	0.0510	0.0487	0.0456	0.0222
26-Jul-16	Fortune Creek	0.1093	0.0544	0.0406	0.0387	0.0362	0.0174
09-Aug-16	Fortune Creek	0.0812	0.0433	0.0341	0.0327	0.0316	0.0171
12-Aug-16	Fortune Creek	0.0455	0.0293	0.0246	0.0242	0.0247	0.0168
20-Aug-16	Fortune Creek	0.0641	0.0367	0.0290	0.0279	0.0275	0.0161
23-Sep-16	Fortune Creek	0.0750	0.0409	0.0321	0.0310	0.0304	0.0166
22-Oct-16	Fortune Creek	0.1537	0.0730	0.0538	0.0508	0.0472	0.0195
20-Nov-16	Fortune Creek	0.1913	0.0879	0.0639	0.0602	0.0548	0.0211
27-Jan-17	Fortune Creek	0.0549	0.0322	0.0262	0.0254	0.0253	0.0156
09-Mar-17	Fortune Creek	0.0307	0.0222	0.0195	0.0193	0.0203	0.0147
20-Mar-17	Fortune Creek	0.1567	0.0690	0.0501	0.0471	0.0438	0.0194
31-Mar-17	Fortune Creek	0.4356	0.1844	0.1285	0.1201	0.1058	0.0319
03-Apr-17	Fortune Creek	0.4528	0.1931	0.1353	0.1262	0.1108	0.0339
07-Apr-17	Fortune Creek	0.4964	0.2084	0.2084	0.1368	0.1205	0.0373
13-Apr-17	Fortune Creek	0.3980	0.1758	0.1758	0.1167	0.1033	0.0341
15-Apr-17	Fortune Creek	0.3885	0.1699	0.1699	0.1118	0.0983	0.0316
25-Apr-17	Fortune Creek	0.3390	0.1493	0.1057	0.0985	0.0869	0.0275
27-Apr-17	Fortune Creek	0.3770	0.1661	0.1176	0.1099	0.0974	0.0312
03-May-17	Fortune Creek	0.2982	0.1321	0.0939	0.0880	0.0781	0.0262

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
05-May-17	Fortune Creek	0.3911	0.1636	0.1141	0.1063	0.0935	0.0309
08-May-17	Fortune Creek	0.4402	0.1725	0.1189	0.1104	0.0974	0.0324
10-May-17	Fortune Creek	0.3651	0.1384	0.0948	0.0882	0.0779	0.0265
12-May-17	Fortune Creek	0.3623	0.1413	0.0984	0.0921	0.0822	0.0297
16-May-17	Fortune Creek	0.5133	0.1539	0.1120	0.1060	0.0971	0.0308
19-May-17	Fortune Creek	0.2721	0.1237	0.0897	0.0843	0.0749	0.0274
23-May-17	Fortune Creek	0.2251	0.1035	0.0762	0.0716	0.0644	0.0265
26-May-17	Fortune Creek	0.2235	0.1023	0.0744	0.0700	0.0629	0.0242
27-May-17	Fortune Creek	0.2086	0.0954	0.0693	0.0652	0.0593	0.0234
30-May-17	Fortune Creek	0.1998	0.0922	0.0676	0.0638	0.0579	0.0231
02-Jun-17	Fortune Creek	0.1802	0.0853	0.0623	0.0586	0.0533	0.0218
07-Jun-17	Fortune Creek	0.2900	0.1089	0.0748	0.0701	0.0628	0.0239
13-Jun-17	Fortune Creek	0.3452	0.0972	0.0624	0.0585	0.0531	0.0213
15-Jun-17	Fortune Creek	0.1885	0.0886	0.0654	0.0616	0.0564	0.0215
23-Jun-17	Fortune Creek	0.1720	0.0794	0.0583	0.0554	0.0509	0.0211
30-Jun-17	Fortune Creek	0.1442	0.0681	0.0506	0.0479	0.0445	0.0194
06-Jul-17	Fortune Creek	0.1680	0.0773	0.0569	0.0536	0.0495	0.0202
11-Jul-17	Fortune Creek	0.1685	0.0778	0.0568	0.0537	0.0491	0.0199
14-Jul-17	Fortune Creek	0.1560	0.0725	0.0533	0.0505	0.0465	0.0195
19-Jul-17	Fortune Creek	0.1321	0.0629	0.0471	0.0446	0.0415	0.0181
25-Jul-17	Fortune Creek	0.1224	0.0600	0.0456	0.0435	0.0412	0.0201
31-Jul-17	Fortune Creek	0.1127	0.0563	0.0431	0.0413	0.0390	0.0186
11-Aug-17	Fortune Creek	0.1111	0.0557	0.0425	0.0402	0.0382	0.0182
05-Jul-16	42km	0.0423	0.0276	0.0232	0.0226	0.0231	0.0153
12-Jul-16	42km	0.0408	0.0267	0.0223	0.0218	0.0224	0.0145
20-Jul-16	42km	0.0422	0.0264	0.0225	0.0222	0.0227	0.0156
26-Jul-16	42km	0.0389	0.0255	0.0215	0.0212	0.0219	0.0151
09-Aug-16	42km	0.0347	0.0247	0.0212	0.0211	0.0220	0.0152
12-Aug-16	42km	0.0373	0.0250	0.0213	0.0210	0.0218	0.0149
20-Aug-16	42km	0.0330	0.0232	0.0201	0.0199	0.0208	0.0147
23-Sep-16	42km	0.0407	0.0293	0.0260	0.0255	0.0264	0.0191
22-Oct-16	42km	0.0502	0.0307	0.0252	0.0246	0.0249	0.0155
20-Nov-16	42km	0.0568	0.0340	0.0276	0.0268	0.0269	0.0161
11-Dec-16	42km	0.0540	0.0312	0.0256	0.0249	0.0250	0.0155
27-Jan-17	42km	0.1960	0.0797	0.0559	0.0526	0.0479	0.0187
09-Mar-17	42km	0.0448	0.0275	0.0230	0.0226	0.0231	0.0153
20-Mar-17	42km	0.0973	0.0485	0.0375	0.0358	0.0344	0.0176
31-Mar-17	42km	0.1101	0.0544	0.0412	0.0393	0.0373	0.0181

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
03-Apr-17	42km	0.1149	0.0554	0.0554	0.0397	0.0376	0.0180
07-Apr-17	42km	0.1294	0.0603	0.0603	0.0428	0.0403	0.0187
13-Apr-17	42km	0.0886	0.0452	0.0452	0.0334	0.0327	0.0173
15-Apr-17	42km	0.1104	0.0556	0.0556	0.0404	0.0387	0.0196
25-Apr-17	42km	0.0893	0.0464	0.0374	0.0366	0.0352	0.0189
27-Apr-17	42km	0.0934	0.0465	0.0358	0.0344	0.0327	0.0167
03-May-17	42km	0.0745	0.0388	0.0300	0.0288	0.0280	0.0154
05-May-17	42km	0.1035	0.0516	0.0389	0.0372	0.0355	0.0169
08-May-17	42km	0.1207	0.0607	0.0467	0.0443	0.0412	0.0193
10-May-17	42km	0.1045	0.0513	0.0406	0.0386	0.0360	0.0179
12-May-17	42km	0.0994	0.0493	0.0387	0.0370	0.0355	0.0183
16-May-17	42km	0.0784	0.0416	0.0324	0.0313	0.0305	0.0169
19-May-17	42km	0.0756	0.0412	0.0325	0.0313	0.0308	0.0174
23-May-17	42km	0.0776	0.0420	0.0332	0.0319	0.0311	0.0174
26-May-17	42km	0.0777	0.0420	0.0335	0.0321	0.0314	0.0180
27-May-17	42km	0.0725	0.0398	0.0314	0.0303	0.0298	0.0171
30-May-17	42km	0.0752	0.0409	0.0322	0.0310	0.0303	0.0170
02-Jun-17	42km	0.0832	0.0438	0.0341	0.0327	0.0320	0.0187
07-Jun-17	42km	0.1717	0.0723	0.0549	0.0520	0.0477	0.0220
09-Jun-17	42km	0.1513	0.0751	0.0584	0.0546	0.0507	0.0240
13-Jun-17	42km	0.1062	0.0534	0.0411	0.0393	0.0376	0.0192
15-Jun-17	42km	0.1288	0.0582	0.0431	0.0412	0.0392	0.0189
23-Jun-17	42km	0.0696	0.0391	0.0311	0.0298	0.0293	0.0168
27-Jun-17	42km	0.0694	0.0390	0.0308	0.0298	0.0292	0.0167
30-Jun-17	42km	0.0586	0.0342	0.0277	0.0271	0.0270	0.0161
06-Jul-17	42km	0.0570	0.0328	0.0264	0.0260	0.0261	0.0159
11-Jul-17	42km	0.0550	0.0325	0.0267	0.0260	0.0260	0.0162
14-Jul-17	42km	0.0527	0.0316	0.0261	0.0253	0.0254	0.0158
19-Jul-17	42km	0.0499	0.0299	0.0247	0.0240	0.0245	0.0156
25-Jul-17	42km	0.0499	0.0303	0.0253	0.0247	0.0249	0.0157
31-Jul-17	42km	0.0444	0.0278	0.0232	0.0229	0.0233	0.0155
11-Aug-17	42km	0.0394	0.0262	0.0224	0.0219	0.0228	0.0155
07-Sep-17	42km	0.0375	0.0248	0.0214	0.0210	0.0220	0.0149
22-Sep-17	42km	0.0411	0.0259	0.0222	0.0219	0.0224	0.0151
20-Oct-17	42km	0.0489	0.0300	0.0248	0.0241	0.0245	0.0155
05-Jul-16	57km	0.0429	0.0278	0.0234	0.0227	0.0234	0.0150
12-Jul-16	57km	0.0407	0.0266	0.0222	0.0218	0.0224	0.0147
20-Jul-16	57km	0.0450	0.0270	0.0226	0.0222	0.0230	0.0154

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
26-Jul-16	57km	0.0362	0.0246	0.0211	0.0207	0.0215	0.0148
09-Aug-16	57km	0.0367	0.0249	0.0214	0.0210	0.0219	0.0151
12-Aug-16	57km	0.0382	0.0254	0.0215	0.0213	0.0219	0.0151
20-Aug-16	57km	0.0334	0.0234	0.0204	0.0201	0.0208	0.0150
23-Sep-16	57km	0.0360	0.0263	0.0232	0.0231	0.0238	0.0173
22-Oct-16	57km	0.0478	0.0296	0.0244	0.0239	0.0244	0.0153
20-Nov-16	57km	0.0601	0.0348	0.0280	0.0273	0.0271	0.0160
11-Dec-16	57km	0.0516	0.0307	0.0253	0.0246	0.0248	0.0152
27-Jan-17	57km	0.0672	0.0374	0.0320	0.0319	0.0335	0.0244
09-Mar-17	57km	0.0516	0.0299	0.0243	0.0237	0.0239	0.0152
20-Mar-17	57km	0.1436	0.0638	0.0469	0.0446	0.0417	0.0193
31-Mar-17	57km	0.2014	0.0769	0.0540	0.0507	0.0466	0.0194
03-Apr-17	57km	0.1580	0.0714	0.0714	0.0498	0.0461	0.0205
07-Apr-17	57km	0.1481	0.0665	0.0665	0.0463	0.0432	0.0205
13-Apr-17	57km	0.1073	0.0520	0.0520	0.0376	0.0361	0.0180
15-Apr-17	57km	0.1177	0.0568	0.0568	0.0413	0.0394	0.0192
25-Apr-17	57km	0.1038	0.0505	0.0385	0.0365	0.0352	0.0173
27-Apr-17	57km	0.1035	0.0501	0.0376	0.0358	0.0344	0.0172
03-May-17	57km	0.0904	0.0443	0.0334	0.0320	0.0308	0.0163
05-May-17	57km	0.1078	0.0518	0.0388	0.0370	0.0351	0.0167
08-May-17	57km	0.1243	0.0600	0.0453	0.0431	0.0410	0.0202
10-May-17	57km	0.1089	0.0558	0.0431	0.0414	0.0391	0.0199
12-May-17	57km	0.0980	0.0508	0.0398	0.0381	0.0364	0.0192
16-May-17	57km	0.0889	0.0448	0.0344	0.0330	0.0320	0.0170
19-May-17	57km	0.0811	0.0426	0.0333	0.0323	0.0315	0.0175
23-May-17	57km	0.0899	0.0478	0.0380	0.0367	0.0361	0.0193
26-May-17	57km	0.3566	0.1581	0.1134	0.1061	0.0934	0.0332
27-May-17	57km	0.0734	0.0400	0.0313	0.0303	0.0297	0.0166
30-May-17	57km	0.0830	0.0424	0.0329	0.0317	0.0310	0.0170
02-Jun-17	57km	0.0839	0.0444	0.0345	0.0332	0.0321	0.0172
07-Jun-17	57km	0.1607	0.0615	0.0472	0.0452	0.0428	0.0212
09-Jun-17	57km	0.1137	0.0606	0.0467	0.0443	0.0419	0.0212
13-Jun-17	57km	0.0907	0.0500	0.0395	0.0379	0.0368	0.0196
15-Jun-17	57km	0.1165	0.0552	0.0418	0.0400	0.0378	0.0186
23-Jun-17	57km	0.0723	0.0399	0.0318	0.0307	0.0303	0.0168
27-Jun-17	57km	0.0693	0.0390	0.0319	0.0307	0.0306	0.0190
30-Jun-17	57km	0.0589	0.0343	0.0277	0.0269	0.0271	0.0162
06-Jul-17	57km	0.0556	0.0332	0.0272	0.0265	0.0263	0.0160
11-Jul-17	57km	0.0555	0.0328	0.0267	0.0260	0.0260	0.0159
14-Jul-17	57km	0.0488	0.0301	0.0250	0.0244	0.0249	0.0157

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
19-Jul-17	57km	0.0477	0.0298	0.0249	0.0243	0.0248	0.0158
25-Jul-17	57km	0.0494	0.0299	0.0246	0.0242	0.0246	0.0156
31-Jul-17	57km	0.0462	0.0287	0.0240	0.0234	0.0240	0.0155
11-Aug-17	57km	0.0417	0.0268	0.0226	0.0222	0.0230	0.0153
07-Sep-17	57km	0.0381	0.0252	0.0212	0.0214	0.0219	0.0149
22-Sep-17	57km	0.0399	0.0259	0.0220	0.0217	0.0224	0.0150
20-Oct-17	57km	0.0506	0.0304	0.0249	0.0245	0.0247	0.0156
05-Jul-16	73km	0.0437	0.0280	0.0236	0.0231	0.0236	0.0150
12-Jul-16	73km	0.0430	0.0276	0.0230	0.0224	0.0230	0.0148
20-Jul-16	73km	0.0442	0.0275	0.0231	0.0226	0.0232	0.0155
26-Jul-16	73km	0.0436	0.0279	0.0234	0.0228	0.0234	0.0154
09-Aug-16	73km	0.0395	0.0258	0.0219	0.0218	0.0224	0.0152
12-Aug-16	73km	0.0413	0.0277	0.0238	0.0234	0.0240	0.0169
20-Aug-16	73km	0.0402	0.0261	0.0221	0.0218	0.0224	0.0151
23-Sep-16	73km	0.0356	0.0250	0.0217	0.0212	0.0221	0.0154
22-Oct-16	73km	0.0510	0.0309	0.0254	0.0248	0.0250	0.0158
20-Nov-16	73km	0.0562	0.0331	0.0271	0.0261	0.0262	0.0158
11-Dec-16	73km	0.0511	0.0304	0.0248	0.0241	0.0245	0.0155
27-Jan-17	73km	0.0546	0.0299	0.0242	0.0236	0.0239	0.0156
09-Mar-17	73km	0.0478	0.0287	0.0239	0.0232	0.0236	0.0155
20-Mar-17	73km	0.0425	0.0273	0.0235	0.0230	0.0239	0.0174
31-Mar-17	73km	0.1226	0.0579	0.0431	0.0410	0.0388	0.0180
03-Apr-17	73km	0.1353	0.0638	0.0638	0.0459	0.0436	0.0219
07-Apr-17	73km	0.1124	0.0544	0.0544	0.0391	0.0369	0.0178
13-Apr-17	73km	0.1049	0.0480	0.0480	0.0349	0.0337	0.0177
15-Apr-17	73km	0.1161	0.0556	0.0556	0.0401	0.0377	0.0191
25-Apr-17	73km	0.0931	0.0462	0.0352	0.0339	0.0326	0.0169
27-Apr-17	73km	0.0969	0.0487	0.0370	0.0355	0.0335	0.0172
03-May-17	73km	0.0742	0.0386	0.0302	0.0290	0.0284	0.0155
05-May-17	73km	0.1134	0.0552	0.0414	0.0393	0.0371	0.0171
08-May-17	73km	0.1145	0.0537	0.0404	0.0383	0.0366	0.0182
19-May-17	73km	0.0775	0.0418	0.0329	0.0318	0.0311	0.0175
23-May-17	73km	0.0832	0.0447	0.0345	0.0332	0.0324	0.0197
26-May-17	73km	0.0779	0.0421	0.0330	0.0319	0.0313	0.0172
27-May-17	73km	0.0722	0.0400	0.0322	0.0312	0.0309	0.0179
30-May-17	73km	0.0799	0.0426	0.0341	0.0329	0.0320	0.0179
02-Jun-17	73km	0.0898	0.0443	0.0339	0.0327	0.0315	0.0172
07-Jun-17	73km	0.1554	0.0784	0.0628	0.0596	0.0538	0.0227

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
09-Jun-17	73km	0.1263	0.0641	0.0497	0.0471	0.0446	0.0223
13-Jun-17	73km	0.1230	0.0612	0.0471	0.0451	0.0427	0.0211
15-Jun-17	73km	0.1200	0.0581	0.0444	0.0424	0.0400	0.0195
23-Jun-17	73km	0.0693	0.0387	0.0309	0.0298	0.0293	0.0168
27-Jun-17	73km	0.0683	0.0374	0.0300	0.0289	0.0285	0.0165
30-Jun-17	73km	0.0626	0.0355	0.0286	0.0278	0.0277	0.0162
06-Jul-17	73km	0.0572	0.0326	0.0267	0.0259	0.0259	0.0160
11-Jul-17	73km	0.0595	0.0326	0.0265	0.0257	0.0257	0.0158
14-Jul-17	73km	0.0489	0.0299	0.0248	0.0242	0.0246	0.0155
19-Jul-17	73km	0.0486	0.0299	0.0249	0.0245	0.0246	0.0156
25-Jul-17	73km	0.0488	0.0297	0.0249	0.0241	0.0245	0.0155
31-Jul-17	73km	0.0467	0.0288	0.0239	0.0235	0.0239	0.0155
11-Aug-17	73km	0.0474	0.0289	0.0242	0.0237	0.0241	0.0156
07-Sep-17	73km	0.0567	0.0330	0.0268	0.0261	0.0260	0.0157
22-Sep-17	73km	0.0541	0.0307	0.0249	0.0245	0.0246	0.0158
20-Oct-17	73km	0.0493	0.0298	0.0247	0.0240	0.0245	0.0155

Table 27: *CDOM data for samples taken along the Salmon River. All data is in absorbance units*

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
05-Jul-16	0km	0.1055	0.0537	0.0406	0.0388	0.0367	0.0192
12-Jul-16	0km	0.1840	0.0833	0.0601	0.0570	0.0520	0.0209
20-Jul-16	0km	0.1993	0.0907	0.0662	0.0626	0.0574	0.0250
12-Aug-16	0km	0.0593	0.0347	0.0286	0.0280	0.0281	0.0183
20-Aug-16	0km	0.0717	0.0424	0.0354	0.0345	0.0343	0.0233
09-Aug-16	0km	0.0554	0.0315	0.0251	0.0242	0.0242	0.0155
30-Sep-16	0km	0.0614	0.0335	0.0269	0.0263	0.0263	0.0164
22-Oct-16	0km	0.1112	0.0537	0.0403	0.0384	0.0366	0.0177
20-Nov-16	0km	0.1301	0.0612	0.0450	0.0430	0.0402	0.0184
27-Jan-16	0km	0.0742	0.0334	0.0257	0.0248	0.0249	0.0153
16-Mar-17	0km	0.1219	0.0564	0.0417	0.0396	0.0372	0.0204
31-Mar-17	0km	0.4169	0.2015	0.1534	0.1451	0.1323	0.0687
03-Apr-17	0km	0.3053	0.1310	0.1310	0.0871	0.0781	0.0285
07-Apr-17	0km	0.2089	0.0923	0.0923	0.0625	0.0570	0.0218
13-Apr-17	0km	0.3905	0.1692	0.1692	0.1136	0.1014	0.0390
15-Apr-17	0km	0.4745	0.1986	0.1986	0.1292	0.1134	0.0351
25-Apr-17	0km	0.5796	0.2477	0.1747	0.1635	0.1431	0.0422
27-Apr-17	0km	0.5482	0.2319	0.1632	0.1525	0.1338	0.0439
03-May-17	0km	0.5184	0.2173	0.1511	0.1407	0.1235	0.0429
05-May-17	0km	0.5505	0.2311	0.1619	0.1514	0.1324	0.0419
08-May-17	0km	0.9120	0.4344	0.3308	0.3148	0.2884	0.1505
10-May-17	0km	0.4633	0.1954	0.1375	0.1283	0.1124	0.0435
12-May-17	0km	0.5182	0.1909	0.1287	0.1196	0.1044	0.0325
16-May-17	0km	0.4557	0.1983	0.1405	0.1311	0.1145	0.0398
19-May-17	0km	0.4635	0.2053	0.1465	0.1376	0.1211	0.0422
23-May-17	0km	0.3572	0.1605	0.1145	0.1070	0.0938	0.0310
26-May-17	0km	0.3301	0.1464	0.1049	0.0979	0.0867	0.0297
27-May-17	0km	0.3231	0.1458	0.1042	0.0975	0.0867	0.0299
30-May-17	0km	0.3715	0.1647	0.1175	0.1099	0.0975	0.0329
02-Jun-17	0km	0.3638	0.1613	0.1145	0.1073	0.0949	0.0319
07-Jun-17	0km	0.2930	0.1285	0.0917	0.0858	0.0767	0.0267
09-Jun-17	0km	0.3338	0.1206	0.0826	0.0772	0.0687	0.0264
13-Jun-17	0km	0.4275	0.1217	0.0793	0.0747	0.0673	0.0269
15-Jun-17	0km	0.3064	0.1057	0.0708	0.0666	0.0597	0.0231
23-Jun-17	0km	0.1971	0.0880	0.0636	0.0603	0.0547	0.0219
27-Jun-17	0km	0.1648	0.0750	0.0553	0.0526	0.0486	0.0206
30-Jun-17	0km	0.1476	0.0655	0.0489	0.0466	0.0441	0.0213
06-Jul-17	0km	0.0896	0.0439	0.0337	0.0325	0.0317	0.0169
11-Jul-17	0km	0.0788	0.0405	0.0316	0.0306	0.0297	0.0165

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
14-Jul-17	0km	0.0732	0.0382	0.0300	0.0290	0.0286	0.0162
19-Jul-17	0km	0.0679	0.0364	0.0290	0.0280	0.0277	0.0161
25-Jul-17	0km	0.0781	0.0399	0.0312	0.0301	0.0294	0.0167
31-Jul-17	0km	0.0644	0.0351	0.0282	0.0274	0.0272	0.0161
11-Aug-17	0km	0.0691	0.0372	0.0295	0.0289	0.0287	0.0167
07-Sep-17	0km	0.0631	0.0346	0.0277	0.0269	0.0268	0.0157
22-Sep-17	0km	0.0604	0.0334	0.0270	0.0264	0.0263	0.0162
20-Oct-17	0km	0.0880	0.0447	0.0347	0.0332	0.0322	0.0170
05-Jul-16	Bolean Creek	0.1371	0.0645	0.0474	0.0449	0.0420	0.0186
12-Jul-16	Bolean Creek	0.1858	0.0845	0.0613	0.0576	0.0527	0.0203
20-Jul-16	Bolean Creek	0.2434	0.1108	0.0802	0.0753	0.0675	0.0245
12-Aug-16	Bolean Creek	0.0992	0.0468	0.0348	0.0331	0.0315	0.0165
20-Aug-16	Bolean Creek	0.0757	0.0388	0.0300	0.0289	0.0282	0.0164
09-Sep-16	Bolean Creek	0.1295	0.0612	0.0448	0.0424	0.0395	0.0179
30-Sep-16	Bolean Creek	0.1024	0.0503	0.0381	0.0362	0.0346	0.0175
22-Oct-16	Bolean Creek	0.2698	0.1233	0.0892	0.0833	0.0749	0.0266
20-Nov-16	Bolean Creek	0.1989	0.0909	0.0657	0.0616	0.0560	0.0214
27-Jan-17	Bolean Creek	0.1070	0.0461	0.0344	0.0328	0.0316	0.0164
16-Mar-17	Bolean Creek	0.1731	0.0791	0.0577	0.0546	0.0502	0.0203
31-Mar-17	Bolean Creek	0.1923	0.0831	0.0595	0.0561	0.0512	0.0202
07-Apr-17	Bolean Creek	0.2701	0.1148	0.1148	0.0779	0.0704	0.0253
13-Apr-17	Bolean Creek	0.2459	0.1088	0.1088	0.0742	0.0673	0.0240
15-Apr-17	Bolean Creek	0.3644	0.1578	0.1578	0.1044	0.0924	0.0306
25-Apr-17	Bolean Creek	0.4488	0.1971	0.1428	0.1339	0.1186	0.0363
27-Apr-17	Bolean Creek	0.4585	0.1921	0.1332	0.1244	0.1089	0.0326
03-May-17	Bolean Creek	0.4458	0.1859	0.1296	0.1209	0.1060	0.0317
05-May-17	Bolean Creek	0.6352	0.2735	0.1918	0.1782	0.1549	0.0463
08-May-17	Bolean Creek	0.4824	0.1934	0.1330	0.1233	0.1077	0.0335
10-May-17	Bolean Creek	0.5724	0.2297	0.1596	0.1483	0.1301	0.0405
12-May-17	Bolean Creek	0.5591	0.2108	0.1435	0.1331	0.1166	0.0372
16-May-17	Bolean Creek	0.3823	0.1664	0.1177	0.1096	0.0958	0.0313
19-May-17	Bolean Creek	0.4035	0.1826	0.1321	0.1237	0.1089	0.0371
23-May-17	Bolean Creek	0.4160	0.1867	0.1344	0.1260	0.1107	0.0373
26-May-17	Bolean Creek	0.4027	0.1795	0.1297	0.1220	0.1081	0.0358
27-May-17	Bolean Creek	0.3822	0.1684	0.1205	0.1128	0.1000	0.0356
30-May-17	Bolean Creek	0.3179	0.1458	0.1055	0.0988	0.0880	0.0317
02-Jun-17	Bolean Creek	0.3121	0.1403	0.1005	0.0941	0.0837	0.0287
07-Jun-17	Bolean Creek	0.2635	0.1201	0.0864	0.0814	0.0726	0.0262

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
09-Jun-17	Bolean Creek	0.3099	0.1223	0.0849	0.0791	0.0702	0.0253
13-Jun-17	Bolean Creek	0.2803	0.1145	0.0810	0.0762	0.0686	0.0273
15-Jun-17	Bolean Creek	0.4053	0.1125	0.0707	0.0662	0.0593	0.0226
23-Jun-17	Bolean Creek	0.1893	0.0866	0.0629	0.0596	0.0546	0.0215
27-Jun-17	Bolean Creek	0.1613	0.0746	0.0548	0.0518	0.0480	0.0215
30-Jun-17	Bolean Creek	0.1611	0.0712	0.0516	0.0488	0.0454	0.0196
06-Jul-17	Bolean Creek	0.1150	0.0519	0.0386	0.0367	0.0349	0.0171
11-Jul-17	Bolean Creek	0.1098	0.0518	0.0388	0.0370	0.0353	0.0175
14-Jul-17	Bolean Creek	0.1009	0.0481	0.0363	0.0347	0.0332	0.0169
19-Jul-17	Bolean Creek	0.0982	0.0470	0.0355	0.0340	0.0326	0.0168
25-Jul-17	Bolean Creek	0.0962	0.0461	0.0351	0.0336	0.0323	0.0168
31-Jul-17	Bolean Creek	0.0886	0.0435	0.0333	0.0321	0.0312	0.0168
11-Aug-17	Bolean Creek	0.0769	0.0397	0.0309	0.0298	0.0293	0.0165
07-Sep-17	Bolean Creek	0.0644	0.0348	0.0275	0.0265	0.0264	0.0155
22-Sep-17	Bolean Creek	0.0663	0.0346	0.0273	0.0264	0.0265	0.0159
20-Oct-17	Bolean Creek	0.0915	0.0460	0.0351	0.0337	0.0326	0.0168
05-Jul-16	28 km	0.0979	0.0478	0.0362	0.0347	0.0332	0.0167
12-Jul-16	28 km	0.1722	0.0815	0.0604	0.0574	0.0530	0.0243
20-Jul-16	28 km	0.1533	0.0712	0.0523	0.0495	0.0459	0.0204
12-Aug-16	28 km	0.0668	0.0360	0.0285	0.0275	0.0274	0.0162
20-Aug-16	28 km	0.0530	0.0303	0.0248	0.0241	0.0244	0.0157
09-Aug-16	28 km	0.0794	0.0404	0.0311	0.0296	0.0291	0.0162
30-Sep-16	28 km	0.0609	0.0340	0.0273	0.0262	0.0265	0.0162
22-Oct-16	28 km	0.1627	0.0770	0.0564	0.0534	0.0494	0.0208
20-Nov-16	28 km	0.1308	0.0616	0.0457	0.0432	0.0404	0.0229
27-Jan-16	28 km	0.0720	0.0318	0.0247	0.0240	0.0241	0.0153
16-Mar-17	28 km	0.1170	0.0553	0.0415	0.0394	0.0374	0.0184
31-Mar-17	28 km	0.1462	0.0634	0.0460	0.0434	0.0405	0.0182
07-Apr-17	28 km	0.2106	0.0915	0.0915	0.0615	0.0559	0.0225
13-Apr-17	28 km	0.3275	0.1466	0.1466	0.0993	0.0889	0.0331
15-Apr-17	28 km	0.3948	0.1714	0.1714	0.1144	0.1019	0.0379
25-Apr-17	28 km	0.4880	0.2020	0.1404	0.1309	0.1149	0.0354
27-Apr-17	28 km	0.4795	0.2015	0.1415	0.1320	0.1160	0.0355
03-May-17	28 km	0.4672	0.1870	0.1288	0.1198	0.1055	0.0355
05-May-17	28 km	0.5759	0.2480	0.1747	0.1629	0.1424	0.0426
08-May-17	28 km	0.8278	0.2907	0.1906	0.1763	0.1509	0.0428
10-May-17	28 km	0.5010	0.1961	0.1339	0.1245	0.1088	0.0334
12-May-17	28 km	0.5869	0.2078	0.1393	0.1295	0.1131	0.0366
16-May-17	28 km	0.4098	0.1784	0.1266	0.1187	0.1041	0.0359

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
19-May-17	28 km	0.4109	0.1799	0.1281	0.1198	0.1057	0.0364
23-May-17	28 km	0.3858	0.1729	0.1244	0.1168	0.1034	0.0364
26-May-17	28 km	0.0815	0.0426	0.0332	0.0322	0.0312	0.0170
27-May-17	28 km	0.3573	0.1701	0.1275	0.1209	0.1102	0.0507
30-May-17	28 km	0.3392	0.1495	0.1070	0.1002	0.0892	0.0310
02-Jun-17	28 km	0.3302	0.1464	0.1048	0.0982	0.0871	0.0296
07-Jun-17	28 km	0.2827	0.1228	0.0882	0.0827	0.0743	0.0276
09-Jun-17	28 km	0.3201	0.1194	0.0824	0.0770	0.0691	0.0259
13-Jun-17	28 km	0.2576	0.0985	0.0686	0.0643	0.0583	0.0225
15-Jun-17	28 km	0.2788	0.1004	0.0692	0.0651	0.0594	0.0257
23-Jun-17	28 km	0.1760	0.0791	0.0574	0.0544	0.0503	0.0210
27-Jun-17	28 km	0.1381	0.0634	0.0465	0.0443	0.0413	0.0187
30-Jun-17	28 km	0.1228	0.0567	0.0421	0.0402	0.0379	0.0180
06-Jul-17	28 km	0.0920	0.0451	0.0344	0.0330	0.0319	0.0168
11-Jul-17	28 km	0.0806	0.0415	0.0322	0.0310	0.0304	0.0167
14-Jul-17	28 km	0.0753	0.0387	0.0306	0.0294	0.0287	0.0162
19-Jul-17	28 km	0.0687	0.0364	0.0288	0.0279	0.0275	0.0161
25-Jul-17	28 km	0.0677	0.0358	0.0284	0.0276	0.0276	0.0162
31-Jul-17	28 km	0.0648	0.0346	0.0277	0.0268	0.0268	0.0158
11-Aug-17	28 km	0.0619	0.0341	0.0275	0.0268	0.0269	0.0164
07-Sep-17	28 km	0.0457	0.0271	0.0225	0.0222	0.0228	0.0150
22-Sep-17	28 km	0.0511	0.0301	0.0247	0.0242	0.0246	0.0158
20-Oct-17	28 km	0.0670	0.0371	0.0294	0.0285	0.0282	0.0163
05-Jul-16	Silver Creek	0.1916	0.0358	0.0284	0.0276	0.0272	0.0156
12-Jul-16	Silver Creek	0.1488	0.0384	0.0299	0.0286	0.0281	0.0156
20-Jul-16	Silver Creek	0.1547	0.0403	0.0318	0.0307	0.0299	0.0168
09-Aug-16	Silver Creek	0.0950	0.0288	0.0236	0.0231	0.0233	0.0150
12-Aug-16	Silver Creek	0.0757	0.0292	0.0242	0.0237	0.0242	0.0154
20-Aug-16	Silver Creek	0.0732	0.0267	0.0225	0.0220	0.0225	0.0150
30-Sep-16	Silver Creek	0.0625	0.0276	0.0231	0.0227	0.0234	0.0153
22-Oct-16	Silver Creek	0.0626	0.0603	0.0455	0.0433	0.0403	0.0186
20-Nov-16	Silver Creek	0.0700	0.0452	0.0348	0.0336	0.0322	0.0167
11-Dec-16	Silver Creek	0.0733	0.0382	0.0300	0.0289	0.0285	0.0159
27-Jan-17	Silver Creek	0.0454	0.0285	0.0237	0.0231	0.0237	0.0153
16-Mar-17	Silver Creek	0.0397	0.0609	0.0454	0.0429	0.0403	0.0184
31-Mar-17	Silver Creek	0.0447	0.0899	0.0647	0.0610	0.0555	0.0219
03-Apr-17	Silver Creek	0.0417	0.0794	0.0794	0.0542	0.0497	0.0201
07-Apr-17	Silver Creek	0.1199	0.0790	0.0790	0.0540	0.0497	0.0201
13-Apr-17	Silver Creek	0.0857	0.0893	0.0893	0.0693	0.0664	0.0435

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
15-Apr-17	Silver Creek	0.0704	0.0665	0.0665	0.0469	0.0439	0.0196
25-Apr-17	Silver Creek	0.0461	0.0580	0.0429	0.0411	0.0384	0.0180
27-Apr-17	Silver Creek	0.1266	0.0545	0.0407	0.0389	0.0367	0.0172
03-May-17	Silver Creek	0.1979	0.0520	0.0389	0.0371	0.0351	0.0166
05-May-17	Silver Creek	0.1745	0.1047	0.0755	0.0706	0.0638	0.0234
08-May-17	Silver Creek	0.1741	0.1201	0.0880	0.0829	0.0749	0.0290
10-May-17	Silver Creek	0.1642	0.0963	0.0697	0.0660	0.0598	0.0238
12-May-17	Silver Creek	0.1436	0.1045	0.0776	0.0734	0.0664	0.0256
16-May-17	Silver Creek	0.1219	0.0735	0.0543	0.0514	0.0471	0.0203
19-May-17	Silver Creek	0.1133	0.0757	0.0560	0.0528	0.0485	0.0220
23-May-17	Silver Creek	0.1078	0.1262	0.0947	0.0897	0.0816	0.0344
26-May-17	Silver Creek	0.2315	0.0835	0.0613	0.0582	0.0528	0.0218
27-May-17	Silver Creek	0.2636	0.0957	0.0706	0.0664	0.0604	0.0246
30-May-17	Silver Creek	0.2044	0.1022	0.0743	0.0699	0.0629	0.0241
02-Jun-17	Silver Creek	0.2181	0.0938	0.0676	0.0636	0.0576	0.0225
07-Jun-17	Silver Creek	0.1531	0.1127	0.0828	0.0780	0.0694	0.0260
09-Jun-17	Silver Creek	0.1575	0.0918	0.0682	0.0645	0.0586	0.0247
13-Jun-17	Silver Creek	0.2549	0.0735	0.0550	0.0521	0.0485	0.0227
15-Jun-17	Silver Creek	0.1778	0.0766	0.0570	0.0539	0.0498	0.0214
23-Jun-17	Silver Creek	0.2033	0.0493	0.0377	0.0362	0.0344	0.0175
27-Jun-17	Silver Creek	0.2194	0.0411	0.0323	0.0310	0.0303	0.0166
30-Jun-17	Silver Creek	0.2079	0.0395	0.0312	0.0298	0.0295	0.0165
06-Jul-17	Silver Creek	0.2519	0.0356	0.0284	0.0276	0.0274	0.0159
11-Jul-17	Silver Creek	0.0574	0.0333	0.0269	0.0262	0.0261	0.0158
14-Jul-17	Silver Creek	0.0538	0.0319	0.0258	0.0252	0.0252	0.0156
19-Jul-17	Silver Creek	0.0515	0.0312	0.0256	0.0250	0.0251	0.0155
25-Jul-17	Silver Creek	0.0496	0.0304	0.0250	0.0244	0.0246	0.0155
31-Jul-17	Silver Creek	0.0486	0.0303	0.0249	0.0243	0.0247	0.0154
11-Aug-17	Silver Creek	0.0470	0.0296	0.0245	0.0240	0.0246	0.0156
07-Sep-17	Silver Creek	0.0418	0.0276	0.0233	0.0226	0.0233	0.0151
22-Sep-17	Silver Creek	0.0379	0.0262	0.0224	0.0221	0.0227	0.0152
20-Oct-17	Silver Creek	0.0463	0.0305	0.0253	0.0248	0.0252	0.0159
05-Jul-16	Spa Creek	0.2345	0.0570	0.0431	0.0408	0.0386	0.0180
12-Jul-16	Spa Creek	0.2317	0.0614	0.0455	0.0431	0.0401	0.0182
20-Jul-16	Spa Creek	0.2371	0.0772	0.0586	0.0558	0.0515	0.0244
09-Aug-16	Spa Creek	0.1710	0.0543	0.0411	0.0392	0.0373	0.0194
12-Aug-16	Spa Creek	0.1591	0.0444	0.0342	0.0329	0.0319	0.0168
20-Aug-16	Spa Creek	0.1456	0.0383	0.0301	0.0289	0.0284	0.0161
30-Sep-16	Spa Creek	0.1316	0.0390	0.0308	0.0300	0.0293	0.0166

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
22-Oct-16	Spa Creek	0.1188	0.1019	0.0751	0.0707	0.0641	0.0246
20-Nov-16	Spa Creek	0.1302	0.0693	0.0513	0.0484	0.0450	0.0194
27-Jan-17	Spa Creek	0.1590	0.0577	0.0404	0.0385	0.0363	0.0179
16-Mar-17	Spa Creek	0.0863	0.0705	0.0518	0.0489	0.0452	0.0204
31-Mar-17	Spa Creek	0.0718	0.1627	0.1140	0.1066	0.0939	0.0297
03-Apr-17	Spa Creek	0.1090	0.1436	0.1436	0.0944	0.0838	0.0290
07-Apr-17	Spa Creek	0.0709	0.1560	0.1560	0.1040	0.0922	0.0319
13-Apr-17	Spa Creek	0.2153	0.1266	0.1266	0.0846	0.0759	0.0282
15-Apr-17	Spa Creek	0.1506	0.1232	0.1232	0.0826	0.0738	0.0265
25-Apr-17	Spa Creek	0.1242	0.0935	0.0681	0.0640	0.0583	0.0230
27-Apr-17	Spa Creek	0.1552	0.0844	0.0612	0.0575	0.0520	0.0208
03-May-17	Spa Creek	0.3808	0.0824	0.0600	0.0564	0.0515	0.0202
05-May-17	Spa Creek	0.3361	0.1222	0.0882	0.0826	0.0738	0.0257
08-May-17	Spa Creek	0.3486	0.1305	0.0956	0.0901	0.0810	0.0315
10-May-17	Spa Creek	0.2984	0.1168	0.0857	0.0808	0.0732	0.0285
12-May-17	Spa Creek	0.2786	0.1128	0.0842	0.0791	0.0717	0.0276
16-May-17	Spa Creek	0.2104	0.0918	0.0666	0.0629	0.0568	0.0228
19-May-17	Spa Creek	0.1888	0.0946	0.0684	0.0645	0.0581	0.0228
23-May-17	Spa Creek	0.1821	0.1042	0.0755	0.0711	0.0634	0.0245
26-May-17	Spa Creek	0.2694	0.0901	0.0655	0.0616	0.0558	0.0224
27-May-17	Spa Creek	0.2843	0.1046	0.0756	0.0710	0.0636	0.0243
30-May-17	Spa Creek	0.2456	0.0998	0.0724	0.0680	0.0611	0.0237
02-Jun-17	Spa Creek	0.2359					
07-Jun-17	Spa Creek	0.2028	0.0965	0.0706	0.0668	0.0604	0.0241
09-Jun-17	Spa Creek	0.2074	0.1154	0.0860	0.0815	0.0739	0.0303
13-Jun-17	Spa Creek	0.2266	0.1135	0.0850	0.0801	0.0729	0.0299
15-Jun-17	Spa Creek	0.1970	0.1100	0.0809	0.0762	0.0688	0.0260
23-Jun-17	Spa Creek	0.2286	0.0791	0.0582	0.0548	0.0508	0.0213
27-Jun-17	Spa Creek	0.2181	0.0735	0.0539	0.0512	0.0474	0.0206
30-Jun-17	Spa Creek		0.0681	0.0506	0.0479	0.0447	0.0199
06-Jul-17	Spa Creek	0.2087	0.0619	0.0463	0.0441	0.0412	0.0188
11-Jul-17	Spa Creek	0.1113	0.0540	0.0408	0.0388	0.0370	0.0182
14-Jul-17	Spa Creek	0.0970	0.0482	0.0370	0.0357	0.0341	0.0173
19-Jul-17	Spa Creek	0.0840	0.0437	0.0339	0.0327	0.0316	0.0167
25-Jul-17	Spa Creek	0.0979	0.0484	0.0370	0.0355	0.0341	0.0174
31-Jul-17	Spa Creek	0.0797	0.0415	0.0323	0.0312	0.0302	0.0166
11-Aug-17	Spa Creek	0.0747	0.0402	0.0315	0.0304	0.0297	0.0166
07-Sep-17	Spa Creek	0.0638	0.0363	0.0291	0.0282	0.0280	0.0160
22-Sep-17	Spa Creek	0.0552	0.0333	0.0271	0.0264	0.0264	0.0159
20-Oct-17	Spa Creek	0.0701	0.0402	0.0319	0.0310	0.0303	0.0168

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
05-Jul-16	51 km	0.0915	0.0464	0.0357	0.0344	0.0332	0.0186
12-Jul-16	51 km	0.1355	0.0624	0.0457	0.0430	0.0400	0.0181
20-Jul-16	51 km	0.1236	0.0572	0.0429	0.0410	0.0387	0.0191
12-Aug-16	51 km	0.0652	0.0344	0.0272	0.0265	0.0265	0.0158
20-Aug-16	51 km	0.0586	0.0321	0.0256	0.0249	0.0250	0.0153
09-Aug-16	51 km	0.0628	0.0339	0.0267	0.0257	0.0254	0.0154
30-Sep-16	51 km	0.0558	0.0316	0.0253	0.0246	0.0249	0.0155
22-Oct-16	51 km	0.1265	0.0613	0.0456	0.0430	0.0406	0.0184
20-Nov-16	51 km	0.1112	0.0536	0.0398	0.0381	0.0359	0.0175
27-Jan-16	51 km	0.0700	0.0316	0.0246	0.0237	0.0241	0.0157
16-Mar-17	51 km	0.1040	0.0516	0.0390	0.0371	0.0353	0.0176
31-Mar-17	51 km	0.1788	0.0769	0.0550	0.0518	0.0473	0.0193
03-Apr-17	51 km	0.2109	0.0916	0.0916	0.0612	0.0555	0.0214
07-Apr-17	51 km	0.2316	0.1001	0.1001	0.0670	0.0605	0.0224
13-Apr-17	51 km	0.2895	0.1253	0.1253	0.0834	0.0749	0.0275
15-Apr-17	51 km	0.3899	0.1698	0.1698	0.1146	0.1021	0.0387
25-Apr-17	51 km	0.4767	0.1990	0.1387	0.1292	0.1133	0.0360
27-Apr-17	51 km	0.4415	0.1928	0.1345	0.1251	0.1095	0.0365
03-May-17	51 km	0.4088	0.1690	0.1178	0.1095	0.0968	0.0299
05-May-17	51 km	0.5006	0.2153	0.1507	0.1410	0.1230	0.0370
08-May-17	51 km	0.7437	0.2752	0.1846	0.1710	0.1479	0.0451
10-May-17	51 km	0.5276	0.1906	0.1276	0.1185	0.1032	0.0338
12-May-17	51 km	0.5668	0.1924	0.1270	0.1183	0.1035	0.0334
16-May-17	51 km	0.3921	0.1691	0.1209	0.1135	0.0998	0.0351
19-May-17	51 km	0.3748	0.1632	0.1160	0.1088	0.0956	0.0324
23-May-17	51 km	0.3511	0.1559	0.1114	0.1043	0.0919	0.0312
26-May-17	51 km	0.3289	0.1449	0.1031	0.0969	0.0853	0.0296
27-May-17	51 km	0.3114	0.1411	0.1014	0.0950	0.0843	0.0299
30-May-17	51 km	0.3008	0.1336	0.0961	0.0901	0.0806	0.0282
02-Jun-17	51 km	0.3073	0.1363	0.0971	0.0908	0.0809	0.0279
07-Jun-17	51 km	0.4507	0.1413	0.0930	0.0869	0.0776	0.0301
09-Jun-17	51 km	0.2716	0.1059	0.0739	0.0695	0.0626	0.0248
13-Jun-17	51 km	0.2283	0.0902	0.0634	0.0596	0.0543	0.0223
15-Jun-17	51 km	0.4185	0.1033	0.0621	0.0579	0.0522	0.0221
23-Jun-17	51 km	0.1581	0.0717	0.0525	0.0500	0.0461	0.0199
27-Jun-17	51 km	0.1343	0.0615	0.0452	0.0432	0.0403	0.0185
30-Jun-17	51 km	0.1242	0.0543	0.0399	0.0380	0.0363	0.0176
06-Jul-17	51 km	0.0927	0.0450	0.0342	0.0328	0.0318	0.0171
11-Jul-17	51 km	0.0824	0.0411	0.0317	0.0304	0.0296	0.0163
14-Jul-17	51 km	0.0781	0.0391	0.0304	0.0293	0.0287	0.0161

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
19-Jul-17	51 km	0.0739	0.0378	0.0297	0.0285	0.0282	0.0159
25-Jul-17	51 km	0.0770	0.0389	0.0305	0.0293	0.0287	0.0161
31-Jul-17	51 km	0.0716	0.0371	0.0291	0.0284	0.0280	0.0167
11-Aug-17	51 km	0.0661	0.0352	0.0279	0.0269	0.0269	0.0161
07-Sep-17	51 km	0.0606	0.0331	0.0264	0.0259	0.0260	0.0155
22-Sep-17	51 km	0.0542	0.0307	0.0251	0.0243	0.0246	0.0154
20-Oct-17	51 km	0.0582	0.0332	0.0267	0.0260	0.0260	0.0156
05-Jul-16	66 km	0.1037	0.0511	0.0384	0.0367	0.0348	0.0174
12-Jul-16	66 km	0.1357	0.0631	0.0462	0.0438	0.0408	0.0182
20-Jul-16	66 km	0.1127	0.0546	0.0415	0.0397	0.0378	0.0186
12-Aug-16	66 km	0.0698	0.0364	0.0287	0.0276	0.0271	0.0158
20-Aug-16	66 km	0.0624	0.0340	0.0271	0.0263	0.0263	0.0157
09-Aug-16	66 km	0.0684	0.0368	0.0286	0.0276	0.0272	0.0157
30-Sep-16	66 km	0.0610	0.0336	0.0267	0.0260	0.0261	0.0158
22-Oct-16	66 km	0.1699	0.0815	0.0604	0.0569	0.0523	0.0215
20-Nov-16	66 km	0.1282	0.0621	0.0461	0.0438	0.0409	0.0185
27-Jan-16	66 km	0.0682	0.0329	0.0260	0.0252	0.0252	0.0154
16-Mar-17	66 km	0.1781	0.0823	0.0602	0.0569	0.0522	0.0209
31-Mar-17	66 km	0.1974	0.0866	0.0623	0.0587	0.0534	0.0211
03-Apr-17	66 km	0.2095	0.0928	0.0928	0.0626	0.0572	0.0257
07-Apr-17	66 km	0.2344	0.1022	0.1022	0.0688	0.0623	0.0226
13-Apr-17	66 km	0.2794	0.1214	0.1214	0.0816	0.0732	0.0278
15-Apr-17	66 km	0.3601	0.1608	0.1608	0.1078	0.0962	0.0346
25-Apr-17	66 km	0.4256	0.1865	0.1350	0.1268	0.1130	0.0407
27-Apr-17	66 km	0.4092	0.1755	0.1235	0.1149	0.1016	0.0324
03-May-17	66 km	0.3640	0.1534	0.1066	0.0996	0.0879	0.0283
05-May-17	66 km	0.4310	0.1861	0.1315	0.1222	0.1074	0.0334
08-May-17	66 km	0.5454	0.2089	0.1420	0.1319	0.1148	0.0380
10-May-17	66 km	0.5038	0.1950	0.1325	0.1233	0.1077	0.0354
12-May-17	66 km	0.5327	0.1784	0.1180	0.1094	0.0960	0.0314
16-May-17	66 km	0.3664	0.1596	0.1134	0.1062	0.0930	0.0313
19-May-17	66 km	0.3601	0.1586	0.1138	0.1065	0.0942	0.0331
23-May-17	66 km	0.3340	0.1510	0.1085	0.1015	0.0895	0.0322
26-May-17	66 km	0.3161	0.1419	0.1013	0.0950	0.0841	0.0302
27-May-17	66 km	0.2947	0.1302	0.0931	0.0877	0.0781	0.0277
30-May-17	66 km	0.2834	0.1274	0.0916	0.0860	0.0771	0.0281
02-Jun-17	66 km	0.2910	0.1320	0.0941	0.0882	0.0784	0.0298
07-Jun-17	66 km	0.4796	0.1414	0.0908	0.0853	0.0760	0.0314
09-Jun-17	66 km	0.2671	0.1033	0.0719	0.0673	0.0607	0.0249

Date	Site	240 nm	310 nm	335 nm	340 nm	350 nm	440 nm
13-Jun-17	66 km	0.2194	0.0893	0.0634	0.0598	0.0549	0.0238
15-Jun-17	66 km	0.3686	0.0962	0.0595	0.0557	0.0507	0.0210
23-Jun-17	66 km	0.1570	0.0720	0.0530	0.0504	0.0470	0.0203
27-Jun-17	66 km	0.1278	0.0596	0.0442	0.0419	0.0393	0.0183
30-Jun-17	66 km	0.1115	0.0528	0.0396	0.0380	0.0362	0.0178
06-Jul-17	66 km	0.0953	0.0461	0.0350	0.0336	0.0323	0.0169
11-Jul-17	66 km	0.0882	0.0435	0.0333	0.0320	0.0310	0.0164
14-Jul-17	66 km	0.0818	0.0410	0.0316	0.0304	0.0297	0.0164
19-Jul-17	66 km	0.0791	0.0399	0.0309	0.0299	0.0292	0.0162
25-Jul-17	66 km	0.0752	0.0383	0.0300	0.0289	0.0283	0.0160
31-Jul-17	66 km	0.0756	0.0386	0.0301	0.0291	0.0285	0.0161
11-Aug-17	66 km	0.0718	0.0374	0.0293	0.0283	0.0280	0.0162
07-Sep-17	66 km	0.0669	0.0358	0.0284	0.0275	0.0272	0.0156
22-Sep-17	66 km	0.0565	0.0317	0.0255	0.0249	0.0250	0.0154
20-Oct-17	66 km	0.0624	0.0348	0.0277	0.0270	0.0268	0.0159