APPENDIX 8-A

Hydro-meteorology Baseline Report

GOLDCORP

Coffee Gold Project: Hydro-meteorology Baseline Report

Project No. A405-3
March 3, 2017

LORAX ENVIRONMENTAL

2289 Burrard Street
Vancouver, BC, V6J 3H9
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Executive Summary

GOLDCORP

Executive Summary

The prevailing climate conditions at the Project site are typical for central Yukon. Average annual temperature is -2.6 °C, with average monthly air temperatures that range from -19°C (December) to +13°C (July). Locally, the Project site experiences notable temperature inversions in the winter months, with observed ridgetop temperatures up to 10°C higher than measurements recorded at valley bottom locations.

Mean annual precipitation at the proposed undertaking (~1,300 m above sea level) is estimated to be 485 mm, with 65% of this total precipitation realized as rain during the months of May through September, and the remaining 35% occurring as snow from October through April. Precipitation gradients were ascertained through an inspection of site- and regional precipitation data, and were established as follows: 4%/100 m elevation gain for rainfall; and 9%/100 m elevation gain for snow.

Annual potential evaporation (PE) for the Project area is estimated to be ~500 mm with monthly rates being highest in May, June, July and August (roughly 70 to 110 mm per month) and considerably lower for autumn, winter and spring months. Consistent with other studies in the Yukon, the evapotranspiration estimate for the Coffee Gold site is roughly 40% of the assumed PE value or 182 mm per year. Results for other climate/weather parameters, including wind speed and direction, relative humidity, solar radiation and atmospheric pressure are presented in Section 3 of this report.

Local patterns of streamflow are dominated by a snowmelt freshet that typically occurs between late April and early June. Following freshet, patterns of streamflow are punctuated by several rainfall-induced runoff events which occur throughout the summer and autumn. In general, these high flow events are short duration, persisting usually for a 1 or 2-day time period. Flows in local creeks and streams abate in October in response to freezing temperatures and it is notable that local watersheds typically experience zero flow conditions throughout the winter (*i.e.*, November through end March). Aufeis (*i.e.*, frozen groundwater seepage that accumulates within- and adjacent to local watercourses) is pervasive in creeks and streams at the Project site and melts during the freshet, but may persist into the early summer.

Based on measurements at Coffee Creek hydrometric stations, average unit yields across the project site are 9 L/s/km^2 for the open water season (May to October), and range from 4.5 to 15 L/s/km^2, with specifics of the runoff regime for each monitoring station being dependent on drainage characteristics (*i.e.*, basin area, shape, mean elevation, extent of permafrost, *etc.*). Unit yields range from 1.2 – 3.3 L/s/km^2 in October, and decrease steadily to annual minima in March (*i.e.*, 0 – 0.7 L/s/km^2), before increasing again in April in response to low-elevation snow melt and spring rains. At Coffee Creek, instantaneous peak flows, expressed as unit yields, are typically between 120 and 200 L/s/km^2, but measurements range widely across the site (from 60 to >300 L/s/km^2).

As part of the baseline study, site- and regional hydrometric data were analyzed in combination to: place the relatively short period of record for Coffee Creek into a broader context; generate long-term (i.e., 30+ year) synthetic climate and discharge records for the Project area; and to compute robust climate and flow metrics (*e.g.*, extreme rainfall depths; instantaneous peak flows; low flows for various return periods) from the combined site- and regional information. These metrics are tabled in Section 3 (see also Appendix A1 and E) of the report and have subsequently been used to inform engineering and design studies related to the mine and water management plan, and to construct and calibrate a site-wide water balance and water quality model for the Coffee Gold Project.

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1. Introduction

1.1 Background

Goldcorp Inc. (Goldcorp) is in the process of developing and permitting the Coffee Gold Project (Project), a proposed heap leach operation located in west-central Yukon, approximately 130 km south of Dawson City (Figure 1-1). The Coffee Gold Project contains several gold occurrences within an exploration concession covering an area more than 600 km^2.

The Project is located in the Yukon-Tanana Terrane (YTT), an accreted pericratonic rock sequence that covers a large portion of the Omineca Belt in the Yukon and extends into Alaska and British Columbia. The YTT underlies part of the Tintina gold belt and hosts multiple gold deposits, including the Sonora Gulch gold deposit, the Casino copper-gold-molybdenum porphyry, the Boulevard gold prospect, and the Golden Saddle gold deposit.

The Project has undergone a detailed Feasibility Study (Coffee Gold 43-101 FS) with project engineering and design progressing with full consideration of environmental conditions within the project area. In parallel to exploration activities and feasibility studies, Kaminak Gold Corporation (Kaminak) launched a full suite of baseline programs (*e.g.*, meteorology, hydrology, surface water quality, groundwater, soils, air, fish and fish habitat, wildlife) in 2010 to characterize site conditions. The purpose of the baseline studies is two-fold: the data gathered is used to support the assessment of the potential effects of the Project and to develop effective mitigation measures to reduce or remove these effects, and; to provide data on the pre-mine condition that will form the basis for future monitoring programs that will be required as part of authorizations issued to the proponent.

1.2 An Introduction to the Baseline Studies

This technical data report, complete with supporting appendices, presents the data and outputs from the Coffee Creek baseline meteorology and surface hydrology monitoring studies. As of February 2016, Goldcorp possesses 3+ years of climate data and more than five years of hydrometric data from the Project area.

The baseline surface hydrology monitoring study was initiated at Coffee Creek in autumn 2010, with the baseline meteorology study commencing later, in July 2012. These two monitoring programs remain fully operational, with data collection scheduled to continue through the assessment and licensing phases of the Project timeline. After Project licensing, monitoring will continue under an approved monitoring plan.

From autumn 2010 to spring 2014, baseline data collection for the meteorology and hydrology disciplines was led by Access Consulting Group, an environmental services firm operating out of Whitehorse, YK. Access Consulting Group established a high-elevation automated weather station, established snow courses at various elevations/aspects around the study site and selected eleven surface monitoring stations for flow and water quality measurement. Surface water quality baseline reporting for these stations may be found under separate cover (Lorax, 2016a).

In spring of 2014, Lorax Environmental Services Ltd. (Vancouver) and Laberge Environmental Service (Whitehorse) assumed responsibility for the baseline meteorology and hydrology programs. At the time of transition, Lorax and Laberge enhanced the existing baseline hydrology study by adding five new hydrometric stations to the monitoring network and by upgrading several of the flow monitoring stations with instrumentation to estimate stream discharge on a continuous basis. The monitoring stations added to the study gauge streamflows on headwater tributaries (*i.e.*, small drainages, high elevation) and were sited at locations downstream of proposed open pits, dumps and heap leach facilities.

Each year, twelve monthly site visits focused on the core activities of the two baseline monitoring studies. Typical activities for these site visits include: climate station downloading and sensor maintenance; winter snow course sampling; hydrometric station downloading and maintenance; station benchmarking and levelling surveys; the collection of stage and discharge measurements to validate and enhance rating curves; and the collection of surface water quality samples.

1.3 Study Objectives

Overall, the objectives of the baseline meteorology and surface hydrology studies are:

- To collect high-quality climate/streamflow data from a representative suite of Project area watersheds/locations;
- To describe runoff generation processes in the context of local climate conditions (*e.g.,* snow accumulation, timing of snowmelt, basin response to summer rainfall) and physiography (*e.g.,* basin size, basin storage, the influence of permafrost, land cover, elevation and aspect);
- To calculate relevant metrics for local watersheds, including annual/monthly runoff depths, low flows, peak flows, unit yields by drainage basin, annual/monthly precipitation depths, monthly air temperatures and typical rates of evaporation;
- To combine site-specific climate/hydrometric data with regional data sources (*i.e.,* Alaska/Yukon climate and flow monitoring data) to better estimate inter-annual

streamflow variability, recurrence intervals for low and peak flows, and to quantify extreme precipitation depths (*e.g.*, 1:100 year 24-hour rainfall event).

- To generate the climate/hydrology datasets that will inform economic/engineering studies (*e.g*., heap leach facility design) and be used to construct and calibrate the site-wide water balance and water quality model (Lorax 2016b) being developed for Project permitting.

1.4 Project Infrastructure and the Baseline Studies

The baseline meteorology and hydrology studies were refined over time as details related to the mining method and project layout became more concrete. The Coffee Gold Project is amenable to development as an open pit mine with gold recovery recommended by heap leach mining methods. Figure 1-2 is excerpted from the Coffee Gold Feasibility Study (43-101 FS) and shows the general arrangement for the Coffee Project, including the open pits, waste rock storage facility (WRSF), heap leach facilities and proposed plant site location. Major infrastructure related to the proposed mining and processing operations at the site includes: the primary and secondary crushing facilities; a carbon adsorption plant; a gold refinery; the heap leach facilities; waste rock storage facilities (WRSF); water drainage structures and storage ponds; haul roads; the accommodations complex; and an all-weather airstrip.

The open pits associated with the Project are Latte, Double Double, Supremo and Kona pits. Waste rock associated with the undertaking is proposed to be stored in the West WRSF or backfilled to Double Double, Kona or select portions of the Supremo pit. Proposed pits and WRSF are all situated at high elevation (*i.e.*, median drainage basin elevations range from 945 to 1,220 m asl), and on or adjacent to headwater tributaries of the Halfway Creek, Latte Creek and YT-24 (an unnamed tributary of the Yukon River) watersheds.

As described in the 43-101 FS, a network of water conveyance structures and sediment control ponds (SCPs) are proposed to collect and convey mine-affected waters (*e.g.*, meteoric water that contacts exposed pitwalls, ore stockpiles, waste rock, *etc*.) associated with the Project. Contact water that reports from water management infrastructure to Halfway Creek and YT-24 tributary will ultimately discharge to the Yukon River, whereas contact water reporting to Latte Creek will ultimately flow to the Yukon River via the main stem of Coffee Creek.

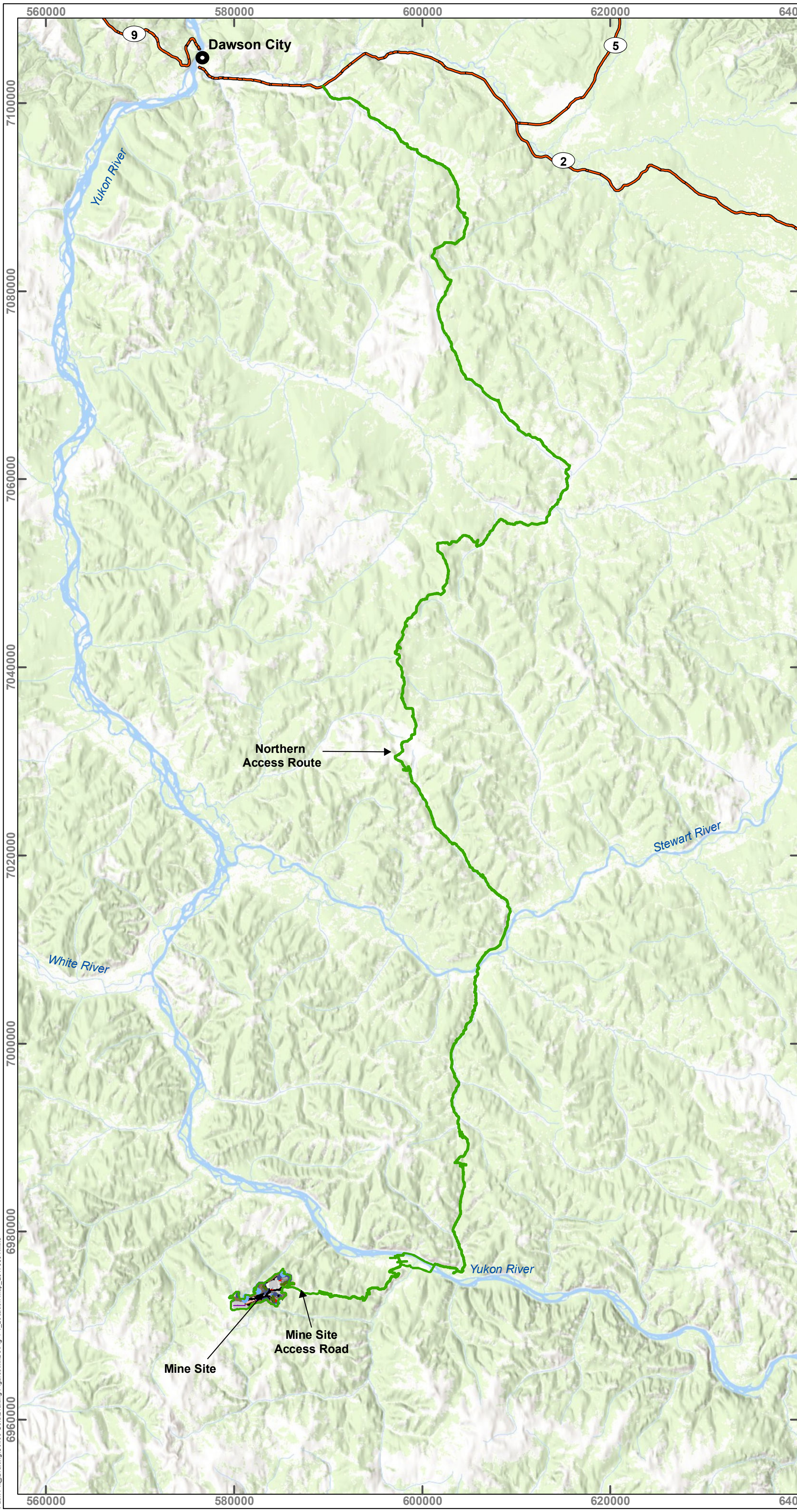
1.5 Report Structure

The sections of the report that follow this introduction build upon an interim hydro-meteorology data report prepared as part of the Coffee Gold Feasibility Study. The remaining sections of this report are as follows:

- Sources of information, methods and outputs for the meteorology and hydrology studies are presented in Section 2 of the report.
    - Section 2.1 of the report presents monitoring stations and data sources as they relate to the meteorology discipline. Site and regional sources of meteorology information are discussed in this section, so to are future climate change scenario data relevant to the Project.
    - Section 2.2 introduces monitoring stations and data sources as they relate to the hydrology discipline. Specifically, Section 2.2.1 outlines data sources and methods as they apply to site hydrometric data, whereas Section 2.2.2 addresses the topic of regional hydrology data.
    - Section 2.3 outlines field methods relevant to the two disciplines and also presents methods/assumptions necessary to process field data and then compute outputs from these data.
        - Notable are the sections that summarize the methods used to screen regional monitoring station data; infill missing data; estimate extreme precipitation depths and runoff volumes for a suite of return periods; and generate synthetic climate (*e.g.*, air temperature, precipitation) and discharge datasets for the Project.
- Section 3 presents baseline study results for the meteorology study (Section 3.1) and hydrology study (Section 3.2), and the report concludes (Section 4) with a summary and discussion of results.
- Over the past two years, a number of climate/flow data products and technical memos were prepared by Lorax, several of which are appended in full to this covering report (see Appendix A through Appendix E).
    - Detailed summaries of the hydrometric data collected from the Project site basins from 2011 to 2015 can be found in Appendix A1. Appendix A2 presents a summary of the hydro-meteorological baseline data collected in 2016.
    - Memos summarizing the estimation of extreme precipitation and probable maximum precipitaiton are presented as Appendix B and Appendix C respectively.

- An overview report presented in Appendix D was prepared by the Pacific Climate Impacts Consortium (University of Victoria) and provides a synthesis of climate change scenario data for the Coffee Creek area.
- Appendix E is a repository for regional hydrometric data summaries.

No substantive changes have been made to the Coffee Creek meteorology and hydrology data since the issuance of the 43-101 FS report, with the exception of site discharge data and a synthetic discharge record for hydrometric station CC-3.5. These data were recently updated for the 2015 open water season only. The update addressed an incorrectly adjusted water level record that was returning lower than expected estimates of discharge.



COFFEE PROJECT

Location Map, General Arrangement for the Coffee Project

Legend

Highway

Coffee Gold Project Footprint

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Kilometres

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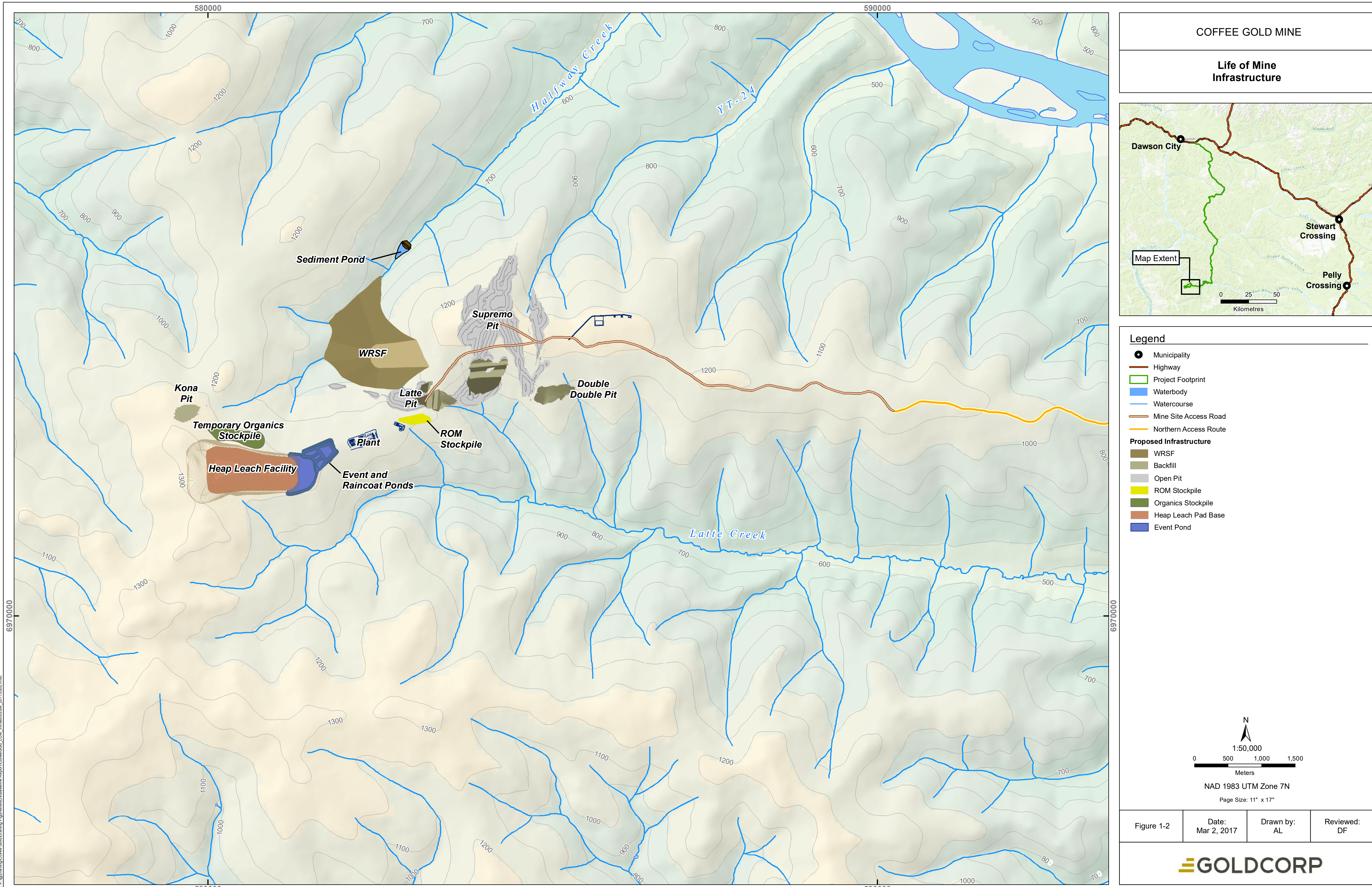

COFFEE GOLD MINE
Life of Mine Infrastructure
Sediment Pond
WRSF
Supremo Pit
Double Double Pit
Latte Pit
Kona Pit
Temporary Organics Stockpile
Plant
ROM Stockpile
Heap Leach Facility
Event and Raincoat Ponds
Halfway Creek
YT-24
Latte Creek
580000
590000
6970000
Dawson City
Stewart Crossing
Pelly Crossing
Map Extent
0 25 50
Kilometres
Legend
Municipality
Highway
Project Footprint
Waterbody
Watercourse
Mine Site Access Road
Northern Access Route
Proposed Infrastructure
WRSF
Backfill
Open Pit
ROM Stockpile
Organics Stockpile
Heap Leach Pad Base
Event Pond
N
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GOLDCORP

2. Sources of Data, Methods, Outputs

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2. Sources of Data, Methods, Outputs

Section 2.1 and Section 2.2 below identify monitoring stations and ancillary data sources as they relate to the meteorology and hydrology disciplines. Section 2.3 outlines field methods relevant to the two disciplines, and also outlines any methods used to process site- and regional data and compute outputs from these various sources of information.

2.1 Baseline Meteorological Study

2.1.1 Site Meteorological Data

Figure 2-1 shows the location of the Coffee Creek automated weather station and snow course stations. The weather station was installed at elevation 975 m asl and remains operational today. The weather station was installed and maintained by Access Consulting Group from July 2012 through May 2014. Lorax and Laberge Environmental Services maintained the weather station from June 2014 to the present.

Measured parameters at the Coffee Creek weather station include the following:

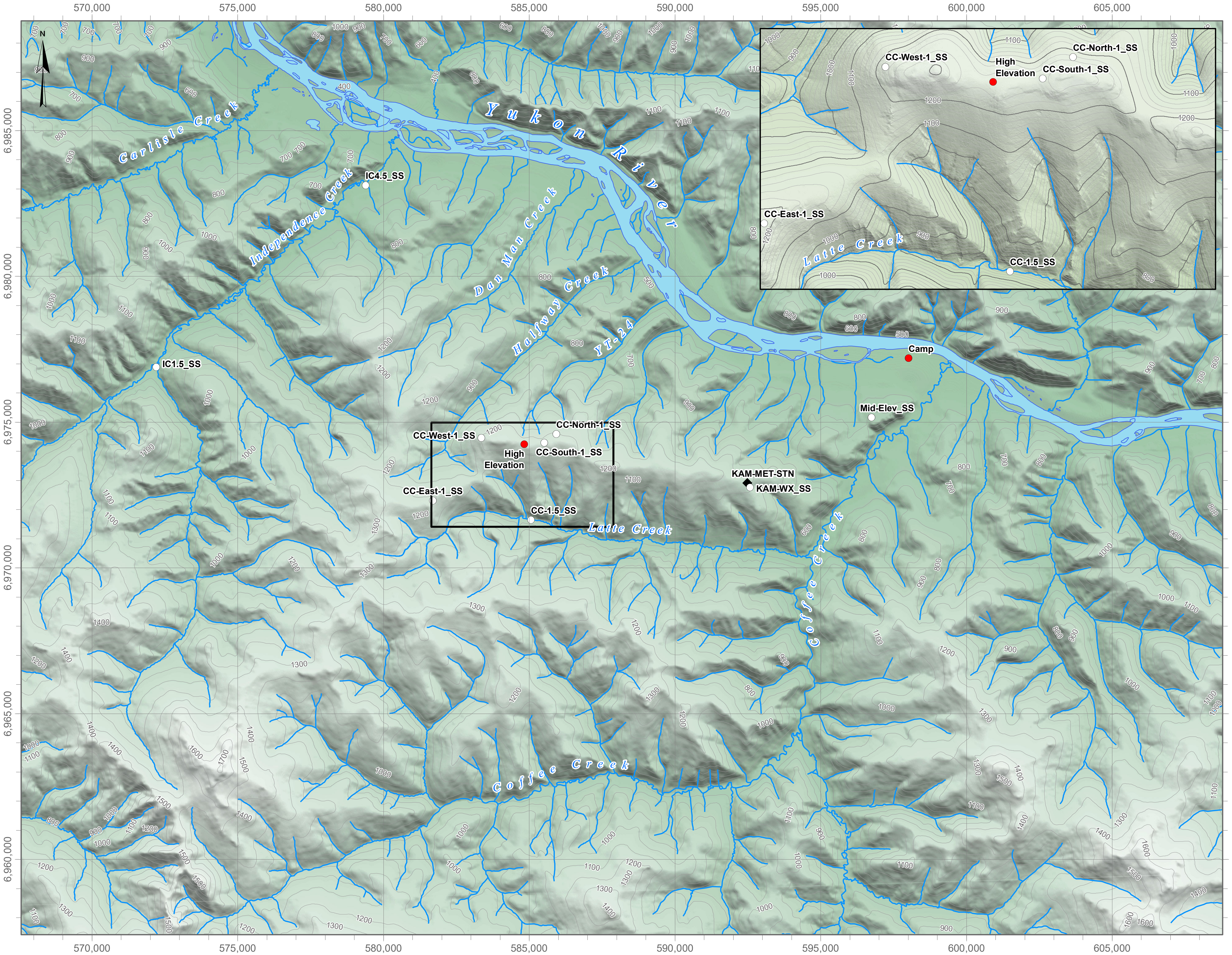
- Air temperature and relative humidity (Rotronic HC2S3);
- Wind speed and direction (10 m; RM Young Alpine anemometer);
- Incoming solar radiation (Kipp and Zonen SP Lite2 pyranometer);
- Barometric pressure (RM Young 61302V);
- Precipitation (Texas Electronics tipping bucket rain gauge with Alter wind screen and snowfall conversion adapter);

For the period of baseline data collection, weather station sensors were sampled at 10-second frequency with observations recorded to a central datalogger at hourly time step.

Each year of the baseline meteorology study, snow course measurements were carried out at the property following Territory protocols (*i.e.*, 10 sampling locations along a transect were each sampled for depth and snow water equivalent [SWE] then averaged). As shown in Figure 2-1, site snow courses were established at various elevations (*i.e.*, low, mid and high elevation) and oriented to discern effects of aspect on local snow accumulation. Snow courses were surveyed at, or near, peak seasonal accumulation between 2012 and the present. Similar to nearby monitoring stations in Alaska and Yukon, peak SWE accumulation is typically realized by the end of March of each year.

Finally, two tipping bucket rain gauges were installed at camp (430 m) and ridge-top (1300 m) in 2015 to further refine the precipitation elevation gradient for the Project site.

Photos of the weather station and snow course sampling are presented in Figure 2-2.



LEGEND

- 2015 Snow Survey Stations
- Tipping Bucket Rain Gauge
- Weather Station
- Watercourses
- Waterbodies
- Surface Contours (100m)

Coordinate System: *NAD 1983 UTM Zone 7N*
Projection: *Transverse Mercator*
Datum: *North American 1983*
Units: *Meter*

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PROJECT:

Coffee Gold Project

TITLE:

2015 Snow Survey Stations

PROJECT #: A362-3 FIGURE: 2-1

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Figure 2-2: Coffee Creek weather station (upper panel) in winter. The lower panel shows snow course sampling in spring 2015 (April).

2.1.2 Regional Meteorology Data

Additional climate data is available from a suite of monitoring networks operated by both Federal and State/Territorial governments in the Yukon and Alaska (refer to Table 2-1 and Figure 2-3). Regional gridded climate re-analysis products are also available for both historical climate and future scenarios.

All considered, data sources relevant to the baseline meteorology study include:

- Stations operated by Environment Canada in the Yukon and the National Oceanic and Atmosphere Administration (NOAA) in Alaska;
- Snow data from stations operated by the Yukon Snow Survey Network and the SNOTEL network operated by the Natural Resources Conservation Service (NRCS) in Alaska;
- Outputs from the ClimateWNA program (v4.85; see Wang *et al.*, 2012).

As part of the 43-101 FS and to support the YESAB submission, site- and regional climate data were combined to produce a number of information products used by technical leads. Two technical memos that drew heavily on regional climate data sources concerned extreme precipitation and probable maximum precipitation for the Project Area. Copies of these memos are appended to this report (see Appendix B and Appendix C) with methods discussed briefly in Section 2.3 below.

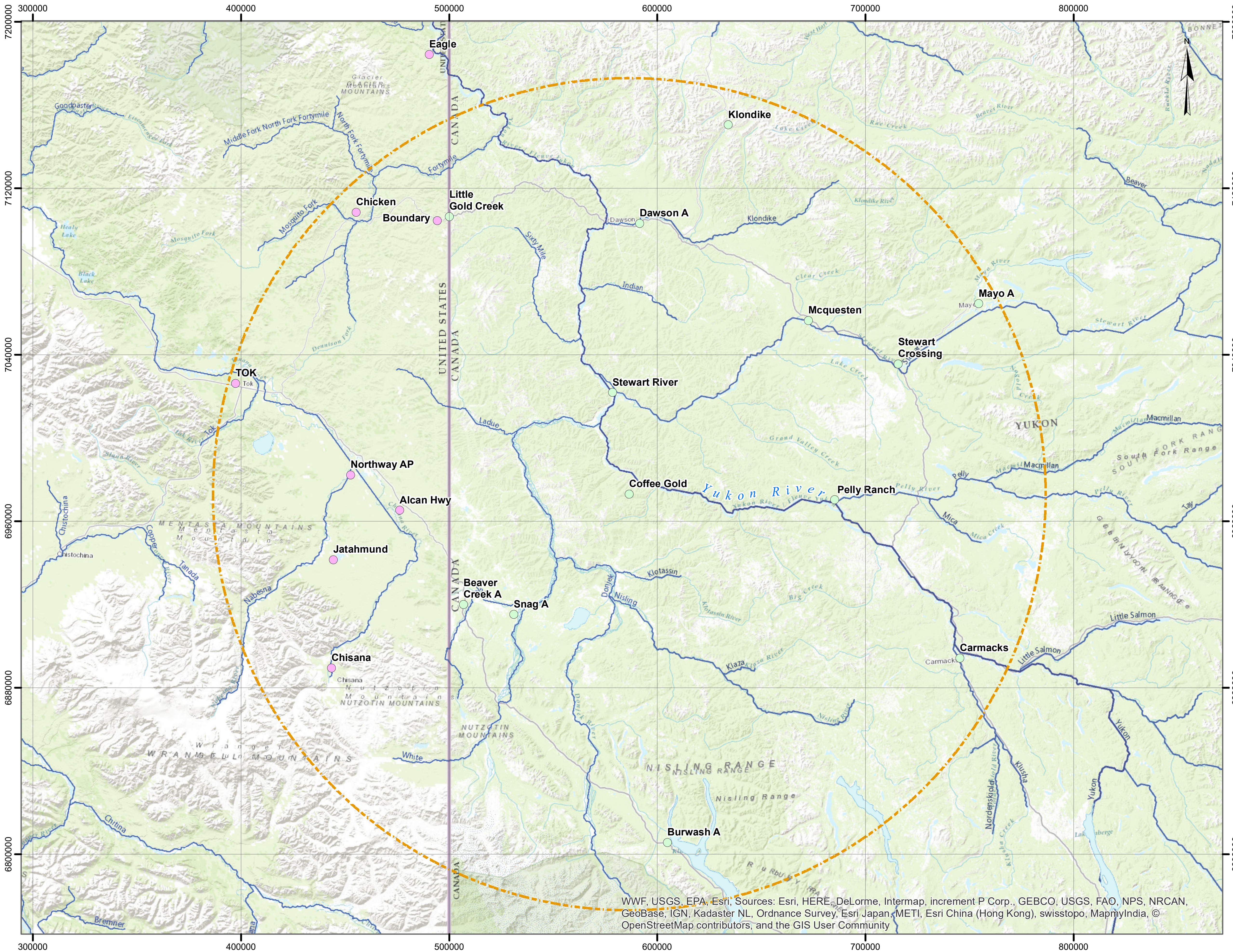
2.1.3 Climate Change

As part of the Coffee Gold Feasibility Study, Kaminak had requested that Lorax Environmental Services Ltd. facilitate a climate change analysis for the Coffee Gold Project. The analysis, appended to this report (Appendix D), was prepared by Dr. Thomas Pedersen, current Director, Pacific Institute for Climate Solutions, University of Victoria; Dr. Pedersen also serves as Chair, Canadian Climate Forum.

Table 2-1: Site and Regional Climate Stations

Station Name	ID	Elev.	Dist. From Project	Record Period	Province /State	Lat.	Long.	Mean Annual Temp.	Mean Annual Precip.	Rain / Snow
		(m asl)	(km)			(°)	(°)	(°C)	(mm)	%
COFFEE GOLD MET		975	0	2012-2015	YT	62.8745	-139.1819	-2.5	370	68 / 32
CASINO CREEK	2100310	1100	30	1969-1995	YT	62.7167	-138.8167	-4.4	399.0	65 / 35
STEWART RIVER	2101033	358	50	1976-1993	YT	63.3170	-139.4330	-2.3	321.0	62 / 38
PELLY RANCH[1]	2100880	454	81	1952-2015	YT	62.8167	-137.3667	-3.8	320.4	64 / 36
PORT ALCAN	507513	585	91	1985-2015	AK	62.6167	-141.0000	-4.8	289.6	68 / 32
BEAVER CREEK	2100160	649	96	1968-2015	YT	62.4103	-140.8675	-4.9	417.3	--[3]
ALCAN HWY	500726	549	111	1990-2015	AK	62.8167	-141.4667	-2.0	285.8	--[3]
MCQUESTEN	2100719	458	118	1987-2015	YT	63.5942	-137.5225	-3.2	340.1	62 / 38
DAWSON[1]	2100402	370	130	1901-2015	YT	64.0431	-139.1278	-5.2	361.7	59 / 41
SNAG	2101000	587	131	1943-1966	YT	62.0333	-137.5167	-5.8	362.0	65 / 35
NORTHWAY	506586	522	132	1940-2015	AK	62.9617	-141.9380	-4.8	255.5	63 / 37
JATAHMUND	500936	701	146	1990-2015	AK	62.6000	-142.0833	-1.5	331.2	--[3]
STEWART CROSSING	2101030	480	150	1963-2008	YT	63.3830	-136.6830	-4.2	299.0	65 / 35
LITTLE GOLD CREEK	2100690	1257	155	1974-1999	YT	64.0830	-141.0000	--[3]	--[3]	--[3]
BOUNDARY	500910	793	161	1949-1957	AK	64.0667	-141.1167	-5.3	340.6	--[3]
CHISANA	500933	1011	165	1988-2015	AK	62.1333	-142.0833	-4.6	236.2	--[3]
BURWASH[1]	2100182	807	173	1967-2015	YT	61.3667	-139.0500	-3.8	338.7	62 / 38
CARMACKS[1]	2100300	525	180	1963-2007	YT	62.1000	-136.3000	-2.8	296.0	68 / 34
MAYO[1]	2100700	504	180	1925-2015	YT	63.6167	-135.8667	-3.2	344.7	63 / 37
KLONDIKE	2100679	973	185	1966-2010	YT	64.4530	-138.2160	-6.2	354.0	50 / 50
CHICKEN	500747	548	190	1998-2015	AK	64.1000	-141.9167	-3.2	341.4	69 / 31
TOK 70 SE[2]	509313	495	193	2005-2015	AK	63.3337	-143.0370	-4.0	267.2	63 / 37
EAGLE	502607	256	225	1902-2015	AK	64.1000	-141.9170	-4.0	316.5	68 / 32

[1]Station data from the Adjusted and Homogenized Canadian Climate Data set (AHCCD)
[2]Included in the US Climate Reference Network
[3]Insufficient data



LEGEND

Regional Precipitation Stations

- Alaska
- Yukon
- 200KM Radius Around Coffee Gold

Coordinate System: *NAD 1983 UTM Zone 7N*
Projection: *Transverse Mercator*
Datum: *North American 1983*
Units: *Meter*

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PROJECT:

Coffee Gold Project

TITLE: Regional Precipitation Stations

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2.2 Baseline Hydrology Study

Table 2-2 summarizes station nomenclature and drainage characteristics for Coffee Creek surface water monitoring stations. Furthermore, Figure 2-4 shows the location of these monitoring station with respect to proposed Project infrastructure and mine footprints.

In autumn 2010, eleven locations were elected as surface water monitoring stations by Access Consulting Group. At eight locations, spot flow measurements were recorded monthly between autumn 2010 and autumn 2013. At three stations (HC-5.0, CC-3.5 and IC-4.5) and in autumn 2010, Access Consulting Group established stilling wells, metric staff gauges and instrumented stations with continuously recording water level recorders. The purpose of the instrumentation as described in Section 2.2.1 was to resolve high-resolution discharge records for these three stations from a rating curve and a continuous record of water level.

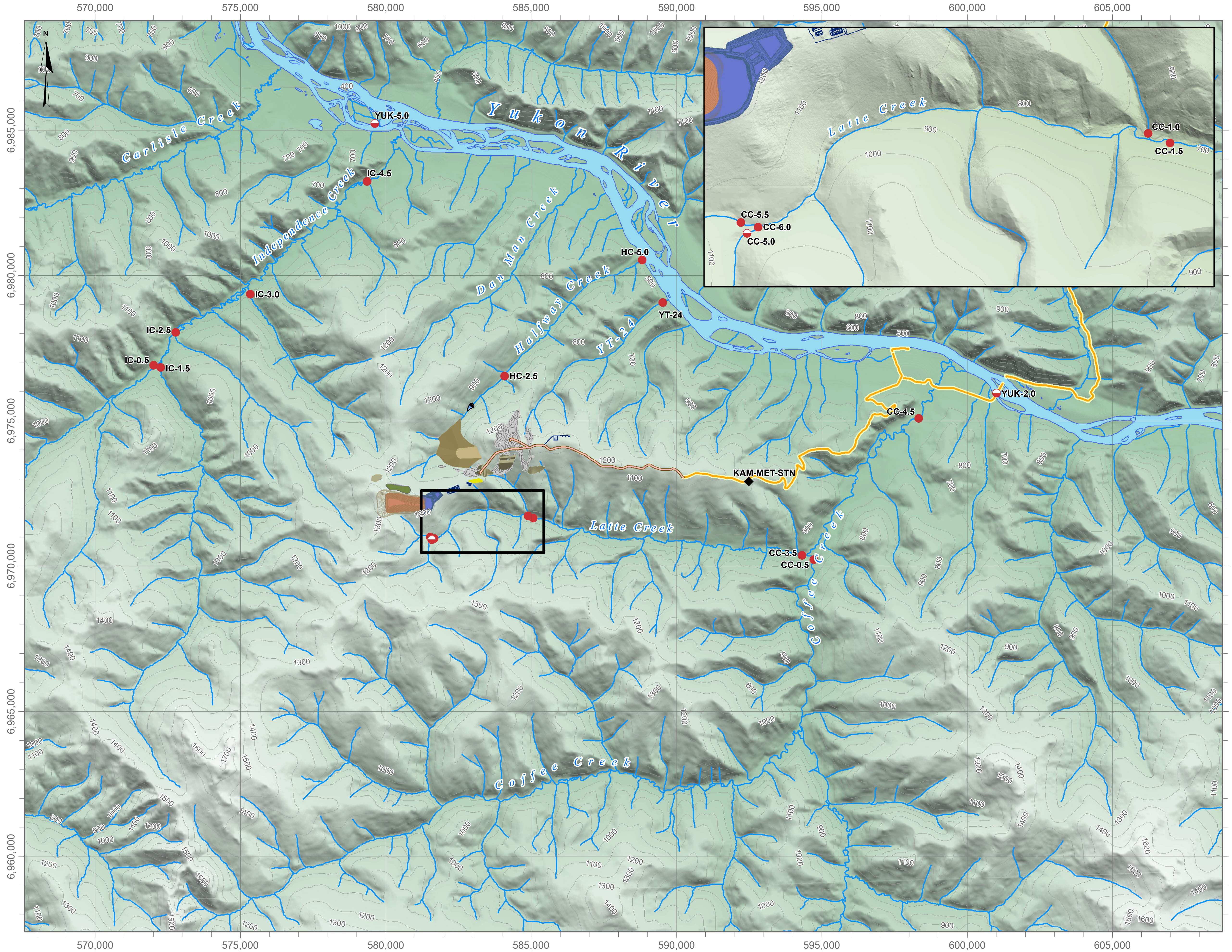
In spring of 2014, Lorax Environmental assumed responsibility for the Coffee Creek surface water monitoring network. At that time, eight additional monitoring stations were added to the network and many of the stations in the network were upgraded from spot flow stations to continuously recording hydrometric stations. In general, new stations were located in close proximity to the resource and downstream of proposed mine footprint areas.

Gauged watersheds at the Coffee Creek site range in size from ~3 to 500 km^2, noting that eight of the watersheds being monitored have drainage areas of less than 25 km^2. HC-2.5 is one example from the network and a watershed photograph is shown in Figure 2-6. In addition to capturing a range of drainage areas, the watersheds gauged for the baseline hydrology study differ in elevation characteristics (*i.e.*, mean catchment elevations range 800 to 1,300 m asl) and represent varying aspects as well.

Table 2-2:
Coffee Creek Surface Water Monitoring Stations – Station IDs and Drainage Basin Characteristics

Station ID	Drainage Area (km^2)	Mean Elevation (m asl)	Min Elevation (m)	Max Elevation (m)
CC-0.5[a]	385.6	1,023	446	1,707
CC-1.0[lw]	3.4	1,017	732	1,302
CC-1.5[a]	23.1	1,120	712	1,379
CC-3.5[a]	69.8	969	447	1,379
CC-4.5[a]	484.0	993	427	1,708
CC-5.0[ls]	6.2	1,221	1,042	1,394
CC-5.5[ls]	3.4	1,236	1,056	1,394
CC-6.0[l]	9.6	1,225	1,042	1,394
CC-7.0[lrs]	124.7	1,010	514	1,656
CC-8.0[lrs]	18.2	1,300	1,008	1,666
CC-8.5[lrs]	214.8	1,058	512	1,707
HC-2.5[a]	14.8	1,043	664	1,343
HC-5.0[a]	27.0	885	428	1,344
IC-0.5[as]	68.9	1,048	522	1,529
IC-1.5[a]	81.1	1,077	522	1,708
IC-2.5[a]	17.3	1,003	493	1,344
IC-3.0[as]	18.3	905	465	1,299
IC-4.5[a]	222.3	989	427	1,708
YT-24[l]	11.8	838	428	1,293

Notes:
[a] Monitoring station established by Access Consulting Group in autumn 2010.
[l] Monitoring station established by Lorax Environmental in spring 2014.
[w] Discharge measured by V-notch weir
[r] Monitoring stations located along proposed southern road route. Stations monitored between August 2014 and August 2015 only.
[s] Spot flow monitoring station only.



LEGEND

- Surface WQ Monitoring Station
- Surface and Hydrology Monitoring Station
- Weather Station
- Mine Site Access Road
- Northern Access Route
- Watercourse
- Waterbody
- Surface Contours (100m)

Proposed Infrastructure

- Backfill
- WRSF
- Open Pit
- Support Infrastructure
- ROM Stockpile
- Organics Stockpile
- Heap Leach Pad Base
- Event pond

Coordinate System: *NAD 1983 UTM Zone 7N*
Projection: *Transverse Mercator*
Datum: *North American 1983*
Units: *Meter*

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LORAX ENVIRONMENTAL

PROJECT:

Coffee Gold Project

TITLE:

Surface Water Monitoring Stations

PROJECT #: A362-3 *FIGURE:* 2-4

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2.2.1 Site Hydrometric Data Collection Methods

The hydrology methods adopted for the study were aligned with standards and procedures outlined in the Manual of British Columbia Hydrometric Standards - Version 1.0 (RISC, 2009). This document defines standards and detailed procedures for the acquisition of water quantity data and provides specific direction on the following topics: monitoring site selection; station construction and benchmarking; recording discharge measurements; developing stage-discharge relationships; and reporting and presenting hydrometric data.

Hydrometric stations were instrumented with metric staff gauges which were surveyed to three nearby benchmarks. Continuously recording water level recorders (*i.e.,* Solinst Levelogger Edge, Solinst LTC) were housed inside protective stilling wells and deployed at each station to record continuously (*i.e.,* 15-minute frequency). Independent measures of stage were recorded manually at station staff gauges during monthly site visits. These data provided a detailed record of any stage height fluctuations at each monitoring location over time (see Figure 2-5).

To acquire continuous discharge data, periodic streamflow measurements were recorded using a current meter or salt dilution gauging (Moore 2004, 2005), and these streamflow measurements were used to develop a stage-discharge relationship specific to each hydrometric station. Finally, a continuous discharge record was computed for each hydrometric station using the stage-discharge relation and the continuous water level record.

Measurements of discharge were mainly recorded in one of two ways: 1) using a current meter, wading rod and tape measure; or 2) by salt dilution gauging methods. To compute an estimate of discharge using a current meter (*i.e.*, a velocity-area approach), a staff gauge reading was first recorded. Next, a tape measure was extended across the watercourse. Measurement cross-sections were typically narrow (*e.g.,* 0.5 to 5 m wide) and for 10-20 locations across the stream, depth measurements and velocity measurements (at 0.6*depth) were recorded. For each increment (or panel) across the stream, depth, width and velocity measurements were multiplied together to generate a discharge. Finally, discharges for the individual panels were summed to give a total discharge for each stream cross-section.

Many of the discharge measurements collected at Coffee Creek were obtained by means of salt dilution gauging. The principles of this tracer measurement method are outlined in Moore (2004, 2005). Briefly, the injection of a tracer (*e.g*., NaCl) and principles governing conservation of mass are used to back-calculate a robust estimate of streamflow from a breakthrough curve. In this approach, background electrical conductivity (EC) is measured to establish baseline EC conditions. Next, a carefully measured mass of salt (*e.g.*, 200 g of table salt) is dissolved into a bucket of stream water and this slug of saline water is injected instantaneously to the stream upstream of the location of the EC probe. EC measurements are used to record the passing of the salt slug (*i.e.*, EC increases from baseline conditions to a peak value and then recesses slowly to the pre-slug baseline condition), recording time and EC values until baseline conditions are re-established. The mass of salt injected and the area under the breakthrough curve (*i.e.*, the area under the curve of the EC versus time plot) are used to calculate discharge.

2.2.1.1 Slope-Area Measurements

Assembly of a robust rating curve requires repeated manual measurements of both stage and discharge to be made. Ideally, these measurements would span the full range of flows possible within a given channel. Accurate characterization of the magnitude, duration and frequency of low flows is critical for assessments of potential Project impacts on water quality and to identify potential limitations on water supply for milling and dust control. Similarly, a robust characterization of peak flows is required for infrastructure design, and an understanding of the total volume of runoff generated by a basin, for example. However, it is relatively easier to plan a field measurement campaign that targets low-flow conditions (due to their predictable seasonality), than it is to time a measurement of a high-magnitude discharge event. This becomes more challenging as the basin response time decreases, and in the small, flashy basins that comprise the Project area, peak flow events usually last for only 1 to 2 days. The spring freshet lasts relatively longer, but here, manual measurements are confounded by extensive channel icing that compromises safety and measurement accuracy. As a result, alternative methods are required to fill in the upper (high flow) end of the rating curve. The most common and simplest way to accomplish this is the slope-area method, described in Dalrymple and Benson (1968).

The slope-area method is based on the principles of open channel hydraulics. Specifically, a uniform flow equation and the relationship between channel characteristics (slope and cross-sectional area), water surface profiles, and a roughness co-efficient. The most commonly used equation for this purpose is the Manning Equation, shown below.

$$Q = \frac{1}{n} A R^{2/3} S^{1/2} \qquad \text{[Equation 1]}$$

Where: Q = discharge (m^3/s)

A = cross sectional area (m^2)

R = hydraulic radius (A/WP; m)

S = friction slope

n = roughness coefficient

WP = wetted perimeter (m)

The section conveyances for all cross-sections were calculated using:

$$K_x = \frac{1}{n} AR^{2/3} \qquad \text{[Equation 2]}$$

Where K_x is the conveyance for the upstream (K_u) and downstream (K_d) cross-sections. The average reach conveyance is then calculated as the geometric mean of the section conveyances.

$$K = (K_u \times K_d)^{1/2} \qquad \text{[Equation 3]}$$

An iterative procedure is then used to calculate discharge using Equation 4. The full procedure is outlined in Dingman (2014; F.7).

$$Q = KS^{1/2} \qquad \text{[Equation 4]}$$

Field surveys were conducted in August 2015 to gather the necessary input data for use in the slope-area method. These surveys were conducted at stations CC-1.5, CC-3.5, HC-2.5, IC-2.5 and YT-24. Standard surveying methods were used to measure three channel cross-sections along a reach whose length exceeded 75 times the bankfull depth. The three cross-sections were surveyed at the hydrometric station, and at locations upstream and downstream of the station. In addition, stream bed and water surface elevations (relative to the established benchmarks) were shot, and in accordance with best practices, a minimum surface water level difference of 0.15 m was present along each channel transect (Dingman, 2014). All surveys were tied into the existing benchmarks and the staff gauge to allow the slope-area measurements to be placed directly onto the existing rating curve.

From these survey data, channel cross-sectional areas, the friction slope, and the wetted perimeter were calculated. The maximum water level height (required to calculate the cross-sectional area), was taken preferentially from high-water marks and/or strand lines. Where these indicators were not present, the high-water mark was assumed equal to the bank height. The flow resistance, or roughness coefficient, was estimated from the channel bedload characteristics, and channel form (step, glide, cascade, *etc.*). The slope-area method is very sensitive to the Manning's *n* value – underestimates of *n* will result in overestimation of discharge, and vice-versa. Yochum and Bledson (2010) was used as a visual reference aid to augment the standard tables of Manning's n values provided in Dingman (2014). The prevalent channel forms at the Project site are usually steeper in gradient with more poorly sorted bedload, and therefore tend to have higher Manning's *n* values as compared to those commonly listed in reference tables (*e.g.*, Comiti *et al.*, 2007 and Reid and Hickin, 2008). The final results of this procedure are provided in Table 2-3 The Manning's *n* values range from 0.03 to 0.25.

Table 2-3:
Comparison of existing maximum stage:discharge measurements and slope-area estimates for the surveyed stations.

Station	Maximum Manual Stage Reading (m)	Maximum Manual Discharge Measurement (m^3/s)	Manning's *n*	Slope-Area Stage Height (m)	Slope-Area Discharge Estimate (m^3/s)
CC-1.5	0.650	1.584	0.105	0.895	8.039
CC-3.5	0.450	0.884	0.080	0.866	7.850
HC-2.5	0.682	0.693	0.120	0.830	1.560
IC-2.5	0.800	0.712	0.250	0.825	2.390
YT-24	0.431	0.087	0.100	0.640	1.967

As a final confirmatory step, the rating equations derived using the slope-area estimates were compared to the existing rating equations to ensure that the shape of the curve remained similar, and that the low-flow portion of the curve remained accurate. If necessary, slight adjustments were made to the Manning's *n* value to adjust the curve. A manual measurement that captured a high flow condition at IC-2.5 superseded the slope-area estimate.

2.2.1.2 Acoustic Doppler Current Profiler Measurements

On some occasions (*e.g.*, high flow event following snow melt) and at select locations (*i.e.*, Independence Creek, Coffee Creek and Yukon River near Halfway Creek), baseline study discharge measurements were recorded using an ADCP (Acoustic Doppler Current Profiler). An ADCP measures water velocity by sound using a principle called the Doppler effect, and works by transmitting sound (or pings) at constant frequency into a flowing watercourse and then recording time and signal frequency that returns to the sensor. In principle, particles in flowing water will alter the transmitted sound from an ADCP, and the measured shift (*i.e.*, the difference in frequency between the sound waves sent and received by an ADCP) is used to calculate the velocity of particles and the water surrounding them.

An ADCP can be mounted to a boom on a boat for an application on a large watercourse like the Yukon River, or be mounted to an unmanned boat or floating board that is maneuvered from bank to bank by ropes or cableway. When used in these ways, ADCPs are capable of resolving channel depth, velocity and discharge data in considerable detail. The Teledyne StreamPro ADCP and Sontek M9 ADCP were used in this study, and Figure 2-7 shows cross-sectional data for a flow measurement recorded August 30, 2015 for the Yukon River downstream of Halfway Creek. This discharge measurement of 2,234 m^3/s was recorded by Environmental Dynamics Inc. (EDI) while retained by Kaminak to conduct bathymetric surveys at proposed barge crossings on the Stewart River and Yukon River.

2.2.2 Drainage Basin Characteristics

To place the streamflow dataset into the broader context of the Project site and to assist with the attribution of various physiological drivers of the streamflow regime in each basin, several spatial analyses were carried out. Specifically, the area and elevation characteristics (*i.e.*, drainage area, aspect, area-elevation relationships) of local drainages were described.

- Drainage areas for surface water monitoring stations were delineated using Surfer 12. The 1:50,000 Grid NRCAN Canadian Digital Elevation Model was used as the source of topographic data utilized for drainage basin delineations.
- Aspect, which is the measure of the direction that a slope faces, was computed with Global Mapper 12 using the NRCAN Canadian DEM as the elevation grid input. Aspect was calculated for each cell in the raster dataset, with output reported for each watershed counter-clockwise in degrees from 0 (due north) to 360. Cells with no slope were assigned a value of -1.
- A hypsometric curve for a drainage basin summarizes the relative proportion of drainage area below (or above) a given elevation. Topographic relief within a drainage basin is commonly summarized in this format, with plots allowing easy comparison of topographic data between adjacent basins. For the Coffee Creek watersheds, hypsometric curves were generated using Scripter BASIC programming language and Surfer 12. For each basin, areas were calculated per 10 m interval from the minimum to the maximum elevation. These areas were standardized as the percentage of the basin area below that elevation (out of 100%) for plotting purposes.

2.2.3 Data Processing

To assemble discharge records, the following data processing steps were followed:

- Stage measurements from staff gauges and corresponding discharge measurements were assembled into site-specific rating curves (Appendix A).
- Compensated water level records were plotted alongside independent measurements of stage recorded at each monitoring station. Because the staff gauges were carefully benchmarked, these independent readings were assumed fixed and true, and water level records were adjusted as required to best fit the staff gauge record time series.
- Once adjusted to an elevation reference consistent with staff gauge measurements, site-specific rating curves were used to compute continuous discharge estimates from the continuous water level readings. Plots and tabular summaries of all hydrometric information collected at Coffee Creek are presented by Station ID in Appendix A.

Figure 2-5: Photo showing hydrometric station instrumentation, including metric staff gauge, perforated and screened stilling well and water level recorder.

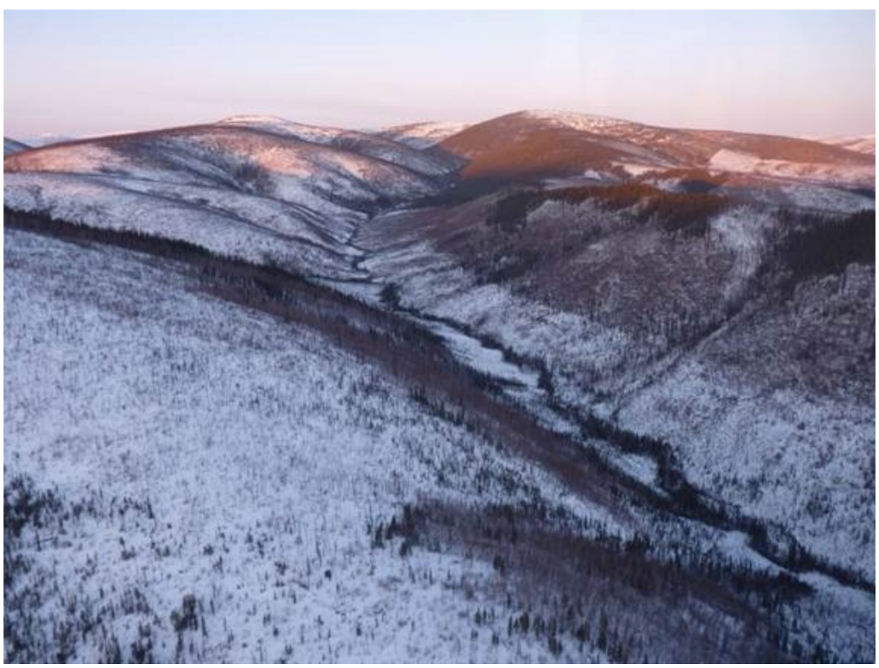


Figure 2-6: Photo looking south and showing the extent of the Halfway Creek watershed.

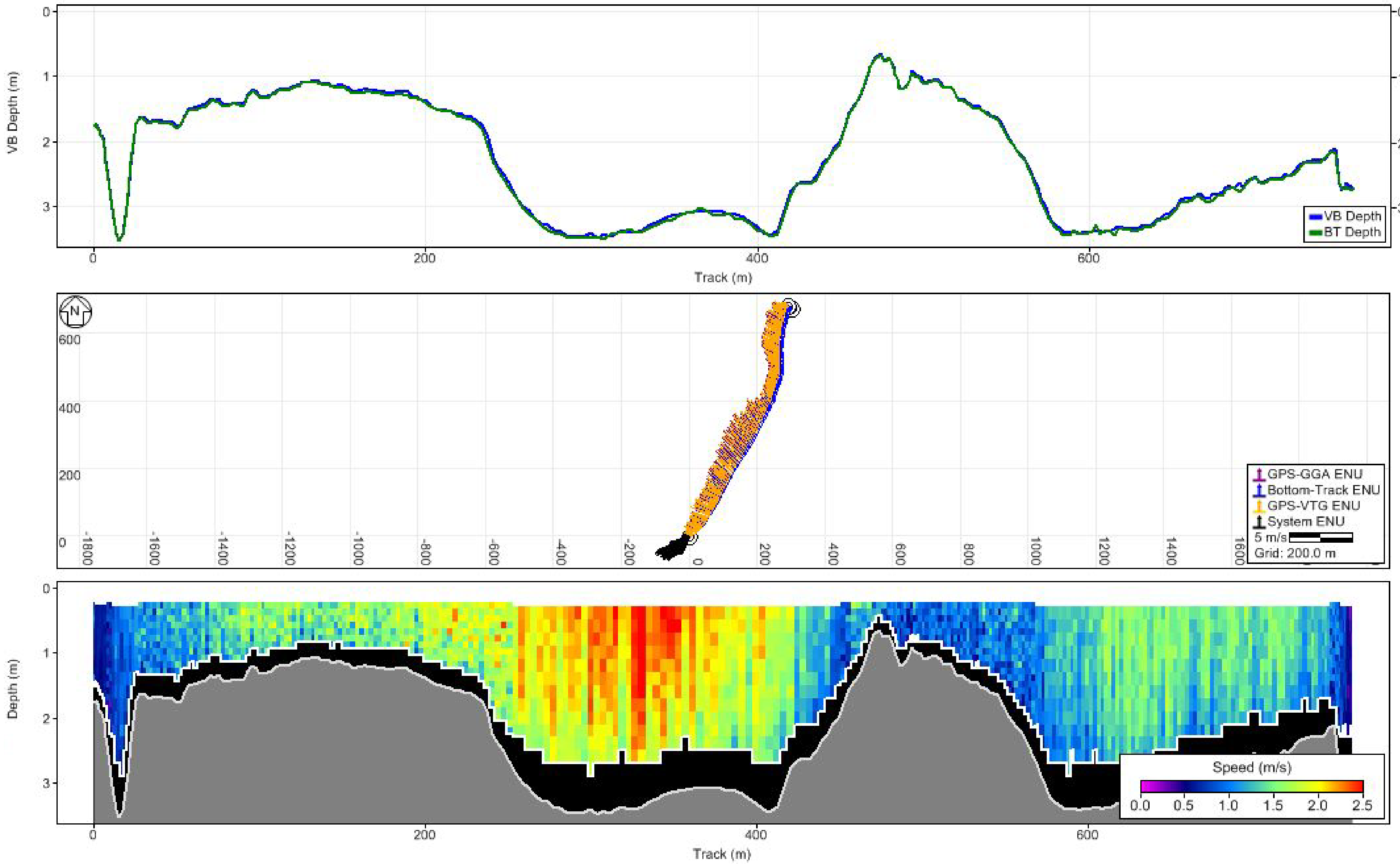


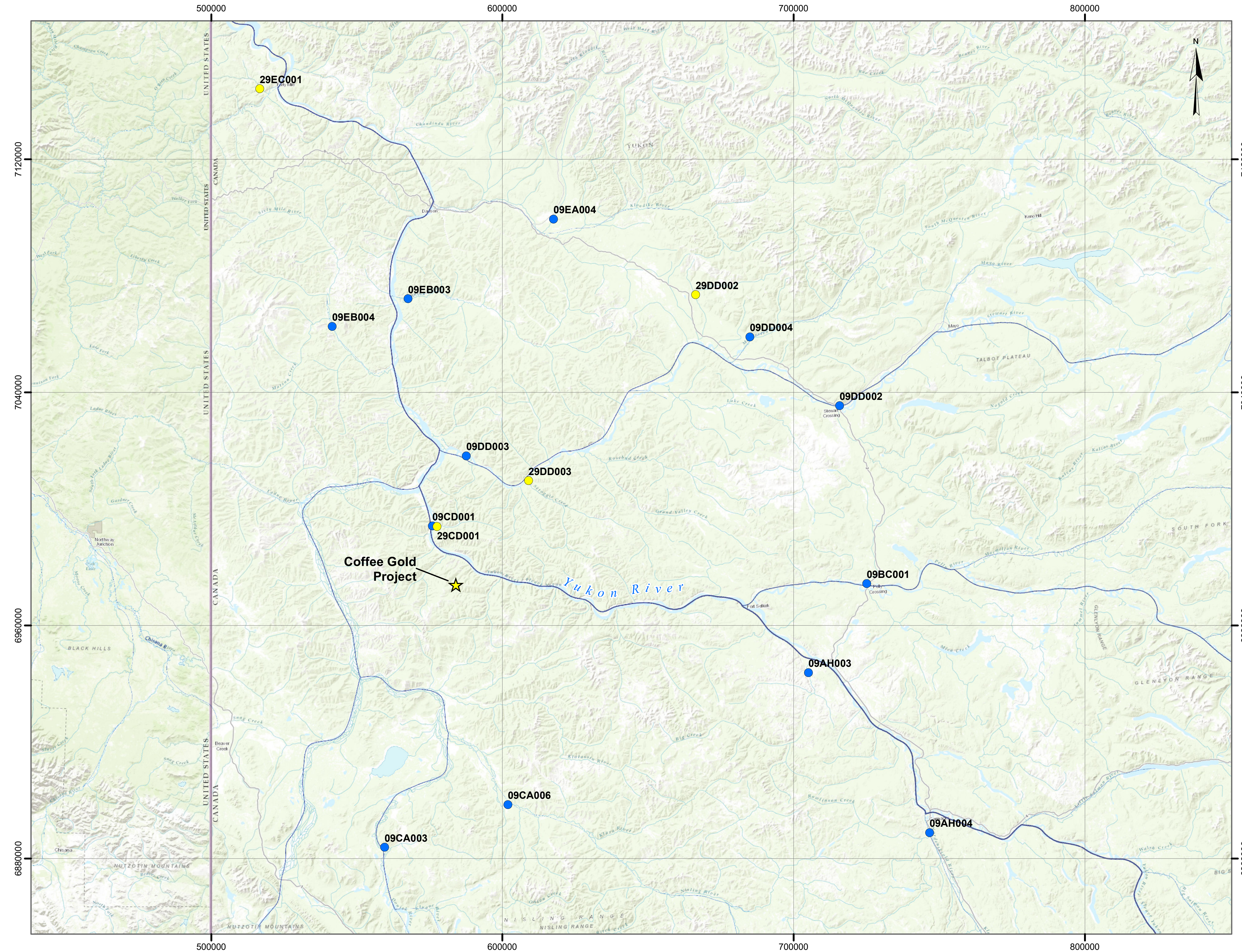
Figure 2-7: Sontek M9 cross section of the Yukon River downstream of Halfway Creek (August 30, 2015).

2.2.4 Regional Hydrometric Data

As per the meteorology discipline, regional hydrometric data were assembled as part of the Coffee Gold Feasibility Study. The regional stations selected and their basin characteristics are summarized in Table 2-4 below and are also shown in Figure 2-8.

Table 2-4:
Regional Hydrometric Stations near Coffee Creek

Station ID	Station Name	Drainage Area (km^2)	Period of Record	Data Frequency	Agency	Comments, Notes
09EB003	Indian River above the Mouth	2,210	1981 to present	Daily	WSC	Used as the regional predictor station to generate long-term, site-specific synthetic discharge records for the Project area, and in the regional peak and low flow analyses
09DD003	Stewart River at the mouth	51,000	1951 to present	Daily	WSC	This station is situated ~35 km downstream of the proposed barge location across the Stewart River, and was used in the regional peak and low flow analyses
09CD001	Yukon River above White River	149,000	1956 to present	Daily	WSC	This station is situated ~45 km downstream of the proposed barge location across the Yukon River, and was used in the regional peak and low flow analyses
09AH003	Big Creek near the Mouth	1,800	1974 to present	Daily	WSC	Used for the regional peak and low flow analyses
09CA003	Donjek River below Kluane River	12,400	1979 to 1994	Daily	WSC	Used for the regional peak and low flow analyses
09DD004	McQuesten River near the Mouth	4,750	1979 to present	Daily	WSC	Used for the regional peak and low flow analyses
09CA006	Nisling River below Onion Creek	7,910	1995 to present	Daily	WSC	Used for the regional peak and low flow analyses
09AH004	Nordenskiold River below Rowlinson Creek	6,410	1982 to present	Daily	WSC	Used for the regional peak and low flow analyses
09EA004	North Klondike River near the Mouth	1,090	1974 to present	Daily	WSC	Used for the regional peak and low flow analyses
09BC001	Pelly River at Pelly Crossing	48,900	1951 to present	Daily	WSC	Used for the regional peak and low flow analyses
09EB004	Sixty Mile River near the Mouth	3,060	1996 to 2013	Daily	WSC	Used for the regional peak and low flow analyses
09DD002	Stewart River at Stewart Crossing	35,000	1960 to 1973	Daily	WSC	Used for the regional peak and low flow analyses
29CD001	Thistle Creek above Yukon River	210	1981 to 1996	Daily	YHN	Used for the regional peak flow analyses
29DD003	Scroggie Creek above Stewart River	730	1981 to 1997	Daily	YHN	Used for the regional peak flow analyses
29DD002	Clear Creek above Barlow Creek	340	1980 to 2011	Daily	YHN	Used for the regional peak flow analyses
29EC001	Clinton Creek above Fortymile River	206	1978 to 1991	Daily	YHN	Used for the regional peak flow analyses



LEGEND

Regional Hydrometric Stations

Network

- WSC
- YHN

Coordinate System: *NAD 1983 UTM Zone 7N*
Projection: *Transverse Mercator*
Datum: *North American 1983*
Units: *Meter*

1:1,250,000

0 25 50 Km

DATE SAVED:	Mar 02, 2017
DRAWN BY:	GM
REVIEWED:	CF
VERSION:	1

CLIENT:

GOLDCORP

LORAX ENVIRONMENTAL

PROJECT:

Coffee Gold Feasibility Study

TITLE: Regional Hydrometric Stations

PROJECT #: A362-3 *FIGURE:* 2-8

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2.3 Outputs

2.3.1 Site Precipitation and Snow Water Equivalent Measurements

Temperature and precipitation (solid and liquid phase) data were summarized for the site and regional stations. Monthly average daily minimum, average and maximum temperatures were computed, as well as extreme minimum and maximum temperatures for the period of record, for each station. Monthly total precipitation amounts were summarized for each climate station, and annual maximum snow water equivalent values were computed for all project site locations and regional snow courses.

Monthly temperature and precipitation data for the Environment Canada stations were downloaded from the Adjusted and Homogenized Canadian Climate Data (AHCCD) archive (http://ec.gc.ca/dccha-ahccd/Default.asp?lang=En&n=B1F8423A-1). These data have been post-processed to adjust discrepancies in the normal station records due to relocations, changes in measurement methods and gauge under-catch of solid phase precipitation. In many cases, records from several stations have been joined to create longer time-series than are available for the individual stations. Due to the location of the project site, the limited availability of long-term regional climatic records, and the potential influences of a changing climate on project operations, these data were deemed to be the most appropriate for this assessment.

For extremes, values for temperature and precipitation were gleaned from the climatic normals for each station, and the same was done for the Alaskan climate stations. Similar metrics as above were calculated from the Coffee Creek climate station data, and they were plotted against the regional data to put the much shorter site record in a long-term context.

It is notable that winter precipitation data (as measured by standpipe or tipping bucket type gauges) is subject to several types of measurement error:

- Gauge undercatch resulting from turbulence effects around the gauge orifice (*e.g.*, Yang *et al*., 2005);
- Gauge capping due to snow falling at or near the triple point temperature that bridges the orifice and effectively seals the gauge;
- The high spatial variability of snowfall (and subsequent redistribution) in mountainous areas (Pomeroy *et al*., 1999).

Sublimation losses also form an important component of the water balance in sub-arctic environments, and particularly losses from forest canopy interception and wind suspension and re-distribution (*e.g.*, Hedstrom and Pomeroy, 1998). However, sublimation is very difficult to measure directly, and is subject to large uncertainties.

The use of the maximum winter SWE value (*i.e.*, a value measured by the April 1st snow survey) effectively integrates sublimation losses up to the time of measurement, and thus these measurements are considered representative of the total potential water available for melt (and therefore freshet generation) in the snowpack.

In total, eighteen snow survey sites have been sampled with varying frequency at Coffee Creek from 2012 – present (Table 2-5). These data are representative of all major cardinal point aspects and cover a wide range in elevation from valley bottom (399 m; 3 sites) to ridge top (1278 m; 16 sites).

Table 2-5:
Coffee Gold Snow Survey Sites

Station	Record Period	Months Sampled	Elevation (m asl)	Aspect[1]	(°)	(°)
IC-4.5-SS Flat	2012-2015	Feb, Mar, Apr	399	VB	62.969263	-139.4342069
IC-1.5 / 0.5 -SS	2012-2015	Feb, Mar, Apr	524	VB	62.914774	-139.5786791
CC-1.5-SS	2012-2015	Feb, Mar	733	N	62.864994	-139.3281748
CC-north-1	2012-2015	Feb, Mar, Apr	1227	N	62.891186	-139.309705
CC-north-2	2012-2013	Mar, Apr	1220	S	62.891383	-139.3096936
CC-east-1	2012-2015	Feb, Mar, Apr	1220	E	62.871695	-139.3941096
CC-east-2	2012-2013	Feb, Mar, Apr	1197	E	62.871379	-139.3916299
CC-east-3	2012-2013	Feb, Mar, Apr	1193	N	62.87138	-139.3909221
CC-south-1	2012-2015	Feb, Mar, Apr	1260	S	62.88724	-139.3107976
CC-south-2	2012-2013	Feb, Mar, Apr	1246	S	62.886333	-139.3107515
CC-west-1	2012-2015	Feb, Mar, Apr	1278	W	62.890002	-139.3561429
CC-west-2	2012-2013	Mar, Apr	1257	W	62.890285	-139.3580354
CC-west-3	2012-2013	Apr	1232	W	62.89059	-139.3603595
KAM-SS-T1	2014	Jan, Feb, Mar, Apr	528	VB	62.914818	-139.578409
KAM-SS-EAST	2014	Apr	987	ENE	62.884825	-139.58468
KAM-SS-NORTH	2014	Apr	994	N	62.882845	-139.385828
KAM-SS-WX	2014-2015	Mar, Apr, May	996	SSE	62.873101	-139.180054
KAM-SS-WEST	2014	Apr	1020	W	62.888606	-139.374293
KAM-SS-HIGH	2014	Apr	1184	N	62.87414	-139.38898

[1]VB = valley bottom, N = north, E = east, S = south, W = west.

The Yukon territorial government maintains an extensive snow survey network for flood and water supply forecasting purposes (http://www.env.gov.yk.ca/air-water-waste/snow_survey.php). The nearest representative high-elevation station from this network is located at Casino Creek (09CD-SC01; 1,065 m – see Table 2-6 and has a record period spanning 1977-2015. This site is surveyed during a one-week window centred on the first of the month in March, April and May, and occasionally on May 15th, depending on snowpack magnitude and flood risk. The nearest station that can be considered representative of valley bottom snowpack accumulations is located at Pelly Farm (09CD-SC03; 472 m).

At the Casino Creek snow survey site, average maximum SWE is 142 mm over the period of record, with approximately half of the annual maximum snowpack occurrences recorded in early April, and the other half in early May. In almost all years with available data, the annual snowpack melts out completely by May 15.

**Table 2-6:
Regional Snow Survey Sites**

Station Name	ID	Elevation	Dist. From Project	Record Period	Province/ State	Latitude	Longitude	Mean Annual
		(m asl)	(km)			(°)	(°)	SWE (mm)
CASINO CREEK	09CD-SC01	1,065	32	1977-2015	YT	62.7333	-138.8	142
PELLY FARM	09CD-SC03	472	81	1986-2015	YT	62.8167	-137.3667	82

The regional and site precipitation data were grouped into summer (May to September) and winter (October to April) seasons, and compared to the respective station elevation to determine whether precipitation varies with elevation (*i.e.*, precipitation increases as elevation increases). This was done for the regional climate stations and snow surveys, and for the site climate station (and tipping bucket rain gauges) and snow surveys.

2.3.2 Synthetic Temperature and Precipitation Record

While the data collected at site are of high-quality, a robust characterization of the long-term variability in site climate requires the record to be extended. This extension involves linking the shorter, site-specific record to a regional station that is representative of climate conditions measured at site. Critical parameters that must vary in concert are:

- Air temperature (daily maximums, means and minimums). In particular, the winter inversions that result in higher ridgetop temperatures than valley bottom must be accurately reproduced.
- Daily precipitation totals, and the annual distribution of precipitation between snow and rain, duration and magnitude of multi-day events and trace (<1 mm) events must be well represented.

- Evaporation, on an annual and daily scale (*i.e.*, lower on days with precipitation, higher on warm days with additional wind and radiation inputs).

The synthetic climate record described in this report forms the foundational input to both the heap leach and site-wide water balance models.

2.3.2.1 Screening of Regional Stations

The first screening step involved correlating the monthly average temperatures and precipitation from the regional stations with the site record. The top six stations with the closest match to the site data were carried forward for a more detailed analysis.

The second step involved correlating both monthly and daily variables to determine which regional stations best represented the intra-annual and sub-monthly variability in project site climate. In addition to the correlation coefficients, the completeness of the regional record was taken into consideration as well. Preference was given to stations with the most complete records in order to reduce the reliance on infilling missing data using other regional stations. Finally, those stations deemed to be most representative of the project area were given priority (*i.e*., similar elevation and longitude).

Considering all the above listed factors, the McQuesten climate station was selected as the best regional proxy for site climate conditions.

2.3.2.2 Estimating Missing Data

The McQuesten daily climate record is 97% complete over the period from October 1986 to September 2014. Missing data (temperature and precipitation) were estimated using the Pelly Ranch record, which had R^2 values of 0.97 to 0.99 for temperature, and 0.48 for daily precipitation. Considering that convective events are the primary driver of precipitation on a daily basis, and the high degree of spatial and temporal variability that this mechanism exhibits (compared to more spatially coherent frontal events), this is considered to be a very good correlation between site and regional data. On days where both records were missing data (n = 49), the gaps in the temperature record were infilled with the average of the preceding and following days. Convective precipitation events do not vary in a linear fashion from day to day, and therefore these were left as null values.

2.3.2.3 Precipitation – Empirical Frequency Pairing methodology

The relatively lower correlations between daily precipitation at site and the McQuesten station required a different approach. While the temperature record was estimated using a chronological pairing methodology (*i.e*., temperatures from the same day were compared), this approach compares values with the same frequency of occurrence. The Empirical Frequency Pairing methodology outlined in Butt (2013) was applied to increase the predictive ability of the linear regression equation. This method is most commonly used to create longer-term records of streamflow from limited site data and a representative regional station. It does not seek to match the specific timing of events, as two basins, or two climate stations recording convective precipitation, are often not in sync, due to lags in snowmelt, precipitation timing, *etc*. Rather, the approach is intended to replicate the frequency of an event of given magnitude.

The data preparation requires that first, the days where one or both time-series have missing values are removed, and then each series is ranked. Days with zero precipitation at both stations were removed from the time-series to ensure that the regression equation was optimized for the days where precipitation occurred. Finally, the series were plotted, with the predictor data on the x-axis and the site climate data on the y-axis (predictand). Once the daily time-series of estimated precipitation and temperature were prepared, the synthetic data was compared to the site climate and hydrometric data to ensure that the annual totals and monthly distribution of both parameters showed an acceptable match with the measured data.

2.3.3 Extreme Precipitation and Snowmelt

Design of water management infrastructure necessitates an understanding of the volume of water that might be delivered by a storm of given frequency and duration (*e.g.*, 1:100 year, 24-hour rain event). A detailed analysis was undertaken of the long-term precipitation records available from the regional climate networks, and the resulting frequency-duration storm magnitude estimates were scaled to the Project site using the precipitation elevation gradient described in Section 3.1.2.3. The full analysis and results of this effort are provided in Appendix B.

An estimate was also required of the probable maximum precipitation (PMP) for a 24-hour period, to inform the required design capacity for the heap leach facility event ponds. The probable maximum precipitation is defined as the greatest depth of precipitation for a given duration meteorologically possible for a design watershed or a given storm area at a particular location at a particular time of year, with no allowance made for long-term climatic trends (WMO, 2009). The statistical procedure used follows the methodology presented in Hershfield (1961), and as summarized by the WMO (2009), and is presented in full in Appendix C.

2.3.4 Evaporation Estimates

Hourly potential evaporation rates were computed using Coffee Gold weather station data and the Ref-ET calculator - a compiled, stand-alone computer program that calculates reference evapotranspiration (ASCE, 2005). For the period of available record, an hourly climate input file was prepared from the Coffee Gold weather station database. The input variables required by Ref-ET are: maximum air temperature, minimum air temperature, relative humidity, incoming solar radiation, atmospheric pressure and wind speed.

From the assembled climate inputs, Ref-ET returned potential evaporation (PE) computations at hourly and daily time-step based on an array of evaporation models (*e.g.*, Penman-Monteith model, Priestley-Taylor formulation). Presented in Section 3, hourly- and daily- potential evaporation (PE) estimates output from site climate inputs are compared to PE values reported for other Yukon Territory mining projects.

2.3.5 Regional Streamflow Summary Statistics

To obtain the input data required for the regional streamflow analyses (peak and low flows, annual runoff, trend analyses, *etc.*), the daily time-series (in m^3/s) from the hydrometric stations listed in Table 2-4 were run through a customized routine to extract the relevant metrics. Extracted metrics included the following:

- Average annual (calendar year and water year [October to September]) discharge;
- Annual maximum and minimum daily discharge;
- Annual and June-September minimum 7-day average discharge;
- Average monthly discharge (m^3/s) and runoff (mm);
- Date of freshet initiation (pulse date; after Cayan *et al.*, 2001);
- Date of freshet peak discharge, and;
- Date of centre of hydrograph mass (calendar year; after Stewart *et al*., 2005).

Summaries of extracted metrics from regional datasets are provided in table format in Appendix E.

2.3.6 Regional Peak Flow Analysis

A frequency analysis was used to estimate the recurrence of discharges of a particular magnitude for all regional hydrometric stations within a 200 km radius of the Project. In a frequency analysis, a time-series of annual flow events are viewed as being a set of events sampled from a population of all events that is infinitely long and therefore continuous. Continuous probability distributions (*e.g.*, Log Pearson 3, Generalized Extreme Value, Log Logistic 3P) are then fitted to the observations and future and/or extreme events (*e.g.*, 1:200 year flood) are estimated from best fitting probability distributions. Statistical tests (*e.g.*, Kolmogorov Smirnov; Anderson Darling) may be used to isolate the probability distributions that best fit the observations or return a conservative result (Meylan *et al.*, 2012). The frequency analysis may also be based a priori on a probability distribution conventionally applied in hydrology studies (*e.g.*, Log Pearson Type III).

Annual time-series of instantaneous maximum discharge values from the regional stations listed in Table 2-4 were compiled. Where the instantaneous maximum value was missing, the maximum daily discharge for that year (assuming a complete record was available) was scaled by the average ratio of instantaneous to daily peak flow from the other years in the station record (*per* Ahmed and Jackson 2013). This ratio ranged from 1.01 to 1.17. The final datasets were then input to the EasyFit Professional (v5.5) software and a range of distributions were fit. The Log Pearson (Type III) distribution was used for most stations, with the Log Logistic 3P distribution providing the best fit (using the Anderson Darling test) for several of the smaller drainage basins.

2.3.7 Regional Low Flow Analysis

As per the peak flow analysis, the same set of regional stations were assessed in a low flow analysis. To process datasets for the low flow analysis, daily discharge data from eleven of the selected regional hydrometric stations were downloaded from the Water Survey of Canada data portal and seven-day rolling averages were computed from the daily discharge data. Next, annual minima time-series of the winter and June-September 7-day average low flows were assembled for each station. These data were then exported to the EasyFit software for further evaluation.

Through an inspection of the statistics and ranking data output by EasyFit, no single probability distribution could be identified that consistently provided a best fit to the station observations of low flow. However, the Log Pearson 3 (LP3), Weibull and Log Normal distributions were, in general, high ranking distributions for each hydrometric station inspected. Furthermore, estimated low flows based on these three probability distributions were very similar. Consistent with guidance from the BC Ministry of Environment (see BC MOE, 2012), low flow values returned by the LP3 distribution are reported in Section 3.2, noting that recurrence interval estimates were derived for the 7Q2 (median), 7Q5, 7Q10 and 7Q20 events. Where the LP3 distribution did not provide a good fit to the data, the Weibull distribution was used following the guidance provided in WMO (2009).

As a final step in the low flow analysis, estimated low flows for each station were plotted against their respective drainage areas. This plot in effect allows a low flow metric to be estimated for a location of interest based on drainage area information alone. Summer and winter manual low flow measurements collected from the Project drainages were added to these regression plots, in an effort to validate the low flow-drainage area relationship for the smaller spatial scale (*i.e.*, drainage areas on the order of 10 to 400 km^2).

2.3.8 Long-term Synthetic Streamflow Records

The high-quality discharge records available for the Project site allowed synthetic discharge time series to be constructed for 11 project hydrometric stations using regional streamflow data as a driver. Synthetic streamflow records allow the site-specific characteristics of the Project basins to be retained in a longer term record, while preserving any regional inter-annual variability in discharge. This allows for more robust recurrence interval estimates of critical discharge regime metrics (*e.g.*, mean annual runoff, seasonal runoff distribution, June-September 7Q10, *etc*.), and also maintains the regional inter-annual variability in streamflows resulting from multi-decadal climate cycles (*e.g.*, PDO, AO) and trends (*e.g.*, increasing winter low flows).

Following the Empirical Frequency Pairing (EFP) methodology described by Butt (2013), the overlapping periods of record were selected for the site station and the representative regional stations. Data were discretized by month, and all available daily average flows for each month were ranked. For example, if there were data available for the month of April over five years, then the number of paired observations was 150. The paired and ranked observations were then plotted, with the regional station set as the predictor variable (x-axis). Due to the limited availability of continuous winter flow data, all data for the months of October through April were grouped to represent the winter low-flow regime. Additionally, all available spot flow measurements were included in the analysis.

The methodology described in Butt (2013) was modified to improve the predictive power of the EFP method. A piece-wise linear regression approach was employed to estimate flow values that fall between each site-regional data pair. For cases where the minimum/maximum daily flow in the record fell outside of the site data record, the relationships were extrapolated using a linear relationship between at least 10 data pairs, and an understanding of the regional peak and low flow unit yields.

The hydrometric record from the Indian River above the Mouth WSC gauge (09EB003) was used as the predictor basin for all synthetic hydrographs. This station was selected based on the following criteria:

- The drainage basin is situated north of Coffee Creek, but south of Dawson City.
- Record period of sufficient length and completeness to capture the full-range of inter-annual streamflow variability over the last 30 years;
- The record provides a good representation of all relevant components of the site hydrographs (*i.e.*, rapid freshet, multiple rainfall driven peaks during the summer and early fall, and extended winter base flows of <1 L/s/km^2).

An example of the EFP relationship for the HC-5.0 hydrometric station is provided in Figure 2-9. Plots of all monthly and low flow EFP relationships are provided in Appendix A1 for all Project hydrometric stations. Also included in Appendix A1 are flow duration curves for the overlapping period of record (site and synthetic time-series), and comparisons of synthetic winter flows to manual streamflow measurements.

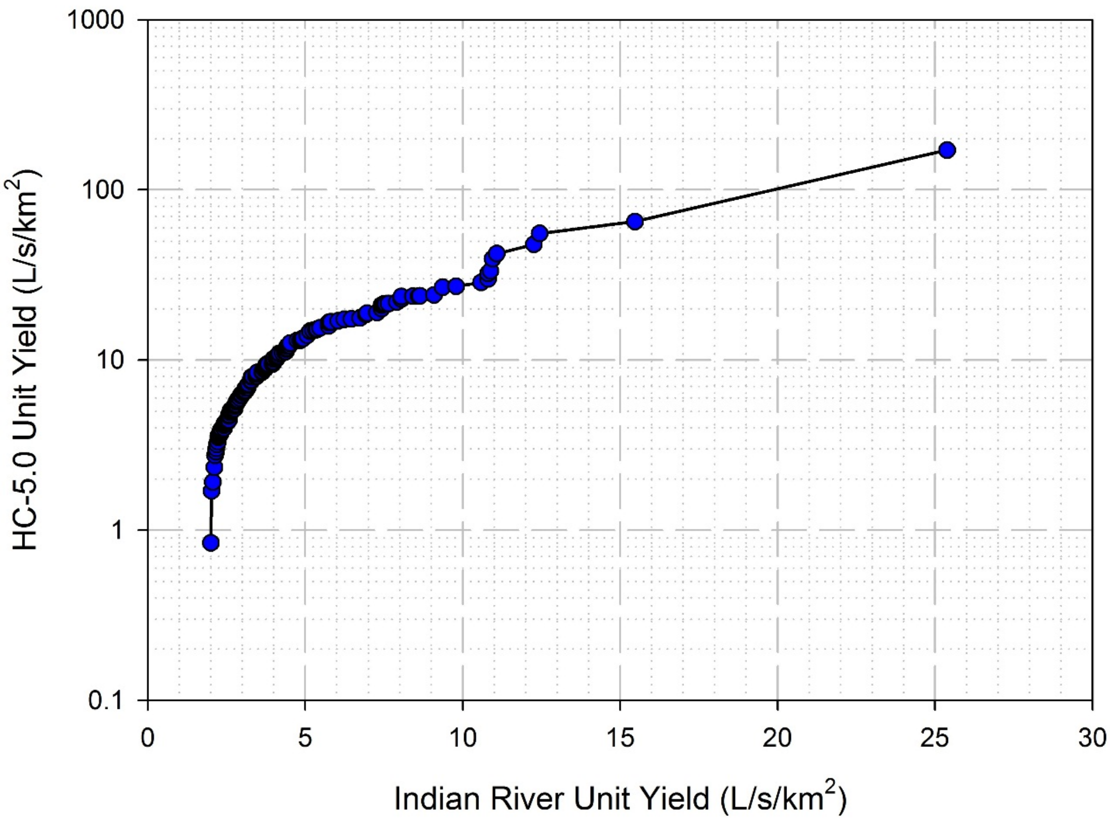


Figure 2-9: Example of an empirical frequency pairing relationship for July at hydrometric station HC-5.0.

2.3.8.1 Supplementary Recurrence Interval Analyses: Annual Runoff Recurrence Intervals and June-September 7Qmin Flows

The synthetic streamflow time-series created using the EFP method were used to estimate several metrics for the 11 site stations analysed. The full synthetic time-series for the project stations are presented in time series format and as standardized anomalies in Appendix A. Standardized anomalies relating to synthetic hydrometric data were calculated as follows:

$$k=\frac{\mu-\bar{X}}{\sigma} \qquad \text{[Equation 5]}$$

where k is the standardized anomaly (dimensionless);

μ is the annual runoff value in mm;

σ is the standard deviation of the annual runoff series in mm;

$\overline{X}$ is the mean annual runoff in mm for the period of record.

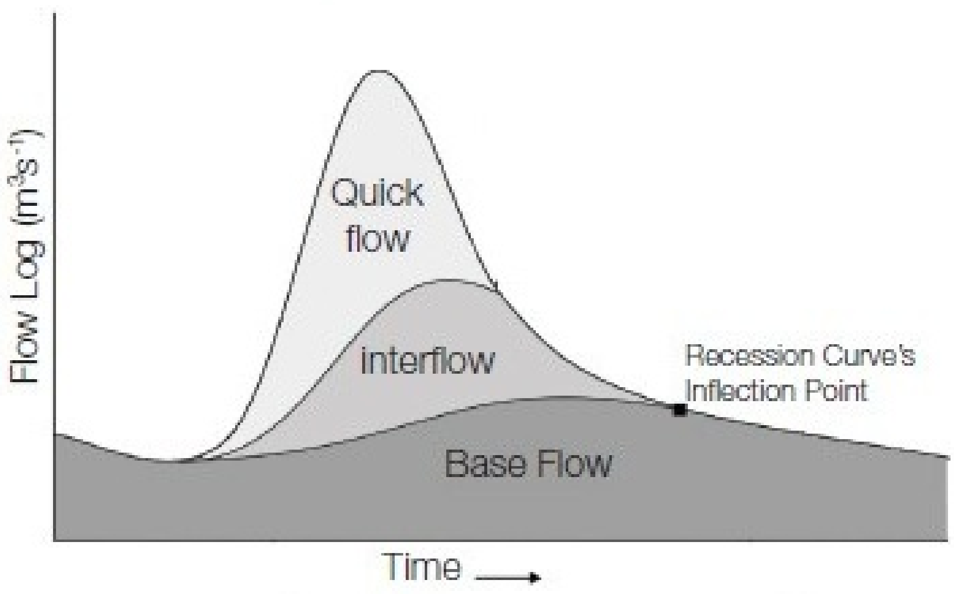
In a similar fashion as was done for the regional data, time-series of June-September minimum 7-day average streamflow (*i.e.*, 7Qs) were analysed using the EasyFit 5.5 statistical package. Annual runoff recurrence interval estimates were derived for the 1:2 (median), 1:10, 1:25, 1:50, 1:100 and 1:200 wet and dry years using the Generalized Extreme Value (GEV) distribution. June-September 7-day minimum streamflow recurrence interval estimates were derived using the Log-Pearson Type III (LP3) distribution for the 7Q2 (median), 7Q5, 7Q10 and 7Q20 events as recommended by MOE (2012). Where the LP3 distribution did not provide a good fit to the data, the LogNormal distribution was used instead (WMO, 2009). The synthetic data were not used for the peak flow analyses, as the extrapolation procedure used for the upper end of the regional-site relationship is likely to introduce bias into the results.

2.3.8.2 Baseflow Separation

Low flow regimes of streams at the Project site show elevated levels for several parameters of concern (mainly arsenic and uranium; see Lorax, 2016a), and as such, it was important to characterize the baseflow regime for each Project basin. Baseflow is typically understood to constitute the portion of streamflow that is derived from groundwater discharge, and is often considered to be equal to the minimum winter low flow, or the minimum summer flow following an extended dry period (Smakhtin, 2001). The low flows, or baseflow that are of interest to this baseline study, are those low flows that reoccur seasonally.

A simplified conceptual model of the contributing sources to streamflow in local drainages would include the following (Figure 2-10):

- Quickflow (or event flow) response to rain and/or snowmelt events that results in rapid rising limbs and peaked streamflow responses;
- Recession limb following a peak flow event, composed of both shallow interflow (soil storage and active layer melt) and the remaining surface runoff, and;
- Deep groundwater discharge.



Source: http://turmalina.igc.usp.br/img/revistas/guspsc/v13n1/a01fig07.jpg

Figure 2-10: Conceptual hydrograph showing runoff partitioning.

Many methods have been developed to partition hydrographs and separate out a measure of baseflow. These methods range from simple visual plotting techniques to more advanced algorithms. The method employed in this baseline study uses the recursive digital filtering technique described by Nathan and McMahon (1990). The filter is shown in Equation 6, and uses three filter passes (*i.e.*, forward-backward-forward).

$$f_k = \alpha f_{k-1} + \frac{(1+\alpha)}{2}(y_k - y_{k-1}) \qquad \text{[Equation 6]}$$

where f_k is the filtered quick response at the k^{th} sampling instant, y_k is the original streamflow and α is the filter parameter (0.925, as recommended by Nathan and McMahon, 1990).

This filter is built into the Streamflow Analysis and Assessment Software (SAAS v4.0) package made available by the Ontario Ministry of Natural Resources and Forestry (Metcalfe and Schmidt, 2014). The baseflow separation filter in SAAS was used to develop time-series of baseflow for both the continuous discharge records from the site stations, as well as the synthetic discharge records developed for the same stations. The baseflow records generated by SAAS account for both interflow and groundwater derived baseflow during the open water season, but equate to groundwater baseflow only during winter months (where flow exists) and during extended summer dry periods.

3. Results and Discussion

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3. Results and Discussion

3.1 Meteorology

3.1.1 Air Temperatures

Air temperatures measured at the Project site are reported in Figure 3-1 and Table 2-1, and are compared to regional stations in Figure 3-2. Overall, site temperatures are generally consistent with regional stations, where mean annual air temperatures in the vicinity of Coffee Creek range from -5.2 to -2.8°C. Further, the coldest month each year is typically January with a regional mean temperature of -23°C, and the warmest month is July with a regional mean of 13°C.

For the comparatively short period of record at Coffee Creek, average annual temperature is -2.5°C, and monthly average air temperatures range from -19°C (December) to +13°C (July) (Table 3-1). To date, the minimum temperature at Coffee Creek is -37.6°C (measured January 28th, 2013) and the maximum temperature is 27.2°C (June 25th, 2013).

3.1.1.1 Temperature Inversions

At the elevation of the Coffee Creek climate station, a notable departure from the regional temperature signal occurs during winter months. Valley bottom temperature inversions occur during winter months and ridgetop temperatures may be 10°C higher than measurements recorded at valley bottom stations. These inversions result in a reversal of the normal lapse rate (decreasing temperature with increasing elevation), and are commonly caused by cold Arctic air masses pooling in the valley bottoms from late October to early March.

Wahl (1987) reports that during a temperature inversion, lapse rates can range from 3-5°C/1000 m of elevation gain. This is generally consistent with the relationship between the Project site and the Pelly Ranch (valley bottom) climate station for 2012-2015, where the average winter lapse rate was estimated to be 7.5°C/1000 m. While higher than the guidance provided by Wahl, it is notable that Project area lapse rates vary by winter month, from a maximum of 14.3°C/1000 m in December to a minimum of 0°C/1000 m in March.

During summer months (April to October), the local lapse rate (-4.6°C/1000 m) is consistent with the standard adiabatic lapse rate of -6.4°C/1000 m and the saturated adiabatic lapse rate of -5.0°C/1000 m. This is likely due to increased frequency of precipitation during the summer months, which receive the majority of the annual precipitation, resulting in warmer and wetter air masses at the Project site.

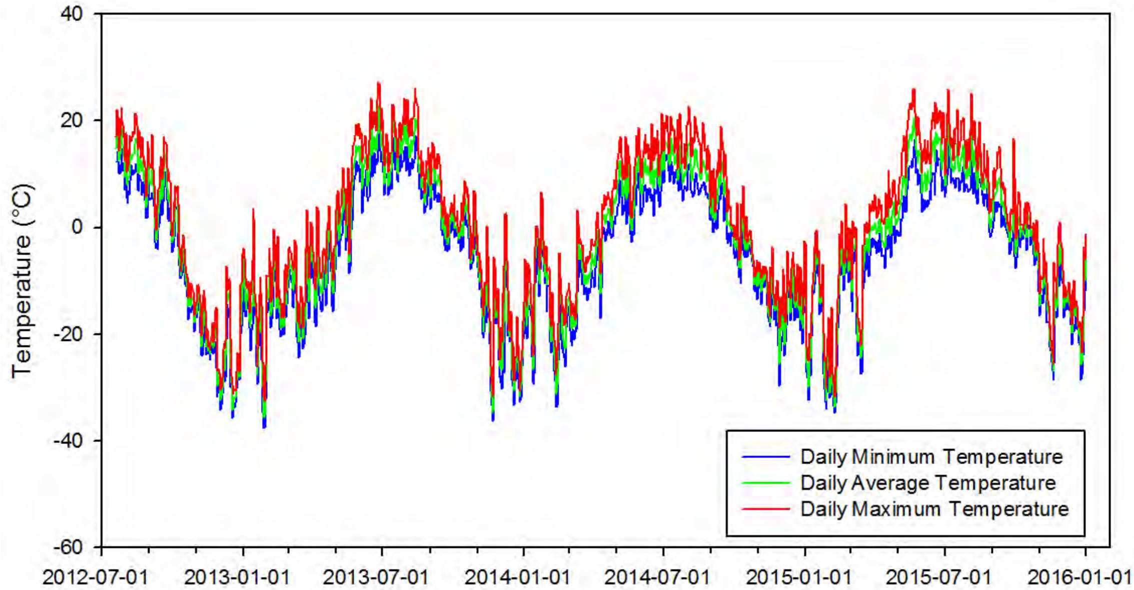


Figure 3-1: Daily minimum, average and maximum temperature record from the Coffee Creek climate station.

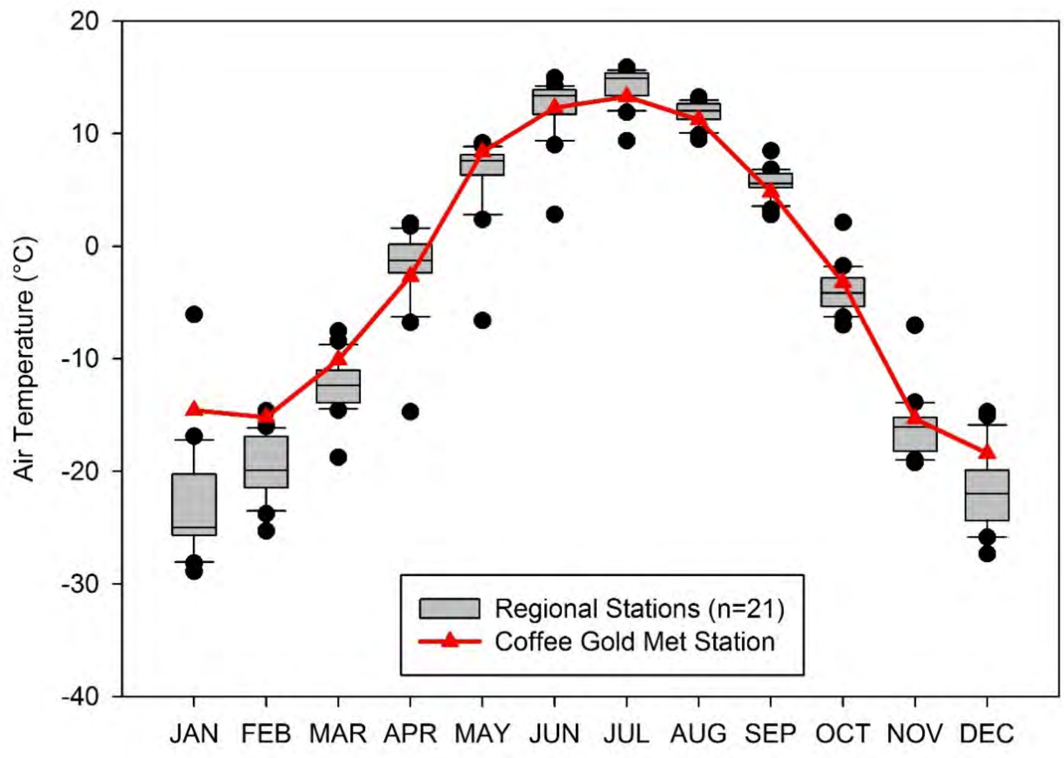


Figure 3-2: Monthly average temperatures for Coffee Creek (2012-15) and surrounding climate stations (period of record).

Table 3-1:
Coffee Creek Climate Station - Air Temperature Measurements by Month

Month	Minimum Recorded Air Temperature[1] (°C)	Average Minimum Air Temperature[1] (°C)	Mean Air Temperature[2] (°C)	Average Maximum Air Temperature[1] (°C)	Maximum Recorded Air Temperature[1] (°C)
Jan	-37.6	-17.2	-14.6	-11.6	6.8
Feb	-34.6	-17.9	-15.2	-12.1	4.4
Mar	-27.4	-12.9	-10.1	-6.7	5.0
Apr	-18.6	-5.9	-2.7	0.9	10.6
May	-8.7	4.4	8.3	12.6	26.2
Jun	2.2	8.2	12.3	16.8	27.2
Jul	5.0	10.1	13.3	17.1	25.9
Aug	-1.8	7.8	11.2	15.2	26.0
Sep	-5.3	2.0	4.8	8.3	18.9
Oct	-19.4	-5.0	-3.2	-1.1	8.8
Nov	-36.2	-17.6	-15.3	-12.8	1.0
Dec	-35.8	-21.0	-18.4	-15.8	2.6
Annual	**-37.6**	**-21.0**	**-2.5**	**17.1**	**27.2**

[1] From hourly data.
[2] From daily data.

3.1.2 Precipitation

3.1.2.1 Regional Setting

The study area is characterized by a cold, continental climate. Large frontal systems generated by the Aleutian Low are blocked by the high topography along the coast, and hence the project lies in the leeward rain-shadow (Figure 3-3 and Figure 3-4).

Cassano and Cassano (2010) analysed sea level pressure patterns for the Yukon River basin and found that the winter circulation patterns are dominated by the strong Aleutian Low. In contrast, summer patterns are characterized by low pressure systems over land and the Beaufort/Chukchi Sea, and weak high pressure cells to the north, resulting in easterly/north-easterly flows into the Basin. The authors found that largest daily precipitation events (*i.e.*, top 10^{th} and 1^{st} percentile daily totals, on an annual basis) were attributable to cyclones and over-land convective events that occur with frequency in summer months. Evapotranspiration rates are highest during the summer, and therefore additional moisture is recycled and available to precipitate.

During the winter, largest precipitation events result from southerly flows from a low pressure centre located to the southwest of the Yukon Basin and north of the Aleutian Islands. This brings moisture past the higher mountains on the southern edge of the basin and appreciable accumulation of precipitation.

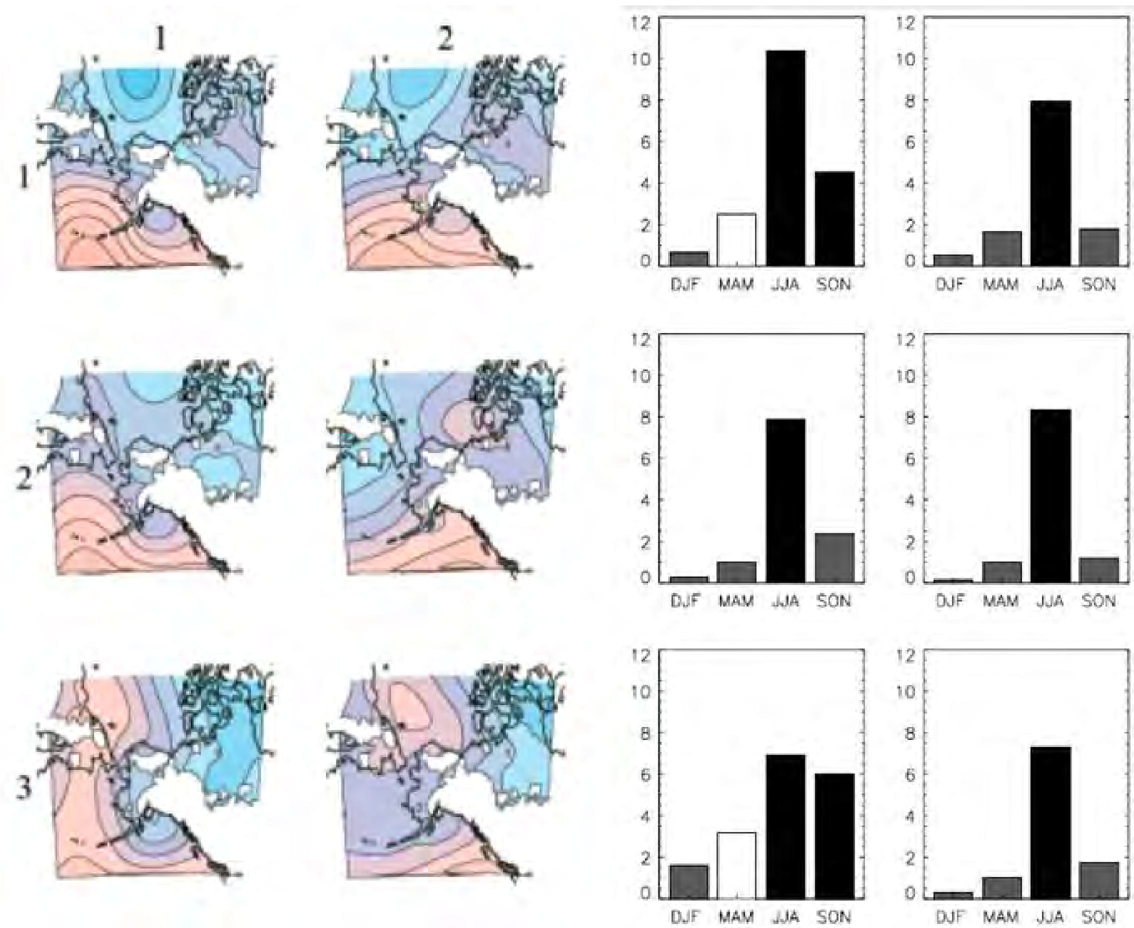


Figure 3-3: Left: Daily sea level pressure anomaly patterns for the period 1957-2002. Blue shading indicates negative anomalies (low pressure) and red shading represents positive anomalies (high pressure). Right: Corresponding frequency of days that map to each pattern seasonally. Each bar represents the percentage of days that the pattern occurs in a season. Black and grey bars represent positive and negative statistical significance, respectively. Source: Figures 2 and 5 in Cassano and Cassano (2010).

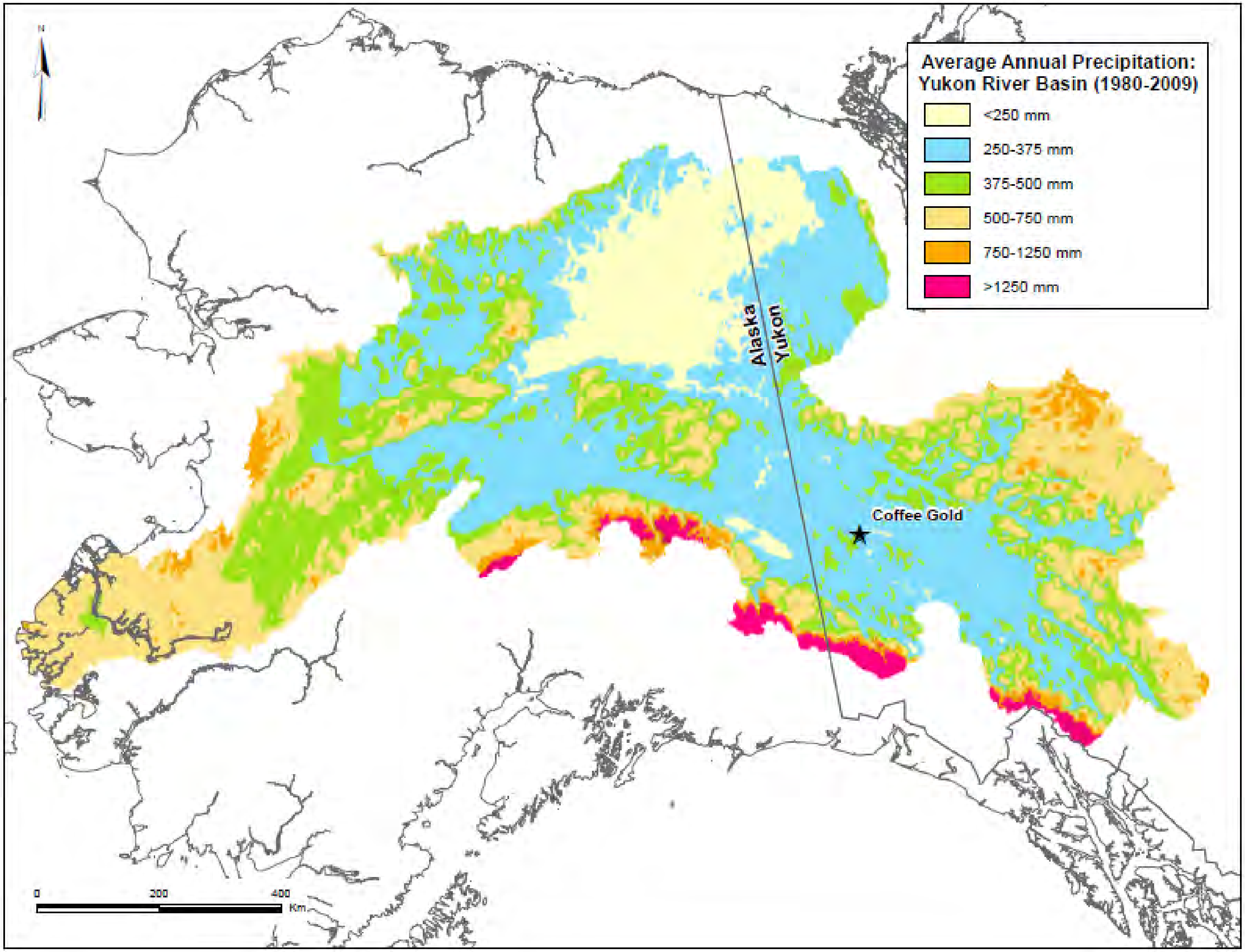


Figure 3-4: Annual precipitation (1980-2009) for the Yukon River Basin (from Brabets *et al*., 2000).

3.1.2.2 Precipitation – Site Data

Precipitation has been measured on-site since July 2012 at a dedicated climate station (Figure 3-5), and at several snow courses distributed at various elevations around the Coffee Creek property. Tipping bucket precipitation gauges were also installed at the camp (425 m) and at ridgetop (>1,200 m) in 2015 to refine assumptions relating to site precipitation accumulation with elevation.

Gauge and snow course data gathered during the baseline study indicate mean annual precipitation (MAP) averages 370 mm (at 975 m), with 32% of this amount falling as snow between October and April, and 68% falling as rain from May to September (Figure 3-6). This measured MAP value for Coffee Creek does not account for the effects of gauge under-catch or sublimation, which will result in measured precipitation values (winter values in particular) being lower than actual values. These are well-documented issues in northern regions (*e.g.*, Yang *et al*., 2005 and Pomeroy *et al*., 1999) and corrections are required to obtain a true MAP estimate.

Figure 3-6 also shows regional precipitation data from nearby climate stations. Overall, site- and regional precipitation measurements show similar magnitudes and monthly pattern. The regional climate signal is very consistent for both temperature and precipitation, and the measured site data tracks the regional signal closely. Further, the seasonal precipitation distribution calculated from valley bottom climate records (*i.e.,* average elevation of 490 m) strongly resembles the proportions measured during the baseline study (*i.e.,* regional data return proportions of snow and rain to be 35 and 65% respectively).

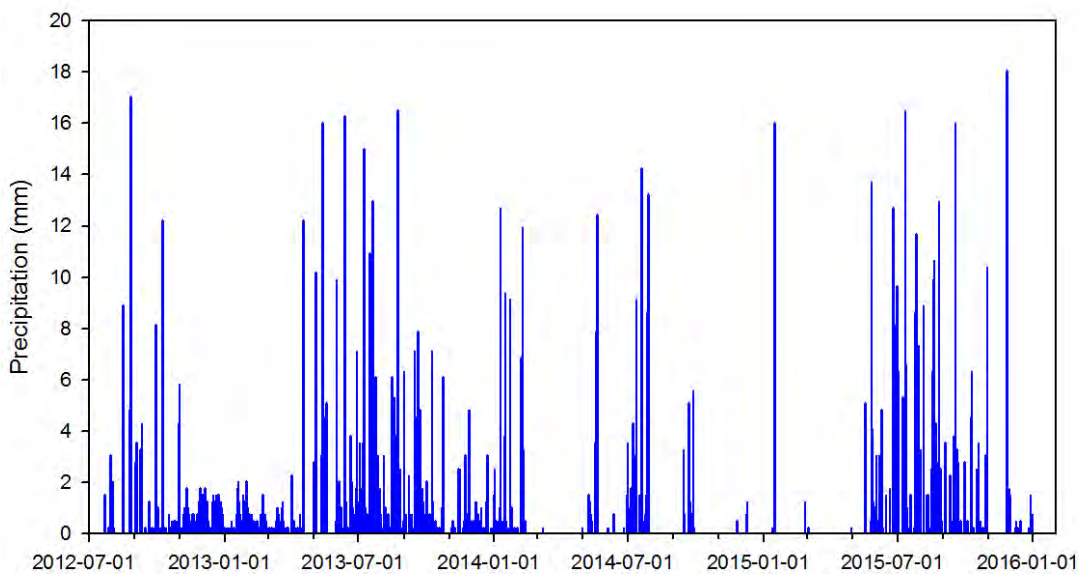


Figure 3-5: Daily precipitation measured at the Coffee Creek climate station.

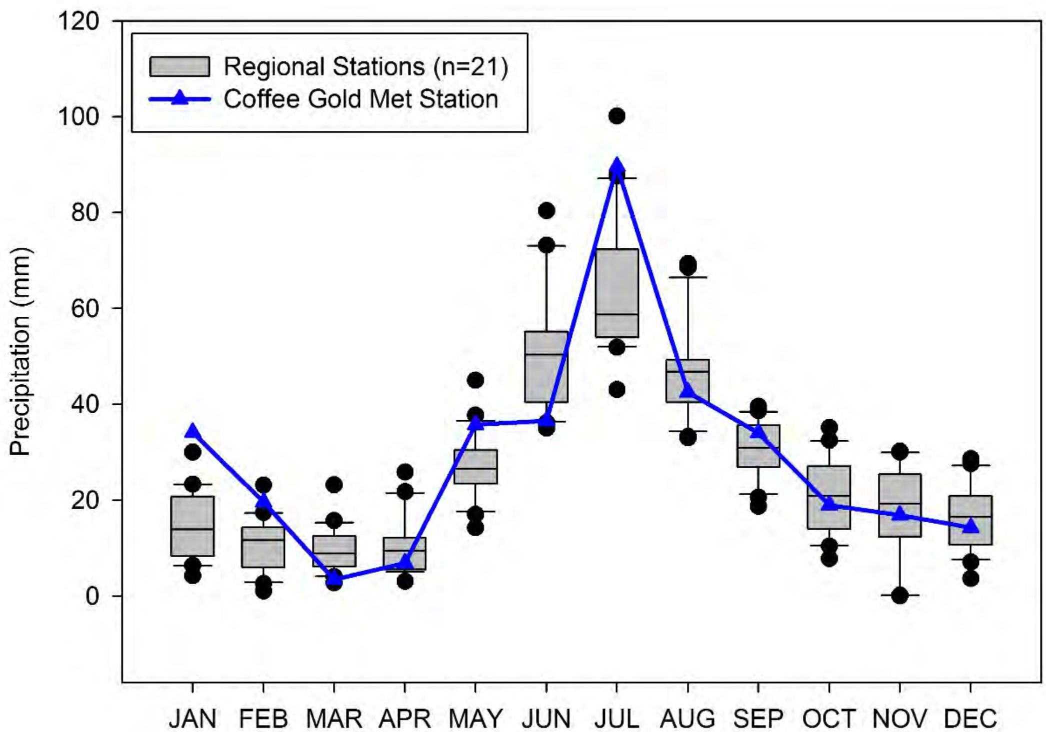


Figure 3-6: Monthly average precipitation from the surrounding climate stations (period of record) and from Coffee Gold (2012-15)

3.1.2.3 Precipitation – Elevational Gradients

It is common in areas with high topographic relief for precipitation amounts (annual, low-frequency/high-magnitude events, *etc*.) to increase with elevation due to orographic effects - primarily cooling of the air mass as it is forced upward by topography and subsequent condensation of the entrained water vapour. Most of the available long-term climate records for the project area are from stations located at lower elevations than the project site. Therefore, any estimate of precipitation derived from the regional stations must take the potential for orographic effects into account.

Site Measurements

The project site snow courses span a wide range of elevations, and provide a useful starting point to identify local gradients. Figure 3-7 presents the variation in SWE with elevation for the maximum measured snow packs of 2013-2015. Precipitation-elevation gradients (% increase with 100 m increase in elevation) were variable for the three years with sufficient data; at 6, 2% and 12%/100 m for 2013, 2014 and 2015 respectively. This inconsistency is likely due to several factors, including timing of the surveys, differing progression in the melt at lower elevations, and wind redistribution at the higher elevations. Nevertheless, an average SWE gradient of 9%/100 m was returned for the available period of record at site.

Two additional tipping bucket rain gauges were installed in 2015 to further resolve the summer precipitation elevation gradient at site. Over the period of May to October, the average gradient from the camp elevation (425 m) to ridge-top (1,300 m) was 4%/100 m (Table 3-2. There is some evidence that this gradient is reduced somewhat at the higher elevations (*i.e.*, does not scale linearly above the hypsometric mid-point of the basin; Loukas and Quick, 1996), but the conservative assumption of a constant gradient was used for all storm event scaling.

Table 3-2:
Rainfall data from 2015 and associated precipitation elevation gradients.

Month	**Camp Tipping Bucket**	**Climate Station**	**High Elevation Tipping Bucket**	**Gradient (camp to Met Stn)**	**Gradient (camp to High Elev)**	**Gradient (Met Stn to High Elev)**
Elevation (m)	*425*	*975*	*1,300*	*(%↑/100m)*	*(%↑/100m)*	*(%↑/100m)*
May-15	16.0	24.9	16.4	8%	0%	-17%
Jun-15	39.8	48.8	47.8	4%	2%	-1%
Jul-15	82.2	99.3	110.8	3%	4%	5%
Aug-15	53.0	73.7	69.5	6%	4%	-3%
Sep-15	17.0	40.1	28.2	17%	7%	-15%
Oct-15	33.0	22.9	46.4	-6%	4%	37%
TOTAL	241.0	309.6	319.1	5%	4%	1%

Regional Stations

To validate this gradient estimate, the two nearest snow survey stations to Coffee Creek were chosen to represent valley bottom (Pelly Farm) and ridge-top (Casino Creek) snowpack regimes. From the available data for these two stations, the elevation gradient calculated from the April 1st SWE data was found to be ~9%/100 m. This gradient matches the average value calculated from the available site data, and was carried forward to represent the winter precipitation elevation gradient.

Subsequent to the SWE gradient analysis, mean annual precipitation (MAP) and May-September (summer) precipitation totals from all regional stations listed in Table 2-1 were plotted against elevation, latitude and longitude. These regional climate stations are situated within a 200 km radius around the project site and display variability in MAP that cannot be attributed to elevation alone. For this reason and with the understanding of the dominant synoptic patterns that drive precipitation in this area, precipitation totals were plotted against latitude and longitude as well. Summary plots from this analysis are presented in Figure 3-8.

For the region as a whole, the annual precipitation gradient was estimated to be 3%/100 m with summer gradient 4%/100 m - albeit with some scatter about the line of best fit, particularly at higher elevations. No latitudinal trends in annual precipitation were found, but a clear decrease in summer precipitation is evident with increasing latitude (Figure 3-8d). Similarly, summer precipitation is found to decrease slightly moving east through the region, but annual precipitation shows the opposite trend (Figure 3-8ef). This incongruity is likely the result of either:

- Winter precipitation being driven by southerly flows that are blocked by the mountain ranges to the south and west of the project area (see Section 3.1.2.1), or;
- Lower precipitation gauge efficiencies for solid phase precipitation at the Alaskan stations, compared to the Canadian sites. The Canadian Nipher snow gauge performs much better than the NWS 8” standard gauge, particularly at higher wind speeds (Yang *et al.*, 2005). This explanation is considered more likely.

Given the known issues with measurement of solid phase precipitation in high-latitude and high-elevation environments, more weight is placed on the summer precipitation data results.

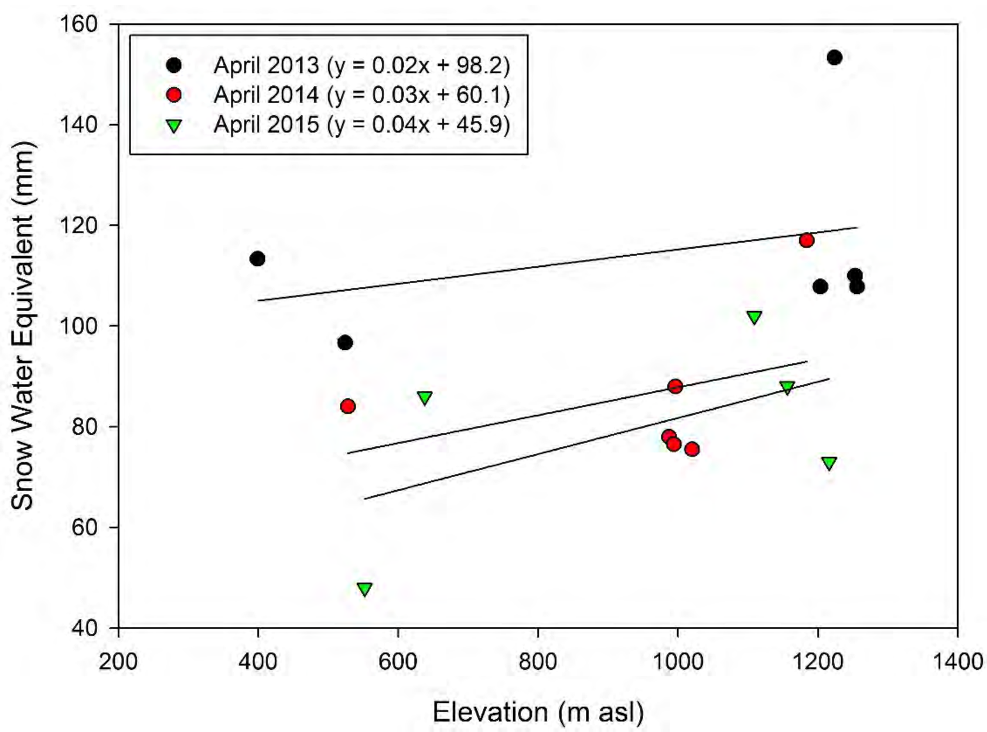


Figure 3-7: Elevation gradients for maximum annual SWE values measured at the Coffee Gold snow courses.

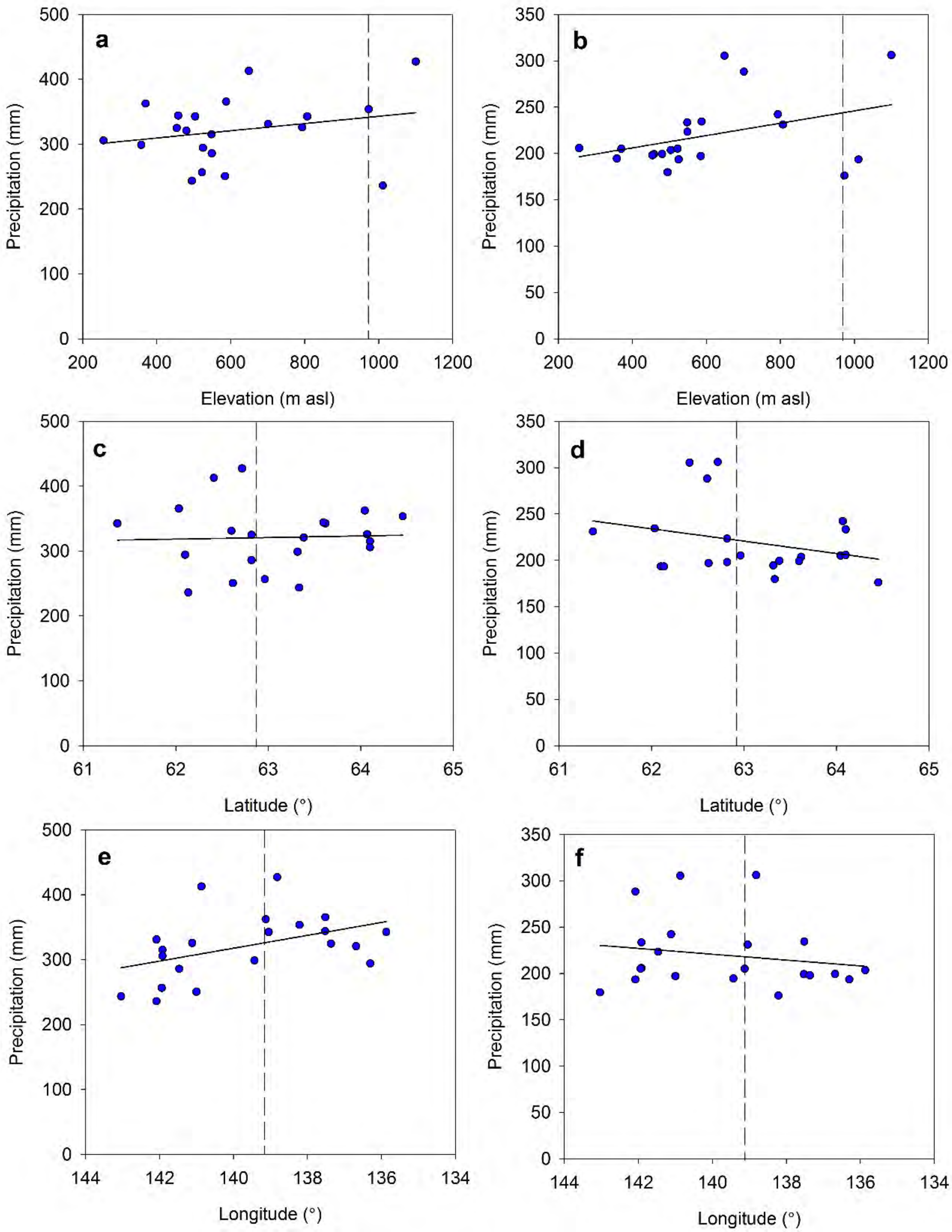


Figure 3-8: Regional precipitation plotted against elevation for mean annual (a) and summer (b) precipitation; latitude for mean annual (c) and summer (d) precipitation, and; longitude for mean annual (e) and summer (f) precipitation. Vertical dashed lines indicate the location of the Coffee Creek climate station.

Summary of Precipitation Gradient Assessment

Overall, regional findings are consistent with the site data, and therefore two elevation gradients were carried forward into subsequent analyses:

- Summer (May-September) gradient is 4%/ 100 m increase in elevation;
- Winter (October-April) gradient is 9%/100 m increase in elevation.

3.1.2.4 Synthetic Temperature and Precipitation Estimates

Initial Screening

The methods outlined in Section 2.3.2 were followed and a 30-year temperature and precipitation record was reconstructed from statistical relationships between site and regional climate data. The initial stage of this process involved screening the regional climate record to find the ones with the best predictive ability for the Project site climate. The results of this step are presented in the initial screening tables below (Table 3-3 and Table 3-4). Following the screening, the McQuesten climate record was selected as the predictor on which the reconstructed site climate record was based.

Table 3-3:
Pearson's correlation coefficients for the daily temperature series.

Station	T_{avg}	T_{max}	T_{min}
Alcan Hwy	0.98	0.97	0.98
McQuesten	0.97	0.96	0.94
Jatahmund	0.98	0.97	0.98
Burwash	0.97	0.96	0.93

Table 3-4:
Pearson's correlation coefficients for the daily and monthly precipitation series.

	Monthly				Daily	
Station	**Annual**	**% complete**	**May-Sept.**	**% complete**	**Annual**	**May-Sept.**
Alcan Hwy	0.70	74%	0.61	100%	0.42	0.46
Beaver Creek	0.85	58%	0.83	63%	0.32	0.35
Burwash	0.79	90%	0.66	87%	0.42	0.43
Northway	0.61	83%	0.65	100%	--	--
McQuesten	0.69	97%	0.80	100%	0.35	0.49
Pelly Ranch	0.76	80%	0.78	80%	0.30	0.39

Air Temperature - Validation

Once the reconstructed climate record was assembled, it was necessary to validate the record against the measured site data. The long-term synthetic average monthly temperatures track the measured values very well (Table 3-5). The only notable exception is the month of January, where the estimated temperatures are low by ~30% (Figure 3-9). This is an artefact of the pronounced valley inversions experienced at site that are not reflected by the regional record. Future analyses could consider the use of a modified lapse rate to estimate winter temperatures for the Coffee Gold Project, but owing to the cold temperatures experienced for this month, the assembled synthetic data are believed to be very robust and suitable for input to the Coffee Creek site-wide water balance model.

Precipitation – Validation

For precipitation (Table 3-5), overall the match between the shorter measured record and the longer synthetic record is quite good. Winter precipitation is slightly higher in the synthetic precipitation record, but this is not surprising, given that the site climate station is located at the ridge top and is subject to high winds, and therefore likely experiences substantial under-catch.

Table 3-5:
Monthly measured and synthetic climate records for the Coffee Gold Project at 1,300 m asl.

	Precipitation (mm)		Air Temperature (°C)	
	Measured (2012-2015)	Synthetic Record	Measured (2012-2015)	Synthetic Record
Jan	38.8	35.9	-14.6	-19.7
Feb	22.3	22.7	-15.2	-14.9
Mar	16.3	20.0	-10.1	-9.0
Apr	13.5	14.3	-2.7	0.8
May	40.7	36.2	8.3	6.9
Jun	41.5	53.0	12.3	11.3
Jul	101.9	76.8	13.3	12.6
Aug	48.3	58.1	11.2	10.1
Sep	38.7	49.8	4.8	5.0
Oct	21.6	37.0	-3.2	-2.4
Nov	19.2	43.7	-15.3	-13.2
Dec	16.2	37.2	-18.4	-17.2
Annual	419.0	484.6	-2.5	-2.5
May-Sep	271.1	273.8	10.0	9.2
Oct-Apr	147.9	210.8	-11.4	-10.8
Casino Creek SWE[1]		158		

[1]The Casino Creek SWE value was scaled up to 1300 m elevation by 9%/100 m.

The scaled maximum annual SWE from the Casino Creek snow course is presented for comparison in Table 3-5. It is reasonable to assume that sublimation occurs at the site throughout the winter months, and could vary from 0.2 – 0.5 mm/day based on the published literature for similar environments (*e.g.*, Jackson and Prowse, 2009). Thus over a 180-day period, this could result in SWE losses of 36 – 90 mm. The annual maximum SWE as measured by a snow course will integrate the effects of sublimation in the volume of available water, and therefore is expected to be lower than the synthetic record by a similar magnitude. The difference between the October to April cumulative precipitation values for the measured data and the synthetic data is approximately 60 mm, which falls within the range of expected sublimation losses.

It is notable that the Casino Creek SWE data were scaled to the proposed heap leach pad elevation of 1,300 m using an elevation relationship. Multiple frequency distributions were fit to the time-series of annual maximum SWE and the Generalized Extreme Value (GEV) was found to provide the best fit. Recurrence intervals for both wet- and dry-years were estimated using the GEV distribution and are presented in Table 3-6.

Synthetic Climate Data for Elevation 1,300 m asl

Year-over-year synthetic daily climate data are plotted on a common calendar year X-axis (Figure 3-11). Plots are provided for both air temperature and precipitation. Synthetic data are presented in this format as the charts clearly shows the range of variability inherent in the synthetic time series. Also shown in the plots are time series data for one year (Year 5), to give indication what a typical year of air temperature and precipitation data look like.

Relevant to Project footprints, mean annual precipitation (MAP) for elevation (~1,300 m asl) is estimated to be 485 mm, with 65% of this total precipitation realized as rain during the months of May through September with the remaining 35% occurring as snow from October through April (Table 3-5; Figure 3-10). On average, July is the wettest month at the property and April is typically the driest month each year. An analysis of the long-term synthetic precipitation record also indicates that, on average, 20 to 30 days each summer (*i.e.,* May-October) will receive appreciable rainfall (~5 mm per day).

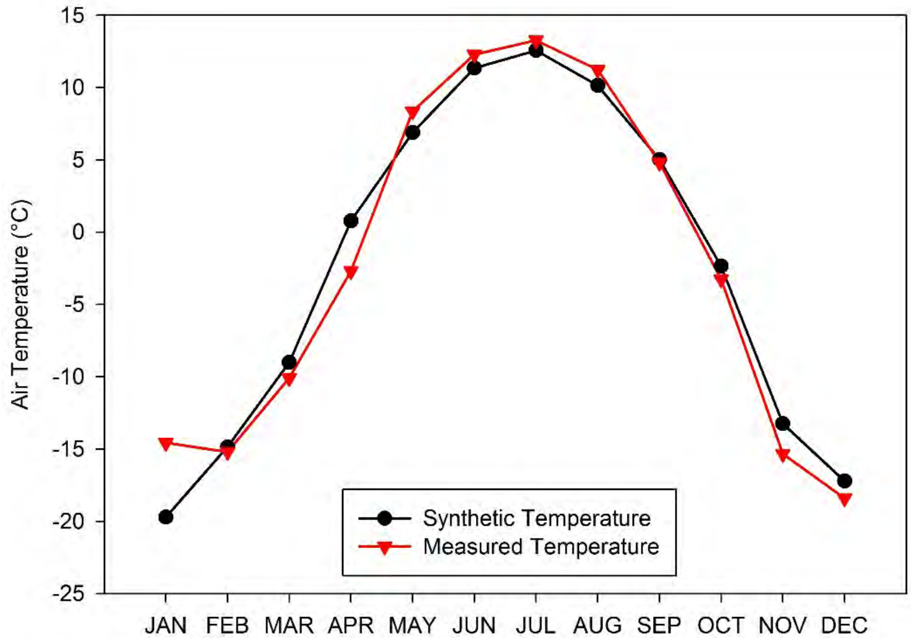


Figure 3-9: Average monthly mean air temperatures as measured by the Coffee Gold climate station, and from the synthetic 28-year record.

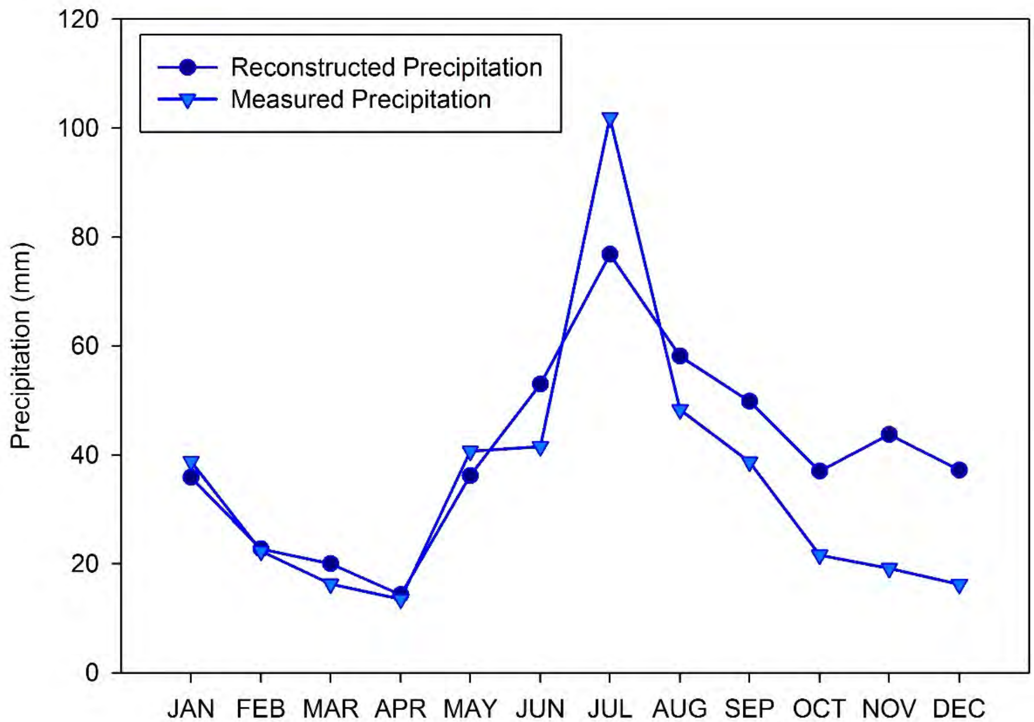


Figure 3-10: Average monthly precipitation as measured by the Coffee Gold climate station and from the synthetic 28-year record. Both data series are scaled to elevation 1,300 m asl.

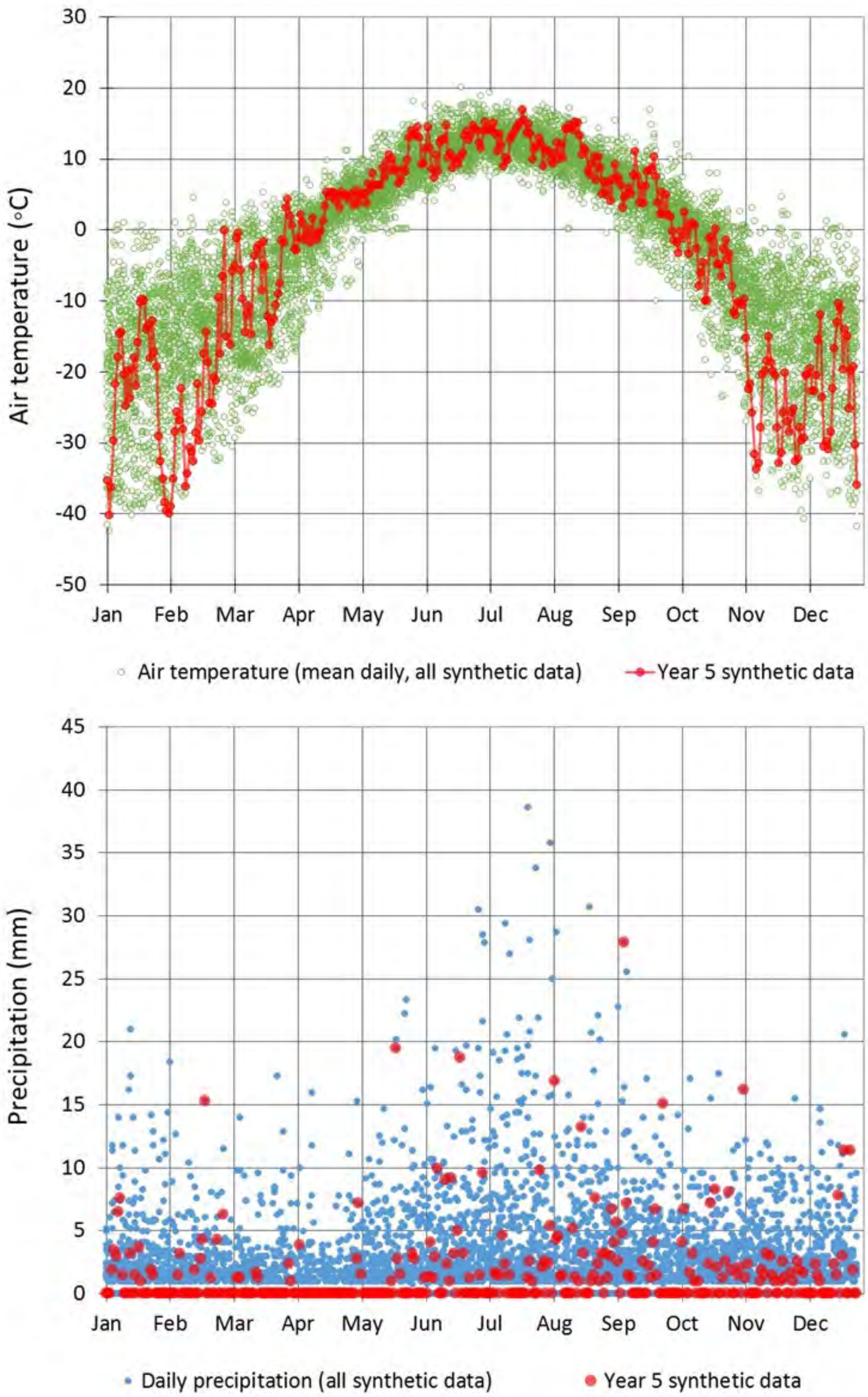


Figure 3-11: Year-over-year synthetic daily climate data plotted on a common calendar year X-axis. Daily data for air temperature (upper plot) and precipitation (lower plot) are shown for the 30-year dataset using green and blue circles respectively. Year 5 air temperature and precipitation data are shown in the plots using red circles (and red line for precipitation).

**Table 3-6:
Recurrence Interval Estimates for Maximum Annual SWE**

			Maximum Annual SWE (mm)		
	Recurrence Interval (yrs)	Probability of Exceedance	Pelly Farm (472 m)	Casino Creek (1065 m)	Casino Creek scaled to 1300 m
Dry	200	0.995	37	71	77
	100	0.99	41	76	82
	50	0.98	44	82	88
	25	0.96	49	88	95
	10	0.9	56	100	108
	5	0.8	63	112	121
Mean	2	0.5	80	139	151
Wet	5	0.2	100	172	191
	10	0.1	112	193	217
	25	0.04	126	218	249
	50	0.02	135	235	272
	100	0.01	144	251	295
	200	0.005	152	267	317

3.1.2.5 Extreme Precipitation and Snowmelt

Estimates of extreme precipitation (*e.g.,* 1:100 year, 24-hour rainfall) including an estimate of Probable Maximum Precipitation (PMP) for the Project area are presented in appended technical memos (see Appendix B and Appendix C). A discussion of snowmelt runoff is also included in Appendix B.

3.1.3 Wind

Wind roses were created from hourly site data for two ‘seasons’. April to September was assumed to represent the period when the majority of annual evapotranspiration would occur and October to March to represent the period of snow accumulation and potential re-distribution by wind. The mean wind speed for April to September for the period of record (2012-2015) was 2.7 m/s, with calm conditions only recorded 1% of the time (Figure 3-12). The primary wind vector was from the southeast, with a secondary vector from the north.

The mean October to March wind speed was 1.8 m/s, with calm conditions recorded 7% of the time (Figure 3-13). The strongest winds were recorded blowing from the north, but with relatively greater frequency from the southwest.

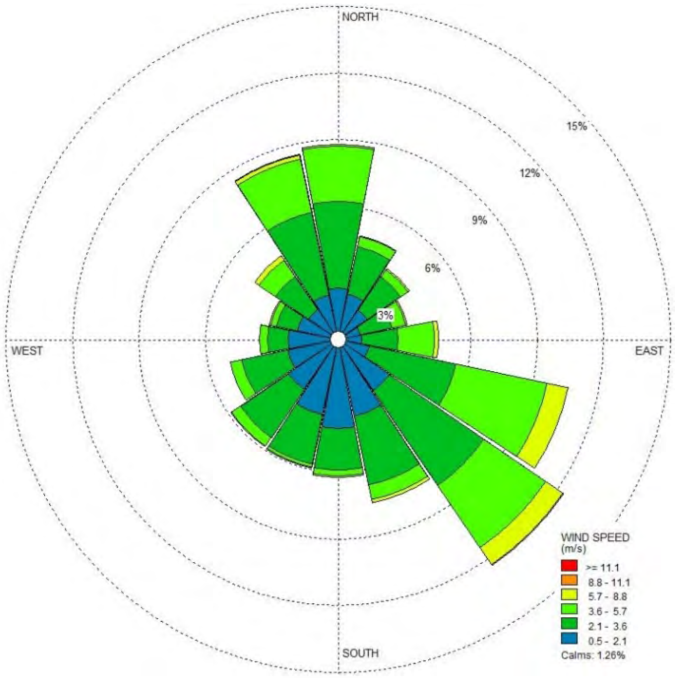


Figure 3-12: Wind rose for the April to September period (2012-2015) for the Coffee Gold Project site. Flow vectors are in the direction that winds are blowing from.

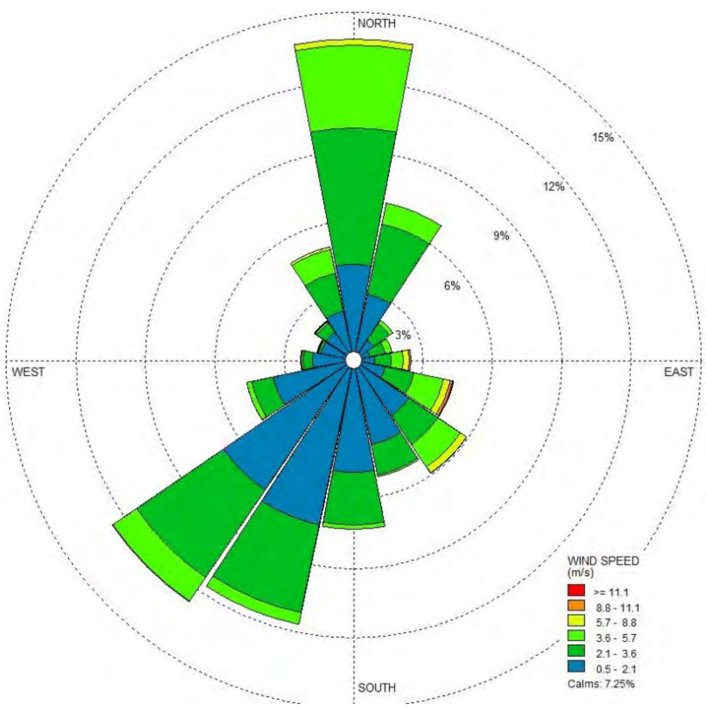


Figure 3-13: Wind rose for the October to March period (2012-2015) for the Coffee Gold Project site. Flow vectors are in the direction that winds are blowing from.

3.1.4 Relative Humidity

On a monthly basis, relative humidity measured at the site climate station varies from lower values in the spring months (lowest is May; 49%) to higher values in the fall and winter of 78-84%. A relative humidity value of 100% was measured on 84 occasions (hourly), and the minimum measured value was 12.6% on May 16, 2015.

The Coffee Creek relative humidity record is shown in Figure 3-14 at daily time step.

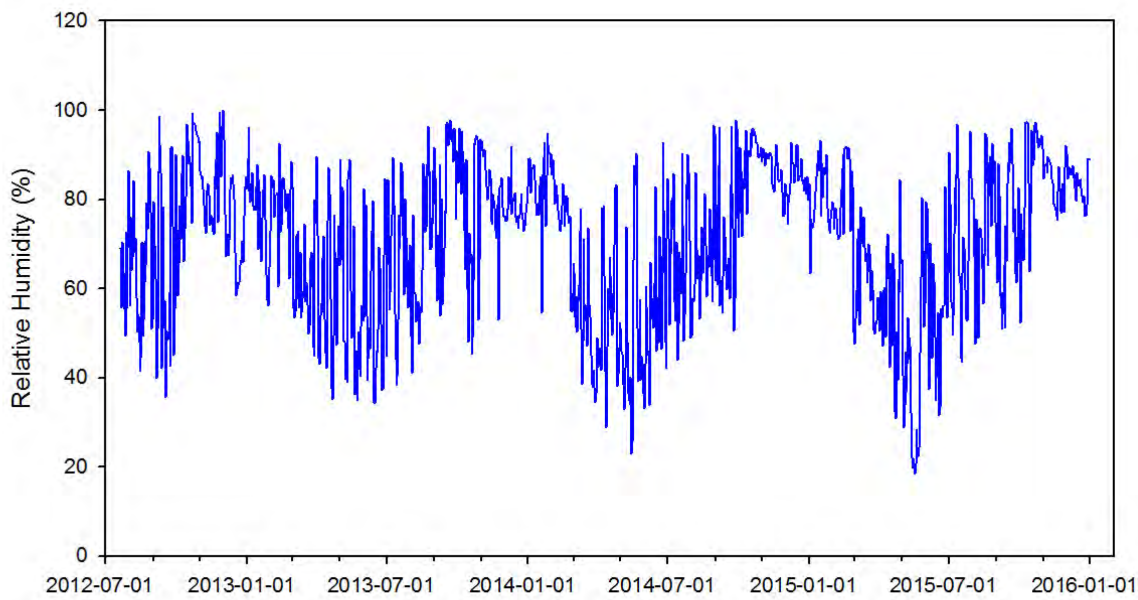


Figure 3-14: Daily average relative humidity measured at the site climate station.

3.1.5 Barometric Pressure

For the period of baseline study, barometric pressure as measured at the site climate station ranged from an hourly low of 971 mb to a high of 1036 mb. Overall, barometric pressures are higher in the summer months, with the highest average pressures occurring in July, as compared to lows in the winter months (*e.g.,* January).

The Coffee Creek barometric pressure record is shown in Figure 3-15 at daily time step.

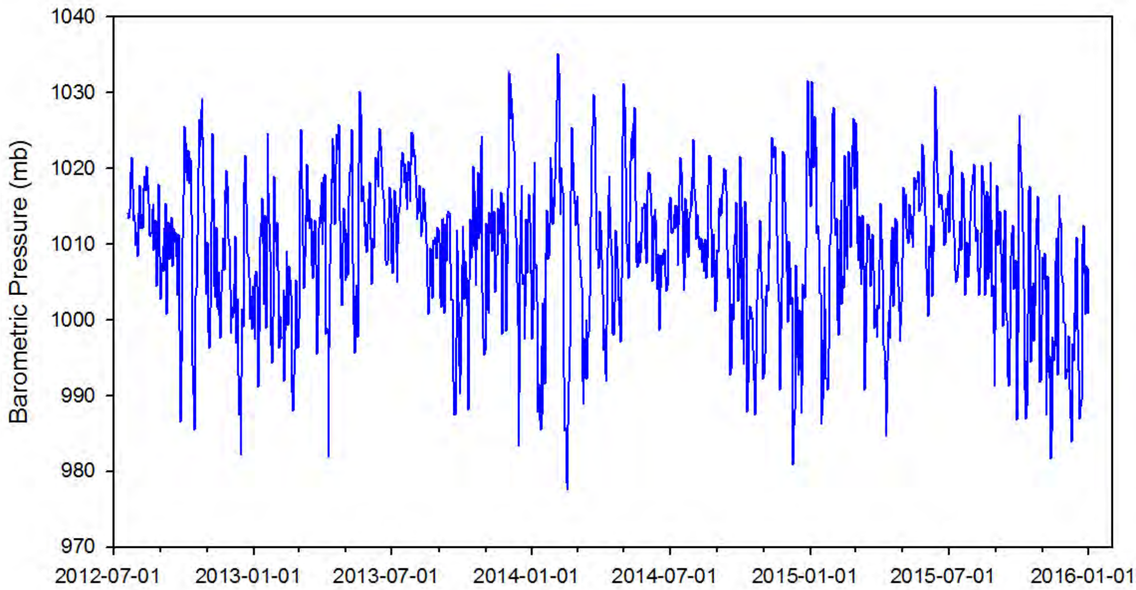


Figure 3-15: Daily average barometric pressure at the site climate station.

3.1.6 Solar Radiation

When data are summarized monthly for the available period of record, solar radiation varies from a monthly average high in June of 0.26 kW/m^2 to a low of 0.003 kW/m^2 in December. Since July 2012, the highest recorded hourly solar radiation value is 0.99 kw/m^2. The Coffee Creek solar radiation record is shown in Figure 3-16 at daily time step.

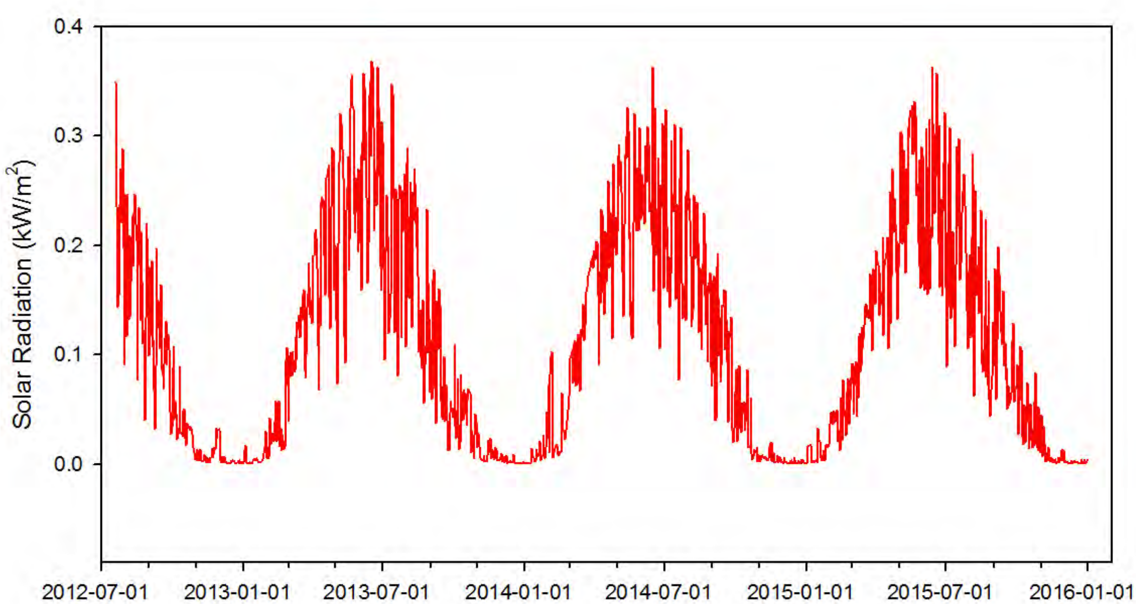


Figure 3-16: Daily average solar radiation measured at the site climate station.

3.1.7 Evapotranspiration and Potential Evaporation (PE)

Site- and regional estimates of evapotranspiration and potential evaporation are presented in Table 3-7. The regional estimates, which were computed by Clearwater Consultants for various territorial mining assessments (WCC, 2006), indicate May-Sep evapotranspiration rates may be expected to be on the of 140-200 mm for west-central Yukon Territory. Also presented in Table 3-7 and plotted in Figure 3-17 at daily time step are evapotranspiration data computed via a Campbell Scientific proprietary climate program using Coffee Creek weather station measurements. Site estimates of evapotranspiration compare favourably (in magnitude and temporal distribution) to those reported by Clearwater (*i.e.*, site measurements were 182 mm on an annual basis and 140 mm for May to end-September).

Table 3-7 (lower) presents six long-term estimates of mean annual lake evaporation (modelled and by pan) for Yukon stations. Overall, May-Sep lake evaporation totals are highly similar at these locations and ranges from 414 to 483 mm. Pelly Ranch is situated near Coffee Creek (see Figure 1-1) and reported long-term lake evaporation is 453 mm there. Potential evaporation estimated for Coffee Creek using a Penman-Monteith formulation is similar and 501 mm per year, noting that period of record is comparatively short for site. For all reported estimates of potential evaporation, monthly rates are highest in May, June, July and August (roughly 70 to 110 mm per month) and considerably lower for autumn, winter and spring months (Table 3-7).

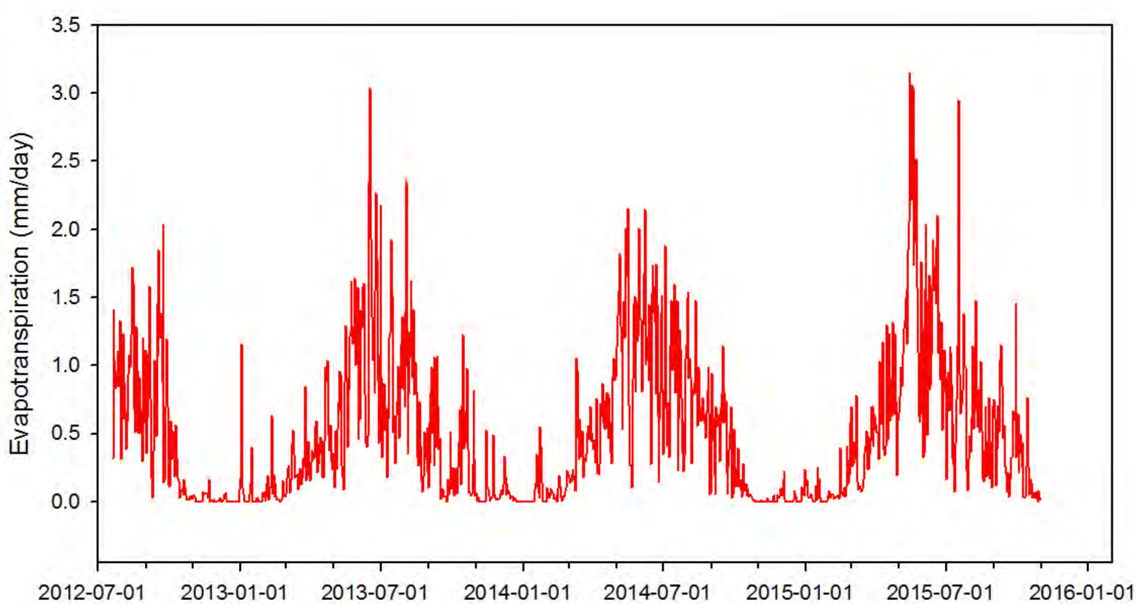


Figure 3-17: Daily average evapotranspiration measured at the site climate station.

Table 3-7:
Estimates of evapotranspiration and potential evaporation from studies at or near Coffee Creek

	Average Monthly Areal Evapotranspiration (mm)													
Station	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**	**May-Sep**
Williams Creek	0	0	17	17	27	41	38	18	15	5	0	0	177	140
Mayo A	0	0	0	19	33	50	56	39	17	6	0	0	220	195
Whitehorse A	0	0	13	24	35	45	45	24	15	8	0	0	209	164
Minto Camp (adjusted)	0	0	6	20	32	40	35	22	16	4	0	0	174	144
Coffee Gold weather station (CS)	2.2	2.9	10.3	17.4	37.6	36.6	26.3	23.1	16.8	6.4	1.4	0.9	182	140
	Average Monthly Lake Evaporation (mm)													
Station	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**	**May-Sep**
Williams Creek (WREVAP)	0	0	22	62	100	119	111	77	34	4	0	0	528	440
Mayo A (WREVAP)	0	0	0	48	91	111	108	78	26	6	0	0	467	414
Whitehorse A (WREVAP)	0	0	15	58	97	119	113	81	34	10	0	0	528	444
Whitehorse A (Adjusted Class A pan)	-	-	-	-	104	125	110	96	48	-	-	-	-	483
Pelly Ranch (Adjusted Class A pan)	-	-	-	-	108	120	108	80	37	-	-	-	-	453
Minto Camp (Adjusted)	0	0	5	56	95	119	112	80	24	4	0	0	495	431
Coffee Gold weather station (Pot Evap)	0.4	5.0	22.6	46.2	103.0	112.2	91.9	71.2	36.9	10.4	1.0	0.2	501	415

3.2 Hydrology

3.2.1 Coffee Creek Hydrometric Data

From the extensive hydrometric network at Coffee Creek, combined with the monthly sampling trips conducted since autumn 2010, a high-quality and high-resolution streamflow dataset has been assembled. These data are presented in full in Appendix A, and have been used to: inform project feasibility studies; complete design and engineering studies related to the Project; and they have also been used to build and calibrate a site-wide water balance and water quality model for the proposed undertaking. As a compliment to the information presented in Appendix A, this section presents examples of the available hydrometric data to illustrate overall quality, and also presents roll up tables (*e.g.,* for unit yields, peak flows, low flows) and discussion in an effort to synthesize the data.

3.2.1.1 Drainage Basin Characteristics, Rating Curves and Discharge Records

Hydrometric data and outputs are presented in Appendix A1 for 2011 to 2015, and in Appendix A2 for 2016. Appendix A1 is separated into eleven sub-sections or data reports, each sub-section reporting out baseline hydrometric data for monitoring locations at Coffee Creek. For each monitoring station, an assortment of information is presented in Appendix A1, including:

Drainage Basin Information

Mean elevation, basin area, a detailed basin map, aspect and hypsometry information are presented per hydrometric station in Appendix A1. Figure 3-18 shows an example of a drainage area map included in Appendix A1 (for hydrometric station CC-3.5 (Latte Creek), upper plot), as well as a summary of available hypsometric data for the Coffee Creek monitoring station (lower plot).

Station Information

Summary reports list all pertinent station information for the various monitoring station. Included in Appendix A1 are the following: Station ID, period of record, instrumentation (type of water level logger) and sampling frequency, and benchmark survey results.

Photos of the stations and watercourses, under various flow conditions, are also included in Appendix A.

Rating Curves

Appendix A1 shows active rating curves for the Coffee Creek hydrometric stations, and also shows plots that indicate range of rating curve validation, using probability of exceedance plot format, for the various hydrometric stations. Examples of these plots are shown for CC-1.5 hydrometric station in Figure 3-19. Appendix A1 also summarizes, by station, all spot measurements of discharge recorded at the property since 2010.

Measured Time Series Data

Period of record discharge data are shown for hydrometric stations in time series format. Discharge data are also presented in summary table format (by month, as yields, discharges and runoff depths) per station for the period of record. Included on time series plots are continuous discharge data estimated from rating curves, spot measurements of discharge, and interpolated baseflows for the hydrometric stations. Discharge data for Halfway Creek stations HC-2.5 and HC-5.0 are shown below (Figure 3-20) as representative examples. Interpolated baseflows are described in more detail in Section 3.2.2.4.

Synthetic Discharge Data

Appendix A1 shows synthetic discharge data in a number of formats: time series, flow duration curve plot; and anomaly plot. Also shown in Appendix A1 are monthly/low-flow relationships (site, Indian River) ascertained and used to compute the daily, long-term synthetic flow records. Representative plots showing synthetic discharge data outputs are presented and discussed in Section 3.2.2 below (refer to Figure 3-23, Figure 3-24 and Figure 3-25).

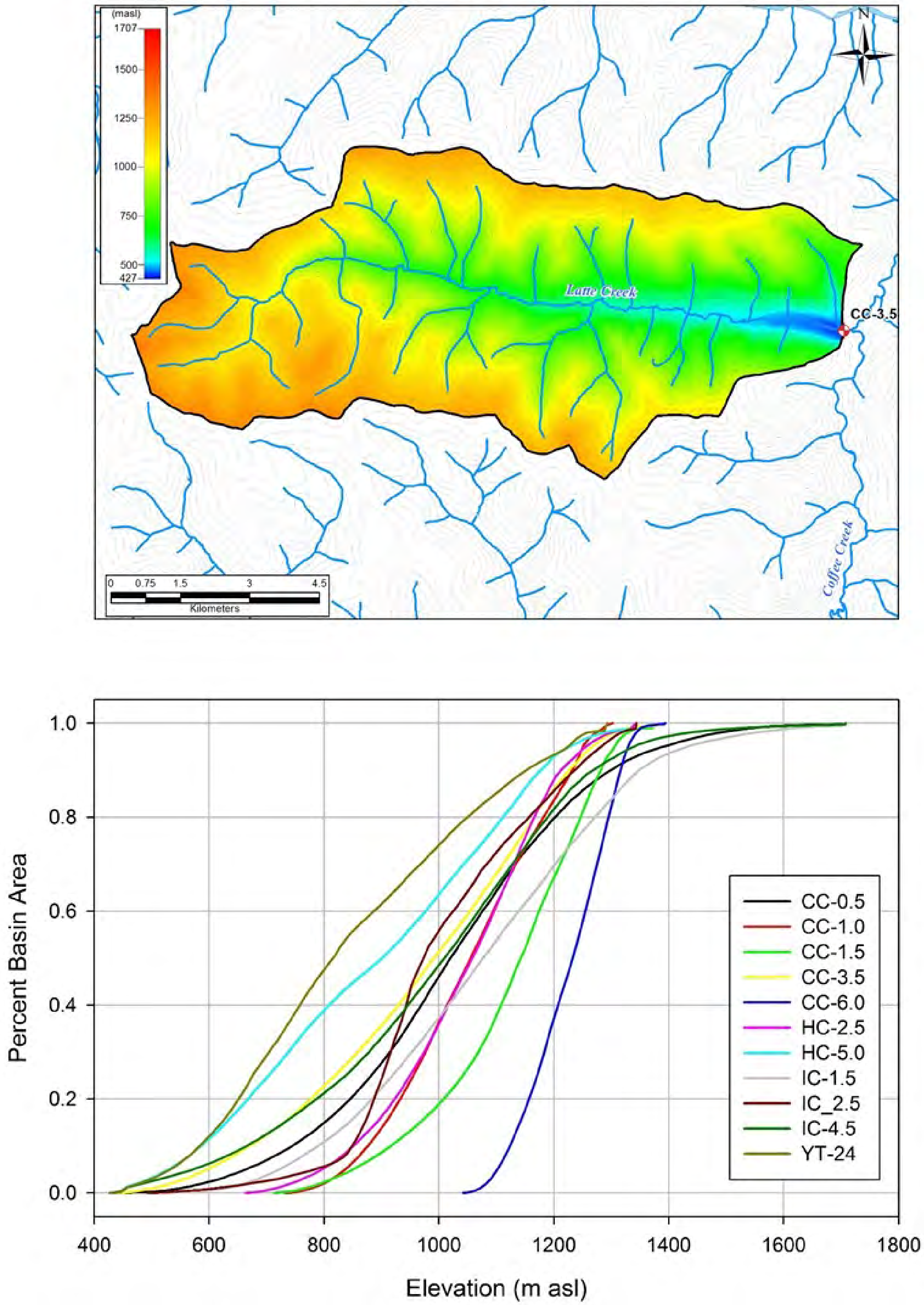


Figure 3-18: Drainage basin map for hydrometric station CC-3.5 (upper plot) and plot showing hypsometric curves (basin area vs. elevation) for all hydrometric stations at Coffee Creek (lower plot).

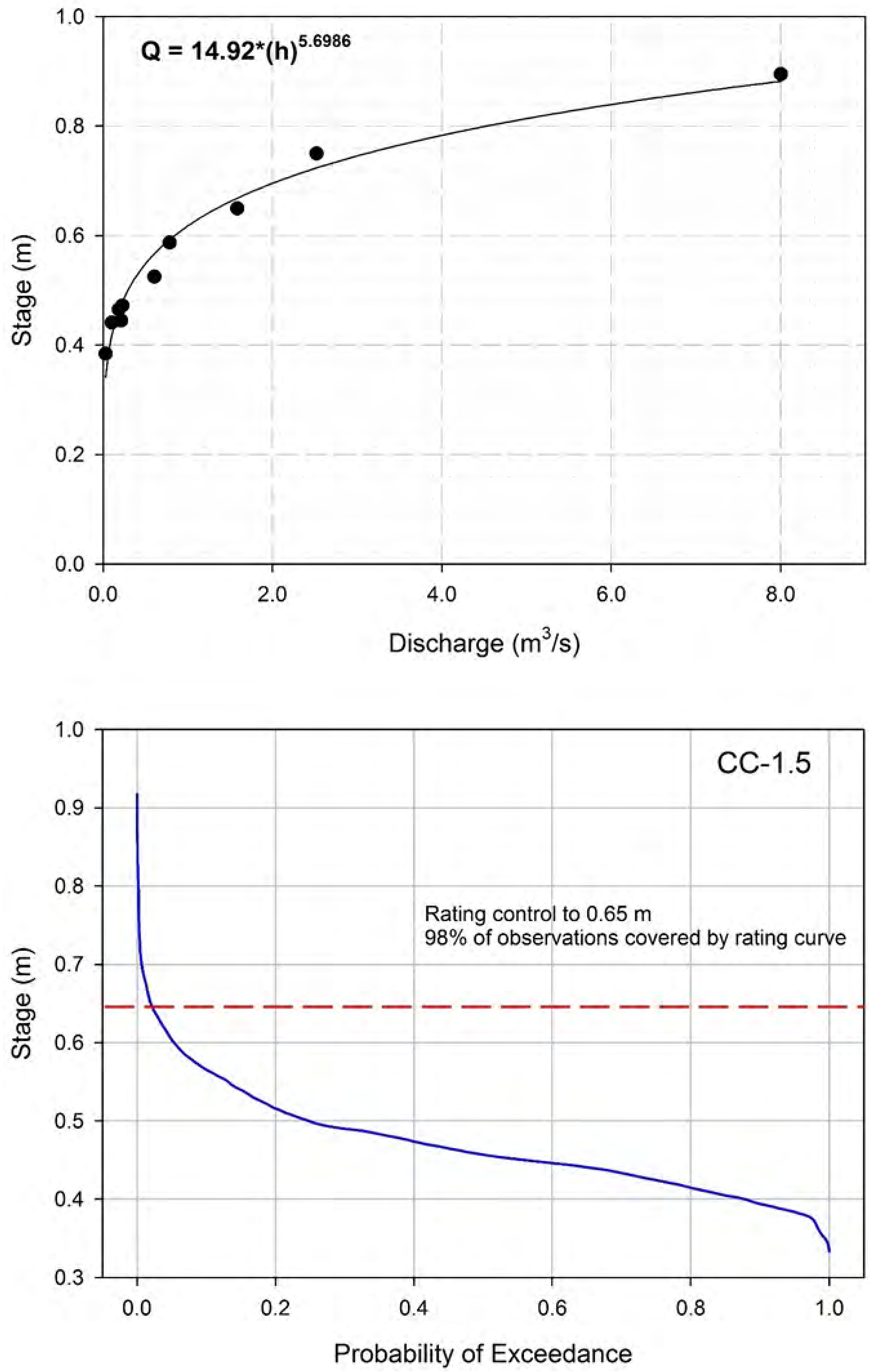


Figure 3-19: Rating curve (upper plot) and plot indicating range of rating curve validation (probability of exceedance plot for stage) for CC-1.5 hydrometric station (lower panel).

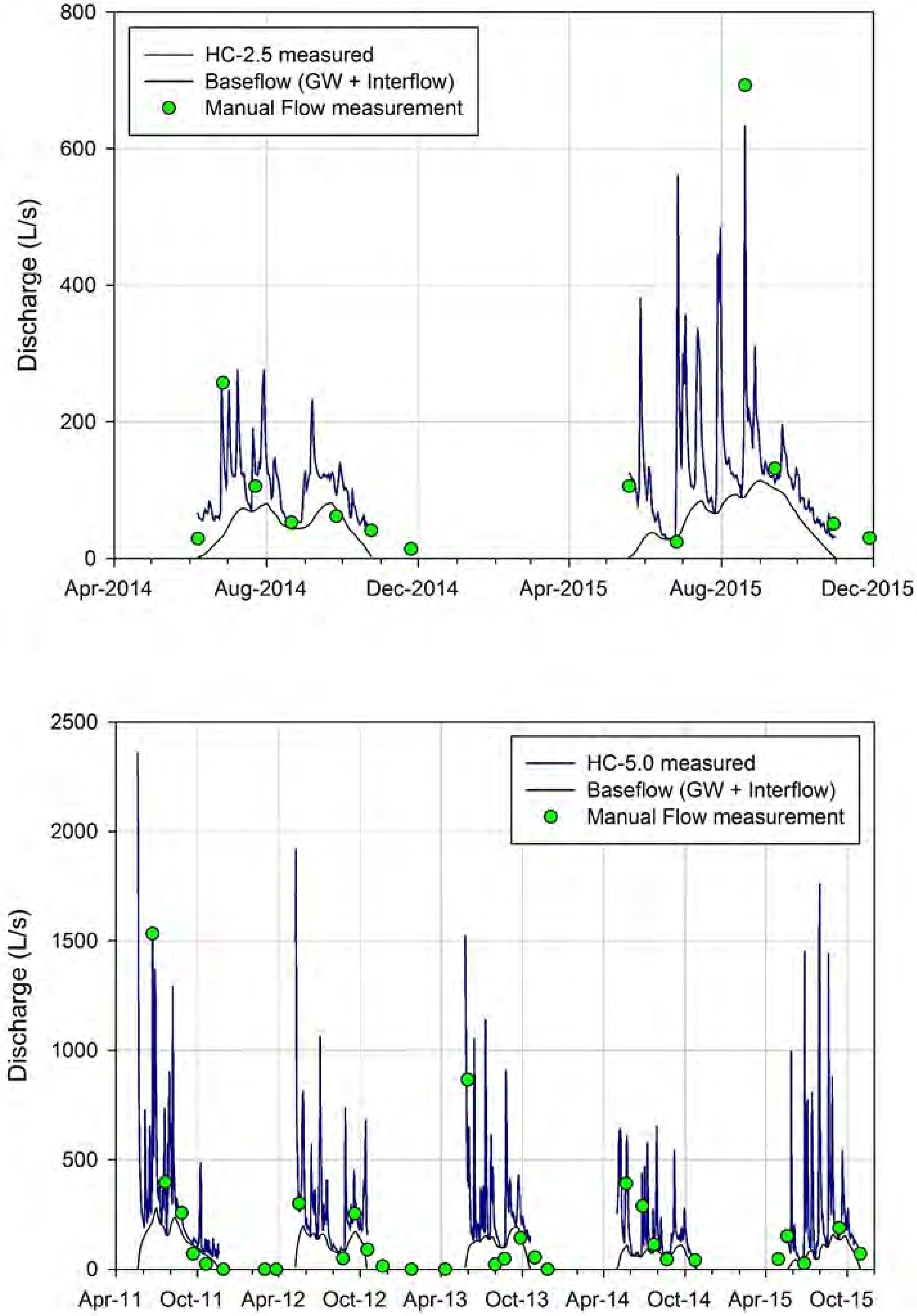


Figure 3-20: Time series discharge data for hydrometric stations on Halfway Creek. The upper panel shows discharge data (blue line), spot measurements of discharge (green circles) and interpolated baseflow (black line) for HC-2.5, whereas the lower panel shows data for HC-5.0.

3.2.1.2 Unit Yields

Local patterns of streamflow are dominated by a snowmelt freshet that typically occurs late-April to mid-June and punctuated by multiple rainfall-induced high flow events that occur throughout the summer and autumn. In general, these high flow events are short lived, often persisting for a duration of 1 or 2 days. A plot showing the unit yields for all Project drainages, for their periods of record, is presented as Figure 3-21.

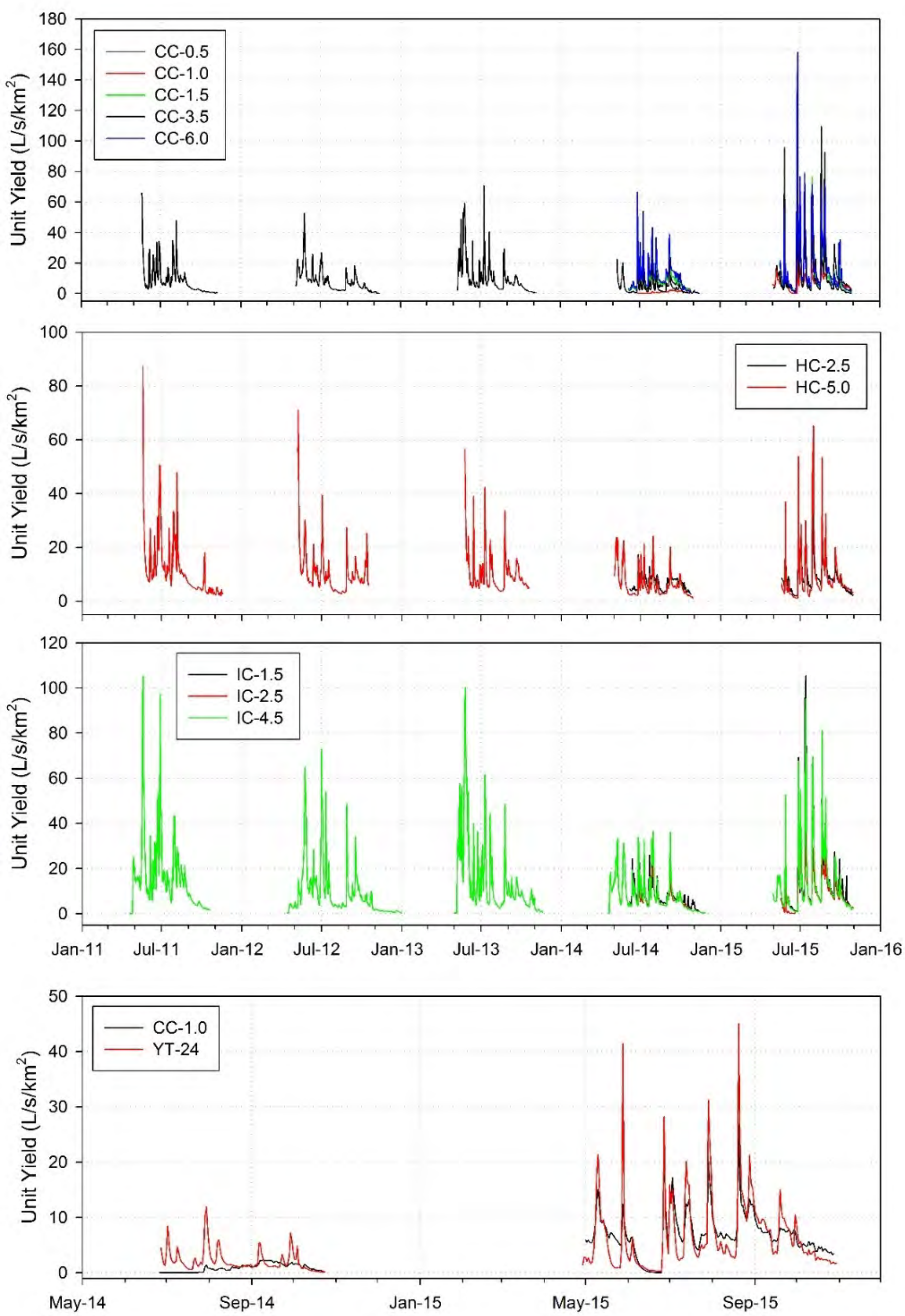


Figure 3-21: Unit yield hydrographs for gauged Project basins.

In general, average unit yields across the Project site are 9 L/s/km^2 for the open water season (May to October), and range from 4.5 to 15 L/s/km^2, depending on the drainage. The YT-24 and CC-1.0 drainages that drain the north and south waste rock dumps (respectively) have the lowest yields, while Upper Latte Creek (CC-6.0 and CC-1.5) and Independence Creek at the Mouth (IC-4.5) have the highest yields.

Measured average unit yields are summarized in Table 3-8 for Coffee Creek.

Table 3-8:
Average unit yields by month (L/s/km^2)

Station	Area (km^2)	Record	May	June	July	Aug	Sept	Oct	Nov	May-Oct Average
CC-0.5	385.6	2014-2015	12	7	13	11	11	4	1	10
CC-1.0	3.4	2014-2015	7	3	5	5	5	3	NA	4
CC-1.5	23.1	2014-2015	13	13	19	15	11	4	NA	12
CC-3.5	69.8	2011-2015	15	12	14	9	6	2	1	9
CC-6.0	9.6	2014-2015	16	15	23	18	13	6	NA	15
HC-2.5	14.8	2014-2015	10	6	11	9	9	5	NA	8
HC-5.0	27.0	2011-2015	15	8	11	9	8	5	3	9
IC-1.5	81.1	2014-2015	9	9	19	13	11	6	2	11
IC-2.5	17.3	2014-2015	6	5	13	10	9	5	NA	8
IC-4.5	222.3	2011-2015	21	14	16	9	10	4	1	13
YT-24	11.8	2014-2015	7	3	6	6	5	2	NA	5

3.2.1.3 Peak Flows

Peak flows are driven primarily by the intense convective rainfall events that are common in the summer months, with secondary peaks occurring in late-May, as a result of melting snowpacks. Measured peak flows are summarized in Table 3-9 for Coffee Creek stations.

Instantaneous peak flow unit yields are typically between 120 and 200 L/s/km^2, although some drainages have recorded peak flows that are much lower and in the 60 L/s/km^2 range (*e.g.*, CC-1.0, HC-2.5 and IC-2.5). Interestingly, Upper Latte Creek experiences relatively larger instantaneous peak flow yields, on the order of 300 to 400 L/s/km^2.

Table 3-9:
Instantaneous peak yields by month (L/s/km^2)

Station	Area (km^2)	Record	May	June	July	Aug	Sept	Oct	Nov	Annual Maximum
CC-0.5	385.6	2014-2015	192	125	96	156	40	15	3	192
CC-1.0	3.4	2014-2015	22	30	50	41	13	7	NA	50
CC-1.5	23.1	2014-2015	85	396	140	105	42	17	NA	396
CC-3.5	69.8	2011-2015	90	375	118	87	25	10	1	375
CC-6.0	9.6	2014-2015	73	310	116	94	49	50	NA	310
HC-2.5	14.8	2014-2015	36	52	57	51	18	13	NA	57
HC-5.0	27.0	2011-2015	118	78	110	76	25	27	6	118
IC-1.5	81.1	2014-2015	51	94	161	112	40	24	7	161
IC-2.5	17.3	2014-2015	29	66	47	42	20	14	NA	66
IC-4.5	222.3	2011-2015	146	147	119	106	45	15	3	147
YT-24	11.8	2014-2015	127	61	92	74	22	26	NA	127

3.2.1.4 Low Flows

During the open water season, the recession limbs of local hydrographs are often steep following the passage of a large rain event and the associated peak flows. Low flow conditions can occur intermittently during the summer and early autumn across the Project site, with unit yields during early summer often approaching those measured during the winter months. Measured low flows are summarized in Table 3-10.

Low flows measured in June 2015 (~1 L/s/km^2) formed a critical input to the site-wide groundwater model calibration. As the summer progresses, baseflows are enhanced by active layer melt and soil moisture recharge. By November, unit yields were observed to drop to 0.5 to 1.5 L/s/km^2 in all project drainages, and zero flow conditions become widespread by late January and are accompanied by extensive aufeis formation. Aufeis (*i.e.,* frozen groundwater seepage that accumulates within- and adjacent to local watercourses) is pervasive in creeks and streams at the Project site. Aufeis melts during the freshet, but may persist into the early summer (mid- to late-June). It is discussed in more detail in Section 3.2.2.3.

**Table 3-10:
Low flow yields by month (L/s/km^2)**

Station	Area (km^2)	Record	May	June	July	Aug	Sept	Oct	Nov	Annual Minimum
CC-0.5	385.6	2014-2015	1.0	0.6	2.5	3.7	3.7	0.1	0.1	0.1
CC-1.0	3.4	2014-2015	4.6	0.0	0.0	0.3	0.5	0.1	NA	0.0
CC-1.5	23.1	2014-2015	3.0	1.8	2.6	2.9	3.5	0.9	NA	0.9
CC-3.5	69.8	2011-2015	1.8	0.5	1.0	1.1	0.9	0.1	0.2	0.2
CC-6.0	9.6	2014-2015	4.0	0.3	3.5	3.8	3.8	0.7	NA	0.3
HC-2.5	14.8	2014-2015	3.5	1.3	3.6	2.5	4.2	1.5	NA	1.3
HC-5.0	27.0	2011-2015	1.9	0.8	1.4	2.1	3.5	1.0	1.6	0.8
IC-1.5	81.1	2014-2015	1.7	0.9	3.3	4.2	4.8	1.9	1.0	0.9
IC-2.5	17.3	2014-2015	0.3	0.0	3.7	3.4	5.0	1.2	NA	0.0
IC-4.5	222.3	2011-2015	0.2	0.8	2.9	2.3	3.1	0.9	0.3	0.2
YR24	11.8	2014-2015	0.2	0.1	0.4	0.9	0.5	0.0	NA	0.0

3.2.1.5 Mean Annual Runoff (MAR) and Elevation

Hydrometric data tabled in Appendix A is presented in runoff depth format. Estimates for each station are presented monthly, annually and as an average (mean annual runoff, MAR) per station, for the available period of record. MAR estimates at Coffee Creek vary from basin to basin. For example, the runoff generated by YT-24 is low and approximately 60 mm based on measurements recorded in 2014 and 2015 (Appendix A). In contrast, runoff generated in the headwaters of Latte Creek are comparatively high and estimated to be 160 mm based on the 2014 and 2015 field campaigns. MAR for CC-6.0, a high-elevation headwater station within the Latte Creek drainage shows an even higher MAR value.

To explore relationships between runoff generation and basin characteristics, MAR estimates were regressed against mean basin elevation (m), basin area (km^2) and dominant aspect within the drainage. While resulting relationships were weak or poor for the basin area and aspect assessments, a robust relationship between runoff and elevation was ascertained. This relationship is shown for Project site drainages in Figure 3-22.

With the exception of the CC-1.0 basin, a small (3.4 km^2) catchment in the headwaters of Latte Creek, MAR increases linearly with increase in mean basin elevation at the Project site. Compared to other basins, the uniqueness of the CC-1.0 flow regime is assumed attributable to its basin outlet configuration (*i.e.*, small, wide, permeable surficial geology) that returns lower than expected surface water flow (especially in 2014) and presumably higher groundwater discharge than other basins that are gauged.

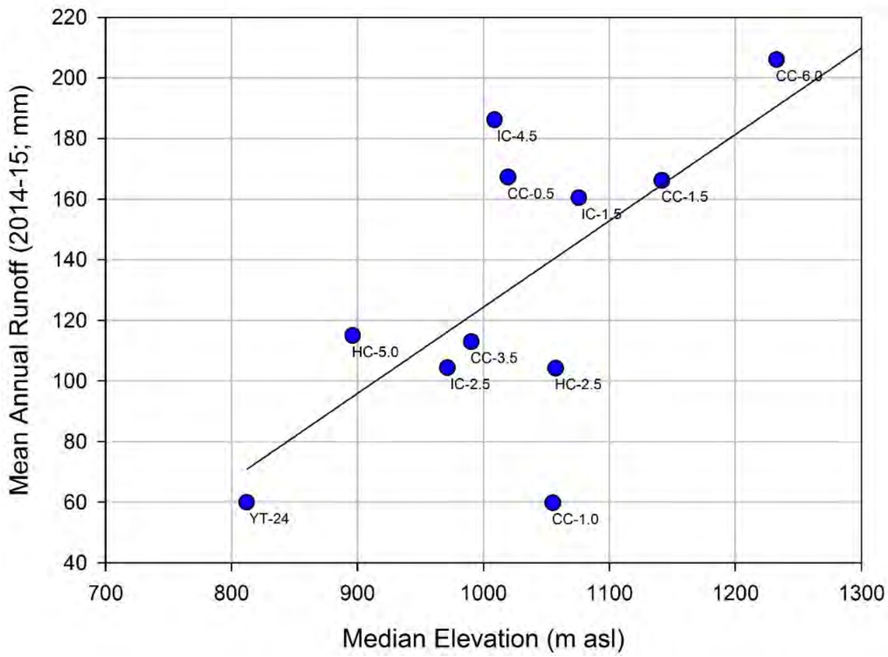


Figure 3-22: Mean annual runoff for the open water season plotted against median basin elevation (2014-2015).

3.2.2 Synthetic Discharge Data and Streamflow Metrics

The creation of synthetic hydrographs for all project stations resulted in a 34-year records (1982-2015) of daily discharge being created for the Project site drainage basins. Ultimately, these records allow the short-term site data to be placed in a broader historical context. An example synthetic record is shown in Figure 3-23 for Independence Creek hydrometric station IC-2.5. The upper plot of this figure shows the synthetically estimated discharge data for this station. The lower plot compares measured and synthetic discharge data for IC-2.5 (for the overlapping record of 2014 and 2015) in flow duration curve format. The strong similarity of these flow duration curves gives an indication that the magnitude of the discharges and the range of variability for discharge in the measured record is appropriately replicated in the synthetic series.

Figure 3-24 depicts the long-term annual runoff time-series for stations CC-1.5, HC-2.5 and YT-24. Given the general arrangement for the proposed mine (refer to Figure 1-2), these three basins may see modification and/or alteration to surface flow, surface water quality and/or groundwater condition (quantity, quality) as project footprints advance. Runoff data in this figure show that overall, range in inter-annual variability for each station is substantial, and the relative magnitude of variation differs between basins. The differences in magnitude are assumed attributable to site-specific differences in mean basin elevation (Figure 3-22), that have been correctly embedded into the respective synthetic discharge series.

The long-term variability in natural runoff contained within each synthetic dataset can be shown in standardized anomaly plot format. An example anomaly plot is shown for YT-24 in Figure 3-25, where positive Y-axis and negative Y-axis scaling indicate progressively higher and lower deviations from long-term average runoff respectively. From Figure 3-25, it is apparent that the baseline study period (*i.e.*, autumn 2010 to end 2015) captured two years that were wetter than average (2011 and 2013), and three years that were average or slightly drier than average (2012, 2014 and 2015). This is critical information, as a series of wet- or dry-years occurring during a short baseline data collection period can heavily bias estimates of streamflow metrics.

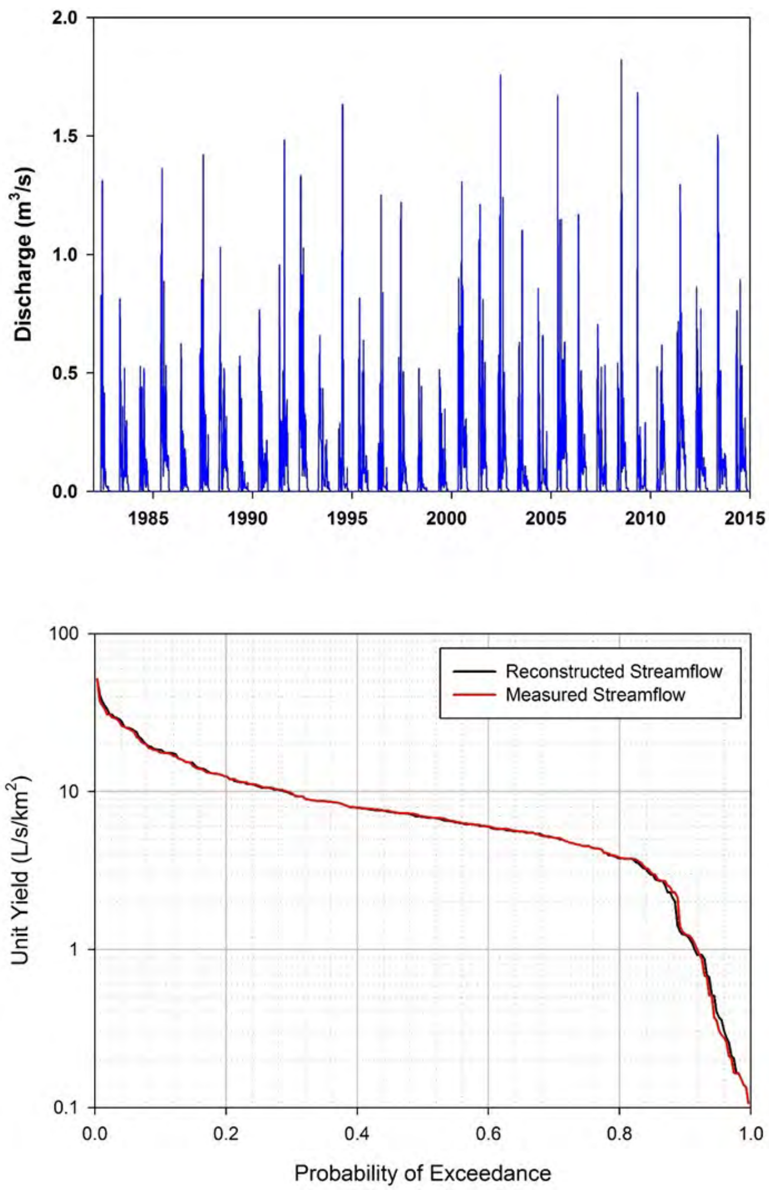


Figure 3-23: Time-series of daily discharge for the IC-2.5 synthetic discharge record (upper panel). The lower panel shows IC-2.5 discharge data (measured and synthetic) in flow duration curve format.

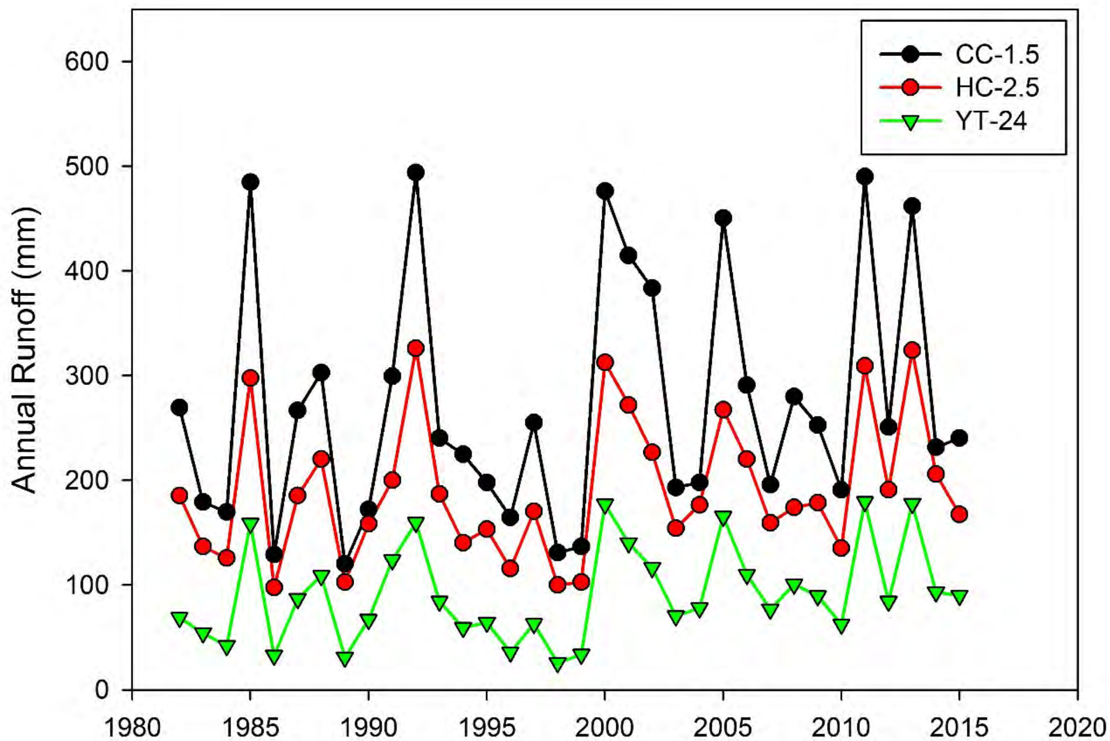


Figure 3-24: Annual runoff time-series for stations CC-1.5, HC-2.5 and YT-24.

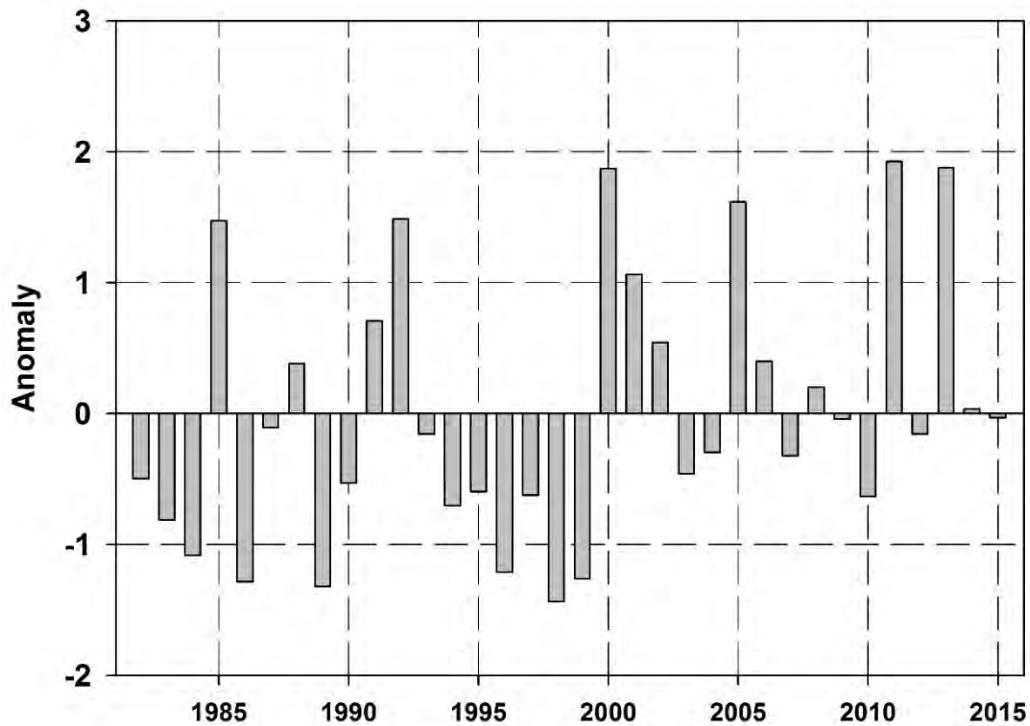


Figure 3-25: Standardized anomaly plot for annual runoff at YT-24.

3.2.2.1 Annual Runoff: Wet- and Dry-year Recurrence Intervals

Results of the annual runoff recurrence interval analysis are presented in Table 3-11, along with the average runoff ascertained from the measured site data. Agreement is generally good for all basins, although the site data are biased toward the 2014-15 monitoring period and hence, drier conditions. The spread between the 1:200 dry- and wet-years is confirmed to be substantial at Coffee Creek, and generally, wet-years are expected to produce ten times more runoff than an extreme dry-year. As a point of reference for the wet- and dry recurrence interval data presented in Table 3-11, the synthetic discharge records vary by factors of 4-7 over the 34 years of record.

Table 3-11:
Annual runoff recurrence interval estimates for Project site basins (all values in mm/year).

Exceedance Probability	Return Period	CC-0.5	CC-1.0	CC-1.5	CC-3.5	CC-6.0	HC-2.5	HC-5.0	IC-1.5	IC-2.5	IC-4.5	YT-24
0.005	1:200 dry	25	14	76	36	125	67	22	57	30	40	5
0.01	1:100 dry	39	19	88	41	141	75	31	69	39	49	10
0.02	1:50 dry	54	23	101	48	158	84	41	83	49	59	17
0.04	1:25 dry	72	29	117	55	179	95	52	99	61	71	25
0.1	1:10 dry	103	38	144	68	216	113	71	127	81	92	38
0.5	1:2 (median)	213	71	248	117	353	179	135	225	146	167	84
Site average (2012-2015)		167	60	166	132	206	104	120	160	104	209	60
0.9	1:10 wet	381	119	427	196	583	282	220	371	233	281	154
0.96	1:25 wet	464	142	526	238	706	334	257	441	271	337	188
0.98	1:50 wet	525	158	603	270	800	372	283	492	297	378	213
0.99	1:100 wet	585	173	683	302	896	410	306	541	321	418	237
0.995	1:200 wet	644	188	766	335	996	447	328	588	343	458	260

The average runoff for all site stations is presented alongside the corresponding annual precipitation estimate for each recurrence interval in Table 3-12. Average runoff coefficients for each interval are presented in this table as well. These data show that the proportion of annual precipitation converted to runoff increases in proportion to the total annual precipitation estimated, which is consistent with the expected basin response. For a wet year, soil moisture storage would likely be fully recharged, and would have limited additional capacity to store infiltrated precipitation. Conversely and for a dry-year, a below average snowpack or prolonged summer drought combined with evaporation, may require appreciable precipitation to replenish basin storage and soil moisture deficit, and only then will surface runoff be produced.

Table 3-12:
Annual precipitation and average annual runoff recurrence interval estimates.

	Recurrence Interval (1:years)	Annual Precipitation (mm)	Average Runoff (mm)	Average Runoff Coefficient
Dry-year	1:200	285	44	0.16
	1:100	300	54	0.18
	1:50	318	64	0.20
	1:25	338	77	0.23
	1:10	372	98	0.26
Median	1:2	479	175	0.37
Wet-year	1:10	613	293	0.48
	1:25	667	352	0.53
	1:50	702	395	0.56
	1:100	734	439	0.60
	1:200	762	482	0.63

3.2.2.2 Peak Flows

As an extension to the peak flow analysis presented using measured data from site, a regional peak flow analysis was conducted using the stations listed in Table 2-4. Recurrence interval estimates of annual instantaneous peak flows were plotted against drainage area, and an enveloping power law function was then fit to the data. For reference, the measured peak flows from the site data were also plotted, with a separate function fit to these data. The enveloping power law functions derived from the regional data for each recurrence interval (*e.g.*, 1:100 year peak flow) were used to estimate the corresponding peak flow for all Project drainages. The results of this analysis are presented as unit yields in Table 3-13 and plot of the regional- and site- peak flow data is provided in Figure 3-26.

Table 3-13:
Instantaneous peak yield recurrence interval estimates for Project basins derived from regional analysis (L/s/km^2)

Station	Drainage Area (km2)	1:2 year	1:5 year	1:10 year	1:25 year	1:50 year	1:100 year	1:200 year	Measured Maximum Peak Yields
CC-0.5	385.6	118	195	288	398	462	570	639	192
CC-1.0	3.4	241	489	805	1261	1597	2132	2579	50
CC-1.5	23.1	181	337	531	790	966	1249	1465	396
CC-3.5	69.8	153	272	418	603	723	918	1057	141
CC-6.0	9.6	206	400	643	979	1216	1596	1899	310
HC-2.5	14.8	193	368	585	881	1086	1415	1671	81
HC-5.0	27	176	327	514	761	928	1196	1399	118
IC-1.5	81.1	149	264	405	582	695	880	1012	161
IC-2.5	17.3	189	357	566	848	1042	1354	1596	66
IC-4.5	222.3	128	217	325	455	534	664	751	147
YT-24	11.8	200	384	615	931	1152	1507	1786	127

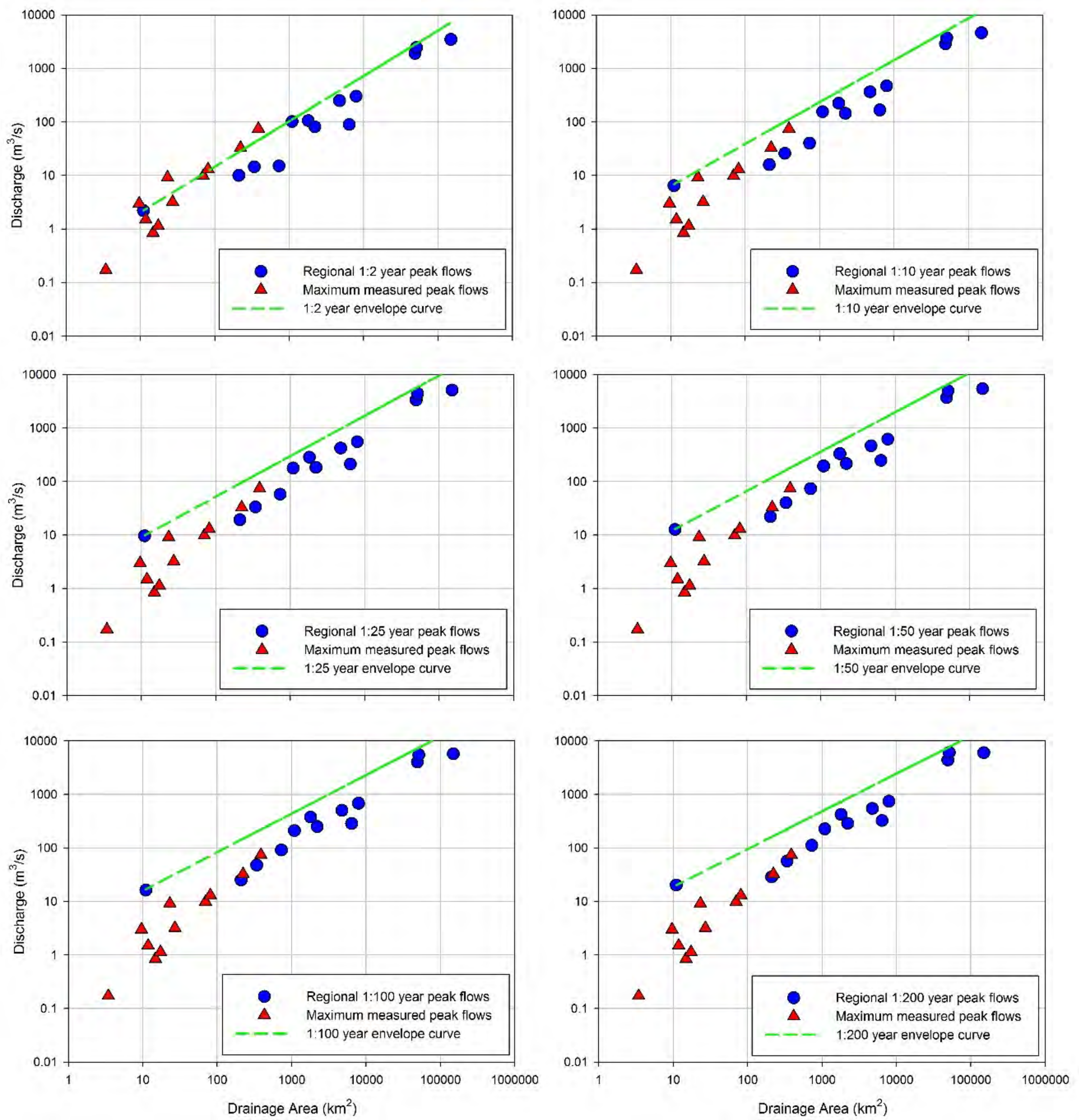


Figure 3-26: Peak flow estimates for regional stations (blue) and maximum recorded instantaneous site discharges (red).

For basins under 1,000 km^2, there is overlap between the regional- and site data for the 1:2 year and 1:10 year envelope curves shown in Figure 3-26, and this is not unexpected given that period of record for Coffee Creek is approximately five years. By comparison, peak flows returned from the regional analysis are higher in magnitude and therefore more conservative that an estimate returned from site- measurements alone for the most extreme peak flow events (*i.e.*, 1:50 year, 1:100 year and 1:100 year). As a validation of the reasonableness of the peak flows returned from the envelope curves, regional guidance documents published by state and territorial governments on the estimation of peak streamflows in ungauged basins were consulted (Curran *et al*., 2003; Janowicz, 1989).

Table 3-14 list the proposed peak flow equations for Project area basins and also reports peak flow estimates for a 100 km^2 drainage using envelope curves and the data models proposed by Curran *et al.,* 2003.

Table 3-14:
Summary of predictive equations for select peak flow events

Event	**Envelope Curve Equation**	**Peak Flow Comparison (Envelope Curve, Curran *et al.*, 2003)**
1:2 year	$y = 290A^{-0.151}$	14, 8
1:5 year	$y = 620A^{-0.194}$	25, 18
1:10 year	$y = 1050A^{-0.217}$	39, 28
1:25 year	$y = 1700A^{-0.244}$	55, 44
1:50 year	$y = 2200A^{-0.262}$	66, 58
1:100 year	$y = 3000A^{-0.279}$	83, 75
1:200 year	$y = 3700A^{-0.295}$	95, 94

Notes: The Envelope Curve Equations in the table above are shown graphically in Figure 3-26. In the right most column above, peak flows (in m^3/s) from the Envelope Curve Equations are compared to estimates after Curran *et al.,* 2003. The values reported are for a hypothetical drainage basin with area 100 km^2. The Envelope Curve Equation uses *A* (basin area in km^2) as the predictor variable for the peak flow value and the equation returns a value in units of $L/s/km^2$. For the Curran *et al.* peak flows the following was assumed: 1) peak flow equations for Region 5 were applied; 2) mean basin elevation (E) was assumed to be 1,067 m asl (3,500 ft); 3) forest cover (F) was set to 75% in the data model; and 4) storage (S) was conservatively set to a value of 1%.

3.2.2.3 Low Flows

A robust characterization of the low flow regime is required to inform potential water quality sensitivities, as well as the potential for shortfalls in water required for process makeup or dust control, for example. A low flow analysis is presented below that considered inspection of regional- and site-specific hydrometric data. Consistent with provincial guidance (see BC MOE, 2012), low flow values returned by the Log Pearson (Type III) (LP3) distribution are reported in this section. In some instances, the LP3 distribution did not fit the data, in which case the Weibull or LogNormal distributions were used.

Both annual and summer (June-September) low flow events ($7Q_2$ [median], $7Q_5$, $7Q_{10}$ and $7Q_{20}$) were considered in this assessment, where recurrence interval estimates for summer low flows were derived from the synthetic discharge records. Due to limited site data available for the winter period, and extensive aufeis conditions documented in Project basins, the same approach was not taken for the annual low flow metrics. Instead, all available spot flow measurements for the winter months are presented for the site stations to give indication of expected annual low flow condition.

Summer Low Flow Regime

The low flow recurrence interval estimates for the summer period (June to September) are presented in Table 3-15 (regional) and Table 3-16 (site). The values are presented as unit yields to allow for easy comparison between basins.

The regional stations represent basins that span three orders of magnitude for area (km^2), and therefore, there is substantial variation in the calculated low flow yields. The most representative regional basins are assumed to be those with drainage areas <10,000 km^2. With the exception of 09EA004, which has anomalously high yields for a basin of this size, and to a lesser extent 09DD004, remaining basins (*i.e.*, 09AH003, 09AH004, 09CA006, 09EB003 and 09EB004) return summer $7Q_{10}$ yields that range from 0.7 to 1.2 L/s/km^2 (Table 3-15). For a parallel analysis conducted using the synthetic streamflow data, these data returned estimated summer $7Q_{10}$ values for the Project stations ranging from 0 to 1.7 L/s/km^2 (Table 3-16), with average of the summer $7Q_{10}$ values for the eleven Project stations being 0.7 L/s/km^2.

Table 3-15:
June – September minimum 7-day low flow recurrence interval estimates for regional stations. Values are unit yields (L/s/km^2).

Exceed. Prob.	Return Period	09AH003	09AH004	09BC001	09CA003	09CA006	09CD001	09DD003	09DD004	09EA004	09EB003	09EB004
		LP3	LP3	Weibull	LP3	LP3	LP3	LP3	LP3	LP3	LP3	LP3
	Basin Area (km^2)	1,800	6,410	48,900	12,400	7,910	149,000	51,000	4,750	1,090	2,210	3,060
0.5	1:2 (median)	2.08	1.50	7.21	11.66	2.52	9.50	8.14	5.96	10.10	1.42	2.14
0.2	1:5	1.36	0.96	5.38	8.48	1.54	8.17	6.16	4.63	8.11	0.92	1.35
0.1	1:10	1.11	0.76	4.43	7.11	1.20	7.51	5.27	4.06	7.15	0.72	1.05
0.05	1:20	0.94	0.63	3.67	6.11	0.97	6.98	4.62	3.65	6.41	0.58	0.85

Table 3-16:
June – September minimum 7-day low flow recurrence interval estimates from synthetic site records. Values are unit yields (L/s/km^2).

Exceed. Prob.	Return Period	CC-0.5	CC-1.0	CC-1.5	CC-3.5	CC-6.0	HC-2.5	HC-5.0	IC-1.5	IC-2.5	IC-4.5	YT-24
		LP3	LP3	LP3	LP3	LP3	LP3	LogNorm	LP3	LogNorm	LP3	LogNorm
0.5	1:2 (median)	1.79	0.00	2.49	0.80	2.55	2.83	1*.72	1.94	0.75	1.64	0.89
0.2	1:5	0.99	0.00	1.89	0.48	1.51	2.05	0.88	1.13	0.45	0.63	0.77
0.1	1:10	0.72	0.00	1.69	0.38	1.15	1.74	0.62	0.87	0.34	0.34	0.71
0.05	1:20	0.55	0.00	1.57	0.33	0.91	1.52	0.46	0.71	0.28	0.19	0.67

Annual Low Flow Regime and Aufeis

Over the course of the 5+ years of baseline study, all available winter spot flow measurements (October through April) were averaged by month then presented in Table 3-17 below. Low flow plots (*i.e.,* spot flow measurements and synthetic discharge estimates) are also presented for the hydrometric stations in Appendix A, with an example presented for Halfway Creek below in Figure 3-27.

Site data show that yields range from 1.2 – 3.3 L/s/km^2 in October, and decrease steadily to their annual minima by March (0 – 0.7 L/s/km^2), before increasing again in April in response to low-elevation snow melt and spring rainfall. Based on the site data alone, winter low flows are expected to range from 0 to 0.7 L/s/km^2.

Table 3-17:
Winter spot flow measurements presented as monthly averages for Project area hydrometric stations. Values are unit yields (L/s/km^2).

	CC-0.5	CC-1.5	CC-3.5	HC-2.5	HC-5.0	IC-1.5	IC-2.5	IC-4.5
JAN	0.07	0.91	0.14	1.32	0.00	0.65	NA	NA
FEB	0.07	0.63	0.00	0.70	0.00	0.31	0.00	NA
MAR	0.03	0.48	0.01	0.65	0.00	NA	NA	NA
APR	1.36	0.76	0.95	1.61	0.57	NA	4.00	2.42
MAY	--	--	--	--	--	--	--	--
JUN	--	--	--	--	--	--	--	--
JUL	--	--	--	--	--	--	--	--
AUG	--	--	--	--	--	--	--	--
SEP	--	--	--	--	--	--	--	--
OCT	2.58	2.71	1.61	3.29	2.19	2.84	1.19	2.16
NOV	0.43	0.78	0.30	1.18	0.21	0.64	0.00	0.20
DEC	NA	NA	0.20	1.17	NA	0.76	NA	0.34

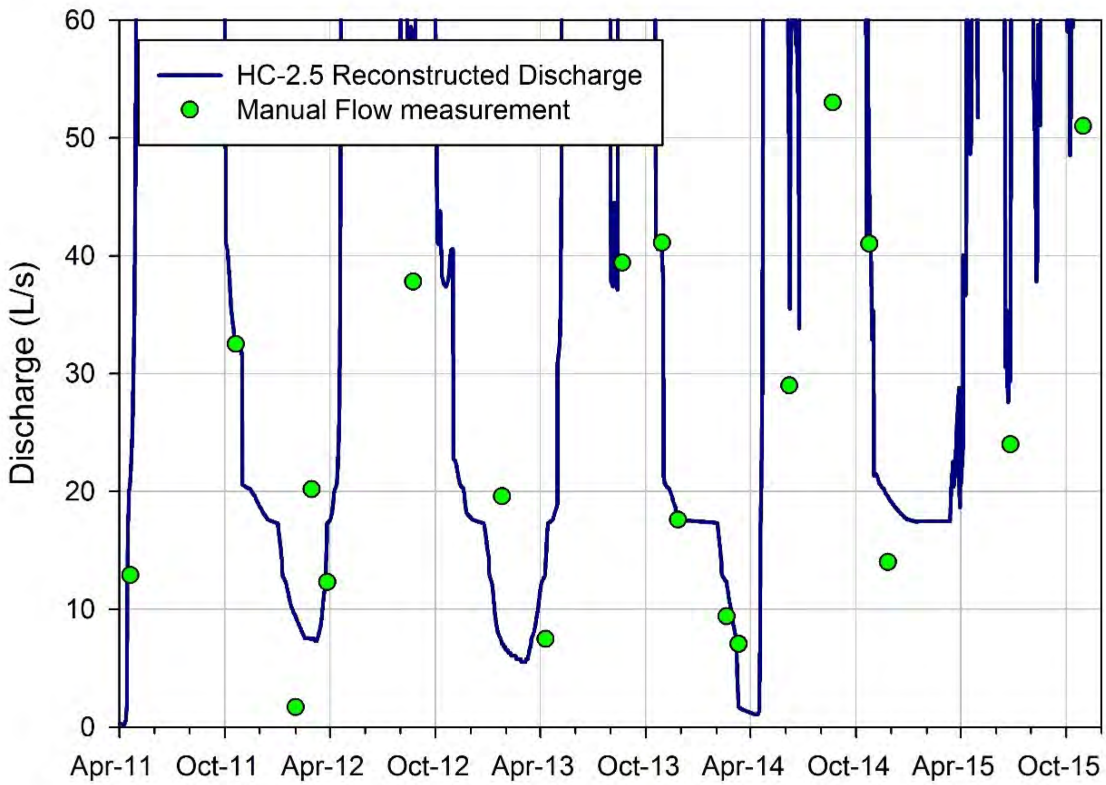


Figure 3-27: Plot showing synthetic discharge data and manual spot flow measurements for the HC-2.5 (Halfway Creek) hydrometric station. The y-axis has been scaled (*i.e.*, 0 to 60 L/s or roughly 0 to 4 L/s/km^2) to illustrate the similarities between the discharge data under low flow condition.

An important component of the winter flow regime at the Project site is the extensive icing of the local channels. This ice growth, or aufeis, is the result of shallow groundwater discharge and/or baseflow in the stream channel freezing. This ice impedes subsequent flow, which is forced on top of the existing ice sheet, where it freezes (see Figure 3-28). This process repeats continuously throughout the winter, and results in laminated ice sheets that have been measured close to 1.5 m in thickness and 50+ m in width in the Project channels (Figure 3-29). Liquid flow is thus either not present, or it can still occur between these laminae, and at the edges of the stream channel. It is these flows that the water quality samples are taken from during the winter. The aufeis process also acts as a storage reservoir for winter baseflows, and can store up to a third of the cumulative annual baseflow in sub-Arctic watersheds (Yoshikawa *et al*., 2007).

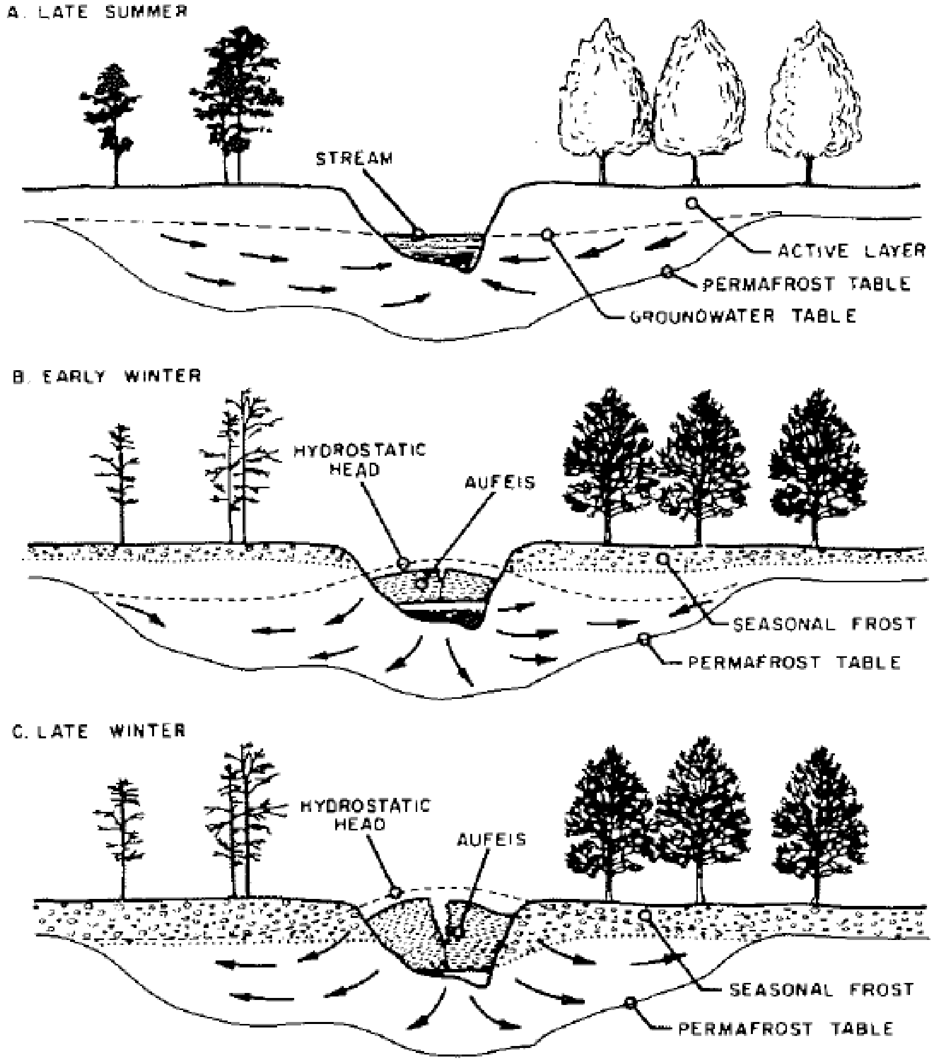


Figure 3-28: Groundwater flow patterns and aufeis formation (from Kane, 1981).

Aufeis often far exceeds the natural stream channel width in the smaller tributaries, and as ice melts much more slowly than the snowpack, much of the freshet occurs while extensive aufeis is still present. This makes accurate measurement of streamflows (where they exist) challenging or impossible during the winter season at most hydrometric stations, and dangerous during the initiation of freshet. This process also influences the distribution of annual streamflow, as the baseflow stored in aufeis during the winter months is released during the freshet and early summer periods. This means that proportionately even more of the total annual runoff is expressed during the months of May through October.

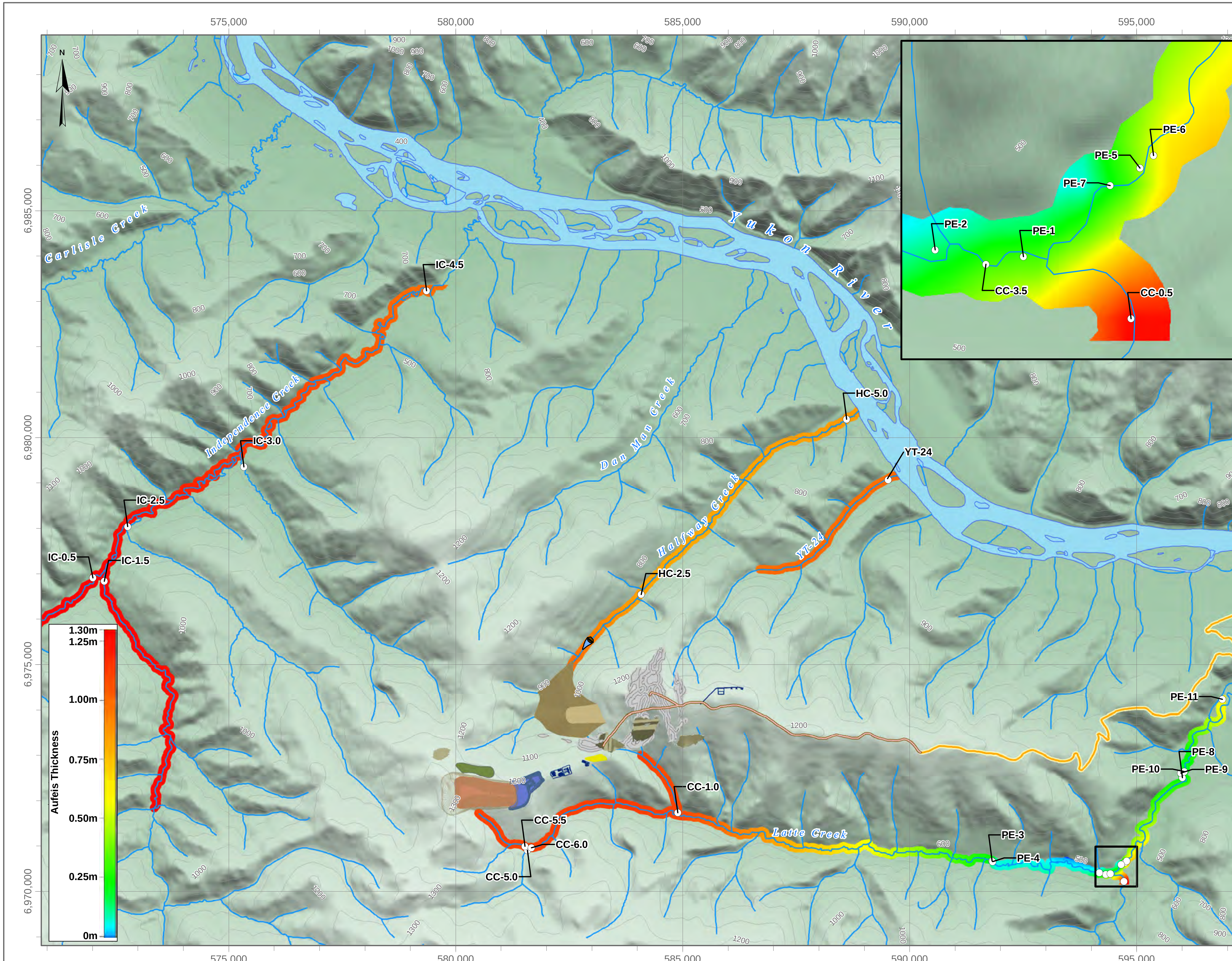
A map of the Project site drainages with measured and inferred aufeis extents and thicknesses is presented in Figure 3-30.

Figure 3-29: Extensive aufeis (~50 m wide) at HC-2.5. For reference, the stream channel is typically 2 m wide at this point.

3.2.2.4 Baseflow Separation

Low flow regimes of streams at the Project site show elevated levels for several parameters of concern (mainly arsenic and uranium; see Lorax 2016a), and as such, it was important to characterize the baseflow regime for each Project basin. Baseflow is typically understood to constitute the portion of streamflow that is derived from groundwater discharge, and is often considered to be equal to the minimum winter low flow, or the minimum summer flow following an extended dry period (Smakhtin, 2001). The low flows, or baseflows that are of interest to this baseline study are those low flows that reoccur seasonally.

The baseflow separation filter in SAAS was used to develop time-series of baseflow for both the continuous discharge records from the site stations, as well as the synthetic discharge records developed for the same stations. Plots showing baseflow separations per monitoring station are included in the hydrometric data assembled in Appendix A. The baseflow records generated by SAAS account for both interflow and groundwater derived baseflow during the open water season, but equate to groundwater baseflow only during winter months (where flow exists) and during extended summer dry periods.



LEGEND

- Measurement Locations
- Watercourses
- Waterbodies
- Surface Contours (100m)
- Mine Site Access Road
- Northern Access Route

Proposed Infrastructure

- Backfill
- WRSF
- pit
- ROM Stockpile
- Organics Stockpile
- Heap Leach Pad Base
- Event pond
- Support Infrastructure

Aufeis thickness along May Lady Creek is assumed to be 1m. No data collected.

Aufeis depths in headwater tributaries are extrapolated, extents are based on field reports

Coordinate System: *NAD 1983 UTM Zone 7N*
Projection: *Transverse Mercator*
Datum: *North American 1983*
Units: *Meter*

1:80,000

0 1 2 Km

DATE SAVED:	Mar 02, 2017
DRAWN BY:	GM
REVIEWED:	DHF
VERSION:	1

CLIENT:

GOLDCORP

LORAX ENVIRONMENTAL

PROJECT:

Coffee Gold Project

TITLE:

Aufeis Thickness

PROJECT #: A362-1 *FIGURE:* 3-30

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3.2.3 Regional Flow Data

3.2.3.1 Regional Flow Summaries

To obtain the input data required for the regional streamflow analyses (peak and low flows, annual runoff, trend analyses, *etc*.), the daily time-series (in m^3/s) for ten of the hydrometric stations listed in Table 2-4 were run through a customized routine to extract the relevant metrics. As indicated in Section 2.3.6 the extracted metrics included the following:

- Average annual (calendar year and water year [October to September]) discharge;
- Annual maximum and minimum daily discharge;
- Annual and June-September minimum 7-day average discharge;
- Average monthly discharge (m^3/s) and runoff (mm);
- Date of freshet initiation (pulse date; after Cayan *et al.*, 2001);
- Date of freshet peak discharge, and;
- Date of centre of hydrograph mass (calendar year; after Stewart *et al*., 2005).

Summaries of the extracted metrics from regional monitoring locations are provided in table format in Appendix E.

3.2.3.2 Yukon River Flow Data

As described in Section 1.4, contact waters associated with the Coffee Gold project will report passively to Halfway Creek, YT-24 (unnamed tributary) or Latte Creek – a headwater tributary of Coffee Creek. Ultimately, these three receiving creeks (*i.e.,* Halfway, Latte, YT-24) report to the Yukon River, and therefore, an understanding of the Yukon River flow regime is critical.

The Yukon River is gauged at a number of locations in the Yukon and Alaska. The Water Survey of Canada hydrometric station Yukon River above White River (09CD001) is situated a short distance downstream of the Coffee Gold Project (~15 km). Period of record for this station is 61 years (1956-2016), and the drainage area for the basin at the location of the gauge is 149,000 km^2.

The drainage area of the Yukon River at locations relevant to the Project are essentially identical in magnitude. For example, the estimated drainage of the Yukon River above Coffee Creek is 147,317 km^2 (*i.e*., an area 1.2% less than that area at 09CD001). The Yukon River downstream of Halfway Creek compares within 0.8% of the drainage at 09CD001 and is 147,839 km^2.

Average, minimum and maximum discharge data (period of record, daily) for the Yukon River above White River are shown in Figure 3-31. These data show that winter flows for the Yukon River are typically 400-500 m^3/s, but may reach winter minima on the order of 250 m^3/s upon occasion. Flows for months May through November, can reasonably be expected to range between 1,000 and 3,000 m^3/s at the Project site. In Appendix E, available stage data are presented for the Yukon River above White River. So too are hydrometric data (stage, flow) for the Stewart River, as they are relevant to barging and ice-road passage proposed for the Project.

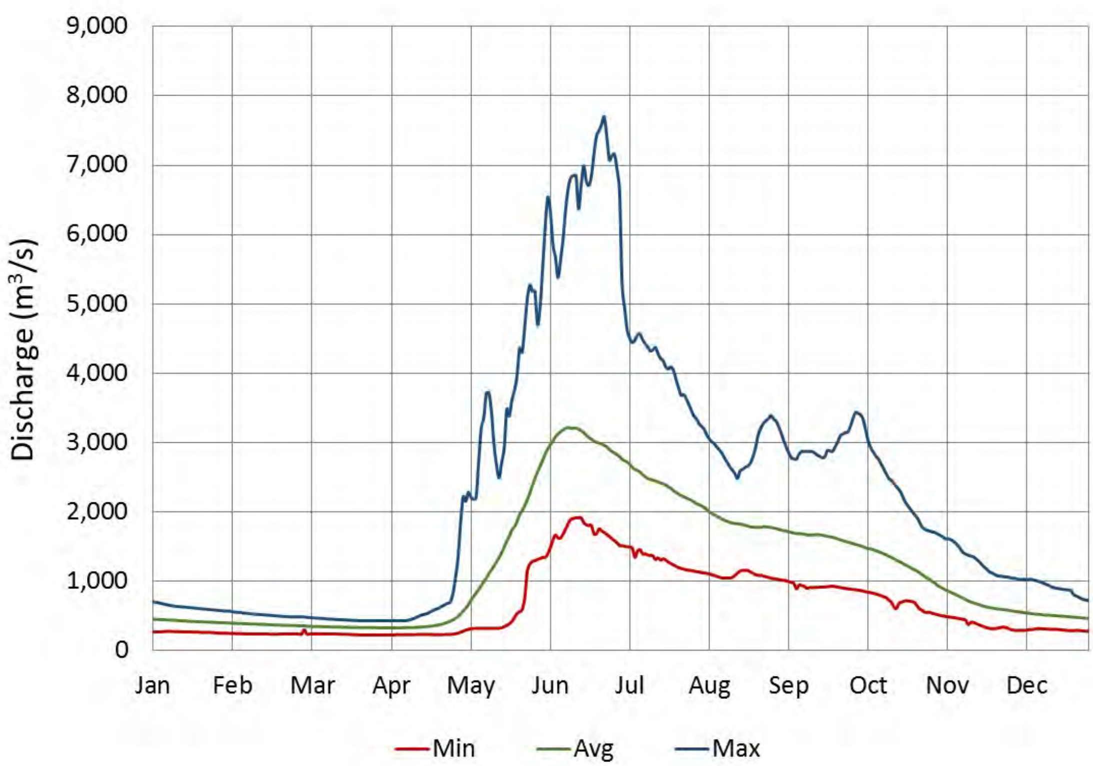

Figure 3-31: Daily average-, minimum- and maximum discharge data for the Yukon River above the White River (09CD001)

4. Conclusions

4. Conclusions

4.1 Summary

Meteorology Monitoring

Figure 2-1 shows the location of the Coffee Creek automated weather station (elevation 975 m asl) and snow course stations established at the property. In addition to the weather station tipping bucket rain gauge (complete with snowfall adaptor), two tipping bucket rain gauges were installed at the Coffee Creek exploration camp (430 m) and at the ridge-top laydown (1,300 m) in 2015 to discern the precipitation-elevation gradient for the Project site. Snow course measurements were carried out at the property following Territory protocols (*i.e.,* 10 sampling locations along a transect were each sampled for depth and snow water equivalent [SWE] then averaged). Snow courses were located at various elevations (*i.e.*, low, mid and high elevation) and oriented to discern effects of aspect on local snow accumulation.

Hydrometric Monitoring

Table 2-2 summarizes station nomenclature and drainage basin characteristics for Coffee Creek surface water monitoring stations. Currently, there are nineteen surface water monitoring stations at the property, each strategically located downstream of proposed project infrastructure and mine footprints.

Figure 2-4 shows the location of these monitoring stations with respect to proposed project infrastructure and mine footprints.

Eleven of the surface water monitoring stations at the property are instrumented with metric staff and continuously recording water level recorders set in well-anchored still wells. The purpose of the instrumentation as described in Section 2.2.1 was to resolve high-resolution discharge records for these three stations from a rating curve and a continuous record of water level. The hydrology methods adopted for the study were aligned with standards and procedures outlined in the Manual of British Columbia Hydrometric Standards - Version 1.0 (RISC, 2009). Streamflow was measured several different ways for this study, including: wading with a current meter, salt dilution gauging, using an acoustic Doppler current profiler, and slope-area approaches.

Gauged watersheds at the Coffee Creek site range in size from ~3 to 500 km^2, noting that eight of the watersheds being monitored have drainage areas of less than 25 km^2. In addition to capturing a range in terms of drainage area, the watersheds gauged for the baseline hydrology study differ in elevation characteristics (*i.e.,* mean catchment elevations range 800 to 1,300 m asl) and represent varying aspects as well. Mean elevation, basin area, a detailed basin map, aspect and hypsometry information are presented per hydrometric station in Appendix A.

Regional Climate and Hydrometric Stations

As part of the baseline study, site- and regional hydrometric data were analyzed in combination to: place the relatively short period of record for Coffee Creek into a broader context; generate long-term (*i.e.*, 30+ year) synthetic climate and discharge records for the Project area, and; to compute robust climate and flow metrics (*e.g.*, extreme rainfall depths; instantaneous peak flows; low flows for various return periods) from the combined site- and regional information. These metrics are tabled in Section 3 (see also Appendix A and E) of the report and have subsequently been used to inform engineering and design studies related to the mine and water management plan, and to construct and calibrate a site-wide water balance and water quality model for the Coffee Gold Project.

Summary of Meteorology Results

Air temperature

For the relatively short period of record at Coffee Creek, measured average annual temperature is -2.5°C, and monthly average air temperatures range from -19°C (December) to +13°C (July) (Table 3-1). To date, the minimum temperature at Coffee Creek is -37.6°C (measured January 28th, 2013) and the maximum temperature is 27.2°C (June 25th, 2013).

At the elevation of the Coffee Creek climate station, a notable departure from the regional temperature signal occurs during winter months. Valley bottom temperature inversions during winter months and ridgetop temperatures may be 10°C higher than measurements recorded at valley bottom stations. These inversions result in a reversal of the normal lapse rate (decreasing temperature with increasing elevation), and are commonly caused by cold Arctic air masses pooling in the valley bottoms from late October to early March.

Precipitation

Mean annual precipitation (MAP) at the proposed undertaking (~1,300 m above sea level) is estimated to be 485 mm, with 65% of this total precipitation realized as rain during the months of May through September, and the remaining 35% occurring as snow from October through April. This estimate of MAP was arrived at using site-measurements of rainfall and snow accumulation that were assessed in combination with regional precipitation data (*i.e.*, from Federal/State weather stations, snow courses, snow pillows).

It is common in areas with high topographic relief for precipitation amounts (annual, low-frequency/high-magnitude events, *etc*.) to increase with elevation due to orographic effects - primarily cooling of the air mass as it is forced upward by topography and subsequent condensation of the entrained water vapour. Precipitation gradients were ascertained through an inspection of site- and regional precipitation data, and were established at Coffee Creek as follows: 4%/100 m elevation gain for rainfall; and 9%/100 m elevation gain for snow.

Evaporation, evapotranspiration

Annual potential evaporation (PE) for the Project area is estimated to be ~500 mm with monthly rates being highest in May, June, July and August (roughly 70 to 110 mm per month) and considerably lower for autumn, winter and spring months. Consistent with other studies in the Yukon, the evapotranspiration estimate for the Coffee Gold site is roughly 40% of the assumed PE value or 182 mm per year.

Summary of Hydrology Results

Local Streamflow Measurements

At Coffee Creek, patterns of streamflow are dominated by a snowmelt freshet that typically occurs between late April and early June. Following freshet, patterns of streamflow are punctuated by several rainfall-induced runoff events which occur throughout the summer and autumn. In general, these high flow events are short duration, persisting usually for a 1 or 2-day time period. Flows in local creeks and streams abate in October in response to freezing temperatures and it is notable that local watersheds typically experience zero flow conditions throughout the winter (*i.e.,* November through end March). Aufeis (*i.e.,* frozen groundwater seepage that accumulates within- and adjacent to local watercourses) is pervasive in creeks and streams at the Project site and melts during the freshet, but may persist into the early summer.

Based on measurements at Coffee Creek hydrometric stations, average unit yields across the project site are 9 L/s/km^2 for the open water season (May to October), and range from 4.5 to 15 L/s/km^2, with specifics of the runoff regime for each monitoring station being dependent on drainage characteristics (*i.e.,* basin area, shape, mean elevation, extent of permafrost, *etc.*). Unit yields range from 1.2 – 3.3 L/s/km^2 in October, and decrease steadily to annual minima in March (*i.e.,* 0 – 0.7 L/s/km^2), before increasing again in April in response to low-elevation snow melt and summer rains. At Coffee Creek, instantaneous peak flows, expressed as unit yields, are typically between 120 and 200 L/s/km^2, but measurements range widely across the site (from 60 to >300 L/s/km^2).

Mean Annual Runoff

Based on the information available, MAR varied by roughly a factor of three in Project site basins (from 60 mm to 200 mm) and when regressed against mean basin elevation (m), basin area (km^2) and dominant aspect within the drainage, showed strong correlation with elevation (Figure 3-22). Results of the annual runoff recurrence interval analysis are presented in Table 3-11 and it is notable that the spread between the 1:200 dry- and wet-years is substantial at Coffee Creek, and generally, wet-years are expected to produce ten times more runoff than an extreme dry-year.

Average runoff for all site stations is presented alongside the corresponding annual precipitation estimate for each recurrence interval in Table 3-12. These data show that the proportion of annual precipitation converted to runoff increases in proportion to the total annual precipitation estimated, which is consistent with the expected basin response. For a wet year, soil moisture storage would likely be fully recharged, and would have limited additional capacity to store infiltrated precipitation. Conversely and for a dry-year, a below average snowpack or prolonged summer drought combined with high evaporation, may require appreciable precipitation to replenish basin storage and soil moisture deficit, and only then will surface runoff be produced.

Peak Flows

A regional peak flow analysis was conducted using the stations listed in Table 2-4. Recurrence interval estimates of annual instantaneous peak flows were plotted against drainage area, and an enveloping power law function was then fit to the data. The enveloping power law functions derived from the regional data for each recurrence interval (*e.g.*, 1:100 year peak flow) were used to estimate the corresponding peak flow for all Project drainages. The results of this analysis are presented as unit yields in Table 3-13 with a plot of the regional- and site- peak flow data is provided in Figure 3-26.

Summer Low Flows

Low flow recurrence interval estimates for the summer period (June to September) are presented in Table 3-15 (regional) and Table 3-16 (site). Based on the regional stations assumed most representative of Project site conditions, the analysis returned summer $7Q_{10}$ yields that range from 0.7 to 1.2 L/s/km^2 (Table 3-15). A parallel analysis conducted using the synthetic streamflow data returned estimated summer $7Q_{10}$ values for the Project stations ranging from 0 to 1.7 L/s/km^2 (Table 3-16). The summer $7Q_{10}$ low flow value based on an average of the eleven Project stations was 0.7 L/s/km^2.

Annual Low Flows

Based on the data collected at Coffee Creek, winter yields typically range from 1.2 – 3.3 L/s/km^2 in October, and decrease steadily to the annual minima in March (0 – 0.7 L/s/km^2), prior to again increasing in April in response to low-elevation snow melt and early spring rains. An important component of the winter flow regime at the Project site is the extensive icing of the local channels. This ice growth, or aufeis, is the result of shallow groundwater discharge and/or baseflow in the stream channel freezing. This ice impedes subsequent flow, which is forced on top of the existing ice sheet, where it freezes. This process repeats continuously throughout the winter, and results in laminated ice sheets that can approach 2 m in thickness and 50+ m in width in the Project channels.

Hydro-meteorology as an Input to the Site-wide Water Balance Model

The baseline surface hydrology monitoring study was initiated at Coffee Creek in autumn 2010, with a baseline meteorology study commencing later, in July 2012. These two monitoring programs remain fully operational, with data collection scheduled to continue through the permitting and licensing phases of the Project timeline. In addition to serving as an input to engineering and design studies for the Project, baseline hydro-meteorology results have been incorporated into surface water modelling efforts related to the Project (see Lorax 2016b).

The Coffee Gold site-wide water balance draws upon and synthesizes data from a number of sources including: the mine plan and site-wide water management layout; baseline hydro-meteorology data; water quality data; hydrogeology information including output from a groundwater model; and results from a heap leach water balance model. The site-wide water balance model was developed in GoldSim, a flexible, object-oriented software tool for the numerical simulation of complex natural or engineered systems. Surface runoff, baseflow, snowfall/melt processes and aufeis production from winter baseflow are all represented in the site-wide water balance model, informed by the hydro-meteorological information presented herein.

5. Closure

5. Closure

We trust that this plan meets your requirements at this time. Please contact us should you have any questions or concerns, or require additional information in support of this work.

Yours sincerely,
Lorax Environmental Services

per:

Signature REDACTED Signature REDACTED

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Hydrologist
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Lorax Environmental Services Ltd.

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Appendix A
Site Hydrology Data

Appendix A1: Site Hydrology Data 2010 to 2015

Appendix A2: Site Hydrology Data 2016

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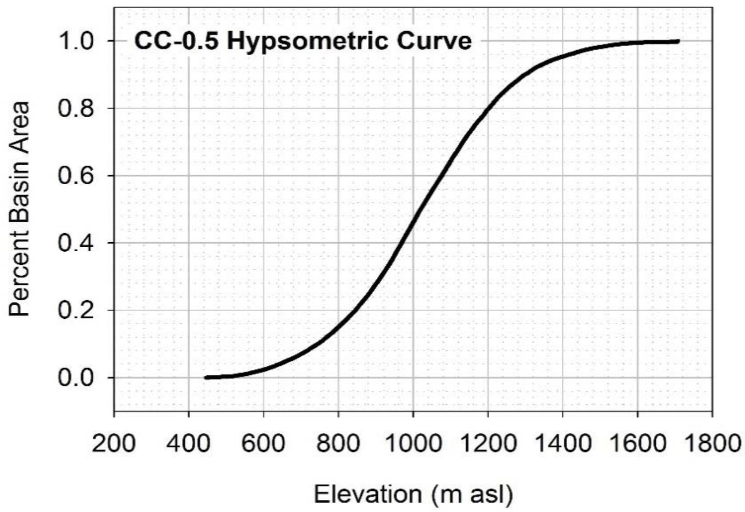
APPENDIX A1: SITE HYDROLOGY DATA - 2010 TO 2015

Hydrometric Station CC-0.5 Metadata

Station Name:	CC-0.5
Location:	Upper Coffee Creek
Basin Area (km^2):	385.6
UTM Easting:	594515
UTM Northing:	6970359
Median Elevation (m asl):	1019
Record Period:	
Spot Measurements	2010-Present
Continuous Record	2014-Present

Hypsometric Curve



Pressure Transducer:	Solinst
Temperature Sensor:	Yes
Conductivity Sensor:	Yes
Barologger:	No
Measurement Interval:	
Summer	15 minute
Winter	Removed

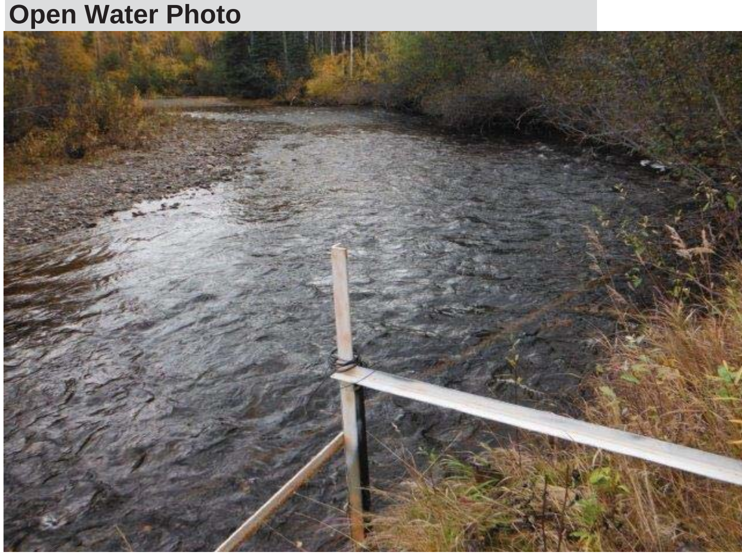
Benchmark surveys

Date	Gauge Height (m)	Change (m)	Notes
05/06/2014	97.26		
25/06/2015	97.26	0	
12/09/2015	97.262	0.002	no movement

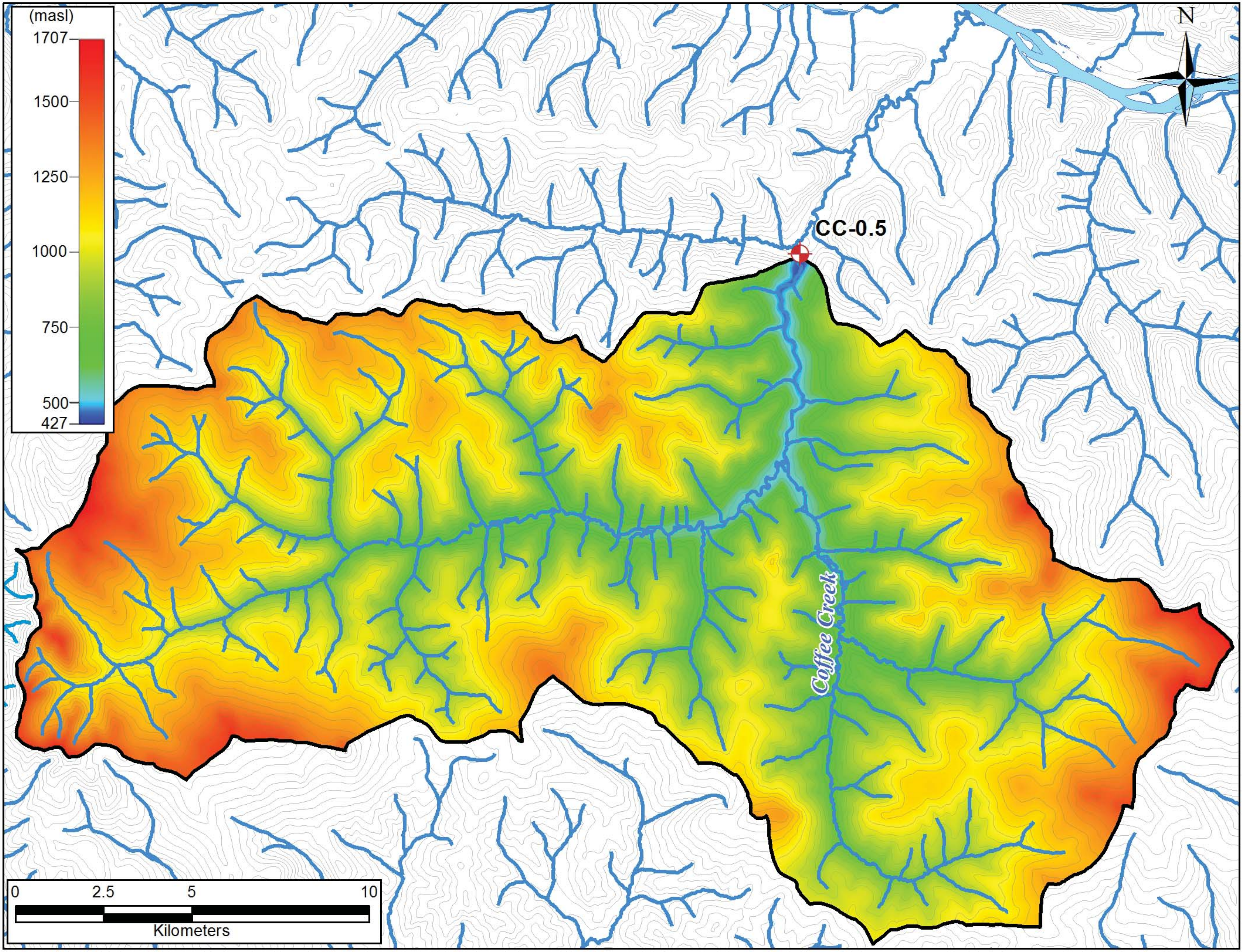
Catchment Slope Aspects (Quadrants in degrees)

North (315-45)	East (45-135)	South (135-225)	West (225-315)
35%	15%	35%	15%

Open Water Photo



Winter Photo



(masl)
1707
1500
1250
1000
750
500
427
N
CC-0.5
Coffee Creek
0
2.5
5
10
Kilometers

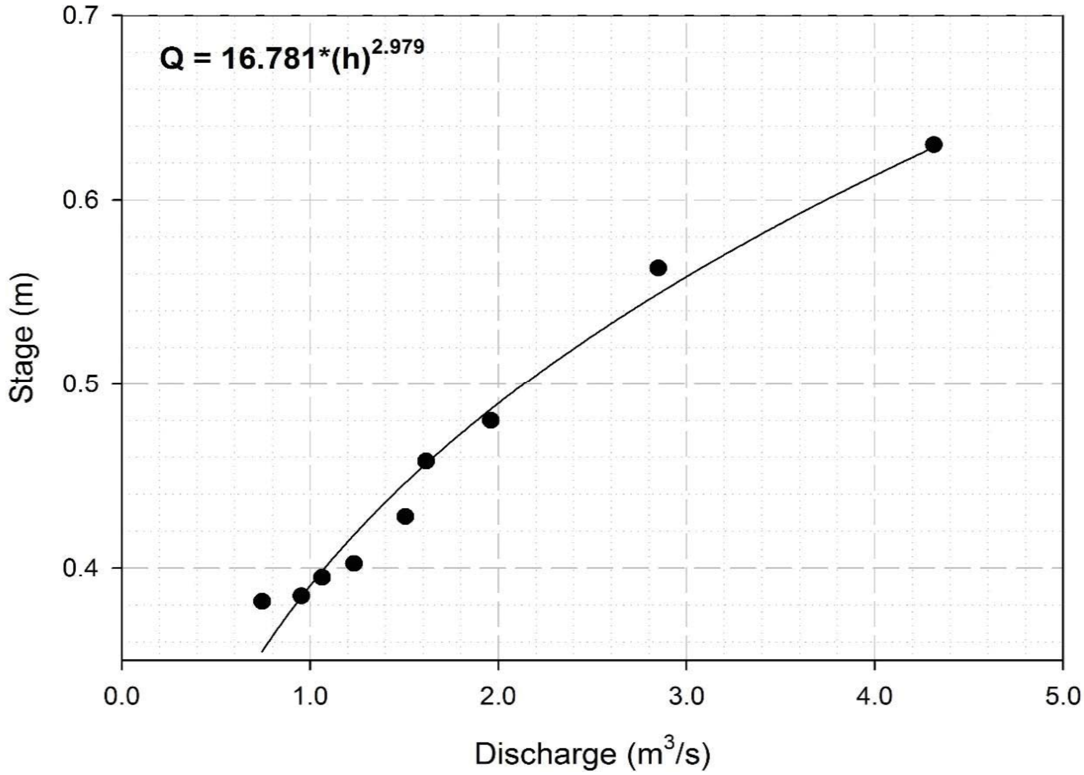
Hydrometric Station CC-0.5 Metadata

Manual Measurements

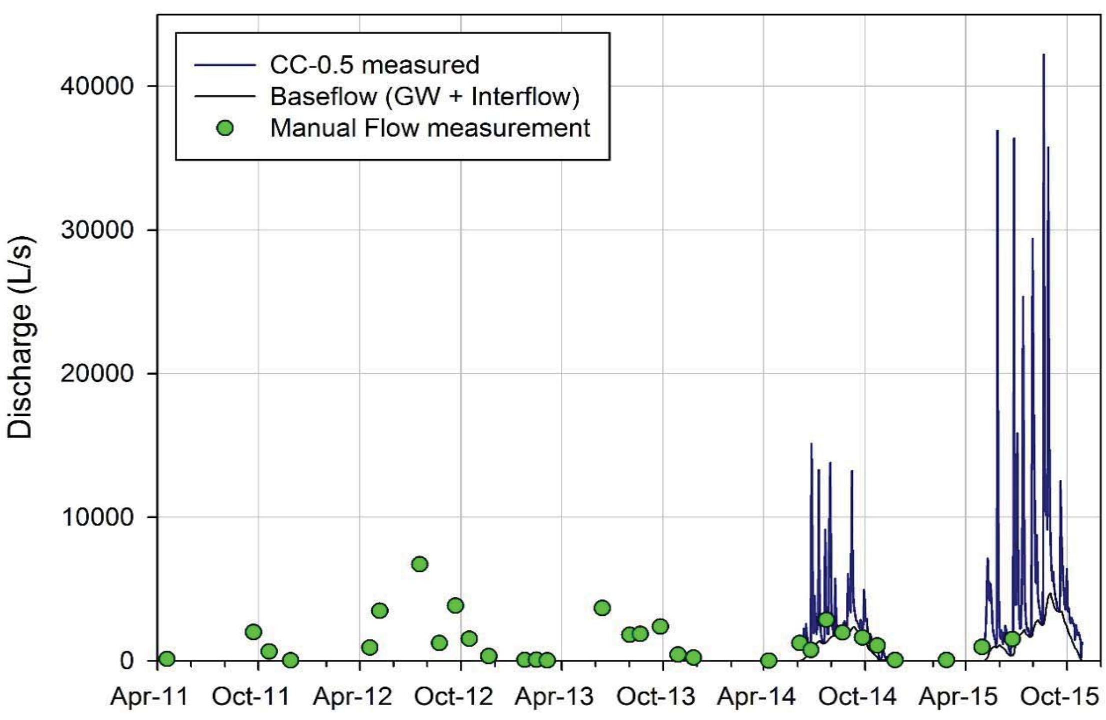
Date	Time	Stage (m)	Discharge (m^3/s)	Salt Dilution	MMB FlowMate	Pygmy	Price AA
11/10/2010	17:22		1.305				x
11/11/2010	12:46		0.214	x			
19/04/2011	18:02		0.115		x		
19/04/2011	18:15		0.120				x
22/09/2011	10:20		2.004		x		
20/10/2011	14:15		0.642		x		
28/11/2011	13:32		0.036		x		
31/01/2012	13:39		0.000				
29/02/2012	13:05		0.000				
19/04/2012	11:32		0.911		x		
07/05/2012	14:42		3.478		x		
18/07/2012	13:34		6.712		x		
23/08/2012	12:53		1.222		x		
21/09/2012	11:54		3.827		x		
16/10/2012	13:56		1.537		x		
20/11/2012	12:15		0.322	x			
24/01/2013	14:36		0.055	x			
14/02/2013	14:17		0.073	x			
06/03/2013	12:38		0.013	x			
13/06/2013	13:36		3.666		x		
02/08/2013	8:21		1.793		x		
21/08/2013	12:51		1.874		x		
26/09/2013	17:43		2.376		x		
28/10/2013	17:28		0.430		x		
25/11/2013	15:43		0.211	x			
10/04/2014	12:00		0.002	x			
05/06/2014	15:20	0.403	1.233				x
25/06/2014	15:00	0.382	0.745		x		
23/07/2014	13:40	0.563	2.848				x
21/08/2014	8:03	0.480	1.960				x
26/09/2014	14:03	0.458	1.616				x
23/10/2014	11:50	0.395	1.063				x
24/11/2014	13:20		0.050	x			
25/02/2015	16:09		0.004				
30/04/2015	10:30	0.385	0.954	x			
24/06/2015	15:55	0.428	1.506	x			
22/07/2015	14:44	0.492					x
19/08/2015	15:10	0.692					x
28/10/2015	13:40	0.399		x			

Hydrometric Station CC-0.5 Metadata

Rating Curve

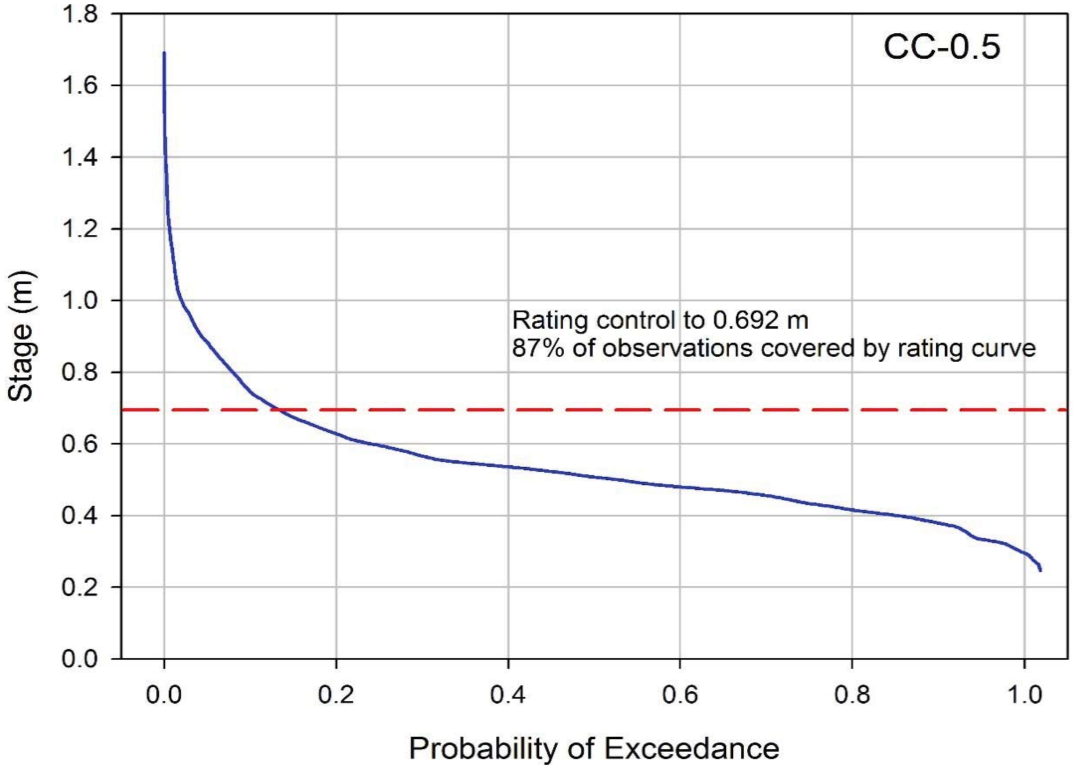


Continuous Discharge Record vs. Spot Flow Measurements

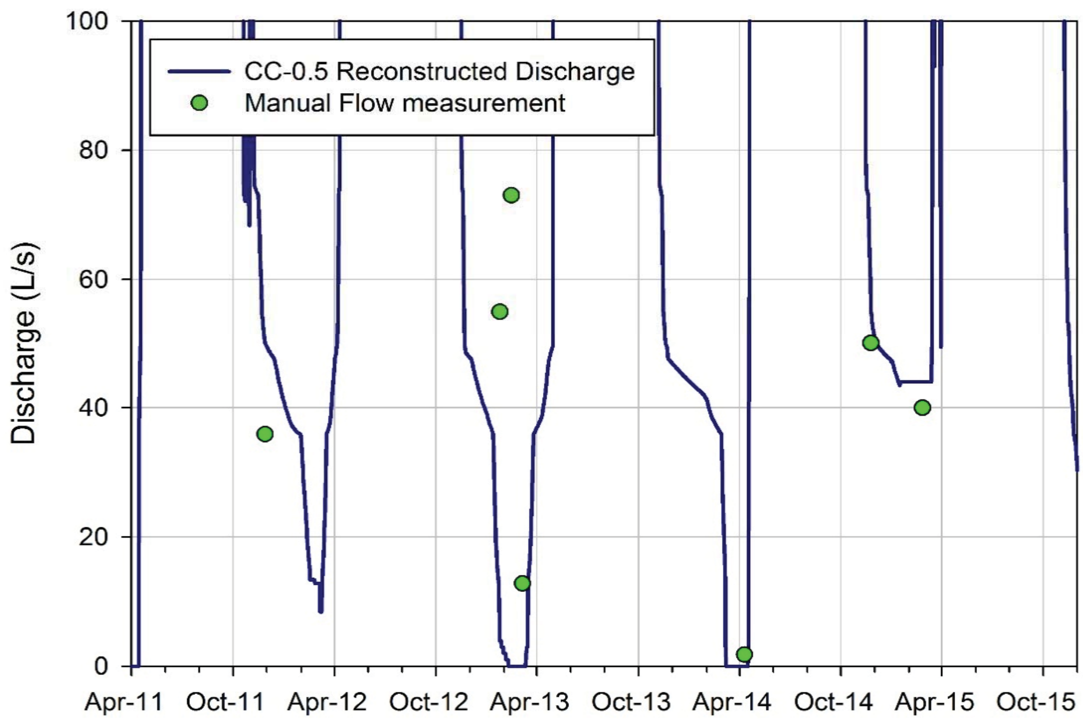


Hydrometric Station CC-0.5 Metadata

Rating Curve Control on Measured Stage

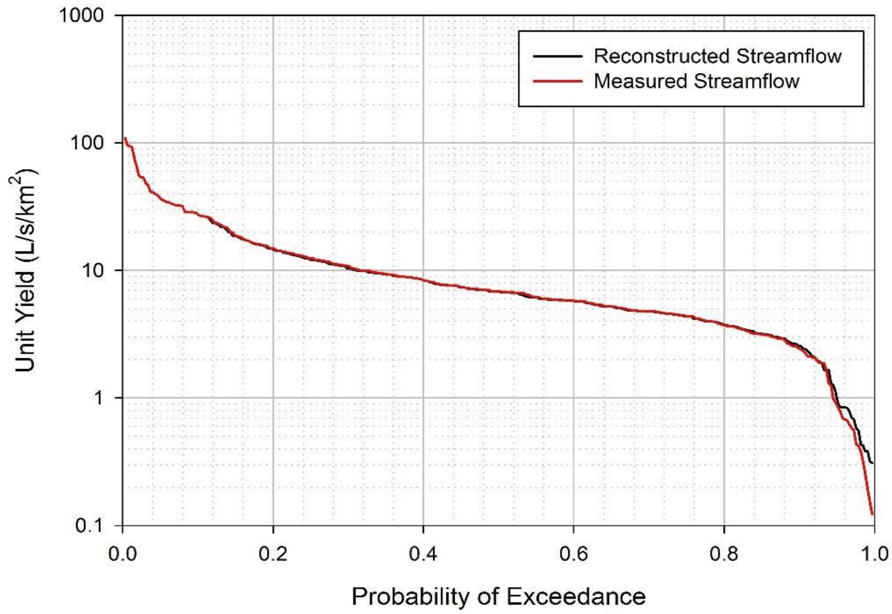


Baseflow comparison - winter spot flows vs. synthetic discharge record

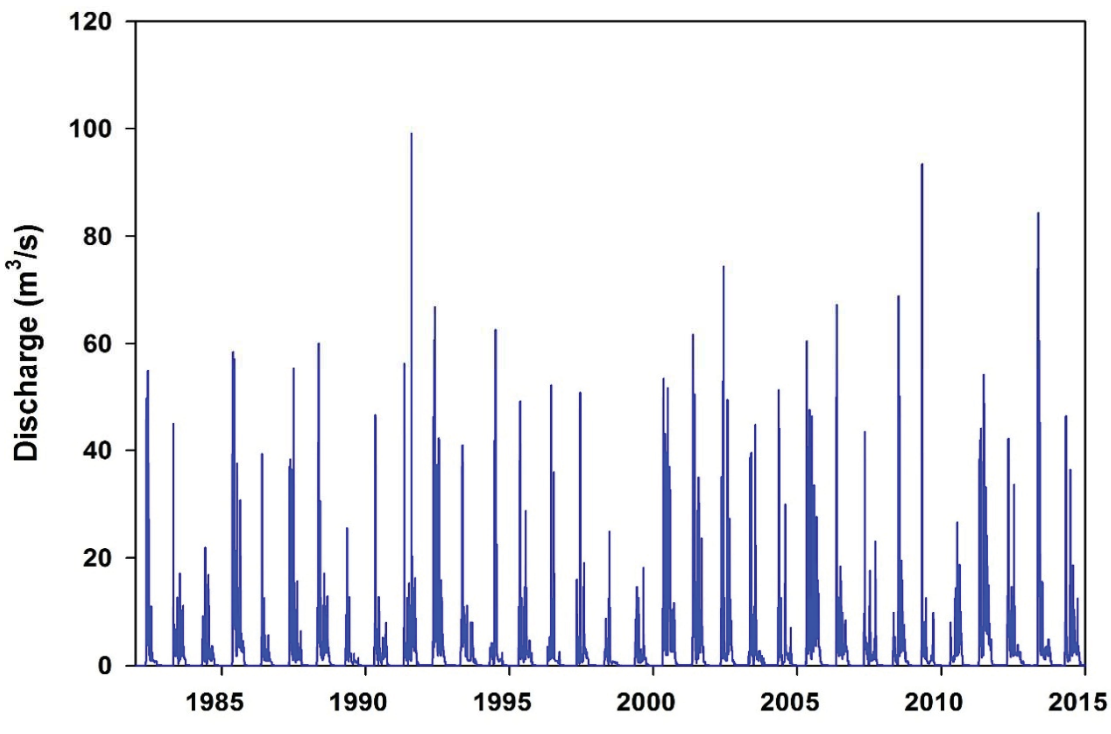


Hydrometric Station CC-0.5 Metadata

Flow Duration Curves - Synthetic vs. Measured Discharge



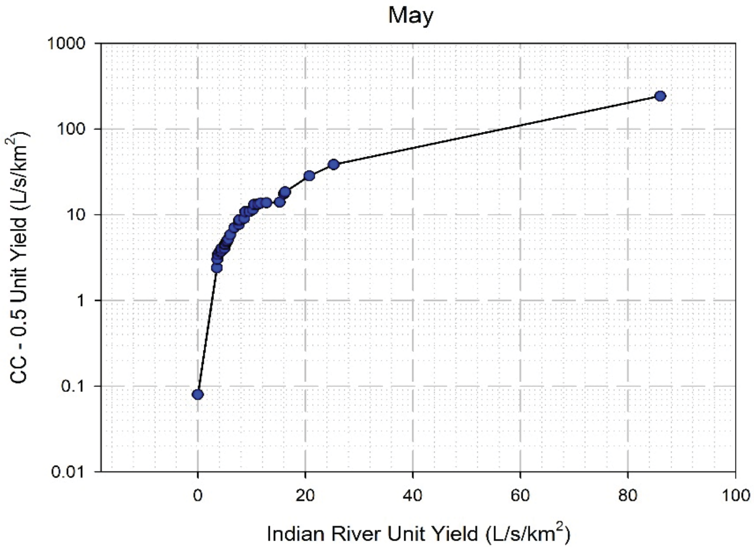
Synthetic Discharge Time-Series

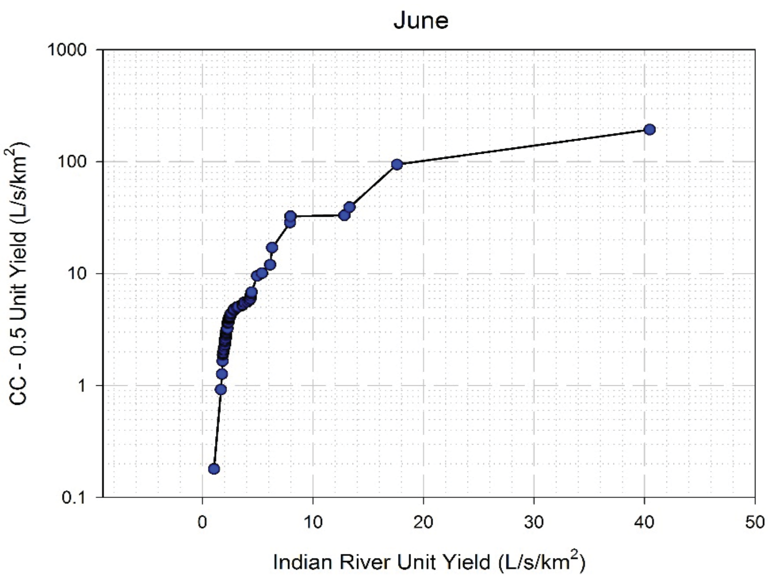


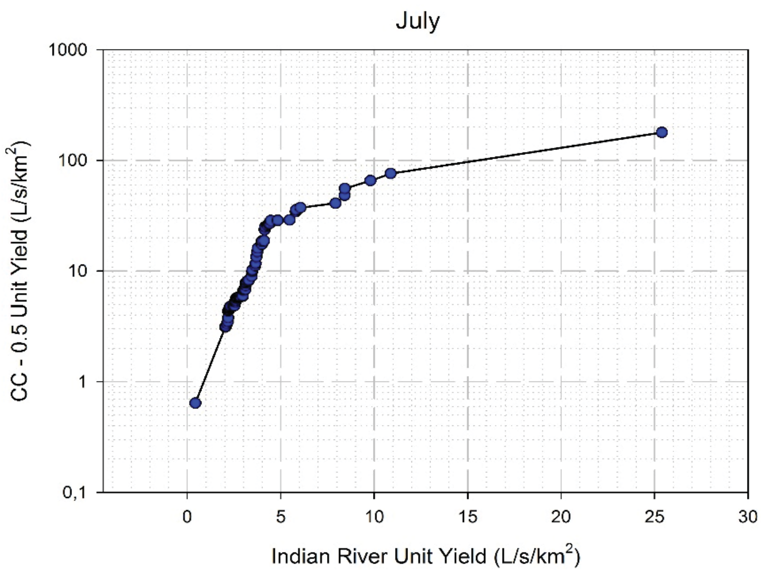
Hydrometric Station CC-0.5 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.



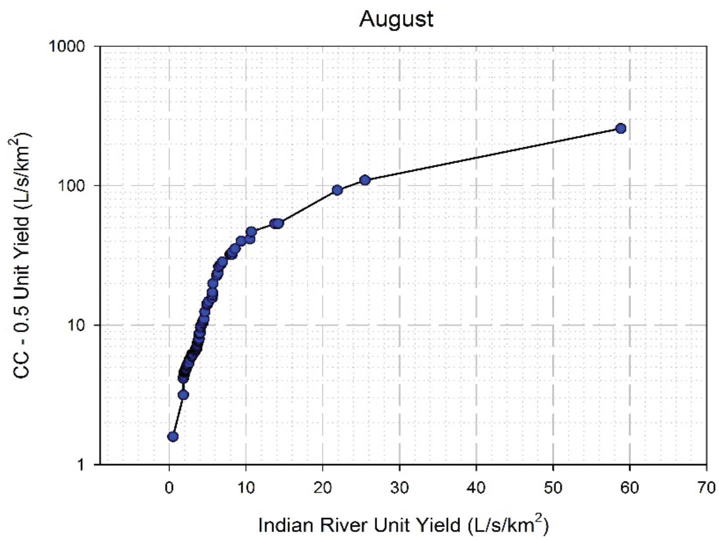


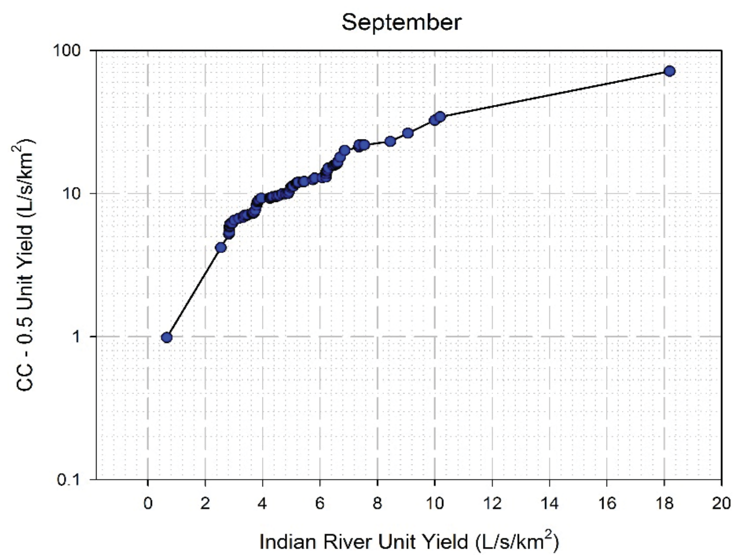


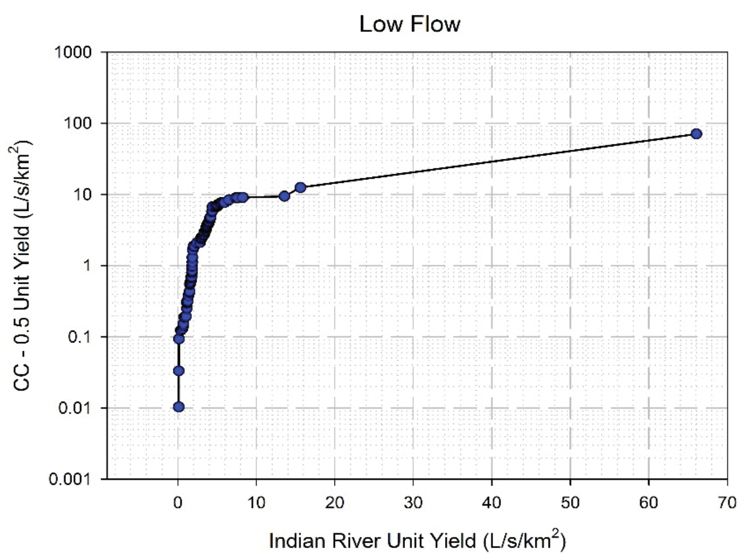
Hydrometric Station CC-0.5 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.







Hydrometric Station CC-0.5 Metadata

Monthly Summaries of Measured Discharge, Unit Yield and Runoff

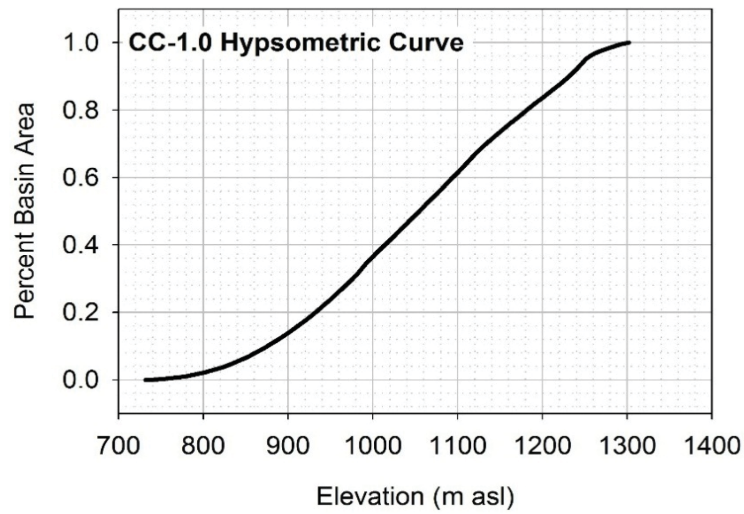
Discharge (m^3/s)									
Year		**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2014	Average	--	2.50	4.12	2.64	3.97	1.39	*0.32*	2.49
	Maximum	--	30.63	17.48	6.86	15.30	4.81	*1.00*	30.63
	Minimum	--	0.51	0.96	1.44	1.42	0.02	*0.04*	0.02
2015	Average	*4.62*	3.64	7.65	10.81	5.57	2.38	--	5.78
	Maximum	*74.21*	48.13	37.18	60.24	14.03	5.87	--	74.21
	Minimum	*0.40*	0.25	1.57	2.24	3.23	0.04	--	0.04
Unit Yield ($L/s/km^2$)									
2014	Average	--	6.5	10.7	6.8	10.3	3.6	*0.8*	6.5
	Maximum	--	79.4	45.3	17.8	39.7	12.5	*2.6*	79.4
	Minimum	--	1.3	2.5	3.7	3.7	0.1	*0.1*	0.1
2015	Average	*12.0*	9.5	19.8	28.0	14.5	6.2	--	15.0
	Maximum	*192.5*	124.8	96.4	156.2	36.4	15.2	--	192.5
	Minimum	*1.0*	0.6	4.1	5.8	8.4	0.1	--	0.1
Runoff (mm)									
2014		--	*15*	29	18	27	10	*1*	99
2015		*29*	25	53	75	37	17	--	236

NOTE: Values in italics indicate that data for that month is not complete.

Hydrometric Station CC-1.0 Metadata

Station Name:	CC-1.0
Location:	South WRSF basin
Basin Area (km^2):	3.4
UTM Easting:	584956
UTM Northing:	6971726
Median Elevation (m asl):	1055
Record Period:	
Spot Measurements	2014-Present
Continuous Record	2014-Present

Hypsometric Curve



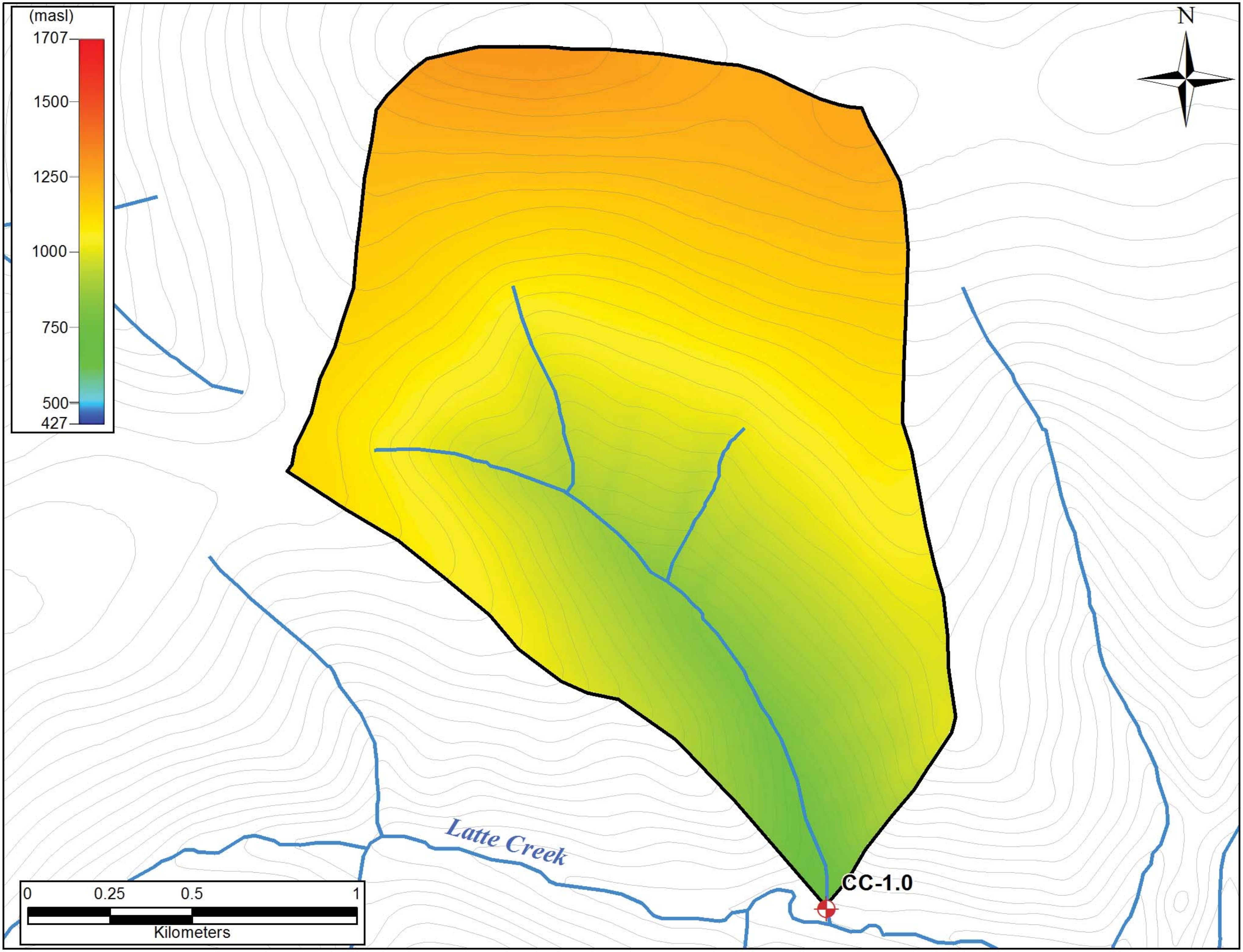
Pressure Transducer:	Solinst
Temperature Sensor:	Yes
Conductivity Sensor:	Yes
Barologger:	No
Measurement Interval:	
Summer	15 minute
Winter	Removed

Benchmark surveys			
Date	**Gauge Height (m)**	**Change (m)**	**Notes**

Catchment Slope Aspects (Quadrants in degrees)			
North (315-45)	**East (45-135)**	**South (135-225)**	**West (225-315)**
1%	23%	61%	15%

Open Water Photo

Winter Photo



(masl)
1707
1500
1250
1000
750
500
427
N
Latte Creek
CC-1.0
0
0.25
0.5
1
Kilometers

Hydrometric Station CC-1.0 Metadata

Manual Measurements

Date	Time	Stage (m)	Discharge (m^3/s)	Salt Dilution	Weir Equation	Pygmy	Price AA
26/06/2014	9:40	0.209	0.009		x		x
24/07/2014		0.215	0.001		x		
21/08/2014	11:16	0.262	0.003	x	x		
25/09/2014	18:07	0.282	0.005	x	x		
23/10/2014	16:15	0.231	0.001		x		
30/04/2015	13:50						
17/05/2015	18:00						
27/06/2015	8:45						
23/07/2015	11:23		0.017	x	x		
23/07/2015	12:36		0.017		x		
23/07/2015	12:45	0.170					
19/08/2015	18:00	0.199					
21/08/2015	18:00	0.430	0.030	x	x		
10/09/2015		0.376	0.014		x		
12/09/2015	17:30	0.368	0.015	x	x		
28/10/2015	15:00	0.339	0.009	x	x		
27/11/2015	13:30	0.314	0.006	x	x		

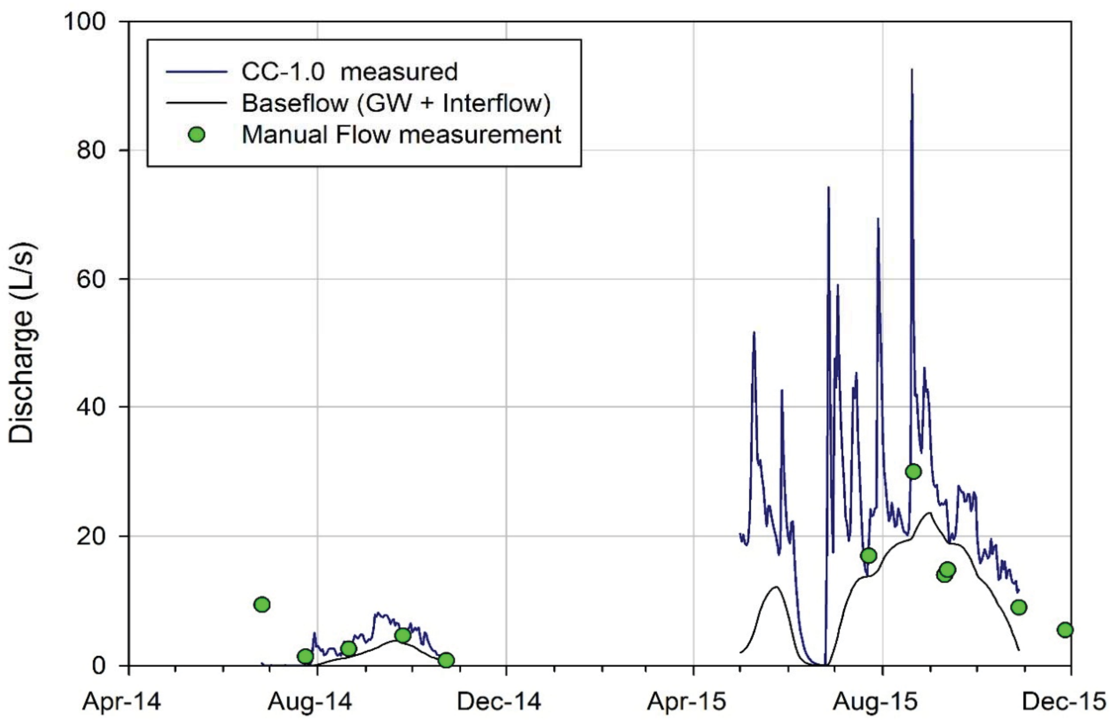
Hydrometric Station CC-1.0 Metadata

Rating Curve

NOTE: this site has a V-notch weir installed, therefore no rating curve was necessary.

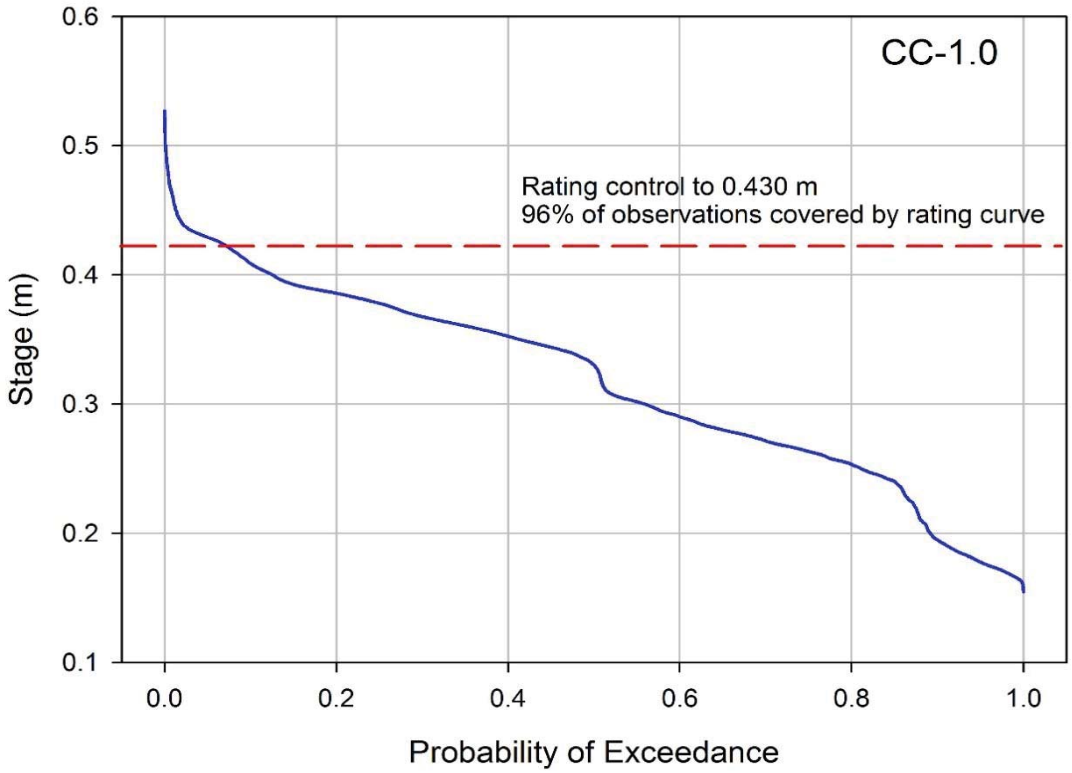
Rating Equation is $Q=1362.9*(h)^{2.5}$

Continuous Discharge Record vs. Spot Flow Measurements



Hydrometric Station CC-1.0 Metadata

Rating Curve Control on Measured Stage

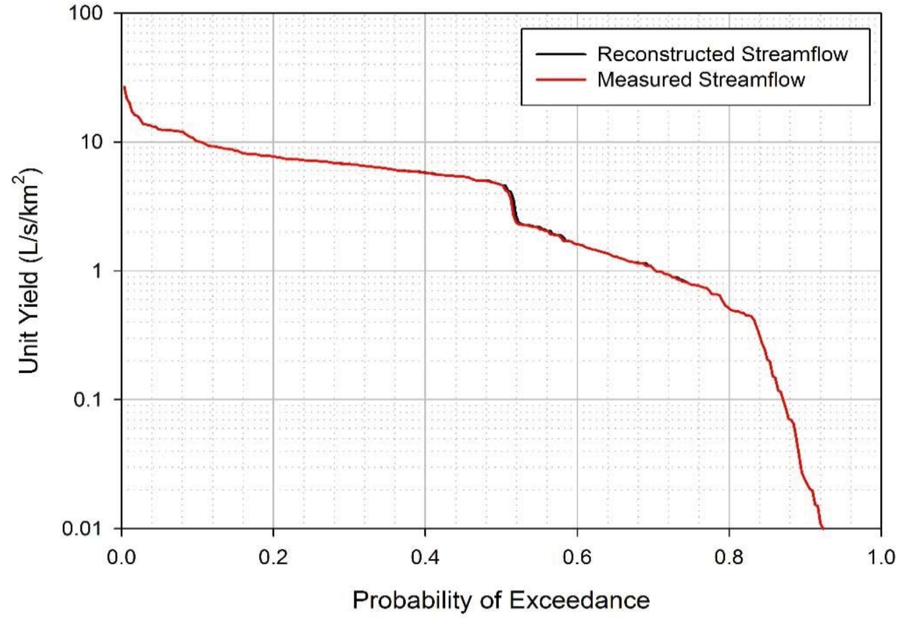


Baseflow comparison - winter spot flows vs. synthetic discharge record

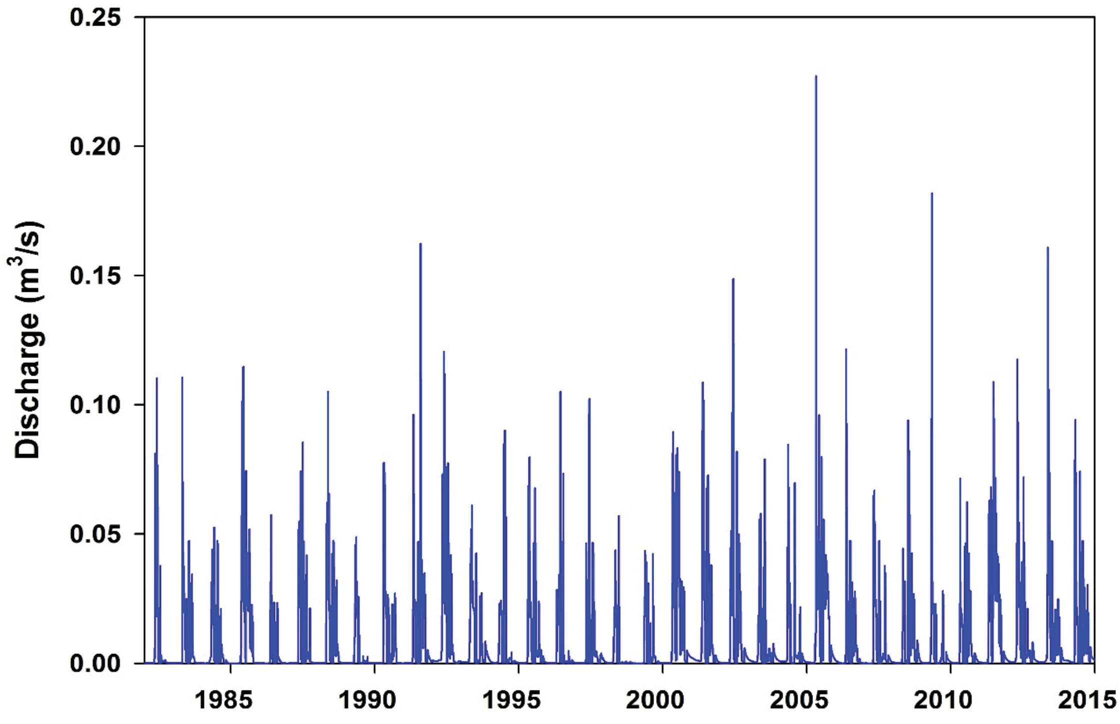
NOTE: This stream experiences extensive aufeis conditions during the winter, and therefore no flow measurements are possible.

Hydrometric Station CC-1.0 Metadata

Flow Duration Curves - Synthetic vs. Measured Discharge



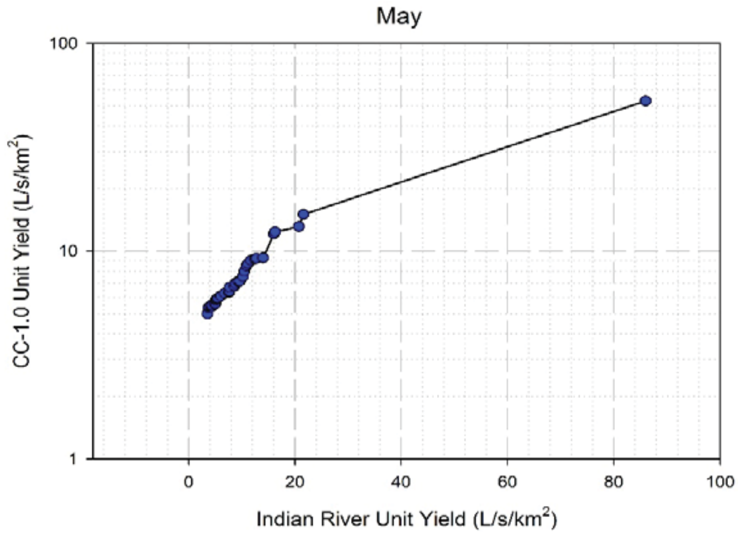
Synthetic Discharge Time-Series

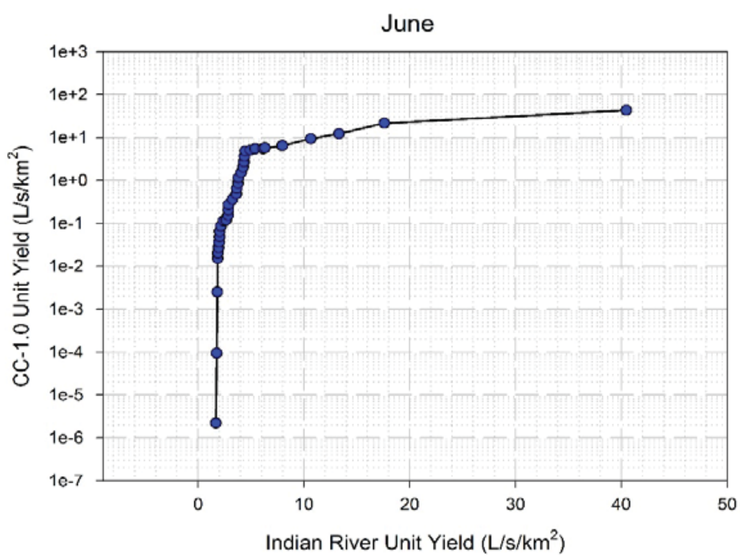


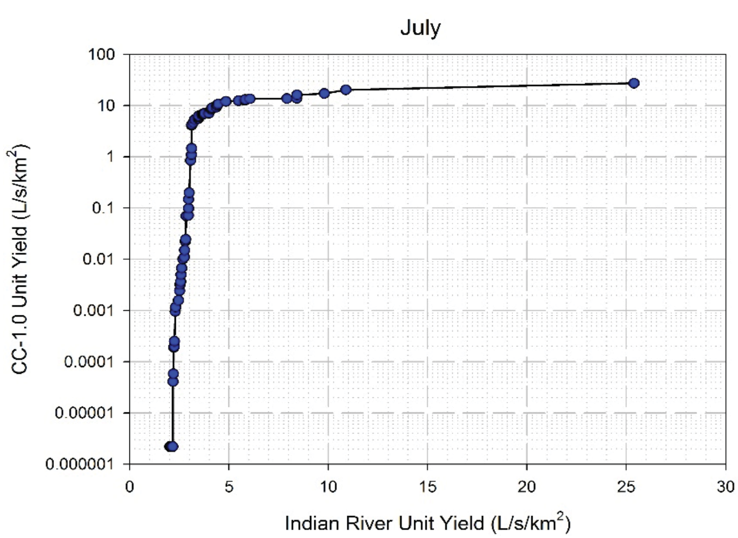
Hydrometric Station CC-1.0 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.



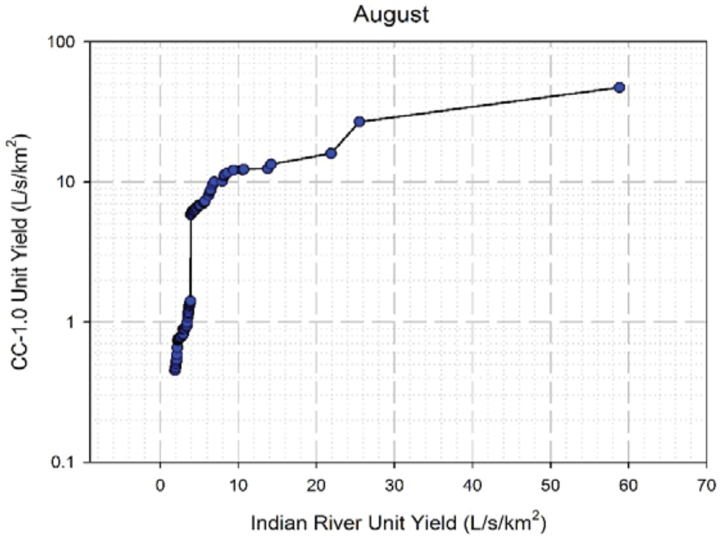


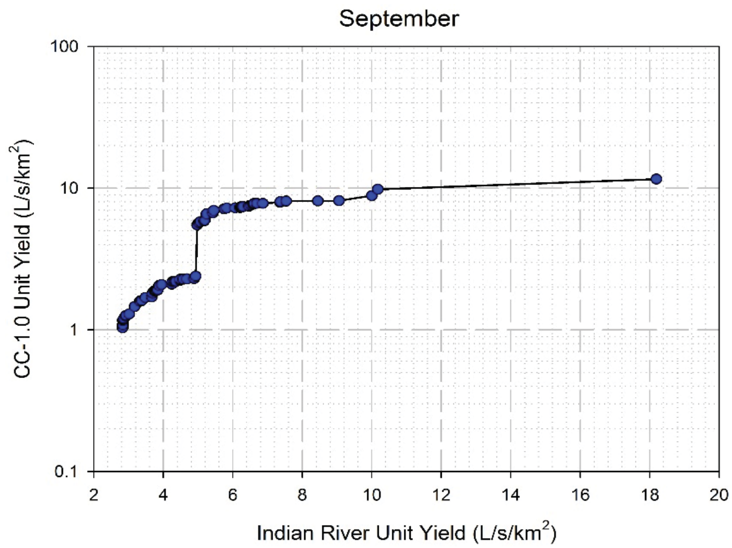


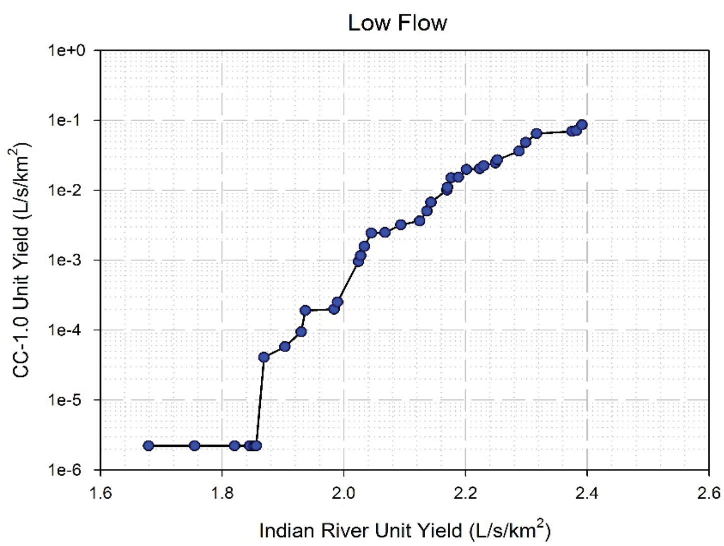
Hydrometric Station CC-1.0 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.







Hydrometric Station CC-1.0 Metadata

Monthly Summaries of Measured Discharge, Unit Yield and Runoff

Year		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Discharge (m^3/s)										
2014	Average	--	--	*0.000*	0.000	0.003	0.006	*0.003*	--	0.00
	Maximum	--	--	*0.001*	0.010	0.006	0.010	*0.010*	--	0.01
	Minimum	--	--	*0.000*	0.000	0.001	0.002	*0.000*	--	0.00
2015	Average	--	0.026	0.011	0.032	0.032	0.025	0.016	--	0.02
	Maximum	--	0.077	0.105	0.172	0.141	0.044	0.026	--	0.17
	Minimum	--	0.016	0.000	0.011	0.018	0.015	0.008	--	0.00
Unit Yield ($L/s/km^2$)										
2014	Average	--	--	*0.0*	0.1	0.9	1.8	*1.0*	--	0.8
	Maximum	--	--	*0.2*	3.0	1.8	2.9	*2.8*	--	3.0
	Minimum	--	--	*0.0*	0.0	0.3	0.5	*0.1*	--	0.0
2015	Average	--	7.7	3.2	9.4	9.4	7.3	4.6	--	6.9
	Maximum	--	22.4	30.4	50.1	40.9	12.7	7.4	--	50.1
	Minimum	--	4.6	0.0	3.3	5.2	4.5	2.3	--	0.0
Runoff (mm)										
2014		--	--	*0*	0	2	5	*2*	--	9
2015		--	21	8	25	25	19	12	--	110

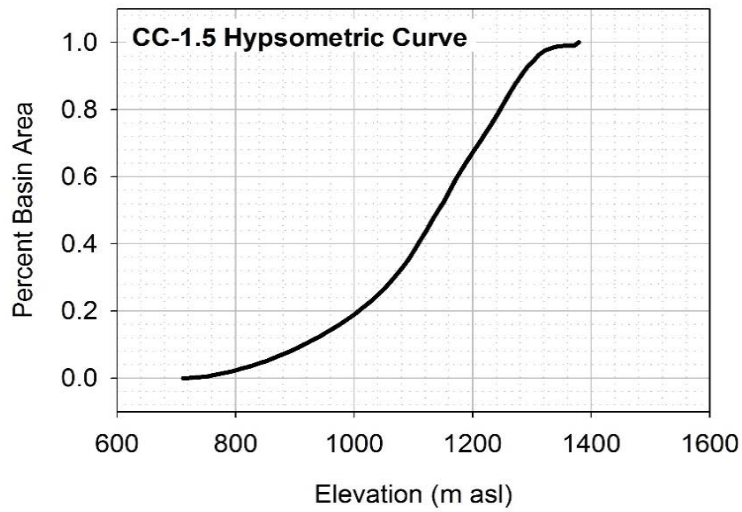
NOTE: Values in italics indicate that data for that month is not complete.

Hydrometric Station CC-1.5 Metadata

Station Name:	CC-1.5
Location:	Latte Creek
Basin Area (km^2):	23.1
UTM Easting:	584944
UTM Northing:	6971695
Median Elevation (m asl):	1142
Record Period:	
Spot Measurements	2010-Present
Continuous Record	2014-Present

Pressure Transducer:	Solinst
Temperature Sensor:	Yes
Conductivity Sensor:	Yes
Barologger:	No
Measurement Interval:	
Summer	15 minute
Winter	Removed

Hypsometric Curve

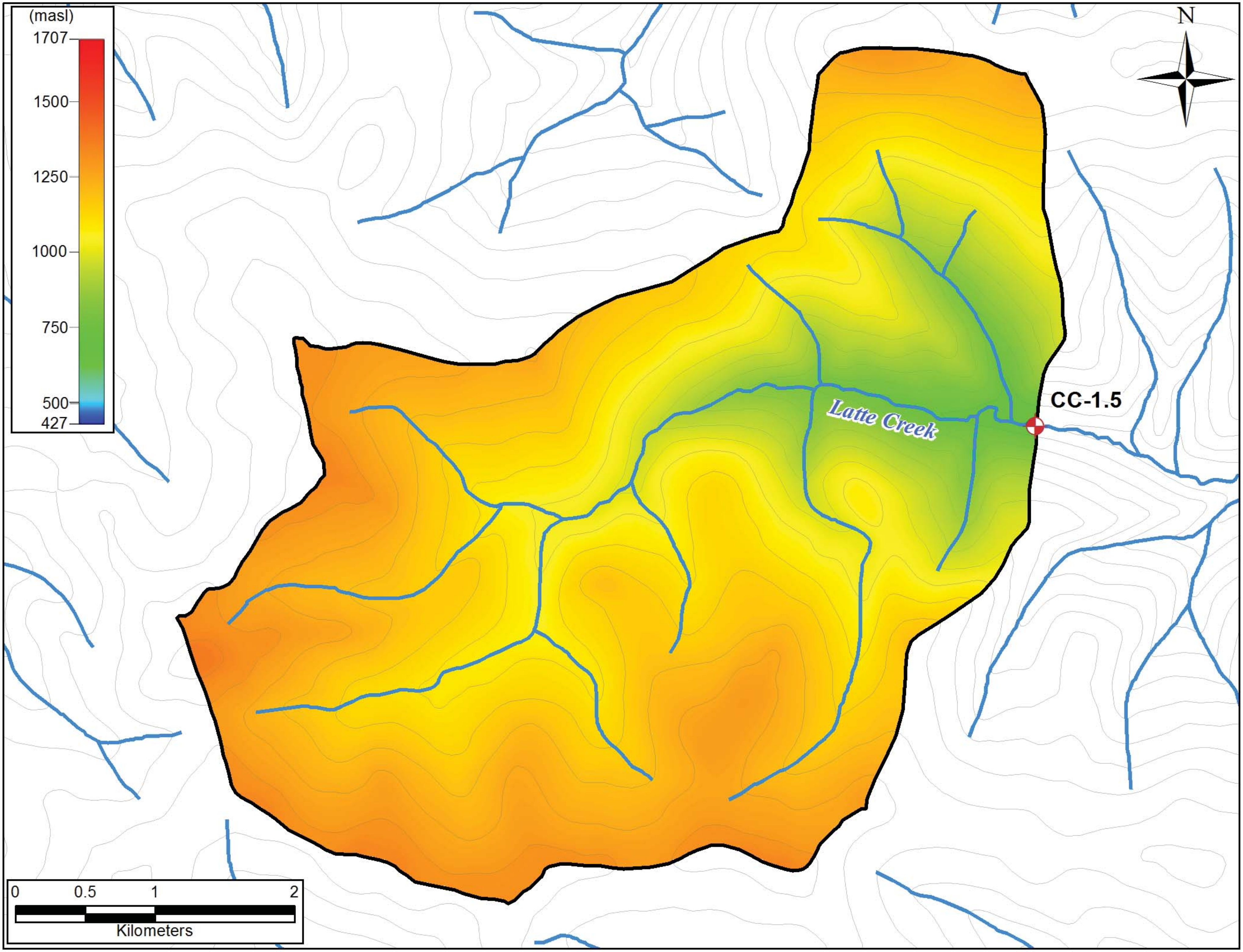


Benchmark surveys			
Date	**Gauge Height (m)**	**Change (m)**	**Notes**
05/06/2014	98.589		
12/09/2015	98.59	0.001	no movement

Catchment Slope Aspects (Quadrants in degrees)			
North (315-45)	**East (45-135)**	**South (135-225)**	**West (225-315)**
44%	14%	36%	6%

Open Water Photo

Winter Photo


(masl)
1707
1500
1250
1000
750
500
427
N
CC-1.5
Latte Creek
0
0.5
1
2
Kilometers

Hydrometric Station CC-1.5 Metadata

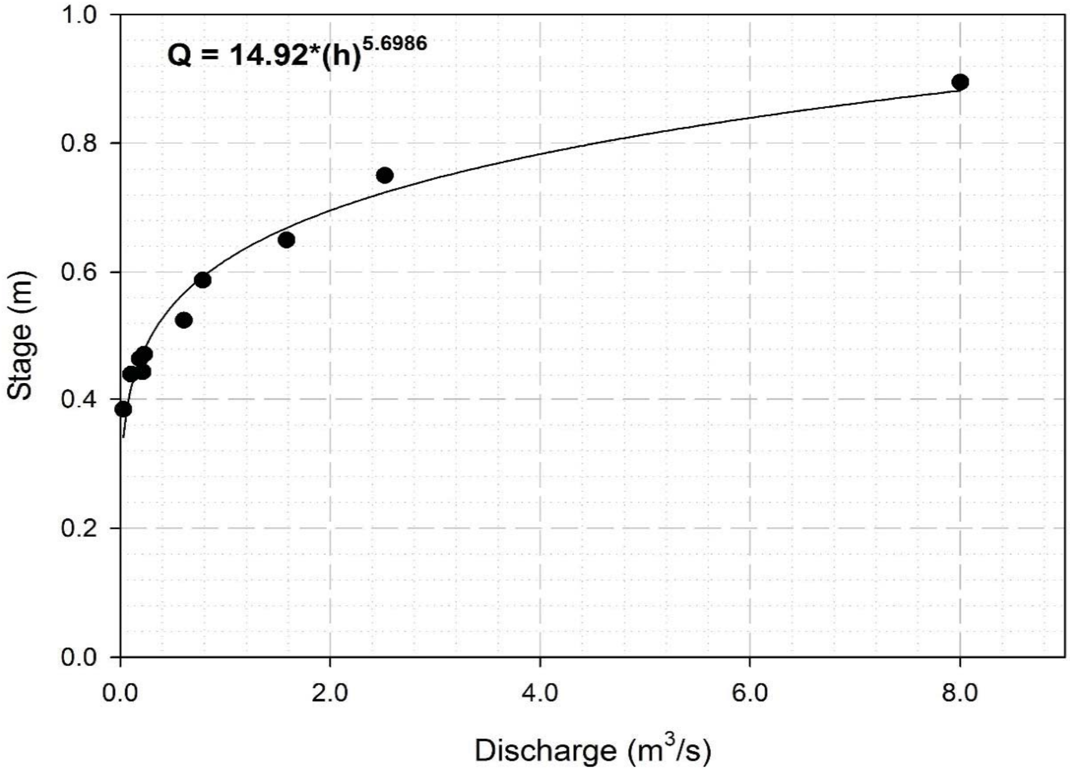
Manual Measurements

Date	Time	Stage (m)	Discharge (m^3/s)	Salt Dilution	MMB FlowMate	Pygmy	Price AA
11/10/2010	15:02		0.036			x	
11/11/2010	11:45		0.018	x			
20/07/2011	13:15		0.410		x		
26/08/2011	12:40		0.438				x
21/09/2011	16:20		0.078		x		
20/10/2011	11:30		0.039		x		
28/11/2011	14:05		0.019		x		
29/02/2012	14:51		0.017	x			
27/03/2012	15:41		0.014	x			
19/04/2012	12:56		0.051		x		
07/05/2012	15:30		0.173		x		
07/05/2012	15:53		0.160	x			
22/06/2012	16:04		0.198		x		
18/07/2012	14:17		0.521		x		
23/08/2012	13:51		0.045		x		
21/09/2012	12:31		0.560		x		
16/10/2012	15:01		0.129	x			
24/01/2013	15:31		0.021	x			
29/05/2013	17:27		1.508	x			
13/06/2013	15:53		0.560		x		
01/08/2013	11:30		0.175	x			
22/08/2013	9:53		0.062	x			
27/09/2013	17:24		0.157	x			
30/10/2013	11:36		0.033	x			
26/11/2013	12:43		0.022	x			
18/02/2014	11:17		0.012	X			
10/03/2014	15:37		0.009	x			
10/04/2014	13:25		0.009	x			
22/05/2014	12:40		0.495				x
26/06/2014	8:30	0.650	1.584				x
24/07/2014	8:40	0.465	0.185				x
21/08/2014	10:21	0.441	0.103				x
25/09/2014	17:20	0.472	0.225				x
23/10/2014	15:40	0.384	0.031	x			
24/11/2014	15:00		0.013	x			
01/04/2015	18:00						
30/04/2015	13:30						
17/05/2015	17:26	0.525	0.604	x			
25/06/2015	9:10	0.587	0.783	x			
23/07/2015	11:44	0.447					
19/08/2015	18:30	0.545					
12/09/2015	17:00	0.445	0.211	x			
28/10/2015	15:15	0.36	0.106	x			
27/11/2015	12:30	0.31	0.018	x			
Slope-Area		0.895	8.039				

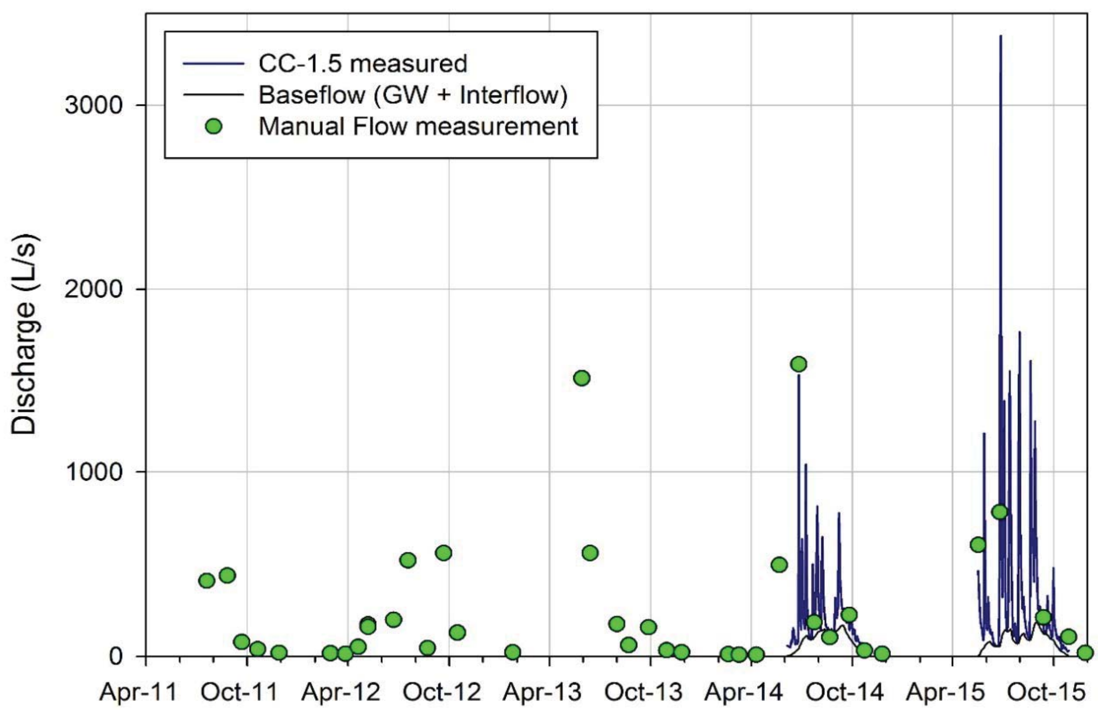
Hydrometric Station CC-1.5 Metadata

Rating Curve

NOTE: Rating curve extended using the slope-area method from a channel survey conducted in 2015.

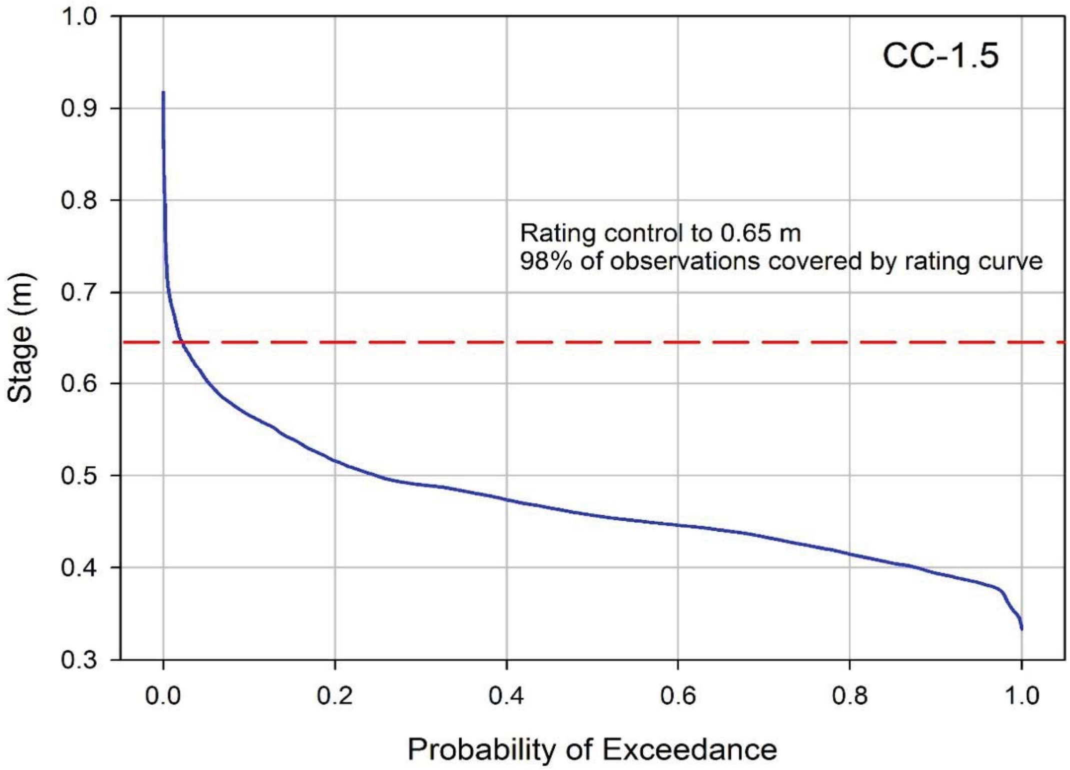


Continuous Discharge Record vs. Spot Flow Measurements

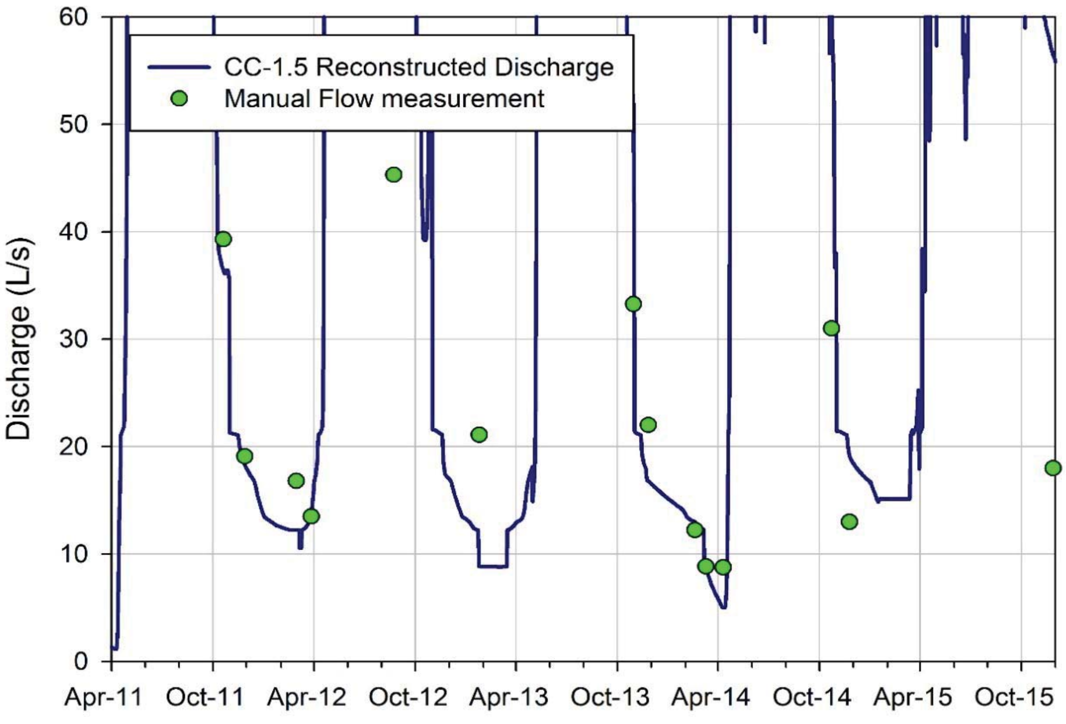


Hydrometric Station CC-1.5 Metadata

Rating Curve Control on Measured Stage

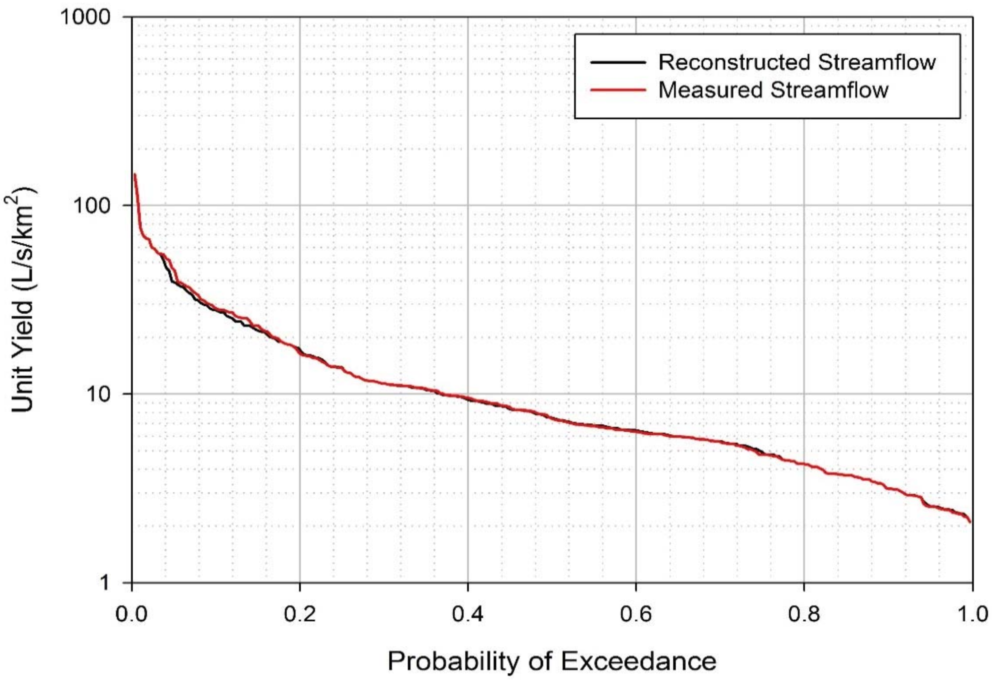


Baseflow comparison - winter spot flows vs. synthetic discharge record

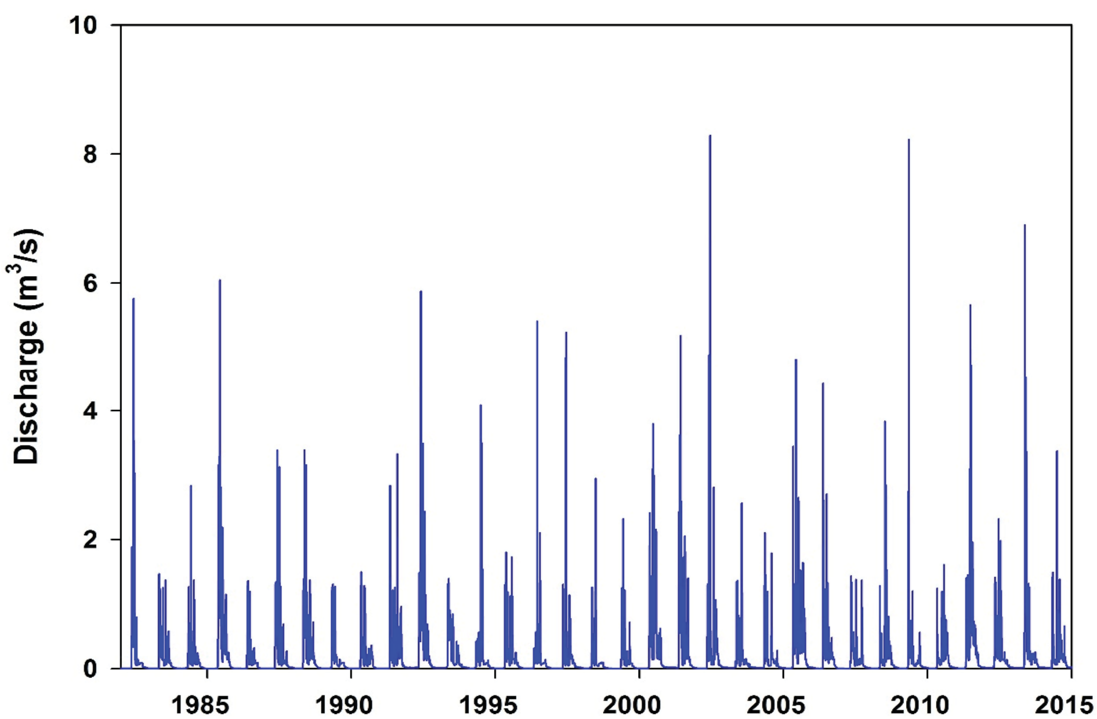


Hydrometric Station CC-1.5 Metadata

Flow Duration Curves - Synthetic vs. Measured Discharge



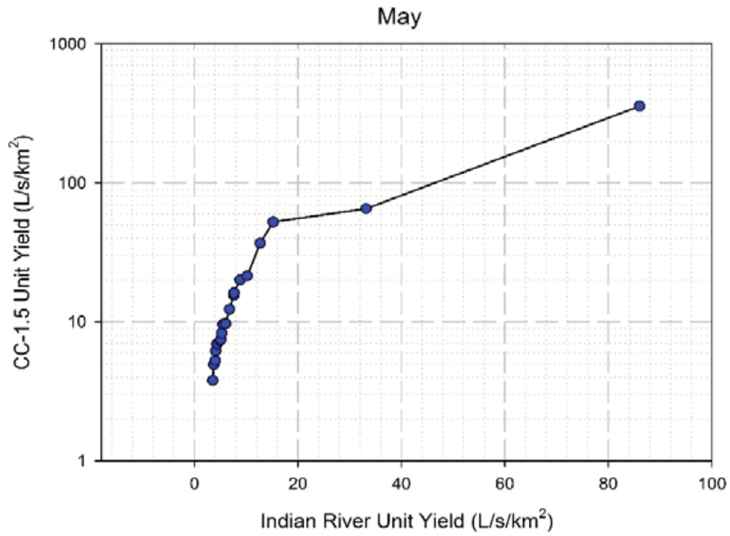
Synthetic Discharge Time-Series

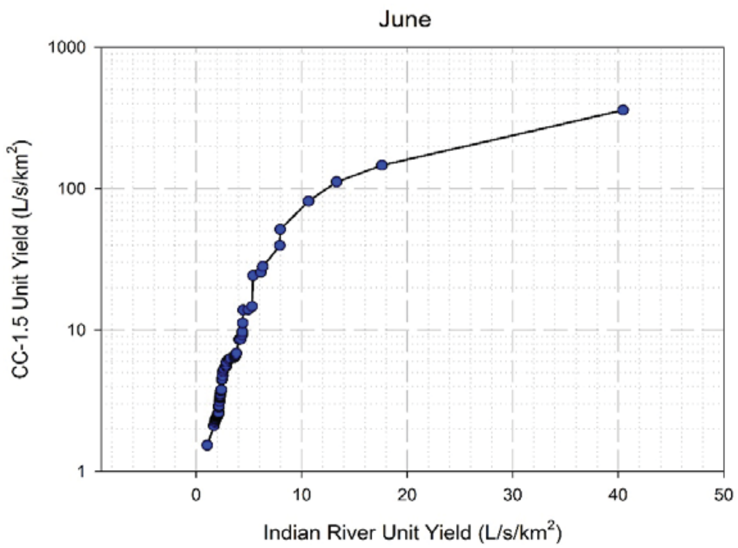


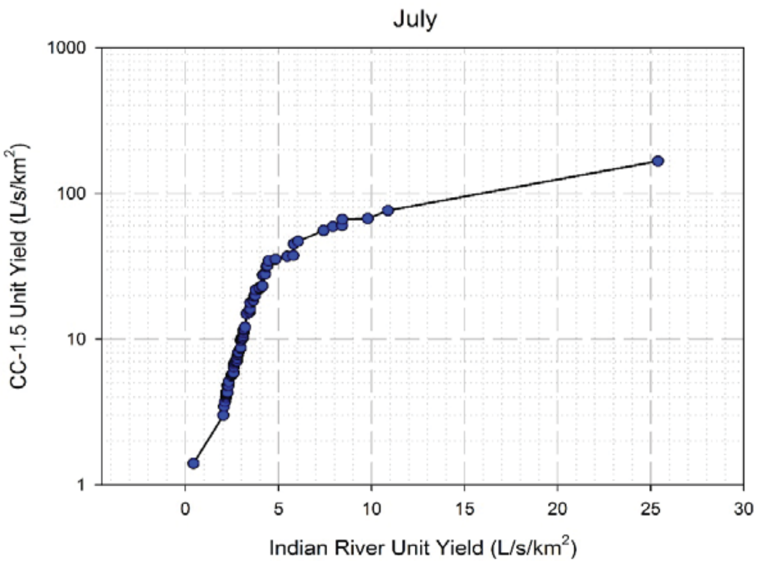
Hydrometric Station CC-1.5 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.



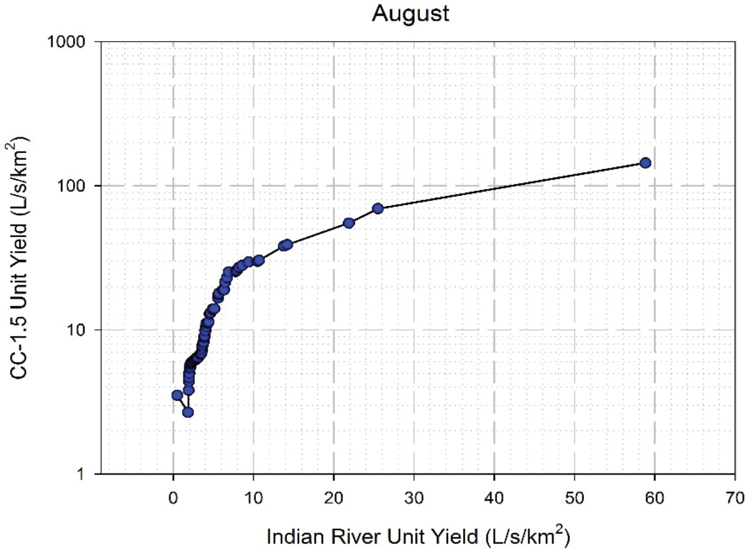


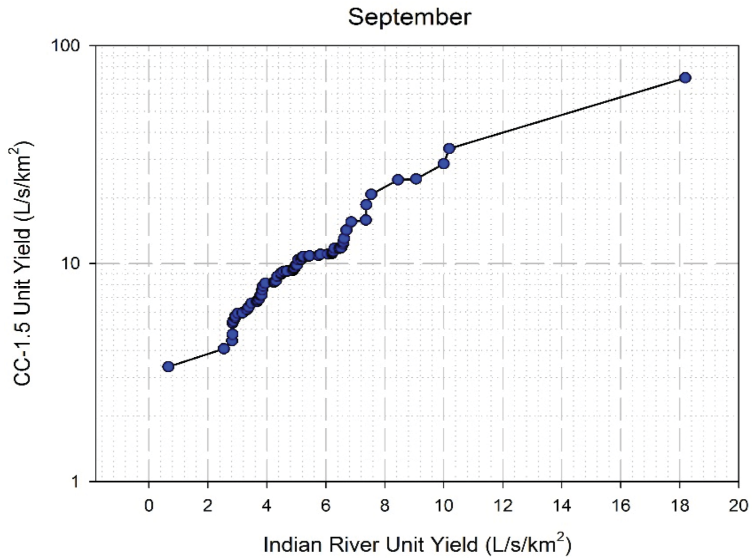


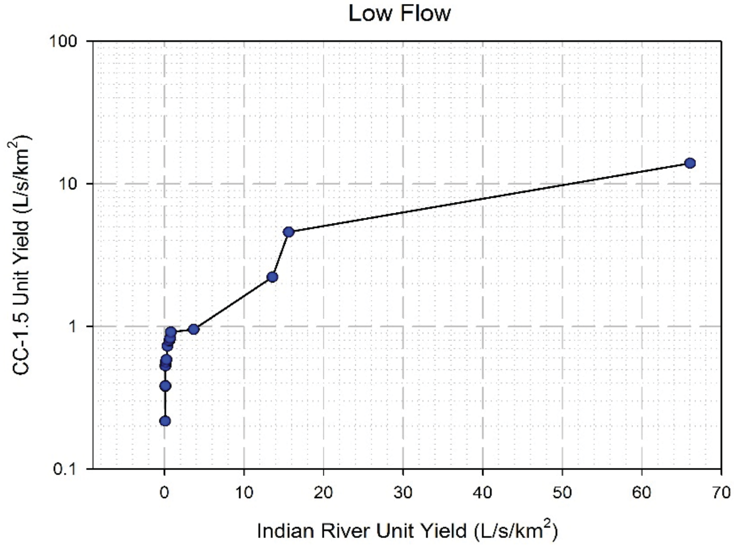
Hydrometric Station CC-1.5 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.







Hydrometric Station CC-1.5 Metadata

Monthly Summaries of Measured Discharge, Unit Yield and Runoff

Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2014	Average	--	--	*0.17*	0.34	0.22	0.28	*0.09*	--	0.22
	Maximum	--	--	*1.61*	1.65	1.02	0.97	*0.17*	--	1.65
	Minimum	--	--	*0.04*	0.07	0.12	0.11	*0.05*	--	0.04
2015	Average	--	*0.31*	0.40	0.56	0.46	0.21	0.08	--	0.33
	Maximum	--	*1.96*	9.15	3.22	2.44	0.84	0.39	--	9.15
	Minimum	--	*0.07*	0.04	0.06	0.07	0.08	0.02	--	0.02
Unit Yield ($L/s/km^2$)										
2014	Average	--	--	*7.2*	14.7	9.4	12.1	*3.9*	--	9.5
	Maximum	--	--	*69.6*	71.5	44.0	42.2	*7.5*	--	71.5
	Minimum	--	--	*1.8*	3.2	5.0	4.9	*2.1*	--	1.8
2015	Average	--	*13.3*	17.2	24.1	19.8	9.0	3.6	--	14.5
	Maximum	--	*85.0*	396.1	139.5	105.4	36.2	17.1	--	396.1
	Minimum	--	*3.0*	1.8	2.6	2.9	3.5	0.9	--	0.9
Runoff (mm)										
2014		--	--	*16*	39	25	31	*11*	--	123
2015		--	*15*	44	65	53	23	10	--	210

NOTE: Values in italics indicate that data for that month is not complete.

Appendix A
Site Hydrology Data

Appendix A1: Site Hydrology Data 2010 to 2015

Appendix A2: Site Hydrology Data 2016

GOLDCORP

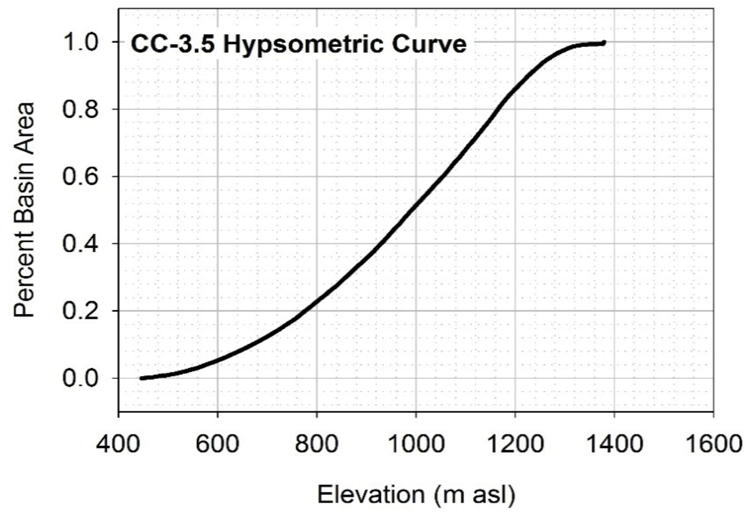
Appendix A1: Site Hydrology Data - 2010 to 2015

Hydrometric Station CC-3.5 Metadata

Station Name:	CC-3.5
Location:	Lower Latte Creek
Basin Area (km^2):	69.8
UTM Easting:	594433
UTM Northing:	6970376
Median Elevation (m asl):	990
Record Period:	
Spot Measurements	2010-Present
Continuous Record	2011-Present

Pressure Transducer:	Solinst
Temperature Sensor:	Yes
Conductivity Sensor:	Yes
Barologger:	Yes
Measurement Interval:	
Summer	15 minute
Winter	Removed

Hypsometric Curve



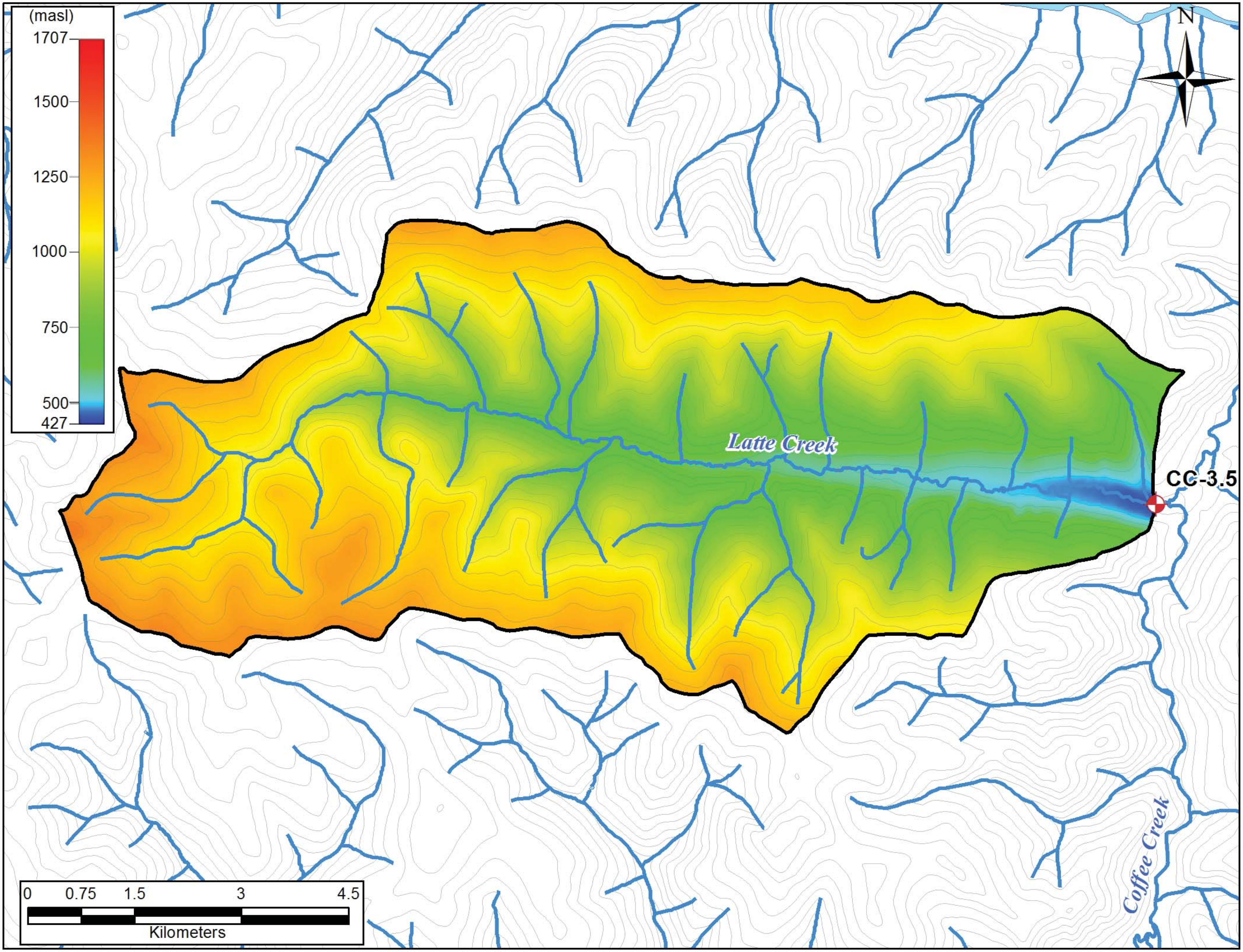
Benchmark surveys			
Date	**Gauge Height (m)**	**Change (m)**	**Notes**
22/09/2011	98.565		
22/06/2012	98.63	0.065	
21/09/2012	98.566	-0.064	
29/05/2013	99.58	1.014	
25/09/2013	99.781	0.201	SG reinstalled
22/05/2014	99.825	0.044	SG moved up
12/09/2015	99.847	0.022	SG moved up

NOTE: rating curve has been corrected for staff gauge movement due to frost jacking.

Catchment Slope Aspects (Quadrants in degrees)			
North (315-45)	**East (45-135)**	**South (135-225)**	**West (225-315)**
41%	13%	41%	5%

Open Water Photo

Winter Photo


(masl)
1707
1500
1250
1000
750
500
427
N
Latte Creek
CC-3.5
Coffee Creek
0
0.75
1.5
3
4.5
Kilometers

Hydrometric Station CC-3.5 Metadata

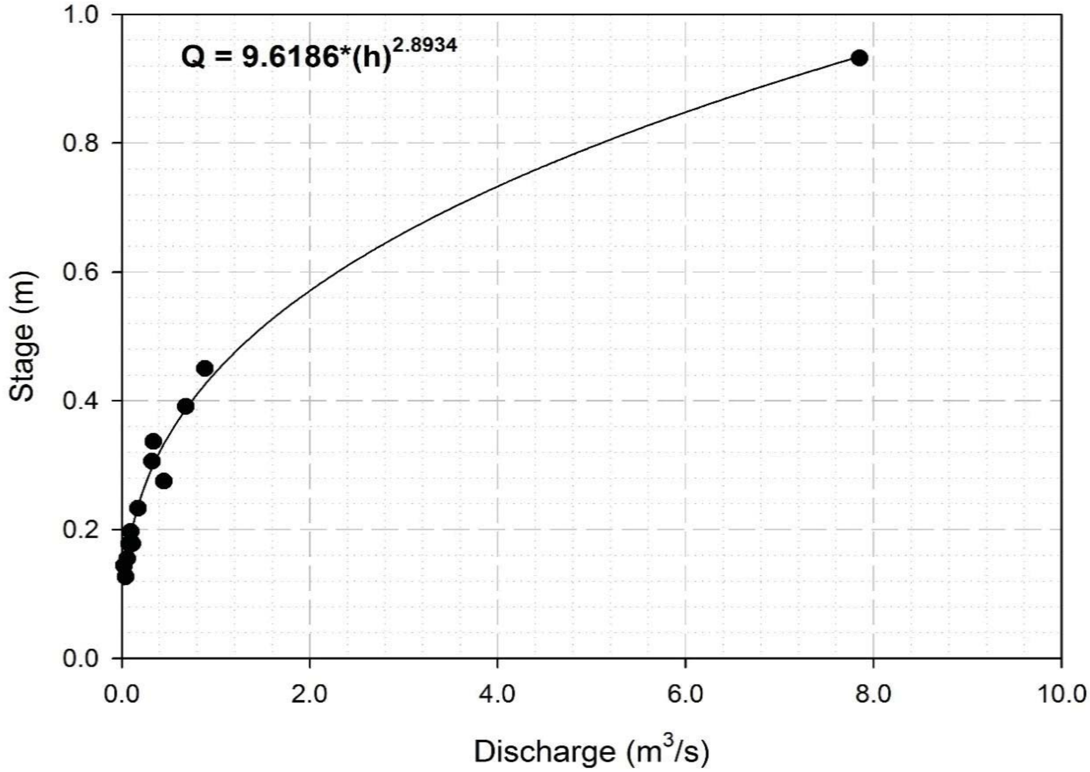
Manual Measurements

Date	Time	Stage (m)	Discharge (m^3/s)	Salt Dilution	MMB FlowMate	Pygmy	Price AA
11/10/2010	16:52		0.095				x
12/10/2010		0.321					
11/11/2010	12:19		0.021	x			
15/12/2010	11:16		0.014	x			
19/04/2011		0.282					
19/05/2011	14:35	0.755					
22/06/2011	17:12	0.840	5.339		x		
20/07/2011	11:52	0.582	1.206		x		
26/08/2011	11:07	0.584	0.965				x
22/09/2011	9:45	0.412	0.286		x		
20/10/2011	13:30	0.332					
28/11/2011	12:25	0.330	0.008		x		
20/12/2011		0.310					
29/02/2012	13:35		0.000				
26/03/2012	14:25		0.000				
19/04/2012	11:05	0.560	0.069		x		
07/05/2012	13:15	0.475	0.410		x		
07/05/2012		0.478					
22/06/2012	14:39	0.530	0.809		x		
18/07/2012	13:06	0.592	1.257		x		
23/08/2012	12:26	0.380	0.109		x		
21/09/2012	11:28	0.556	0.800		x		
16/10/2012	13:10	0.344	0.203		x		
20/11/2012	12:55		0.036	x			
10/04/2013	12:00		0.000				
29/05/2013	13:32	0.736	2.352		x		
13/06/2013	14:18	0.533	0.534		x		
01/08/2013	12:47	0.593	0.491		x		
21/08/2013	12:08	0.427	0.134		x		
26/09/2013	18:39	0.337	0.337		x		
28/10/2013	16:48	0.197	0.094		x		
25/11/2013	15:00		0.017	x			
08/01/2014	14:12		0.010	x			
10/03/2014	13:55		0.001	x			
22/05/2014	14:30	0.450	0.884		x		
05/06/2014	12:30	0.178	0.090				x
25/06/2014	15:45	0.178	0.078		x		
23/07/2014	13:40	0.306	0.322				x
21/08/2014	8:59	0.233	0.171				x
26/09/2014	14:53	0.243					
23/10/2014	12:45	0.155	0.058	x			
24/11/2014	14:30	0.144	0.023	x			
30/04/2015	11:45	0.276	0.13				x
17/05/2015	16:00	0.391	0.681	x			
24/06/2015	17:55	0.127	0.04				
19/08/2015	16:00	0.353					
12/09/2015	14:30	0.275	0.447		x		
28/10/2015	14:00	0.178	0.113		x		
Slope-Area		0.932	7.85				

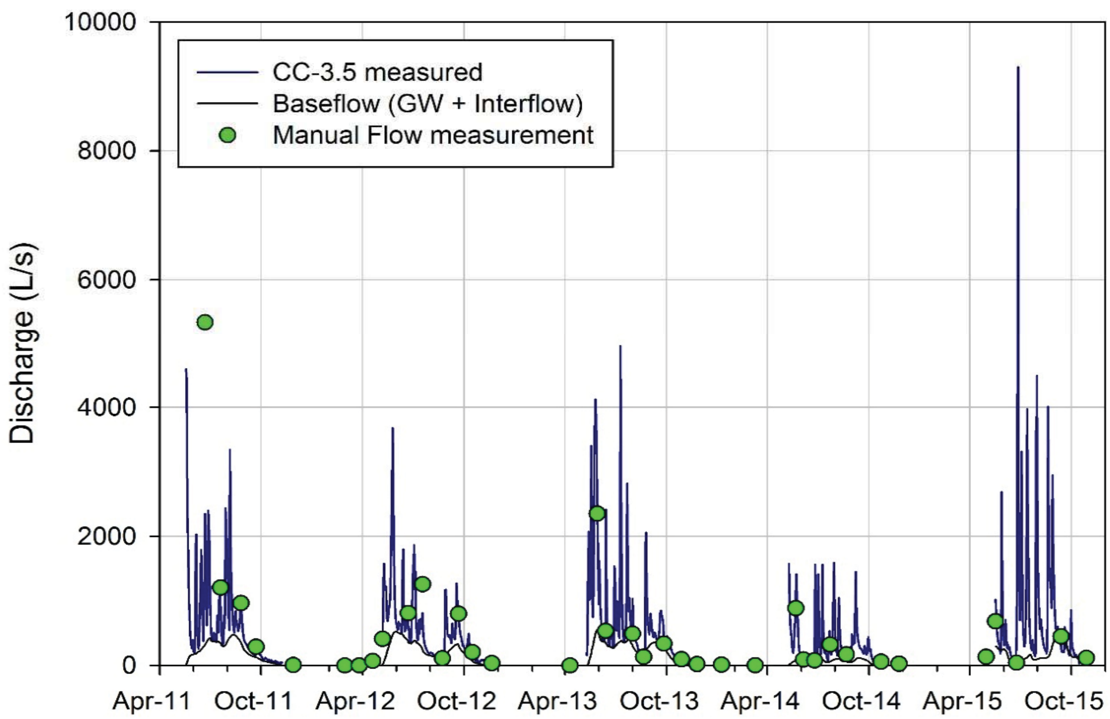
Hydrometric Station CC-3.5 Metadata

Rating Curve

NOTE: Rating curve extended using the slope-area method from a channel survey conducted in 2015.

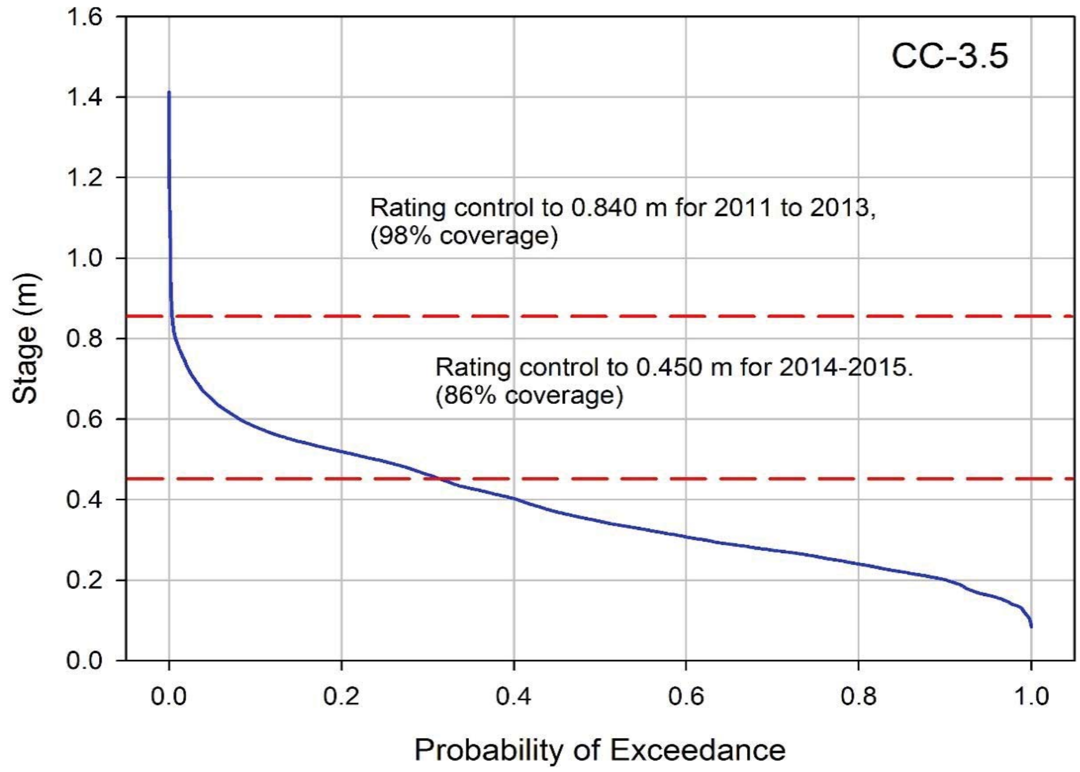


Continuous Discharge Record vs. Spot Flow Measurements

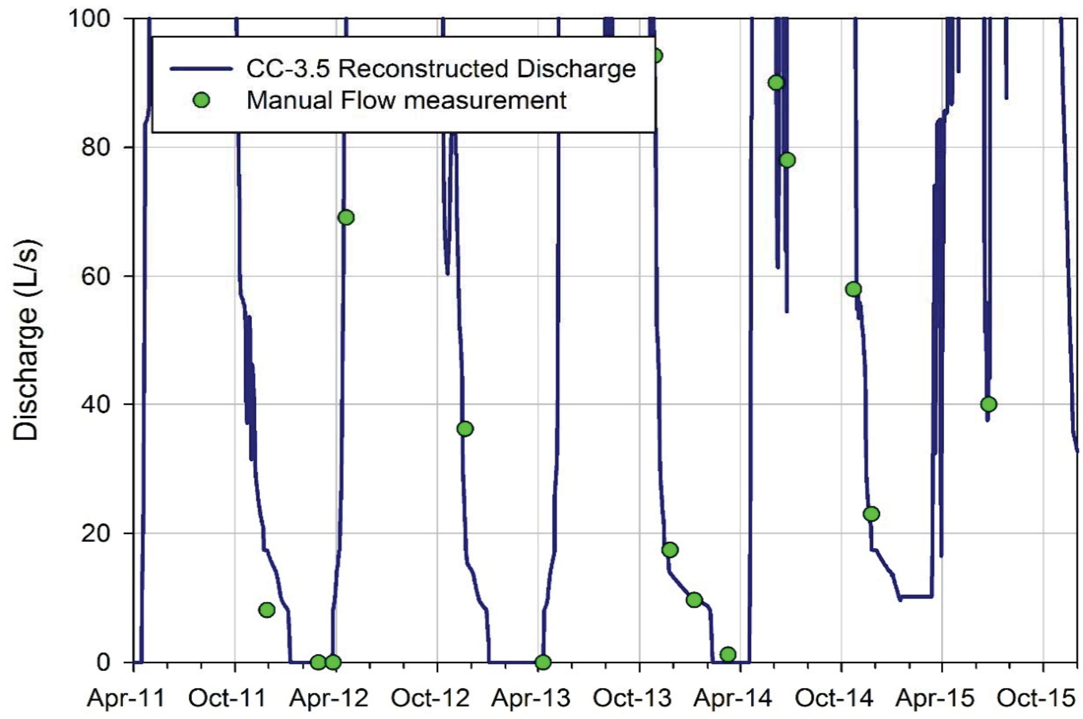


Hydrometric Station CC-3.5 Metadata

Rating Curve Control on Measured Stage

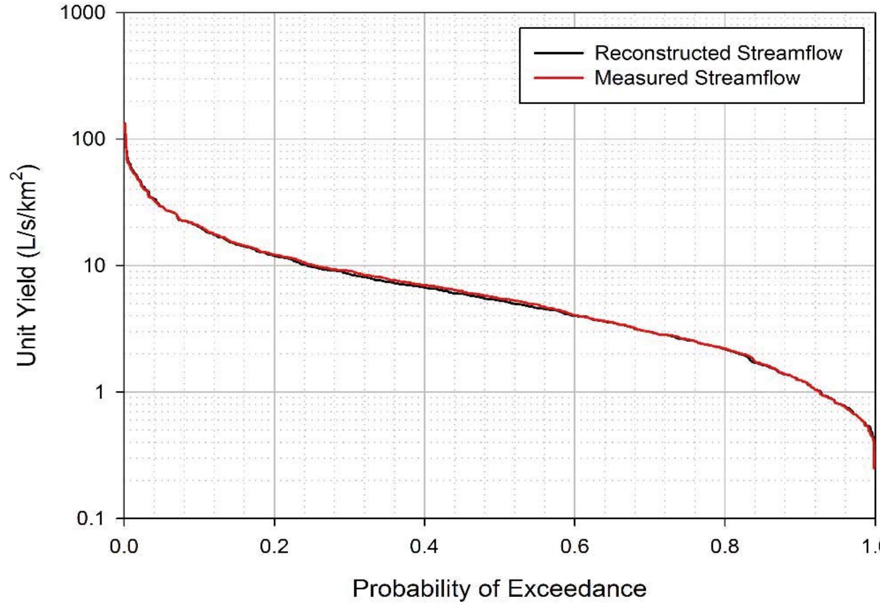


Baseflow comparison - winter spot flows vs. synthetic discharge record

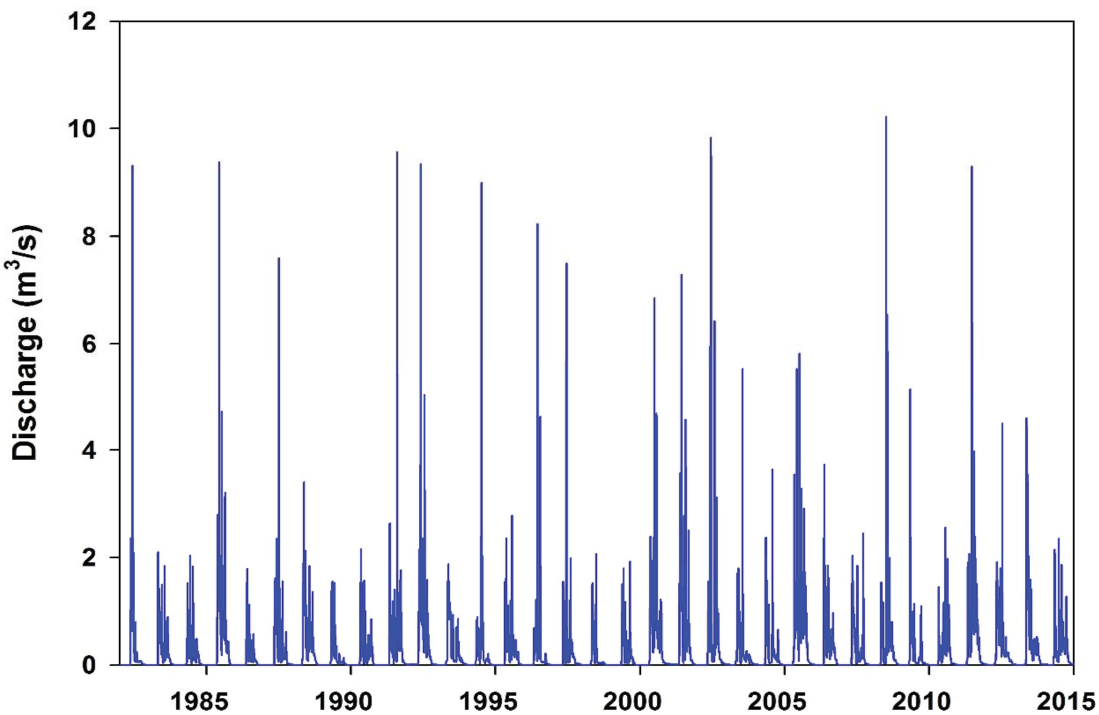


Hydrometric Station CC-3.5 Metadata

Flow Duration Curves - Synthetic vs. Measured Discharge



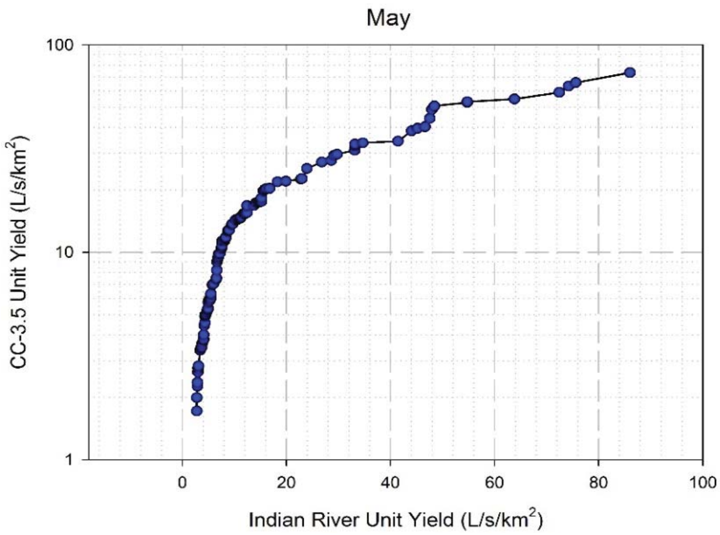
Synthetic Discharge Time-Series

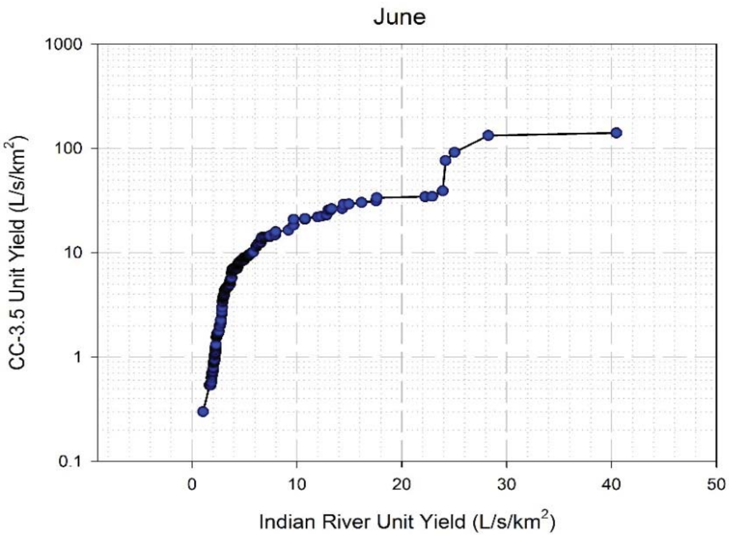


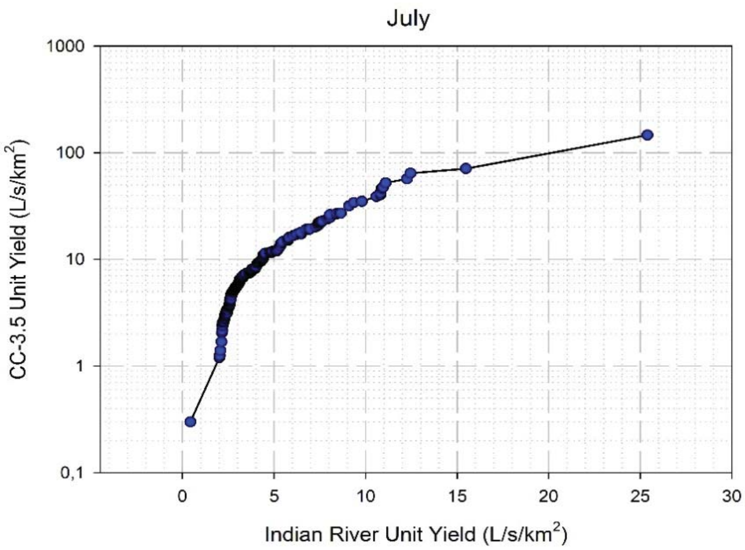
Hydrometric Station CC-3.5 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.



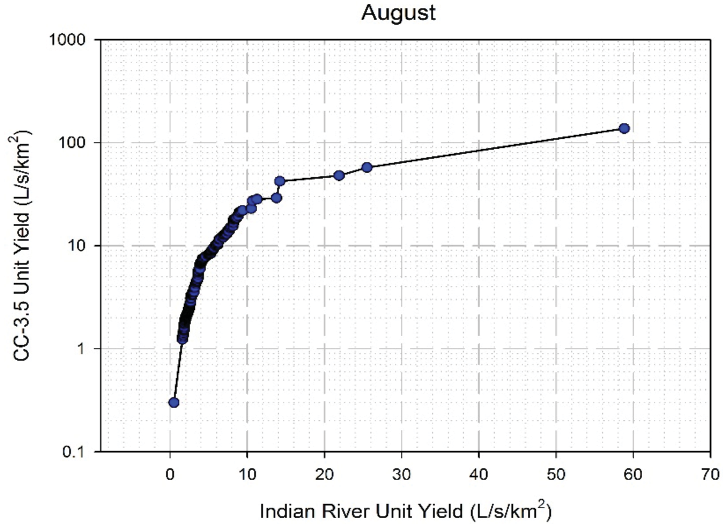


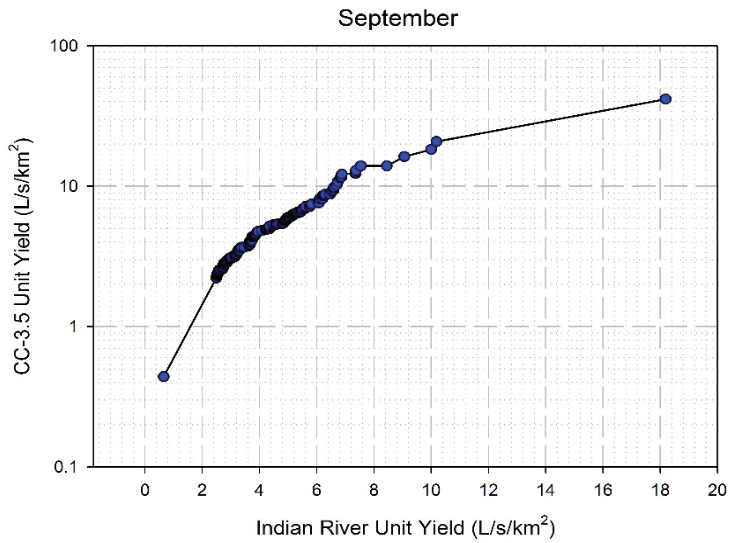


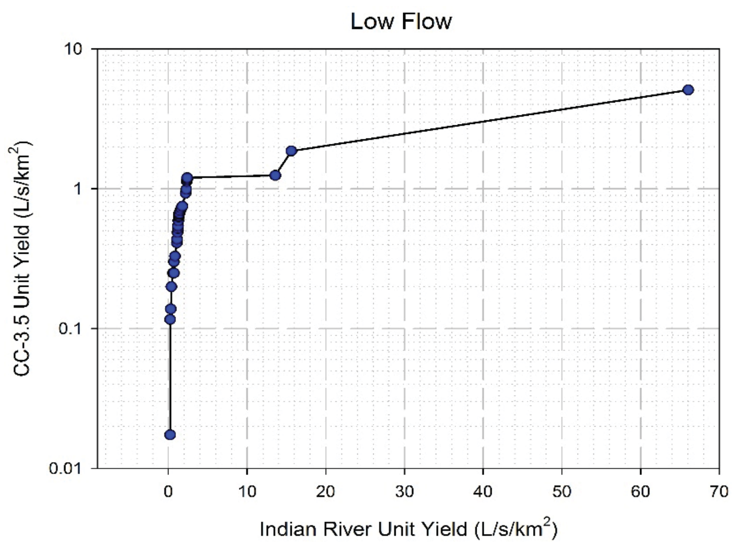
Hydrometric Station CC-3.5 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.







Hydrometric Station CC-3.5 Metadata

Monthly Summaries of Measured Discharge, Unit Yield and Runoff

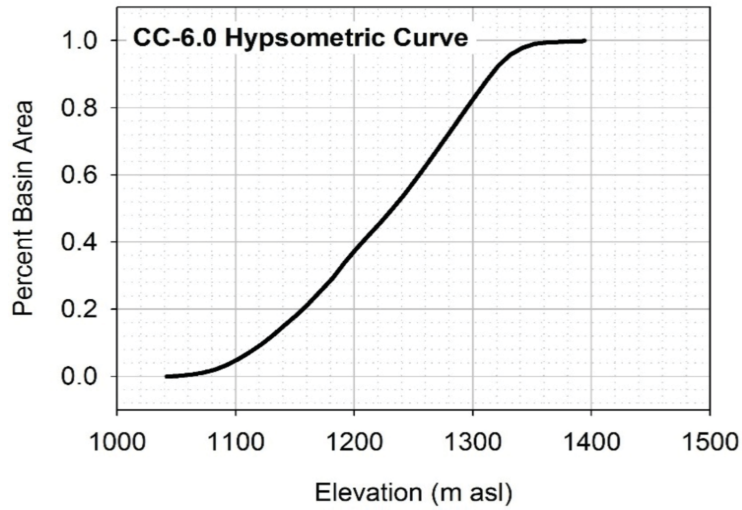
Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2011	Average	--	*1.276*	1.05	0.74	0.88	0.23	0.08	*0.042*	0.62
	Maximum	--	*6.267*	4.86	3.19	5.21	0.41	0.18	*0.052*	6.27
	Minimum	--	*0.243*	0.17	0.27	0.39	0.14	0.05	*0.013*	0.01
2012	Average	--	*1.306*	0.69	0.62	0.26	0.55	0.20	*0.079*	0.53
	Maximum	--	*4.047*	2.66	2.57	1.73	1.40	0.54	*0.092*	4.05
	Minimum	--	*0.284*	0.32	0.16	0.12	0.28	0.04	*0.037*	0.04
2013	Average	--	*2.012*	0.69	1.06	0.51	0.54	0.19	*0.039*	0.72
	Maximum	--	*5.922*	3.64	7.30	3.26	0.96	0.47	*0.055*	7.30
	Minimum	--	*0.145*	0.25	0.32	0.17	0.06	0.05	*0.027*	0.03
2014	Average	--	*0.583*	0.17	0.53	0.25	0.39	*0.10*	--	0.34
	Maximum	--	*2.173*	2.25	2.14	1.41	1.75	*0.60*	--	2.25
	Minimum	--	*0.124*	0.03	0.07	0.08	0.11	*0.03*	--	0.03
2015	Average	--	*0.67*	0.96	1.28	1.02	0.40	0.12	--	0.74
	Maximum	--	*4.06*	26.14	8.26	6.10	1.42	0.72	--	26.14
	Minimum	--	*0.14*	0.08	0.12	0.14	0.11	0.01	--	0.01
Unit Yield ($L/s/km^2$)										
2011	Average	--	*18.28*	15.0	10.7	12.6	3.3	1.2	*0.602*	8.8
	Maximum	--	*89.78*	69.7	45.7	74.7	5.9	2.5	*0.751*	89.8
	Minimum	--	*3.476*	2.4	3.8	5.6	2.0	0.7	*0.186*	0.2
2012	Average	--	*18.71*	9.9	8.9	3.8	7.9	2.9	*1.138*	7.6
	Maximum	--	*57.98*	38.1	36.8	24.7	20.0	7.8	*1.316*	58.0
	Minimum	--	*4.074*	4.6	2.3	1.7	3.9	0.5	*0.534*	0.5
2013	Average	--	*28.82*	9.9	15.2	7.3	7.8	2.7	*0.556*	10.3
	Maximum	--	*84.84*	52.2	104.6	46.6	13.7	6.8	*0.789*	104.6
	Minimum	--	*2.082*	3.6	4.5	2.5	0.9	0.7	*0.391*	0.4
2014	Average	--	*8.356*	2.4	7.6	3.6	5.6	*1.4*	--	4.8
	Maximum	--	*31.13*	32.2	30.6	20.1	25.1	*8.6*	--	32.2
	Minimum	--	*1.772*	0.5	1.0	1.1	1.6	*0.4*	--	0.4
2015	Average	--	*9.6*	13.7	18.3	14.6	5.7	1.7	--	10.6
	Maximum	--	*58.2*	374.5	118.4	87.4	20.4	10.3	--	374.5
	Minimum	--	*2.0*	1.2	1.7	2.0	1.6	0.1	--	0.1
Runoff (mm)										
2011		--	*20.53*	*39*	29	34	8	3	*0*	134
2012		--	*43.64*	*26*	24	10	20	*8*	*1*	132
2013		--	*54.79*	*26*	41	20	20	7	*0*	168
2014		--	*15.88*	*6*	20	10	15	*3*	--	70
2015		--	*12*	36	49	39	15	5	--	156

NOTE: Values in italics indicate that data for that month is not complete.

Hydrometric Station CC-6.0 Metadata

Station Name:	CC-6.0
Location:	Upper Latte Creek
Basin Area (km^2):	9.6
UTM Easting:	581667
UTM Northing:	6970960
Median Elevation (m asl):	1233
Record Period:	
Spot Measurements	2014-Present
Continuous Record	2014-Present

Hypsometric Curve



Pressure Transducer:	Solinst
Temperature Sensor:	Yes
Conductivity Sensor:	Yes
Barologger:	Yes
Measurement Interval:	
Summer	15 minute
Winter	Removed

Benchmark surveys

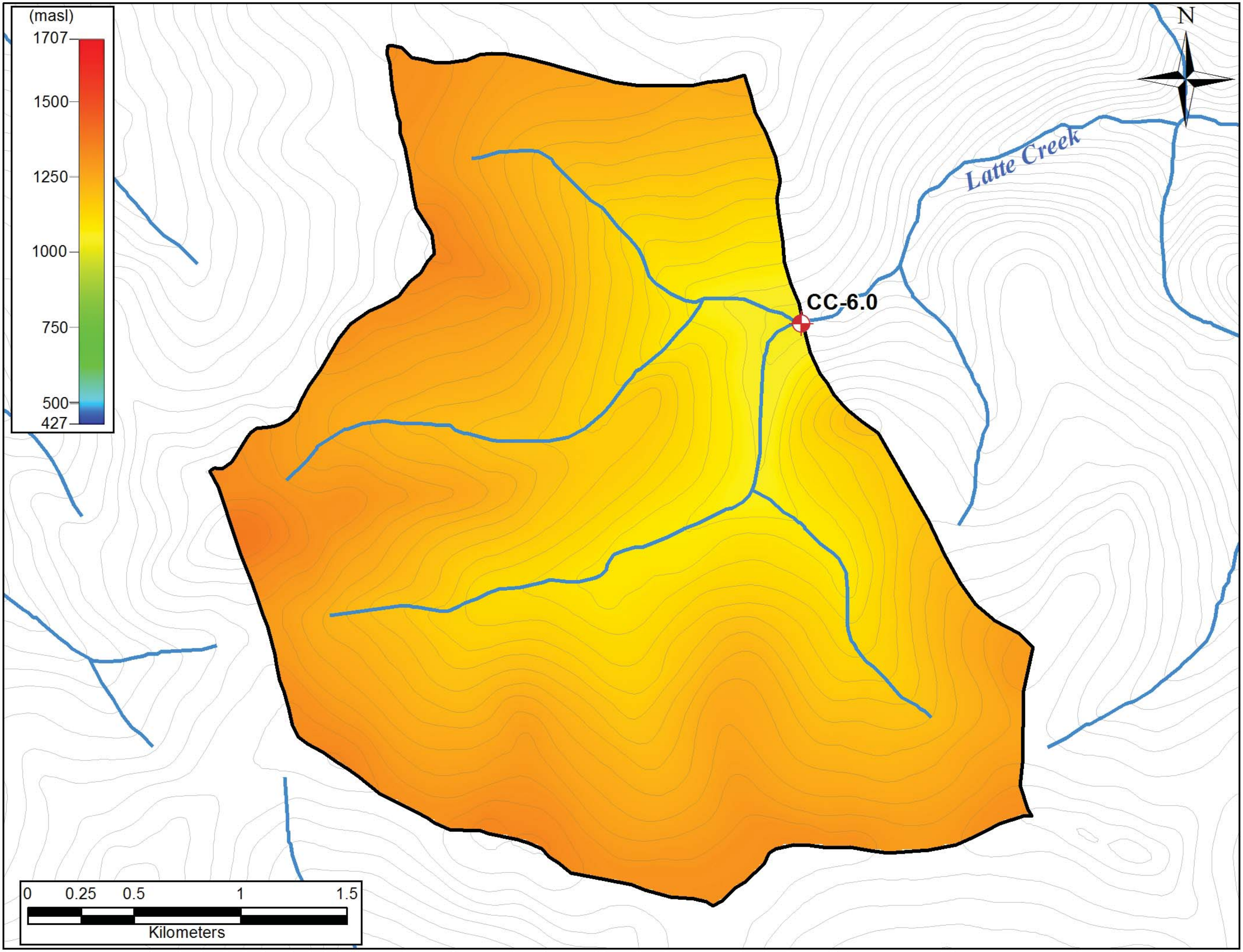
Date	Gauge Height (m)	Change (m)	Notes
14/09/2014	96.677		
13/09/2015	96.677	0.000	no movement

Catchment Slope Aspects (Quadrants in degrees)

North (315-45)	East (45-135)	South (135-225)	West (225-315)
27%	29%	43%	0%

Open Water Photo

Winter Photo


(masl)
1707
1500
1250
1000
750
500
427
N
Latte Creek
CC-6.0
0
0.25
0.5
1
1.5
Kilometers

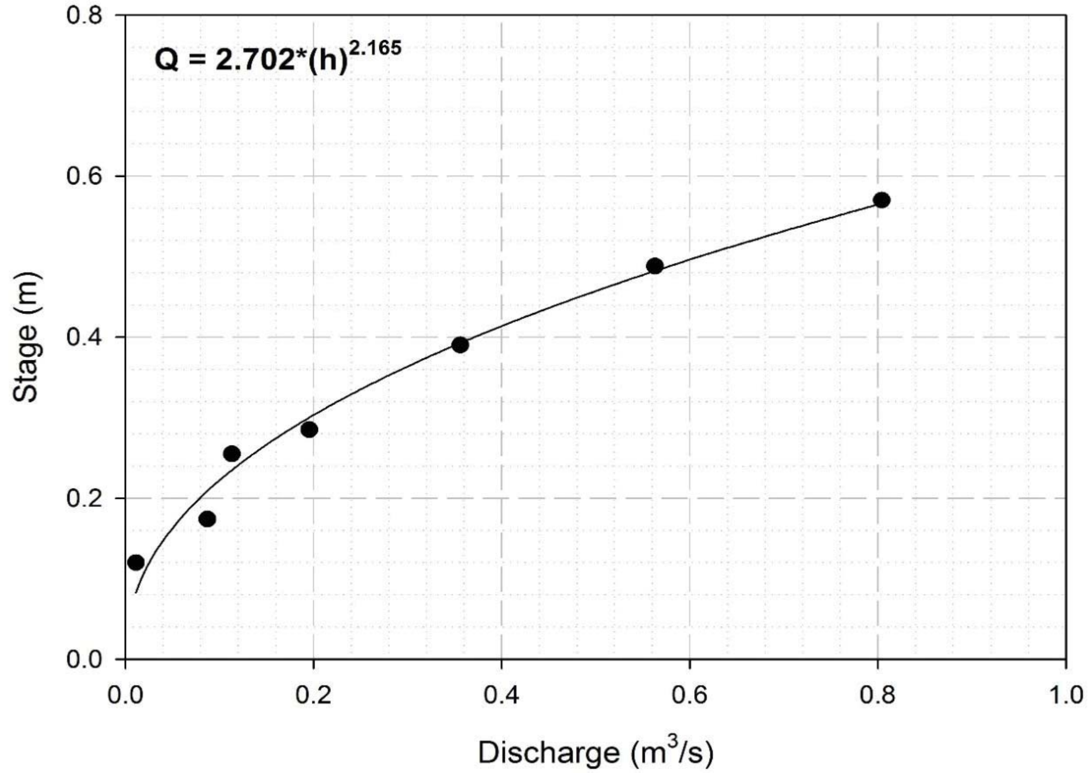
Hydrometric Station CC-6.0 Metadata

Manual Measurements

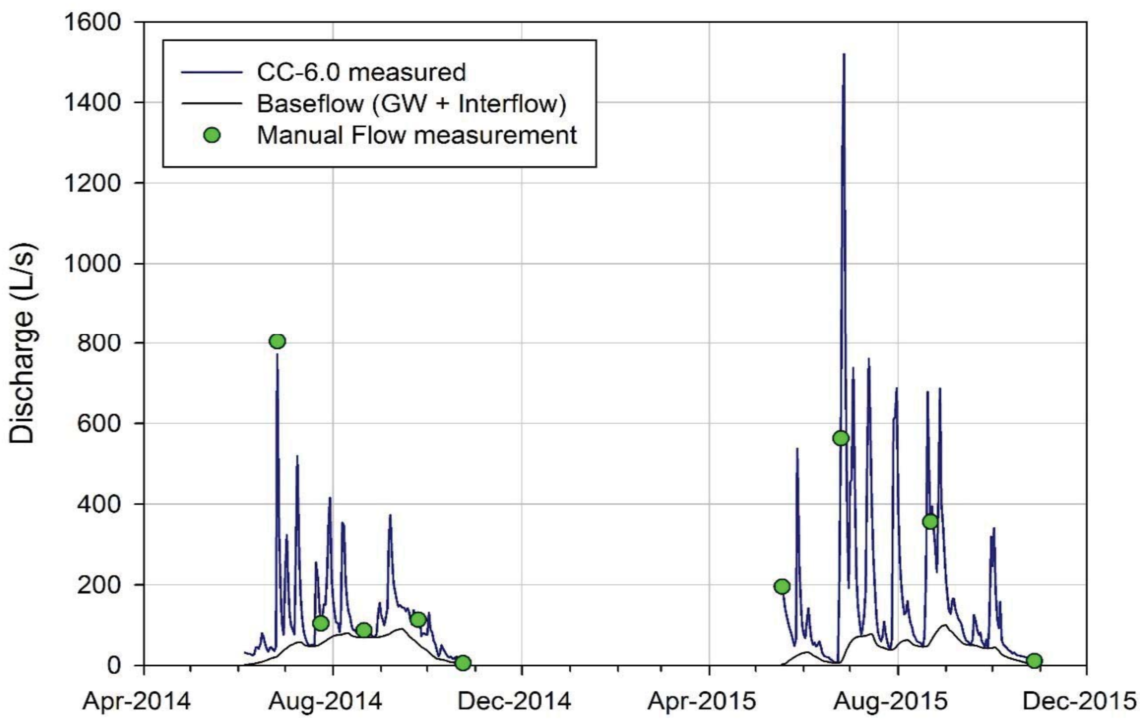
Date	Time	Stage (m)	Discharge (m^3/s)	Salt Dilution	MMB FlowMate	Pygmy	Price AA
26/06/2014	11:00	0.570	0.804	x			
24/07/2014	14:45		0.104				x
21/08/2014	12:19	0.174	0.087				x
25/09/2014	15:23	0.255	0.113				x
24/10/2014	12:30		0.005				x
30/04/2015	15:00						
18/05/2015	12:00	0.285	0.196	x			
25/06/2015	12:00	0.488	0.563	x			
23/07/2015	13:09	0.217					
22/08/2015	9:30	0.390	0.356	x			
13/09/2015	16:00	0.192					
28/10/2015	11:35	0.120	0.011	x			
25/11/2015	11:30						

Hydrometric Station CC-6.0 Metadata

Rating Curve

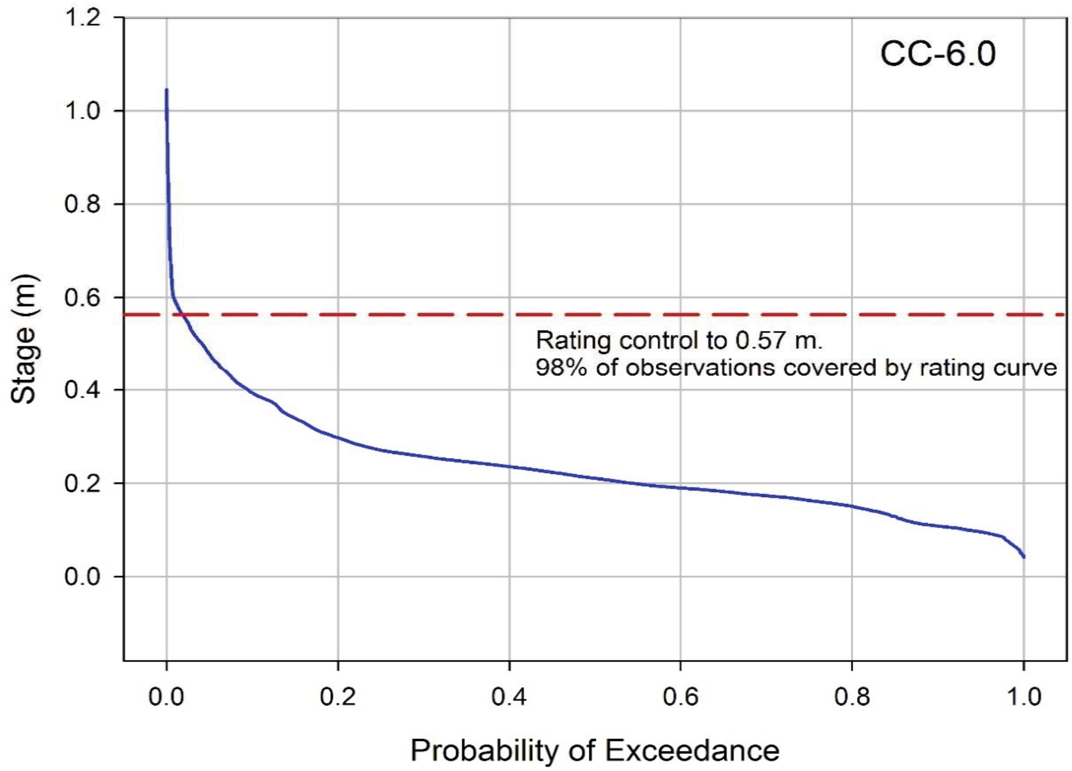


Continuous Discharge Record vs. Spot Flow Measurements



Hydrometric Station CC-6.0 Metadata

Rating Curve Control on Measured Stage

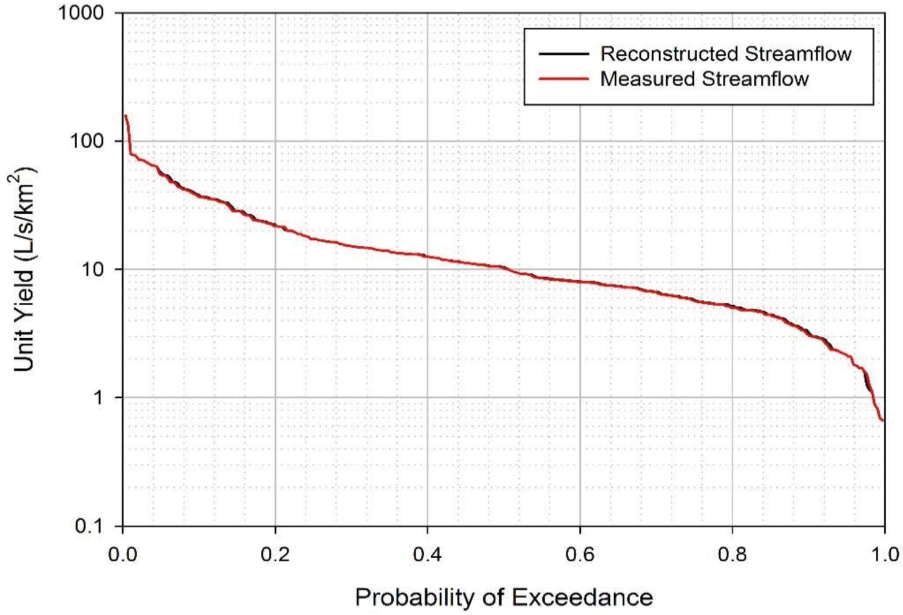


Baseflow comparison - winter spot flows vs. synthetic discharge record

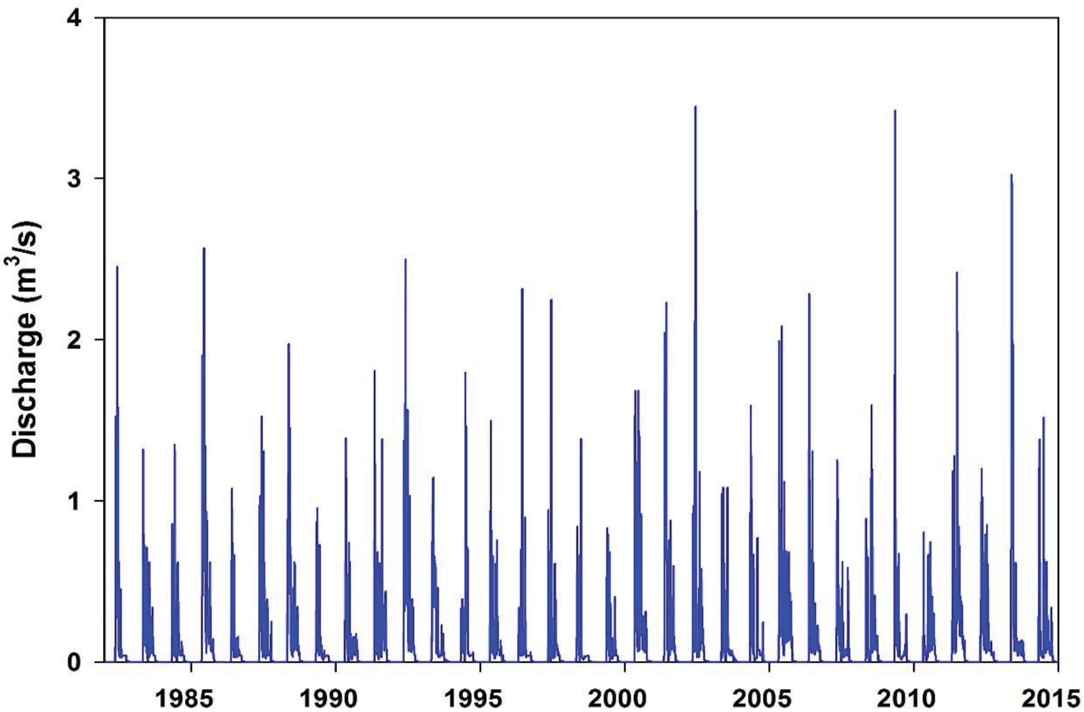
NOTE: This stream experiences extensive aufeis conditions during the winter, and therefore no flow measurements are possible.

Hydrometric Station CC-6.0 Metadata

Flow Duration Curves - Synthetic vs. Measured Discharge



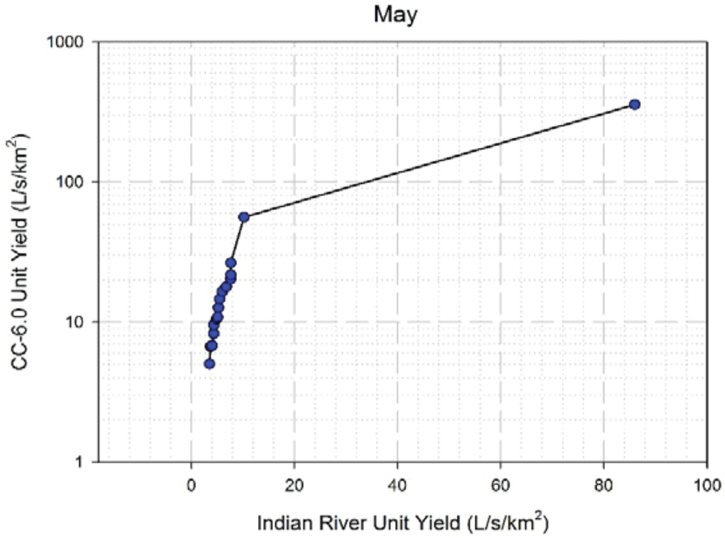
Synthetic Discharge Time-Series

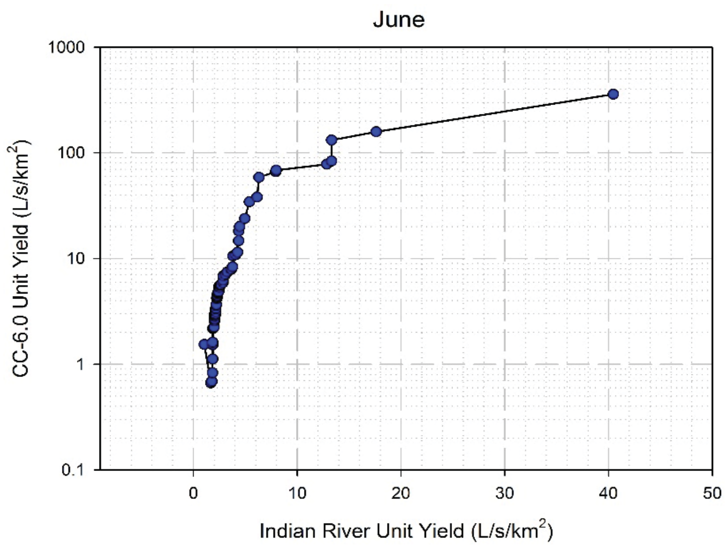


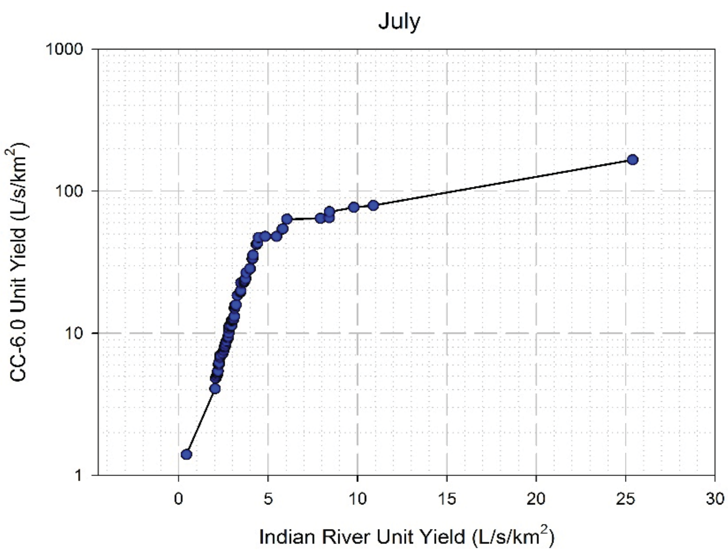
Hydrometric Station CC-6.0 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.



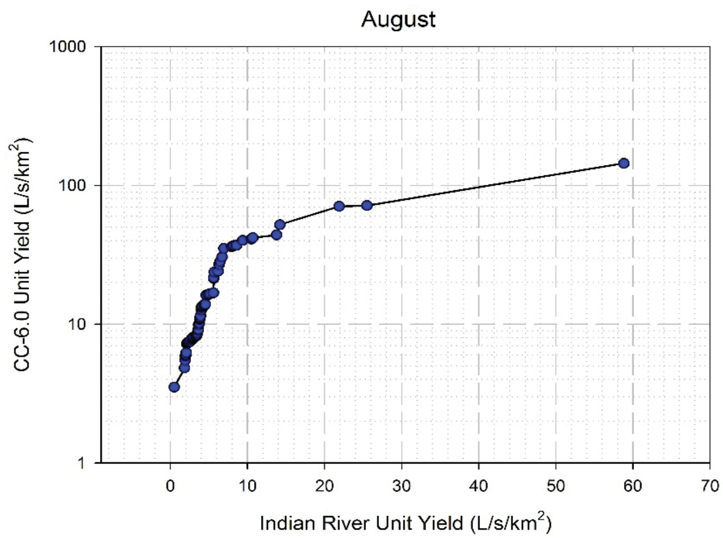


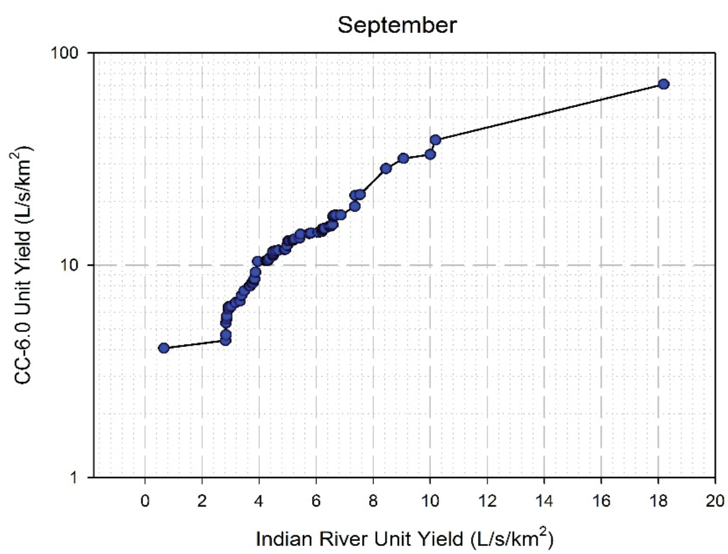


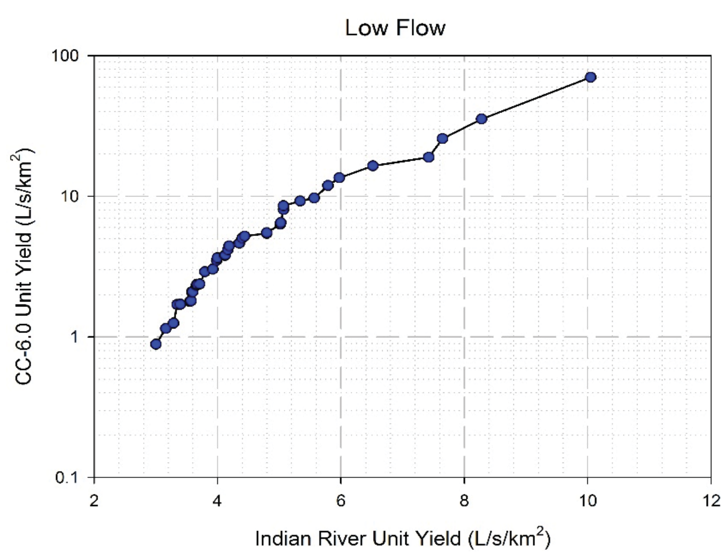
Hydrometric Station CC-6.0 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.







Hydrometric Station CC-6.0 Metadata

Monthly Summaries of Measured Discharge, Unit Yield and Runoff

Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2014	Average	--	--	0.09	0.17	0.12	0.15	*0.04*	--	0.11
	Maximum	--	--	0.78	0.80	0.61	0.47	*0.19*	--	0.80
	Minimum	--	--	0.02	0.04	0.06	0.07	*0.01*	--	0.01
2015	Average	--	*0.15*	0.20	0.28	0.24	0.11	0.07	--	0.17
	Maximum	--	*0.70*	2.98	1.11	0.90	0.35	0.48	--	2.98
	Minimum	--	*0.04*	0.00	0.03	0.04	0.04	0.01	--	0.00
Unit Yield ($L/s/km^2$)										
2014	Average	--	--	8.9	18.0	12.1	15.1	*4.1*	--	11.7
	Maximum	--	--	81.6	83.7	63.3	49.4	*19.8*	--	83.7
	Minimum	--	--	2.3	4.1	5.8	7.0	*0.7*	--	0.7
2015	Average	--	*15.8*	21.0	28.7	24.9	11.0	6.9	--	18.0
	Maximum	--	*73.3*	310.0	115.8	94.0	36.5	49.9	--	310.0
	Minimum	--	*4.0*	0.3	3.5	3.8	3.8	1.4	--	0.3
Runoff (mm)										
2014		--	--	*20*	48	32	39	*9*	--	148
2015		--	*19*	54	77	67	29	18	--	264

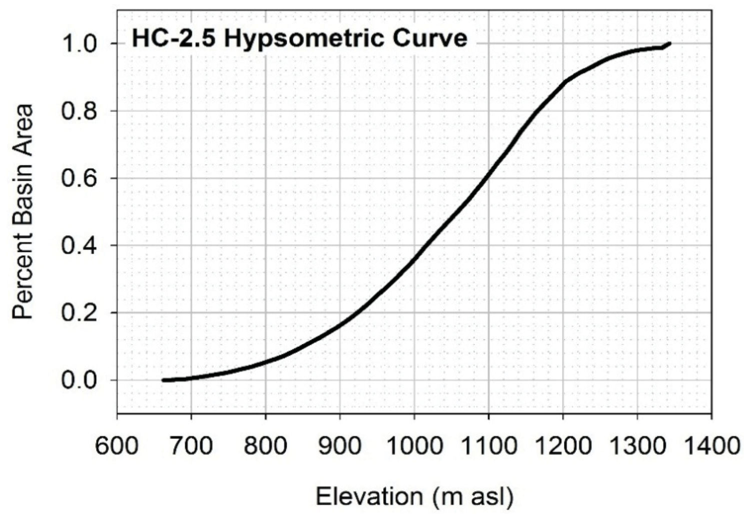
NOTE: Values in italics indicate that data for that month is not complete.

Hydrometric Station HC-2.5 Metadata

Station Name:	HC-2.5
Location:	Upper Halfway Creek
Basin Area (km^2):	14.8
UTM Easting:	584058
UTM Northing:	6976584
Median Elevation (m asl):	1057
Record Period:	
Spot Measurements	2010-Present
Continuous Record	2014-Present

Pressure Transducer:	Solinst
Temperature Sensor:	Yes
Conductivity Sensor:	Yes
Barologger:	No
Measurement Interval:	
Summer	15 minute
Winter	Removed

Hypsometric Curve

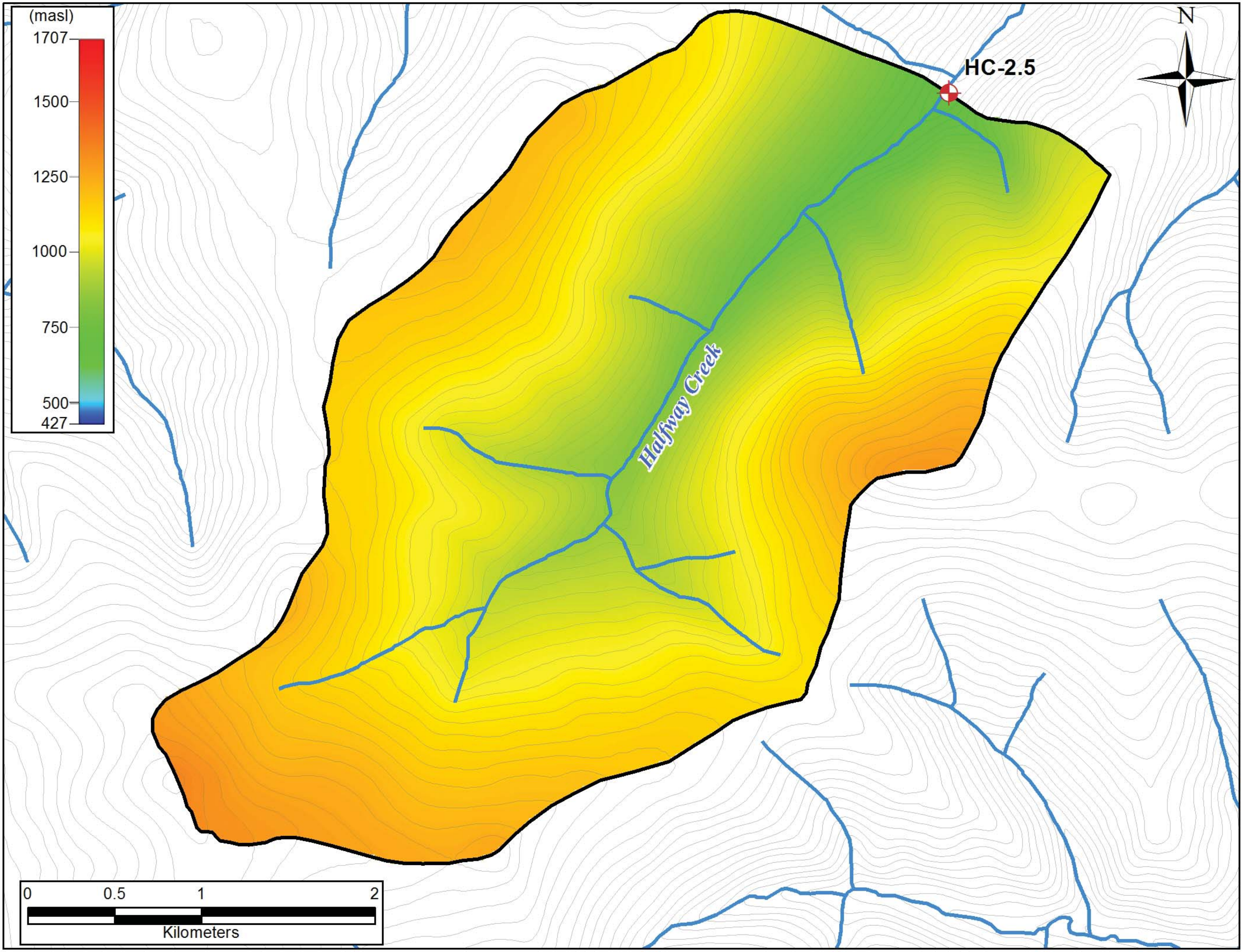


Benchmark surveys			
Date	**Gauge Height (m)**	**Change (m)**	**Notes**
07/06/2014	98.695		
14/09/2015	98.732	0.037	SG moved up

Catchment Slope Aspects (Quadrants in degrees)			
North (315-45)	**East (45-135)**	**South (135-225)**	**West (225-315)**
48%	16%	27%	8%

Open Water Photo

Winter Photo



(masl)
1707
1500
1250
1000
750
500
427
HC-2.5
N
Halfway Creek
0
0.5
1
2
Kilometers

Hydrometric Station HC-2.5 Metadata

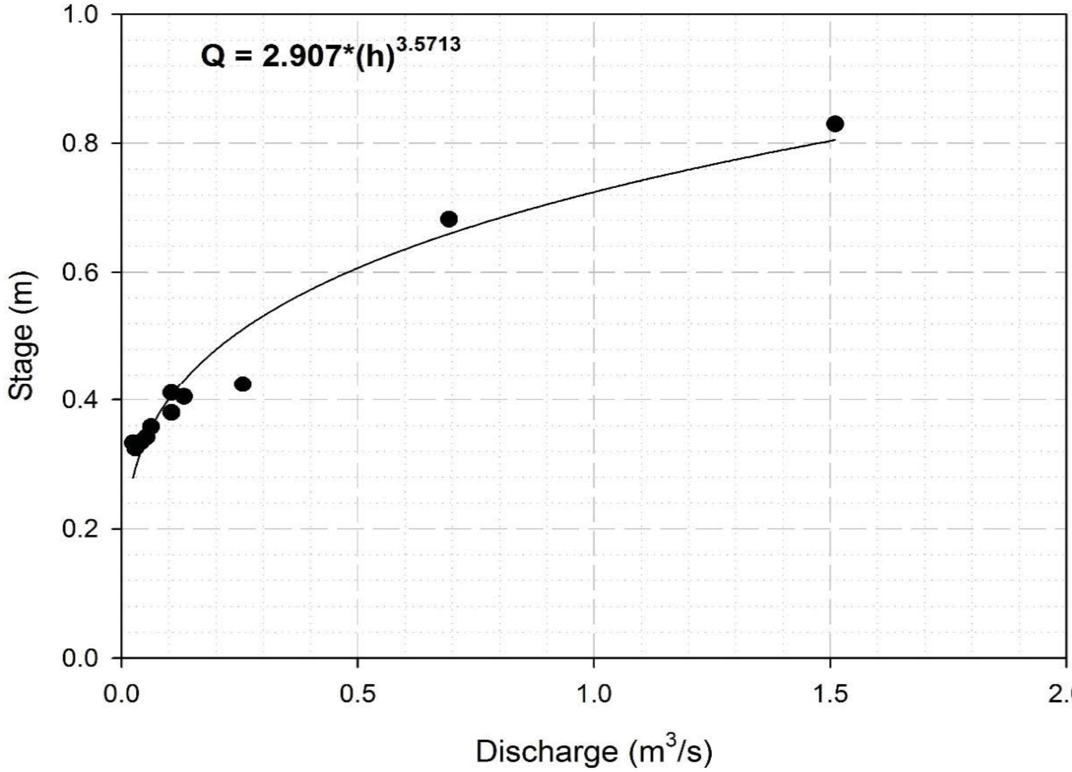
Manual Measurements

Date	Time	Stage (m)	Discharge (m^3/s)	Salt Dilution	MMB FlowMate	Pygmy	Price AA
10/11/2010	16:03		0.021	x			
15/12/2010	13:00		0.017	x			
20/04/2011	10:31		0.013	x			
22/06/2011	20:17		1.244		x		
20/07/2011	10:50		0.376		x		
26/08/2011	13:42		0.173				x
21/09/2011	15:47		0.065		x		
20/10/2011	10:45		0.033		x		
28/11/2011	14:27						
01/02/2012	14:47		0.002		x		
29/02/2012	11:37		0.020	x			
27/03/2012	13:14		0.012	x			
19/04/2012	16:22		0.051		x		
07/05/2012	16:39		0.162	x			
22/06/2012	16:45		0.232		x		
18/07/2012	14:55		0.325		x		
23/08/2012	15:01		0.038		x		
19/09/2012	18:07		0.199		x		
16/10/2012	15:49		0.078		x		
24/01/2013	12:06		0.020	x			
06/03/2013	16:52		0.012	x			
10/04/2013	13:02		0.008	x			
30/05/2013	9:19		1.229		x		
14/06/2013	9:27		1.009		x		
31/07/2013	16:15		0.097	x			
21/08/2013	13:55		0.039	x			
26/09/2013	11:05		0.109		x		
29/10/2013	15:25		0.041	x			
26/11/2013	13:33		0.018	x			
18/02/2014	12:20		0.009	x			
11/03/2014	11:25		0.007	x			
22/05/2014	9:45		0.383		x		
07/06/2014	12:50	0.325	0.029				x
27/06/2014	11:05	0.425	0.257				x
23/07/2014	16:10	0.380	0.106				x
21/08/2014	16:05	0.342	0.053				x
26/09/2014	9:07	0.358	0.062				x
24/10/2014	11:45	0.334	0.041	x			
25/11/2014	15:45		0.014	x			
29/04/2015	16:30						
19/05/2015	8:00	0.374	0.106	x			
26/06/2015	10:15	0.296	0.024	x			
23/07/2015	10:13	0.328					
20/08/2015	16:10	0.645	0.693	x			
13/09/2015	13:00	0.368	0.132			x	
30/10/2015	11:05		0.051	x			
28/11/2015	11:05		0.03	x			
Slope-Area		0.83	1.51				

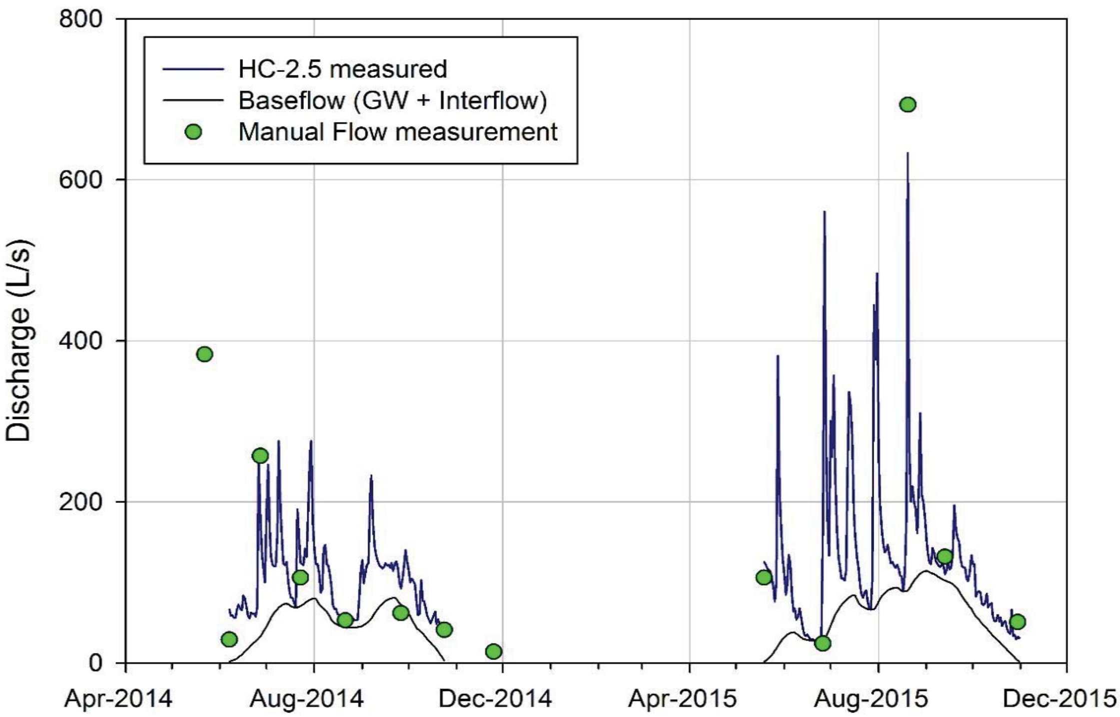
Hydrometric Station HC-2.5 Metadata

Rating Curve

NOTE: Rating curve extended using the slope-area method from a channel survey conducted in 2015.

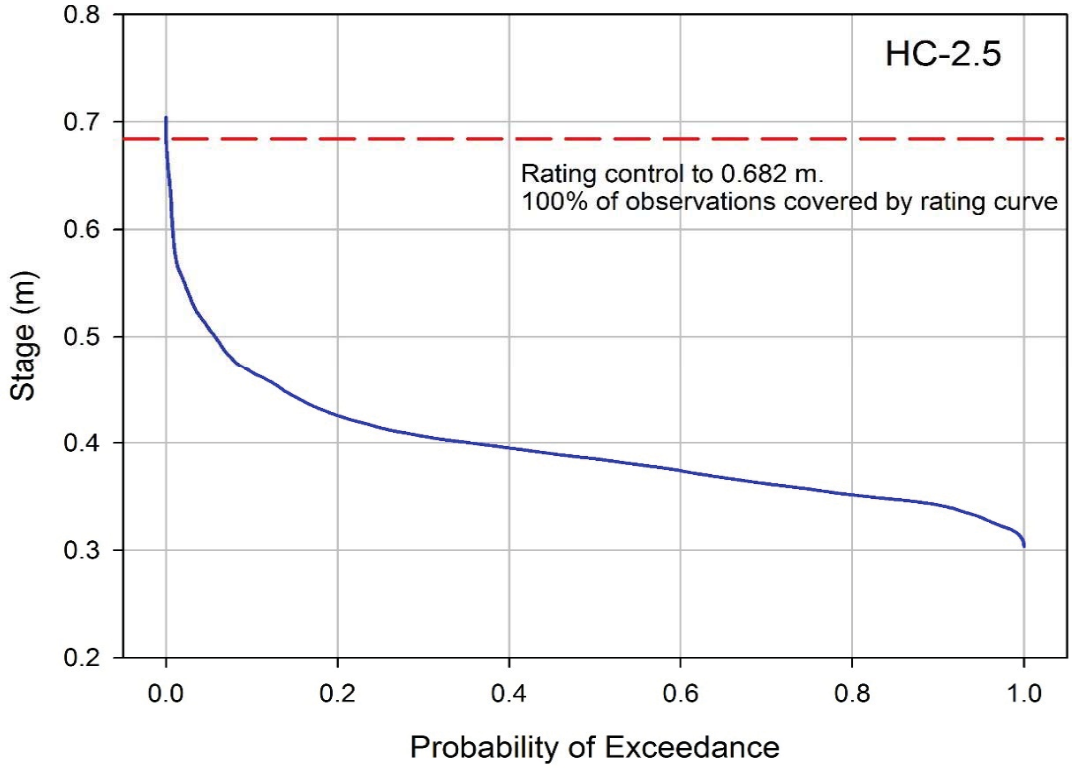


Continuous Discharge Record vs. Spot Flow Measurements

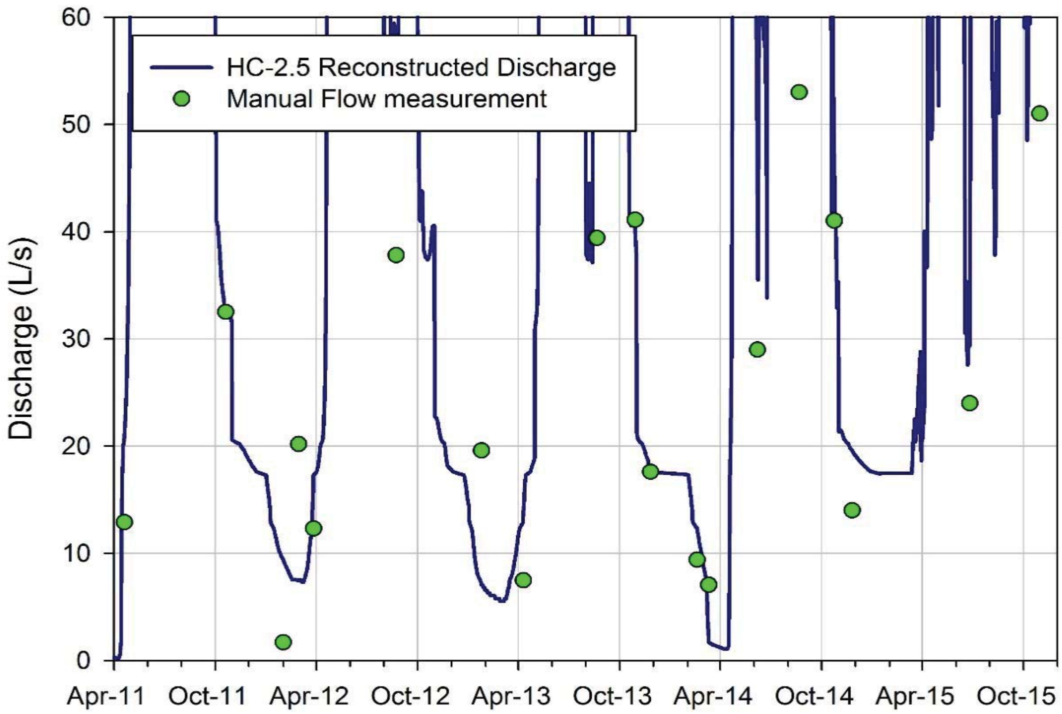


Hydrometric Station HC-2.5 Metadata

Rating Curve Control on Measured Stage

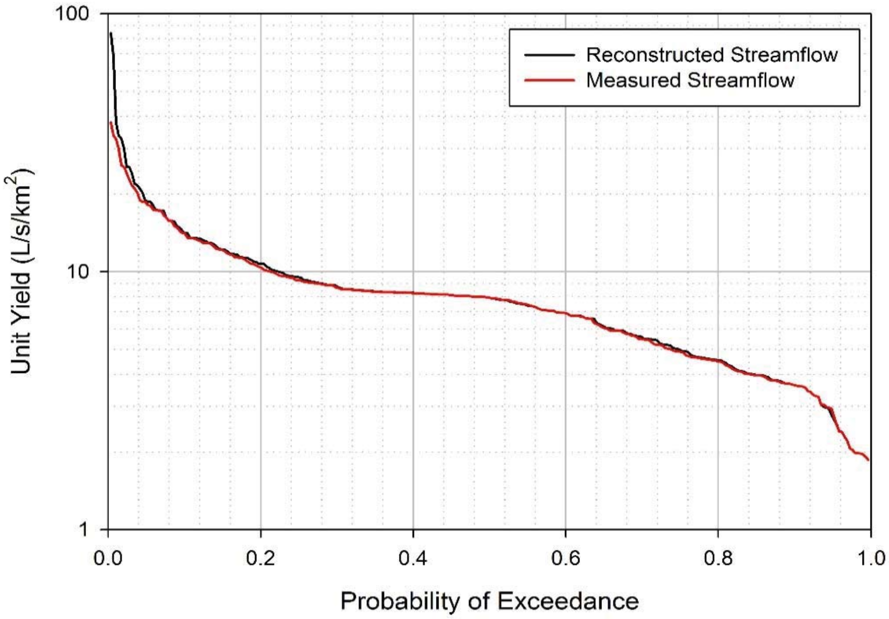


Baseflow comparison - winter spot flows vs. synthetic discharge record

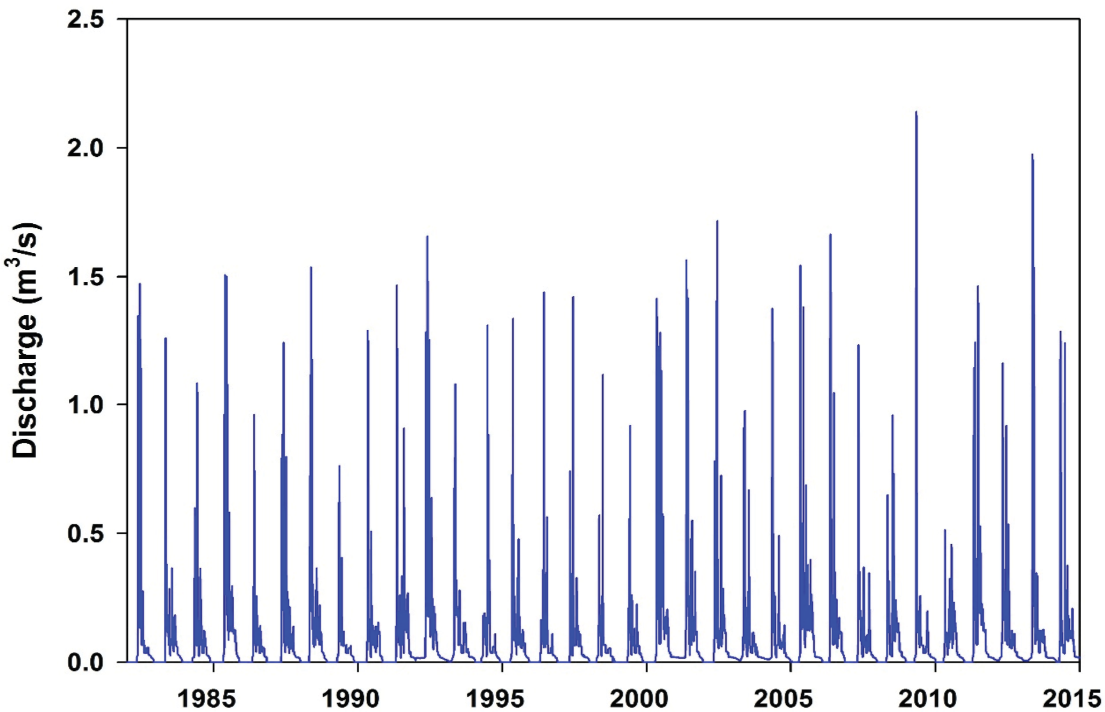


Hydrometric Station HC-2.5 Metadata

Flow Duration Curves - Synthetic vs. Measured Discharge



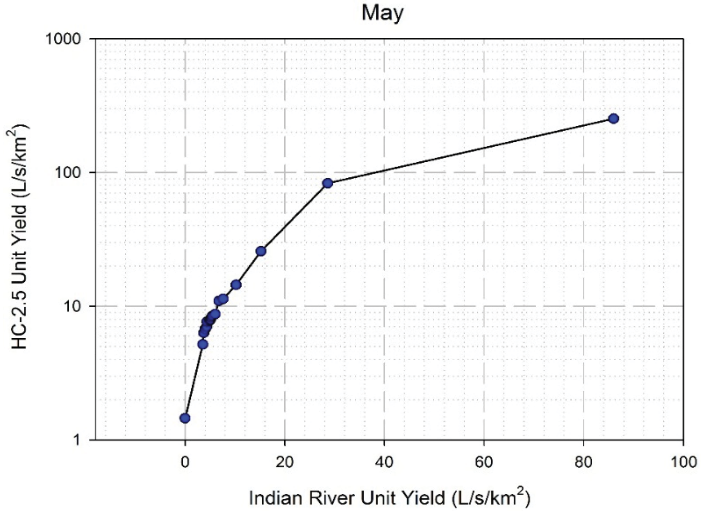
Synthetic Discharge Time-Series

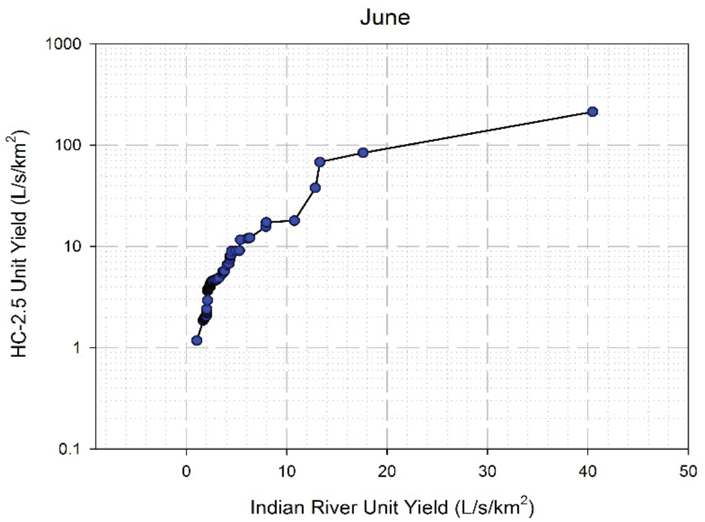


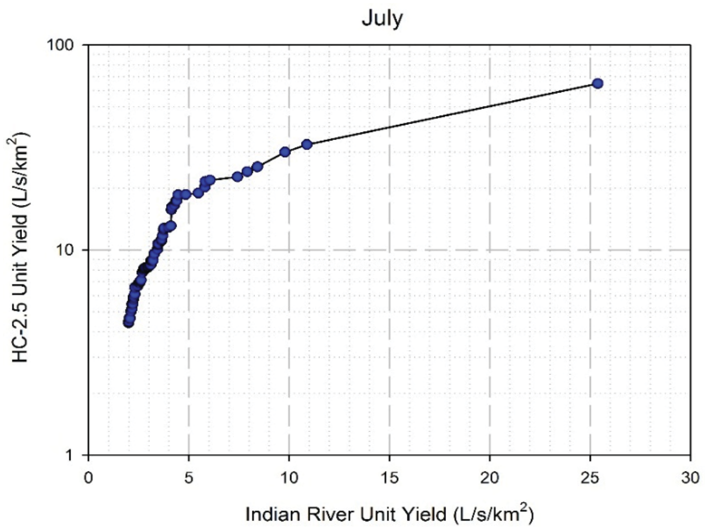
Hydrometric Station HC-2.5 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.



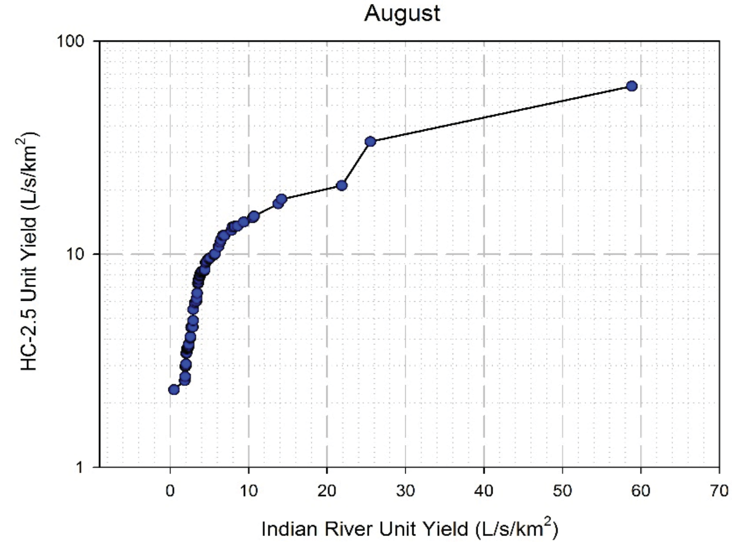


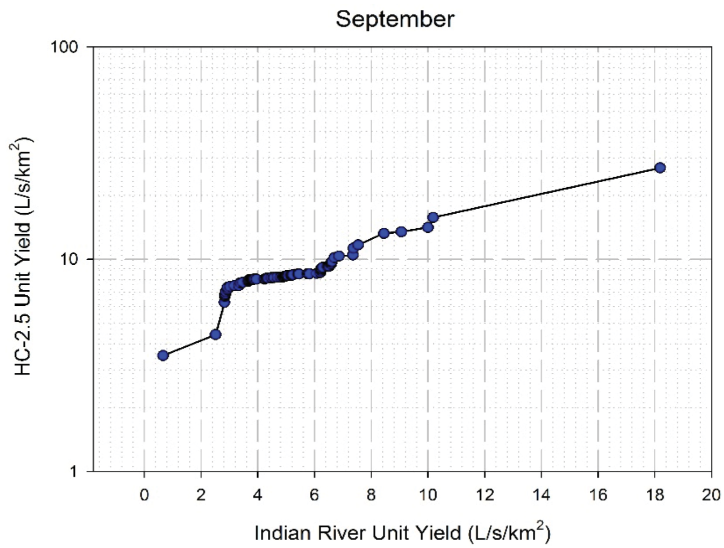


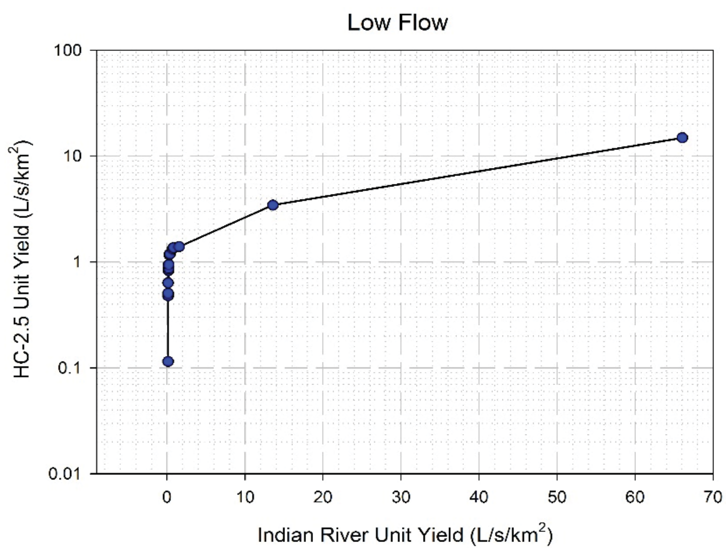
Hydrometric Station HC-2.5 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.







Hydrometric Station HC-2.5 Metadata

Monthly Summaries of Measured Discharge, Unit Yield and Runoff

Year		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Discharge (m^3/s)										
2014	Average	--	--	*0.08*	0.15	0.08	0.13	*0.07*	--	0.10
	Maximum	--	--	*0.32*	0.41	0.18	0.27	*0.19*	--	0.41
	Minimum	--	--	*0.04*	0.06	0.04	0.06	*0.03*	--	0.03
2015	Average	--	*0.14*	0.09	0.19	0.18	0.13	0.06	--	0.13
	Maximum	--	*0.53*	0.77	0.84	0.75	0.22	0.15	--	0.84
	Minimum	--	*0.05*	0.02	0.05	0.06	0.06	0.02	--	0.02
Unit Yield ($L/s/km^2$)										
2014	Average	--	--	*5.7*	10.1	5.6	8.7	*4.7*	--	7.0
	Maximum	--	--	*21.3*	27.6	11.9	18.2	*13.2*	--	27.6
	Minimum	--	--	*2.5*	4.3	2.5	4.2	*2.1*	--	2.1
2015	Average	--	*9.8*	6.1	12.7	12.0	8.7	4.3	--	9.0
	Maximum	--	*35.7*	52.2	57.0	50.8	14.8	10.4	--	57.0
	Minimum	--	*3.5*	1.3	3.6	4.2	4.2	1.5	--	1.3
Runoff (mm)										
2014		--	--	*12*	27	15	23	*10*	--	86
2015		--	*11*	16	34	32	23	12	--	127

NOTE: Values in italics indicate that data for that month is not complete.

Appendix A
Site Hydrology Data

Appendix A1: Site Hydrology Data 2010 to 2015

Appendix A2: Site Hydrology Data 2016

GOLDCORP

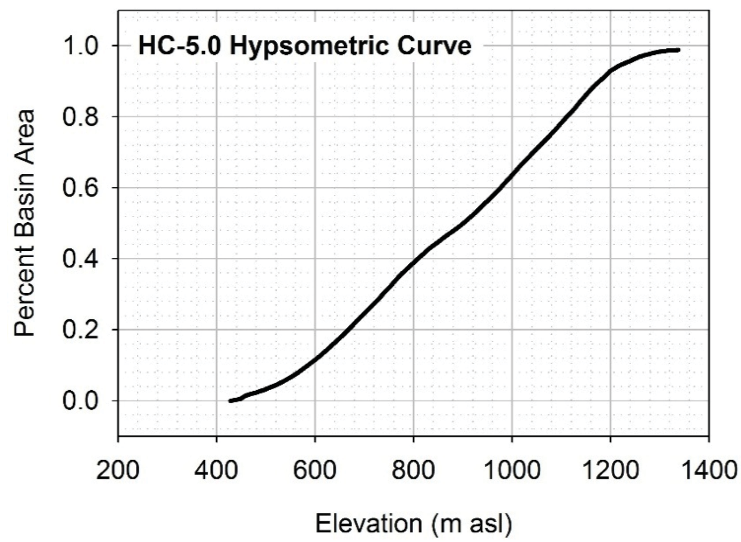
APPENDIX A1: SITE HYDROLOGY DATA - 2010 TO 2015

Hydrometric Station HC-5.0 Metadata

Station Name:	HC-5.0
Location:	Lower Halfway Creek
Basin Area (km^2):	27.0
UTM Easting:	588839
UTM Northing:	6980553
Median Elevation (m asl):	896
Record Period:	
Spot Measurements	2010-Present
Continuous Record	2011-Present

Pressure Transducer:	Solinst
Temperature Sensor:	Yes
Conductivity Sensor:	Yes
Barologger:	No
Measurement Interval:	
Summer	15 minute
Winter	Removed

Hypsometric Curve

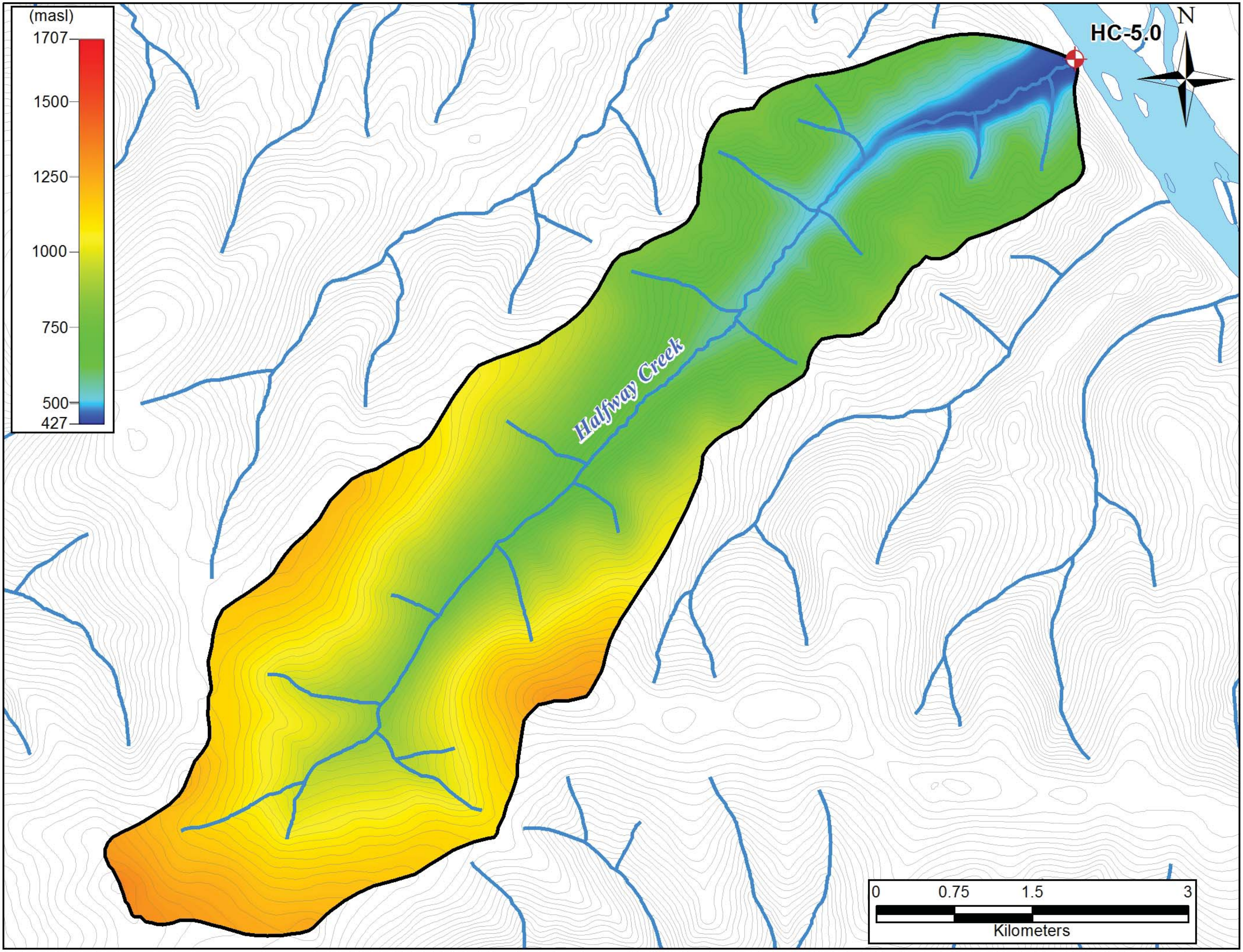


Benchmark surveys			
Date	**Gauge Height (m)**	**Change (m)**	**Notes**
21/09/2011	98.619		
19/09/2012	98.616	-0.003	
30/05/2013	99.621	1.005	
25/09/2013	99.378	-0.243	Staff gauge relocated
23/07/2014	99.384	0.006	
13/09/2015	99.392	0.008	No movement

Catchment Slope Aspects (Quadrants in degrees)			
North (315-45)	**East (45-135)**	**South (135-225)**	**West (225-315)**
45%	17%	31%	7%

Open Water Photo

Winter Photo


(masl)
1707
1500
1250
1000
750
500
427
HC-5.0
N
Halfway Creek
0
0.75
1.5
3
Kilometers

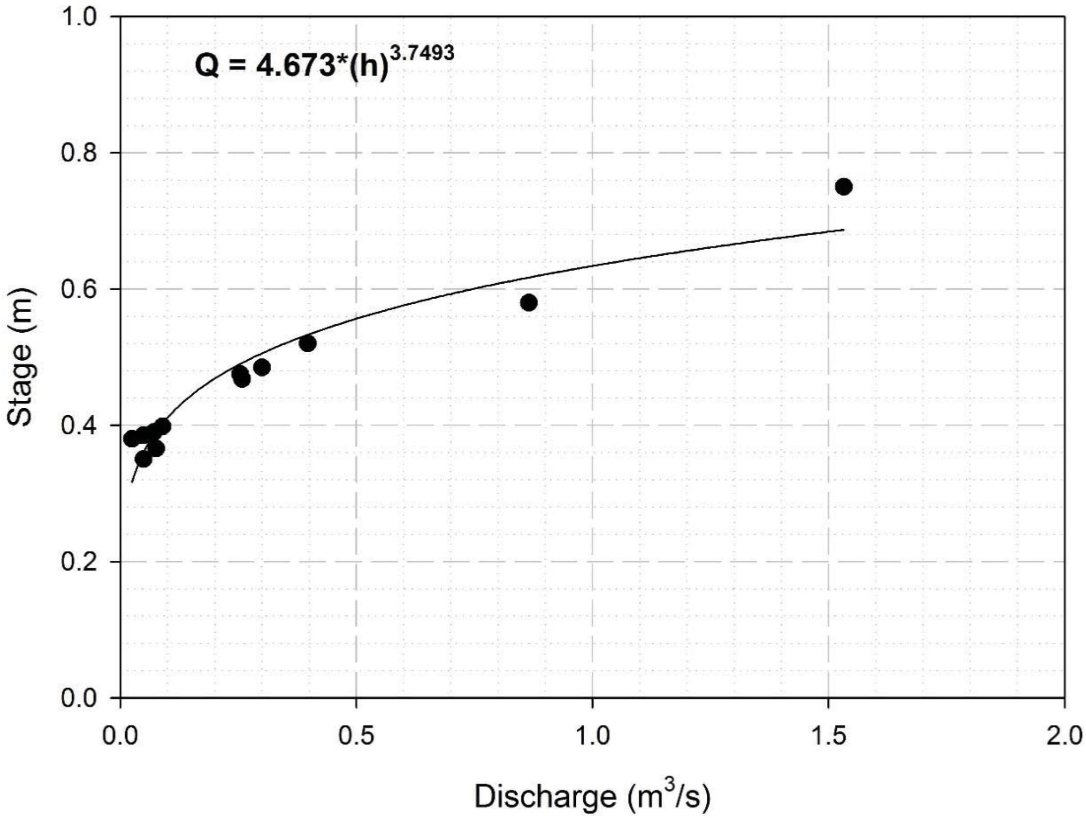
Hydrometric Station HC-5.0 Metadata

Manual Measurements

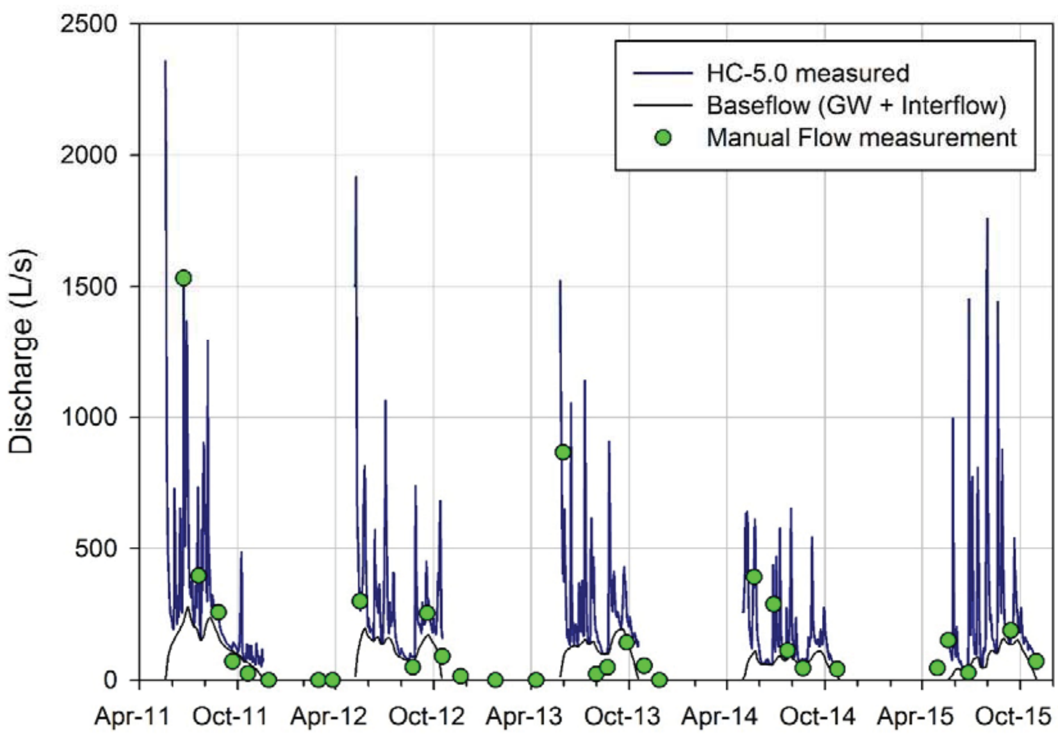
Date	Time	Stage (m)	Discharge (m^3/s)	Salt Dilution	MMB FlowMate	Pygmy	Price AA
12/10/2010	16:27	0.366	0.076			x	
10/11/2010	16:51		0.008	x			
19/05/2011		0.750					
22/06/2011	19:27	0.750	1.532		x		
20/07/2011	14:55	0.520	0.397		x		
26/08/2011	10:00	0.468	0.258		x		
21/09/2011	15:07	0.390	0.071		x		
20/10/2011	10:02	0.380	0.025		x		
28/11/2011	15:02		0.000				
29/02/2012	12:10		0.000				
26/03/2012	12:23		0.000				
10/04/2013			0.000				
16/05/2012	11:52	0.485	0.300		x		
23/08/2012	15:44	0.350	0.049		x		
19/09/2012		0.475					
19/09/2012	19:00		0.254		x		
17/10/2012	9:20	0.398	0.089		x		
20/11/2012	15:21		0.015	x			
24/01/2013	12:35		0.000				
10/04/2013			0.000				
30/05/2013	16:50	0.580	0.866		x		
31/07/2013	15:07	0.429	0.023		x		
21/08/2013	14:45	0.385	0.048		x		
26/09/2013	9:48	0.323	0.142		x		
29/10/2013	16:00		0.054	x			
26/11/2013	13:00		0.000				
22/05/2014	8:40	0.395	0.392				x
27/06/2014	12:05	0.351	0.288				x
23/07/2014	17:28	0.292	0.112				x
21/08/2014	17:21	0.248	0.045				x
25/09/2014	9:54	0.282					x
24/10/2014	10:45	0.228	0.041	x			
29/04/2015	14:00		0.046	x			
19/05/2015	11:00	0.303	0.151	x			
26/06/2015	8:40	0.224	0.028	x			
23/07/2015	9:18	0.266		x			
20/08/2015	9:00	0.590		x			
13/09/2015	10:00	0.295	0.189	x			
30/10/2015	13:05	0.248	0.071	x			

Hydrometric Station HC-5.0 Metadata

Rating Curve

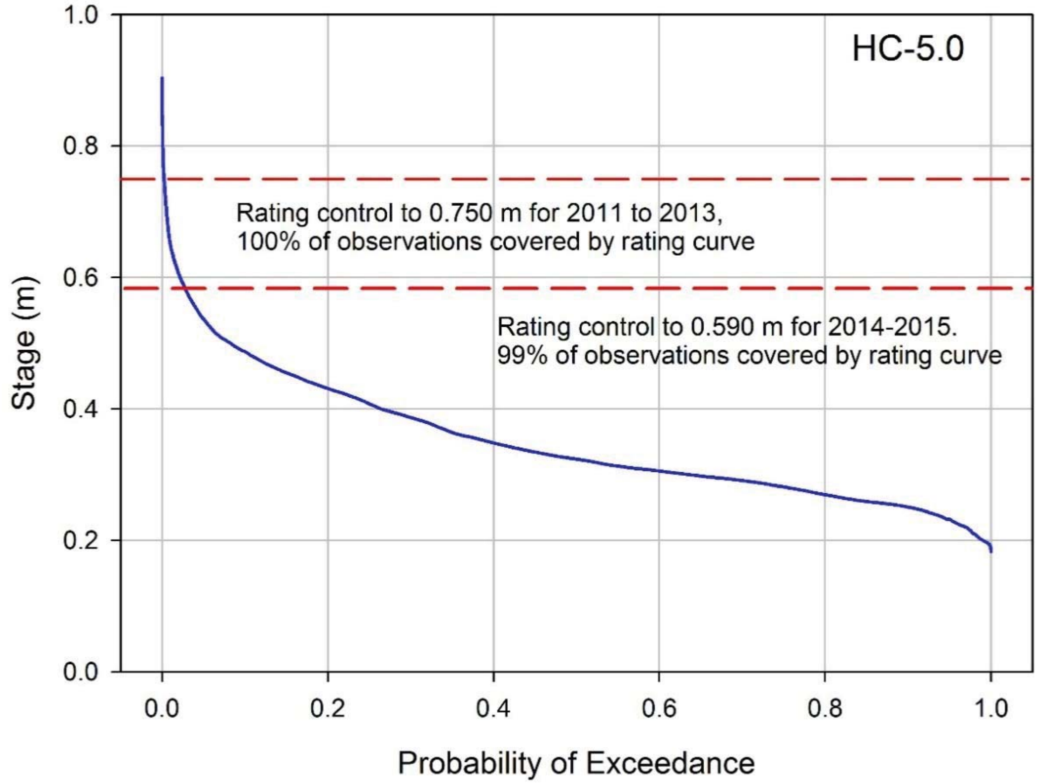


Continuous Discharge Record vs. Spot Flow Measurements

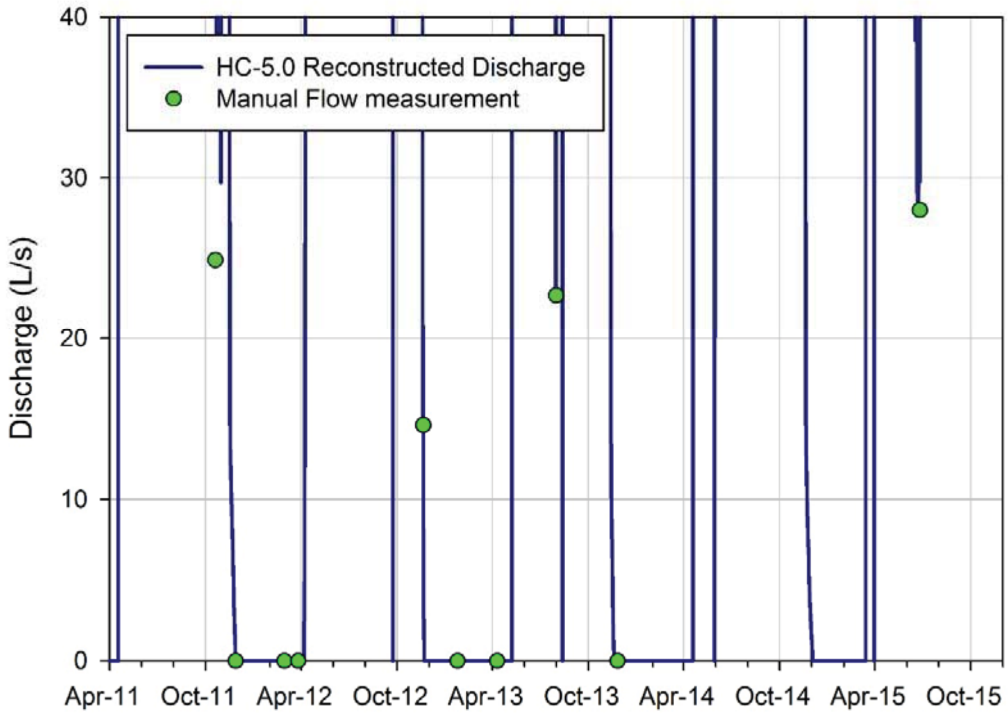


Hydrometric Station HC-5.0 Metadata

Rating Curve Control on Measured Stage

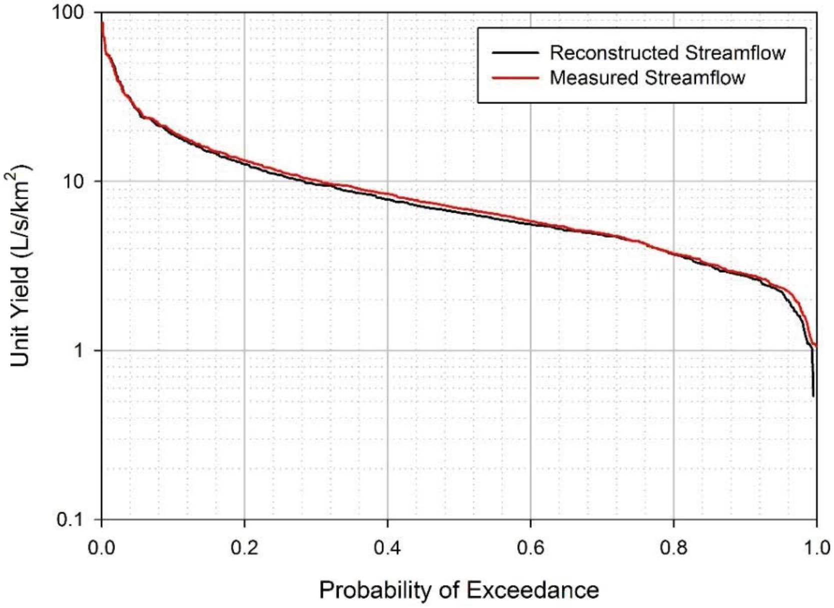


Baseflow comparison - winter spot flows vs. synthetic discharge record

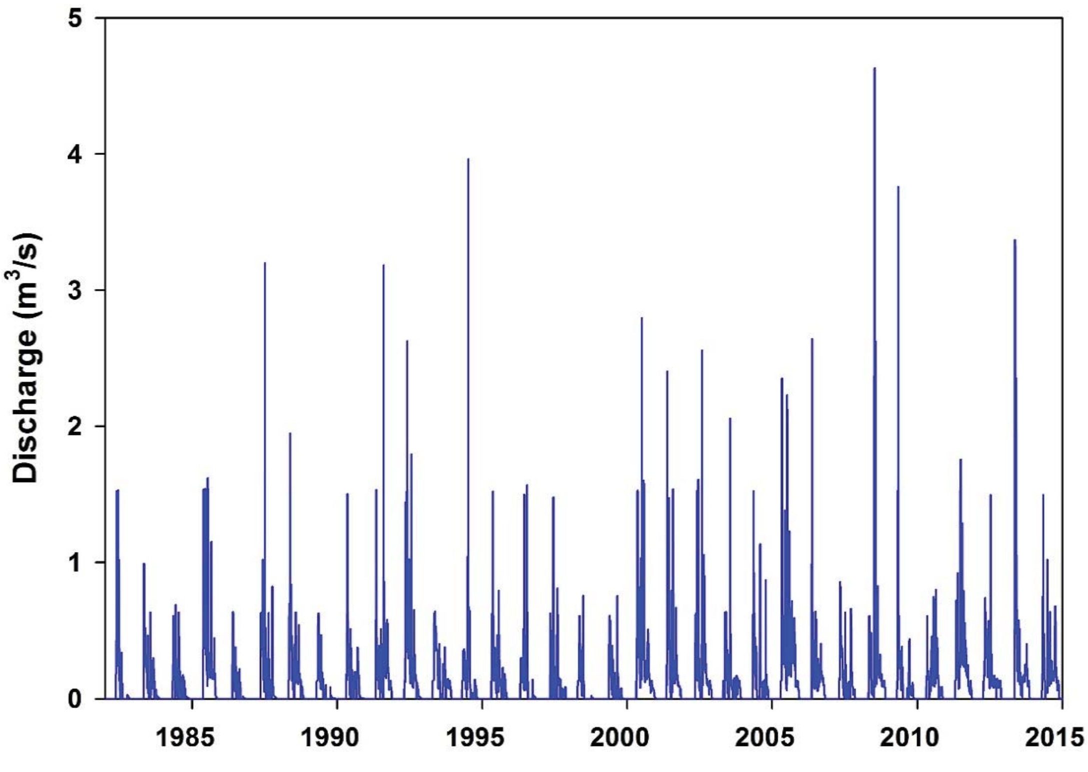


Hydrometric Station HC-5.0 Metadata

Flow Duration Curves - Synthetic vs. Measured Discharge



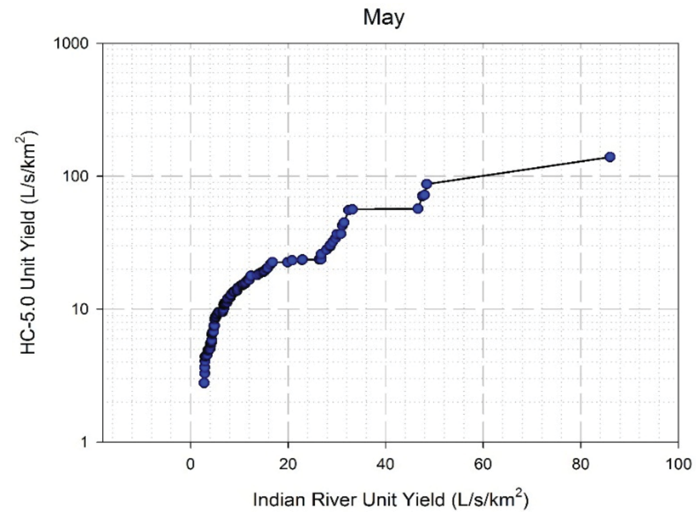
Synthetic Discharge Time-Series

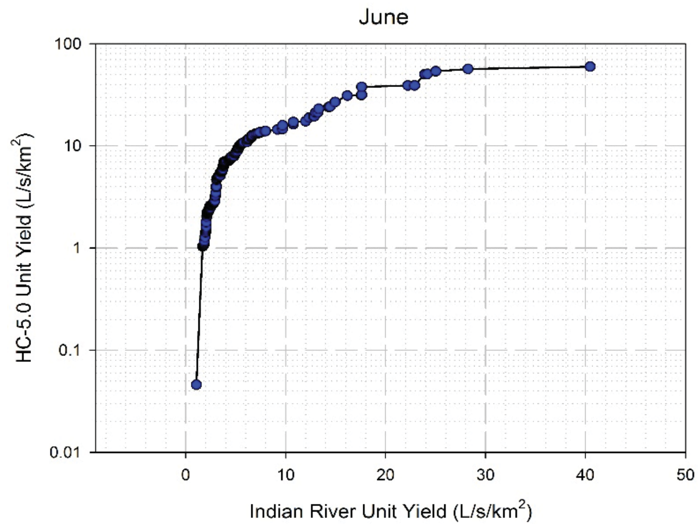


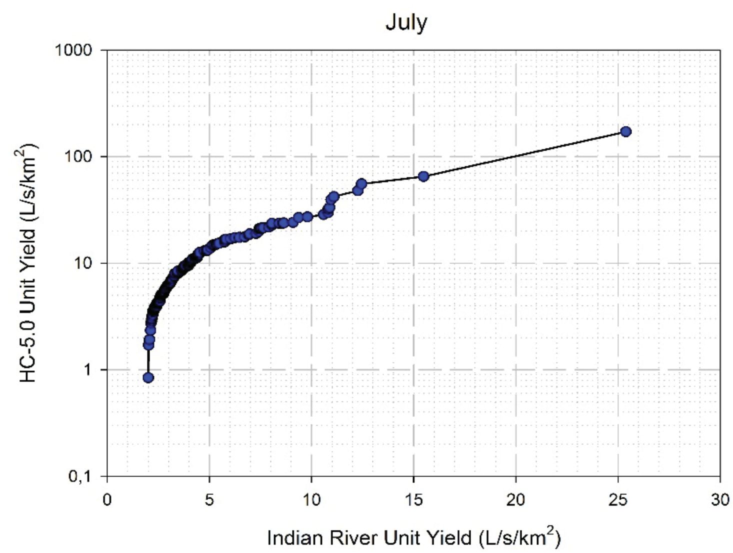
Hydrometric Station HC-5.0 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.



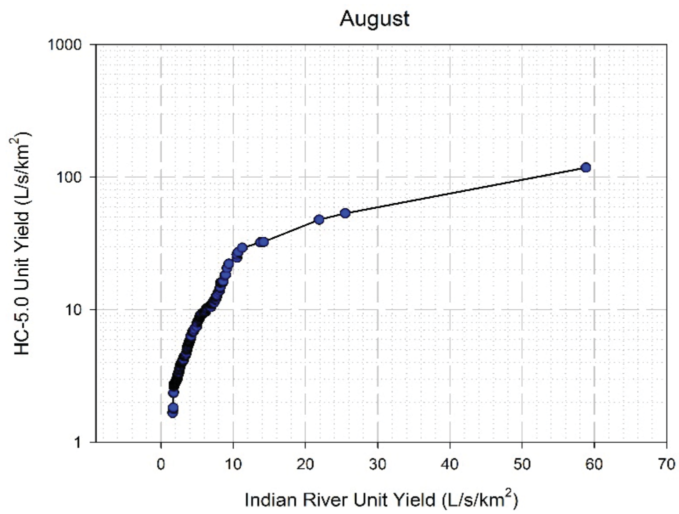


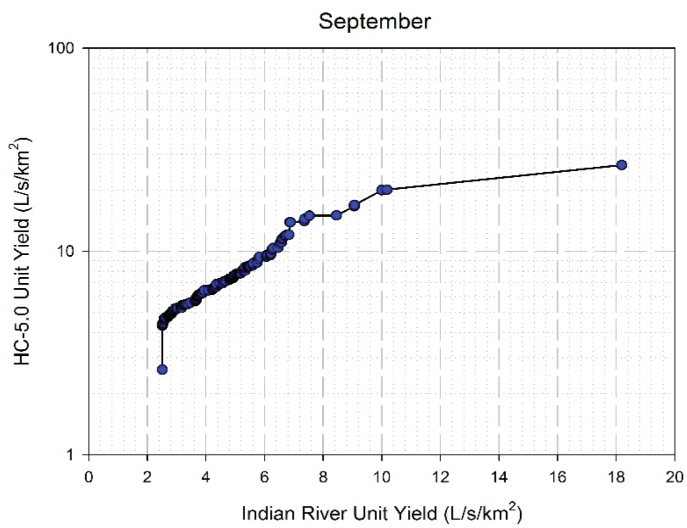


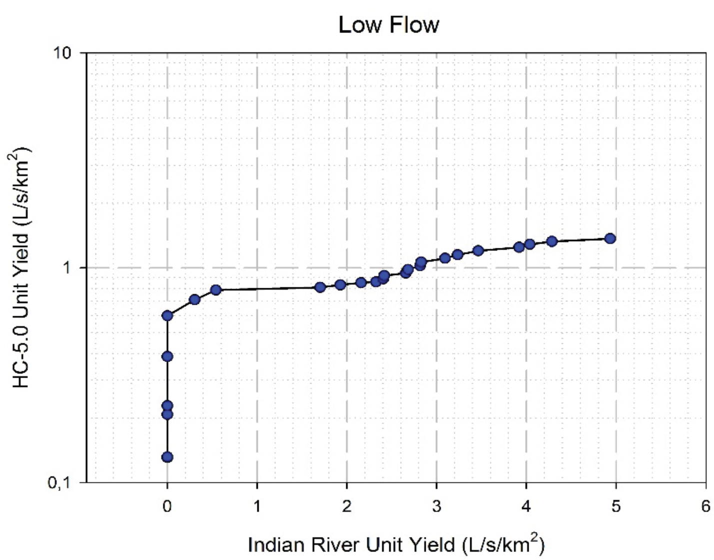
Hydrometric Station HC-5.0 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.







Hydrometric Station HC-5.0 Metadata

Monthly Summaries of Measured Discharge, Unit Yield and Runoff

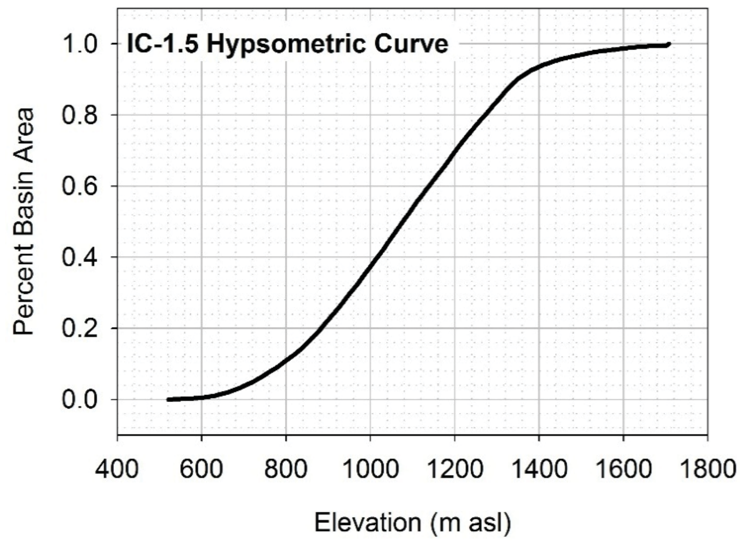
Year		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Discharge (m^3/s)										
2011	Average	--	*0.634*	0.53	0.40	0.36	0.14	0.13	*0.086*	0.33
	Maximum	--	*3.198*	1.82	1.31	2.05	0.18	0.58	*0.155*	3.20
	Minimum	--	*0.217*	0.19	0.14	0.18	0.10	0.05	*0.044*	0.04
2012	Average	--	*0.614*	0.25	0.28	0.14	0.24	*0.30*	--	0.31
	Maximum	--	*2.603*	0.97	1.50	1.08	0.50	*0.72*	--	2.60
	Minimum	--	*0.187*	0.13	0.09	0.07	0.17	*0.15*	--	0.07
2013	Average	--	*0.708*	0.27	0.32	0.21	0.28	*0.17*	--	0.33
	Maximum	--	*2.034*	1.98	2.00	1.49	0.49	*0.24*	--	2.03
	Minimum	--	*0.273*	0.11	0.13	0.09	0.19	*0.12*	--	0.09
2014	Average	--	*0.334*	0.11	0.22	0.10	0.19	*0.08*	--	0.17
	Maximum	--	*0.977*	0.66	1.06	0.29	0.69	*0.25*	--	1.06
	Minimum	--	*0.098*	0.05	0.06	0.06	0.11	*0.03*	--	0.03
2015	Average	--	*0.22*	0.14	0.38	0.36	0.23	0.14	--	0.25
	Maximum	--	*1.64*	2.11	2.98	2.04	0.61	0.39	--	2.98
	Minimum	--	*0.05*	0.02	0.04	0.08	0.11	0.07	--	0.02
Unit Yield ($L/s/km^2$)										
2011	Average	--	*23.47*	19.5	14.8	13.3	5.2	4.8	*3.202*	12.0
	Maximum	--	*118.4*	67.3	48.5	76.1	6.9	21.3	*5.744*	118.4
	Minimum	--	*8.024*	6.9	5.2	6.6	3.5	1.9	*1.631*	1.6
2012	Average	--	*22.73*	9.4	10.4	5.1	9.0	*11.3*	--	11.3
	Maximum	--	*96.41*	35.8	55.7	40.0	18.7	*26.7*	--	96.4
	Minimum	--	*6.936*	4.8	3.3	2.6	6.4	*5.5*	--	2.6
2013	Average	--	*26.23*	9.8	12.0	7.8	10.5	*6.5*	--	12.1
	Maximum	--	*75.32*	73.2	74.2	55.3	18.1	*9.1*	--	75.3
	Minimum	--	*10.12*	4.2	4.8	3.4	7.1	*4.3*	--	3.4
2014	Average	--	*12.39*	4.1	8.1	3.7	7.0	*3.1*	--	6.4
	Maximum	--	*36.19*	24.6	39.4	10.6	25.4	*9.1*	--	39.4
	Minimum	--	*3.629*	1.9	2.2	2.1	4.0	*1.0*	--	1.0
2015	Average	--	*8.1*	5.3	14.0	13.3	8.7	5.2	--	9.1
	Maximum	--	*60.8*	78.2	110.4	75.6	22.7	14.6	--	110.4
	Minimum	--	*1.9*	0.8	1.4	2.9	4.0	2.7	--	0.8
Runoff (mm)										
2011		--	*26.36*	*51*	40	36	13	13	*5*	183
2012		--	*49.1*	*24*	28	14	23	*17*	--	155
2013		--	*15.86*	*25*	32	21	27	*10*	--	132
2014		--	33.176	*11*	22	10	18	*8*	--	102
2015		--	*9*	14	38	36	23	14	--	133

NOTE: Values in italics indicate that data for that month is not complete.

Hydrometric Station IC-1.5 Metadata

Station Name:	IC-1.5
Location:	Independence Creek
Basin Area (km^2):	81.1
UTM Easting:	572258
UTM Northing:	6976969
Median Elevation (m asl):	1076
Record Period:	
Spot Measurements	2010-Present
Continuous Record	2014-Present

Hypsometric Curve

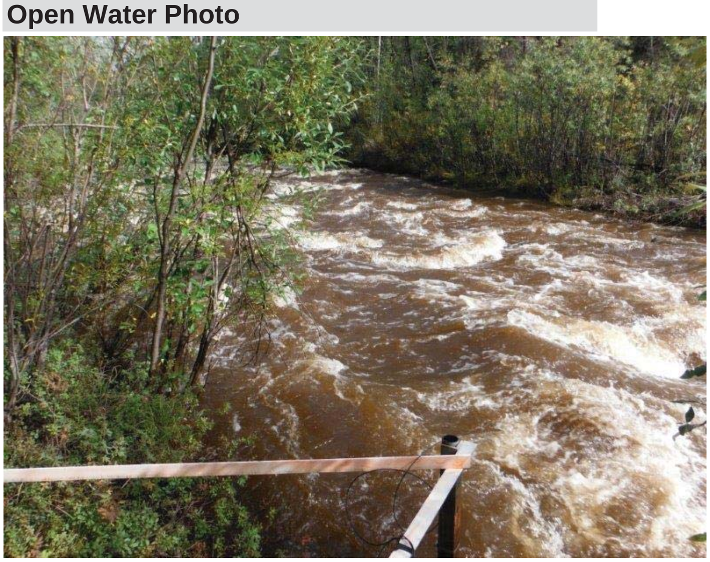


Pressure Transducer:	Solinst
Temperature Sensor:	Yes
Conductivity Sensor:	Yes
Barologger:	No
Measurement Interval:	
Summer	15 minute
Winter	Removed

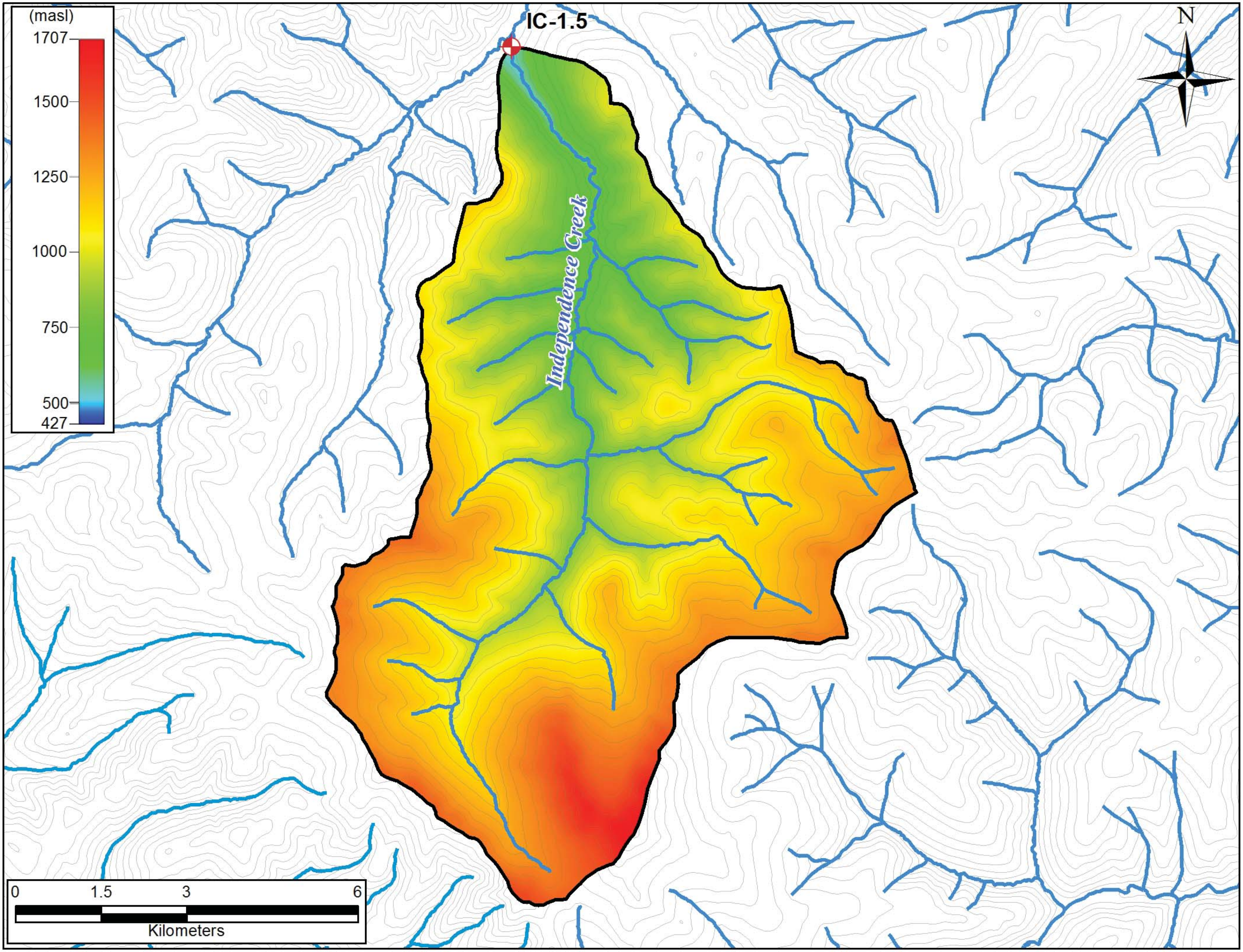
Benchmark surveys			
Date	**Gauge Height (m)**	**Change (m)**	**Notes**
06/06/2015	97.898		

Catchment Slope Aspects (Quadrants in degrees)			
North (315-45)	**East (45-135)**	**South (135-225)**	**West (225-315)**
46%	12%	24%	18%

Open Water Photo



Winter Photo



(masl)
1707
1500
1250
1000
750
500
427
IC-1.5
N
Independence Creek
0
1.5
3
6
Kilometers

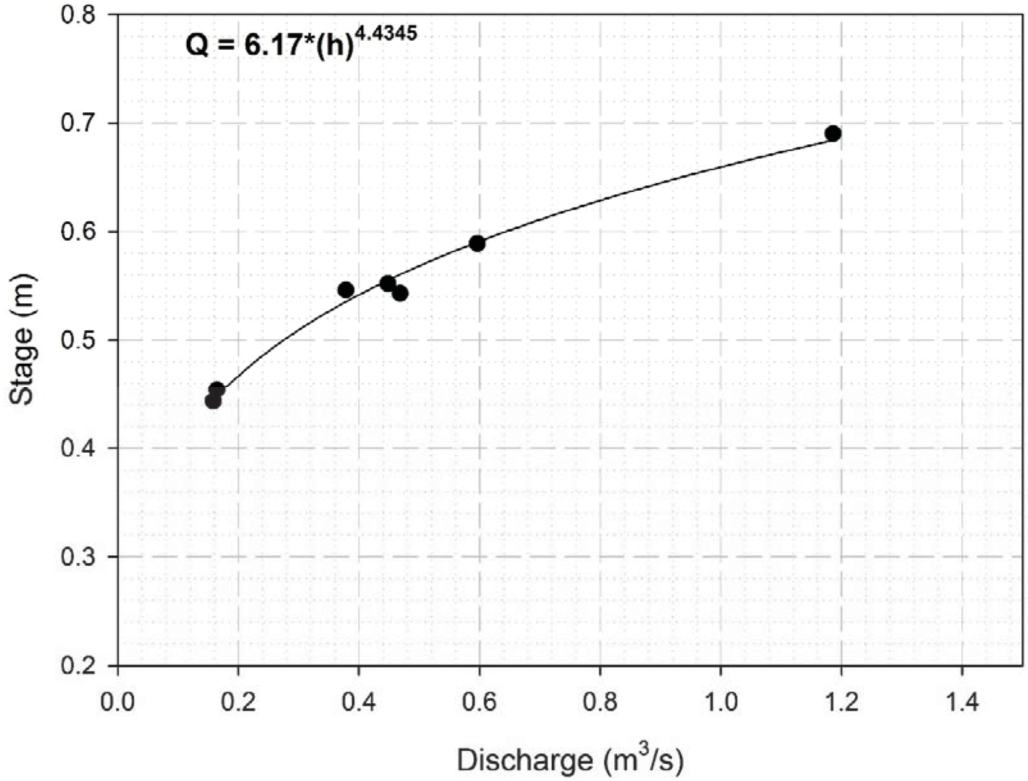
Hydrometric Station IC-1.5 Metadata

Manual Measurements

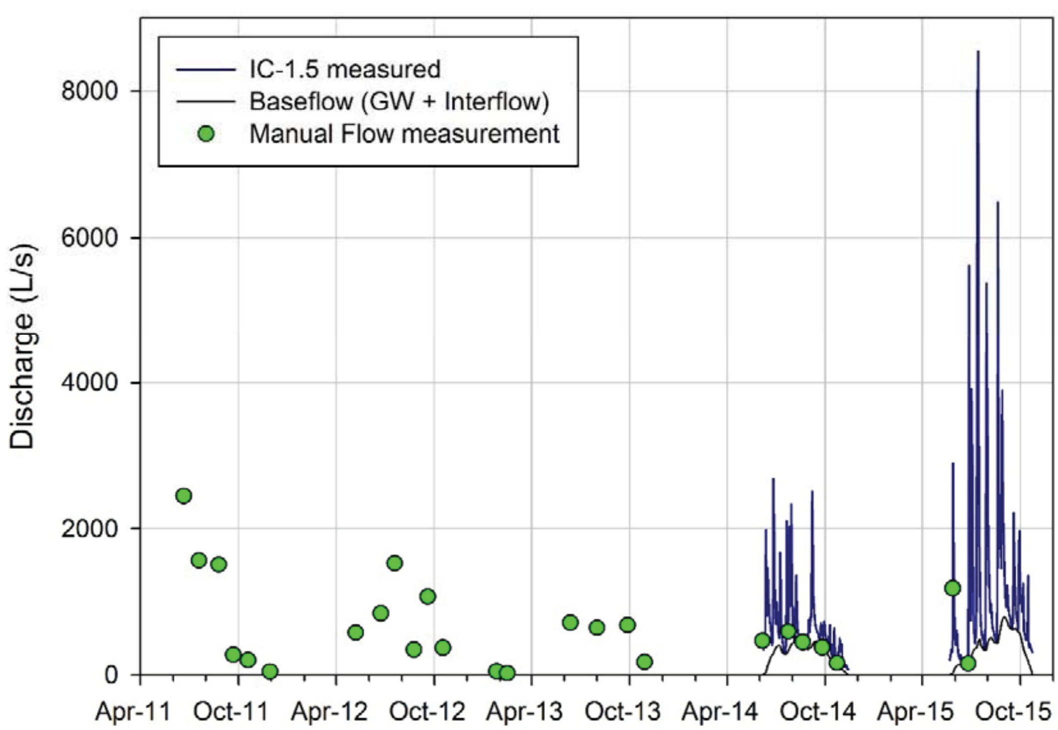
Date	Time	Stage (m)	Discharge (m^3/s)	Salt Dilution	MMB FlowMate	Pygmy	Price AA
10/11/2010	15:27		0.055	x			
14/12/2010	12:51		0.061	x			
21/06/2011	14:30		2.448		x		
19/07/2011	16:37		1.569		x		
25/08/2011	17:32		1.510				x
21/09/2011	10:30		0.279		x		
19/10/2011	15:35		0.204		x		
29/11/2011	12:40		0.048		x		
07/05/2012	18:53		0.580	x			
23/06/2012	8:44		0.845		x		
19/07/2012	9:47		1.528		x		
24/08/2012	9:53		0.351		x		
19/09/2012	16:39		1.072	x			
17/10/2012	17:07		0.375	x			
25/01/2013	11:58		0.053	x			
14/02/2013	11:45		0.025	x			
12/06/2013	12:20		0.715		x		
01/08/2013	8:40		0.647	x			
27/09/2013	15:26		0.683	x			
29/10/2013	13:17		0.179	x			
06/06/2014	10:20	0.543	0.468				
27/06/2014	9:00	0.791		x			
24/07/2014	17:00	0.589	0.596				x
20/08/2014	11:24	0.552	0.448				x
25/09/2014	12:10	0.546	0.378				x
23/10/2014	18:00	0.454	0.164				x
30/04/2015	17:00						
18/05/2015	14:00	0.690	1.186	x			
25/06/2015	13:55	0.443	0.158	x			
23/07/2015	15:53	0.575					
20/08/2015	14:00	1.050					
14/09/2015	12:30	0.603					

Hydrometric Station IC-1.5 Metadata

Rating Curve

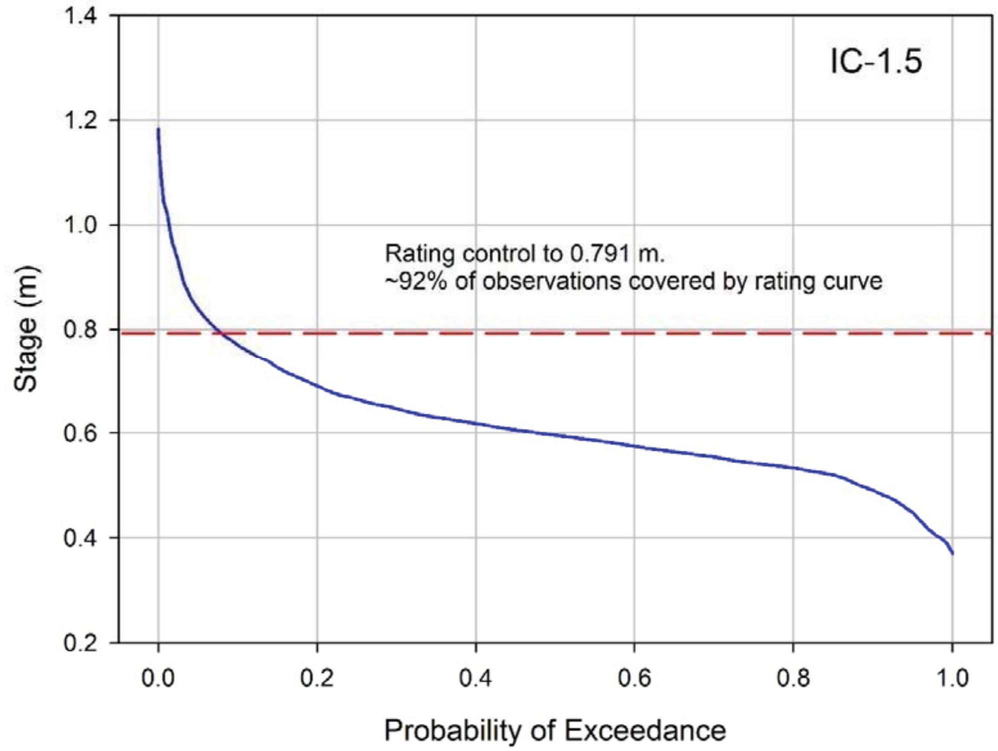


Continuous Discharge Record vs. Spot Flow Measurements

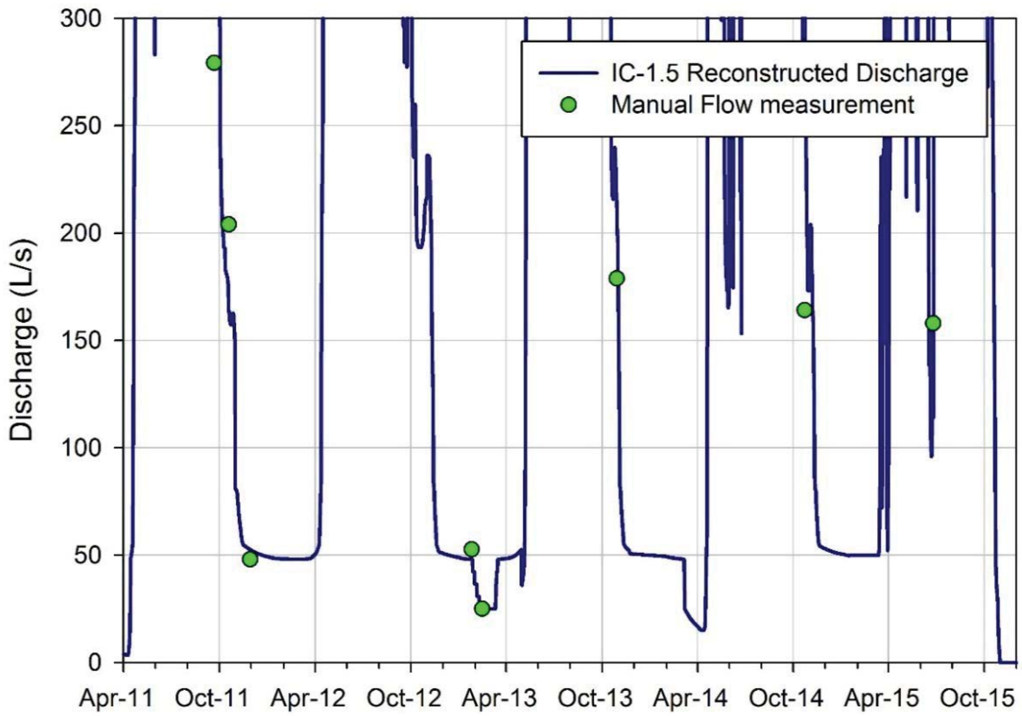


Hydrometric Station IC-1.5 Metadata

Rating Curve Control on Measured Stage

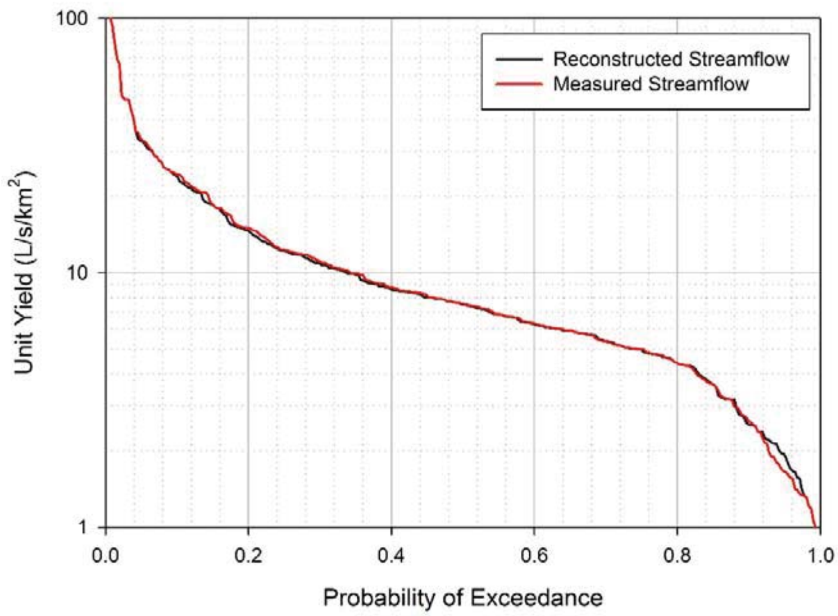


Baseflow comparison - winter spot flows vs. synthetic discharge record

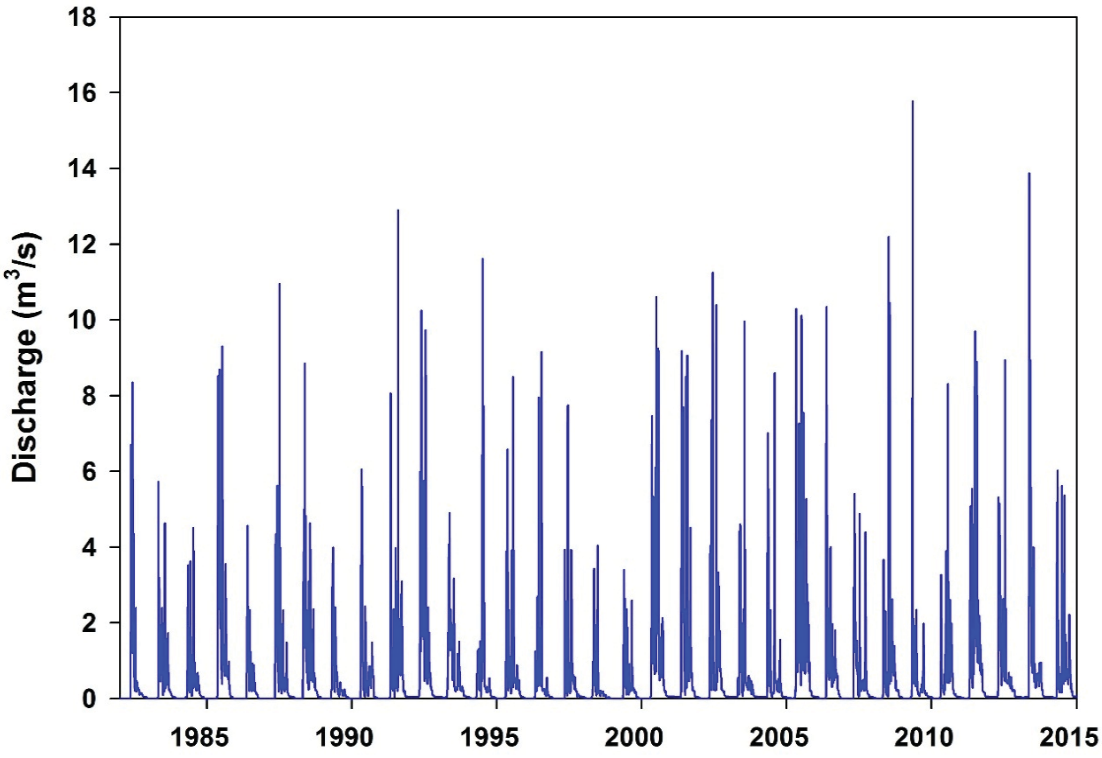


Hydrometric Station IC-1.5 Metadata

Flow Duration Curves - Synthetic vs. Measured Discharge



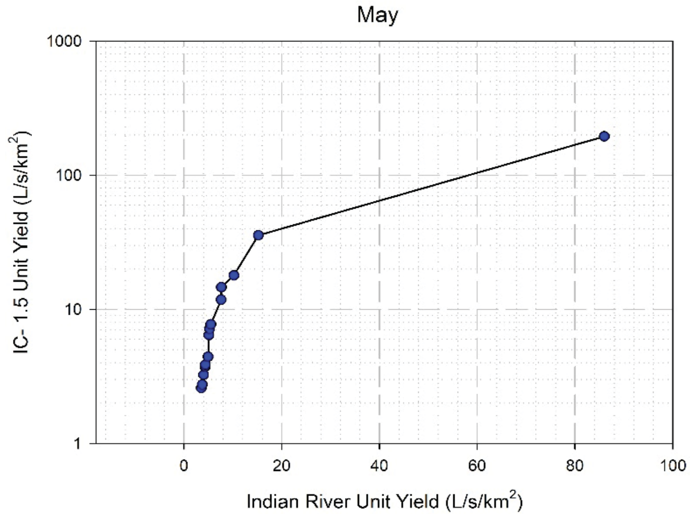
Synthetic Discharge Time-Series

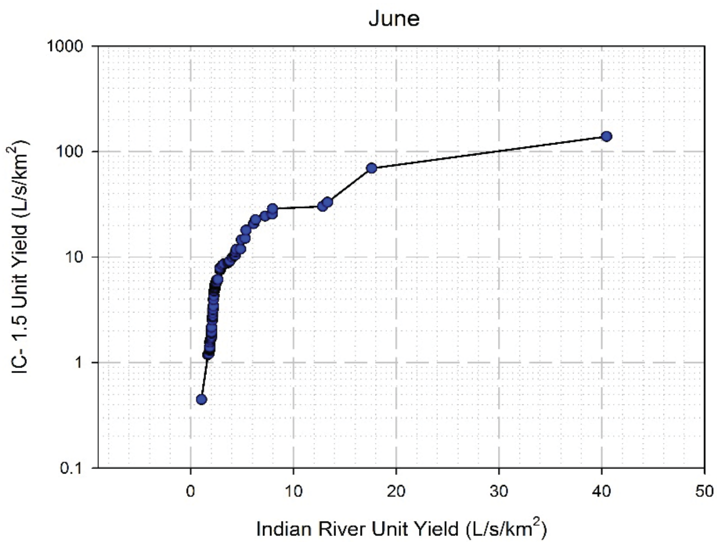


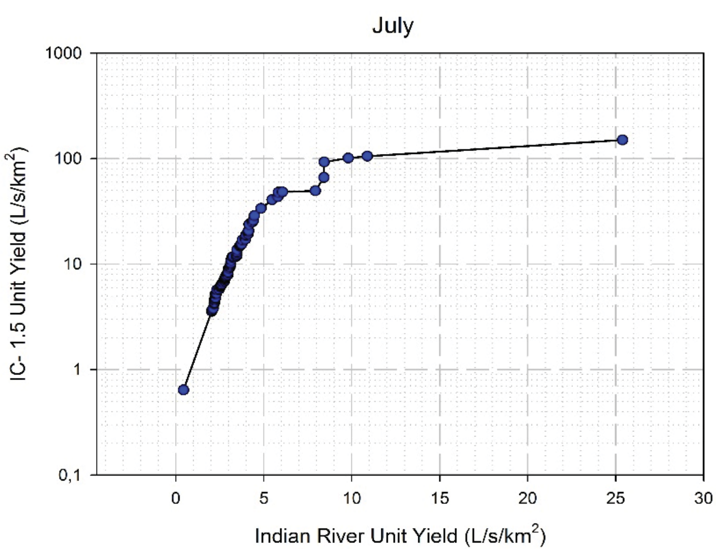
Hydrometric Station IC-1.5 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.



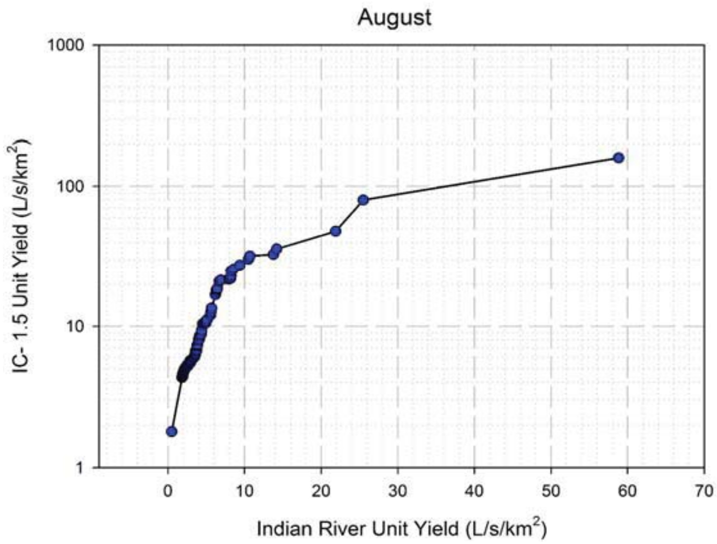


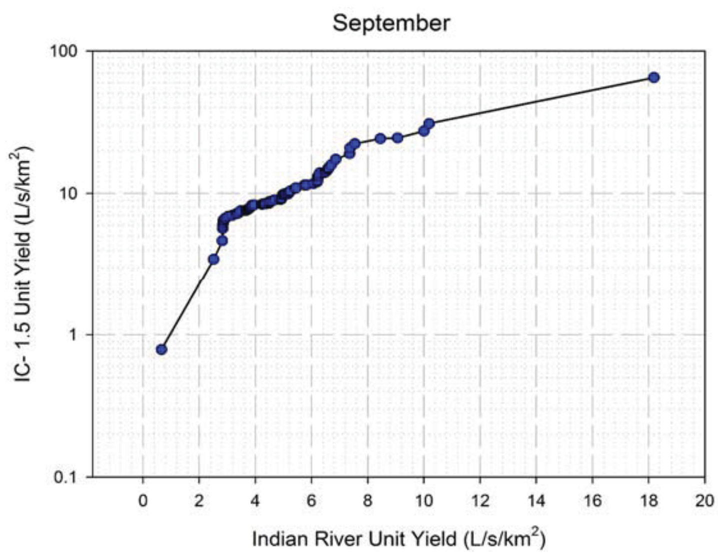


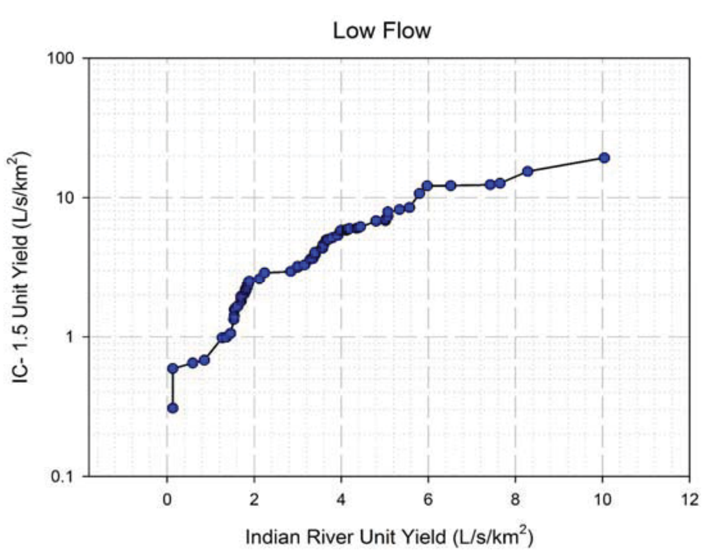
Hydrometric Station IC-1.5 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.







Hydrometric Station IC-1.5 Metadata

Monthly Summaries of Measured Discharge, Unit Yield and Runoff

Year		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Discharge (m^3/s)										
2014	Average	--	--	*0.95*	0.91	0.54	0.80	0.39	*0.149*	0.62
	Maximum	--	--	*4.69*	3.13	1.68	3.22	1.04	*0.55*	4.69
	Minimum	--	--	*0.30*	0.27	0.34	0.39	0.15	*0.077*	0.08
2015	Average	--	*0.77*	0.57	2.17	1.59	1.05	0.67	--	1.14
	Maximum	--	*4.17*	7.65	13.04	9.07	3.12	1.94	--	13.04
	Minimum	--	*0.14*	0.08	0.31	0.37	0.56	0.30	--	0.08
Unit Yield ($L/s/km^2$)										
2014	Average	--	--	*11.7*	11.3	6.7	9.8	4.8	*1.841*	7.7
	Maximum	--	--	*57.9*	38.5	20.7	39.7	12.9	*6.785*	57.9
	Minimum	--	--	*3.7*	3.3	4.2	4.8	1.9	*0.954*	1.0
2015	Average	--	*9.5*	7.1	26.8	19.6	13.0	8.2	--	14.0
	Maximum	--	*51.4*	94.3	160.8	111.9	38.4	23.9	--	160.8
	Minimum	--	*1.7*	0.9	3.8	4.6	6.9	3.7	--	0.9
Runoff (mm)										
2014		--	--	*25*	30	18	26	13	*2*	114
2015		--	*9*	18	72	52	34	22	--	207

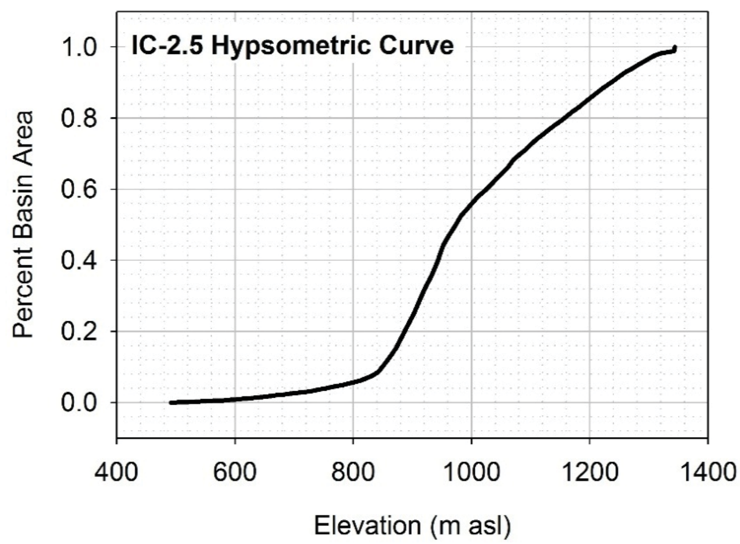
NOTE: Values in italics indicate that data for that month is not complete.

Hydrometric Station IC-2.5 Metadata

Station Name:	IC-2.5
Location:	Independence Creek
Basin Area (km^2):	17.3
UTM Easting:	572782
UTM Northing:	6978036
Median Elevation (m asl):	971
Record Period:	
Spot Measurements	2011-Present
Continuous Record	2014-Present

Pressure Transducer:	Solinst
Temperature Sensor:	Yes
Conductivity Sensor:	Yes
Barologger:	No
Measurement Interval:	
Summer	15 minute
Winter	Removed

Hypsometric Curve

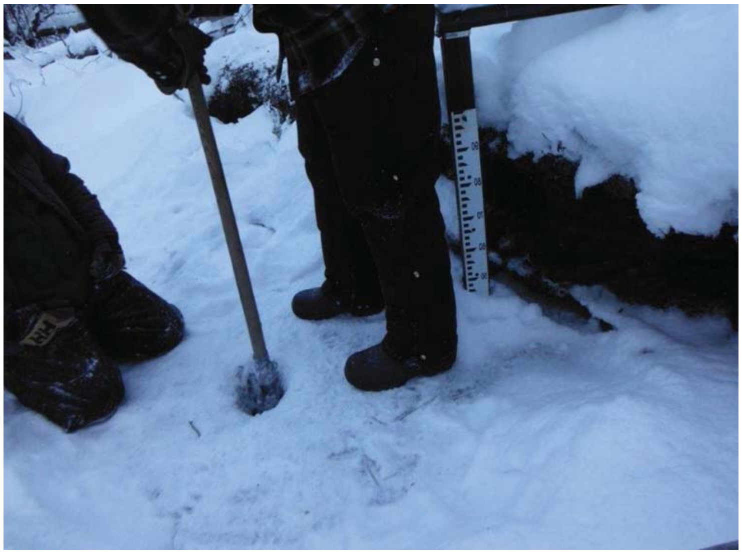


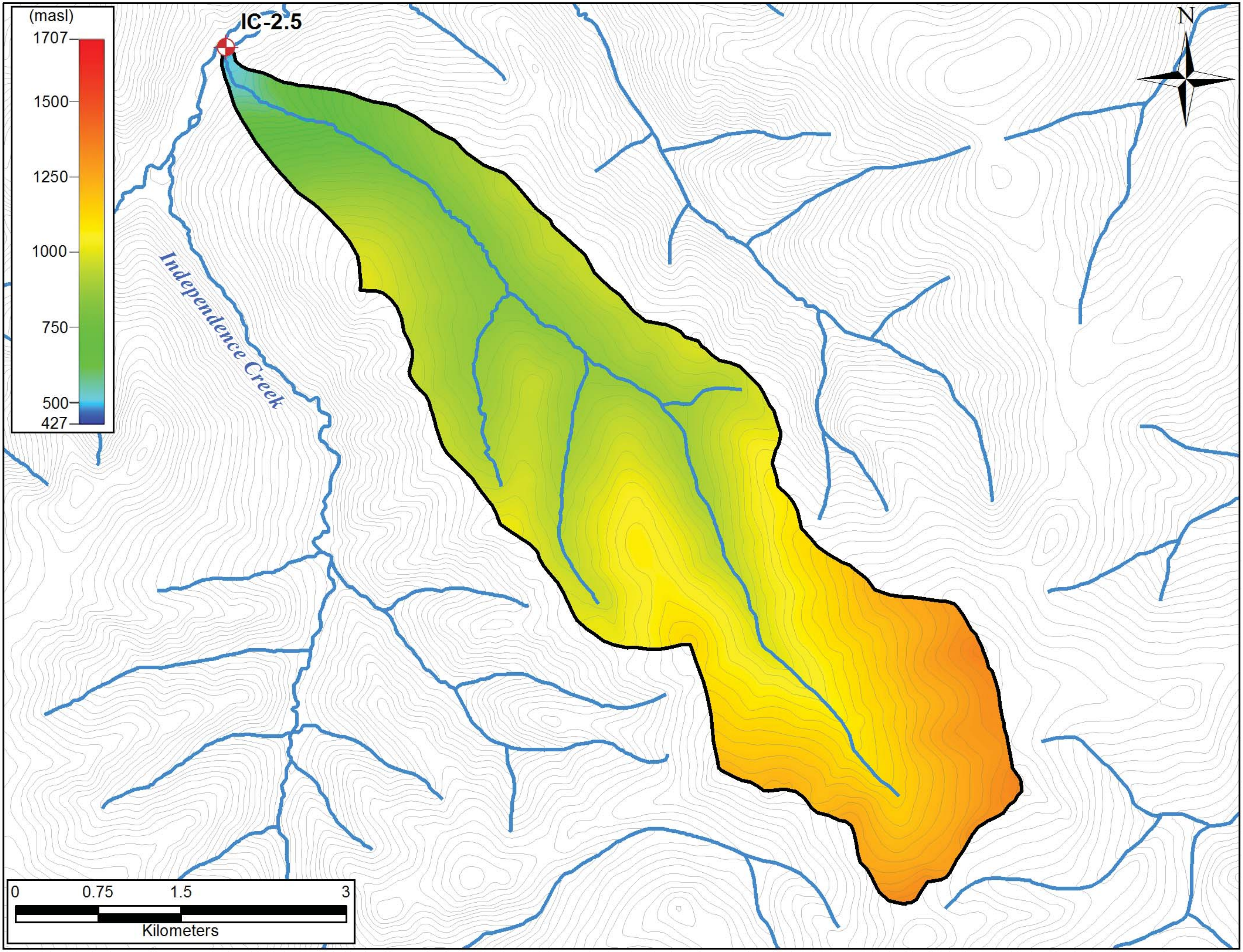
Benchmark surveys			
Date	**Gauge Height (m)**	**Change (m)**	**Notes**
07/06/2014	99.412		
14/09/2015	99.413	0.001	no movement

Catchment Slope Aspects (Quadrants in degrees)			
North (315-45)	**East (45-135)**	**South (135-225)**	**West (225-315)**
43%	10%	19%	28%

Open Water Photo

Winter Photo





(masl)
1707
1500
1250
1000
750
500
427
IC-2.5
N
Independence Creek
0
0.75
1.5
3
Kilometers

Hydrometric Station IC-2.5 Metadata

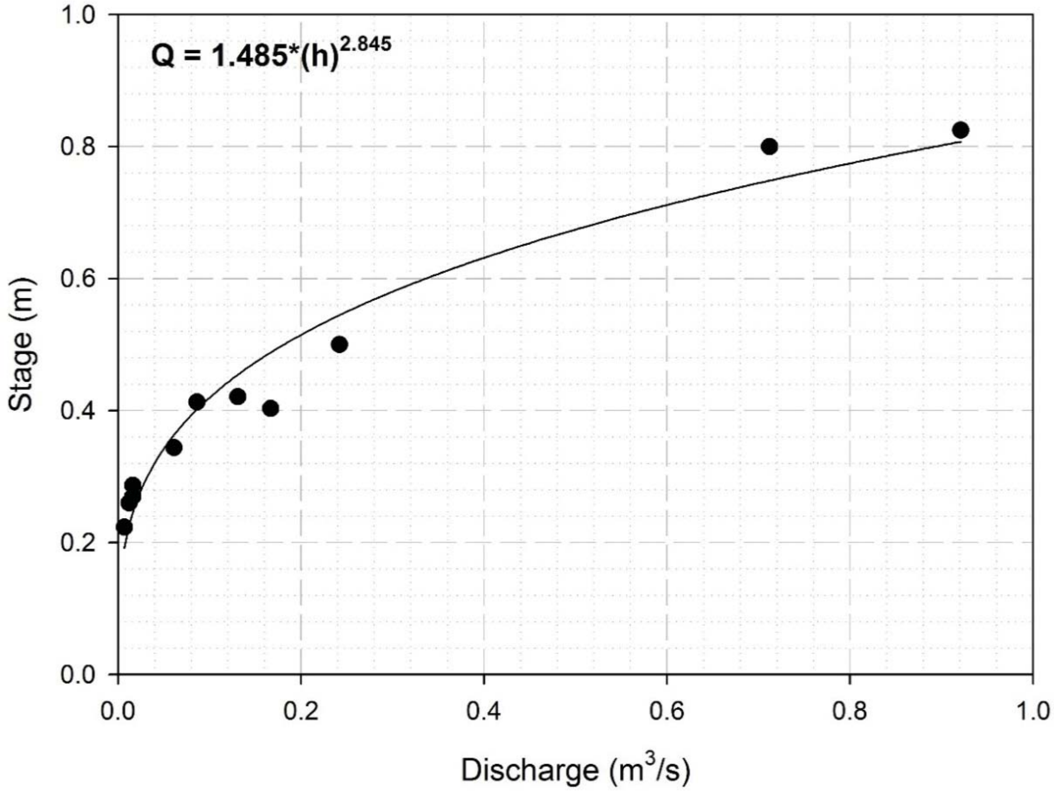
Manual Measurements

Date	Time	Stage (m)	Discharge (m^3/s)	Salt Dilution	MMB FlowMate	Pygmy	Price AA
21/06/2011	16:10		0.436		x		
19/07/2011	17:42		0.264		x		
21/09/2011	12:00		0.042		x		
19/10/2011	16:45		0.006		x		
29/11/2011	12:07		0.000				
29/02/2012	15:35		0.000				
16/05/2012	9:20		0.316		x		
23/06/2012	9:47		0.109		x		
18/07/2012	17:21		0.333		x		
24/08/2012	9:11		0.035		x		
19/09/2012	15:49		0.320	x			
17/10/2012	12:11		0.049	x			
22/11/2012	11:53		0.000				
13/06/2013	17:13		0.062		x		
01/08/2013	10:31		0.336	x			
22/08/2013	12:11		0.113	x			
27/09/2013	14:13		0.130	x			
07/06/2014	9:50	0.270	0.016	x			
27/06/2014		0.610	0.242				x
24/07/2014	18:30	0.421	0.131				x
20/08/2014	13:30	0.344	0.061				x
25/09/2014	11:20	0.413	0.086				x
22/10/2014	18:00	0.287	0.016	x			
18/05/2015			0.095	x			
25/06/2015	16:30	0.223	0.007	x			
22/07/2015		0.370					
20/08/2015	13:00	0.800	0.712	x			
14/09/2015	10:30	0.403	0.167	x			
30/10/2015	12:20	0.260	0.012	x			

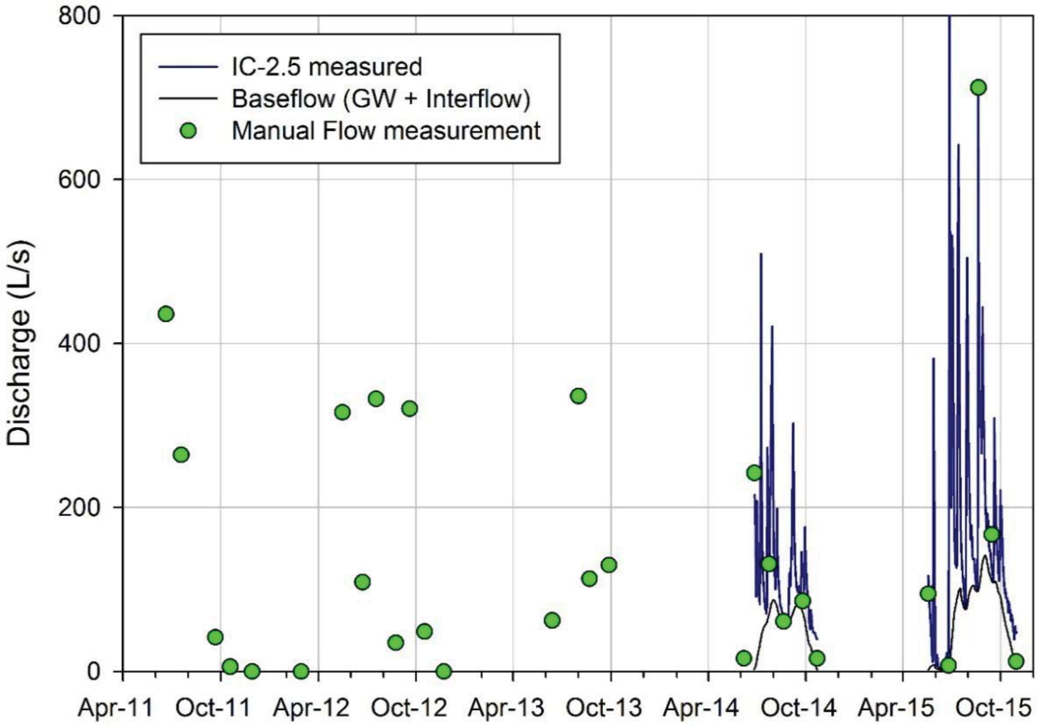
Hydrometric Station IC-2.5 Metadata

Rating Curve

NOTE: Slope-area method was used to calculate bankfull discharge, but was superseded by a manual measurement.

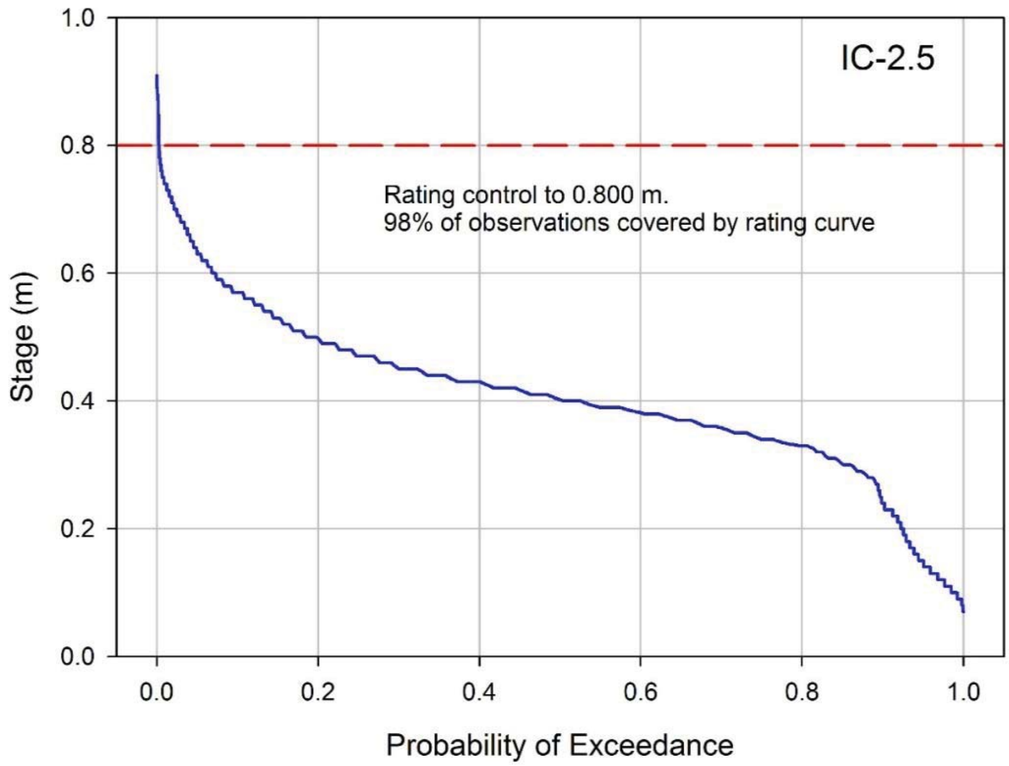


Continuous Discharge Record vs. Spot Flow Measurements

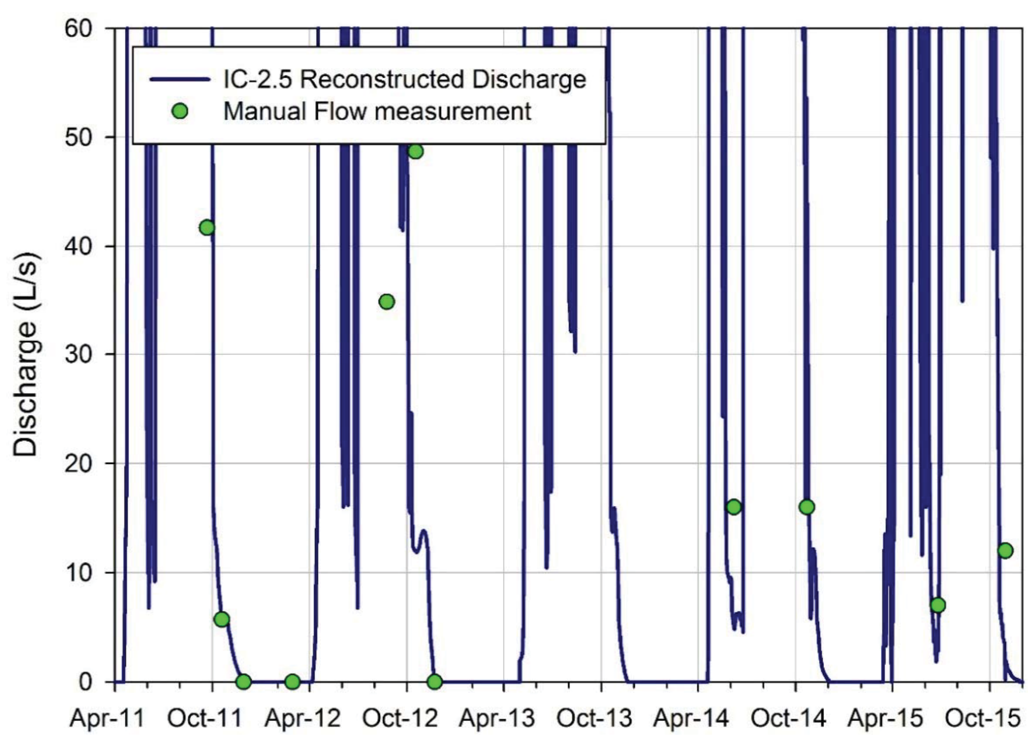


Hydrometric Station IC-2.5 Metadata

Rating Curve Control on Measured Stage

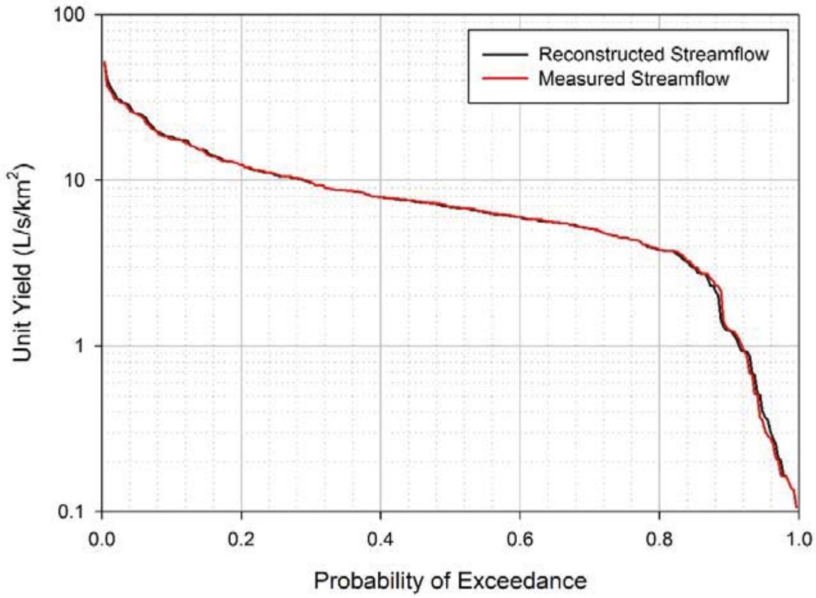


Baseflow comparison - winter spot flows vs. synthetic discharge record

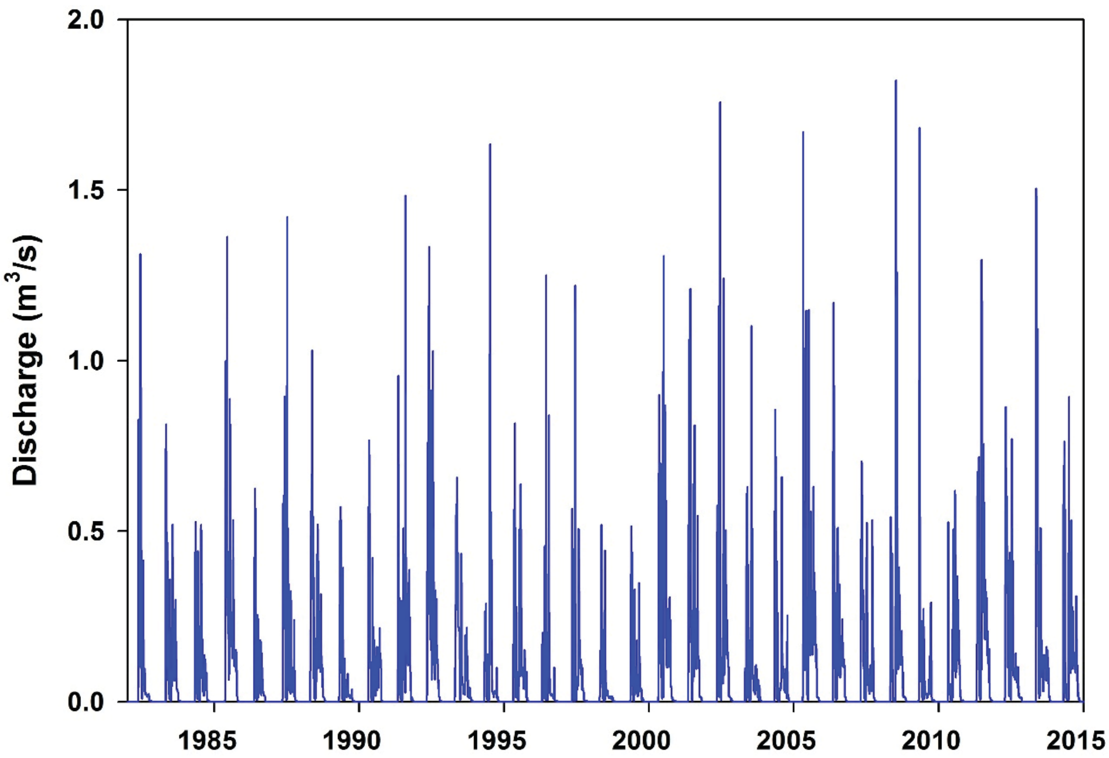


Hydrometric Station IC-2.5 Metadata

Flow Duration Curves - Synthetic vs. Measured Discharge



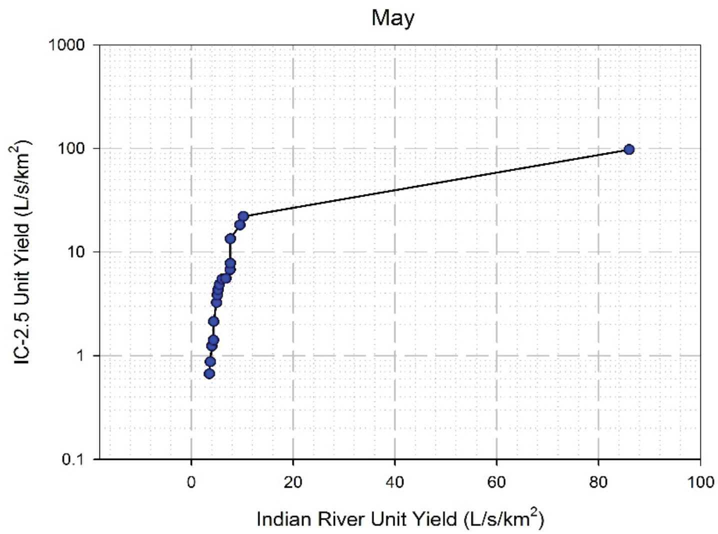
Synthetic Discharge Time-Series

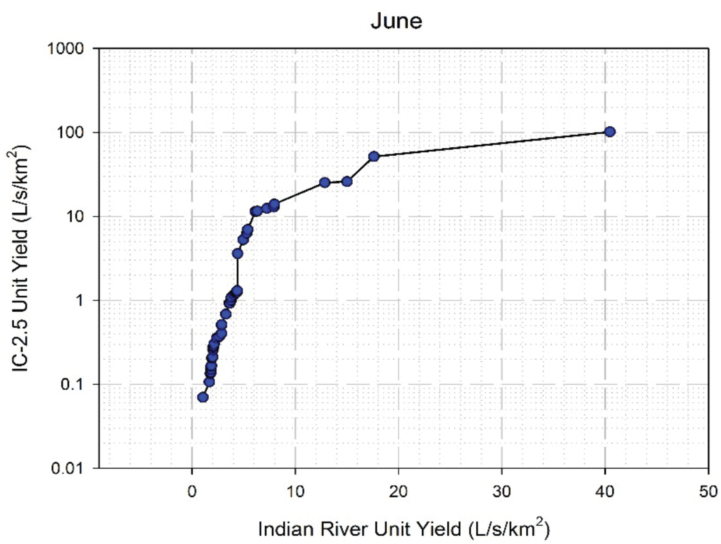


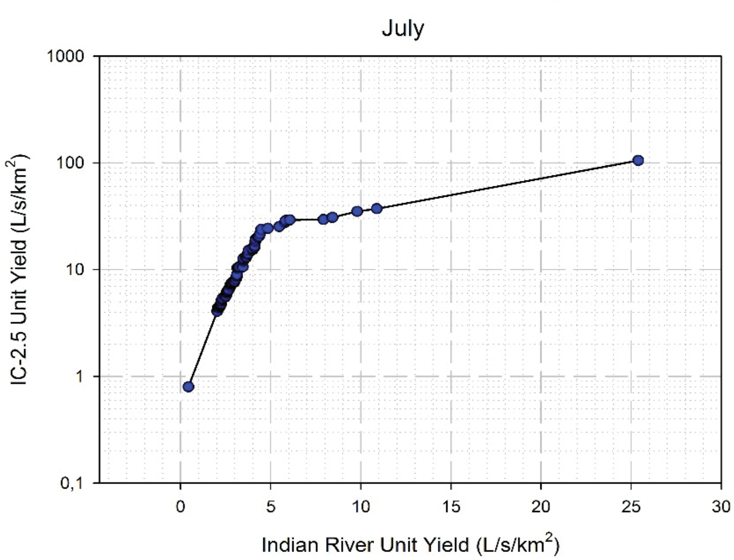
Hydrometric Station IC-2.5 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.



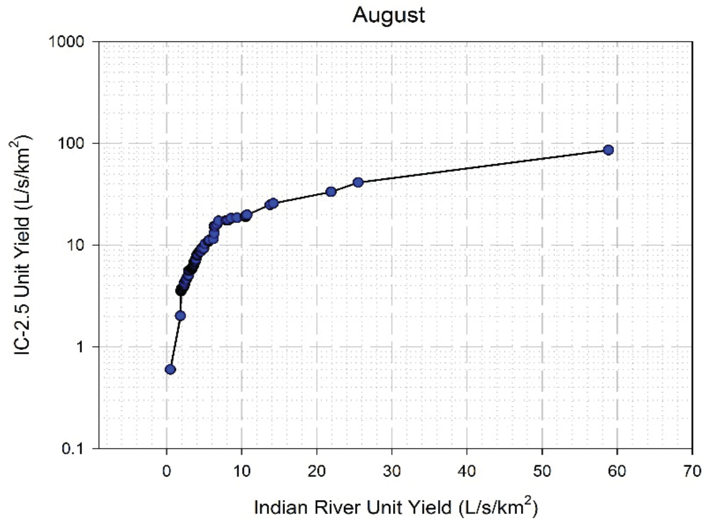


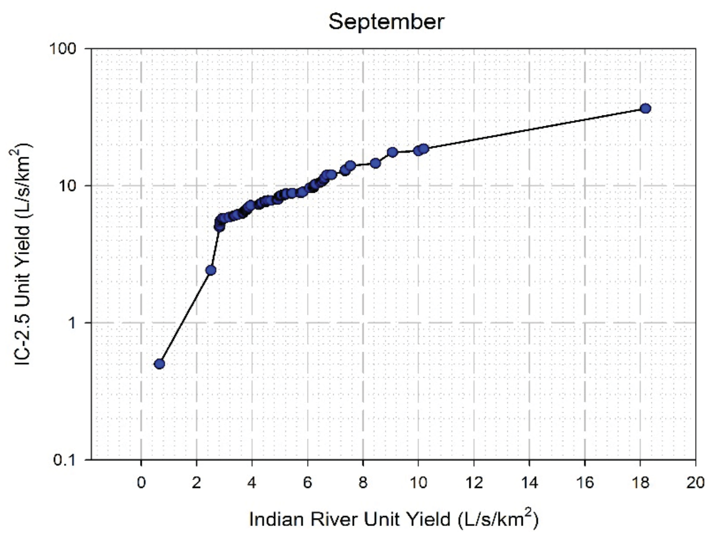


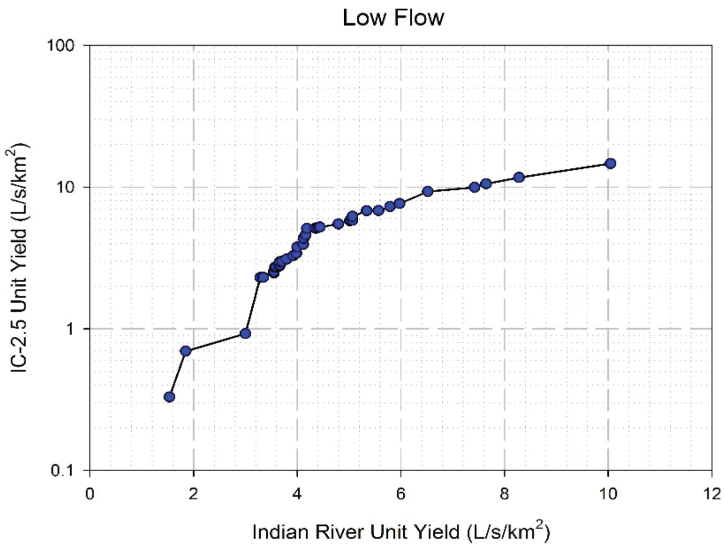
Hydrometric Station IC-2.5 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.







Hydrometric Station IC-2.5 Metadata

Monthly Summaries of Measured Discharge, Unit Yield and Runoff

Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2014	Average	--	--	*0.15*	0.18	0.10	0.14	*0.07*	--	0.12
	Maximum	--	--	*0.26*	0.66	0.22	0.34	*0.15*	--	0.66
	Minimum	--	--	*0.08*	0.06	0.06	0.09	*0.02*	--	0.02
2015	Average	--	*0.10*	0.08	0.27	0.23	0.17	0.09	--	0.16
	Maximum	--	*0.50*	1.14	0.82	0.73	0.35	0.24	--	1.14
	Minimum	--	*0.00*	0.00	0.07	0.08	0.09	0.02	--	0.00
Unit Yield ($L/s/km^2$)										
2014	Average	--	--	*8.6*	10.3	5.6	7.8	*3.8*	--	7.2
	Maximum	--	--	*15.0*	38.2	12.7	19.4	*8.8*	--	38.2
	Minimum	--	--	*4.7*	3.7	3.4	5.0	*1.2*	--	1.2
2015	Average	--	*5.5*	4.4	15.5	13.6	9.7	5.2	--	9.0
	Maximum	--	*28.7*	65.7	47.1	42.3	20.1	14.1	--	65.7
	Minimum	--	*0.3*	0.0	4.0	4.7	5.1	1.2	--	0.0
Runoff (mm)										
2014		--	--	*3*	28	15	20	*7*	--	73
2015		--	*7*	11	42	36	25	14	--	135

NOTE: Values in italics indicate that data for that month is not complete.

Appendix A
Site Hydrology Data

Appendix A1: Site Hydrology Data 2010 to 2015

Appendix A2: Site Hydrology Data 2016

GOLDCORP

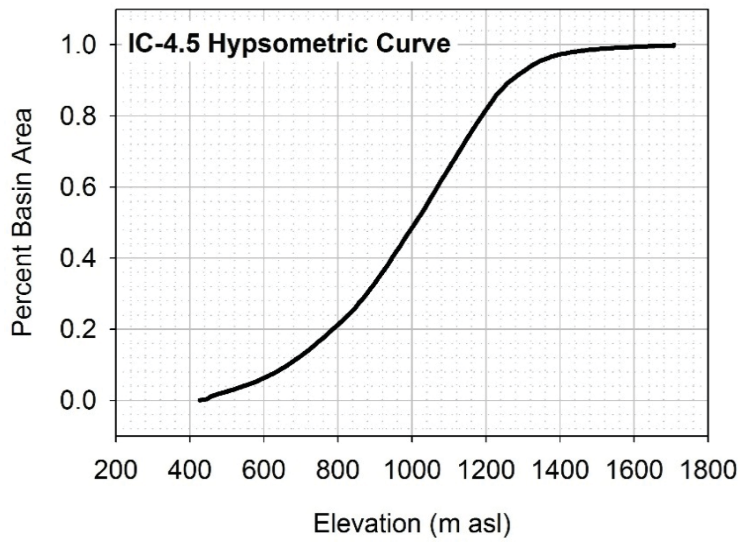
APPENDIX A1: SITE HYDROLOGY DATA - 2010 TO 2015

Hydrometric Station IC-4.5 Metadata

Station Name:	IC-4.5
Location:	Independence Creek
Basin Area (km^2):	222.3
UTM Easting:	579384
UTM Northing:	6983229
Median Elevation (m asl):	1009
Record Period:	
Spot Measurements	2010-Present
Continuous Record	2011-Present

Pressure Transducer:	Solinst
Temperature Sensor:	Yes
Conductivity Sensor:	Yes
Barologger:	Yes
Measurement Interval:	
Summer	15 minute
Winter	Removed

Hypsometric Curve

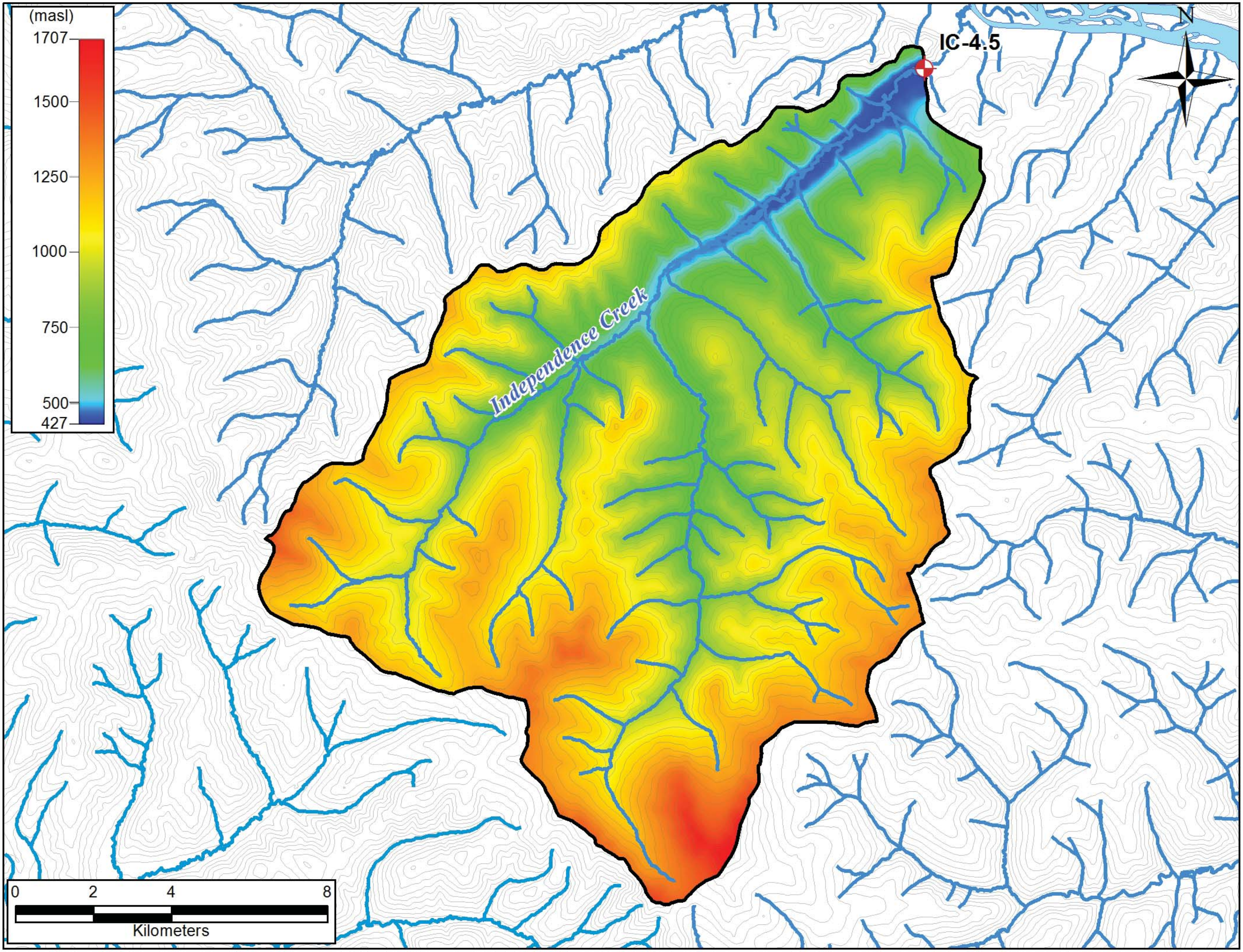


Benchmark surveys			
Date	**Gauge Height (m)**	**Change (m)**	**Notes**
21/09/2011	97.705		
23/06/2012	97.721	0.016	Staff gauge reinstalled
19/09/2012	97.724	0.003	
30/05/2013	99.713	1.989	
26/09/2013	99.826	0.113	Staff gauge reinstalled
13/09/2015	99.851	0.025	SG moved up

Catchment Slope Aspects (Quadrants in degrees)			
North (315-45)	**East (45-135)**	**South (135-225)**	**West (225-315)**
42%	14%	28%	16%

Open Water Photo

Winter Photo


(masl)
1707
1500
1250
1000
750
500
427
IC-4.5
N
Independence Creek
0
2
4
8
Kilometers

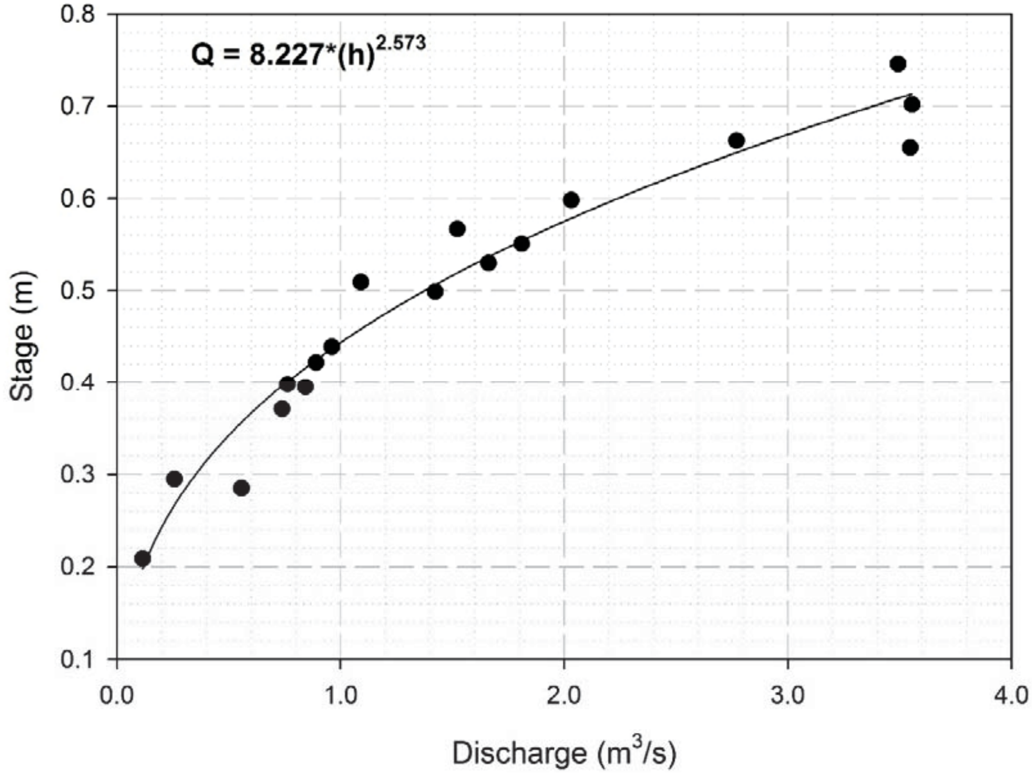
Hydrometric Station IC-4.5 Metadata

Manual Measurements

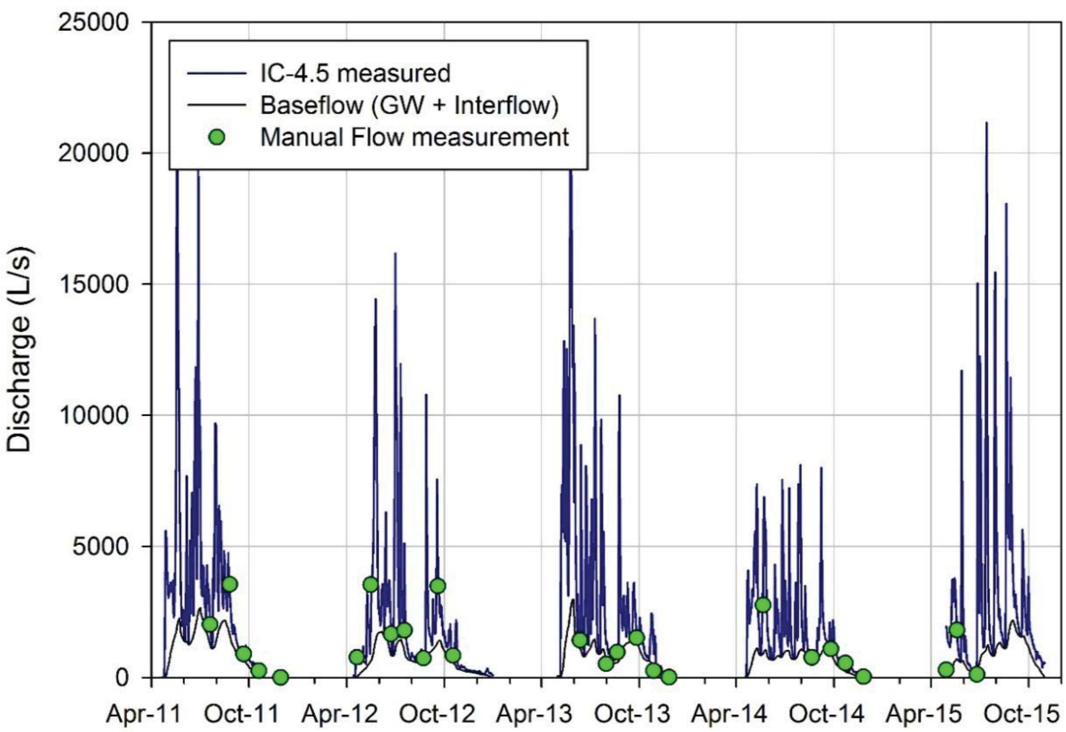
Date	Time	Stage (m)	Discharge (m^3/s)	Salt Dilution	MMB FlowMate	Pygmy	Price AA
09/11/2010	15:17		0.132	x			
14/12/2010	10:45		0.076	x			
20/04/2011		0.058					
19/05/2011							
20/05/2011							
21/06/2011							
20/07/2011	8:52	0.598	2.032		x		
26/08/2011	8:45	0.702	3.555				x
21/09/2011	13:47	0.422	0.890		x		
19/10/2011	13:52	0.295	0.258		x		
29/11/2011	11:02		0.002		x		
29/02/2012	9:52						
26/03/2012	10:05						
20/04/2012	10:07		0.775		x		
16/05/2012	10:44	0.655	3.546		x		
23/06/2012	10:57	0.530	1.662		x		
18/07/2012	16:10		1.802		x		
23/08/2012	16:40	0.371	0.739		x		
19/09/2012	14:16	0.746	3.492		x		
17/10/2012	10:26	0.395	0.842		x		
10/04/2013	15:25						
12/06/2013	16:08	0.499	1.423		x		
31/07/2013	18:32		0.522		x		
21/08/2013	15:54	0.439	0.961		x		
26/09/2013	14:46	0.567	1.521		x		
28/10/2013	13:45		0.268		x		
26/11/2013	15:06		0.011	x			
21/05/2014	16:50	0.663	2.770		x		
20/08/2014	16:49	0.398	0.763				x
25/09/2014	9:25	0.509	1.091				x
22/10/2014	15:45	0.285	0.556				x
25/11/2014	12:30		0.033	x			
20/12/2014	13:27						
29/04/2015	15:00		0.302	x			
19/05/2015	12:00	0.551	1.810	x			
26/06/2015	17:50	0.209	0.115	x			

Hydrometric Station IC-4.5 Metadata

Rating Curve

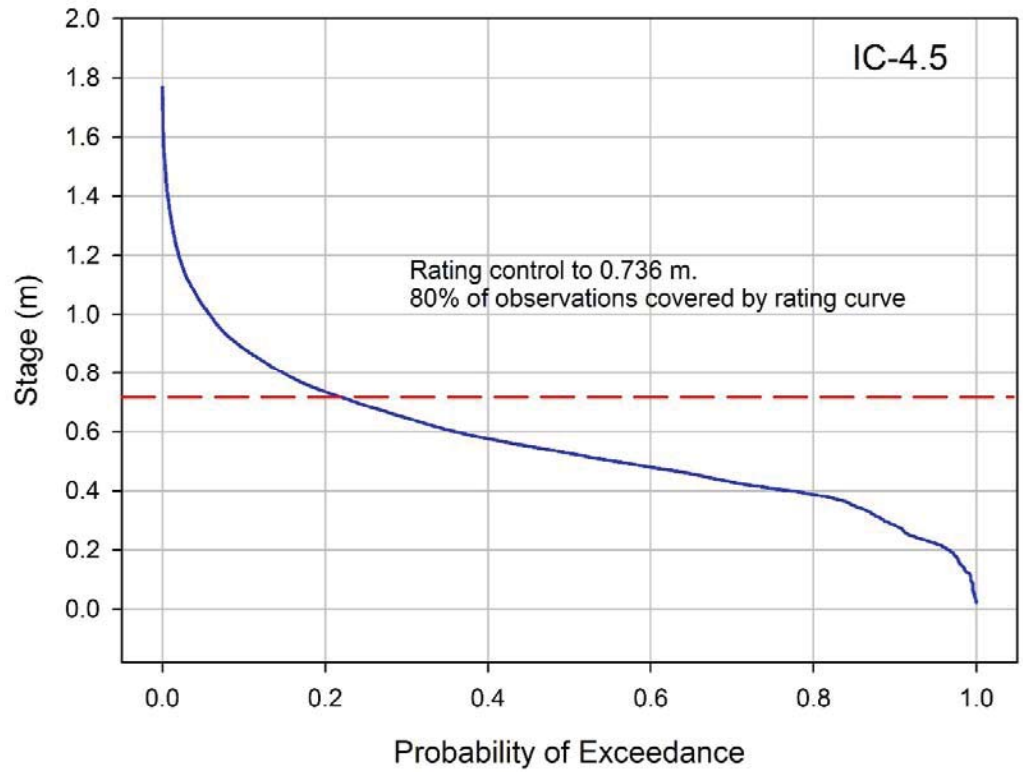


Continuous Discharge Record vs. Spot Flow Measurements

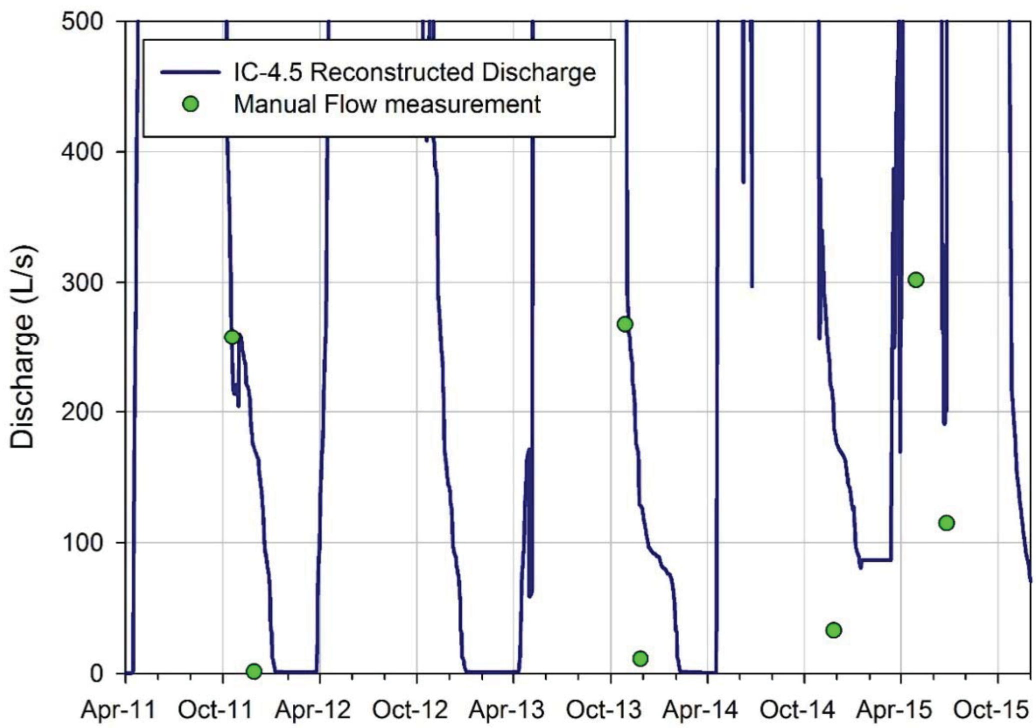


Hydrometric Station IC-4.5 Metadata

Rating Curve Control on Measured Stage

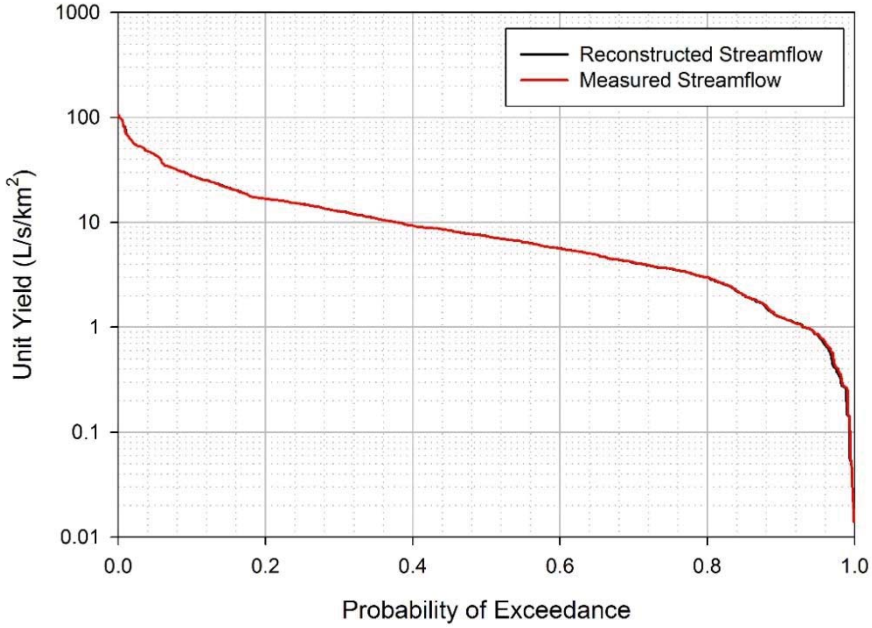


Baseflow comparison - winter spot flows vs. synthetic discharge record

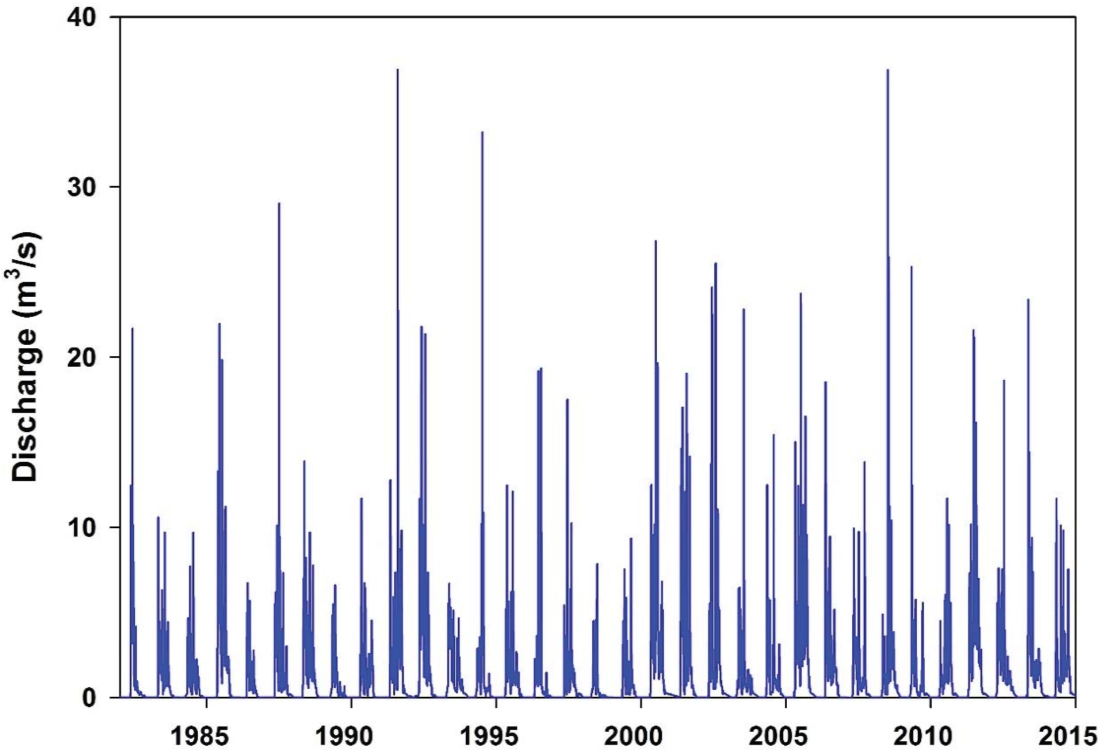


Hydrometric Station IC-4.5 Metadata

Flow Duration Curves - Synthetic vs. Measured Discharge



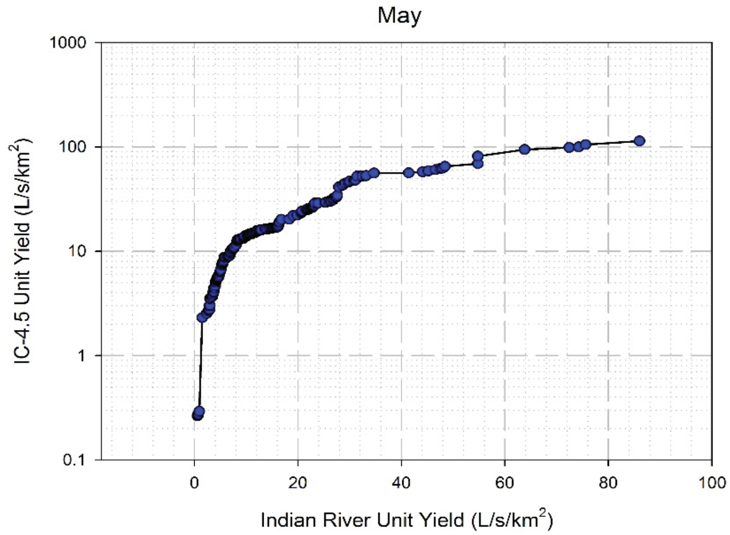
Synthetic Discharge Time-Series

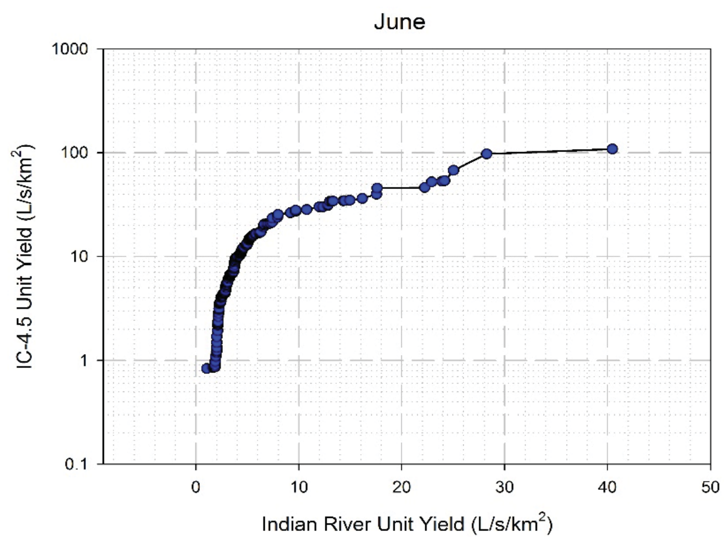


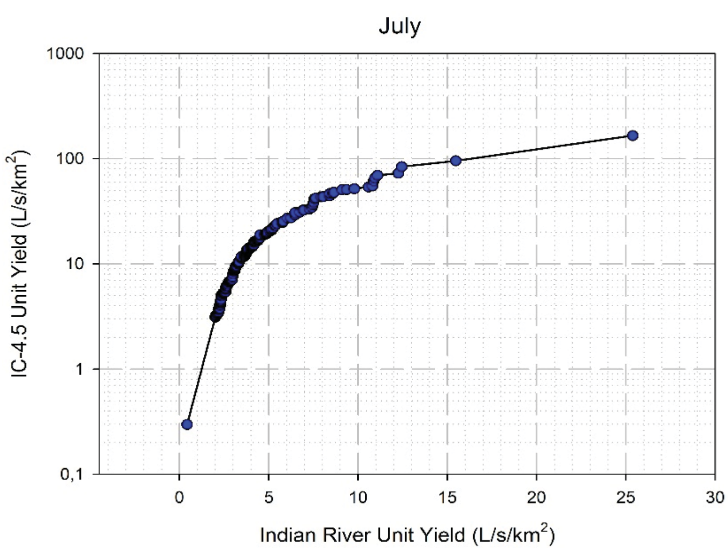
Hydrometric Station IC-4.5 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.



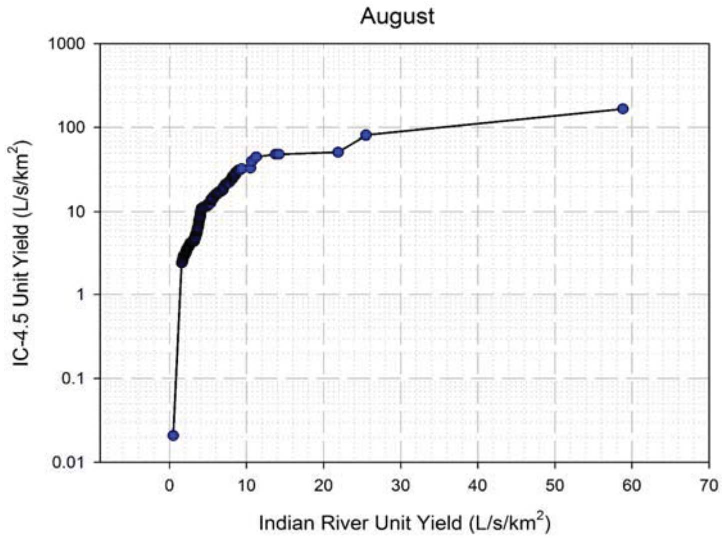


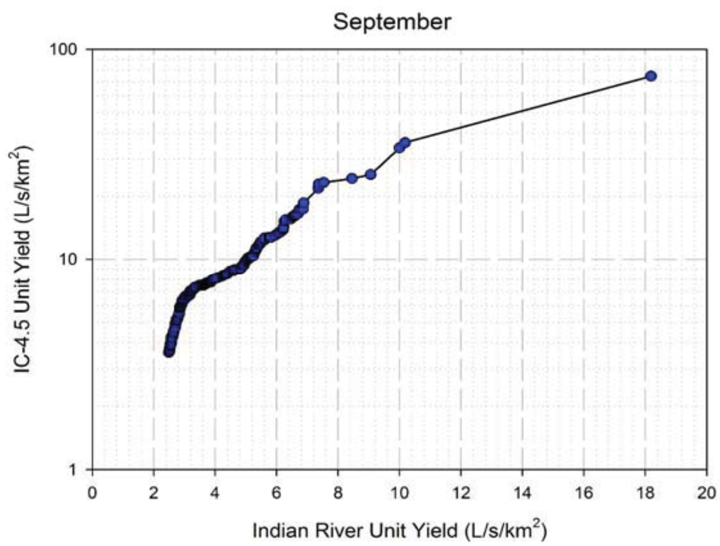


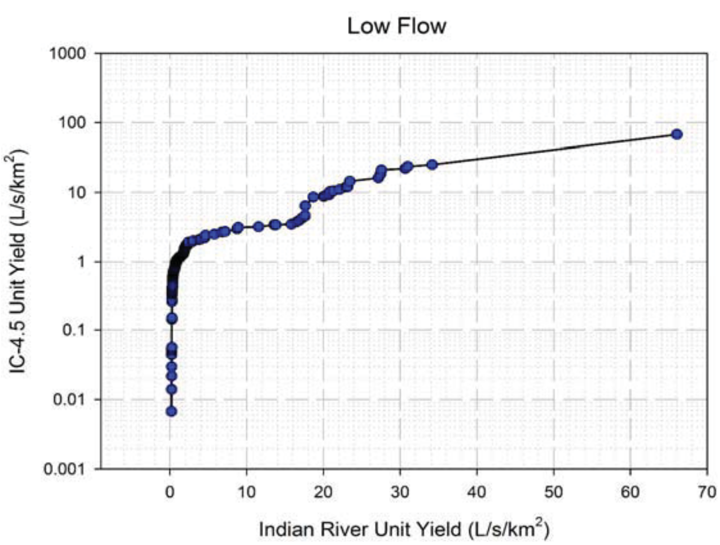
Hydrometric Station IC-4.5 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.







Hydrometric Station IC-4.5 Metadata

Monthly Summaries of Measured Discharge, Unit Yield and Runoff

Year		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Discharge (m^3/s)										
2011	Average	*2.11*	5.805	5.49	3.85	3.77	1.19	*0.53*	--	3.25
	Maximum	*6.54*	32.512	32.72	13.45	8.88	2.11	*0.91*	--	32.72
	Minimum	*0.00*	1.8481	1.20	0.98	1.67	0.69	*0.33*	--	0.00
2012	Average	*0.63*	4.0081	2.92	3.97	1.40	2.46	1.17	*0.306*	2.11
	Maximum	*1.92*	16.864	10.82	25.28	15.44	9.02	2.87	*0.504*	25.28
	Minimum	*0.05*	0.4048	0.80	0.70	0.51	1.16	0.34	*0.214*	0.05
2013	Average	--	8.0713	3.59	4.08	1.89	2.18	1.37	*0.317*	3.07
	Maximum	--	29.663	15.29	16.81	18.11	4.28	2.88	*0.744*	29.66
	Minimum	--	0.0547	0.73	0.88	0.52	1.27	0.57	*0.129*	0.05
2014	Average	*2.123*	3.57	2.58	2.84	1.29	2.24	0.62	*0.191*	1.93
	Maximum	*4.952*	12.97	10.68	10.09	3.96	9.91	1.94	*0.421*	12.97
	Minimum	*0.028*	0.6686	0.61	0.65	0.72	0.88	0.20	*0.063*	0.03
2015	Average	*1.926*	2.42	1.44	5.79	4.57	2.70	1.05	--	2.84
	Maximum	*2.095*	18.78	19.66	26.53	23.60	6.38	3.31	--	26.53
	Minimum	*1.695*	0.47	0.17	0.78	1.05	1.51	0.31	--	0.17
Unit Yield ($L/s/km^2$)										
2011	Average	*9.491*	26.113	24.7	17.3	17.0	5.4	*2.4*	--	14.6
	Maximum	*29.4*	146.25	147.2	60.5	40.0	9.5	*4.1*	--	147.2
	Minimum	*0.006*	8.3137	5.4	4.4	7.5	3.1	*1.5*	--	0.0
2012	Average	*2.813*	18.03	13.2	17.9	6.3	11.1	5.3	*1.377*	9.5
	Maximum	*8.621*	75.863	48.7	113.7	69.5	40.6	12.9	*2.268*	113.7
	Minimum	*0.207*	1.821	3.6	3.1	2.3	5.2	1.6	*0.962*	0.2
2013	Average	--	36.308	16.2	18.4	8.5	9.8	6.2	*1.427*	13.8
	Maximum	--	133.44	68.8	75.6	81.4	19.3	12.9	*3.347*	133.4
	Minimum	--	0.246	3.3	4.0	2.4	5.7	2.6	*0.581*	0.2
2014	Average	*9.552*	16.06	11.6	12.8	5.8	10.1	2.8	*0.858*	8.7
	Maximum	*22.27*	58.346	48.0	45.4	17.8	44.6	8.7	*1.893*	58.3
	Minimum	*0.124*	3.0077	2.8	2.9	3.2	4.0	0.9	*0.283*	0.1
2015	Average	*8.666*	10.9	6.5	26.0	20.6	12.1	4.7	--	12.8
	Maximum	*9.423*	84.5	88.5	119.3	106.1	28.7	14.9	--	119.3
	Minimum	*7.624*	2.1	0.8	3.5	4.7	6.8	1.4	--	0.8
Runoff (mm)										
2011		*9*	69.942	*64*	46	45	14	*4*	--	253
2012		*4*	48.291	*34*	48	17	29	14	*4*	198
2013		--	97.248	*42*	49	23	25	17	*2*	255
2014		*11*	43.014	*30*	34	16	26	7	*2*	169
2015		*1*	29	17	70	55	31	13	--	216

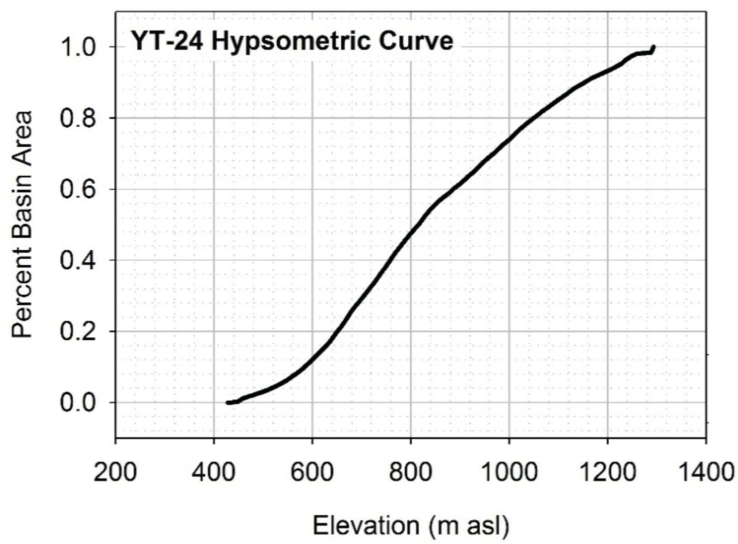
NOTE: Values in italics indicate that data for that month is not complete.

Hydrometric Station YT-24 Metadata

Station Name:	YT-24
Location:	Yukon R. Trib. 24
Basin Area (km^2):	11.8
UTM Easting:	589677
UTM Northing:	6979153
Median Elevation (m asl):	812
Record Period:	
Spot Measurements	2014-Present
Continuous Record	2014-Present

Pressure Transducer:	Solinst
Temperature Sensor:	Yes
Conductivity Sensor:	Yes
Barologger:	No
Measurement Interval:	
Summer	15 minute
Winter	Removed

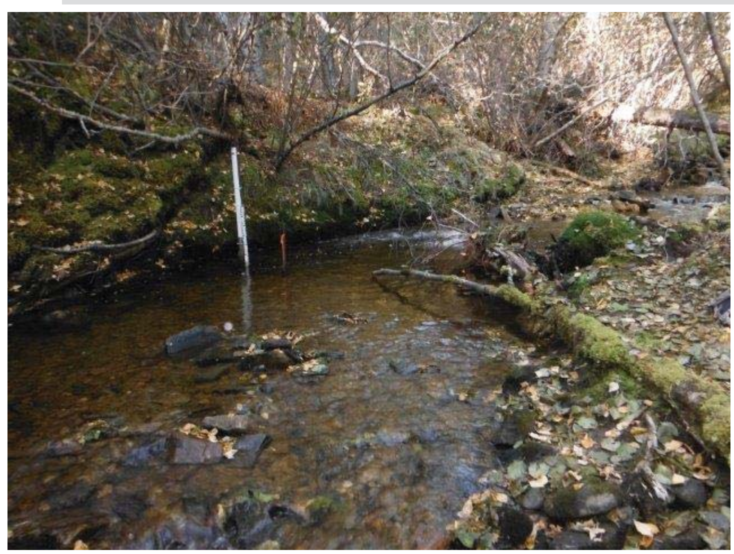
Hypsometric Curve



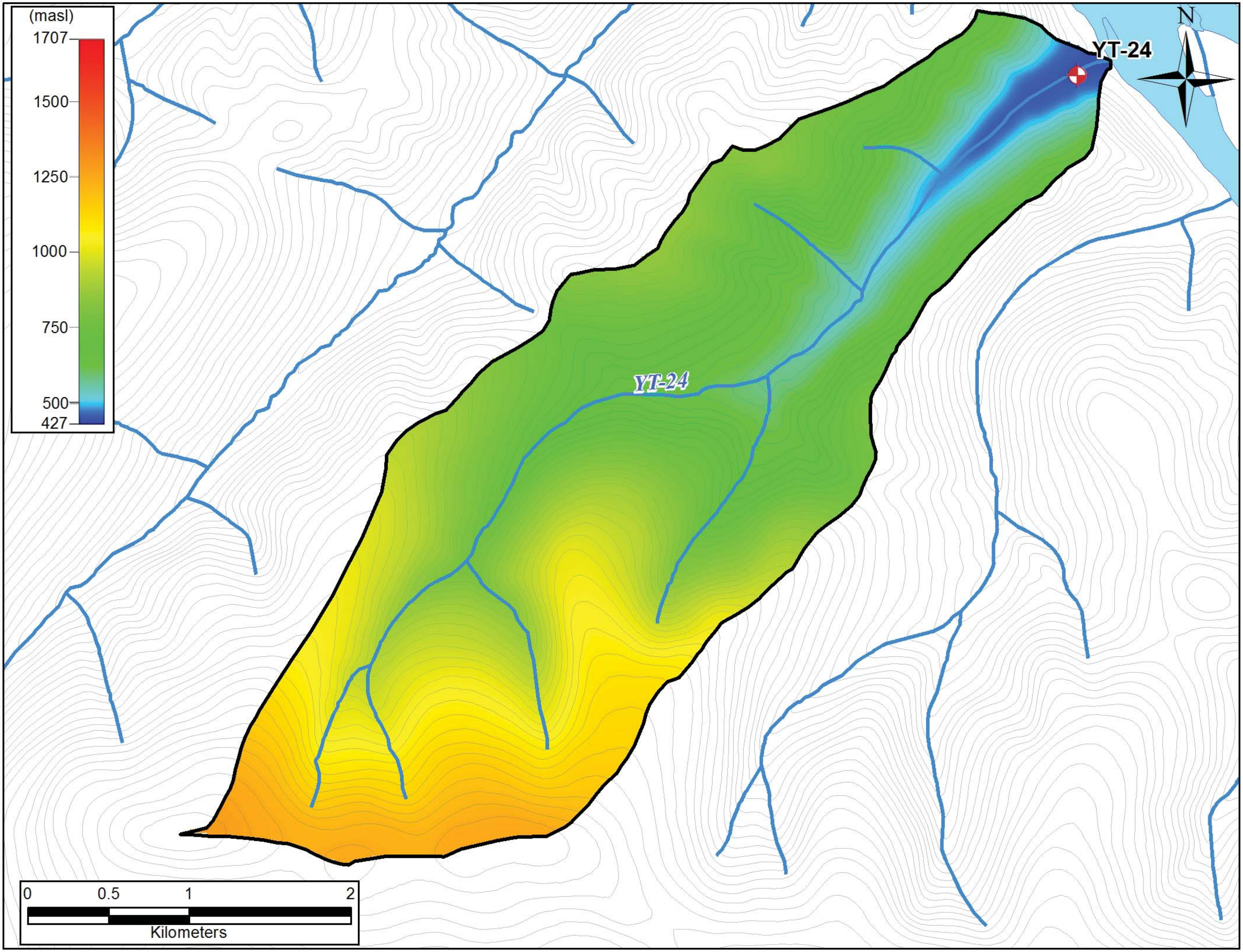
Benchmark surveys			
Date	**Gauge Height (m)**	**Change (m)**	**Notes**
15/09/2015	98.200		

Catchment Slope Aspects (Quadrants in degrees)			
North (315-45)	**East (45-135)**	**South (135-225)**	**West (225-315)**
54%	21%	20%	5%

High Flow Photo **Low Flow Photo**



NOTE: This site goes dry during the winter, and therefore no winter photo is available.



(masl)
1707
1500
1250
1000
750
500
427
YT-24
YT-24
N
0
0.5
1
2
Kilometers

Hydrometric Station YT-24 Metadata

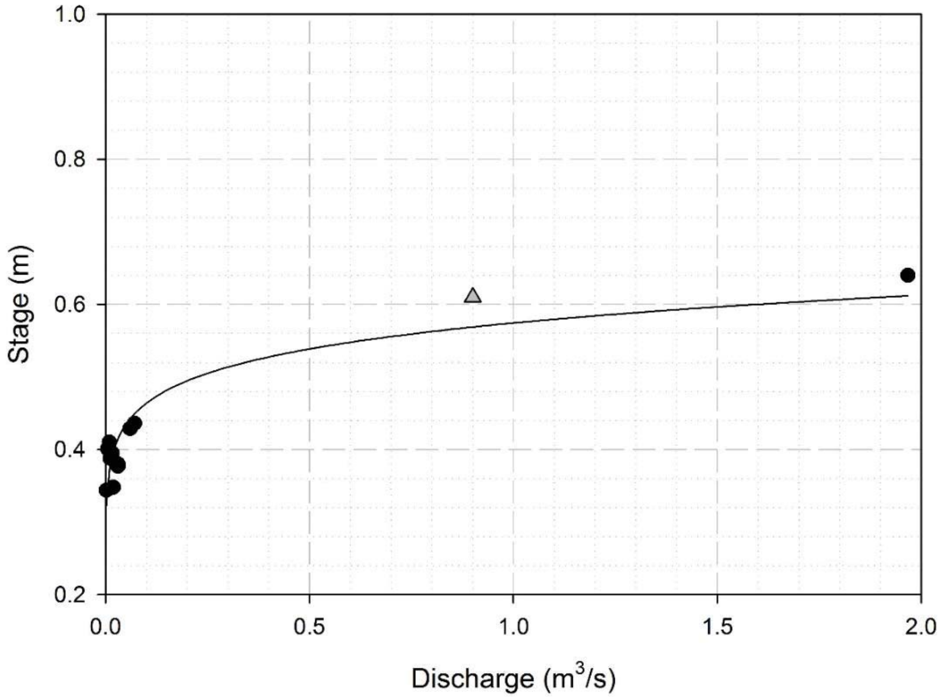
Manual Measurements

Date	Time	Stage (m)	Discharge (m^3/s)	Salt Dilution	MMB FlowMate	Pygmy	Price AA
06/07/2014	13:30		0.003				x
27/06/2014	13:50	0.431	0.087				x
23/07/2014	18:40	0.390	0.030				x
22/08/2014	10:36	0.380	0.016				x
26/09/2014	11:05	0.395	0.019				x
24/10/2014	9:30	0.348	0.002	x			
29/04/2015	13:00	0.344	0.005	x			
19/05/2015	13:30	0.401	0.030	x			
26/06/2015	9:25	0.377	0.009				
23/07/2015	8:22	0.410					
20/08/2015	16:30						
11/09/2015	10:00	0.436	0.071	x			
13/09/2015	11:30	0.429	0.060			x	
30/10/2015	15:00	0.388	0.011	x			
Slope-Area		0.640	1.967				

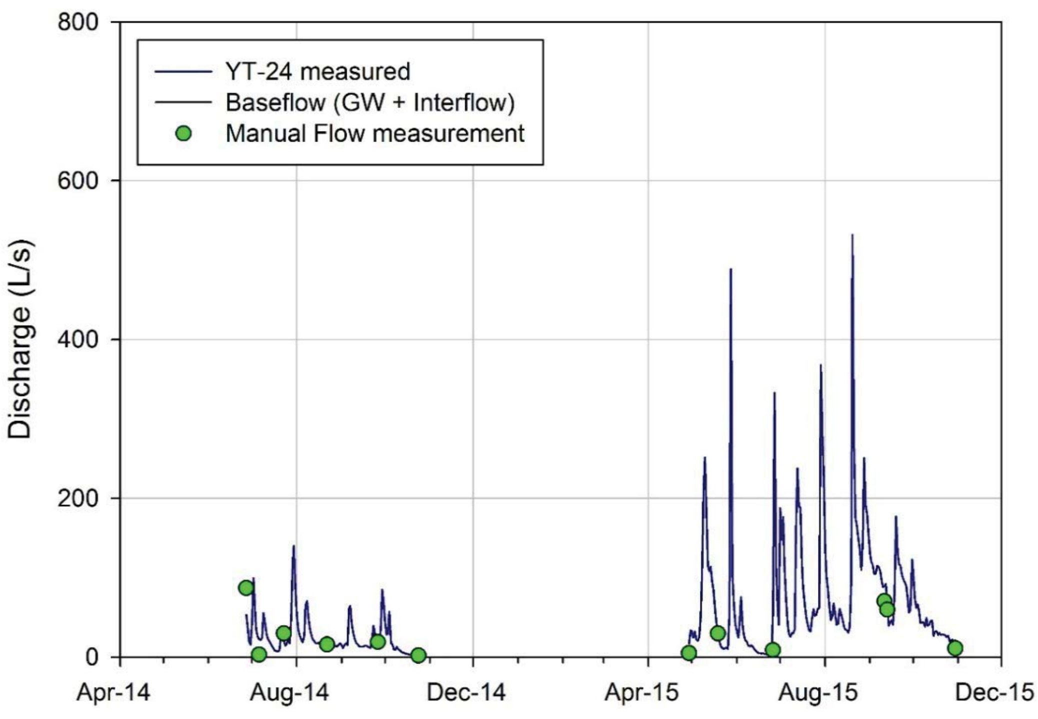
Hydrometric Station YT-24 Metadata

Rating Curve

NOTE: Rating curve extended using the slope-area method from a channel survey conducted in 2015.
Grey triangle indicates stage measurement and flow estimate from August 20, 2015.

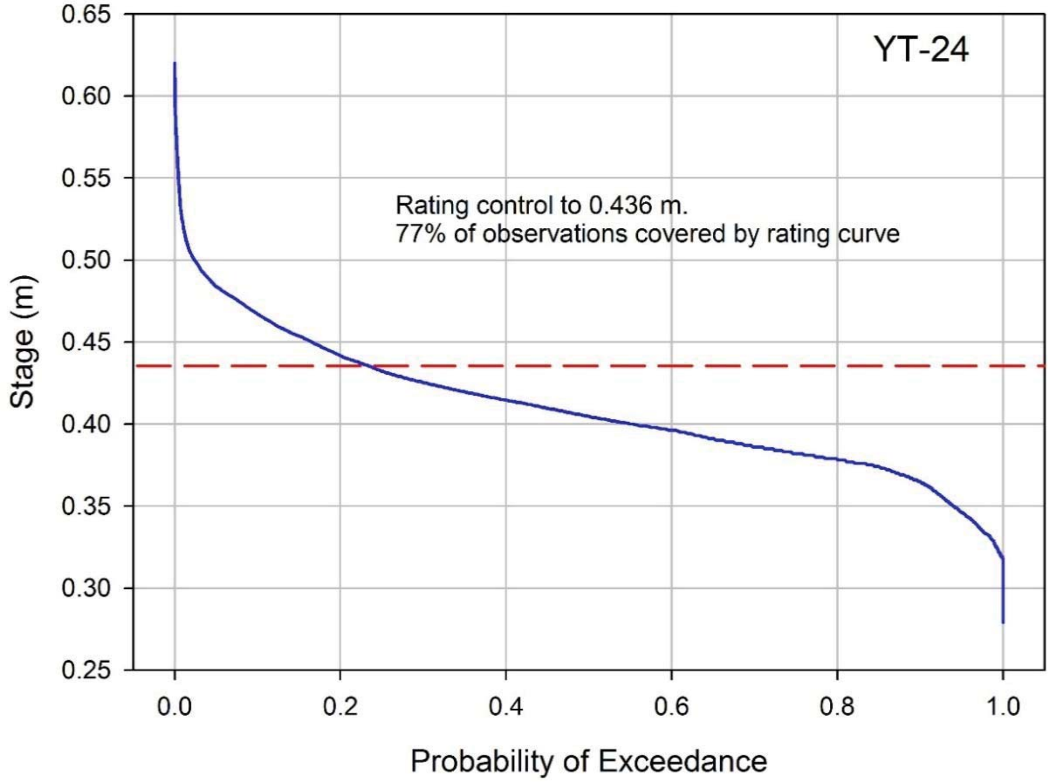


Continuous Discharge Record vs. Spot Flow Measurements



Hydrometric Station YT-24 Metadata

Rating Curve Control on Measured Stage

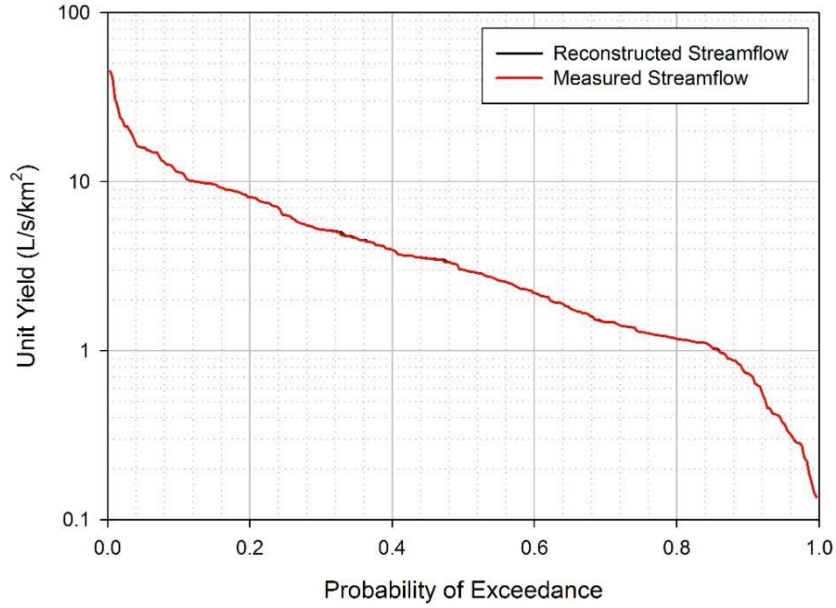


Baseflow comparison - winter spot flows vs. synthetic discharge record

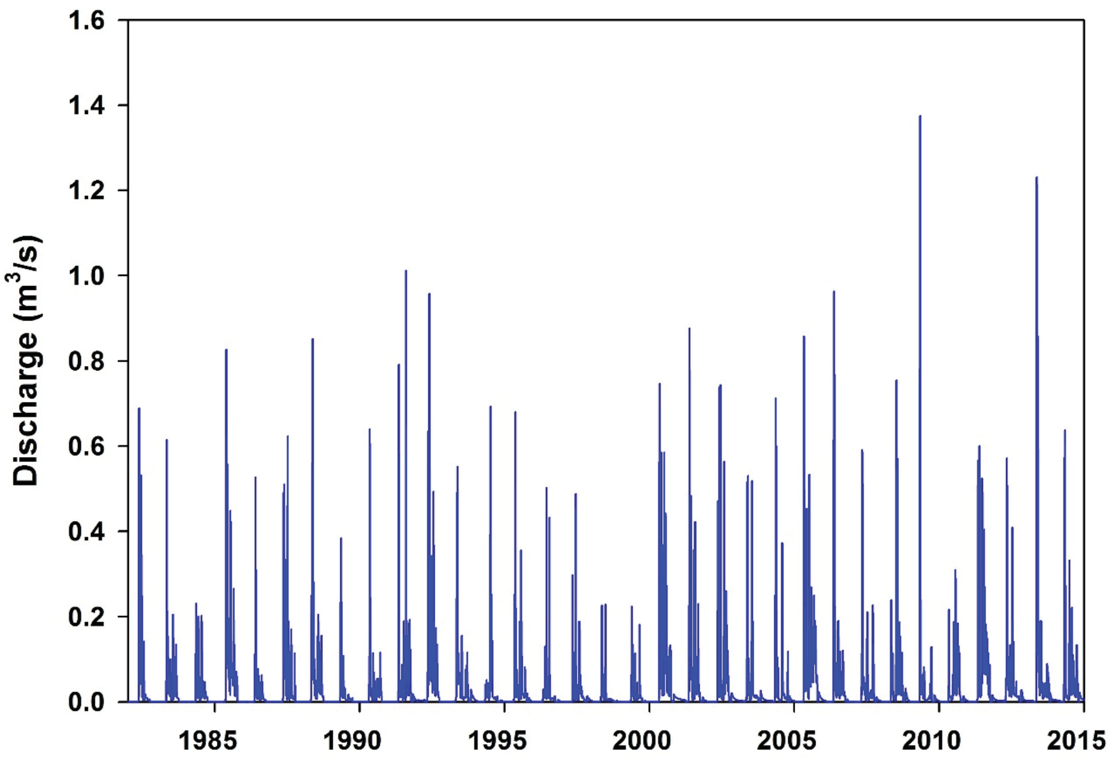
NOTE: This stream experiences extensive aufeis conditions during the winter, and therefore no flow measurements are possible.

Hydrometric Station YT-24 Metadata

Flow Duration Curves - Synthetic vs. Measured Discharge



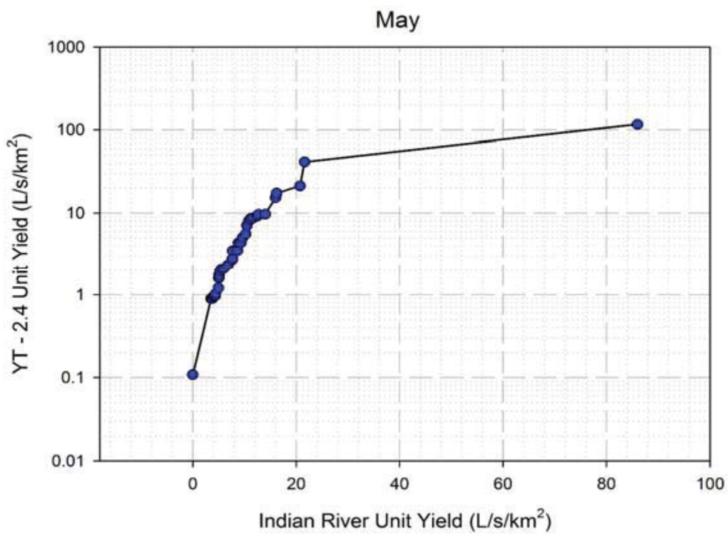
Synthetic Discharge Time-Series

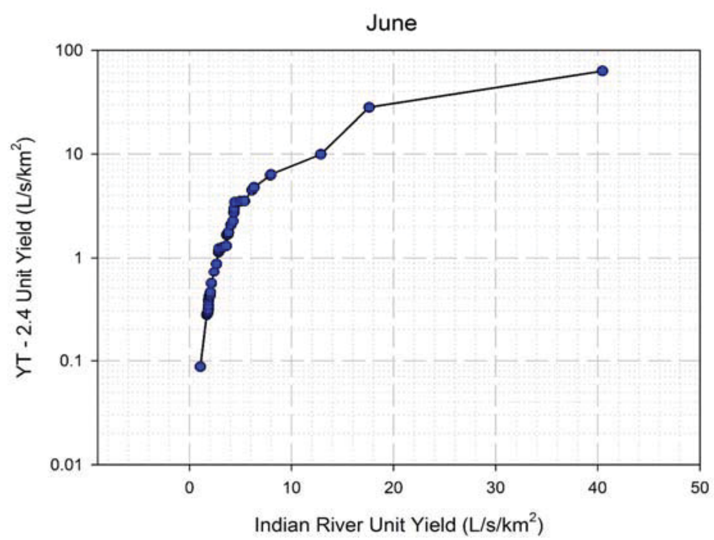


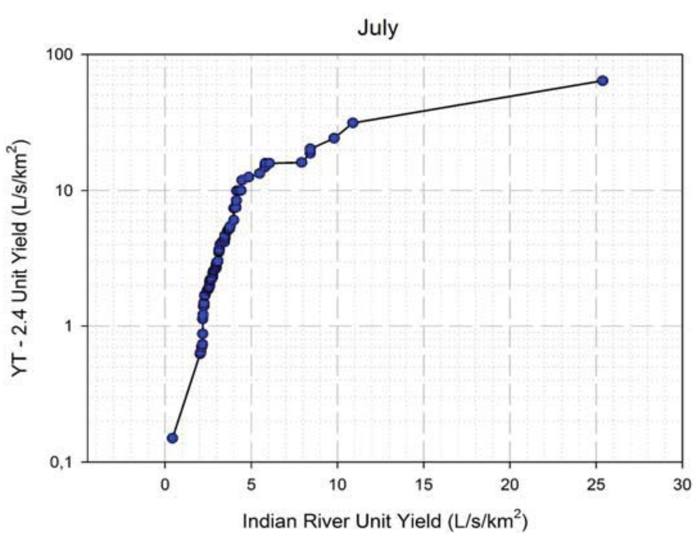
Hydrometric Station YT-24 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.



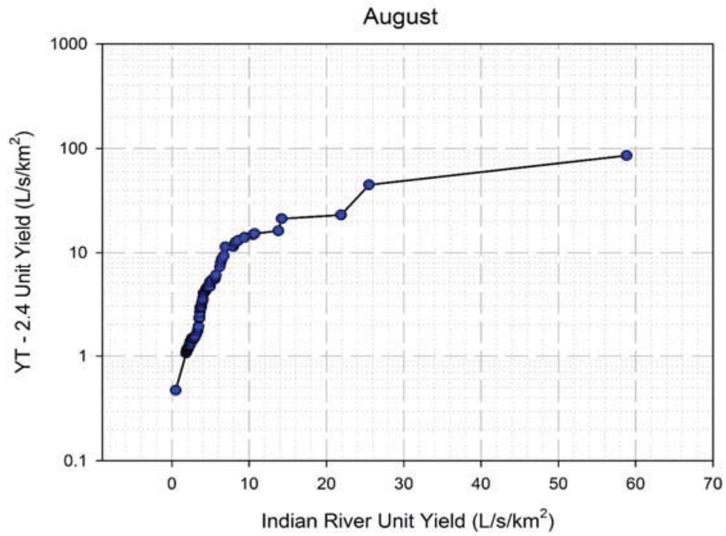


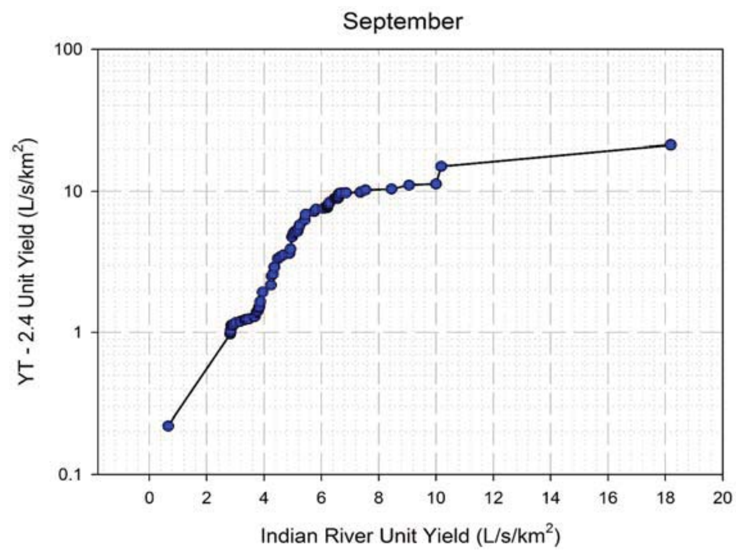


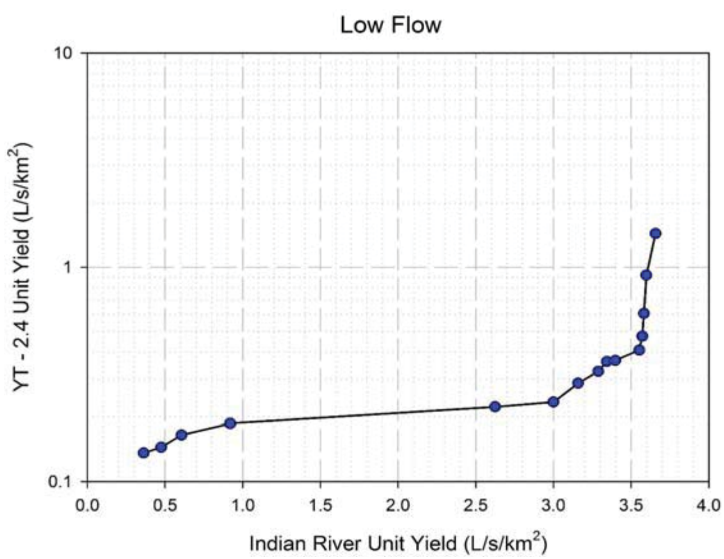
Hydrometric Station YT-24 Metadata

Piece-wise Ranked Regression Plots by Month

NOTE: Site:Regional station unit yield has been extended to match maximum measured yield at the regional station.







Hydrometric Station YT-24 Metadata

Monthly Summaries of Measured Discharge, Unit Yield and Runoff

Year		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Annual
Discharge (m^3/s)										
2014	Average	--	--	*0.03*	0.04	0.02	0.03	*0.01*	--	0.03
	Maximum	--	--	*0.07*	0.32	0.09	0.11	*0.30*	--	0.32
	Minimum	--	--	*0.01*	0.00	0.01	0.01	*0.00*	--	0.00
2015	Average	*0.0286*	0.08	0.03	0.11	0.12	0.09	0.04	--	0.07
	Maximum	*0.0657*	1.50	0.72	1.09	0.87	0.26	0.13	--	1.50
	Minimum	*0.0059*	0.00	0.00	0.02	0.02	0.02	0.01	--	0.00
Unit Yield ($L/s/km^2$)										
2014	Average	--	--	*2.3*	3.1	2.0	2.2	*1.0*	--	2.1
	Maximum	--	--	*5.9*	27.3	7.4	9.0	*25.6*	--	27.3
	Minimum	--	--	*0.8*	0.4	0.9	0.5	*0.0*	--	0.0
2015	Average	*2.4*	6.7	2.9	9.0	9.8	8.0	3.3	--	6.0
	Maximum	*5.6*	127.1	60.8	92.2	73.6	22.5	11.2	--	127.1
	Minimum	*0.5*	0.2	0.1	1.4	1.4	2.1	1.0	--	0.1
Runoff (mm)										
2014		--	--	*1*	8	5	6	*2*	--	22
2015		*0.4*	18	8	24	17	21	9	--	97

NOTE: Values in italics indicate that data for that month is not complete.

Appendix A
Site Hydrology Data

Appendix A1: Site Hydrology Data 2010 to 2015

Appendix A2: Site Hydrology Data 2016

GOLDCORP

APPENDIX A2: SITE HYDROLOGY DATA – 2016

GOLDCORP

Coffee Gold Project:

Hydro-meteorology Baseline Report – 2016 Data

Prepared by:
Lorax Environmental Services Ltd.
2289 Burrard St.
Vancouver, BC, V6J 3H9

Prepared for:

Goldcorp Inc.
Vancouver, BC

Project No. A405-3

March 3, 2017

LORAX ENVIRONMENTAL
2289 Burrard Street
Vancouver, BC, V6J 3H9
Canada
1-604-688-7173

Executive Summary

GOLDCORP

Executive Summary

This memo presents the data collected in 2016 by the climate and streamflow baseline monitoring program at the Coffee Gold Project (the Project). The baseline program was unmodified from 2015, with the exception of two additional continuous hydrometric stations that were installed in Upper Latte tributary and in the upper reach of YT-24. This brings the total number of hydrometric stations instrumented with continuous water level recorders to 13. The meteorological station operated through the winter, and the tipping bucket rainfall gauges were again installed at Camp (425 m) and at the ridgetop (1,200 m) and operated from May through September. Four snow courses were surveyed on April 1st to provide end-of-winter snow water equivalent (SWE) values, and a fifth was surveyed on May 1st.

In 2016, the average annual temperature was -0.5 °C, which is substantially higher than the long-term estimated average of -2.6 °C. The average daily (15-minute) minimum and maximum temperatures were -25.9 °C (-30.0 °C) and 19.1 °C (24.9 °C), respectively. Annual precipitation totaled 378 mm at the meteorological station elevation (975 m asl). The October 2015 to March 2016 precipitation total was 107.7 mm, which compares well with the April 1st SWE measured at the same site (98 mm). April to September precipitation totaled 267.2 mm at 975 m asl. The largest daily precipitation event occurred on October 19th, 2016 (25.7 mm) as snow, and the largest daily rainfall occurred on June 6th, 2016 (18.0 mm).

Streamflows at the Project site conformed to the general annual progression presented in the main baseline report (Lorax 2016), however the freshet occurred slightly earlier than in past years by approximately 1-2 weeks, and was of relatively lower magnitude. Overall, open water season runoff (May to October) for 2016 was generally slightly lower (89%) than that measured in 2015, and much higher than that measured in 2014 (161% on average). In 2016, unit yields across the project site averaged 9.2 L/s/km^2 for the open water season (May to October), and ranged from 5.5 to 13.3 L/s/km^2.

In Lorax (2016), the site streamflow data were extended using statistical relationships with the Indian River above the Mouth WSC gauge (09EB003) to create long-term synthetic streamflow record for the 11 Project hydrometric stations. The water balance model (WBM), which was used to estimate the potential streamflow alterations associated with the proposed Project, and formed the basis of the water quality model, was calibrated to these synthetic streamflow series. As a confirmation exercise, the 2016 baseline streamflow data were compared to the preliminary 2016 data for the predictor station (Indian River at the Mouth; 09EB003) that the synthetic data are based on.

The hydro-climatic data collected in 2016 did not indicate the occurrence of an extreme event (*e.g.*, wet- or dry-year, high-magnitude rainfall, *etc*.), and so the recurrence interval estimates of annual runoff, peak and low flows, rainfall events, annual precipitation and end-of-winter SWE that are presented in Lorax (2016) have not been updated.

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1. Introduction

1. Introduction

1.1 Background

Goldcorp Inc. (Goldcorp) is in the process of developing and permitting the Coffee Gold Project (Project), a proposed heap leach operation located in west-central Yukon, approximately 130 km south of Dawson City. The Coffee Gold Project contains several gold occurrences within an exploration concession covering an area more than 600 km^2.

The Project is located in the Yukon-Tanana Terrane (YTT), an accreted pericratonic rock sequence that covers a large portion of the Omineca Belt in the Yukon and extends into Alaska and British Columbia. The YTT underlies part of the Tintina gold belt and hosts multiple gold deposits, including the Sonora Gulch gold deposit, the Casino copper-gold-molybdenum porphyry, the Boulevard gold prospect, and the Golden Saddle gold deposit. The Project is also located within the traditional territory of the Tr´ondëk Hwëch´in and the asserted traditional territory of the White River First Nation. A portion of Goldcorp's claim block is located in Selkirk First Nation's traditional territory.

The Project has undergone a detailed Feasibility Study (Coffee Gold 43-101 FS) with project engineering and design progressing with full consideration of environmental conditions within the project area. In parallel to exploration activities and feasibility studies, Goldcorp launched a full suite of baseline programs (*e.g.*, meteorology, hydrology, surface water quality, groundwater, soils, air, fish and fish habitat, wildlife) to characterize site conditions. Ultimately, outputs from these baseline studies will be used to define environmental benchmarks that potential Project effects may be measured against.

1.2 Baseline Monitoring Program - 2016

This technical data report presents the data and outputs from the Coffee Gold baseline meteorology and surface hydrology monitoring studies for 2016, and forms a supplementary appendix to the Hydrometeorology Baseline Report (Lorax, 2016). As of February 2017, Goldcorp possesses 5+ years of climate data and six years of hydrometric data from the Project area.

In 2016, twelve monthly sampling trips were made, and focused on the core activities of the two baseline monitoring studies. Typical activities for these site visits include: climate station downloading and sensor maintenance; winter snow course sampling; hydrometric station downloading and maintenance; station benchmarking and levelling surveys; the collection of stage and discharge measurements to validate and enhance rating curves; and the collection of surface water quality samples. In addition to the eleven continuously recording hydrometric stations described in Lorax (2016), two new continuously recording water level sensors were installed in Upper Latte Creek and Upper YT-24. This brings the total number of hydrometric stations at the Project site to 13.

2. Sources of Data, Methods, Outputs

2. Sources of Data, Methods, Outputs

Section 2.1 and Section 2.2 below identify monitoring stations and ancillary data sources as they relate to the meteorology and hydrology disciplines. Field methods relevant to the two disciplines, are described in Section 2.3 of the main report.

2.1 Baseline Meteorological Study

2.1.1 Site Meteorological Data

Figure 2-1 shows the location of the Coffee Creek automated weather station and snow course stations. The weather station was installed at elevation 975 m asl and remains operational today. The weather station was installed and maintained by Access Consulting Group from July 2012 through May 2014. Lorax and Laberge Environmental Services maintained the weather station from June 2014 to the present.

Measured parameters at the Coffee Creek weather station include the following:

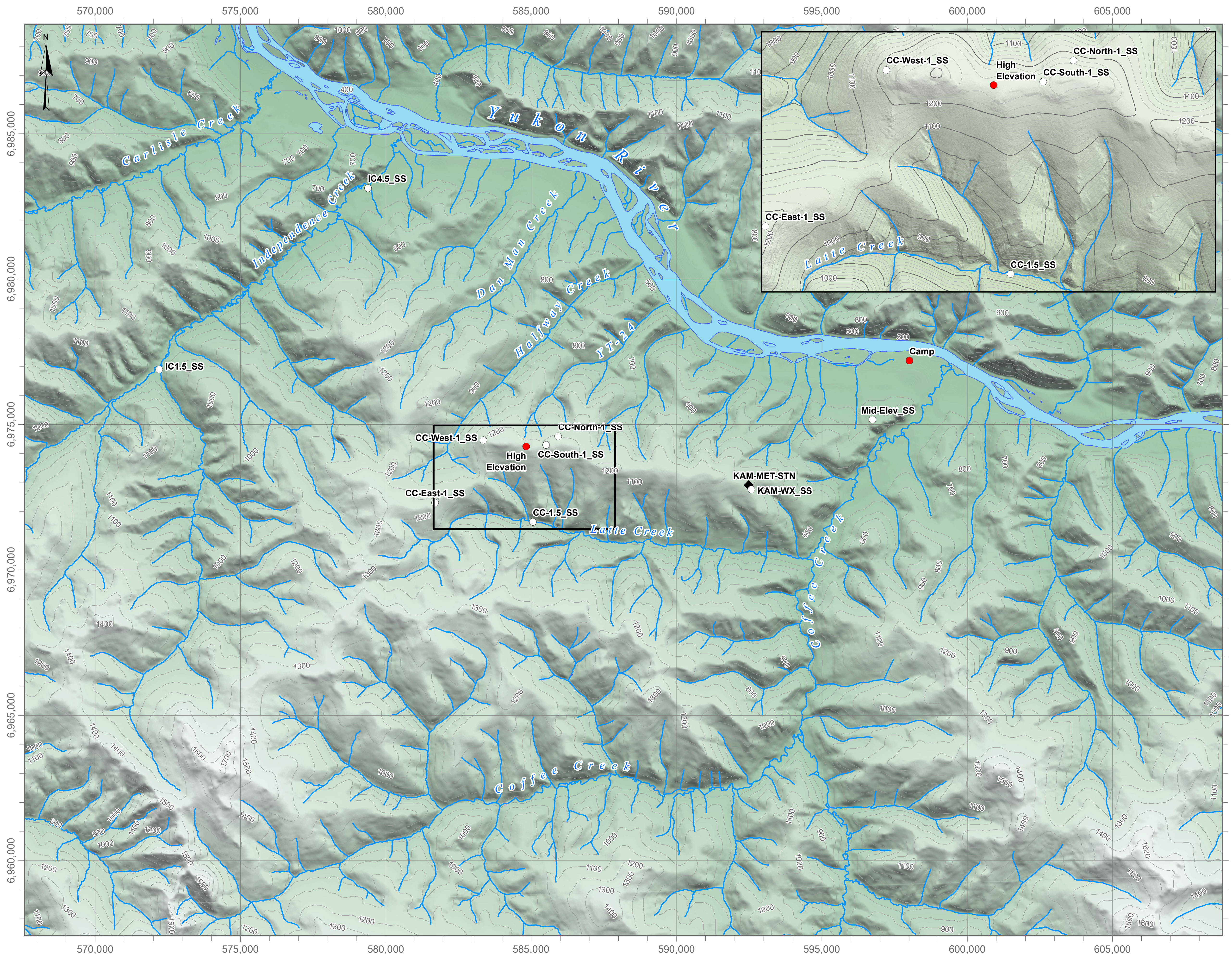
- Air temperature and relative humidity (Rotronic HC2S3);
- Wind speed and direction (10 m; RM Young Alpine anemometer);
- Incoming solar radiation (Kipp and Zonen SP Lite2 pyranometer);
- Barometric pressure (RM Young 61302V);
- Precipitation (Texas Electronics tipping bucket rain gauge with Alter wind screen and snowfall conversion adapter);

For the period of baseline data collection, weather station sensors were sampled at 10-second frequency with observations recorded to a central datalogger at hourly time step.

As in previous years, snow course measurements were carried out at the property following Territory protocols (*i.e.*, 10 sampling locations along a transect were sampled for depth and snow water equivalent [SWE] then averaged). As shown in Figure 2-1, site snow courses were established at various elevations (*i.e.*, low, mid and high elevation) and oriented to discern effects of aspect on local snow accumulation. Snow courses were surveyed at, or near, peak seasonal accumulation between 2012 and the present. Similar to nearby monitoring stations in Alaska and Yukon, peak SWE accumulation is typically realized by the end of March of each year.

Finally, two tipping bucket rain gauges were installed at camp (430 m) and ridge-top (1300 m) in 2015 to further refine the precipitation elevation gradient for the Project site, and continued to be operated in the summer of 2016.

A map of the weather station and snow survey sites is presented in Figure 2-1.



LEGEND

- 2015 Snow Survey Stations
- Tipping Bucket Rain Gauge
- Weather Station
- Watercourses
- Waterbodies
- Surface Contours (100m)

Coordinate System: *NAD 1983 UTM Zone 7N*
Projection: *Transverse Mercator*
Datum: *North American 1983*
Units: *Meter*

1:125,000

0 2 4 km

DATE SAVED:	Mar 01, 2017
DRAWN BY:	GM
REVIEWED:	SJ
VERSION:	1

CLIENT:

GOLDCORP

LORAX ENVIRONMENTAL

PROJECT:

Coffee Gold Project

TITLE:

2015 Snow Survey Stations

PROJECT #: A362-3 *FIGURE:* 2-1

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2.2 Baseline Hydrology Study

Table 2-1 summarizes station nomenclature and drainage characteristics for Coffee Creek surface water monitoring stations. Furthermore, Figure 2-2 shows the location of these monitoring station with respect to proposed Project infrastructure and mine footprints.

In autumn 2010, eleven locations were elected as surface water monitoring stations by Access Consulting Group. At eight locations, spot flow measurements were recorded monthly between autumn 2010 and autumn 2013. At three stations (HC-5.0, CC-3.5 and IC-4.5) and in autumn 2010, Access Consulting Group established stilling wells, metric staff gauges and instrumented stations with continuously recording water level recorders. The purpose of the instrumentation as described in Section 2.1.1 was to resolve high-resolution discharge records for these three stations from a rating curve and a continuous record of water level.

In spring of 2014, Lorax Environmental assumed responsibility for the Coffee Creek surface water monitoring network. At that time, eight additional monitoring stations were added to the network and many of the stations in the network were upgraded from spot flow stations to continuously recording hydrometric stations. In general, new stations were located in close proximity to the resource and downstream of proposed mine footprint areas.

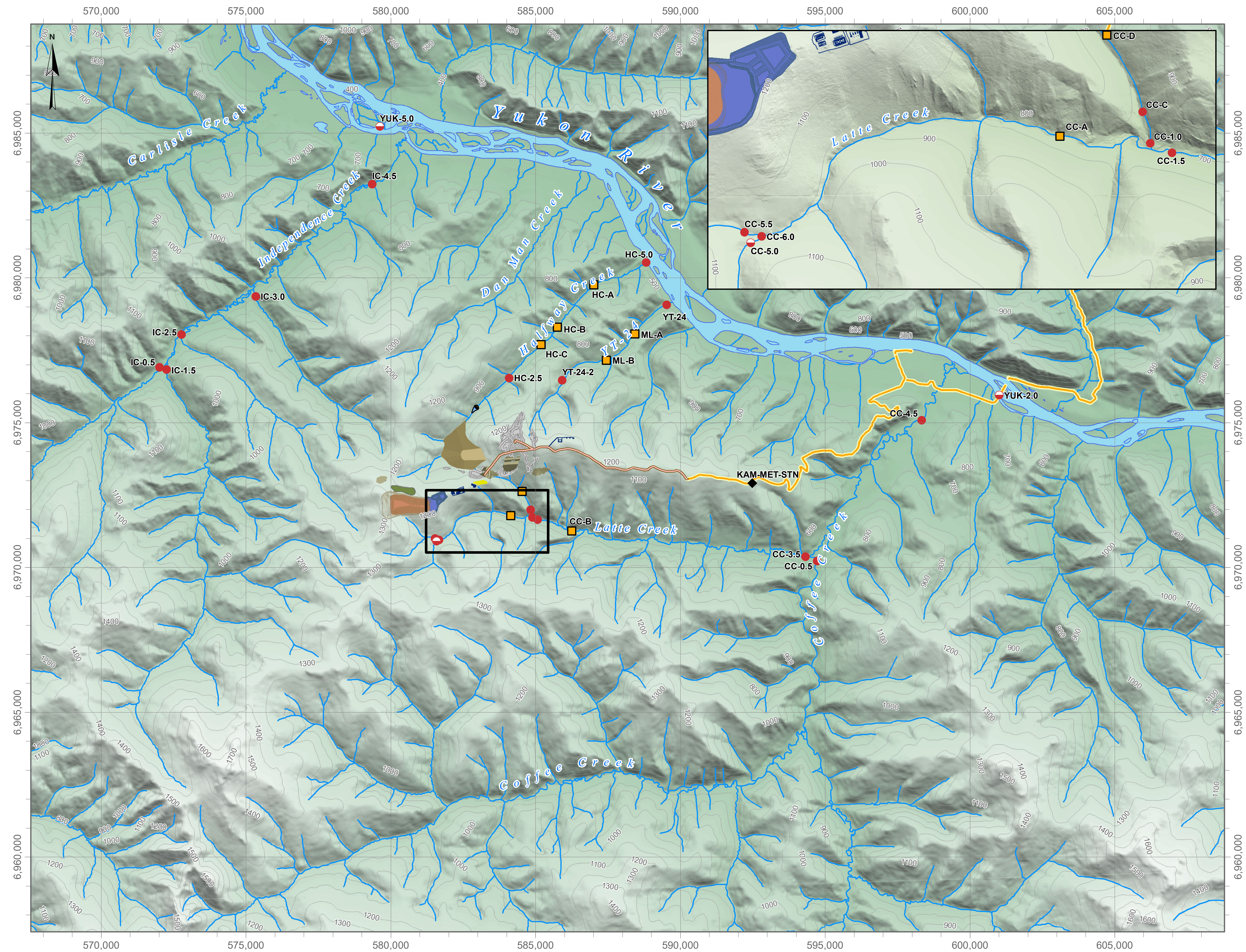
In 2015, several additional sites were added on Halfway Creek (below the HC-2.5 station), on YT-24 (above the YT-24 station), on Upper Latte Creek (above and below the CC-1.5 station), and on the Upper Latte Tributary (above the CC-1.0 station; Figure 2-2). Sampling of these sites was initiated to further refine the apparent attenuation of certain parameters along these reaches, and to determine whether these were gaining (streamflow increases from groundwater inputs) or losing (streamflow reductions due to infiltration to groundwater). Monthly water quality samples and manual flow measurements (when possible) were taken throughout 2015 and 2016.

In the summer of 2016, staff gauges, benchmarks, stilling wells and continuous water level recorders were installed at two of these stations (CC-C and YT-24-2; see Table 2-1 and Figure 2-3 and Figure 2-4 for details). Sufficient data does not yet exist for these stations with which to construct rating curves and develop preliminary estimates of discharge, but sampling will continue throughout 2017.

Table 2-1:
Coffee Gold Surface Water Monitoring Stations – Station IDs and Drainage Basin Characteristics

Station ID	Drainage Area (km^2)	Mean Elevation (m asl)	Min Elevation (m)	Max Elevation (m)
CC-0.5[a]	385.6	1,023	446	1,707
CC-C[2]	3.36	1,058	763	1,302
CC-1.0[lw]	3.4	1,017	732	1,302
CC-1.5[a]	23.1	1,120	712	1,379
CC-3.5[a]	69.8	969	447	1,379
CC-4.5[a]	484.0	993	427	1,708
CC-5.0[ls]	6.2	1,221	1,042	1,394
CC-5.5[ls]	3.4	1,236	1,056	1,394
CC-6.0[l]	9.6	1,225	1,042	1,394
HC-2.5[a]	14.8	1,043	664	1,343
HC-5.0[a]	27.0	885	428	1,344
IC-0.5[as]	68.9	1,048	522	1,529
IC-1.5[a]	81.1	1,077	522	1,708
IC-2.5[a]	17.3	1,003	493	1,344
IC-3.0[as]	18.3	905	465	1,299
IC-4.5[a]	222.3	989	427	1,708
YT-24[l]	11.8	838	428	1,305
YT-24-2[2]	4.0	1,071	757	1,305

Notes:
[a] Monitoring station established by Access Consulting Group in autumn 2010.
[l] Monitoring station established by Lorax Environmental in spring 2014.
[2] Monitoring station established by Lorax Environmental in summer 2016.
[w] Discharge measured by V-notch weir
[r] Monitoring stations located along proposed southern road route. Stations monitored between August 2014 and August 2015 only.
[s] Spot flow monitoring station only.



LEGEND

- Surface WQ Monitoring Station
- Surface and Hydrology Monitoring Station
- Weather Station
- Mine Site Access Road
- Northern Access Route
- Watercourse
- Waterbody
- Surface Contours (100m)

Proposed Infrastructure

- Backfill
- WRSF
- Open Pit
- Support Infrastructure
- ROM Stockpile
- Organics Stockpile
- Heap Leach Pad Base
- Event pond

Coordinate System: *NAD 1983 UTM Zone 7N*
Projection: *Transverse Mercator*
Datum: *North American 1983*
Units: *Meter*

1:125,000

0 2 4 km

DATE SAVED:	Mar 02, 2017
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VERSION:	1

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LORAX ENVIRONMENTAL

PROJECT:

Coffee Gold Project

TITLE:

Surface Water Monitoring Stations

PROJECT #: A362-3 *FIGURE:* 2-4

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Figure 2-3: CC-C Hydrometric station

Figure 2-4: T-24-2 Hydrometric station

2.2.1 Hydrometric Data Collection

The methods used to collect and QA/QC the hydrometric data collected in support of the Project are described in the main body of the hydro-meteorology baseline report, as are the methods used to develop rating curves. All methods as described previously were applied to the 2016 hydrometric data, with one exception, which is described below in Section 2.2.2.

2.2.2 Zero Flow Rating Curve Estimation

As described in the main report, zero flow conditions occur at some Project stations during the winter season (*e.g.*, HC-5.0), but it is notable that no zero flow condition has been observed during the open water season. It is standard hydrometric practice to extend the rating curve through the zero flow point on the plot to ensure that the rating equation accurately estimates streamflows that fall below the lowest measured discharge on record. This is particularly important in light of the fact that accurate definition of the low-flow condition plays a critical role in determining the available dilutive capacity in the receiving streams during ecologically sensitive periods (*i.e.*, summer low flows), and the use of open water season low flows as a calibration target for the numerical groundwater model developed in support of the EA application. In the absence of field measurements documenting zero flow stage a curve fitting approach was used to establish zero-flow stages for rating curve development.

As illustrated in Figure 2-5 below, a graphical technique for determining the gauge height for zero flow is outlined in RISC (2009). As shown in the figure, field measurements of stage (Y axis) and discharge (X axis) are plotted and three discharges in geographic progression are selected. Horizontal and vertical lines plotted through selected discharges create points of intersection, and diagonal lines drawn through points of intersection indicate a zero flow stage. This curve fitting approach was applied to field measurements collected per hydrometric station and zero flow stages were isolated. As a final step and subsequent to curve fitting, available stage data were appropriately adjusted to a new frame of reference and rating curve equations were computed per station using the SigmaPlot 10.0 software package.

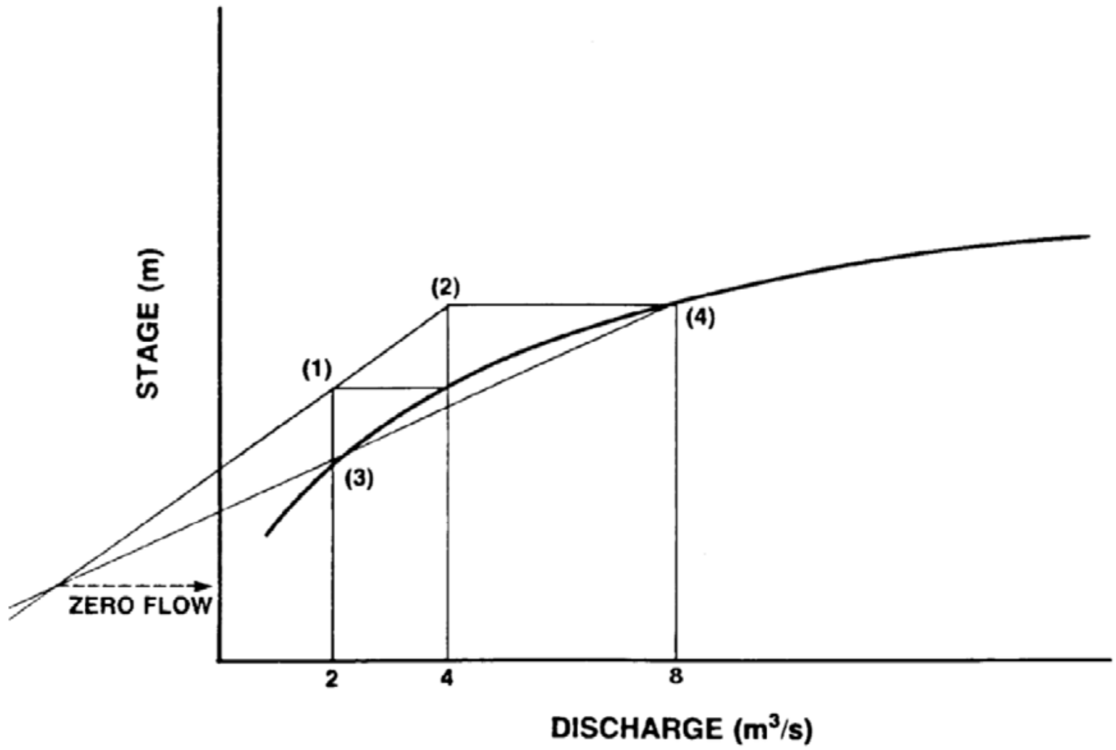

Figure 2-5: Conceptual diagram illustrating a curve-fitting approach to assign zero flow stage (from RISC, 2009).

This process was undertaken for all hydrometric stations at the Project site, with the exception of CC-1.0, which is gauged by a V-notch weir. The zero flow fitted rating curves for the site hydrometric stations are presented in Figure 2-6 through Figure 2-16 for the entire baseline monitoring period. Note that station CC-1.0 is instrumented with a V-notch weir, and therefore a rating curve has not been developed for this station.

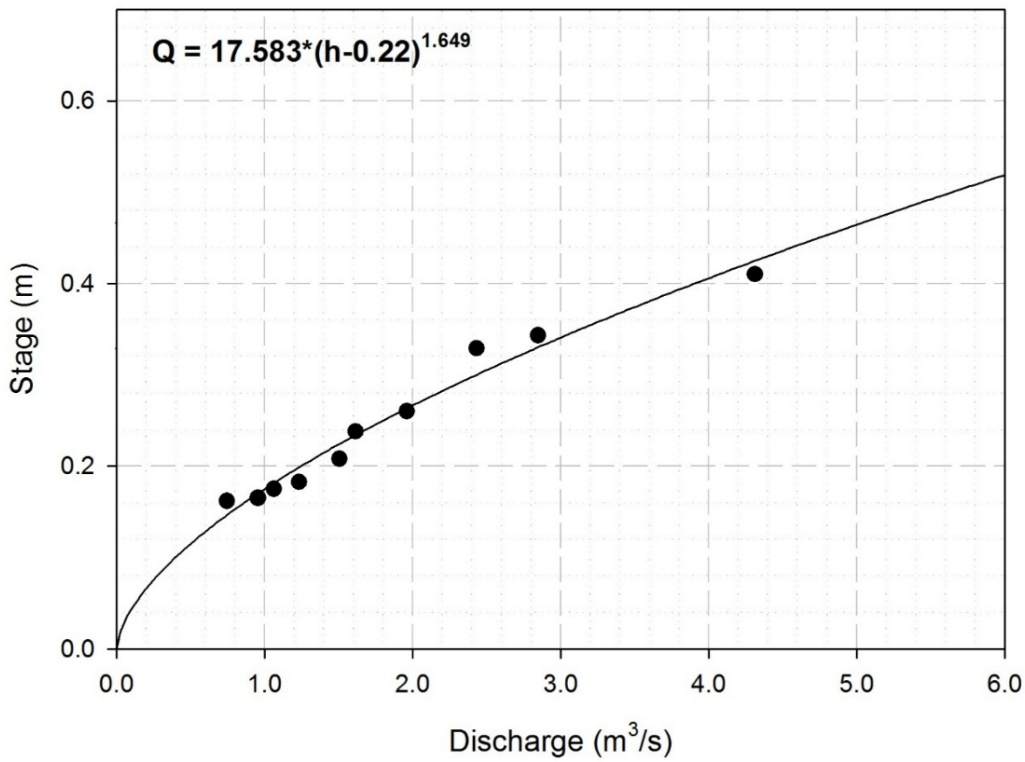

Figure 2-6: Rating curve for hydrometric station CC-0.5 (2014-2016).

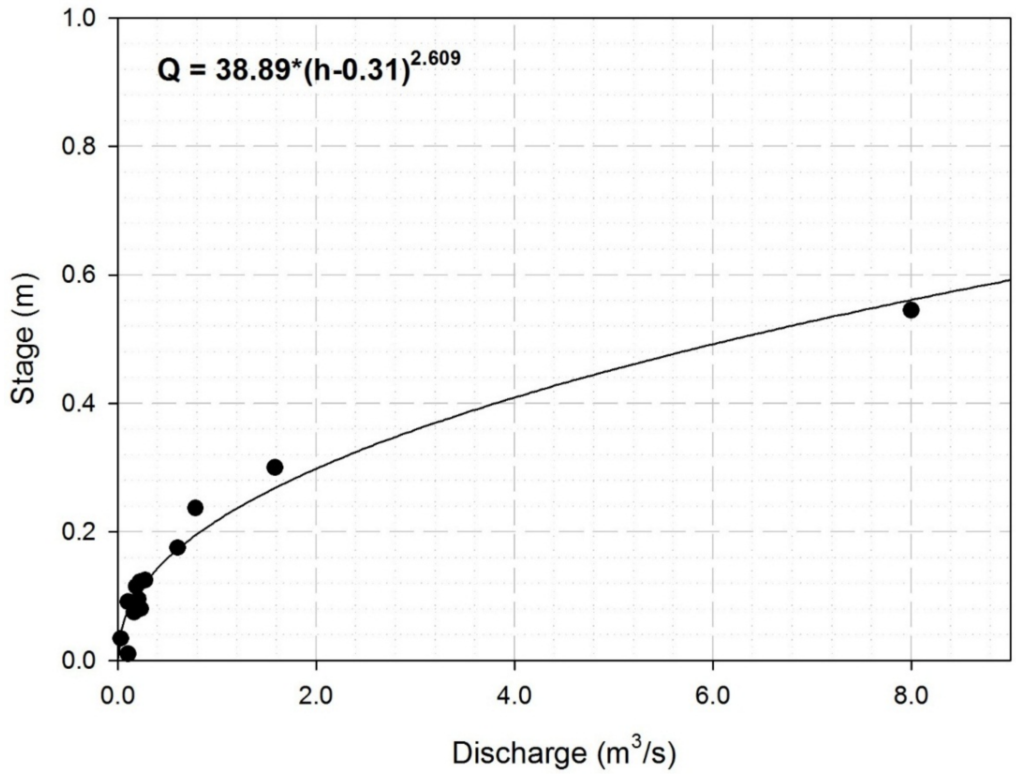

Figure 2-7: Rating curve for hydrometric station CC-1.5 (2014-2016).

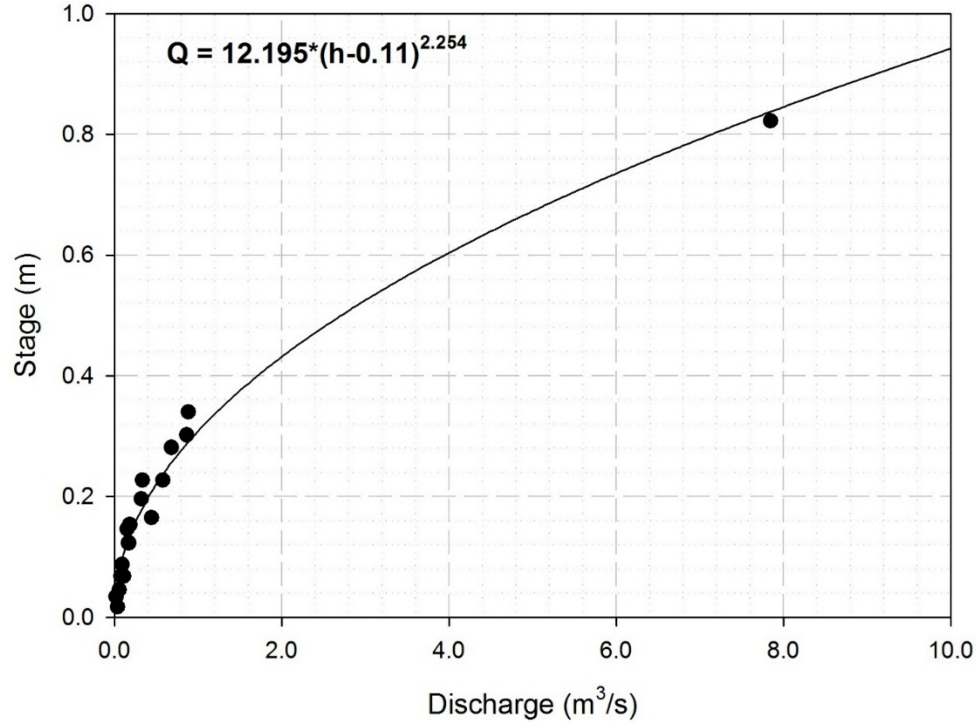

Figure 2-8: Rating curve for hydrometric station CC-3.5 (2014-2016).

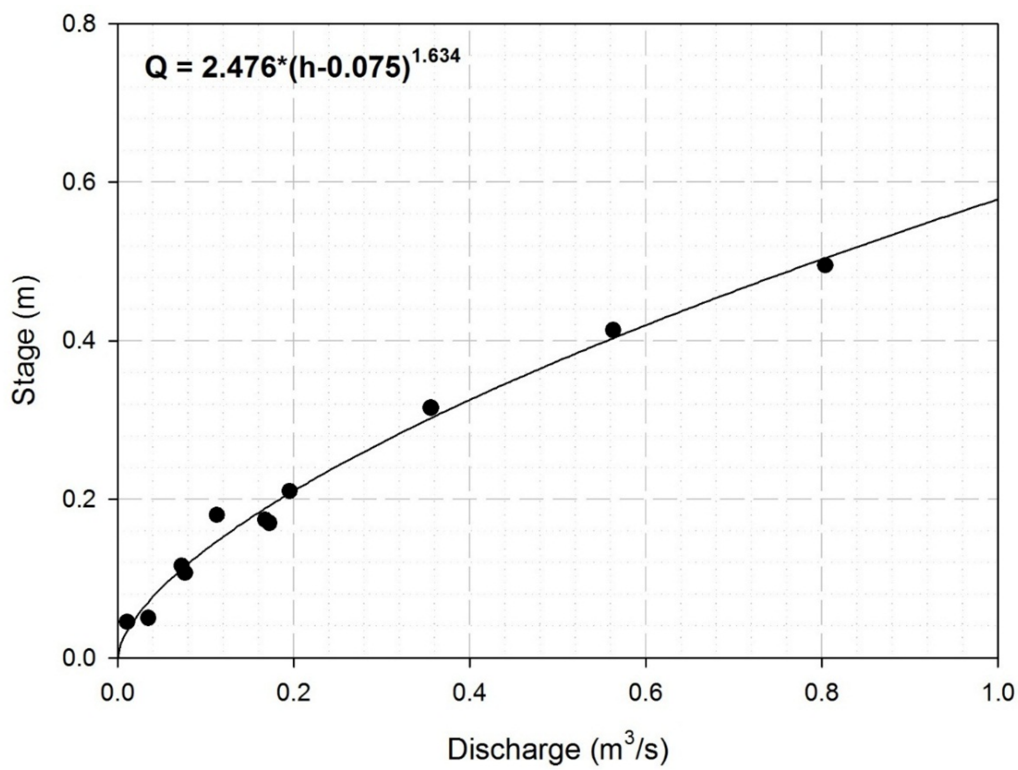

Figure 2-9: Rating curve for hydrometric station CC-6.0 (2014-2016).

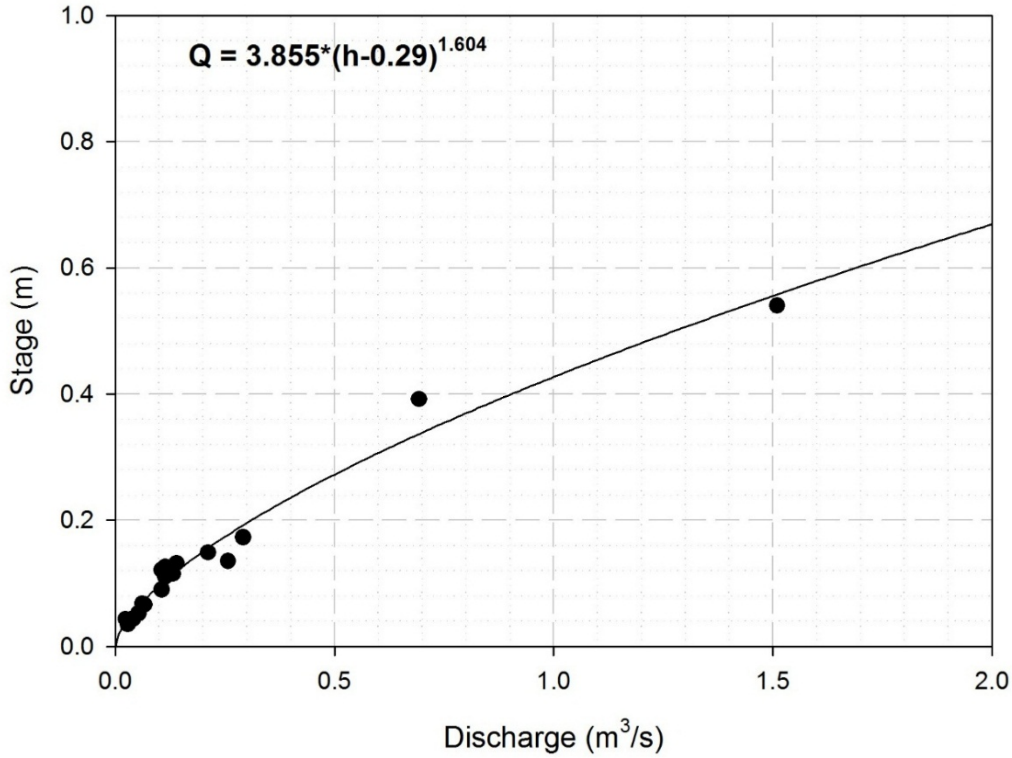

Figure 2-10: Rating curve for hydrometric station HC-2.5 (2014-2016).

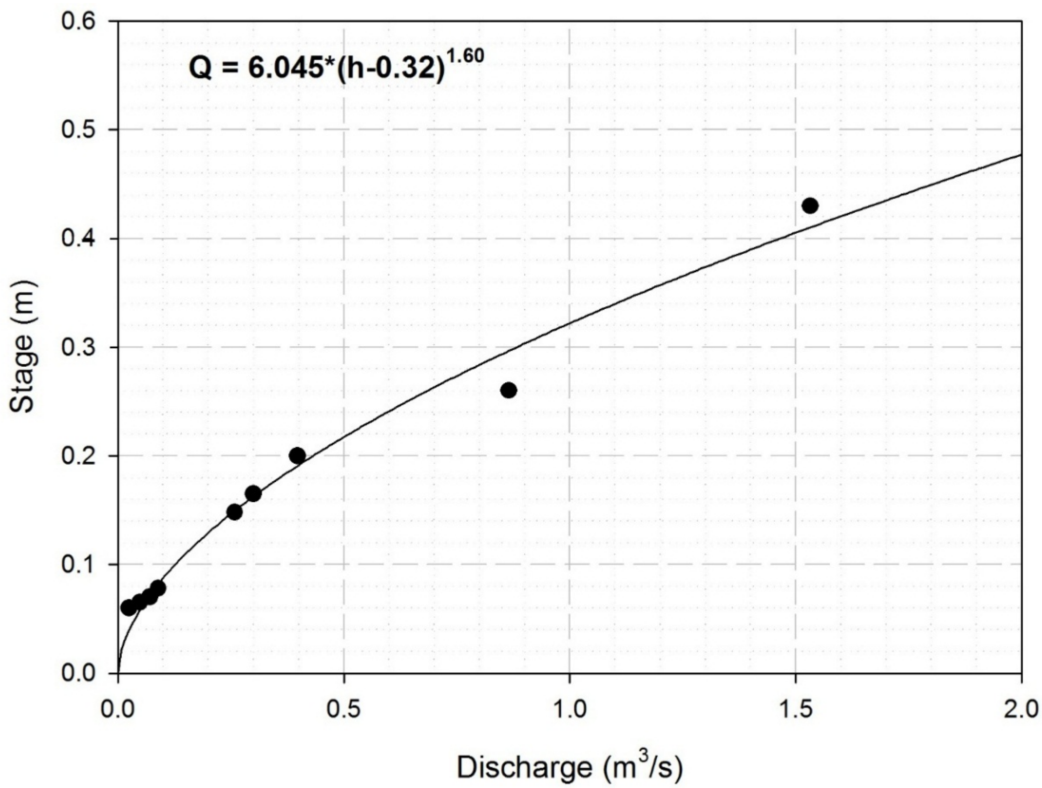

Figure 2-11: Rating curve for hydrometric station HC-5.0 (2011-2013).

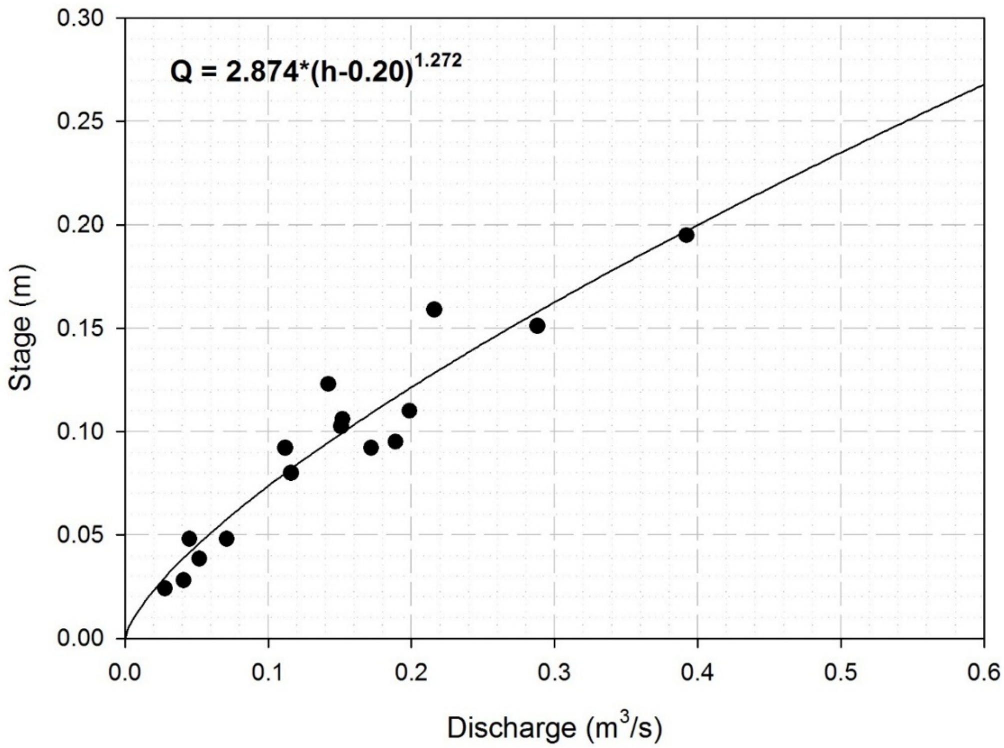

Figure 2-12: Rating curve for hydrometric station HC-5.0 (2014-2016).

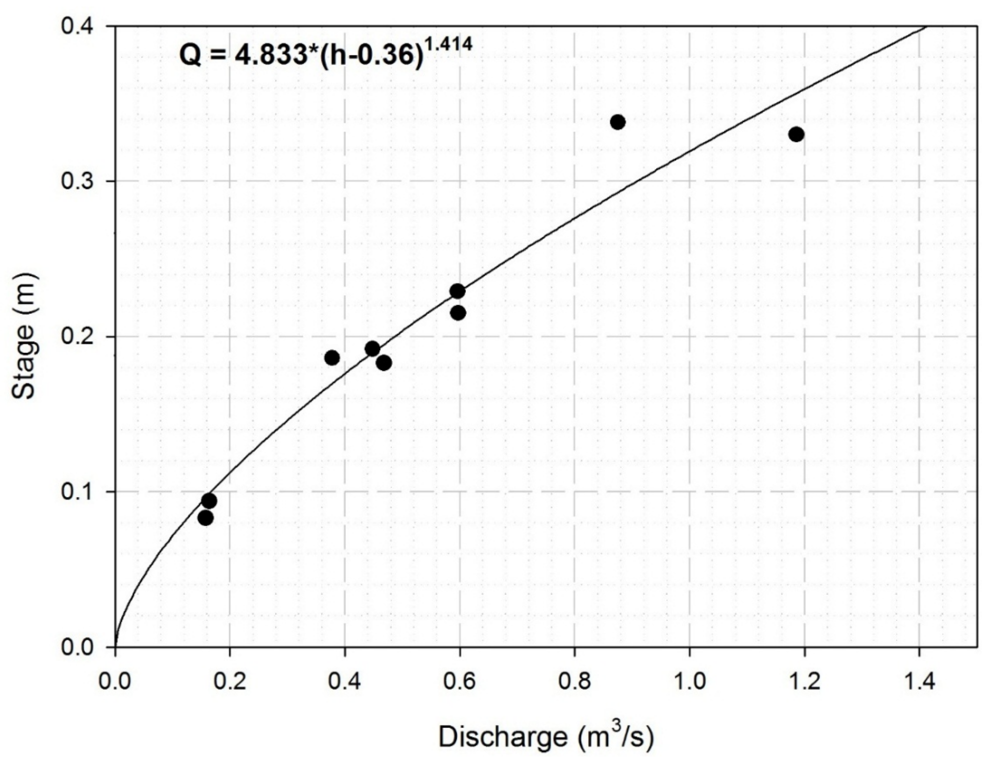

Figure 2-13: Rating curve for hydrometric station IC-1.5 (2014-2016).

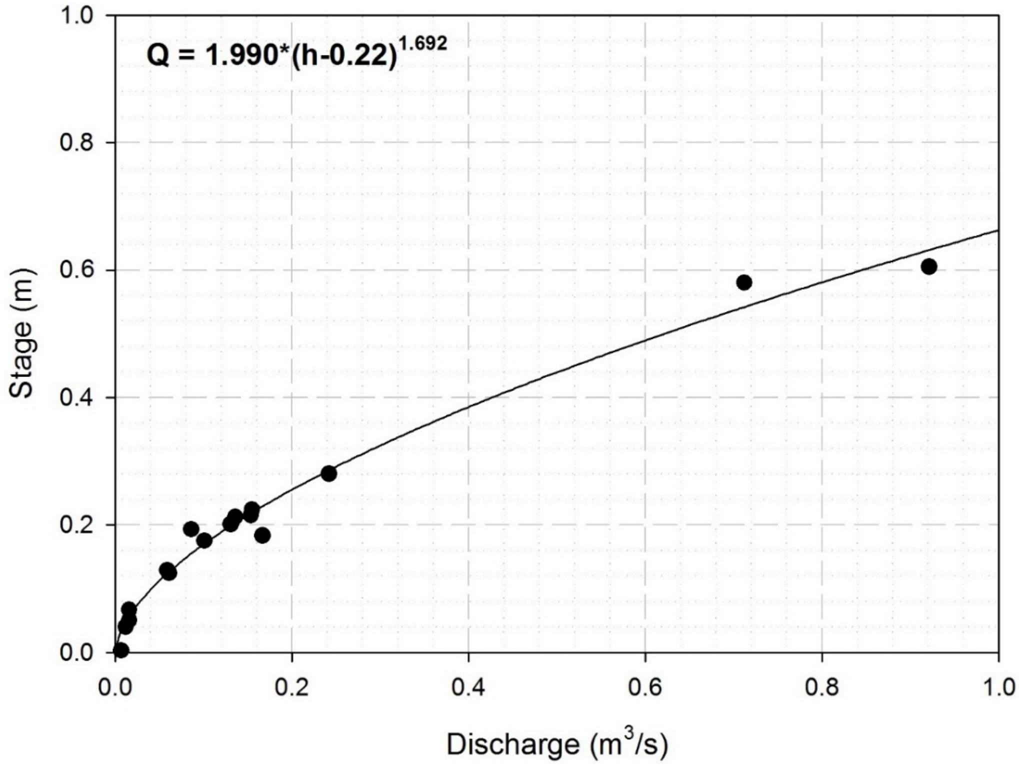

Figure 2-14: Rating curve for hydrometric station IC-2.5 (2014-2016).

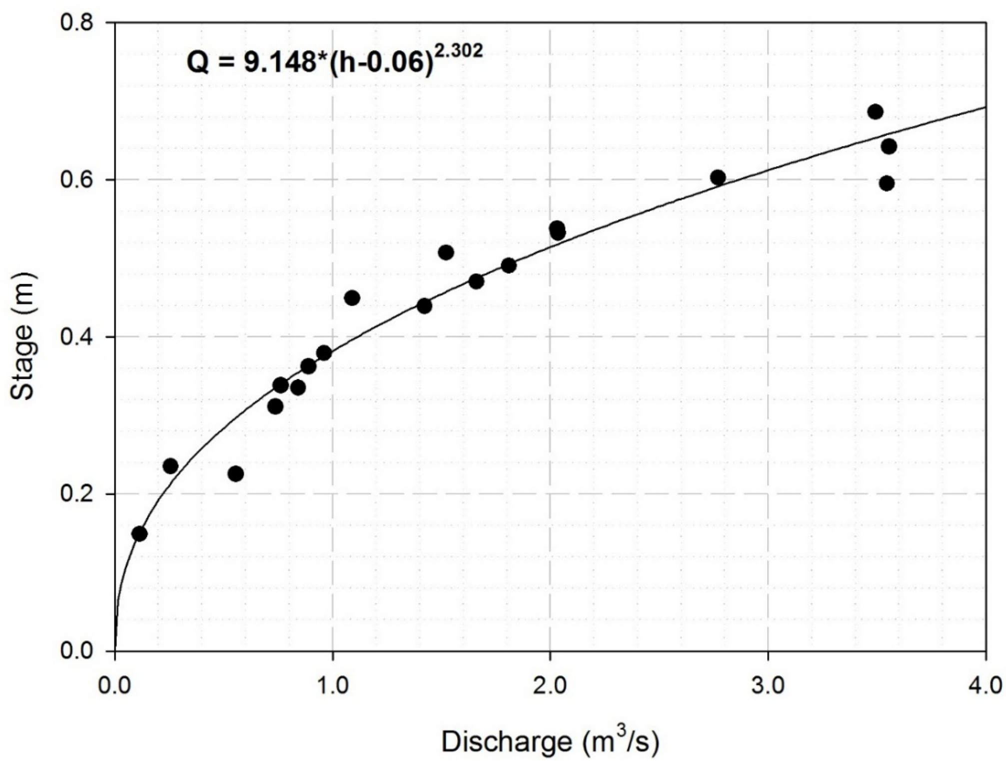

Figure 2-15: Rating curve for hydrometric station IC-4.5 (2011-2016).

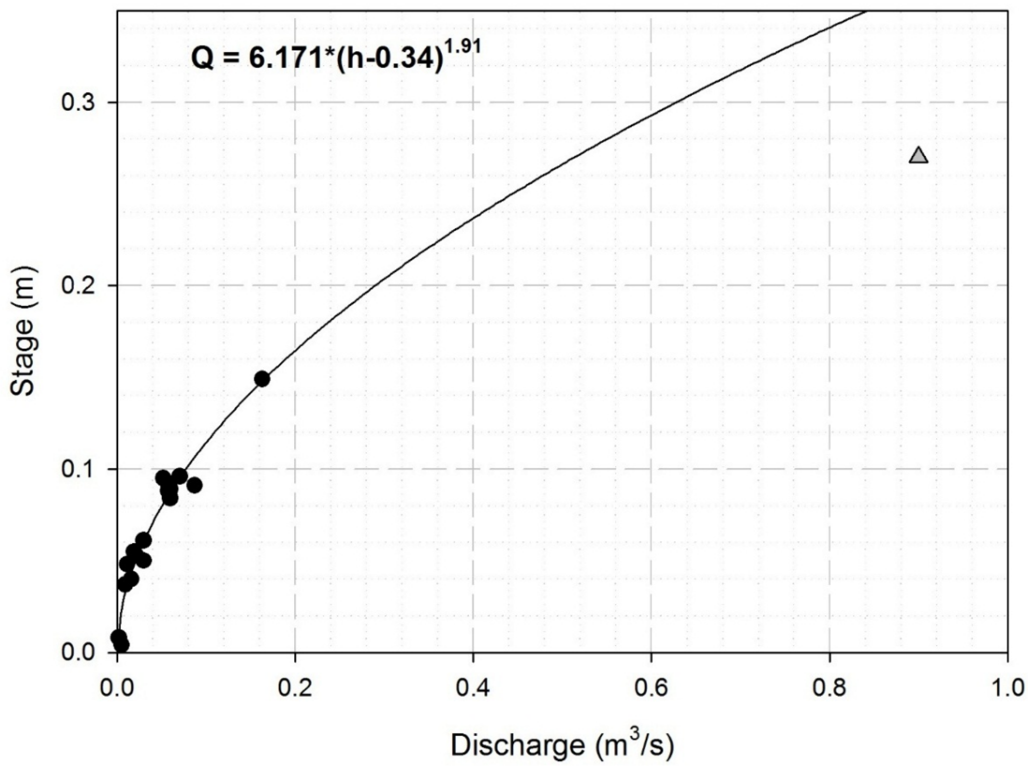

Figure 2-16: Rating curve for hydrometric station YT-24 (2014-2016). Grey triangle indicates an estimate of 0.9 m^3/s made on August 20, 2015. Rating curve does not include this point.

2.2.3 Rating Curve Error

The overall quality of the discharge records generated by applying the rating curves described in Section 2.2.2 to the measured water level record can be assessed by reviewing the average and standard errors calculated from the differences between the measured discharges, and those estimated from the rating equation. A positive rating curve error is defined where the discharge calculated from the rating curve overestimates the value when compared to the measured discharge, and vice-versa for a negative error.

A summary of the error metrics for all stations is presented in Table 2-2, with reporting for each station in Table 2-3 through Table 2-12. All stations (except CC-0.5 and IC-1.5) have the recommended minimum of 10 discrete stage-discharge measurements required to construct a robust rating curve (RISC, 2009). Overall, the rating curves provide reasonable estimates of discharge across a wide range of flows at the Project stations. The rating curve errors presented in Table 2-2 indicate that the average errors are relatively low, ranging from -11% to 5%. The standard error, or the degree of variability about the average error values varies more between stations, from a high of 42% for stations CC-3.5 and IC-2.5, to a low of 11% for station CC-0.5.

The Manual of British Columbia Hydrometric Standards (RISC, 2009) defines the standard requirements for hydrometric data quality grades. Based on the criteria presented in Table 1 of that document, the hydrometric data collected for the Coffee Gold Project meet the criteria for Grade A data when the average rating curve error is < 7%, and Grade B data when the error is > 7% and < 15%.

Table 2-2:
Rating curve error metric summary for Coffee Gold Project site hydrometric stations

Station	Measurements (n)	Average Error (%)	Standard Error (%)
CC-0.5	9	0%	11%
CC-1.5	10	-2%	21%
CC-3.5	28	-11%	42%
CC-6.0	12	-4%	25%
HC-2.5	15	4%	31%
HC-5.0	24	5%	22%
IC-1.5	8	2%	12%
IC-2.5	15	-2%	42%
IC-4.5	18	2%	14%
YT-24	14	2%	19%
Average	15.3	0%	24%

Table 2-3:
Rating curve error metric summary hydrometric station CC-0.5

Date	Stage (m)	Discharge (m^3/s)	Rating Curve Discharge (m^3/s)	Rating Curve Error (%)
05/06/2014	0.403	1.233	1.064	-14%
25/06/2014	0.382	0.745	0.874	17%
23/07/2014	0.563	2.848	3.012	6%
21/08/2014	0.480	1.960	1.907	-3%
26/09/2014	0.458	1.616	1.648	2%
23/10/2014	0.395	1.063	0.993	-7%
24/11/2014	--	0.050	--	--
25/02/2015	--	0.004	--	--
30/04/2015	0.385	0.954	0.901	-6%
24/06/2015	0.428	1.506	1.320	-12%
22/07/2015	0.492	--	--	--
19/08/2015	0.692	--	--	--
28/10/2015	0.399	--	--	--
22/06/2016	--	1.634	--	--
25/08/2016	0.551	2.432	2.840	17%
Average Error (%)				0%
Standard Error (%)				11%

Notes:
1. Stage-discharge measurements that were affected by channel icing are indicated by 'NA' and are not included in rating curve development or error calculation.

Table 2-4:
Rating curve error metric summary hydrometric station CC-1.5

Date	Stage (m)	Discharge (m^3/s)	Rating Curve Discharge (m^3/s)	Rating Curve Error (%)
26/06/2014	0.650	1.584	1.831	16%
24/07/2014	0.465	0.185	0.171	-7%
21/08/2014	0.441	0.103	0.098	-5%
25/09/2014	0.472	0.225	0.197	-12%
23/10/2014	0.384	0.031	NA	NA
24/11/2014	--	0.013	--	--
17/05/2015	0.525	0.604	0.476	-21%
25/06/2015	0.587	0.783	1.012	29%
23/07/2015	0.447	--	--	--
19/08/2015	0.545	--	--	--
12/09/2015	0.445	0.211	0.209	-1%
27/11/2015	0.31	0.018	NA	NA
02/04/2016	--	0.013	--	--
26/04/2016	--	0.285	--	--
26/05/2016	--	0.276	--	--
22/06/2016	0.385	--	--	--
20/07/2016	0.475	0.277	0.353	28%
25/08/2016	0.43	0.232	0.154	-34%
15/09/2016	0.425	0.163	0.138	-15%
20/10/2016	0.324	--	--	--
08/11/2016	--	0.021	--	--
10/12/2016	--	0.015	--	--
Average Error (%)				-2%
Standard Error (%)				21%

Notes:

1. Stage-discharge measurements that were affected by channel icing are indicated by ‘NA’ and are not included in rating curve development or error calculation.

Table 2-5:
Rating curve error metric summary hydrometric station CC-3.5

Date	Stage (m)	Discharge (m^3/s)	Rating Curve Discharge (m^3/s)	Rating Curve Error (%)
11/10/2010	--	0.095	--	--
12/10/2010	0.321	--	--	--
11/11/2010	--	0.021	--	--
15/12/2010	--	0.014	--	--
19/04/2011	0.282	--	--	--
19/05/2011	0.755	--	--	--
22/06/2011	0.840	5.339	5.194	-3%
20/07/2011	0.582	1.206	0.887	-26%
26/08/2011	0.584	0.965	0.902	-7%
22/09/2011	0.412	0.286	0.168	-41%
20/10/2011	0.332	--	--	--
28/11/2011	0.330	0.008	NA	NA
20/12/2011	0.310	--	--	--
29/02/2012	--	0.000	--	--
26/03/2012	--	0.000	--	--
19/04/2012	0.560	0.069	NA	NA
07/05/2012	0.475	0.410	0.333	-19%
07/05/2012	0.478	--	--	--
22/06/2012	0.530	0.809	0.565	-30%
18/07/2012	0.592	1.257	0.963	-23%
23/08/2012	0.380	0.109	0.114	4%
21/09/2012	0.556	0.800	0.712	-11%
16/10/2012	0.344	0.203	NA	NA
20/11/2012	--	0.036	--	--
10/04/2013	--	0.000	--	--
29/05/2013	0.736	2.352	2.748	17%
13/06/2013	0.533	0.534	0.578	8%
01/08/2013	0.593	0.491	0.967	97%
21/08/2013	0.427	0.134	0.198	48%
26/09/2013	0.337	0.337	0.431	28%
28/10/2013	0.197	0.094	NA	NA
25/11/2013	--	0.017	--	--
08/01/2014	--	0.010	--	--
10/03/2014	--	0.001	--	--
22/05/2014	0.450	0.884	1.072	21%
05/06/2014	0.178	0.090	0.028	-68%
25/06/2014	0.178	0.078	0.028	-63%
23/07/2014	0.306	0.322	0.310	-4%
21/08/2014	0.233	0.171	0.108	-37%
26/09/2014	0.243	--	--	--
23/10/2014	0.155	0.058	NA	NA
24/11/2014	0.144	0.023	0.006	-74%
30/04/2015	0.276	0.13	0.213	64%
17/05/2015	0.391	0.681	0.698	2%
24/06/2015	0.127	0.04	0.001	-97%
19/08/2015	0.353	--	--	--
12/09/2015	0.275	0.447	0.210	-53%
28/10/2015	0.178	0.113	NA	NA
25/04/2016	0.412	0.865	0.821	-5%
25/05/2016	0.337	0.583	0.431	-26%
20/07/2016	0.313	--	--	--
25/08/2016	0.263	0.186	0.177	-5%
14/09/2016	0.256	0.156	0.159	2%
20/10/2016	0.146	--	--	--
Average Error (%)				-11%
Standard Error (%)				42%

Notes:

1. Stage-discharge measurements that were affected by channel icing are indicated by 'NA' and are not included in rating curve development or error calculation.
2. Station was relocated on September 26, 2013, therefore new rating curve developed for 2014-2016.

Table 2-6:
Rating curve error metric summary hydrometric station CC-6.0

Date	Stage (m)	Discharge (m^3/s)	Rating Curve Discharge (m^3/s)	Rating Curve Error (%)
26/06/2014	0.570	0.804	0.785	-2%
24/07/2014	--	0.104	--	--
21/08/2014	0.174	0.087	0.057	-35%
25/09/2014	0.255	0.113	0.150	33%
24/10/2014	--	0.005	--	--
18/05/2015	0.285	0.196	0.193	-1%
25/06/2015	0.488	0.563	0.584	4%
23/07/2015	0.217	--	--	--
22/08/2015	0.390	0.356	0.375	5%
13/09/2015	0.192	--	--	--
28/10/2015	0.120	0.011	0.016	42%
26/04/2016	--	0.270	--	--
26/05/2016	0.249	0.168	0.142	-15%
22/06/2016	0.125	0.035	0.019	-47%
21/07/2016	0.245	0.173	0.137	-21%
25/08/2016	0.182	0.077	0.064	-16%
15/09/2016	0.191	0.073	0.073	0%
Average Error (%)				-4%
Standard Error (%)				25%

Notes:
1. Stage-discharge measurements that were affected by channel icing are indicated by 'NA' and are not included in rating curve development or error calculation.

Table 2-7:
Rating curve error metric summary hydrometric station HC-2.5

Date	Stage (m)	Discharge (m^3/s)	Rating Curve Discharge (m^3/s)	Rating Curve Error (%)
07/06/2014	0.325	0.029	0.048	66%
27/06/2014	0.425	0.257	0.214	-17%
23/07/2014	0.380	0.106	0.129	21%
21/08/2014	0.342	0.053	0.070	32%
26/09/2014	0.358	0.062	0.093	50%
24/10/2014	0.334	0.041	NA	NA
25/11/2014	--	0.014	--	--
19/05/2015	0.374	0.106	0.118	12%
26/06/2015	0.296	0.024	0.019	-22%
23/07/2015	0.328	--	--	--
20/08/2015	0.645	0.693	0.732	6%
13/09/2015	0.368	0.132	0.064	-51%
30/10/2015	--	0.051	--	--
28/11/2015	--	0.03	--	--
03/04/2016	--	0.015	--	--
26/04/2016	0.463	0.292	0.231	-21%
27/04/2016	0.444	--	--	--
26/05/2016	0.422	0.14	0.150	7%
24/06/2016	0.356	0.067	0.049	-26%
21/07/2016	0.400	0.114	0.112	-2%
26/08/2016	0.439	0.212	0.182	-14%
16/09/2016	0.416	0.114	0.139	22%
08/11/2016	--	0.019	--	--
11/12/2016	--	0.019	--	--
Average Error (%)				4%
Standard Error (%)				31%

Notes:
1. Stage-discharge measurements that were affected by channel icing are indicated by 'NA' and are not included in rating curve development or error calculation.

Table 2-8:
Rating curve error metric summary hydrometric station HC-5.0

Date	Stage (m)	Discharge (m^3/s)	Rating Curve Discharge (m^3/s)	Rating Curve Error (%)
12/10/2010	0.366	0.076	NA	NA
10/11/2010	--	0.008	--	--
19/05/2011	0.750	--	--	--
22/06/2011	0.750	1.532	1.567	2%
20/07/2011	0.520	0.397	0.460	16%
26/08/2011	0.468	0.258	0.284	10%
21/09/2011	0.390	0.071	0.086	21%
20/10/2011	0.380	0.025	NA	NA
28/11/2011	--	0.000	--	--
29/02/2012	--	0.000	--	--
26/03/2012	--	0.000	--	--
10/04/2013	--	0.000	--	--
16/05/2012	0.485	0.300	0.338	13%
23/08/2012	0.350	0.049	NA	NA
19/09/2012	0.475	--	0.306	--
19/09/2012	--	0.254	--	--
17/10/2012	0.398	0.089	0.102	14%
20/11/2012	--	0.015	--	--
24/01/2013	--	0.000	--	--
10/04/2013	--	0.000	--	--
30/05/2013	0.580	0.866	0.700	-19%
31/07/2013	0.429	0.023	NA	NA
21/08/2013	0.385	0.048	0.076	58%
26/09/2013[1]	0.323	0.142	0.200	41%
29/10/2013	--	0.054	--	--
26/11/2013	--	0.000	--	--
22/05/2014	0.395	0.392	0.359	-8%
27/06/2014	0.351	0.288	0.260	-10%
23/07/2014	0.292	0.112	0.138	23%
21/08/2014	0.248	0.045	0.060	34%
25/09/2014	0.282	--	--	--
24/10/2014	0.228	0.041	0.030	-26%
29/04/2015	--	0.046	--	--
19/05/2015	0.303	0.151	0.159	5%
26/06/2015	0.224	0.028	0.025	-11%
23/07/2015	0.266	--	--	--
20/08/2015	0.590	--	--	--
13/09/2015	0.295	0.189	0.144	-24%
30/10/2015	0.248	0.071	0.060	-15%
03/04/2016	--	0.017	--	--
26/04/2016	0.359	0.216	0.277	28%
26/05/2016	0.306	0.152	0.165	9%
24/06/2016	0.239	0.052	0.046	-12%
21/07/2016	0.280	0.116	0.116	0%
26/08/2016	0.310	0.199	0.173	-13%
16/09/2016	0.292	0.172	0.138	-20%
Average Error (%)				5%
Standard Error (%)				22%

Notes:

1. Stage-discharge measurements that were affected by channel icing are indicated by 'NA' and are not included in rating curve development or error calculation.
2. Station was relocated on September 26, 2013, therefore new rating curve developed for 2014-2016.

Table 2-9: Rating curve error metric summary hydrometric station IC-1.5

Date	Stage (m)	Discharge (m^3/s)	Rating Curve Discharge (m^3/s)	Rating Curve Error (%)
06/06/2014	0.543	0.468	0.438	-6%
27/06/2014	0.791	--	--	--
24/07/2014	0.589	0.596	0.601	1%
20/08/2014	0.552	0.448	0.469	5%
25/09/2014	0.546	0.378	0.448	19%
23/10/2014	0.454	0.164	0.171	4%
30/04/2015	--	--	--	--
18/05/2015	0.690	1.186	1.008	-15%
25/06/2015	0.443	0.158	0.143	-9%
23/07/2015	0.575	--	--	--
20/08/2015	1.050	--	--	--
14/09/2015	0.603	--	--	--
25/04/2016	0.698	0.875	1.043	19%
27/05/2016	0.625	--	--	--
24/06/2016	0.519	--	--	--
22/07/2016	0.660	--	--	--
Average Error (%)				2%
Standard Error (%)				12%

Notes:

1. Stage-discharge measurements that were affected by channel icing are indicated by 'NA' and are not included in rating curve development or error calculation.

Table 2-10: Rating curve error metric summary hydrometric station IC-2.5

Date	Stage (m)	Discharge (m^3/s)	Rating Curve Discharge (m^3/s)	Rating Curve Error (%)
07/06/2014	0.270	0.016	0.017	7%
27/06/2014	0.610	0.242	0.422	74%
24/07/2014	0.421	0.131	0.143	9%
20/08/2014	0.344	0.061	0.066	9%
25/09/2014	0.413	0.086	0.134	56%
22/10/2014	0.287	0.016	0.026	62%
18/05/2015	--	0.095	--	--
25/06/2015	0.223	0.007	0.001	-82%
22/07/2015	0.370	--	--	--
20/08/2015	0.800	0.712	0.815	14%
14/09/2015	0.403	0.167	0.123	-26%
30/10/2015	0.260	0.012	0.013	4%
27/05/2016	0.384	0.136	0.103	-24%
24/06/2016	0.301	0.059	0.034	-42%
22/07/2016	0.387	0.154	0.106	-31%
26/08/2016	0.396	0.155	0.116	-25%
15/09/2016	0.347	0.101	0.069	-32%
Average Error (%)				-2%
Standard Error (%)				42%

Notes:

1. Stage-discharge measurements that were affected by channel icing are indicated by 'NA' and are not included in rating curve development or error calculation.

Table 2-11:
Rating curve error metric summary hydrometric station IC-4.5

Date	Stage (m)	Discharge (m^3/s)	Rating Curve Discharge (m^3/s)	Rating Curve Error (%)
09/11/2010	--	0.132	--	--
14/12/2010	--	0.076	--	--
20/04/2011	0.058	--	--	--
20/07/2011	0.598	2.032	2.196	8%
26/08/2011	0.702	3.555	3.298	-7%
21/09/2011	0.422	0.890	0.882	-1%
19/10/2011	0.295	0.258	0.326	27%
29/11/2011	--	0.002	--	--
20/04/2012	--	0.775	--	--
16/05/2012	0.655	3.546	2.769	-22%
23/06/2012	0.530	1.662	1.609	-3%
18/07/2012	--	1.802	--	--
23/08/2012	0.371	0.739	0.622	-16%
19/09/2012	0.746	3.492	3.835	10%
17/10/2012	0.395	0.842	0.735	-13%
12/06/2013	0.499	1.423	1.375	-3%
31/07/2013	--	0.522	--	--
21/08/2013	0.439	0.961	0.980	2%
26/09/2013	0.567	1.521	1.915	26%
28/10/2013	--	0.268	--	--
26/11/2013	--	0.011	--	--
21/05/2014	0.663	2.770	2.850	3%
20/08/2014	0.398	0.763	0.753	-1%
25/09/2014	0.509	1.091	1.448	33%
22/10/2014	0.285	0.556	NA	NA
25/11/2014	--	0.033	--	--
29/04/2015	--	0.302	--	--
19/05/2015	0.551	1.810	1.775	-2%
26/06/2015	0.209	0.115	0.114	-1%
27/05/2016	0.592	2.035	2.140	5%
24/06/2016	0.401	--	--	--
15/09/2016	0.510	--	--	--
19/10/2016	--	0.236	--	--
Average Error (%)				2%
Standard Error (%)				14%

Notes:

1. Stage-discharge measurements that were affected by channel icing are indicated by 'NA' and are not included in rating curve development or error calculation.

Table 2-12:
Rating curve error metric summary hydrometric station YT-24

Date	Stage (m)	Discharge (m^3/s)	Rating Curve Discharge (m^3/s)	Rating Curve Error (%)
06/07/2014	--	0.003	--	--
27/06/2014	0.431	0.087	0.063	-27%
23/07/2014	0.390	0.030	0.020	-33%
22/08/2014	0.380	0.016	0.013	-18%
26/09/2014	0.395	0.019	0.024	28%
24/10/2014	0.348	0.002	NA	NA
29/04/2015	0.344	0.005	NA	NA
19/05/2015	0.401	0.030	0.030	-2%
26/06/2015	0.377	0.009	0.011	26%
23/07/2015	0.410	--	--	--
11/09/2015	0.436	0.071	0.070	0%
13/09/2015	0.429	0.060	0.061	1%
30/10/2015	0.388	0.011	NA	NA
16/04/2016	0.489	0.163	0.163	0%
26/05/2016	0.432	0.058	0.065	13%
24/06/2016	0.393	0.021	0.023	8%
21/07/2016	0.424	0.060	0.054	-9%
25/08/2016	0.428	0.058	0.059	3%
16/09/2016	0.435	0.052	0.069	32%
Average Error (%)				2%
Standard Error (%)				19%

Notes:

1. Stage-discharge measurements that were affected by channel icing are indicated by 'NA' and are not included in rating curve development or error calculation.

Appendix A
Site Hydrology Data

Appendix A1: Site Hydrology Data 2010 to 2015

Appendix A2: Site Hydrology Data 2016

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APPENDIX A2: SITE HYDROLOGY DATA – 2016

Coffee Gold Project:

Hydro-meteorology Baseline Report – 2016 Data

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3. 2016 Baseline Program Results

GOLDCORP

3. 2016 Baseline Program Results

3.1 Meteorology

3.1.1 Air temperatures

Air temperatures measured at the Project site are reported in Figure 3-1 and Table 3-1. In 2016, the average annual temperature was -0.5 °C, which is substantially higher than the long-term estimated average of -2.6 °C. The average (15-minute) daily minimum and maximum temperatures were -25.9 °C (-30.0 °C) and 19.1 °C (24.9 °C), respectively.

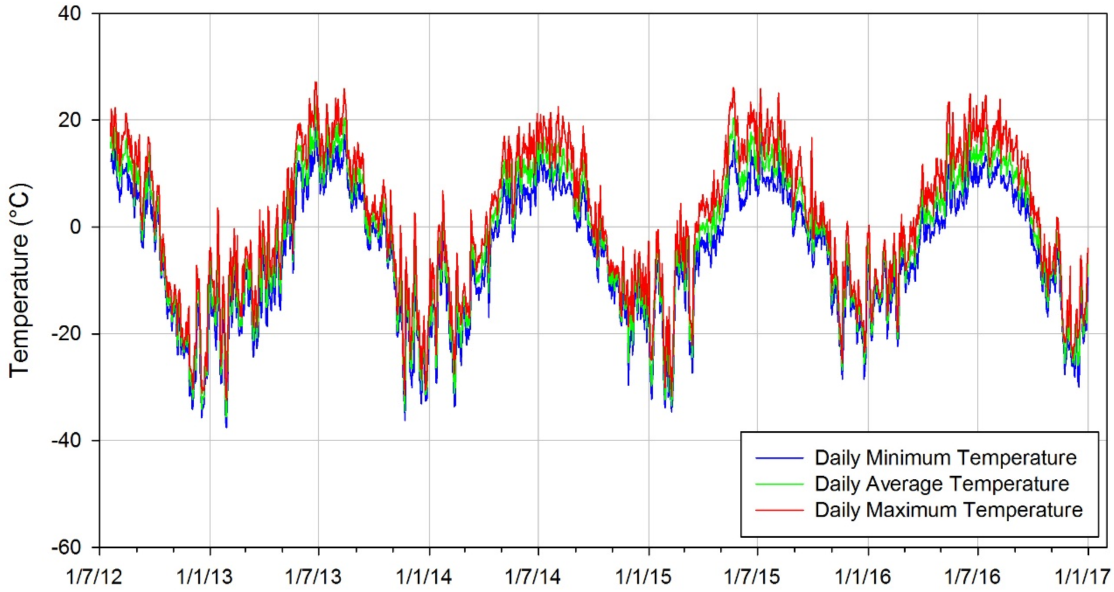

Figure 3-1: Daily minimum, average and maximum temperature record from the Coffee Creek climate station.

Table 3-1:
Coffee Gold Climate Station - Air Temperature Measurements by Month

Year	Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2012	Average	--	--	--	--	--	--	*14.9*	11.5	6.3	-7.1	-19.7	-24.0	-3.0
	Minimum	--	--	--	--	--	--	*8.0*	1.7	-4.0	-19.4	-31.7	-35.8	-35.8
	Maximum	--	--	--	--	--	--	*22.4*	21.4	17.4	7.8	-10.8	-4.9	22.4
2013	Average	-17.7	-12.3	-11.6	-7.8	4.9	14.3	13.8	13.0	4.6	-0.2	-15.8	-21.1	-1.0
	Minimum	-37.6	-20.4	-24.4	-18.6	-8.7	2.8	6.0	2.8	-4.3	-7.8	-36.2	-33.1	-37.6
	Maximum	3.6	-0.3	3.2	4.1	19.5	27.2	24.2	26.0	15.8	8.8	0.3	2.6	27.2
2014	Average	-10.1	-18.6	-10.4	-0.6	8.2	10.4	12.9	11.1	4.6	-4.2	-12.6	-12.9	-0.2
	Minimum	-29.3	-33.7	-22.1	-16.9	-2.8	2.2	5.0	1.5	-3.9	-13.5	-29.6	-24.0	-33.7
	Maximum	6.8	-4.9	3.2	8.9	18.8	21.3	21.4	22.6	18.9	7.8	-3.7	-2.6	22.6
2015	Average	-17.3	-14.7	-8.3	0.4	11.9	12.1	12.5	9.3	3.7	-1.6	-13.2	-15.6	-0.8
	Minimum	-33.9	-34.6	-27.4	-7.6	-1.6	3.0	5.8	-1.8	-5.3	-11.9	-28.5	-28.5	-34.6
	Maximum	-0.5	4.4	5.0	10.6	26.2	23.4	25.9	25.1	16.7	6.7	1.0	-1.2	26.2
2016	Average	-11.1	-10.2	-3.9	3.2	8.8	12.3	13.4	12.5	6.6	-6.4	-12.8	-18.7	-0.9
	Minimum	-21.3	-22.4	-12.3	-3.0	-0.3	3.3	7.3	3.8	-3.5	-16.9	-27.7	-30.0	-30.0
	Maximum	0.4	2.3	11.1	12.9	23.5	24.9	24.7	24.0	17.2	5.7	1.8	-4.0	24.9
All Years	Average	-14.1	-13.9	-8.5	-1.2	8.5	12.3	13.3	11.5	5.2	-3.9	-14.8	-18.5	-1.2
	Minimum	-37.6	-34.6	-27.4	-18.6	-8.7	2.2	5.0	-1.8	-5.3	-19.4	-36.2	-35.8	-37.6
	Maximum	6.8	4.4	11.1	12.9	26.2	27.2	25.9	26.0	18.9	8.8	1.8	2.6	27.2

Notes:
1. All values are derived from daily average data.
2. Meteorological station was installed on July 20th, 2012, therefore data for this month is incomplete.

3.1.2 Precipitation

Precipitation has been measured on-site since July 2012 at a dedicated climate station (Figure 3-5), and at several snow courses distributed at various elevations around the Coffee Creek property. Tipping bucket precipitation gauges were also installed at the camp (425 m) and at ridgetop (>1,200 m) in 2015 to refine assumptions relating to site precipitation accumulation with elevation.

Gauge and snow course data gathered during the baseline study indicate mean annual precipitation (MAP) averages 370 mm (at 975 m), with 38% of this amount falling as snow between October and April, and 62% falling as rain from May to September (Figure 3-2). As indicated in Table 3-2, precipitation has fallen as snow at the upper elevations in all months of the year, with the exception of June and July over the 5-year baseline monitoring period.

Annual precipitation in 2016 totaled 378 mm at the meteorological station elevation (975 m asl). The October 2015 to March 2016 precipitation total was 107.7 mm, which compares well with the April 1st SWE measured at the same site (98 mm). April to September precipitation totaled 267.2 mm at 975 m asl. The largest daily precipitation event occurred on October 19th, 2016 (25.7 mm) as snow, and the largest daily rainfall occurred on June 6th, 2016 (18.0 mm).

The proportion precipitation that fell as rain and snow in 2016 reflects the relatively warmer conditions, with 71% of annual precipitation falling as rain, and 29% as snow (Table 3-2).

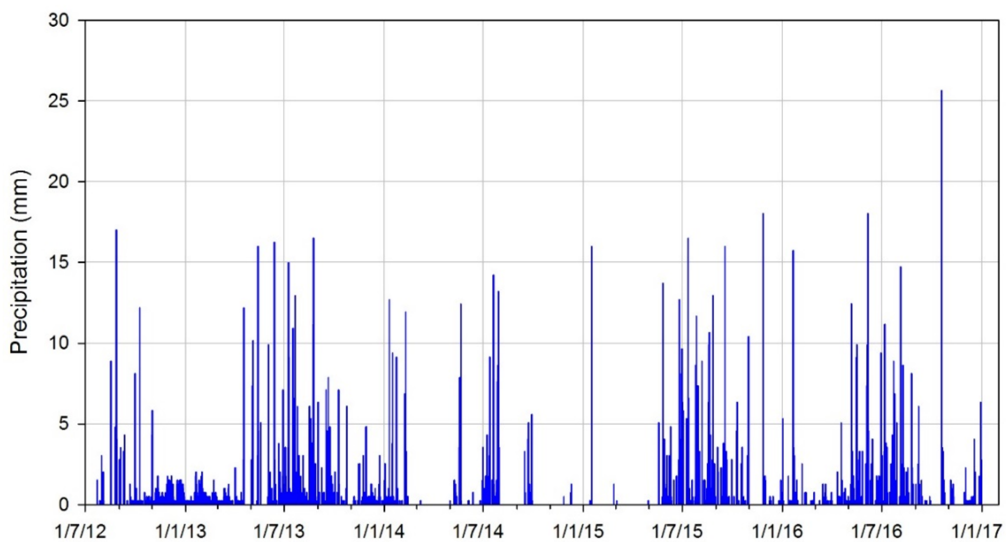

Figure 3-2: Daily precipitation measured at the Coffee Creek climate station.

Table 3-2:
Coffee Gold Climate Station - Precipitation Measurements by Month

Year	Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2012	Rain	--	--	--	--	--	--	*4.8*	37.8	9.4	1.3	0.0	0.0	53.3
	% Rain	--	--	--	--	--	--	*100%*	100%	34%	5%	0%	0%	36%
	Snow	--	--	--	--	--	--	*0.0*	0.0	18.0	21.8	23.4	33.3	96.5
	% Snow	--	--	--	--	--	--	*0%*	0%	66%	95%	100%	100%	64%
2013	Rain	0.0	0.0	0.0	0.0	15.2	57.9	89.7	58.7	25.9	4.3	0.0	1.3	253.0
	% Rain	0%	0%	0%	0%	31%	100%	100%	100%	55%	22%	0%	8%	59%
	Snow	20.1	14.7	9.9	20.3	34.0	0.0	0.0	0.0	21.3	15.5	23.4	14.7	174.0
	% Snow	100%	100%	100%	100%	69%	0%	0%	0%	45%	78%	100%	92%	41%
2014	Rain	0.0	0.0	0.0	0.0	29.0	3.0	80.0	0.0	20.3	0.0	0.0	0.0	143.0
	% Rain	0%	0%	0%	--	87%	100%	100%	--	95%	--	0%	0%	68%
	Snow	46.8	23.6	0.3	0.0	4.3	0.0	0.0	0.0	1.0	0.0	0.5	2.0	67.8
	% Snow	100%	100%	100%	--	13%	0%	0%	--	5%	--	100%	100%	32%
2015	Rain	0.0	0.0	0.0	0.3	24.9	48.8	99.3	71.1	30.2	6.9	0.0	0.0	281.4
	% Rain	0%	0%	0%	100%	100%	100%	100%	97%	75%	21%	0%	0%	77%
	Snow	16.3	1.3	0.3	0.0	0.0	0.0	0.0	2.5	9.9	26.2	20.3	5.8	82.6
	% Snow	100%	100%	100%	0%	0%	0%	0%	3%	25%	79%	100%	100%	23%
2016	Rain	0.0	0.0	1.0	14.0	53.3	71.1	68.3	46.0	14.5	0.0	0.0	0.0	268.2
	% Rain	0%	0%	17%	100%	100%	100%	100%	100%	100%	0%	0%	0%	71%
	Snow	36.1	6.4	5.1	0.0	0.0	0.0	0.0	0.0	0.0	34.8	5.1	22.4	109.7
	% Snow	100%	100%	83%	0%	0%	0%	0%	0%	0%	100%	100%	100%	29%
All Years	Rain	0.0	0.0	0.3	3.6	30.6	45.2	68.4	42.7	20.1	2.5	0.0	0.3	199.8
	% Rain	0%	0%	4%	67%	79%	100%	100%	99%	72%	12%	0%	2%	62%
	Snow	29.8	11.5	3.9	5.1	9.6	0.0	0.0	0.5	10.1	19.7	14.5	15.6	106.1
	% Snow	100%	100%	96%	33%	21%	0%	0%	1%	28%	88%	100%	98%	38%

Notes:
1. Snowfall values as presented here have not been corrected for gauge undercatch, and therefore likely underestimated.
2. Precipitation measured by gauge was counted as snow if T_{avg} <=0 °C, and as rain if T_{avg} => 0 °C.
3. Precentages could not be calculated if measured precipitation for a given month was zero, and are indicated by '-- '.

3.1.3 Relative Humidity

On a monthly basis, relative humidity measured at the site climate station varies from lower values in the spring months (lowest is May; 49%) to higher values in the fall and winter of 78-84%. A relative humidity value of 100% was measured on 84 occasions (hourly), and the minimum measured value was 12.6% on May 16, 2015. In 2016, the average annual relative humidity was slightly higher (71.2%) than the 2013 to 2015 average (70.2%).

The Coffee Gold relative humidity record is shown in Figure 3-3 at daily time step.

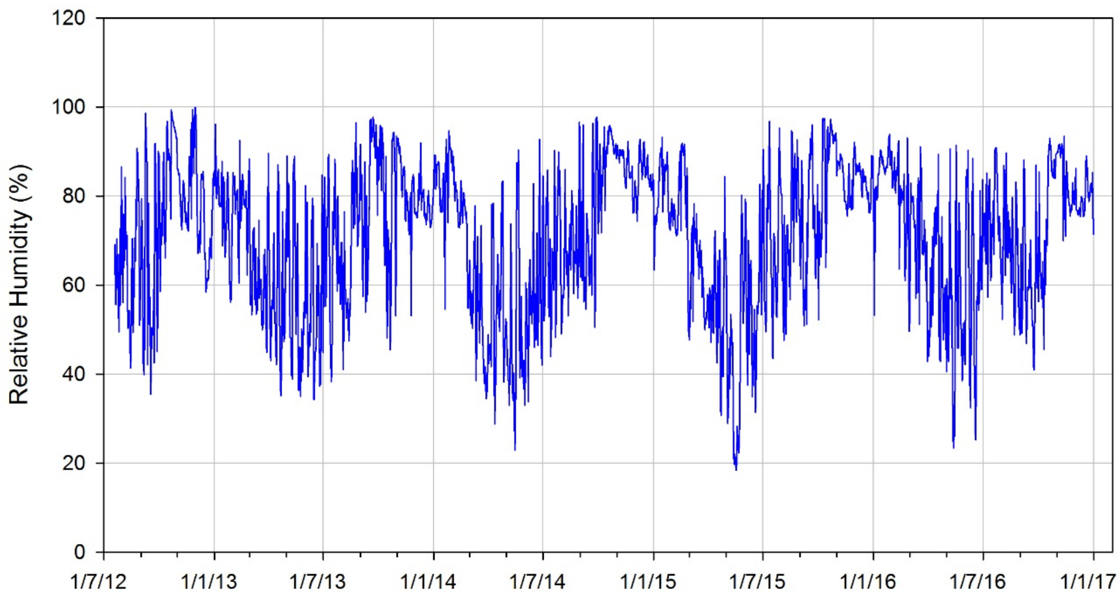

Figure 3-3: Daily average relative humidity measured at the site climate station.

3.1.4 Barometric Pressure

For the period of baseline study, barometric pressure as measured at the site climate station ranged from an hourly low of 971 mb to a high of 1036 mb. Overall, barometric pressures are higher in the summer months, with the highest average pressures occurring in July, as compared to lows in the winter months (*e.g.,* January).

The Coffee Creek barometric pressure record is shown in Figure 3-4 at daily time step.

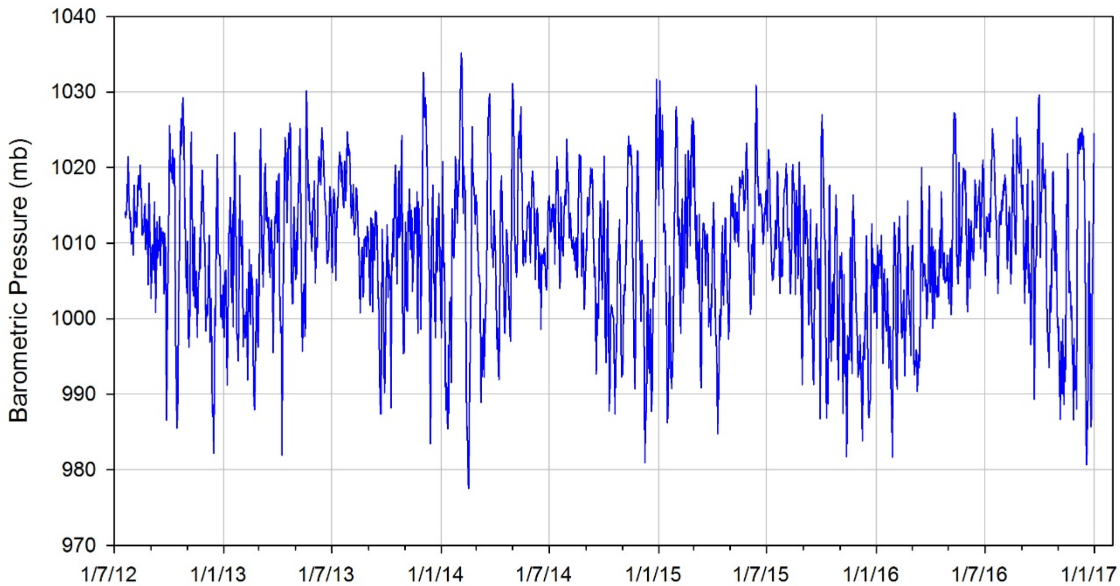

Figure 3-4: Daily average barometric pressure at the site climate station.

3.1.5 Solar Radiation

When data are summarized monthly for the available period of record, solar radiation varies from a monthly average high in June of 0.26 kW/m^2 to a low of 0.003 kW/m^2 in December. Since July 2012, the highest recorded hourly solar radiation value is 0.99 kw/m^2. The Coffee Creek solar radiation record is shown in Figure 3-5 at daily time step.

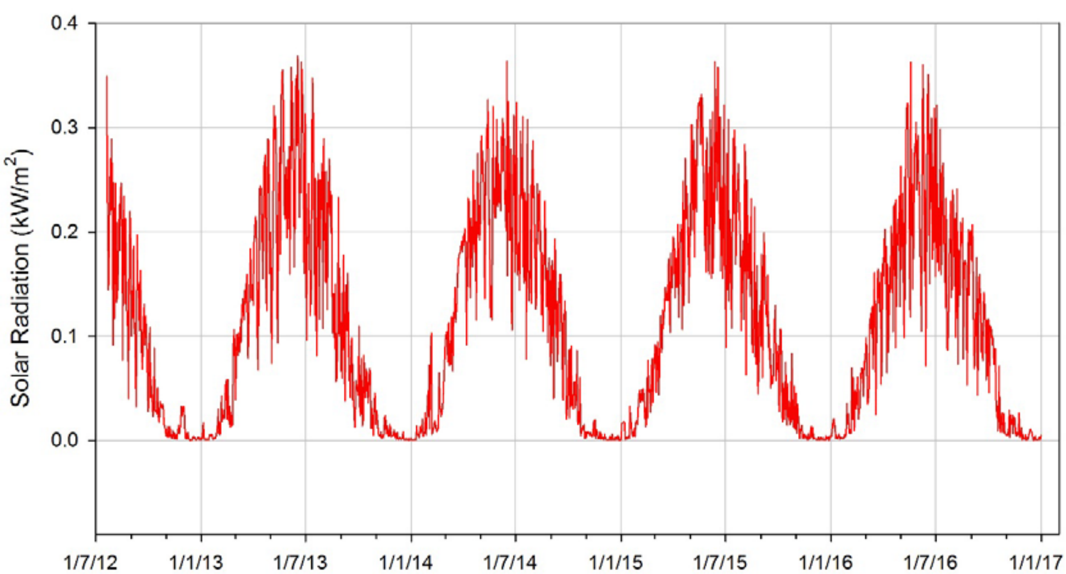

Figure 3-5: Daily average solar radiation measured at the site climate station.

3.1.6 Evapotranspiration and potential evaporation (PE)

Site- and regional estimates of evapotranspiration and potential evaporation are presented in Table 3-7 of the main report. Evapotranspiration data computed via a Campbell Scientific proprietary climate program using Coffee Gold weather station measurements are plotted in Figure 3-6 at daily time step. Total annual evapotranspiration as calculated by the weather station was 185.6 mm for 2016, slightly higher than the 2013-2015 average of 177.8 mm.

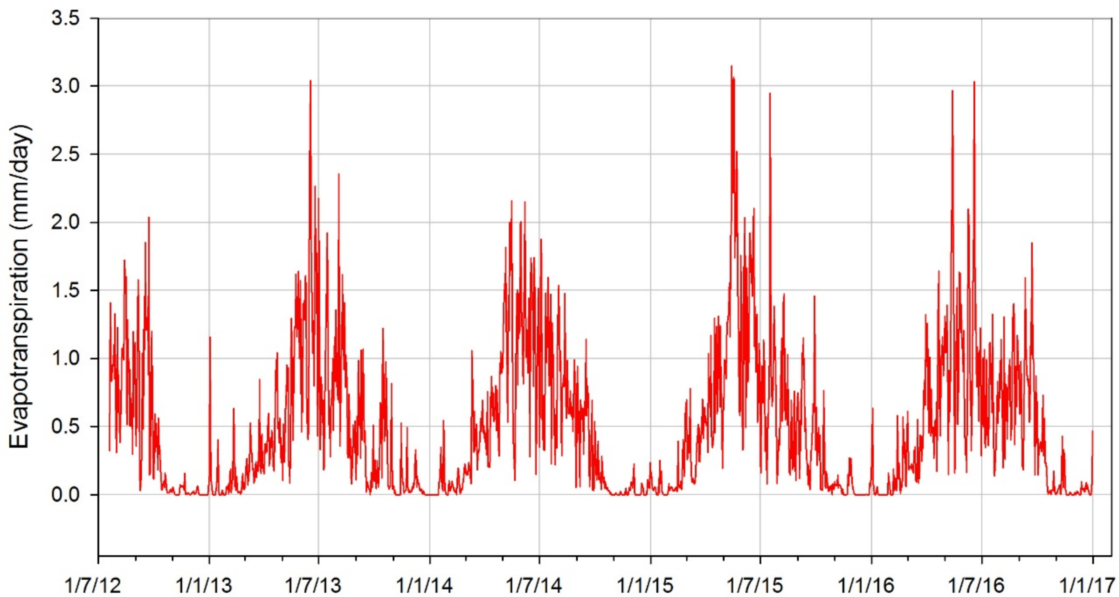

Figure 3-6: Daily average evapotranspiration measured at the site climate station.

3.2 Hydrology

3.2.1 Coffee Creek Hydrometric Data

From the extensive hydrometric network at Coffee Creek, combined with the monthly sampling trips conducted since autumn 2010, a high-quality and high-resolution streamflow dataset has been assembled. These data are presented in full in Appendix A1, and have been used to: inform project feasibility studies; complete design and engineering studies related to the Project; and they have also been used to build and calibrate a site-wide water balance and water quality model for the proposed undertaking. The hydrometric data collected in 2016 for the Project area creeks are presented in this section.

Streamflow time-series (in L/s) are presented in Figure 3-7 through Figure 3-17, and monthly summaries of total runoff (mm), average, maximum and minimum discharge (m^3/s), and unit yields ($L/s/km^2$) are presented in Table 3-4 through Table 3-14.

Site-wide, runoff was generally lower than what was measured in 2015, and much higher than what was measured at site in 2016. To place the Project site baseline record in the context of the long-term variability in streamflows, the average discharge record from the Indian River station was analysed to determine whether streamflows were higher or lower than the long-term average for the 2011-2016 period. The results are presented in Table 3-3, and indicate that the baseline period of record likely represents a period of increased runoff relative to the long-term mean (133% higher).

Table 3-3:
Annual average discharges for the Indian River (09EB003) station, for the Project baseline record period

Year	Annual Average Discharge (m^3/s)	Annual Average Unit Yield ($L/s/km^2$)	% 1978-2016 Average
2011	9.41	4.44	143%
2012	8.01	3.78	122%
2013	10.15	4.79	154%
2014	7.51	3.54	114%
2015	7.76	3.66	118%
2016	9.85	4.65	150%
Average	**6.58**	**3.10**	**133%**

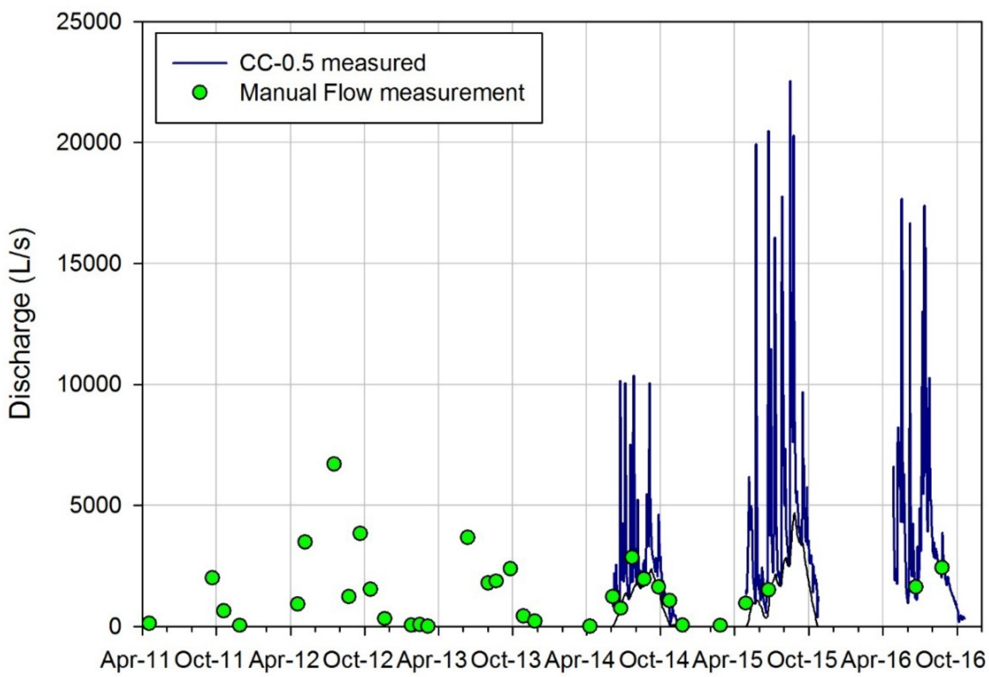

Figure 3-7: Time series discharge data for the CC-0.5 hydrometric station. Discharge data (blue line) and spot measurements of discharge (green circles) are shown.

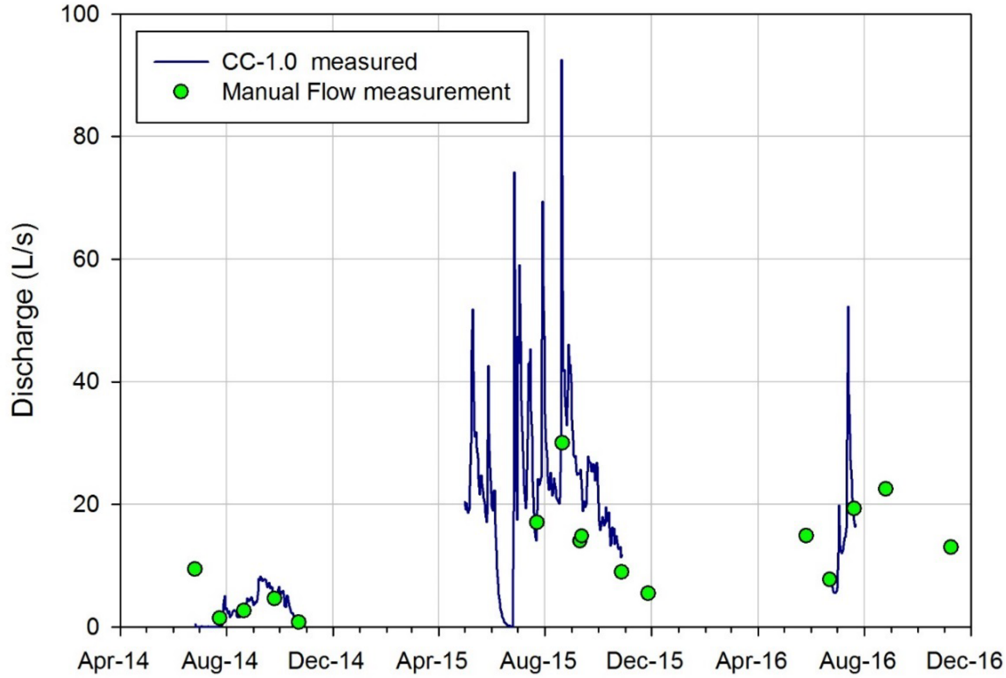

Figure 3-8: Time series discharge data for the CC-1.0 hydrometric station. Discharge data (blue line) and spot measurements of discharge (green circles) are shown.

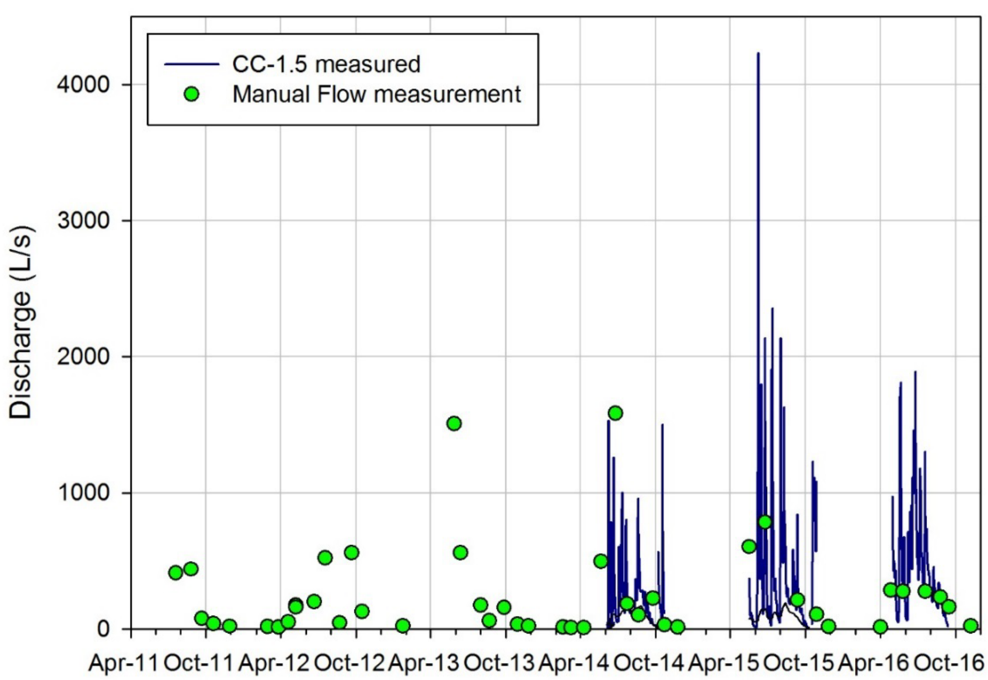

Figure 3-9: Time series discharge data for the CC-1.5 hydrometric station. Discharge data (blue line) and spot measurements of discharge (green circles) are shown.

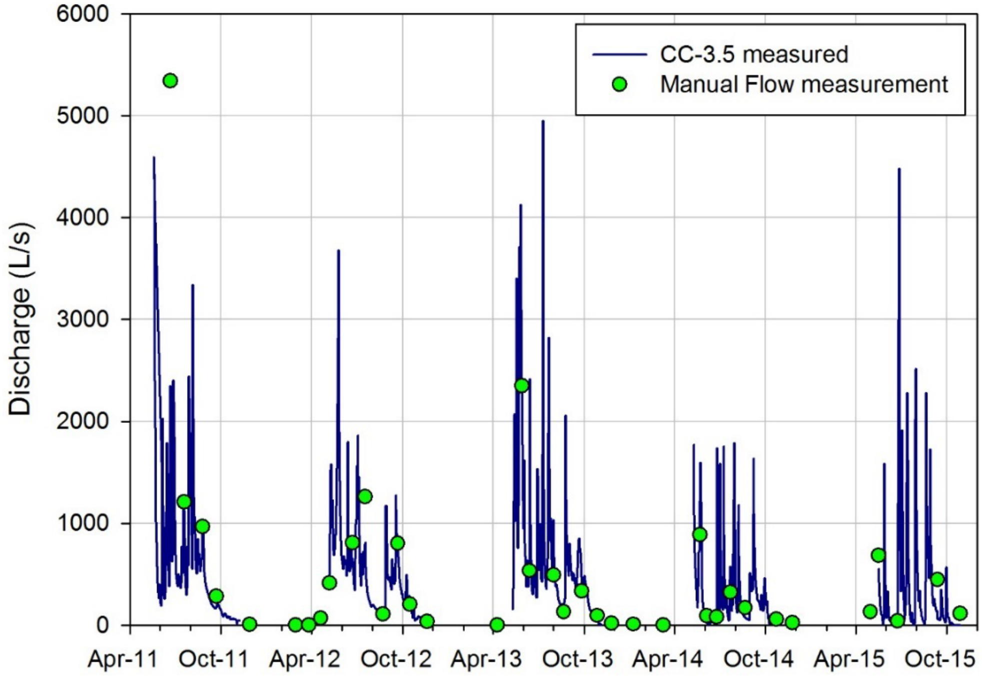

Figure 3-10: Time series discharge data for the CC-3.5 hydrometric station. Discharge data (blue line) and spot measurements of discharge (green circles) are shown.

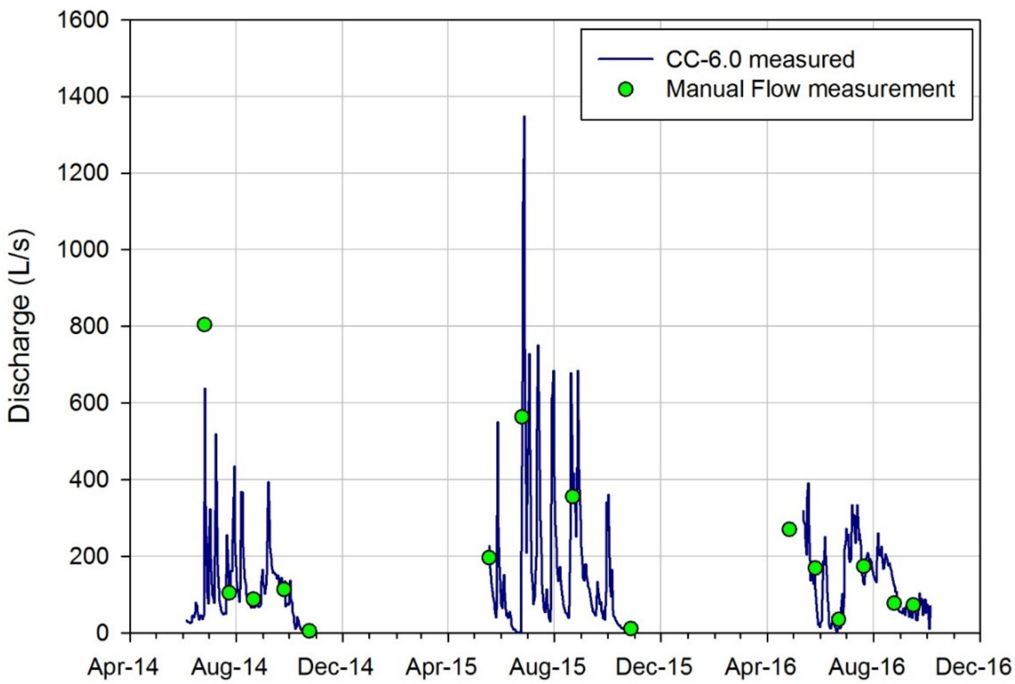

Figure 3-11: Time series discharge data for the CC-6.0 hydrometric station. Discharge data (blue line) and spot measurements of discharge (green circles) are shown.

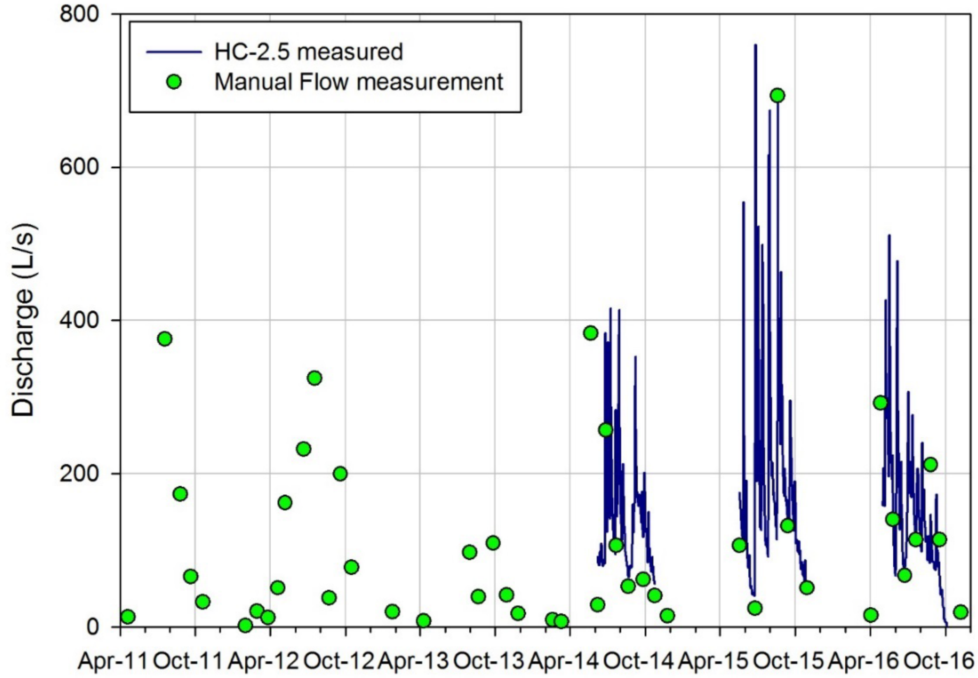

Figure 3-12: Time series discharge data for the HC-2.5 hydrometric station. Discharge data (blue line) and spot measurements of discharge (green circles) are shown.

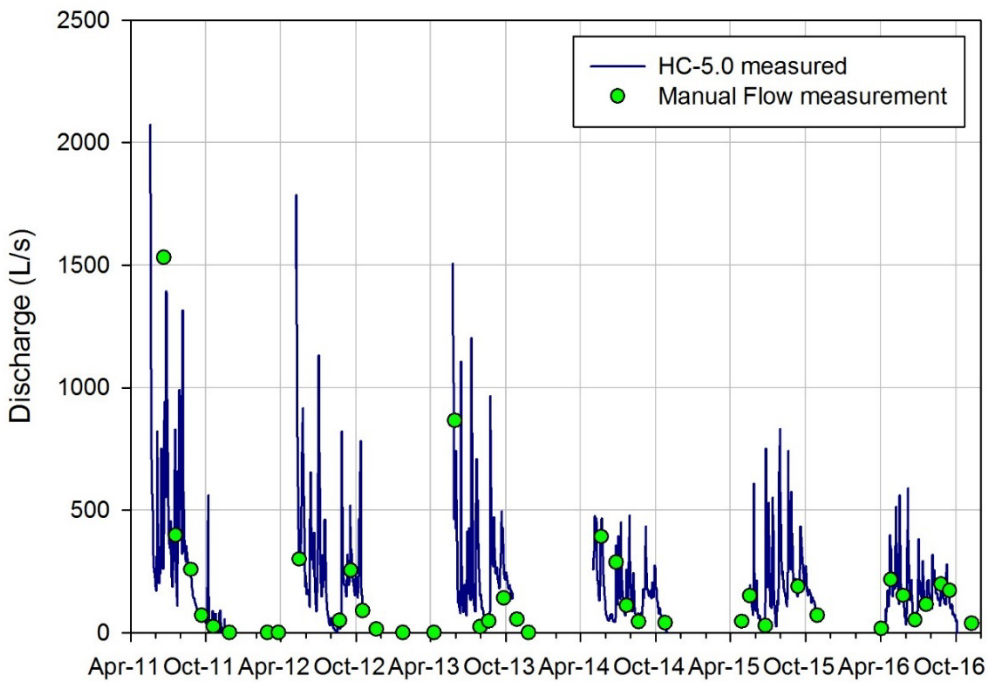

Figure 3-13: Time series discharge data for the HC-5.0 hydrometric station. Discharge data (blue line) and spot measurements of discharge (green circles) are shown.

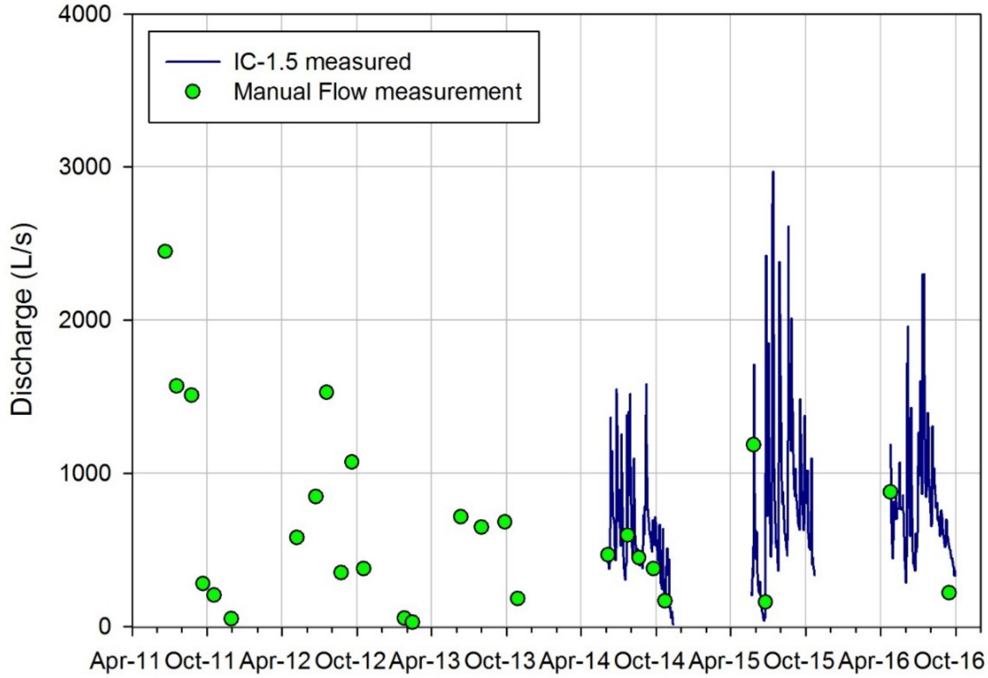

Figure 3-14: Time series discharge data for the IC-1.5 hydrometric station. Discharge data (blue line) and spot measurements of discharge (green circles) are shown.

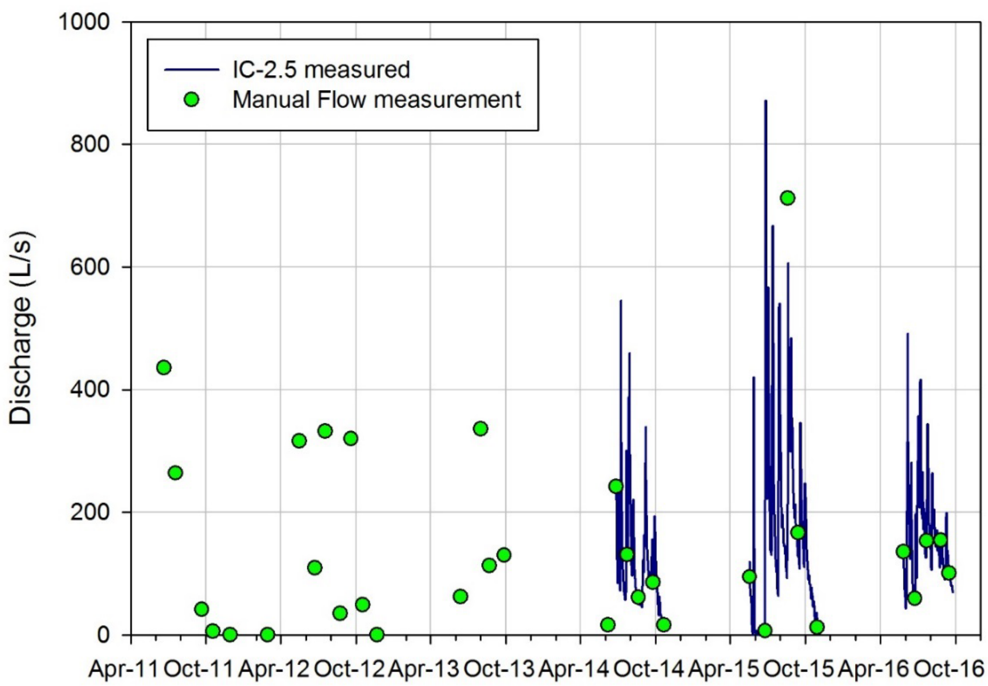

Figure 3-15: Time series discharge data for the IC-2.5 hydrometric station. Discharge data (blue line) and spot measurements of discharge (green circles) are shown.

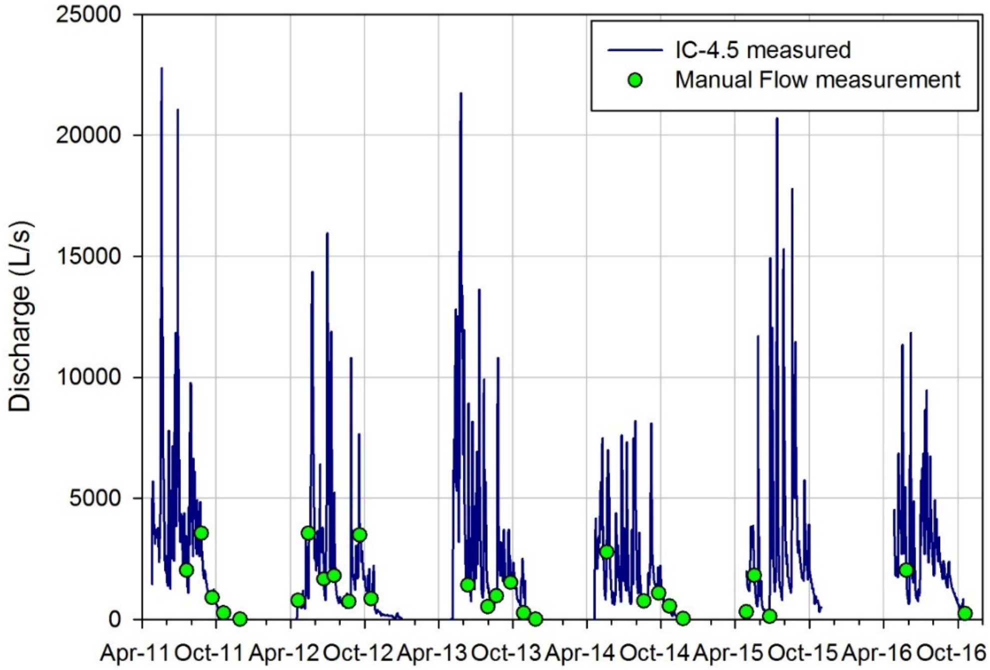

Figure 3-16: Time series discharge data for the IC-4.5 hydrometric station. Discharge data (blue line) and spot measurements of discharge (green circles) are shown.

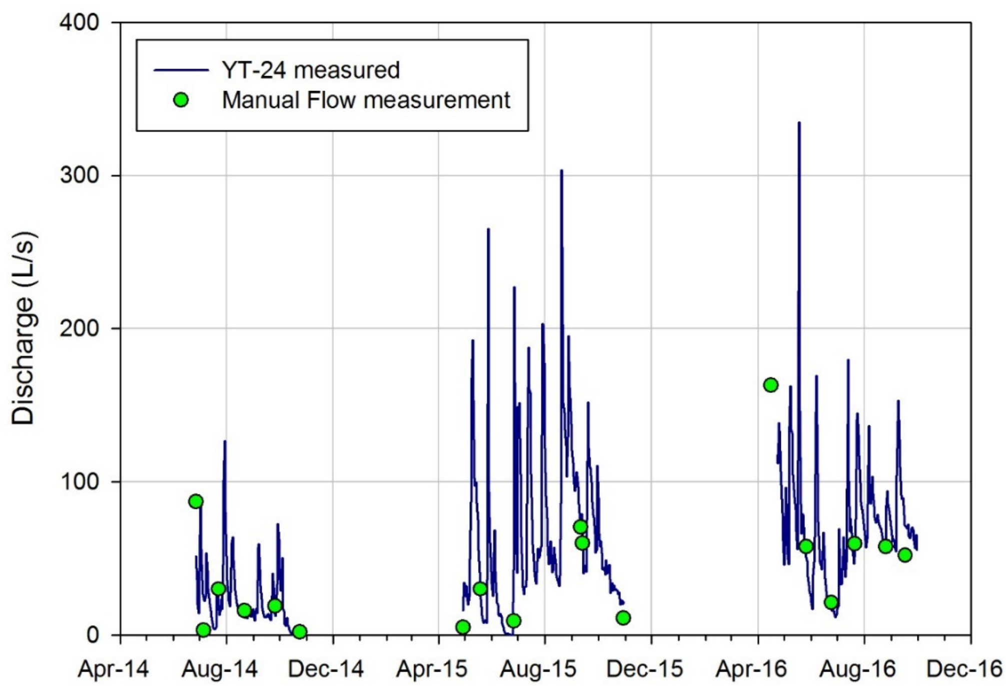

Figure 3-17: Time series discharge data for the YT-24 hydrometric station. Discharge data (blue line) and spot measurements of discharge (green circles) are shown.

3.2.1.1 Monthly Streamflow Metric Summaries

Table 3-4:
Monthly summaries of discharge (m^3/s), unit yield ($L/s/km^2$) and runoff (mm) for the CC-0.5 hydrometric station

Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2014	Average	--	--	*2.18*	3.62	2.58	3.69	1.39	*0.49*	2.33
	Maximum	--	--	*18.37*	12.37	6.08	11.23	4.52	*0.96*	18.37
	Minimum	--	--	*0.69*	0.95	1.39	1.37	0.04	*0.09*	0.04
2015	Average	--	*3.79*	2.87	5.88	7.95	5.04	2.35	--	4.65
	Maximum	--	*33.24*	24.97	20.98	28.98	10.54	5.35	--	33.24
	Minimum	--	*0.60*	0.45	1.54	2.24	3.19	0.09	--	0.09
2016	Average	*3.84*	5.45	2.98	7.14	2.83	1.50	0.40	--	3.45
	Maximum	*7.02*	22.30	22.75	23.04	4.32	2.23	1.02	--	23.04
	Minimum	*2*	1.06	0.83	2.77	1.93	0.62	0.03	--	0.03
Unit Yield ($L/s/km^2$)										
2014	Average	--	--	*5.7*	9.4	6.7	9.6	3.6	*1.3*	6.0
	Maximum	--	--	*47.6*	32.1	15.8	29.1	11.7	*2.5*	47.6
	Minimum	--	--	*1.8*	2.5	3.6	3.6	0.1	*0.2*	0.1
2015	Average	--	*9.8*	7.4	15.2	20.6	13.1	6.1	--	12.0
	Maximum	--	*86.2*	64.8	54.4	75.2	27.3	13.9	--	86.2
	Minimum	--	*1.5*	1.2	4.0	5.8	8.3	0.2	--	0.2
2016	Average	*9.95*	*14.1*	7.7	18.5	7.3	3.9	*1.0*	--	8.9
	Maximum	*18.2*	*57.8*	59.0	59.7	11.2	5.8	*2.6*	--	59.7
	Minimum	*5.2*	*2.7*	2.2	7.2	5.0	1.6	*0.1*	--	0.1
Runoff (mm)										
2014		--	--	*13*	25	18	25	10	*2*	92
2015		--	*24*	19	41	55	34	16	--	189
2016		*3*	38	*20*	50	20	10	*2*	--	142

Table 3-5:
Monthly summaries of discharge (m^3/s), unit yield ($L/s/km^2$) and runoff (mm) for the CC-1.0 hydrometric station

Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2014	Average	--	--	*0.000*	0.000	0.003	0.006	*0.003*	--	0.00
	Maximum	--	--	*0.001*	0.010	0.006	0.010	*0.010*	--	0.01
	Minimum	--	--	*0.000*	0.000	0.001	0.002	*0.000*	--	0.00
2015	Average	--	0.026	0.011	0.032	0.032	0.025	0.016	--	0.02
	Maximum	--	0.077	0.105	0.172	0.141	0.044	0.026	--	0.17
	Minimum	--	0.016	0.000	0.011	0.018	0.015	0.008	--	0.00
2016	Average	--	--	*0.006*	*0.020*	--	--	--	--	0.01
	Maximum	--	--	*0.009*	*0.081*	--	--	--	--	0.08
	Minimum	--	--	*0.004*	*0.005*	--	--	--	--	0.00
Unit Yield ($L/s/km^2$)										
2014	Average	--	--	*0.0*	0.1	0.9	1.8	*1.0*	--	0.8
	Maximum	--	--	*0.2*	3.0	1.8	2.9	*2.8*	--	3.0
	Minimum	--	--	*0.0*	0.0	0.3	0.5	*0.1*	--	0.0
2015	Average	--	7.7	3.2	9.4	9.4	7.3	4.6	--	6.9
	Maximum	--	22.4	30.4	50.1	40.9	12.7	7.4	--	50.1
	Minimum	--	4.6	0.0	3.3	5.2	4.5	2.3	--	0.0
2016	Average	--	--	*1.8*	*5.8*	--	--	--	--	3.84
	Maximum	--	--	*2.8*	*23.6*	--	--	--	--	23.60
	Minimum	--	--	*1.2*	*1.4*	--	--	--	--	1.25
Runoff (mm)										
2014		--	--	*0*	0	2	5	*2*	--	9
2015		--	21	8	25	25	19	12	--	110
2016		--	--	1	11	--	--	--	--	13

Table 3-6: Monthly summaries of discharge (m^3/s), unit yield ($L/s/km^2$) and runoff (mm) for the CC-1.5 hydrometric station

Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
	Average	--	--	*0.15*	0.38	0.22	0.31	*0.05*	--	0.22
2014	Maximum	--	--	*1.85*	1.90	1.24	1.19	*0.16*	--	1.90
	Minimum	--	--	*0.00*	0.03	0.08	0.08	*0.01*	--	0.00
	Average	--	*0.34*	0.44	0.67	0.55	0.28	0.11	--	0.40
2015	Maximum	--	*2.19*	9.30	3.94	3.08	1.39	0.70	--	9.30
	Minimum	--	*0.03*	0.00	0.02	0.02	0.10	0.00	--	0.00
	Average		*0.63*	0.48	0.84	0.42	0.16	--	--	0.5
2016	Maximum		*1.40*	3.97	2.73	1.99	0.38	--	--	4.0
	Minimum		*0.01*	0.03	0.31	0.16	0.01	--	--	0.0
Unit Yield ($L/s/km^2$)										
	Average	--	--	*6.6*	16.5	9.5	13.3	*2.3*	--	9.6
2014	Maximum	--	--	*80.3*	82.1	53.6	51.6	*6.9*	--	82.1
	Minimum	--	--	*0.2*	1.4	3.5	3.4	*0.4*	--	0.2
	Average	--	*14.7*	18.9	29.2	23.6	12.3	4.6	--	17.2
2015	Maximum	--	*94.7*	402.4	170.6	133.5	60.1	30.3	--	402.4
	Minimum	--	*1.1*	0.2	0.7	1.0	4.3	0.1	--	0.1
	Average	--	*27.4*	20.9	36.5	18.3	7.0	--	--	22.0
2016	Maximum	--	*60.6*	171.9	118.4	86.1	16.7	--	--	171.9
	Minimum	--	*0.4*	1.2	13.3	6.9	0.3	--	--	0.3
Runoff (mm)										
2014		--	--	*15*	44	26	34	*6*	--	125
2015		--	*16*	49	78	63	32	12	--	251
2016		--	*74*	54	98	49	18	--	--	281

Table 3-7:
Monthly summaries of discharge (m^3/s), unit yield ($L/s/km^2$) and runoff (mm) for the CC-3.5 hydrometric station

Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2011	Average	--	*1.28*	1.05	0.74	0.88	0.23	0.08	*0.04*	0.62
	Maximum	--	*6.27*	4.86	3.19	5.21	0.41	0.18	*0.05*	6.27
	Minimum	--	*0.24*	0.17	0.27	0.39	0.14	0.05	*0.01*	0.01
2012	Average	--	*1.31*	0.69	0.62	0.26	0.55	0.20	*0.08*	0.53
	Maximum	--	*4.05*	2.66	2.57	1.73	1.40	0.54	*0.09*	4.05
	Minimum	--	*0.28*	0.32	0.16	0.12	0.28	0.04	*0.04*	0.04
2013	Average	--	*2.01*	0.69	1.06	0.51	0.55	0.17	*0.01*	0.71
	Maximum	--	*5.92*	3.64	7.30	3.26	0.96	0.50	*0.02*	7.30
	Minimum	--	*0.15*	0.25	0.32	0.17	0.35	0.01	*0*	0.00
2014	Average	--	*0.63*	0.15	0.56	0.24	0.41	*0.07*	--	0.34
	Maximum	--	*2.42*	2.50	2.38	1.58	1.97	*0.66*	--	2.50
	Minimum	--	*0.09*	0.00	0.03	0.04	0.08	*0.00*	--	0.00
2015	Average	--	*0.31*	0.43	0.68	0.54	0.16	0.04	--	0.36
	Maximum	--	*2.34*	9.56	4.20	3.30	1.07	0.45	--	9.56
	Minimum	--	*0.00*	0.00	0.00	0.00	0.01	0.00	--	0.00
2016	Average	*0.59*	*0.71*	0.53	0.90	0.34	0.14	*0.01*	--	0.46
	Maximum	*1.15*	*2.84*	5.14	2.69	1.34	0.27	*0.05*	--	5.14
	Minimum	*0.24*	*0.00*	0.04	0.27	0.15	0.03	*0.00*	--	0.00
Unit Yield ($L/s/km^2$)										
2011	Average	--	*18.3*	15.0	10.7	12.6	3.3	1.2	*0.6*	8.8
	Maximum	--	*89.8*	69.7	45.7	74.7	5.9	2.5	*0.75*	89.8
	Minimum	--	*3.48*	2.4	3.8	5.6	2.0	0.7	*0.19*	0.2
2012	Average	--	*18.7*	9.9	8.9	3.8	7.9	2.9	*1.14*	7.6
	Maximum	--	*58*	38.1	36.8	24.7	20.0	7.8	*1.32*	58.0
	Minimum	--	*4.07*	4.6	2.3	1.7	3.9	0.5	*0.53*	0.5
2013	Average	--	*28.8*	9.9	15.2	7.3	7.8	2.4	*0.12*	10.2
	Maximum	--	*84.8*	52.2	104.6	46.6	13.7	7.2	*0.28*	104.6
	Minimum	--	*2.08*	3.6	4.5	2.5	5.0	0.2	*0.03*	0.0
2014	Average	--	*9.01*	2.1	8.0	3.5	5.8	*1.0*	--	4.9
	Maximum	--	*34.7*	35.8	34.1	22.7	28.2	*9.4*	--	35.8
	Minimum	--	*1.26*	0.1	0.4	0.6	1.1	*0.0*	--	0.0
2015	Average	--	*4.4*	6.2	9.7	7.7	2.4	0.6	--	5.2
	Maximum	--	*33.5*	136.9	60.1	47.2	15.3	6.4	--	136.9
	Minimum	--	*0.0*	0.0	0.0	0.0	0.1	0.0	--	0.0
2016	Average	*8.48*	*10.2*	7.5	12.9	4.9	1.9	0.1	--	6.59
	Maximum	*16.5*	*40.7*	73.7	38.5	19.1	3.9	0.7	--	73.69
	Minimum	*3.48*	*0.0*	0.5	3.9	2.2	0.4	0.0	--	0.00
Runoff (mm)										
2011		--	*20.5*	*39*	29	34	8	3	*0*	134
2012		--	*43.6*	*26*	24	10	20	*8*	*1*	132
2013		--	*54.8*	*26*	41	20	20	6	*0*	167
2014		--	*17.1*	*5*	22	9	15	*2*	--	71
2015		--	*6*	16	26	21	6	2	--	76
2016		*4*	27	20	35	13	5	*0.23*	--	104

Table 3-8:
Monthly summaries of discharge (m^3/s), unit yield ($L/s/km^2$) and runoff (mm) for the CC-6.0 hydrometric station

Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2014	Average	--	--	*0.09*	0.18	0.12	0.15	*0.03*	--	0.11
	Maximum	--	--	*0.78*	0.80	0.62	0.49	*0.21*	--	0.80
	Minimum	--	--	*0.02*	0.04	0.05	0.06	*0.00*	--	0.00
2015	Average	--	*0.16*	0.19	0.28	0.25	0.11	0.06	--	0.17
	Maximum	--	*0.70*	2.36	1.04	0.87	0.37	0.50	--	2.36
	Minimum	--	*0.03*	0.00	0.02	0.03	0.03	0.00	--	0.00
2016	Average		*0.12*	0.08	0.22	0.16	0.06	*0.05*		0.11
	Maximum		*0.43*	0.45	0.41	0.35	0.19	*0.45*		0.45
	Minimum		*0.01*	0.00	0.11	0.04	0.02	*0.00*		0.00
Unit Yield ($L/s/km^2$)										
2014	Average	--	--	*8.9*	18.3	12.4	15.9	*3.2*	--	11.7
	Maximum	--	--	*81.6*	83.7	64.1	51.2	*21.3*	--	83.7
	Minimum	--	--	*2.3*	4.1	5.1	6.5	*0.0*	--	0.0
2015	Average	--	*16.4*	19.4	29.1	25.8	11.3	6.3	--	18.1
	Maximum	--	*73.0*	245.6	108.4	90.7	38.9	51.9	--	245.6
	Minimum	--	*3.0*	0.0	2.4	2.7	2.7	0.2	--	0.0
2016	Average	--	*12.5*	7.9	23.0	16.4	6.3	*5.2*	--	11.88
	Maximum	--	*44.3*	47.1	42.4	36.9	19.3	*47.0*	--	47.11
	Minimum	--	*0.5*	0.0	11.2	4.0	1.8	*0.3*	--	0.00
Runoff (mm)										
2014		--	--	*20*	49	33	41	*7*	--	150
2015		--	*20*	50	78	69	29	17	--	263
2016		--	*24*	20	62	44	16	*2*	--	168

Table 3-9:
Monthly summaries of discharge (m^3/s), unit yield ($L/s/km^2$) and runoff (mm) for the HC-2.5 hydrometric station

Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2014	Average	--	--	*0.12*	0.21	0.11	0.17	*0.09*	--	0.14
	Maximum	--	--	*0.47*	0.59	0.26	0.41	*0.29*	--	0.59
	Minimum	--	--	*0.06*	0.09	0.06	0.09	*0.05*	--	0.05
2015	Average	--	*0.20*	0.13	0.27	0.26	0.18	0.09	--	0.19
	Maximum	--	*0.73*	0.98	1.05	0.96	0.33	0.23	--	1.05
	Minimum	--	*0.08*	0.03	0.08	0.09	0.09	0.03	--	0.03
2016	Average	--	0.23	0.16	0.18	0.12	0.07	*0.01*	--	0.13
	Maximum	--	0.55	0.95	0.51	0.31	0.20	*0.05*	--	0.95
	Minimum	--	0.05	0.05	0.10	0.07	0.00	*0.00*	--	0.00
Unit Yield ($L/s/km^2$)										
2014	Average	--	--	*8.0*	14.2	7.6	11.8	*6.4*	--	9.6
	Maximum	--	--	*31.9*	40.0	17.8	27.6	*19.8*	--	40.0
	Minimum	--	--	*3.8*	6.0	3.8	5.9	*3.1*	--	3.1
2015	Average	--	*13.5*	8.6	18.0	17.3	11.8	5.9	--	12.5
	Maximum	--	*49.4*	66.4	70.9	65.1	22.4	15.2	--	70.9
	Minimum	--	*5.1*	1.7	5.2	6.0	5.9	2.1	--	1.7
2016	Average	--	15.4	11.1	12.3	8.3	4.7	*0.5*	--	8.72
	Maximum	--	37.4	63.9	34.5	20.9	13.6	*3.4*	--	63.92
	Minimum	--	3.5	3.2	6.6	4.4	0.0	*0.0*	--	0.00
Runoff (mm)										
2014		--	--	*17*	38	20	31	*13*	--	119
2015		--	*15*	22	48	46	31	16	--	179
2016		--	41	29	33	22	12	*1*	--	138

Table 3-10:
Monthly summaries of discharge (m^3/s), unit yield ($L/s/km^2$) and runoff (mm) for the HC-5.0 hydrometric station

Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2011	Average	--	*0.65*	0.57	0.44	0.38	0.09	0.08	*0.02*	0.32
	Maximum	--	*2.56*	1.73	1.35	1.89	0.16	0.67	*0.11*	2.56
	Minimum	--	*0.21*	0.16	0.09	0.15	0.03	0.00	*0*	0.00
2012	Average	--	*0.65*	0.25	0.28	0.09	0.24	*0.32*	--	0.30
	Maximum	--	*2.23*	1.06	1.50	1.16	0.58	*0.82*	--	2.23
	Minimum	--	*0.16*	0.08	0.02	0.00	0.14	*0.10*	--	0.00
2013	Average	--	*0.78*	0.26	0.33	0.18	0.30	*0.19*	--	0.34
	Maximum	--	*1.87*	1.84	1.85	1.49	0.57	*0.25*	--	1.87
	Minimum	--	*0.29*	0.05	0.07	0.02	0.17	*0.13*	--	0.02
2014	Average	--	*0.3*	0.11	0.21	0.10	0.20	*0.08*	--	0.16
	Maximum	--	*0.61*	0.49	0.64	0.28	0.50	*0.25*	--	0.64
	Minimum	--	*0.1*	0.03	0.05	0.05	0.12	*0.00*	--	0.00
2015	Average	--	*0.19*	0.10	0.27	0.30	0.23	0.15	--	0.21
	Maximum	--	*0.81*	0.92	1.09	0.90	0.47	0.35	--	1.09
	Minimum	--	*0.03*	0.00	0.01	0.08	0.12	0.07	--	0.00
2016	Average	*0.18*	*0.21*	0.15	0.18	0.17	0.13	*0.03*	--	0.1
	Maximum	*0.51*	*0.61*	0.86	0.51	0.36	0.30	*0.07*	--	0.9
	Minimum	*0.00*	*0.04*	0.02	0.08	0.08	0.03	*0.00*	--	0.0
Unit Yield ($L/s/km^2$)										
2011	Average	--	*24.1*	21.0	16.3	14.2	3.4	2.8	*0.93*	11.8
	Maximum	--	*94.6*	64.0	50.1	69.9	5.9	24.7	*4.19*	94.6
	Minimum	--	*7.61*	5.9	3.4	5.4	1.0	0.0	*0.01*	0.0
2012	Average	--	*24.1*	9.3	10.3	3.2	8.9	*11.7*	--	11.3
	Maximum	--	*82.4*	39.2	55.6	43.0	21.7	*30.5*	--	82.4
	Minimum	--	*5.99*	2.8	0.7	0.1	5.1	*3.8*	--	0.1
2013	Average	--	*28.7*	9.6	12.3	6.7	11.1	*6.9*	--	12.6
	Maximum	--	*69.4*	68.0	68.7	55.3	20.9	*9.3*	--	69.4
	Minimum	--	*10.6*	1.9	2.8	0.8	6.3	*4.7*	--	0.8
2014	Average	--	*11*	4.0	7.7	3.8	7.2	*2.9*	--	6.1
	Maximum	--	*22.8*	18.2	23.8	10.4	18.6	*9.3*	--	23.8
	Minimum	--	*3.84*	1.3	1.8	1.7	4.3	*0.0*	--	0.0
2015	Average	--	*7.1*	3.9	9.9	11.0	8.7	5.6	--	7.7
	Maximum	--	*30.0*	34.0	40.2	33.5	17.4	13.1	--	40.2
	Minimum	--	*1.2*	0.0	0.4	2.9	4.3	2.6	--	0.0
2016	Average	*6.8*	*7.7*	5.5	6.7	6.1	4.8	*1.0*	--	5.5
	Maximum	*18.8*	*22.8*	31.9	18.8	13.2	10.9	*2.8*	--	31.9
	Minimum	*0*	*1.4*	0.7	2.8	3.0	1.0	*0.0*	--	0.0
Runoff (mm)										
2011		--	*27*	*54*	44	38	9	8	*1*	181
2012		--	*52*	*24*	28	8	23	*17*	--	153
2013		--	*17*	*25*	33	18	29	*11*	--	133
2014		--	30	*10*	21	10	19	*7*	--	97
2015		--	*8*	10	27	29	23	15	--	111
2016		*11*	*21*	14	18	16	12	*1*	--	94

Table 3-11:
Monthly summaries of discharge (m^3/s), unit yield ($L/s/km^2$) and runoff (mm) for the IC-1.5 hydrometric station

Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2014	Average	--	--	*0.79*	0.78	0.54	0.73	0.40	*0.11*	0.56
	Maximum	--	--	*2.24*	1.80	1.26	1.83	0.92	*0.57*	2.24
	Minimum	--	--	*0.31*	0.28	0.36	0.41	0.12	*0.01*	0.01
2015	Average	--	*0.62*	0.40	1.19	1.10	0.90	0.63	--	0.81
	Maximum	--	*2.10*	2.86	3.67	3.10	1.80	1.37	--	3.67
	Minimum	--	*0.10*	0.01	0.33	0.40	0.58	0.32	--	0.01
2016	Average	0.74	*0.73*	0.77	1.24	0.78	0.51	--	--	0.79
	Maximum	1.23	*1.43*	2.47	3.29	1.62	0.73	--	--	3.29
	Minimum	0.42	*0.34*	0.25	0.75	0.57	0.18	--	--	0.18
Unit Yield ($L/s/km^2$)										
2014	Average	--	--	*11.7*	11.3	6.7	9.8	4.8	*1.84*	7.7
	Maximum	--	--	*57.9*	38.5	20.7	39.7	12.9	*6.78*	57.9
	Minimum	--	--	*3.7*	3.3	4.2	4.8	1.9	*0.95*	1.0
2015	Average	--	*9.5*	7.1	26.8	19.6	13.0	8.2	--	14.0
	Maximum	--	*51.4*	94.3	160.8	111.9	38.4	23.9	--	160.8
	Minimum	--	*1.7*	0.9	3.8	4.6	6.9	3.7	--	0.9
2016	Average	9.13	*8.99*	9.53	15.31	9.57	6.24	--	--	9.79
	Maximum	15.2	*17.62*	30.45	40.53	19.93	8.94	--	--	40.53
	Minimum	5.18	*4.23*	3.14	9.27	6.97	2.23	--	--	2.23
Runoff (mm)										
2014		--	--	*21*	26	18	23	13	*2*	103
2015		--	*7*	13	39	36	29	21	--	145
2016		*5*	*24*	25	41	26	16	--	--	136

Table 3-12:
Monthly summaries of discharge (m^3/s), unit yield ($L/s/km^2$) and runoff (mm) for the IC-2.5 hydrometric station

Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2014	Average	--	--	*0.16*	0.19	0.09	0.14	*0.05*	--	0.13
	Maximum	--	--	*0.29*	0.68	0.25	0.38	*0.16*	--	0.68
	Minimum	--	--	*0.07*	0.05	0.04	0.08	*0.00*	--	0.00
2015	Average	--	*0.09*	0.07	0.29	0.26	0.18	0.08	--	0.16
	Maximum	--	*0.53*	1.06	0.81	0.75	0.39	0.27	--	1.06
	Minimum	--	*0.00*	0.00	0.06	0.07	0.08	0.00	--	0.00
2016	Average	--	*0.09*	0.15	0.23	0.15	*0.11*		--	0.15
	Maximum	--	*0.16*	0.65	0.47	0.28	*0.22*		--	0.65
	Minimum	--	*0.06*	0.04	0.11	0.10	*0.05*		--	0.04
Unit Yield ($L/s/km^2$)										
2014	Average	--	--	*9.1*	10.9	5.3	8.2	*3.0*	--	7.3
	Maximum	--	--	*16.9*	39.5	14.2	21.7	*9.5*	--	39.5
	Minimum	--	--	*4.1*	2.8	2.4	4.5	*0.0*	--	0.0
2015	Average	--	*5.2*	4.2	16.6	14.8	10.5	4.7	--	9.3
	Maximum	--	*30.9*	61.4	47.1	43.1	22.4	15.9	--	61.4
	Minimum	--	*0.0*	0.0	3.2	4.1	4.6	0.0	--	0.0
2016	Average	--	*5.16*	8.90	13.45	8.66	*6.50*	--	--	8.54
	Maximum	--	*9.03*	37.66	27.13	16.32	*12.55*	--	--	37.66
	Minimum	--	*3.28*	2.04	6.61	5.73	*3.04*	--	--	2.04
Runoff (mm)										
2014		--	--	*3*	29	14	21	*6*	--	73
2015		--	*6*	11	44	40	27	13	--	141
2016		--	*2*	23	36	23	*13*	--	--	98

Table 3-13:
Monthly summaries of discharge (m^3/s), unit yield ($L/s/km^2$) and runoff (mm) for the IC-4.5 hydrometric station

Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2011	Average	*2.19*	5.84	5.54	3.92	3.85	1.18	*0.45*	--	3.28
	Maximum	*6.66*	31.2	31.40	13.42	8.98	2.15	*0.88*	--	31.40
	Minimum	*0.00*	1.88	1.20	0.97	1.70	0.62	*0.24*	--	0.00
2012	Average	*0.58*	4.04	2.98	3.99	1.37	2.51	1.16	*0.22*	2.1
	Maximum	*1.95*	16.7	10.88	24.57	15.33	9.12	2.94	*0.42*	24.6
	Minimum	*0.01*	0.32	0.75	0.64	0.43	1.16	0.26	*0.13*	0.0
2013	Average	--	8.06	3.64	4.13	1.88	2.23	1.37	*0.23*	3.08
	Maximum	--	28.6	15.18	16.63	17.86	4.39	2.95	*0.69*	28.61
	Minimum	--	0.01	0.68	0.85	0.45	1.27	0.50	*0.06*	0.01
2014	Average	*2.17*	3.64	2.61	2.88	1.28	2.28	0.56	*0.12*	1.94
	Maximum	*5.07*	13	10.74	10.16	4.06	9.99	1.97	*0.33*	12.96
	Minimum	*0*	0.61	0.54	0.59	0.66	0.85	0.12	*0.02*	0.00
2015	Average	*1.96*	2.44	1.39	5.78	4.63	2.76	1.03	--	2.86
	Maximum	*2.14*	18.49	19.33	25.72	23.01	6.51	3.40	--	25.72
	Minimum	*1.72*	0.38	0.10	0.73	1.04	1.52	0.22	--	0.10
2016	Average	*3.01*	3.59	2.55	4.62	2.52	*1.37*	--	--	2.94
	Maximum	*4.86*	13.98	16.04	11.91	5.50	*2.48*	--	--	16.04
	Minimum	*2.02*	0.75	0.59	2.26	1.57	*0.55*	--	--	0.55
Unit Yield ($L/s/km^2$)										
2011	Average	*9.84*	26.3	24.9	17.6	17.3	5.3	*2.0*	--	14.8
	Maximum	*30.0*	140.4	141.3	60.4	40.4	9.7	*4.0*	--	141.3
	Minimum	*0.0*	8.5	5.4	4.3	7.6	2.8	*1.1*	--	0.0
2012	Average	*2.6*	18.2	13.4	17.9	6.2	11.3	5.2	*0.99*	9.5
	Maximum	*8.78*	75.1	48.9	110.5	69.0	41.0	13.2	*1.9*	110.5
	Minimum	*0.04*	1.43	3.4	2.9	1.9	5.2	1.2	*0.6*	0.0
2013	Average	--	36.3	16.4	18.6	8.4	10.0	6.2	*1.05*	13.8
	Maximum	--	129	68.3	74.8	80.3	19.7	13.3	*3.11*	128.7
	Minimum	--	0.06	3.1	3.8	2.0	5.7	2.2	*0.28*	0.1
2014	Average	*9.74*	16.4	11.7	12.9	5.8	10.3	2.5	*0.53*	8.7
	Maximum	*22.8*	58.3	48.3	45.7	18.3	44.9	8.9	*1.51*	58.3
	Minimum	*0.01*	2.72	2.4	2.7	3.0	3.8	0.5	*0.08*	0.0
2015	Average	*8.82*	11.0	6.3	26.0	20.8	12.4	4.6	--	12.8
	Maximum	*9.61*	83.2	87.0	115.7	103.5	29.3	15.3	--	115.7
	Minimum	*7.74*	1.7	0.4	3.3	4.7	6.9	1.0	--	0.4
2016	Average	*13.5*	16.15	11.49	20.77	11.35	*6.18*	--	--	13.25
	Maximum	*21.8*	62.89	72.15	53.57	24.74	*11.14*	--	--	72.15
	Minimum	*9.1*	3.39	2.65	10.15	7.08	*2.46*	--	--	2.46
Runoff (mm)										
2011		*9*	69.9	*64*	46	45	14	*4*	--	253
2012		*4*	48.3	*34*	48	17	29	14	*4*	198
2013		--	97.2	*42*	49	23	25	17	*2*	255
2014		*11*	43	*30*	34	16	26	7	*2*	169
2015		*1*	29	17	70	55	31	13	--	216
2016		*5*	43	30	56	30	*10*	--	--	174

Table 3-14:
Monthly summaries of discharge (m^3/s), unit yield ($L/s/km^2$) and runoff (mm) for the YT-24 hydrometric station

Discharge (m^3/s)										
Year		**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Annual**
2014	Average	--	--	*0.03*	0.03	0.02	0.02	*0.01*	--	0.02
	Maximum	--	--	*0.06*	0.23	0.07	0.08	*0.22*	--	0.23
	Minimum	--	--	*0.01*	0.00	0.01	0.00	*0.00*	--	0.00
2015	Average	*0.03*	0.06	0.03	0.09	0.10	0.09	0.04	--	0.06
	Maximum	*0.06*	0.54	0.37	0.46	0.41	0.20	0.12	--	0.54
	Minimum	*0*	0.00	0.00	0.02	0.02	0.03	0.01	--	0.00
2016	Average	*0.11*	0.07	0.04	0.07	0.08	0.08	--	--	0.07
	Maximum	*0.18*	0.54	0.30	0.35	0.17	0.17	--	--	0.54
	Minimum	*0.04*	0.02	0.01	0.01	0.05	0.04	--	--	0.01
Unit Yield ($L/s/km^2$)										
2014	Average	--	--	*2.3*	2.8	2.0	2.1	*0.8*	--	2.0
	Maximum	--	--	*5.4*	19.6	6.3	7.2	*18.7*	--	19.6
	Minimum	--	--	*0.6*	0.0	0.7	0.2	*0.0*	--	0.0
2015	Average	*2.4*	5.4	2.3	7.5	8.2	7.3	3.3	--	5.2
	Maximum	*5.1*	46.0	31.4	39.2	34.8	17.2	10.3	--	46.0
	Minimum	*0.1*	0.0	0.0	1.4	1.3	2.2	0.8	--	0.0
2016	Average	*8.91*	5.87	3.74	6.26	6.60	6.63	--	--	6.33
	Maximum	*15.6*	45.76	25.42	30.07	14.19	14.39	--	--	45.76
	Minimum	*3.8*	1.55	0.45	1.10	3.95	3.46	--	--	0.45
Runoff (mm)										
2014		--	--	*1*	8	5	5	*2*	--	21
2015		*0.4*	14	6	20	14	19	9	--	83
2016		*6.2*	16	10	17	18	17	--	--	83

Table 3-15:
Annual runoff (mm) for Coffee Gold Project hydrometric stations

Year	**Annual Runoff (mm)**										
	CC-0.5	**CC-1.0**	**CC-1.5**	**CC-3.5**	**CC-6.0**	**HC-2.5**	**HC-5.0**	**IC-1.5**	**IC-2.5**	**IC-4.5**	**YT-24**
2011	--	--	--	134	--	--	181	--	--	253	--
2012	--	--	--	132	--	--	153	--	--	198	--
2013	--	--	--	167	--	--	133	--	--	255	--
2014	92	9	125	71	150	119	97	103	73	169	21
2015	189	110	251	76	263	179	111	145	141	216	90
2016	142	NA	281	104	168	138	94	136	98	174	87
Average (2014-2016)	141	60	223	83	194	145	101	128	104	186	66

3.2.1.2 Unit Yields

Local patterns of streamflow are dominated by a snowmelt freshet that typically occurs late-April to mid-June and punctuated by multiple rainfall-induced high flow events that occur throughout the summer and autumn. In general, these high flow events are short lived, often persisting for a duration of 1 or 2 days. A plot showing the unit yields for all Project drainages, for their periods of record, is presented in Figure 3-18

In general, average unit yields across the Project site are 9 L/s/km^2 for the open water season (May to October), and range from 4.5 to 15 L/s/km^2, depending on the drainage. The YT-24 and CC-1.0 drainages that drain the north and south waste rock dumps (respectively) have the lowest yields, while Upper Latte Creek (CC-6.0 and CC-1.5) and Independence Creek at the Mouth (IC-4.5) have the highest yields.

In 2016, unit yields across the project site averaged 9.2 L/s/km^2 for the open water season (May to October), and ranged from 5.5 to 13.3 L/s/km^2.

As described in the main report, long-term synthetic streamflow records are based on statistical relationships with the discharge data collected at the Indian River at the Mouth (09EB003; 2120 km^2) Water Survey of Canada (WSC) station. The objective of this approach is to re-create a longer stream flow record for the Project site basins that provides a realistic estimate of the long-term frequency and magnitude distribution of discharges at the Project site. As the data from the Indian River record for 2016 is preliminary, and subject to revision by the WSC, the synthetic discharge series have not been extended to 2016. However, plots of unit yields for the site stations and the Indian River records are presented below in Figure 3-18 through Figure 3-24 for comparative purposes. The Indian River record is reflective of a much larger watershed area compared to the Project site watersheds, and therefore the runoff responses to larger events (*i.e.*, freshet and rainfall driven) is more muted than for the Project watersheds. However, notably, the timing of larger discharge events is generally comparable between the watersheds, and the low flow signature is remarkably similar.

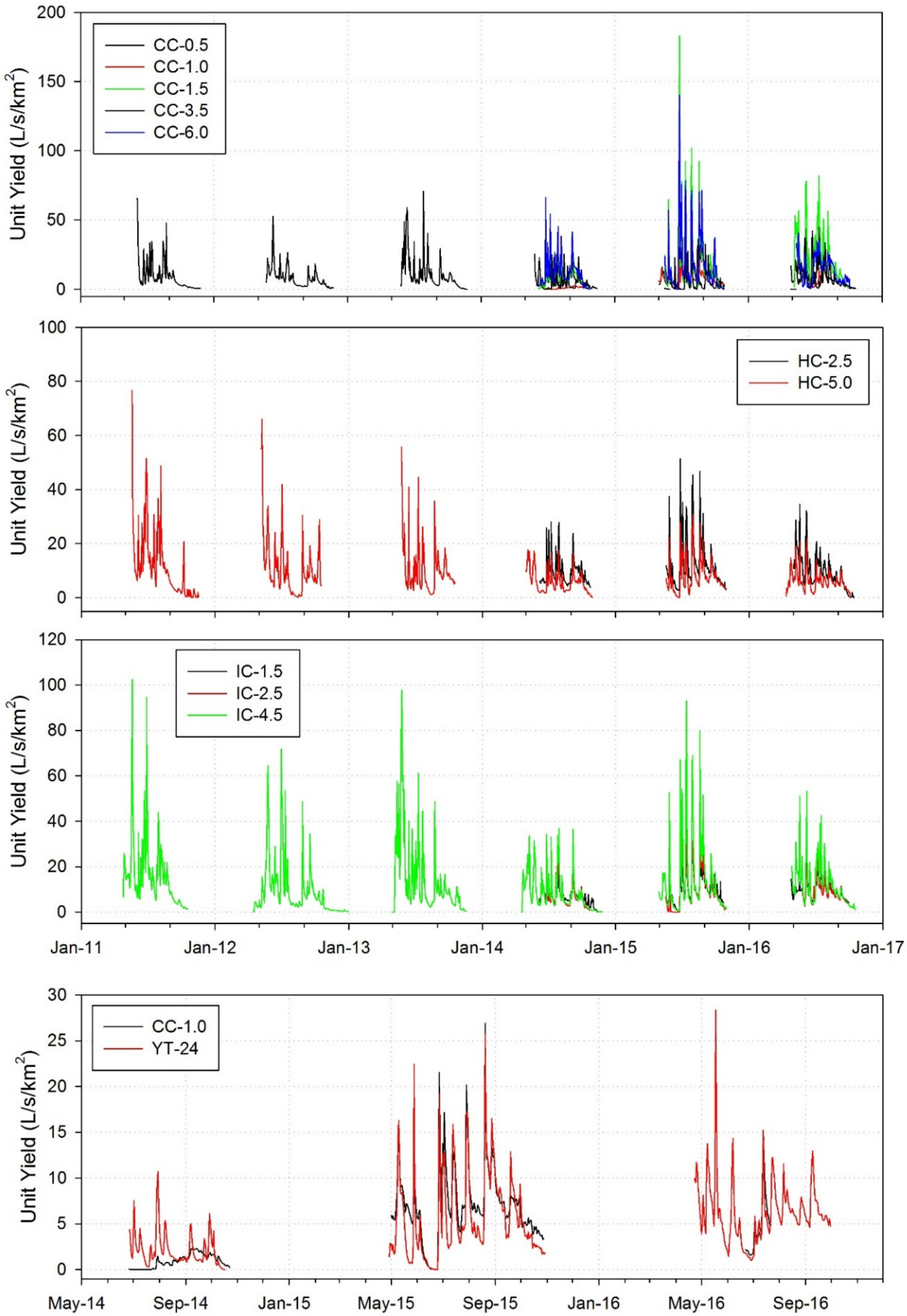

Figure 3-18: Unit yield hydrographs for gauged Project basins.

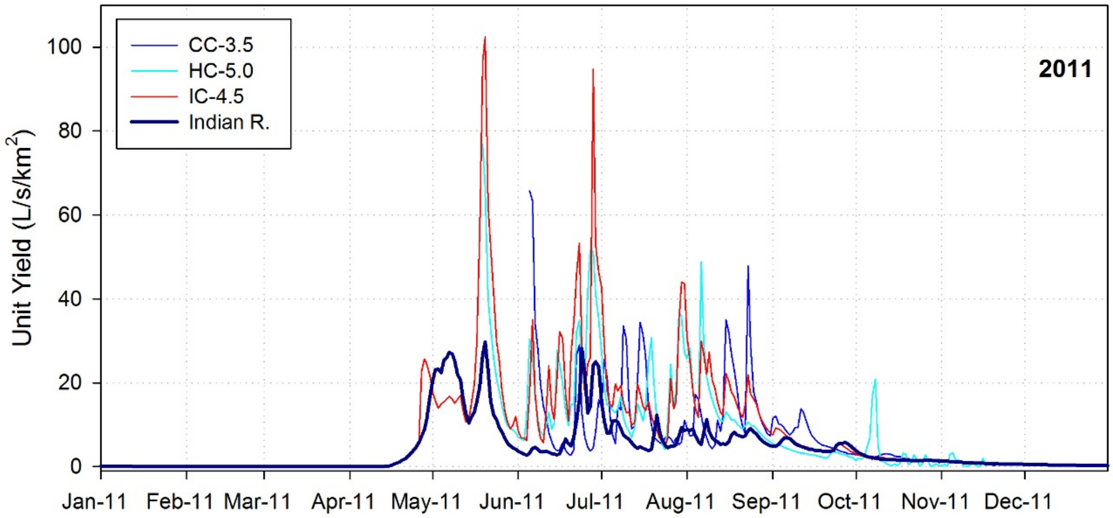

Figure 3-19: 2011 unit yield hydrographs for gauged Project basins and the Indian River (09EB003)

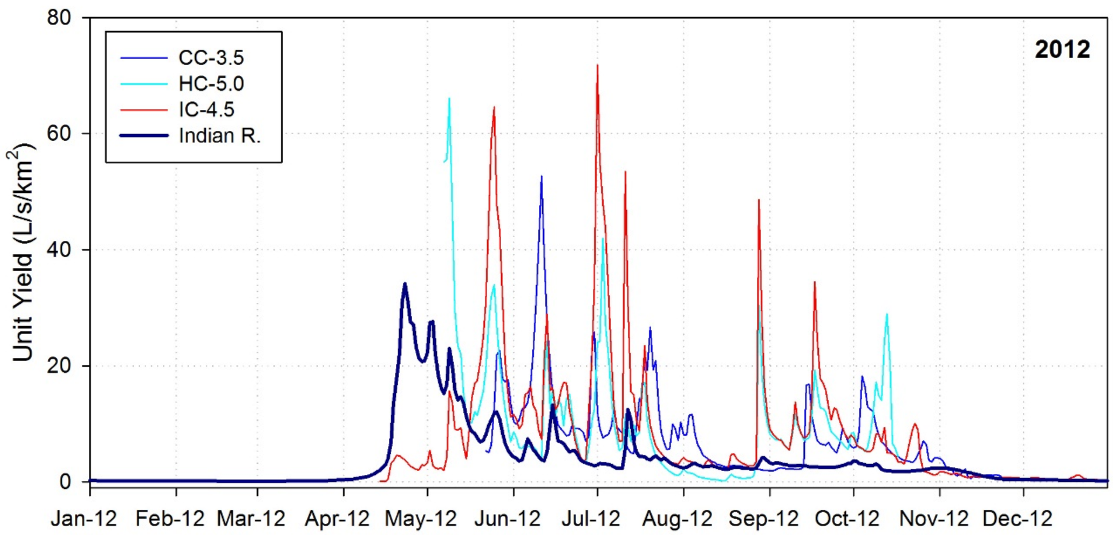

Figure 3-20: 2012 unit yield hydrographs for gauged Project basins and the Indian River (09EB003)

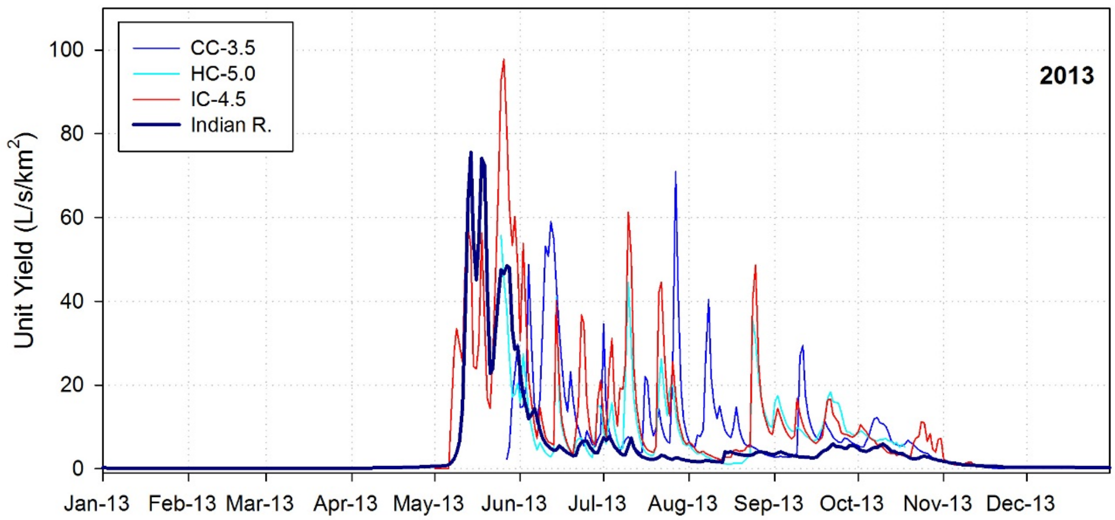

Figure 3-21: 2013 unit yield hydrographs for gauged Project basins and the Indian River (09EB003)

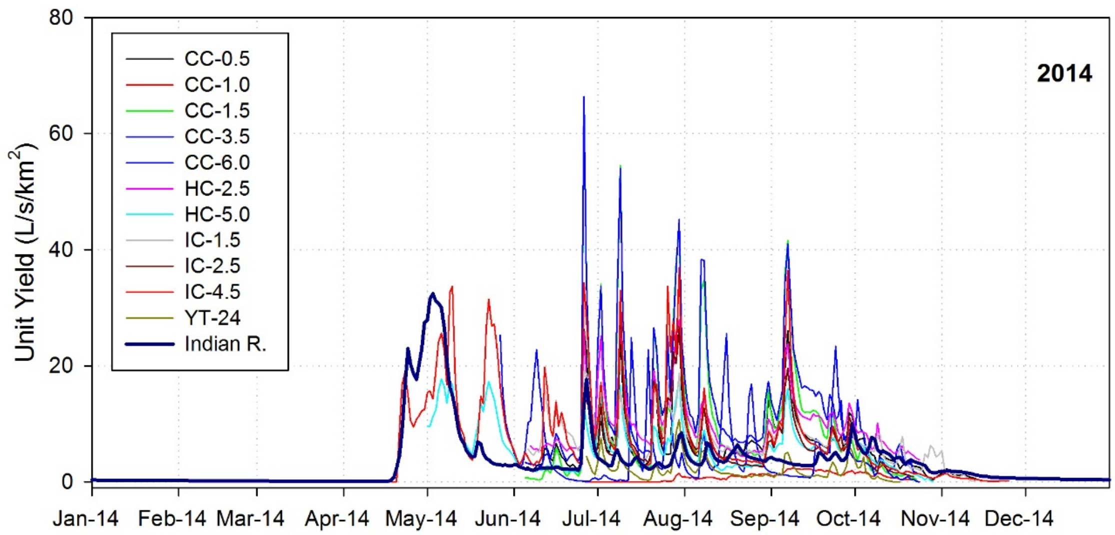

Figure 3-22: 2014 unit yield hydrographs for gauged Project basins and the Indian River (09EB003)

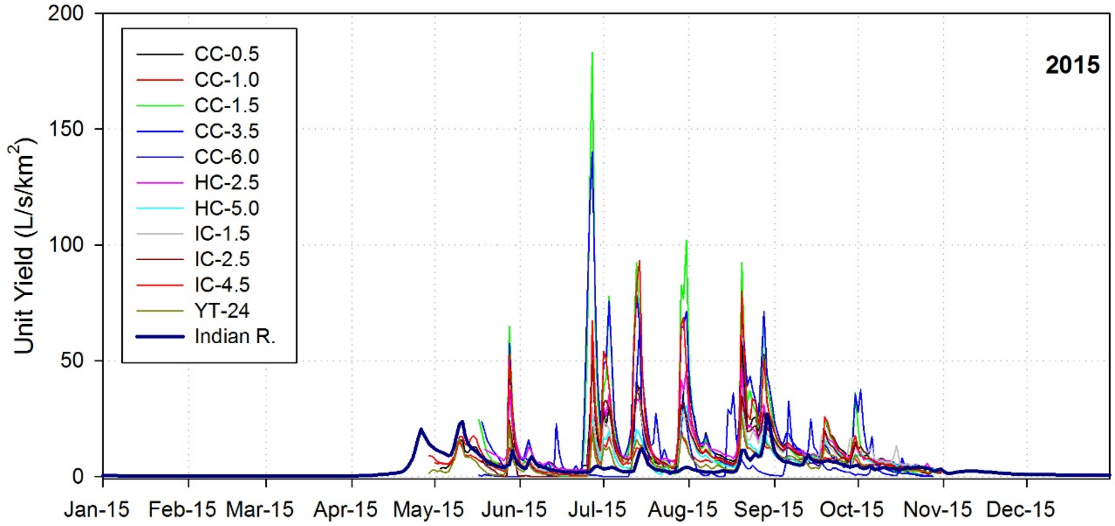

Figure 3-23: 2015 unit yield hydrographs for gauged Project basins and the Indian River (09EB003)

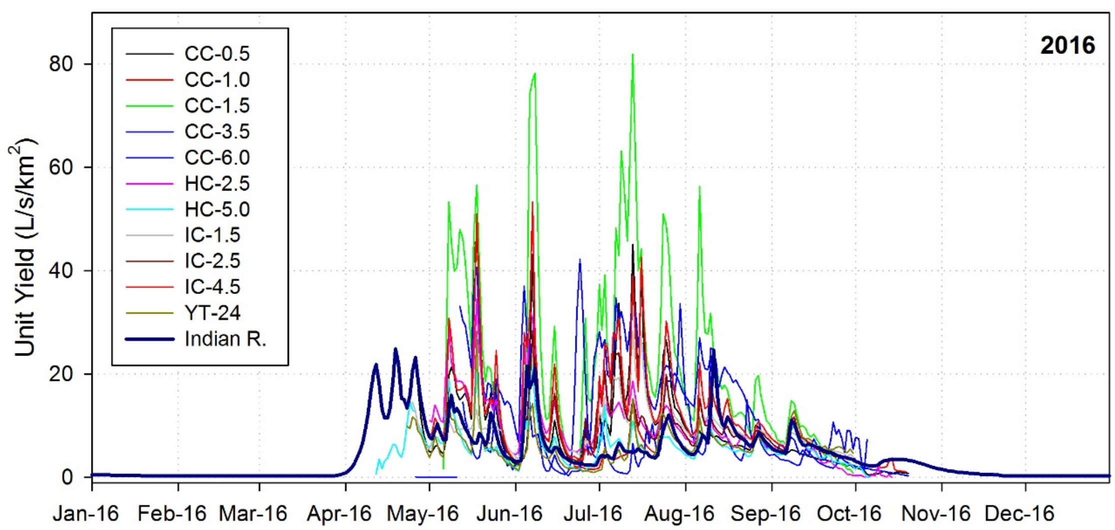

Figure 3-24: 2016 unit yield hydrographs for gauged Project basins and the Indian River (09EB003)

4. Closure

4. Closure

We trust that this plan meets your requirements at this time. Please contact us should you have any questions or concerns, or require additional information in support of this work.

Yours sincerely,
Lorax Environmental Services

per:

Signature REDACTED

Signature REDACTED

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References

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References

Resource Inventory Standards Committee (2009). *Manual of Standard Operating Procedures for Hydrometric Surveys in British Columbia - Version 1.0*. Prepared by Ministry of Environment, Science and Information Branch for the Resources Information Standards Committee. 222 p.

Appendices

GOLDCORP

Appendix B
Extreme Precipitation and Snowmelt Runoff Technical Memo

GOLDCORP

MEMORANDUM

To:	**Allison Rippon Armstrong, Kaminak Gold Corp**	**Date: 1 April, 2015**
From:	**Colin Fraser and Scott Jackson**	**Project #: A362-3**
Subject:	**Extreme precipitation depths and snowmelt – Coffee Creek**	

1. Introduction

1.1 Memo Objectives and Layout

This memo synthesizes regional climate data (rainfall, snowfall) for stations near (within 200 km radius) the Coffee Creek property. Specifically, return period estimates of extreme precipitation (1:2 year, 1:5 year, 1:10 year, 1:25 year, 1:50 year, 1:100 year and 1:200 year) are presented for an array of metrics (*e.g.,* 24-hour, 2-day, 3-day, 10-day and 30-day precipitation depths).

These precipitation estimates are intended for use in infrastructure design and engineering studies at the Project Site, as well as the site-wide water balance model – as appropriate. By means of example, 24-hour precipitation with 1:100 and 1:200 year return periods will inform heap leach pad design overall, including the sizing of event ponds. Return period precipitation depths for longer durations (*e.g.,* 3-day, 10-day) may be evaluated in the context of 'upset condition' in site-wide water balance and water quality modelling (*e.g.*, implications of a 3-day power outage during closure).

Methods for this analysis are presented in Section 2 below and they describe the climate stations considered in the analysis, the steps taken to process the climate data, and the guiding principles of the frequency analysis. Results of the analysis are presented in Section 3 and Appendix A and B of the memo. A majority of the results in the memo focus on extreme summer rainfall (see Sections 3.1 and 3.2), noting that snow accumulation and rates of melt are discussed in Section 3.3. It is assumed there will be necessity to consider snow and snow melt to some degree during Project development. Section 3.3 results may be used for such purpose.

The memo concludes with a recap of key findings and a table of recommendations (see Section 4).

2. Methods

2.1 Sources of Data

The Coffee Creek property is situated ~80 km from the Alaska border and therefore, two main sources of climate data were used to assemble this memo:

1) NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 7 Version 2.0: Alaska.

- The NOAA Atlas 14 contains recent precipitation frequency estimates for Alaska with associated 90% confidence intervals and supplementary information on: temporal distribution of heavy precipitation; and analysis of seasonality and trends in annual maximum series data.
  NOAA Atlas 14 results are published through the Precipitation Frequency Data Server viewable at this location: http://hdsc.nws.noaa.gov/hdsc/pfds
- Throughout this memo, these data and resources are references as NOAA (2012).

2) Environment Canada daily climate station data.

- Long-term climate data from nearby Yukon Territory climate observatories (*i.e*, within 200 km radius of proposed heap leach location).
- Daily climate data for variables of interest (air temperature (min, max, average), wind speed, relative humidity, atmospheric pressure, precipitation (rain, snow, total)) were retrieved from http://climate.weather.gc.ca/.
- After Bonifacio *et al*. (2015), the Canadian Climate Data Scraping Tool (CCDST) was used to retrieve and pre-process Environment Canada station files.

State of Alaska and Yukon Territory climate stations situated near the Coffee Creek property are listed in Table 2.1-1. Of these 20 stations (Coffee Creek location excluded), 19 showed period of record ≥18 years and were included in the frequency analysis. Eight of the 19 climate stations are situated in Alaska with the remaining eleven being in Yukon Territory. A map showing the location of relevant climate stations is provided as Figure 2.1-1.

Prior to conducting the extreme rainfall frequency analysis on the available datasets, raw climate data files were inspected and explored to identify spatial, temporal and orographic patterns within. Some preliminary findings from this initial data inspection are presented in Section 3.1, noting that Alaska and Yukon climate station are described and compared to Coffee Creek baseline climate measurements in detail and under a separate cover (*i.e*., see Lorax 2015).

2.2 Rainfall Frequency Analysis

Overall, frequency analysis is a process of fitting common distributions to input data (*e.g.*, the Generalized Extreme Value (GEV), LogPearson 3 and Gumbel Maximum distribution). Return period (*e.g.*, 1 in 2 year, 1 in 10 year, 1 in 100 year, 1 in 200 year) estimates of precipitation depth may then be estimated from best-fitting distribution(s) to the input data.

State of Alaska

A recent and comprehensive extreme precipitation analysis was completed for the State of Alaska. The results of this assessment are summarized within NOAA (2012). Extreme precipitation output for nearby station Northway, Alaska (~130 km from Coffee Creek), is presented in Appendix A to illustrate the overall quality and comprehensiveness of this extreme precipitation assessment. Eight State of Alaska climate stations were considered in this assessment: EAGLE, CHICKEN, BOUNDARY, ALCAN HWY, NORTHWAY AP, JATAHMUND, TOK and CHISANA.

Yukon Territory

To utilize State of Alaska extreme precipitation data to its fullest and to also allow meaningful comparisons - a frequency analysis was undertaken on Yukon Territory climate stations using complimentary methods. To assemble and process the raw climate data for the Yukon, the following steps were followed:

- Daily climate data files were downloaded for Environment Canada stations for meteorological parameters of interest.
- From the complete dataset per climate station, May to end-September daily precipitation data was extracted from the available period of record.
- From the available period of record, 24-hour, 2-day (*i.e.*, rolling two-day sum), 3-day, 10-day and 30-day precipitation depths were calculated per station.
  - Consistent with NOAA (2012), 24-hour precipitation depths were computed from daily precipitation observations by applying a data scalar of 1.12.
    - Due to the fixed beginning and ending of observation times at Environment Canada stations, it was assumed reasonable that extracted maxima are lower than an unconstrained maxima for any 24-hour period. This assumption was the basis for applying a data scalar to daily precipitation observations.
  - Also consistent with with NOAA (2012), 2-day and 3-day precipitation depths were adjusted by data scalars of 1.05 and 1.04 respectively.
  - For the 10-day and 30-day precipitation depth calculations no adjustments were made to the raw data (*i.e.*, no data scalar applied).
- Next, daily precipitation data were inspected on a year by year basis.
  - For years of record showing prolonged data gaps (*e.g.*, >10 days of missing data; <80% complete) during June, July and August – the year of record was considered incomplete and excluded from the frequency analysis. This screening reduced available data entered into the frequency analysis by a small amount (*e.g.*, a year or two of record excluded for a 50-year long climate record).
- Lastly, annual maximum 24-hour, 2-day, 3-day, 10-day and 30-day precipitation depths were extracted per station for the available period of record.

Annual maximum series per station and per extreme event (*i.e.*, 24-hour, 2-day, 3-day, 10-day and 30-day) were imported to EasyFit Statistical Software and continuous probability distributions were fitted to the data. Similar to NOAA (2012) and through an inspection of the statistics and ranking data outputted by EasyFit - several distributions were found to fit the input data well. For purposes of consistency with the NOAA (2012) assessment, the GEV distribution was adopted as the de facto distribution for the Yukon assessment. The following return periods were estimated for the climate stations and events of interest: 1:2 (median), 1:5 (wet/dry), 1:10 (wet/dry), 1:25 (wet/dry), 1:50 (wet/dry), 1:100 (wet/dry) and 1:200 (wet/dry).

Presentation of results

As a final step in the extreme precipitation analysis, return period precipitation estimates were plotted in Excel and mapped. Estimates were regressed against station latitude, station longitude and station elevation in an effort to ascertain patterns and/or trends within the amalgamated datasets. Three plots for each of the five precipitation metrics (*i.e.*, 24-hour, 2-day, 3-day, 10-day and 30-day) are presented in Appendix B.

Two patterns in the data emerged via this analysis: 1) a strong west-east extreme precipitation gradient, where precipitation estimates were higher west of the Coffee Creek property and lower east of the property; and 2) a general increase in precipitation with elevation. These patterns are illustrated by the two panels of Figure 2.2-1.

Owing to these two patterns and the objective to represent extreme precipitation at the elevation of the heap leach pad, Coffee Creek return period precipitation estimates were computed two ways. In the first method, an envelope or upper bounding curve was fitted to precipitation estimates when plotted against station longitude. Next, the precipitation estimate on this upper bounding curve that corresponded to the Coffee property (*i.e.*, 139.3°W) was entered to a summary table (see results in Section 4.2). An example of this approach is shown in Figure 2.2-2 for 3-day precipitation, 1:25 year event.

For the second method, precipitation estimates (*e.g.*, 24-hour, 2-day, 3-day, 10-day and 30-day) for five stations showing similar location to the Coffee Creek property were first aggregated and then up-scaled to elevations 1,200 m and 1,300 m respectively. The five stations aggregated were in this approach were McQuesten, Klondike, Dawson, Stewart River and Snag. For each metric and return period, the 90th-percentile precipitation depth for the five stations was assumed to be representative of elevation 600 m. Precipitation depths were up-scaled using elevation gradients estimated from 1:2 year regression equations presented in Figure 2.2-1 (lower panel).

2.3 Snow accumulation and melt

An assessment of snow accumulation and snow melt is provided in this memo as the onset of freshet may overlap with an extreme rainfall event. In this regard, aspects of Project design may need to consider event water derived from melting snowpack, in addition to, extreme rainfall.

Return period estimates of April 1 snow water equivalent are presented for Coffee Creek elevation 1,200 m and 1,300 m in Lorax (2015). Methods for their estimation are presented in their report with results presented in Section 3.3 below. These values give indication of the typical (1:2 year) and extreme wet/dry (1:100 year, 1:200 year) snow storage at elevations corresponding to the heap leach pad and related water management infrastructure.

To better understand snowmelt timing, duration and rates of melt, period of record snow pillow data was inspected for six Snotel stations (Chisana, May Creek, American Creek, Granite Creek, Teuchet Creek and Upper Chena) near the Coffee Creek property. Of the six stations, three are situated close (within ~150 km; Chisana, May Creek and American Creek) to Coffee and show period of record ranging from 3 to seven years. The remaining three stations show much longer period of record, very similar patterns in melt onset, rate and duration of snowpack ablation. However, these stations are situated at further distance (on the order of 250 km) from site.

A table summarizing rates of snowmelt across the region is presented in Section 3.3. Minimum, average and maximum rates presented therein are computed from the annual series of maximum melt per station.

Table 2.1-1:
Alaska and Yukon Climate Stations near the Coffee Creek Property

Station	State, Prov	Elevation (m)	Latitude	Longitude	Distance to Site (km)	Period of Record*
EAGLE	AK	256	64.783	-141.200	225	1902 to present (82)
CHICKEN	AK	548	64.100	-141.917	180	1911 to present (20)
BOUNDARY	AK	793	64.067	-141.117	160	1948-1957 (10)
ALCAN HWY	AK	549	62.817	-141.467	105	1990 to present (20)
NORTHWAY AP	AK	522	62.967	-141.933	125	1943 to present (63)
JATAHMUND	AK	701	62.600	-142.083	140	1991 to present (20)
TOK	AK	494	63.350	-143.050	190	1959 to present (41)
CHISANA	AK	1,012	62.133	-142.083	160	1988 to present (19)
BEAVER CREEK A	YK	649	62.410	-140.868	90	1968 to present (37)
SNAG A	YK	587	62.367	-140.400	80	1943-1966 (23)
STEWART CROSSING	YK	480	63.383	-136.683	150	1963-2008 (24)
STEWART RIVER	YK	358	63.317	-139.433	50	1976-1993 (18)
BURWASH A	YK	807	61.371	-139.040	170	1966 to present (45)
CARMACKS	YK	525	62.100	-136.300	180	1963 to present (41)
DAWSON A	YK	350	64.043	-139.128	130	1897 to present (114)
LITTLE GOLD CREEK	YK	1,257	64.083	-141.000	155	1974 to 1999 (17)
KLONDIKE	YK	973	64.453	-138.216	185	1966 to 2010 (37)
MAYO A	YK	504	63.617	-135.867	195	1924 to present (88)
MCQUESTEN	YK	458	63.594	-137.523	120	1986 to present (28)
PELLY RANCH	YK	445	62.817	-137.367	100	1952 to present (59)
COFFEE GOLD	YK	975	62.877	-139.300	0	2012 (July) to present

***Bracketed values indicate number of years (n) incorporated into the extreme precipitation analysis.**

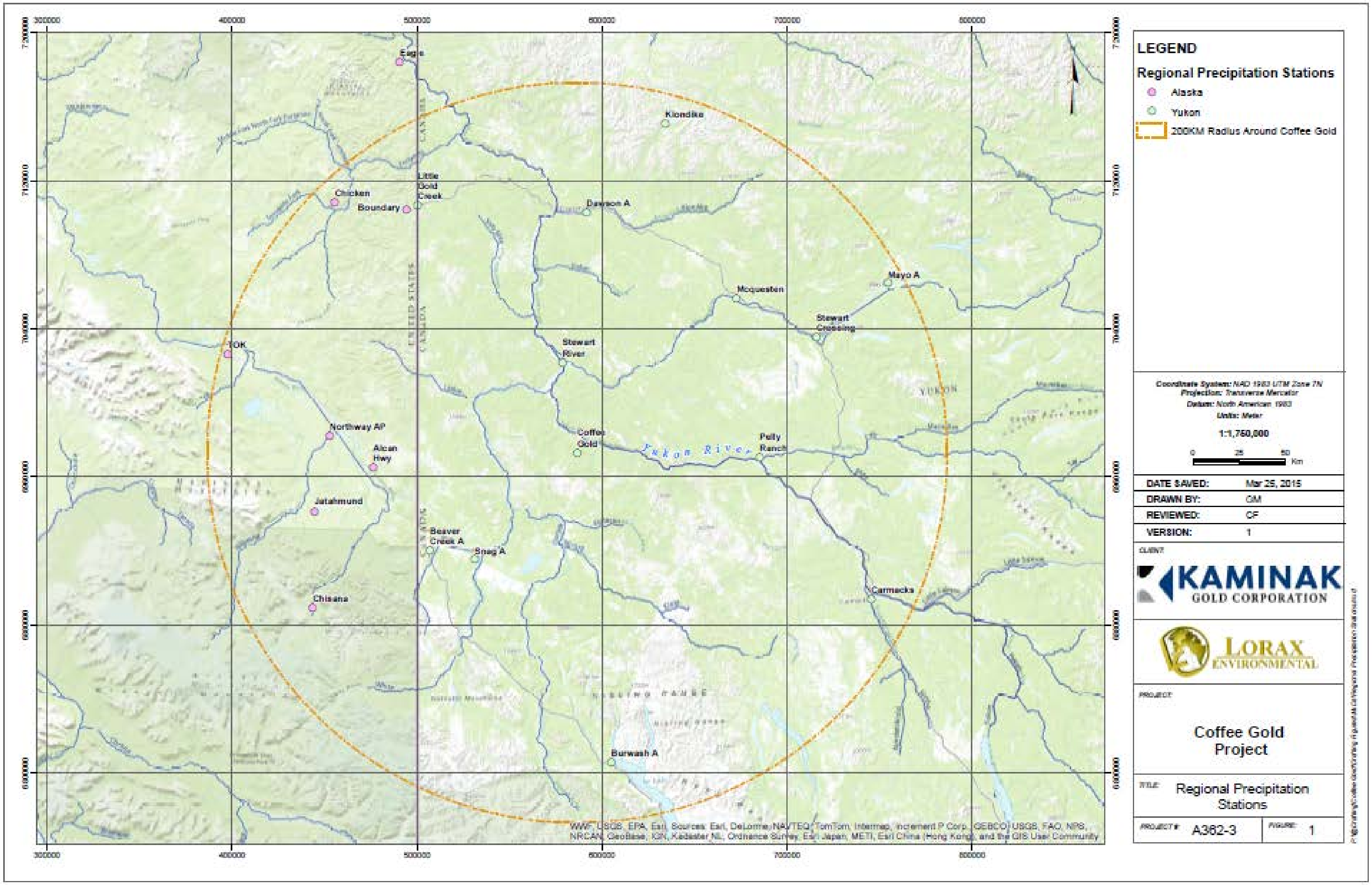
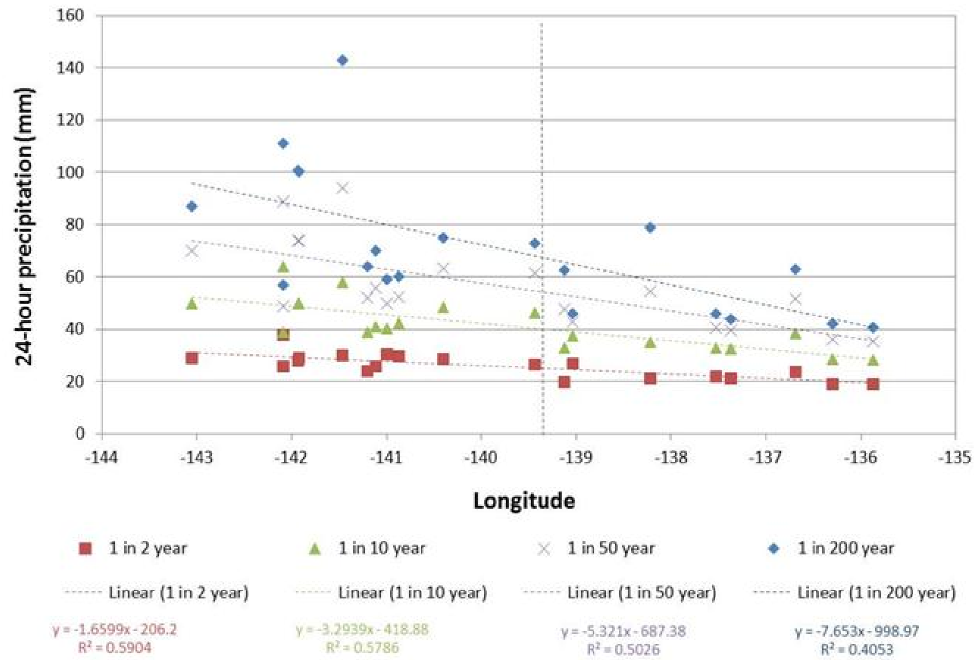


Figure 2.1-1: Alaska and Yukon climate station location map (from PDF, looks like above).



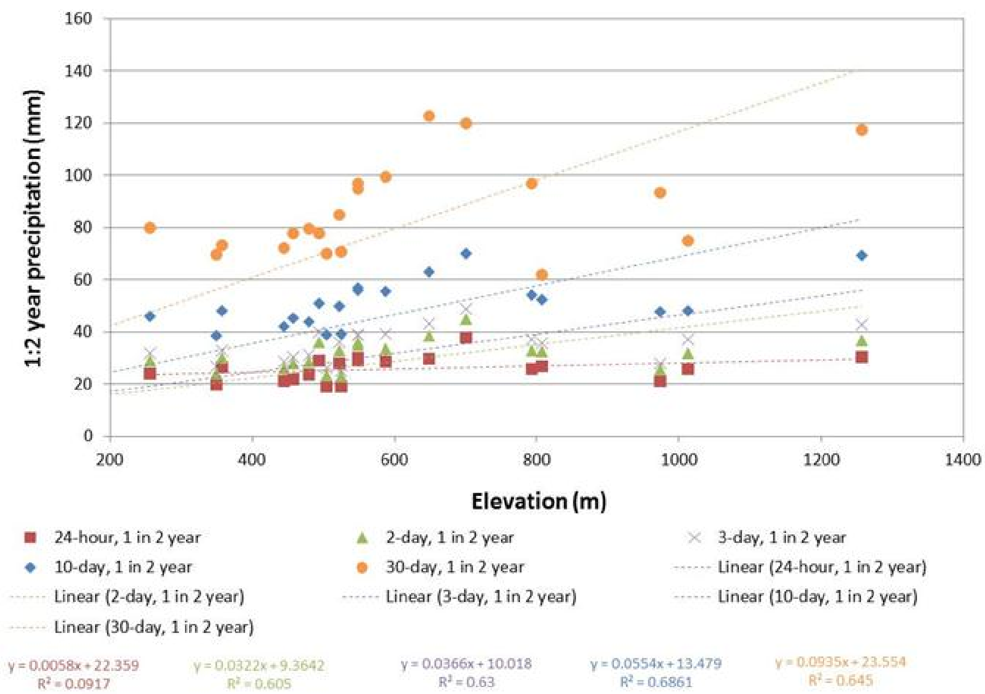


Figure 2.2-1: Example of the local relationship between extreme precipitation and station longitude (upper panel). In this figure (24-hour precipitation is shown), the longitude of Coffee Creek is shown with vertical dashed line. The lower panel shows the relationship between 1:2 year precipitation (for five precipitation metrics) and station elevation.

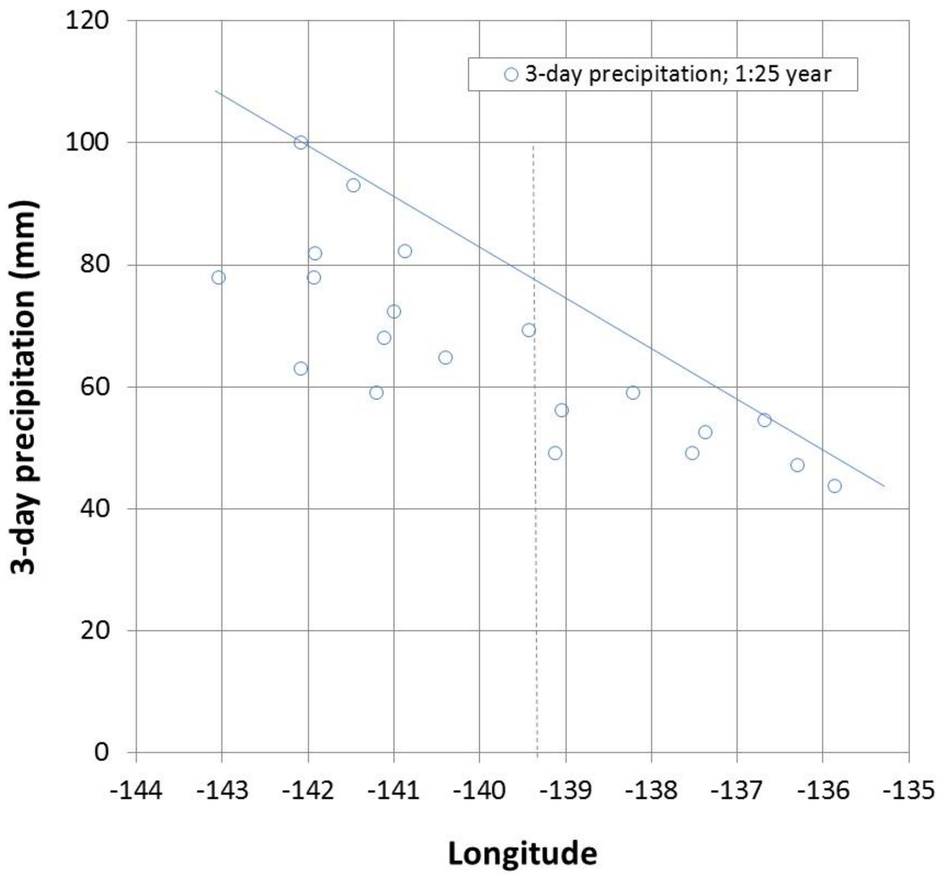


Figure 2.2-2: Example of an upper bounding envelope to a subset of data. The data shown are for 3-day precipitation and frequency of 1:25 year.

3. Results

3.1 Extreme precipitation – Processes, patterns, record length

Processes

Synoptic patterns and mechanisms governing summer and winter precipitation near the Coffee Creek property are reviewed in Lorax (2015).

Briefly, Cassano and Cassano (2010) analysed sea level pressure patterns for the Yukon River basin and found that the winter circulation patterns are dominated by the strong Aleutian Low. By comparison, summer patterns are characterized by low pressure systems over land and the Beaufort/Chukchi Sea and weak high pressure cells to the north. This results in easterly/northeasterly circulation into the Basin in the summer.

The authors report that in the summer and owing to easterly/northeasterly circulation, largest daily precipitation events (*i.e.*, top 10th and 1st percentile daily totals, on an annual basis) were associated with an increased frequency of cyclones and over-land convective events. Evapotranspiration rates are highest during the summer, and therefore additional moisture is recycled and available to precipitate.

From a state-wide and Alaskan perspective, the following description is provided in NOAA (2012) for extreme summer precipitation there:

"During the summer months, a large area of high pressure that resides over the northern Pacific Ocean, the North Pacific High, dominates much of the state below the Arctic. Radiational warming due to increased hours of sunlight helps to destabilize the atmosphere creating areas of convection in the interior region. The convective storms can be triggered and intensified by the passing of an upper-level trough or a cold front, which are more prevalent during the warm season. Under the right large-scale pressure pattern, strong southwest flow over Alaska can bring warm moist subtropical air from the Pacific into the state.

The remnants of tropical systems can be picked up in this flow and supply additional moisture for the air mass as it surges northeast over the Alaska Range. Such was the case in August 1967 when the Fairbanks area received more than half of its annual precipitation amount in less than a week."

Monthly Patterns of Extreme Precipitation

Maximum 1-day precipitation depths are presented for nearest climate stations in Table 3.1-1 for each month of the year and for available period of record. These data show that summer months – and in particular, June, July and August – return largest 1-day precipitation observations. A subset of the data reported in Table 3.1-1 data (8 stations plotted) is shown in Figure 3.1-1 (upper panel) and the plot clearly illustrates this pattern.

A seasonality analysis on extreme precipitation was included in NOAA (2012) for the State of Alaska. An example of a seasonality graph from that study is presented in Figure 3.1-1 (lower panel. This figure show the percentage of annual maxima for a given duration that exceeded the NOAA Atlas 14 precipitation frequency estimates for the duration and selected annual exceedance probabilities in each month. Like the upper panel of Figure 3.1-1, this panel underscores the importance of June, July and August for realization of extreme precipitation.

Record length

This assessment was assembled with readily available Alaskan and Yukon climate station data, and for stations showing ~20 years or more record. Stations with shortest periods of record were: Little Gold Creek, Stewart River, Chisana, Alcan Hwy and Chicken. In contrast, several stations (*e.g.*, Dawson, Eagle, Mayo and Northway, AP) show period of record in the range of 60 to >110 years.

24-hour, maximum precipitation series are shown for Dawson, Eagle, Mayo and Northway in Figure 3.1-2. Consistent with recent research (*e.g.*,see Papineau, 2015 for a current synthesis) data in figure 3.1-2 show evidence for inter-decadal variability in extreme precipitation. Of note, there are two periods with generally larger extreme events: 1) 1930 to 1960; and 2) 1990 to the present. Current research points to the timing and phase of climate cycles (*e.g*., Pacific Decadal Oscillation, Artic Oscillation, La Nina/El Nino) as potential controls on extreme precipitation in this locale.

Table 3.1-1:
Extremes (Maximum 1-day precipitation depths) at Alaska and Yukon climate stations.

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
EAGLE	15.2	12.7	14.5	18.8	35.1	34.5	42.4	47.2	36.8	22.9	26.7	17.8	44.2
CHICKEN	0.5	8.1	8.1	38.1	44.5	30.5	69.9	34.3	46.0	10.2	10.2	5.6	69.9
BOUNDARY	12.7	5.1	10.7	6.6	25.4	23.6	50.8	42.7	11.2	10.9	14.7	12.7	50.8
ALCAN HWY	13.0	21.3	13.2	20.3	22.9	37.6	80.3	59.7	19.1	10.7	1.3	57.7	80.3
NORTHWAY AP	20.1	15.5	9.4	13.5	26.4	49.5	96.5	39.6	28.4	17.5	13.5	9.9	96.5
JATAHMUND	13.7	6.4	13.2	9.4	14.7	82.8	82.3	43.4	40.9	15.2	0.3	40.9	82.8
TOK	26.7	26.7	12.7	17.0	26.7	53.6	57.2	35.6	37.1	26.2	50.8	33.0	57.2
CHISANA	24.4	14.2	8.4	8.1	20.1	31.2	93.2	25.7	17.0	14.0	2.8	28.2	93.2
BEAVER CREEK A	18.3	25.0	11.5	19.6	22.0	35.2	45.6	35.6	34.5	17.0	20.0	20.0	45.6
SNAG A	19.8	13.7	19.3	22.9	34.0	52.6	51.8	42.7	25.1	24.1	8.9	21.8	52.6
STEWART CROSSING	12.0	12.0	16.0	12.0	40.0	27.2	33.5	42.2	25.0	20.0	20.0	27.0	42.2
STEWART RIVER	12.2	13.2	12.7	12.0	51.0	28.2	39.4	39.2	22.6	9.2	10.6	10.6	51.0
BURWASH	12.2	9.6	22.9	11.2	24.9	36.8	38.4	34.6	18.5	46.0	15.0	14.7	38.4
CARMACKS	16.0	23.0	10.0	12.2	30.0	25.0	31.4	34.0	21.2	13.4	13.2	16.0	34.0
DAWSON	19.6	15.5	22.4	31.8	50.8	31.8	52.8	47.2	22.9	30.5	27.4	24.1	52.8
LITTLE GOLD CREEK	---	---	---	---	34.5	33.0	42.0	32.0	22.6	---	---	---	42.0
KLONDIKE	26.0	25.0	21.8	25.0	20.6	50.0	44.0	25.0	47.5	27.0	21.0	29.0	50.0
MAYO	35.6	16.5	16.0	21.6	25.4	34.6	30.6	31.8	23.6	22.4	16.3	15.7	35.6
McQUESTEN	18.4	16.0	15.0	13.8	20.5	27.0	34.4	31.8	24.6	15.2	14.0	18.0	34.4
PELLY RANCH	15.2	13.5	20.0	17.5	26.4	29.2	34.8	30.4	33.0	20.1	20.8	15.0	34.8
COFFEE GOLD	12.7	11.9	1.3	12.2	16.0	16.3	15.0	17.0	8.1	12.2	5.8	3.0	17.0

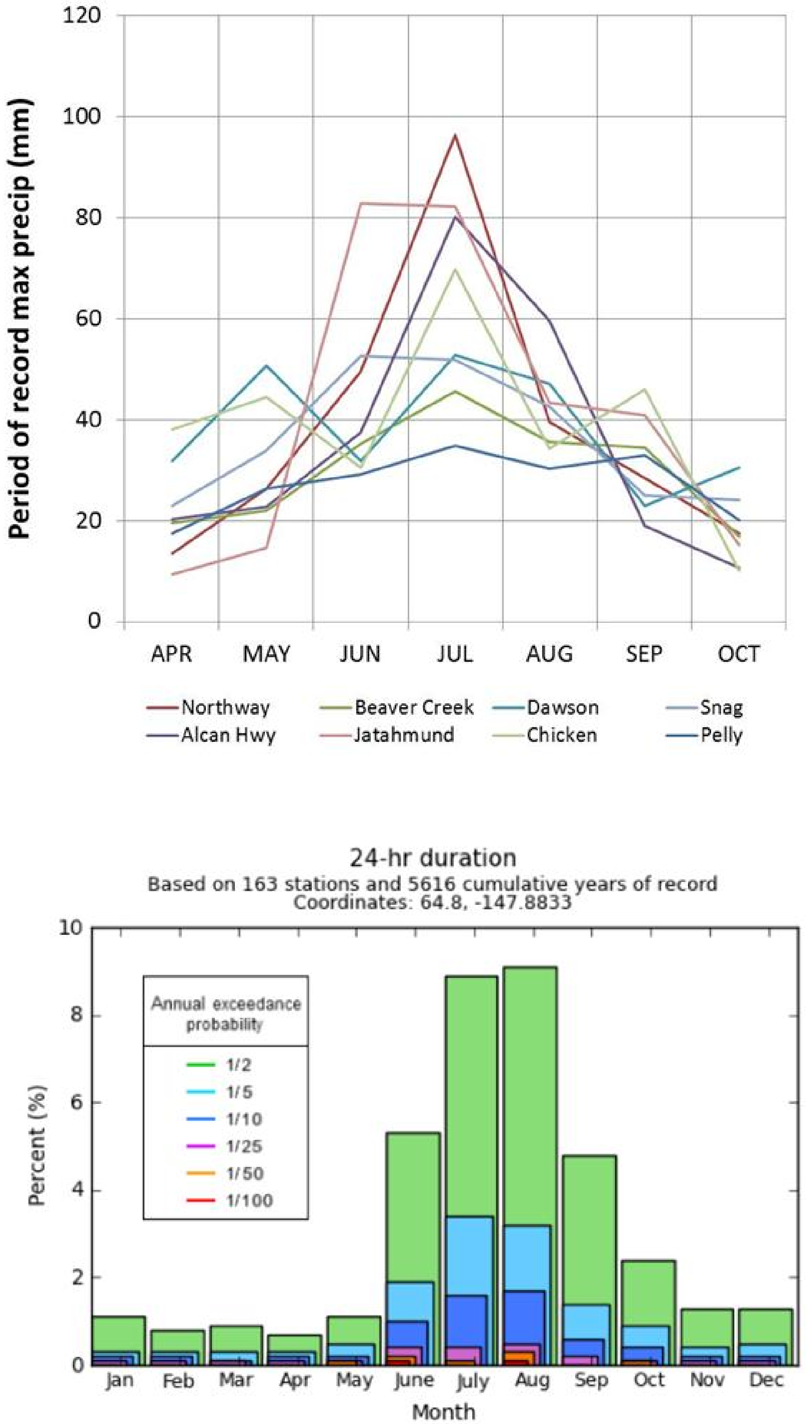


Figure 5.3.8. Sample 24-hour seasonal exceedance graph.

Figure 3.1-1: Monthly distribution of period of record maximum 1-day precipitation at climate stations near Coffee Creek (upper panel). The lower panel shows a sample 24-hour seasonal exceedance graph for State of Alaska (from NOAA 2012).

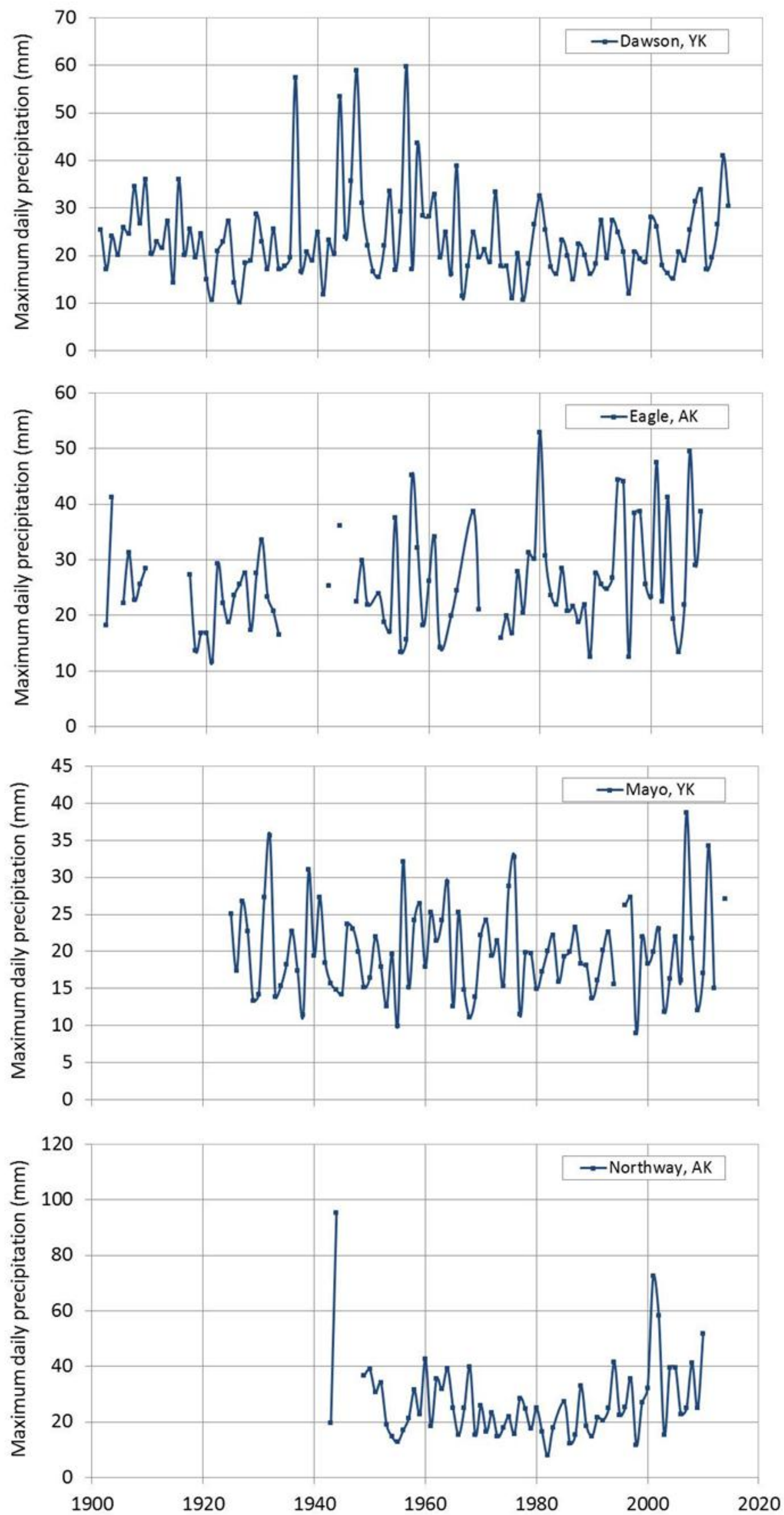


Figure 3.1-2: 24-hour, maximum precipitation records for Dawson, YK; Eagle, AK; Mayo, YK; and Northway, AK.

3.2 Frequency analysis results – Summer Rainfall

A summary of the frequency analysis results is presented below for five precipitation metrics (*i.e.*, 24-hour, 2-day, 3-day, 10-day and 30-day) and seven return periods *i.e.*, 1:2, 1:5, 1:10, 1:25, 1:50, 1:100 and 1:200 year) in this section. This summary is presented in Tables 3.2-1 through 3.2-5 and Figures 3.2-1 through 3.2-5. Additional supporting tables and plots (*e.g.*, precipitation depths regressed against each of station latitude, station longitude and station elevation) related to the assessment are presented in Appendix B.

Overall, the upper bounding envelope and elevation up-scaling approaches returned complimentary precipitation depths per metric and return period of interest. Of note, the 24-hour and 2-day, 1:100 year and 200 year precipitation depths returned by the upper bounding envelope approach were conservative compared to the results obtained through a scaling by elevation. At this point in the feasibility study, Section 3.2 results are recommended for use in mine planning and design studies. In circumstances where upper bound envelope estimates exceed elevation up-scaling – and vice versa – the more conservative result (higher value) is recommended for use.

Table 3.2-1:
24-hour precipitation for various return periods and elevations

		Annual exceedance probability (1:n years, 24-hour)						
Gradient (%)	**Elevation (m)**	**1:2 yr**	**1:5 yr**	**1:10 yr**	**1:25 yr**	**1:50 yr**	**1:100 yr**	**1:200 yr**
	600	28	40	48	56	63	69	77
2.2	700	28	41	49	58	64	70	79
2.2	800	29	42	50	59	66	72	81
2.1	900	30	43	51	60	67	73	83
2.1	1000	30	44	52	62	68	75	84
2.1	1100	31	45	53	63	70	76	86
2.0	1200	32	45	54	64	71	78	88
2.0	1300	32	46	55	65	73	79	90
	Upper bound approach	31	44	51	63	75	88	108

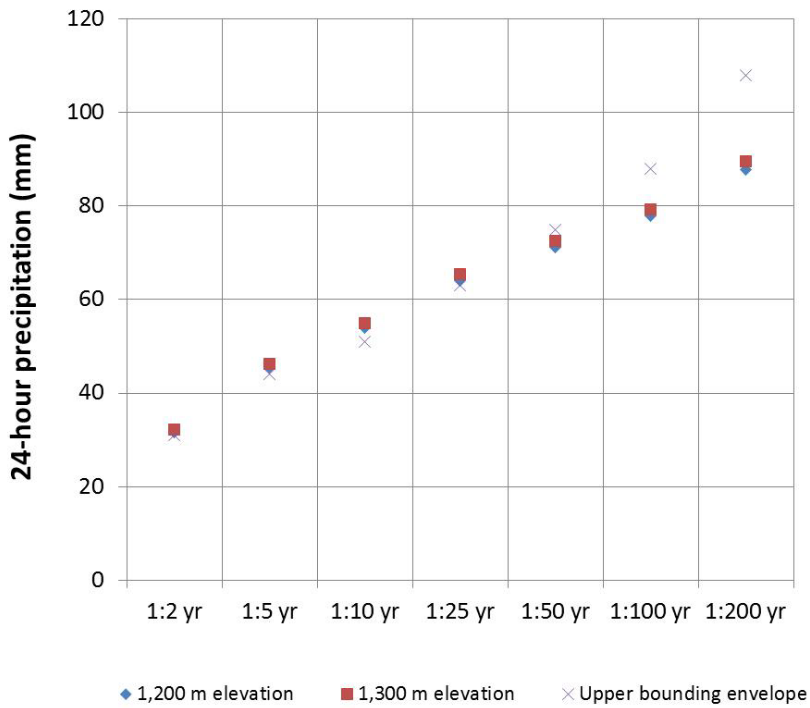


Figure 3.2-1: 24-hour precipitation for various return periods. Data are shown for the 1,200 and 1,300 m elevations as well as the result for the upper bounding envelope approach.

Table 3.2-2:
2-day precipitation for various return periods and elevations

		Annual exceedance probability (1:n years, 2-day)						
Gradient (%)	**Elevation (m)**	**1:2 yr**	**1:5 yr**	**1:10 yr**	**1:25 yr**	**1:50 yr**	**1:100 yr**	**1:200 yr**
	600	32	45	53	62	70	77	83
2.4	700	33	46	54	64	71	78	85
2.3	800	34	47	55	65	73	80	87
2.3	900	35	48	56	67	75	82	89
2.2	1000	35	49	58	68	76	84	91
2.2	1100	36	50	59	70	78	86	93
2.1	1200	37	51	60	71	80	88	95
2.1	1300	38	52	62	73	81	89	97
	Upper bound approach	37	51	60	72	84	95	114

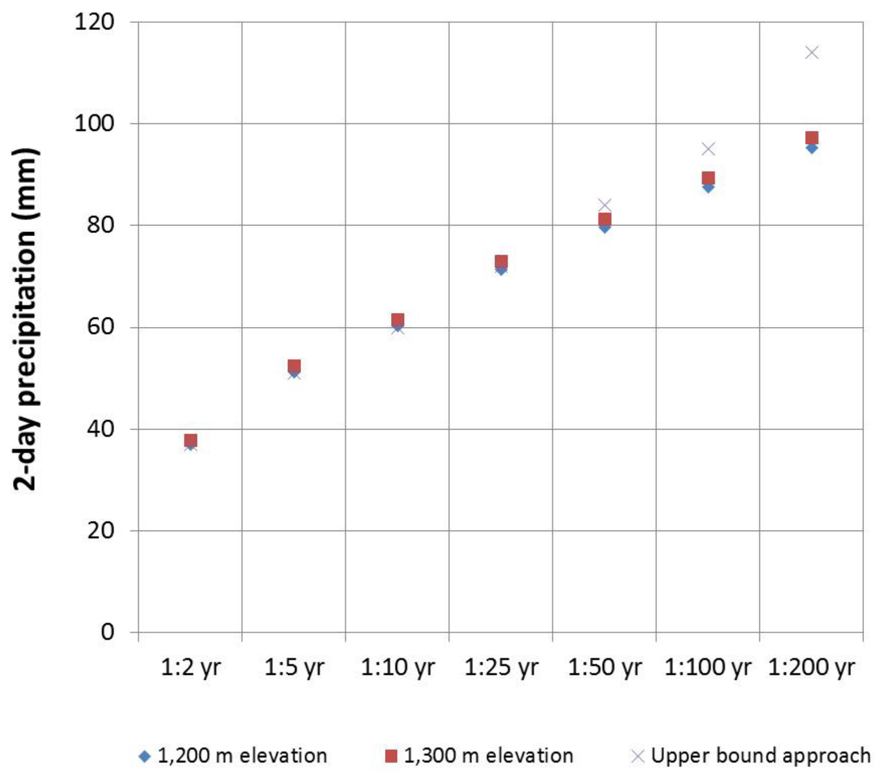


Figure 3.2-2: 2-day precipitation for various return periods. Data are shown for the 1,200 and 1,300 m elevations as well as the result for the upper bounding envelope approach.

Table 3.2-3:
3-day precipitation for various return periods and elevations

		Annual exceedance probability (1:n years, 3-day)						
Gradient (%)	**Elevation (m)**	**1:2 yr**	**1:5 yr**	**1:10 yr**	**1:25 yr**	**1:50 yr**	**1:100 yr**	**1:200 yr**
	600	37	50	58	68	75	86	99
3.0	700	38	51	59	70	78	89	101
2.9	800	39	53	61	72	80	91	104
2.8	900	40	54	63	74	82	94	107
2.7	1000	41	56	64	76	84	97	110
2.6	1100	42	57	66	78	86	99	113
2.6	1200	43	59	68	80	89	102	116
2.5	1300	44	60	69	82	91	104	119
	Upper bound approach	40	56	65	77	89	103	122

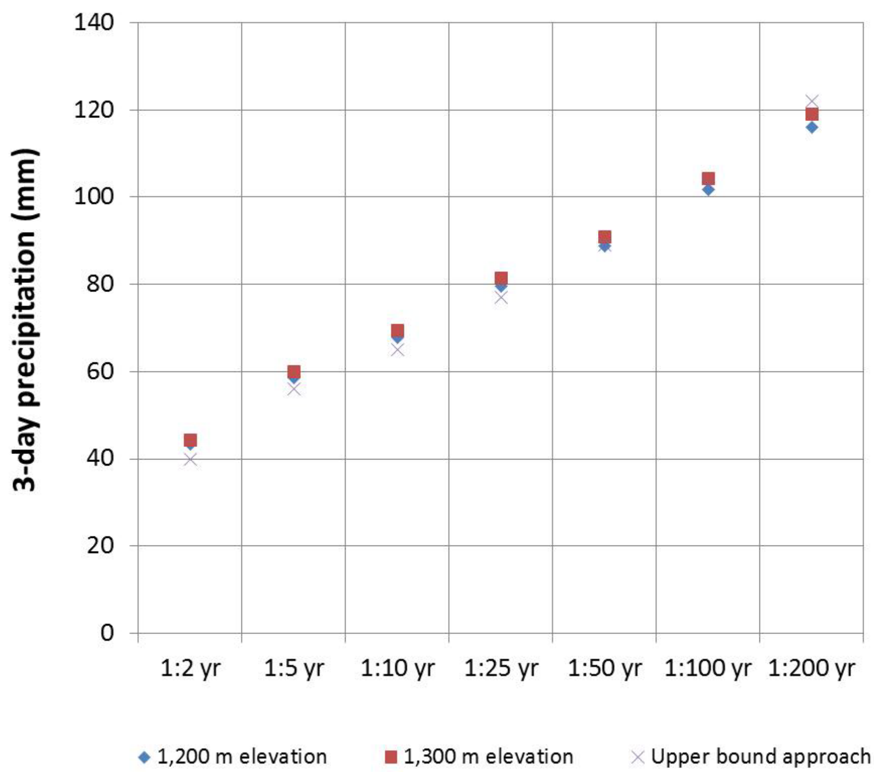


Figure 3.2-3: 3-day precipitation for various return periods. Data are shown for the 1,200 and 1,300 m elevations as well as the result for the upper bounding envelope approach.

Table 3.2-4:
10-day precipitation for various return periods and elevations

		Annual exceedance probability (1:n years, 10-day)						
Gradient (%)	**Elevation (m)**	**1:2 yr**	**1:5 yr**	**1:10 yr**	**1:25 yr**	**1:50 yr**	**1:100 yr**	**1:200 yr**
	600	53	69	79	93	103	116	129
3.9	700	55	72	82	96	107	120	134
3.8	800	57	74	85	100	112	125	140
3.6	900	59	77	88	104	116	130	145
3.5	1000	61	80	91	107	120	134	150
3.4	1100	63	83	94	111	124	139	155
3.3	1200	65	85	97	115	128	143	160
3.2	1300	67	88	100	118	132	148	165
	Upper bound approach	60	77	90	107	120	137	158

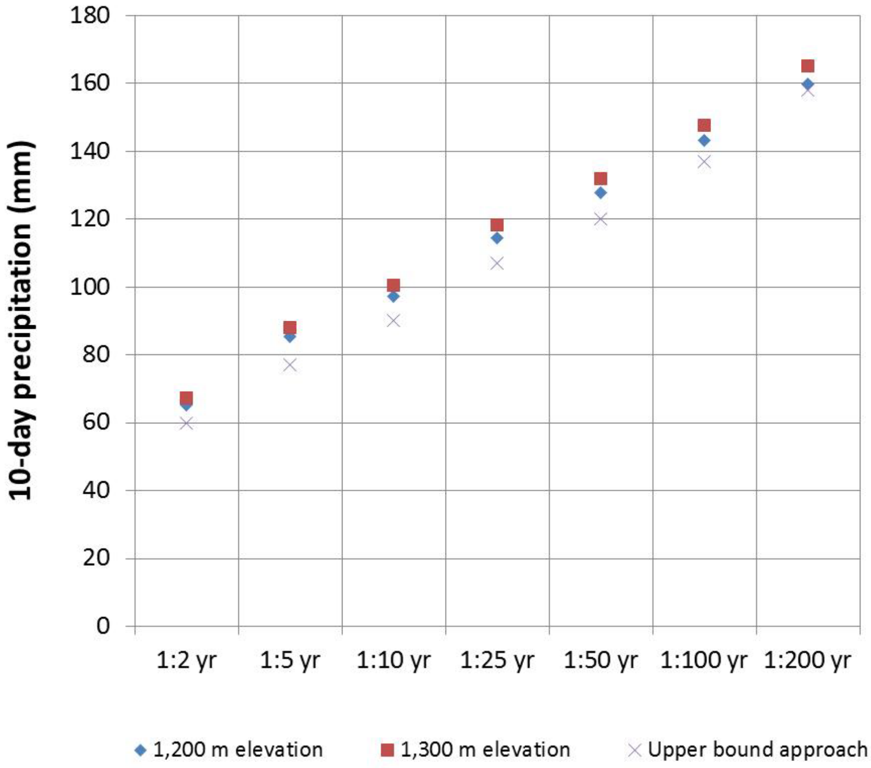


Figure 3.2-4: 10-day precipitation for various return periods. Data are shown for the 1,200 and 1,300 m elevations as well as the result for the upper bounding envelope approach.

Table 3.2-5:
30-day precipitation for various return periods and elevations

		Annual exceedance probability (1:n years, 30-day)						
Gradient (%)	**Elevation (m)**	**1:2 yr**	**1:5 yr**	**1:10 yr**	**1:25 yr**	**1:50 yr**	**1:100 yr**	**1:200 yr**
	600	97	123	137	152	161	171	180
3.6	700	101	128	142	157	167	177	186
3.5	800	104	132	147	163	173	183	193
3.4	900	108	137	152	169	179	190	199
3.3	1000	111	141	157	174	184	196	206
3.2	1100	115	146	162	180	190	202	213
3.1	1200	118	150	168	185	196	208	219
3.0	1300	122	155	173	191	202	214	226
	Upper bound approach	108	140	155	180	200	225	245

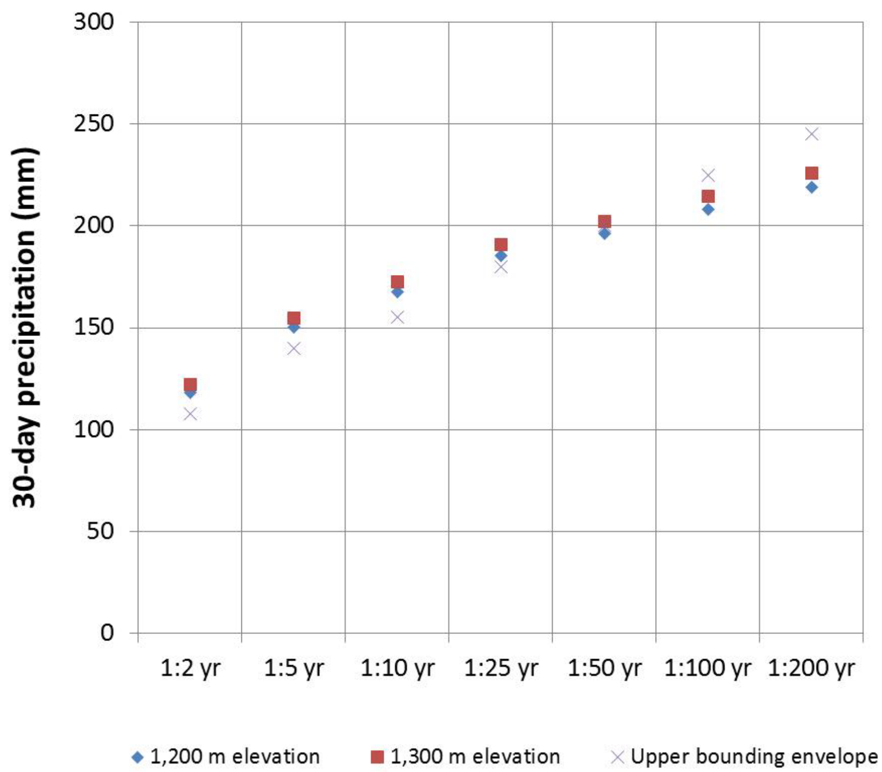


Figure 3.2-5: 30-day precipitation for various return periods. Data are shown for the 1,200 and 1,300 m elevations as well as the result for the upper bounding envelope approach.

3.3 Snowpack and snow melt results

Snowpack and snow melt results relevant to this study are presented in Figure 3.3-1, Table 3.3-2 and Table 3.3-2 below. Depending on the design/engineering aspect of the proposed project, it may be necessary to consider magnitude of snow storage and rates of melt, in addition, to depths of extreme rainfall.

Snow pack maxima, timing of melt, length of melt

Snow pillow results for six State of Alaska snow pillow stations are shown in Figure 3.3-1. The Chisana, May Creek and American Creek stations are nearest the Coffee Creek property – situated approximately 150-200 km away. These three stations have periods of record ranging from 3 to seven years. The Granite Creek, Upper Chena and Teuchet Creek stations are situated at slightly greater distance (>300 km) but show considerably longer period of record (≥23 years of record at each) and similar patterns overall.

Of note, these snow pillow data show local snow packs to reach their maxima by April 1st each year. Onset of melt conditions varies little by site (Figure 3.3-1, upper panel), with ablation of snowpack occurring in earnest by approximately April 15th. These data show melt to be complete, on average, between May 15th and June 1 – with longer duration melt at Upper Chena attributed to higher elevation and deeper snow packs on average at this station. In the lower panel of Figure 3.3-1, period of record SWE measurements for Chisana are shown to give indication of between year variability in snow accumulation and snow melt. At this station, duration of melt ranges from 10-25 days. The Chisana snow pillow is ~150 km from Coffee Creek and situated at elevation ~1,000 m asl.

Snowmelt rates estimated from nearest snow pillow stations

Snowmelt rates were calculated from daily snow pillow records for the six State of Alaska snow pillow stations. These rates are presented in Table 3.3-1, alongside station data (*i.e.*, elevation, location data and period of record) and SWE statistics for the six stations. Snowmelt statistics in Table 3.3-1 were computed on the annual series of maximum melt rates per station and for the period of record at each station.

Average of maximum annual melt rates were ~20 mm/day for five of the stations, noting that the average rate was slightly higher and 27 mm/day at Upper Chena. The maximum of the maximum annual melt rates was ~30 mm/day at three stations (Chisana, May Creek and Granite Creek), but ≥50 mm/day at Teuchet Creek and Upper Chena (*i.e.*, 53 mm/day at each location). The next highest rate of melt computed at Teuchet Creek was 33 mm/day, potentially indicative that the 53 mm/day is erroneous. However, at the Upper Chena station several rates of melt on the order of 40 mm/day were computed from the available station data and supportive that melt rates in the range 40-50 mm/day are conservative – but plausible.

Return period estimates of snowpack for Coffee Creek

There are numerous State of Alaska and Yukon Territory snow course stations near the Coffee Creek property. At these stations, 1st of month SWE data (*e.g*., Jan1, Feb1, Mar1, Apr1) are collected along a snow course and many of these stations show considerable period of record.

Snow course data are synthesized by Lorax (2015) to: better understand spatial patterns in snow accumulation; estimate orographic effects for precipitation realized as snow; and summarize return period estimates for snow at the Coffee Creek property. Return period SWE estimates for the heap leach pad location (elevation ~1,300 m) are presented in Table 3.3-2. Coffee Creek return period estimates of Apr 1 SWE were computed using Casino Creek snow course data and a scaling factor for elevation of X%/100 m elevation. Data for two nearby snow course stations (Pelly Farm, Casino Creek) are also presented in Table Y.

2015 Snow Surveys at Coffee Creek

Snow surveys at Coffee Creek are scheduled for early April 2015. Therefore, snow pack estimates for the mine site are considered provisional, as it may be necessary to refine Table 3.3-2 values given the 2015 snow survey results. However, the provisional SWE estimates for the heap leach pad and the melt rates estimated from snow pillow stations are believed to be representative and robust and may be considered in screening level design and engineering work for the project.

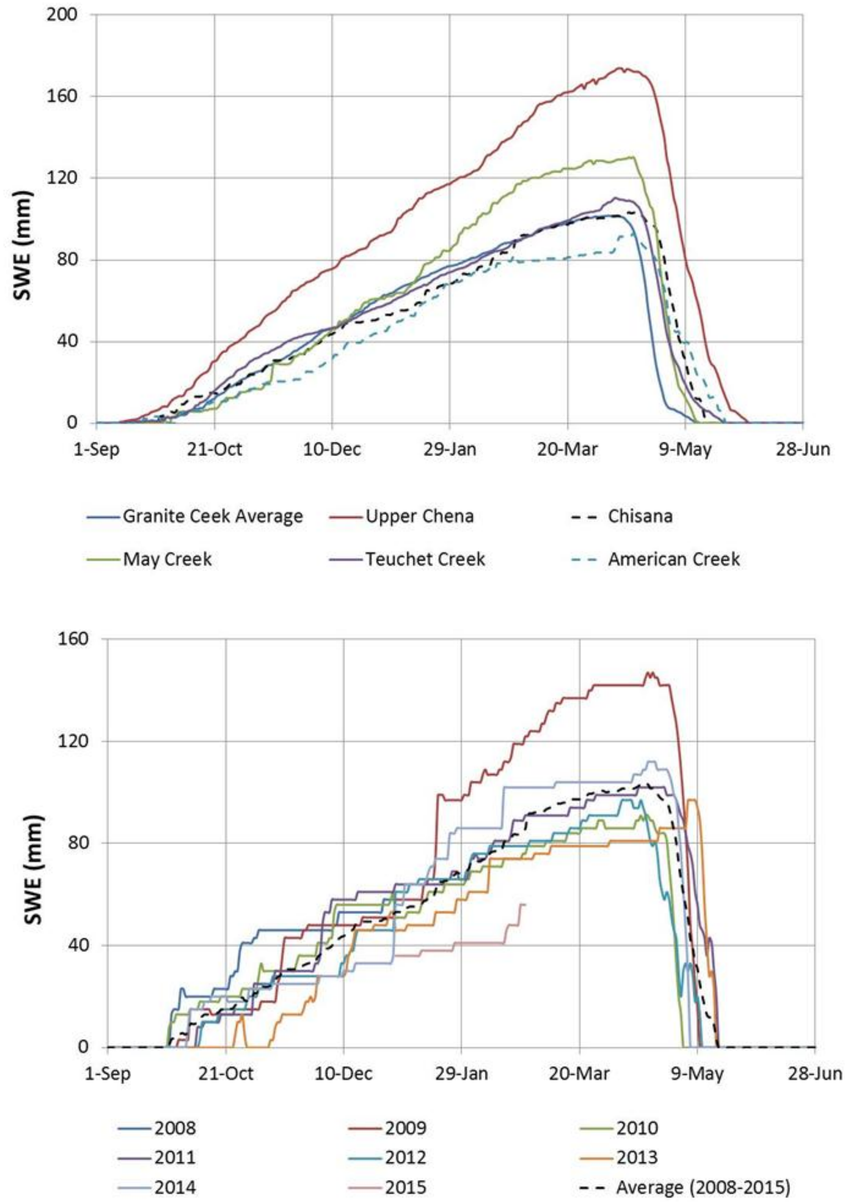


Figure 3.3-1: Period of record average SWE data for snow pillow stations nearest Coffee Creek (upper panel). Daily SWE data for Chisana snow pillow station for period of record (2008-2015) (lower panel).

Table 3.3-1:
Summary of snow water equivalent and snow melt rates from snow pillow stations near Coffee Creek

	Parameter	Chisana	May Creek	American Creek	Granite Creek	Teuchet Creek	Upper Chena
Station Information	*Latitude*	62.07	61.35	64.79	63.94	64.95	65.1
	Longitude	-142.05	-142.71	-141.23	-145.4	-145.52	-144.93
	Elevation (m)	1012	491	320	378	500	867
	Period of Record	2008-15	2007-15	2012-14	1998-2015	1981-2015	1987-2013
	Complete years (n)	6	7	3	26	33	23
Snow water equivalent (SWE)	*Min SWE (mm)*	91	104	94	61	53	86
	Avg SWE (mm)	108	137	95	106	117	187
	Max SWE (mm)	147	173	97	196	196	338*
[A]***Snow melt rates***	*Min (mm/day)*	13	16	15	10	8	13
	Avg (mm/day)	20	20	15	20	21	27
	Max (mm/day)	28	30	15	30	53	53*

* Measurements reflect late May melting of a deep snow pack (year 1993).

[A] Statistics computed on the annual series of maximum melt rates (per station and for period of record).

Table 3.3-2:
Return period estimates of April 1 snow pack (expressed as snow water equivalents) for Pelly Farm, Casino Creek and Coffee Creek (Casino Creek scaled to elevation 1,300 m).

			Maximum Annual SWE (mm)		
	Recurrence Interval (yrs)	Probability of Exceedance	Pelly Farm	Casino Creek	Casino Creek scaled to 1,300 m*
Dry	200	0.995	37	71	77
	100	0.99	41	76	82
	50	0.98	44	82	88
	25	0.96	49	88	95
	10	0.9	56	100	108
	5	0.8	63	112	121
Mean	2	0.5	80	139	151
Wet	5	0.2	100	172	191
	10	0.1	112	193	217
	25	0.04	126	218	249
	50	0.02	135	235	272
	100	0.01	144	251	295
	200	0.005	152	267	317

*Casino Creek snow course data were scaled to elevation 1,300 m using the estimated gradient X%/100 m. The derivation of this gradient is presented in Lorax (2015).

4. Summary

This memo synthesizes regional climate data (rainfall, snowfall) for stations near (within 200 km radius) the Coffee Creek property. Specifically, return period estimates of extreme precipitation (1:2 year, 1:5 year, 1:10 year, 1:25 year, 1:50 year, 1:100 year and 1:200 year) are presented for an array of metrics (*e.g.*, 24-hour, 2-day, 3-day, 10-day and 30-day precipitation depths).

Precipitation depths recommended for the Coffee Creek property are presented in Section 3.2 and Appendix B of this memo. These precipitation estimates are intended for use in infrastructure design and engineering studies at the Project Site, as well as the site-wide water balance model – as appropriate.

References

C. Bonifacio, T. Barchyn, C. Hugenholtz and S. Kienzle. 2015. CCDST: A free Canadian climate data scraping tool. Computers &Geosciences (75): 13–16.

Lorax (2015). Coffee Gold Project Baseline Meteorology Report. Project No. 362-3, March 2015. 32 pp.

NOAA (2012). NOAA Atlas 14 Precipitation-Frequency Atlas of the United States, Volume 7 Version 2.0: Alaska. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service and University of Alaska Fairbanks, Water and Environmental Research Center. 127 pp.

Papineau, J. 2015. Understanding Alaska's Climate Variation. NWS Anchorage, Alaska. Website: http://pafc.arh.noaa.gov/climvar/climate-paper.html

Appendix A: Frequency Analysis Results

Example – Northway AP (from NOAA, 2012)

Table A1-1:
Precipitation Frequency Estimates for Northway, AP after NOAA (2012).

NOAA Atlas 14 Volume 7 Version 2
Data type: Precipitation depth
Time series type: Annual maximum
Project area: Alaska
Location name: Northway, Alaska, US*
Station Name: NORTHWAY AP
Latitude: 62.9667°
Longitude: -141.9333°
Elevation: 522 m*

PRECIPITATION FREQUENCY ESTIMATES (in mm)

by duration for AEP:	'1/2	'1/5	'1/10	'1/25	'1/50	'1/100	'1/200
5-min:	4	5	7	8	10	11	13
10-min:	5	7	9	11	13	15	18
15-min:	6	8	11	13	15	17	21
30-min:	8	11	14	18	20	23	27
60-min:	10	15	19	24	28	32	37
2-hr:	13	19	24	30	35	40	47
3-hr:	16	23	29	36	42	47	56
6-hr:	21	31	39	49	56	64	75
12-hr:	25	36	44	56	65	75	89
24-hr:	28	40	50	63	74	86	101
2-day:	33	47	57	72	84	97	112
3-day:	36	52	63	78	90	104	119
4-day:	39	55	67	83	96	109	125
7-day:	45	64	77	95	110	125	142
10-day:	50	71	85	105	121	137	156
20-day:	68	95	113	137	156	176	197
30-day:	85	118	140	168	190	212	235
45-day:	110	151	177	210	234	258	282
60-day:	132	180	210	245	269	292	312

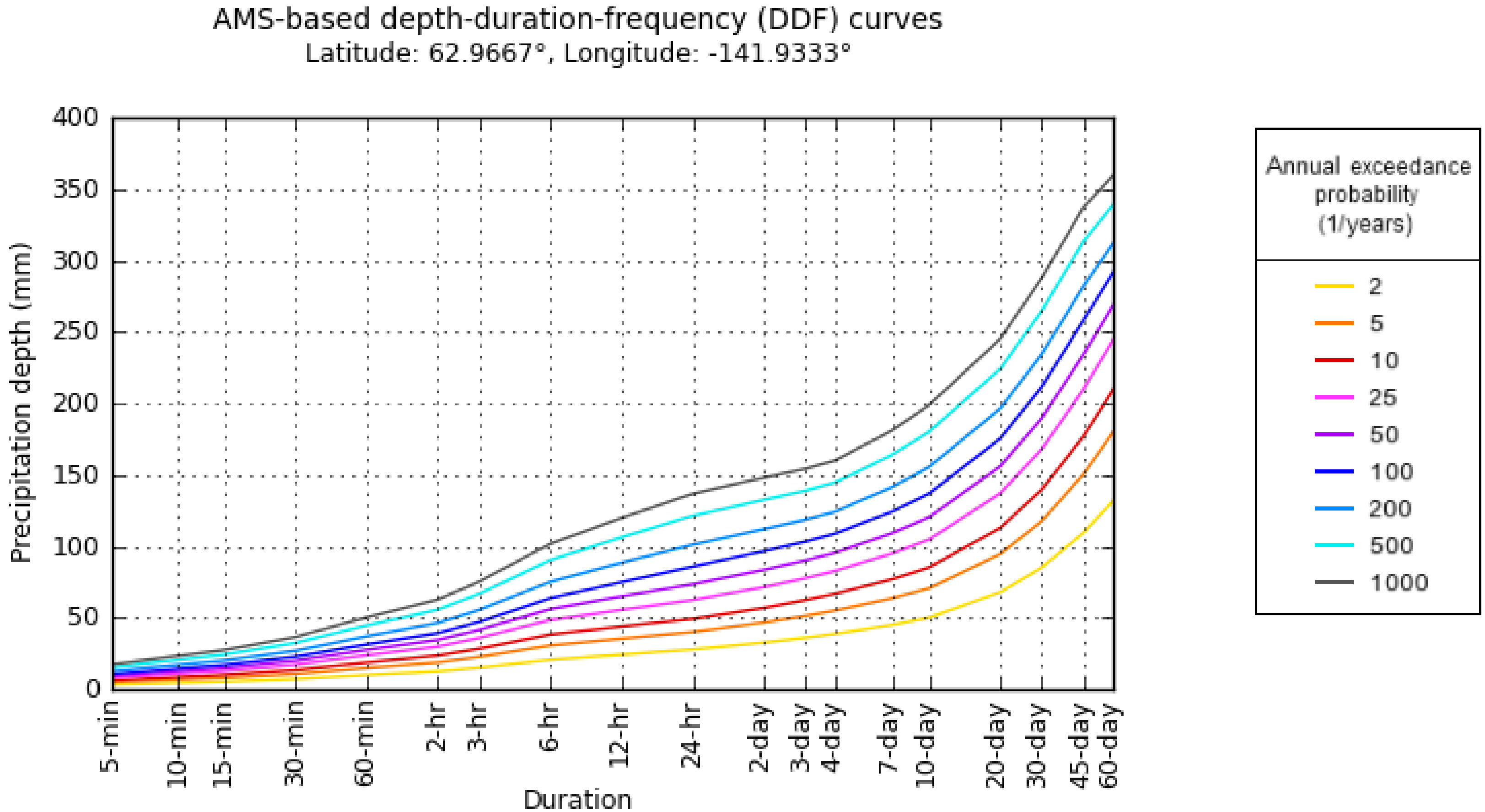


Figure A.1-1: Depth-duration-frequency plot for Northway, AP.

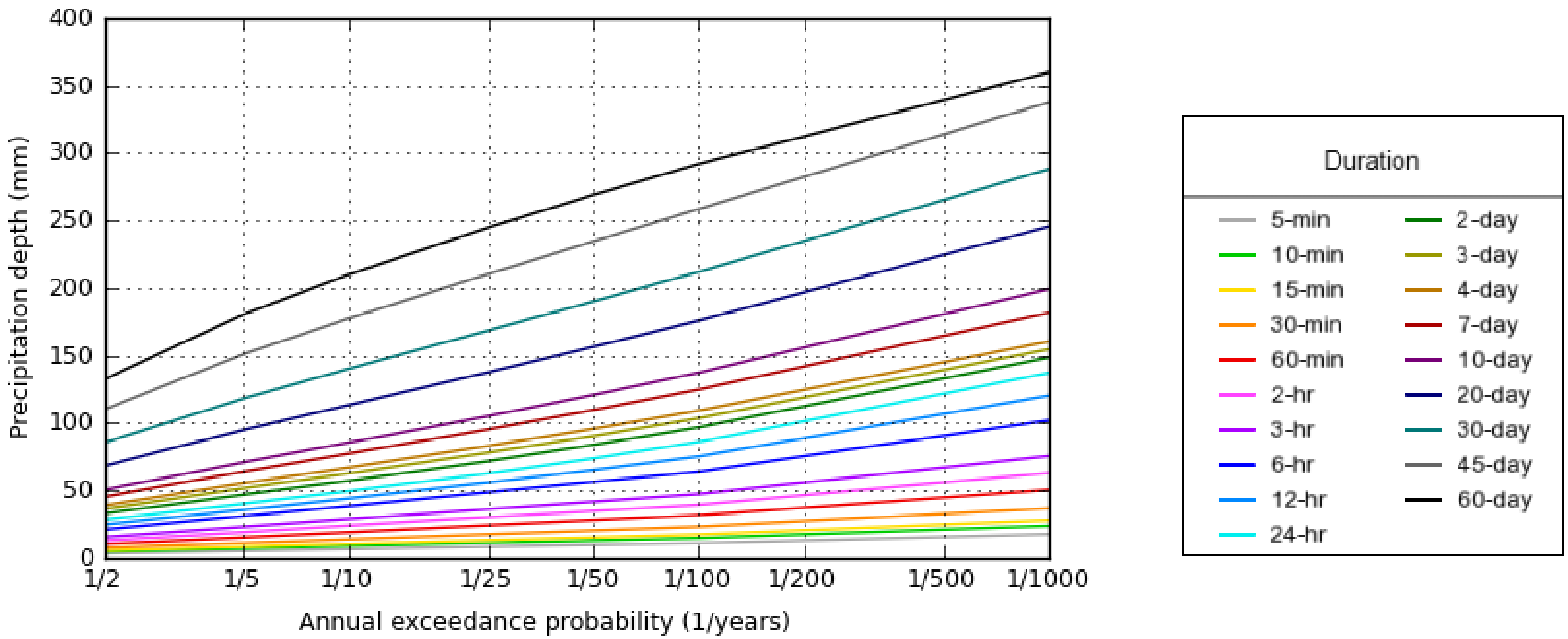
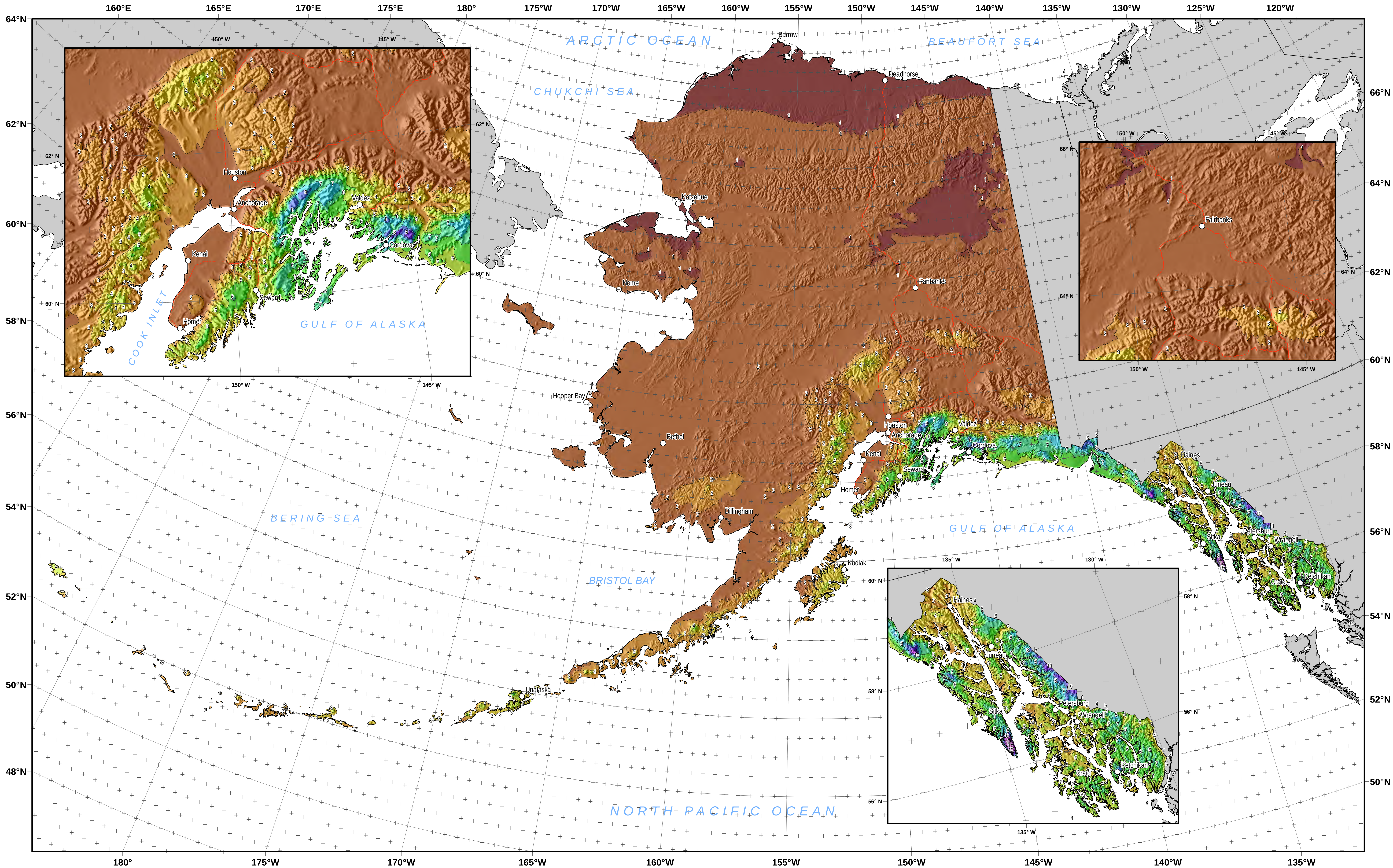


Figure A.1-2: Depth-exceedance-duration plot for Northway, AP.



NOAA Atlas 14, Volume 7, Version 2
Alaska

Prepared by U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
OFFICE OF HYDROLOGIC DEVELOPMENT
HYDROMETEOROLOGICAL DESIGN STUDIES CENTER
January 2012

0 30 60 90 120 150 Miles

0 50 100 150 200 250 Kilometers

ALASKA

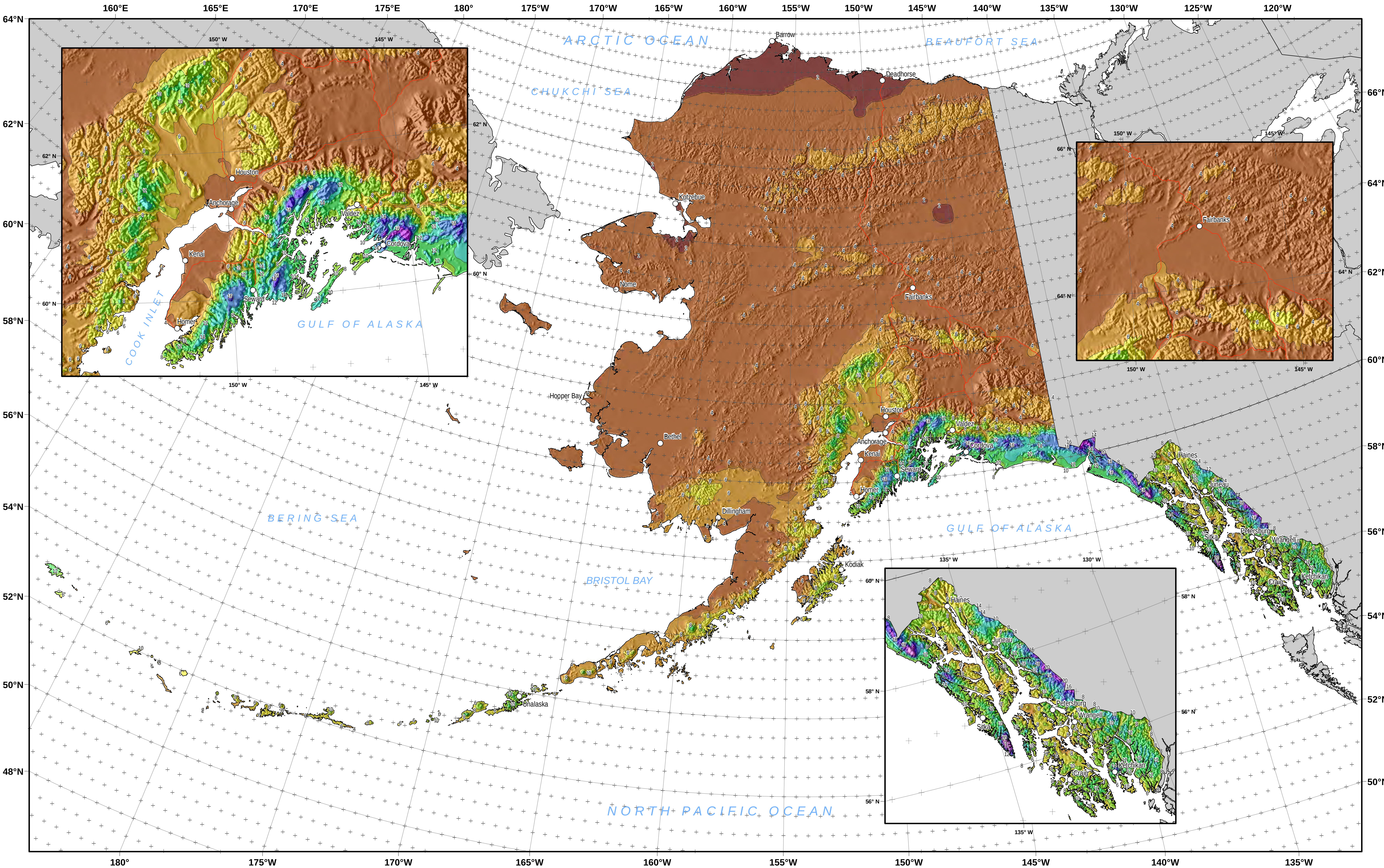
Isopluvials of 2-year 24-hour precipitation in inches

SCALE 1:7,500,000

Projection: Alaska Albers Equal Area Conic; Datum NAD83; Standard Parallels: 65°N and 55°N; Central Meridian 154°W.

Figure A.1-3: 1:2 year, 24-hour rainfall map for the State of Alaska

- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- 4.01 - 5.00
- 5.01 - 6.00
- 6.01 - 7.00
- 7.01 - 8.00
- 8.01 - 9.00
- 9.01 - 10.00
- 10.01 - 11.00
- 11.01 - 12.00
- 12.01 - 12.70



NOAA Atlas 14, Volume 7, Version 2
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NATIONAL WEATHER SERVICE
OFFICE OF HYDROLOGIC DEVELOPMENT
HYDROMETEOROLOGICAL DESIGN STUDIES CENTER
January 2012

0 30 60 90 120 150 Miles
0 50 100 150 200 250 Kilometers

ALASKA

Isopluvials of 100-year 24-hour precipitation in inches

SCALE 1:7,500,000

Projection: Alaska Albers Equal Area Conic; Datum NAD83; Standard Parallels: 65°N and 55°N; Central Meridian 154°W.

Figure A.1-4: 1:100 year, 24-hour rainfall map for the State of Alaska

1.33 - 2.00	6.01 - 8.00	12.01 - 14.00	18.01 - 20.00
2.01 - 4.00	8.01 - 10.00	14.01 - 16.00	20.01 - 22.00
4.01 - 6.00	10.01 - 12.00	16.01 - 18.00	22.01 - 23.01

Appendix B: Frequency Analysis Results

B1. 24-hour, maximum precipitation

B2. 2-day, maximum precipitation

B3. 3-day, maximum precipitation

B4. 10-day, maximum precipitation

B5. 30-day, maximum precipitation

B1. 24-hour, maximum precipitation

Table B1.1:
Frequency analysis results for 24-hour maximum precipitation for climate stations situated near Coffee Creek, YK.

				Annual exceedance probability (1:n years, 24-hour)						
Station	**Elevation (m)**	**Latitude**	**Longitude**	**1:2 yr**	**1:5 yr**	**1:10 yr**	**1:25 yr**	**1:50 yr**	**1:100 yr**	**1:200 yr**
EAGLE	256	64.78	-141.20	24	33	39	46	52	58	64
CHICKEN	548	64.10	-141.92	29	41	50	63	74	85	100
BOUNDARY	793	64.07	-141.12	26	35	41	50	56	63	70
ALCAN HWY	549	62.82	-141.47	30	45	58	77	94	114	143
NORTHWAY AP	522	62.97	-141.93	28	40	50	63	74	86	101
JATAHMUND	701	62.60	-142.08	38	54	64	78	89	100	111
TOK	494	63.35	-143.05	29	42	50	61	70	78	87
CHISANA	1012	62.13	-142.08	26	34	39	45	49	53	57
BEAVER CREEK A	649	62.41	-140.87	30	37	42	48	52	56	60
SNAG A	587	62.37	-140.40	29	41	48	57	63	69	75
STEWART CROSSING	480	63.38	-136.68	24	32	38	46	52	57	63
STEWART RIVER	358	63.32	-139.43	27	39	46	55	62	67	73
BURWASH A	807	61.37	-139.04	27	34	37	41	43	45	46
CARMACKS	525	62.10	-136.30	19	25	29	33	36	39	42
DAWSON A	350	64.04	-139.13	20	27	33	41	48	55	63
LITTLE GOLD CREEK	1257	64.08	-141.00	31	36	40	46	50	54	59
KLONDIKE	973	64.45	-138.22	21	29	35	45	54	66	79
MAYO A	504	63.62	-135.87	19	25	28	32	35	38	41
MCQUESTEN	458	63.59	-137.52	22	29	33	37	41	43	46
PELLY RANCH	445	62.82	-137.37	21	28	32	37	39	42	44

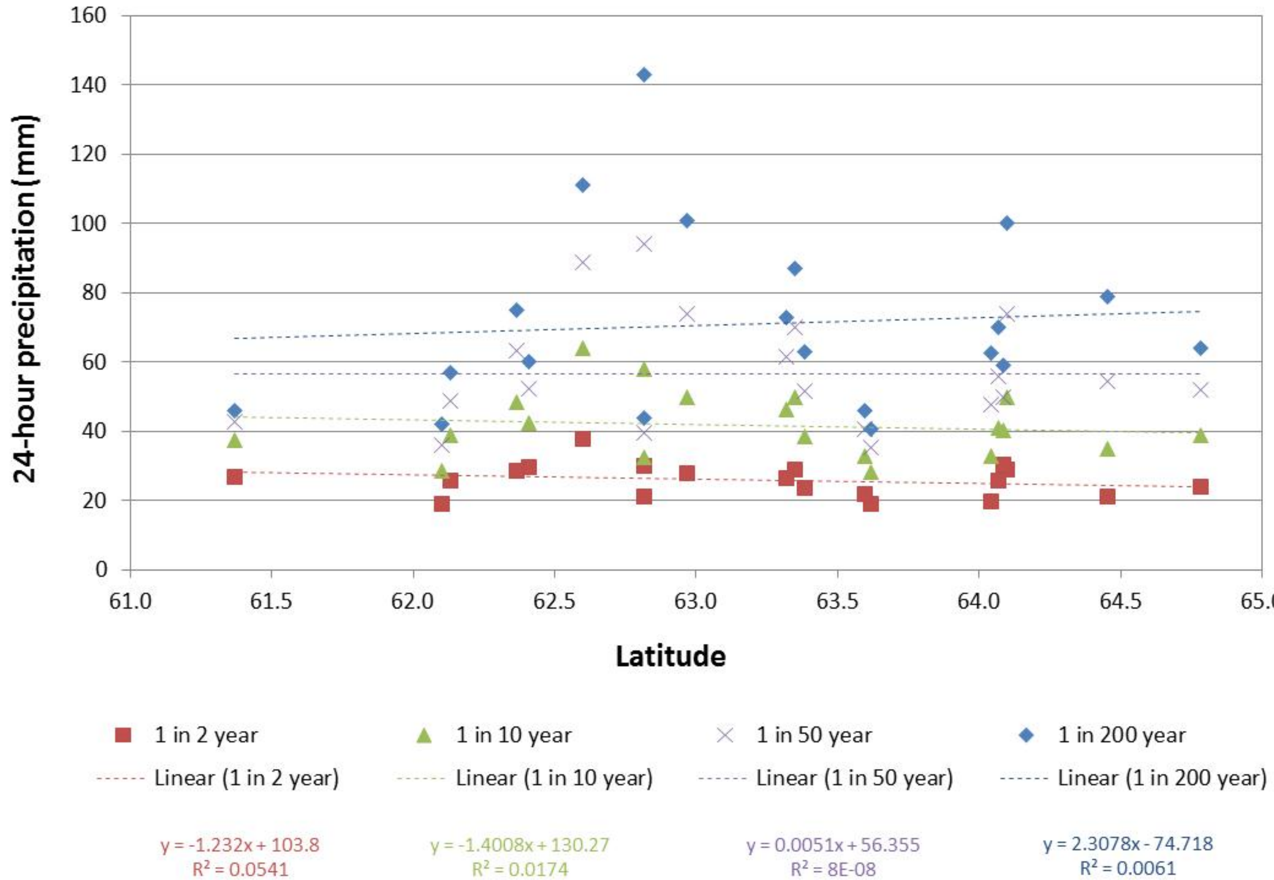

Figure B1.1: Frequency analysis results for 24-hour maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station latitude.

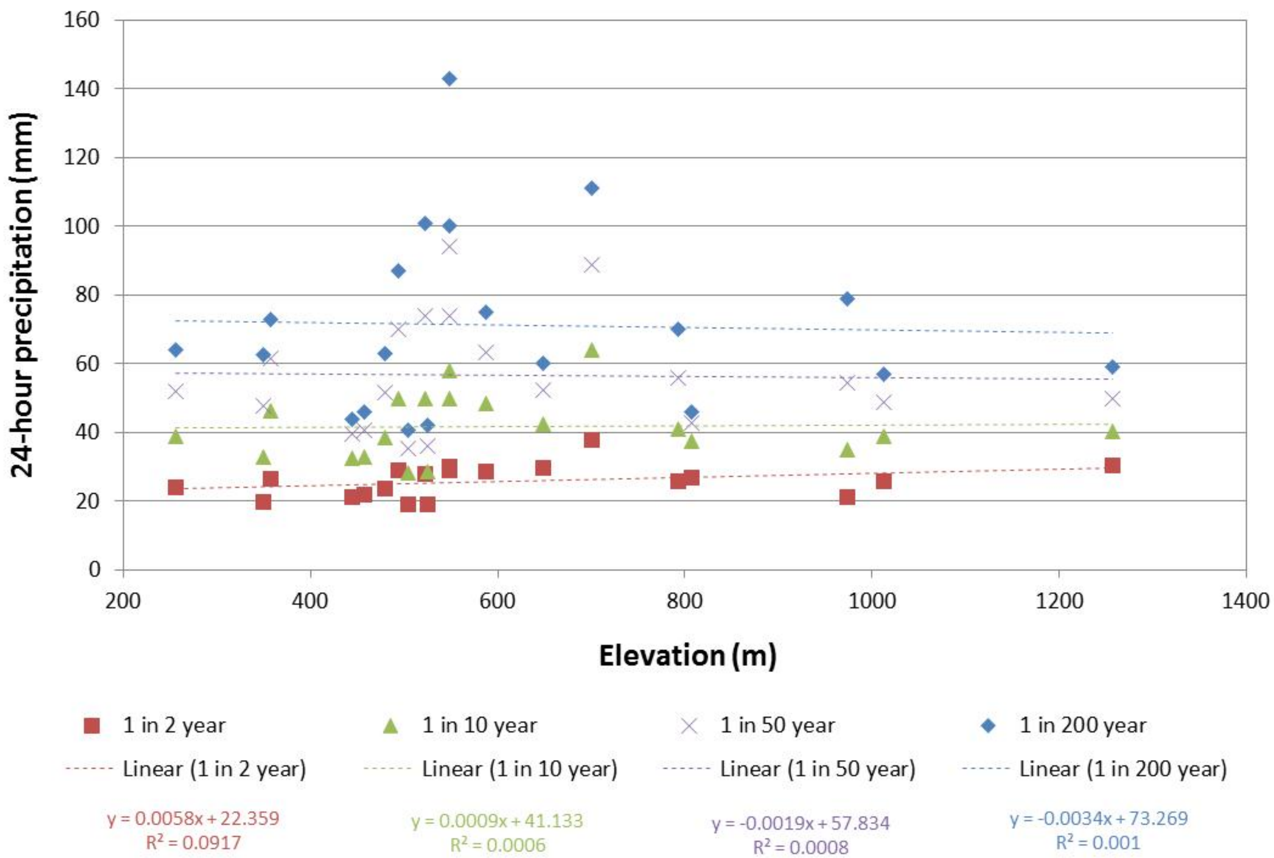

Figure B1.2: Frequency analysis results for 24-hour maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station elevation (m).

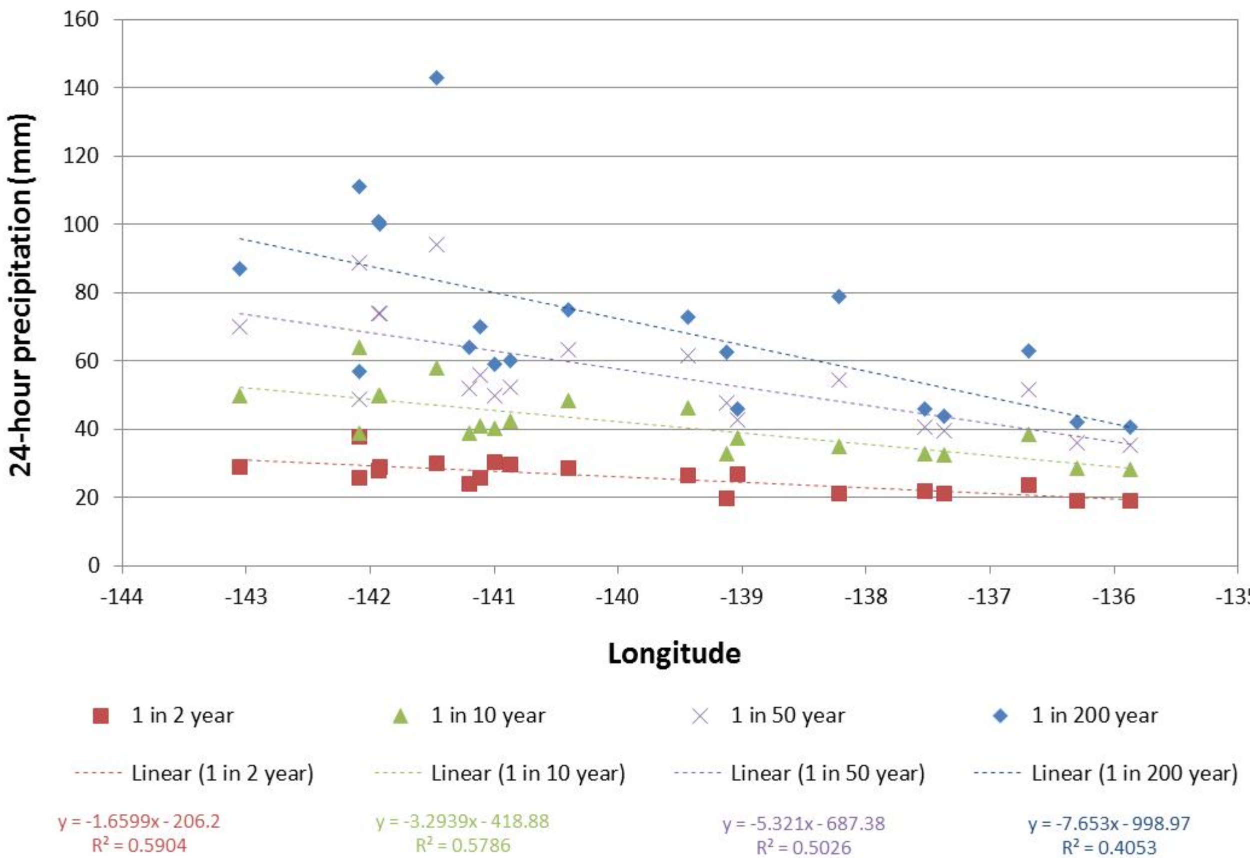

Figure B1.3: Frequency analysis results for 24-hour maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station latitude.

B2. 2-day, maximum precipitation

Table B2.1:
Frequency analysis results for 2-day maximum precipitation for climate stations situated near Coffee Creek, YK.

				Annual exceedance probability (1:n years, 2-day)						
Station	**Elevation (m)**	**Latitude**	**Longitude**	**1:2 yr**	**1:5 yr**	**1:10 yr**	**1:25 yr**	**1:50 yr**	**1:100 yr**	**1:200 yr**
EAGLE	256	64.78	-141.20	29	39	45	54	61	68	75
CHICKEN	548	64.10	-141.92	35	49	59	74	88	102	121
BOUNDARY	793	64.07	-141.12	33	44	51	61	68	76	84
ALCAN HWY	549	62.82	-141.47	36	53	67	88	106	126	153
NORTHWAY AP	522	62.97	-141.93	33	47	57	72	84	97	112
JATAHMUND	701	62.60	-142.08	45	63	76	92	104	117	129
TOK	494	63.35	-143.05	36	50	59	72	81	90	100
CHISANA	1012	62.13	-142.08	32	42	48	56	61	66	70
BEAVER CREEK A	649	62.41	-140.87	39	50	58	69	76	84	92
SNAG A	587	62.37	-140.40	34	46	53	62	68	74	79
STEWART CROSSING	480	63.38	-136.68	28	38	44	51	56	61	65
STEWART RIVER	358	63.32	-139.43	30	43	52	63	71	79	86
BURWASH A	807	61.37	-139.04	32	42	48	54	57	61	64
CARMACKS	525	62.10	-136.30	23	30	36	43	49	55	62
DAWSON A	350	64.04	-139.13	24	32	38	45	51	57	63
LITTLE GOLD CREEK	1257	64.08	-141.00	37	45	51	59	66	73	80
KLONDIKE	973	64.45	-138.22	25	34	41	50	59	68	78
MAYO A	504	63.62	-135.87	23	30	35	40	43	47	50
MCQUESTEN	458	63.59	-137.52	28	36	41	46	49	52	55
PELLY RANCH	445	62.82	-137.37	26	35	40	46	49	52	55

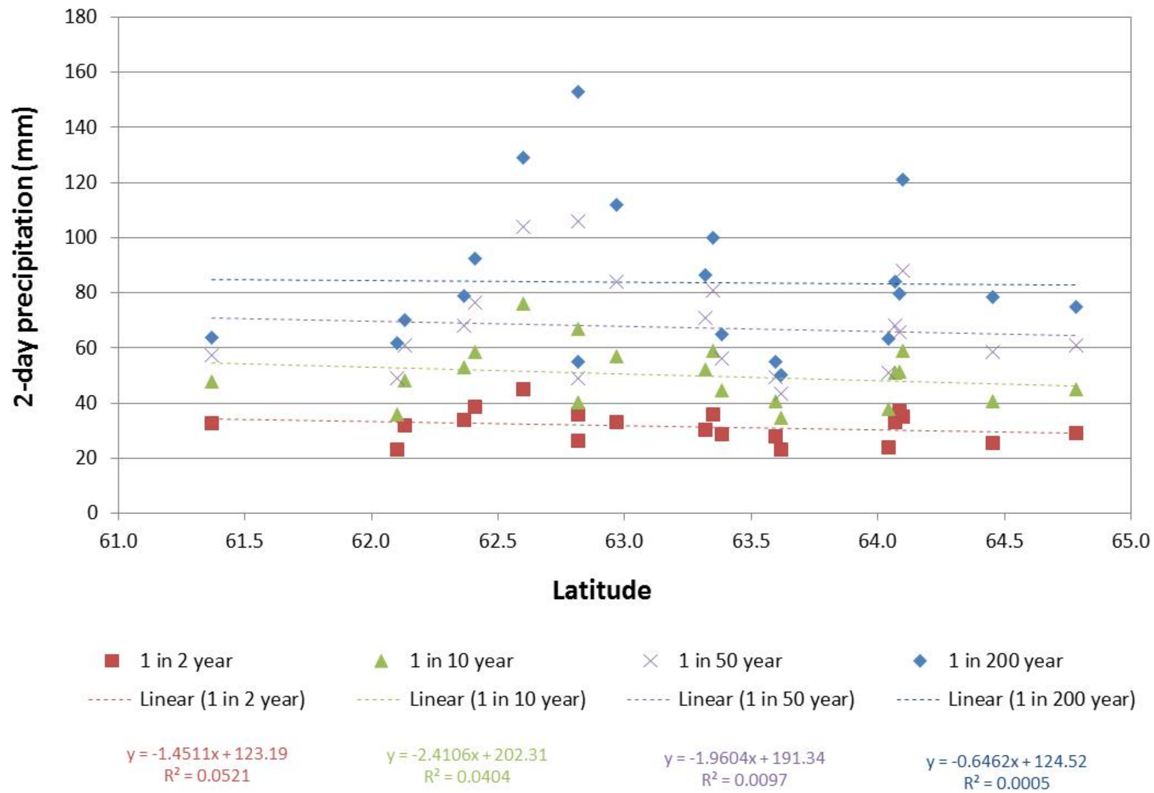

Figure B2.1: Frequency analysis results for 2-day maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station latitude.

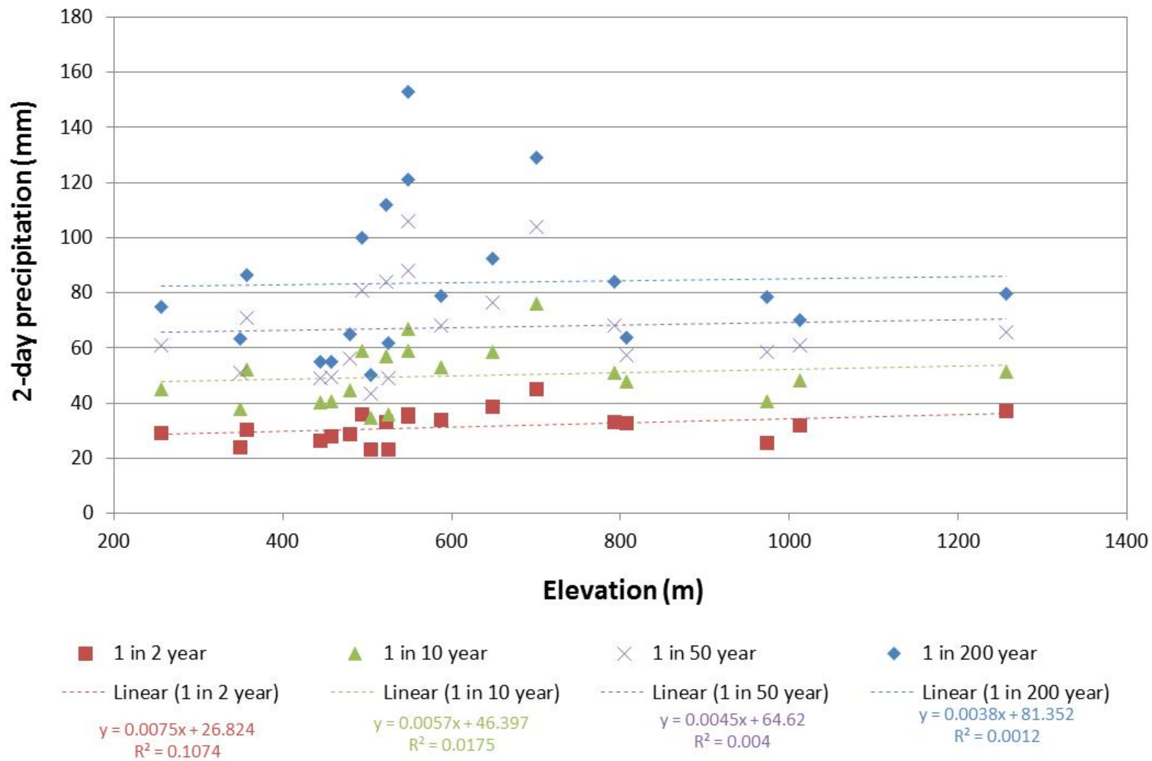

Figure B2.2: Frequency analysis results for 2-day maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station elevation (m).

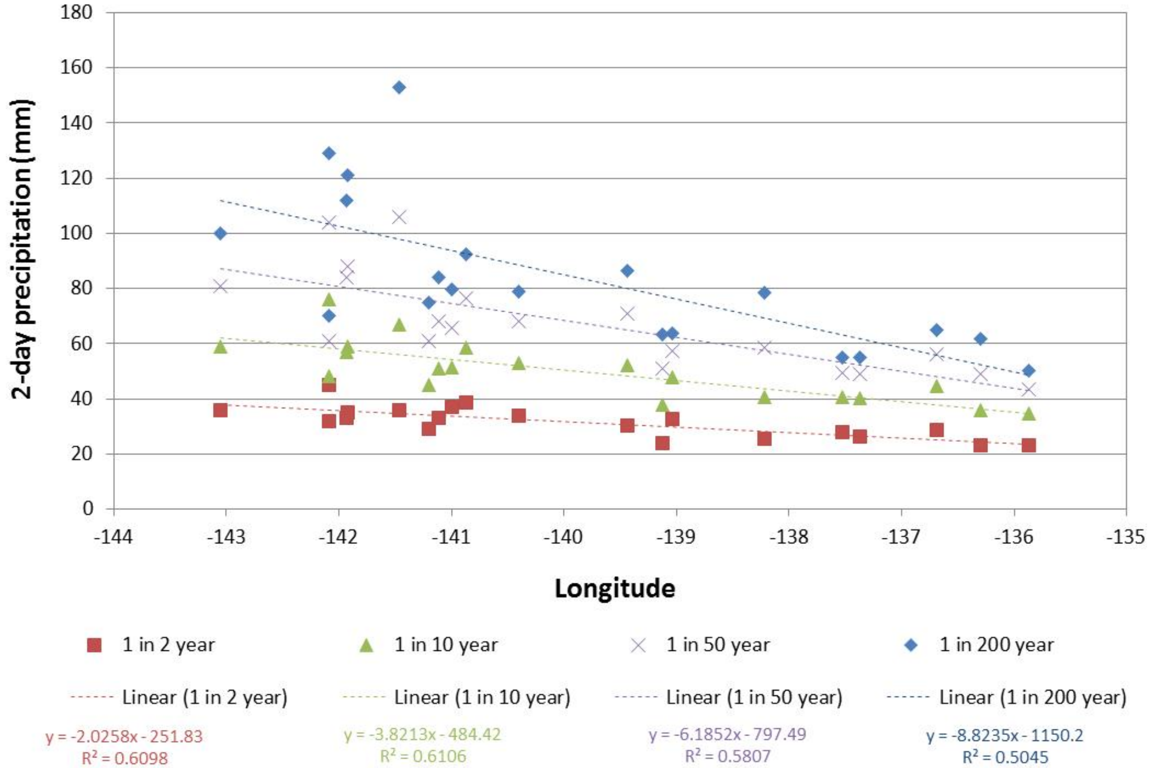

Figure B2.3: Frequency analysis results for 2-day maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station latitude.

B3. 3-day, maximum precipitation

Table B3.1:
Frequency analysis results for 3-day maximum precipitation for climate stations situated near Coffee Creek, YK.

				Annual exceedance probability (1:n years, 3-day)						
Station	**Elevation (m)**	**Latitude**	**Longitude**	**1:2 yr**	**1:5 yr**	**1:10 yr**	**1:25 yr**	**1:50 yr**	**1:100 yr**	**1:200 yr**
EAGLE	256	64.78	-141.20	32	42	49	59	66	73	82
CHICKEN	548	64.10	-141.92	39	54	65	82	97	114	136
BOUNDARY	793	64.07	-141.12	37	49	58	68	76	84	92
ALCAN HWY	549	62.82	-141.47	39	58	72	93	111	132	158
NORTHWAY AP	522	62.97	-141.93	36	52	63	78	90	104	119
JATAHMUND	701	62.60	-142.08	49	69	82	100	113	126	140
TOK	494	63.35	-143.05	40	55	65	78	88	98	108
CHISANA	1012	62.13	-142.08	37	48	55	63	69	74	79
BEAVER CREEK A	649	62.41	-140.87	43	57	68	82	94	106	119
SNAG A	587	62.37	-140.40	39	51	58	65	69	73	76
STEWART CROSSING	480	63.38	-136.68	31	41	47	55	59	64	68
STEWART RIVER	358	63.32	-139.43	33	47	57	69	79	88	98
BURWASH A	807	61.37	-139.04	36	46	51	56	59	62	64
CARMACKS	525	62.10	-136.30	25	33	39	47	54	60	67
DAWSON A	350	64.04	-139.13	27	36	42	49	54	60	65
LITTLE GOLD CREEK	1257	64.08	-141.00	43	55	63	72	79	86	92
KLONDIKE	973	64.45	-138.22	28	38	46	59	70	84	99
MAYO A	504	63.62	-135.87	26	34	38	44	48	51	54
MCQUESTEN	458	63.59	-137.52	30	39	44	49	53	56	58
PELLY RANCH	445	62.82	-137.37	29	39	45	53	58	63	68

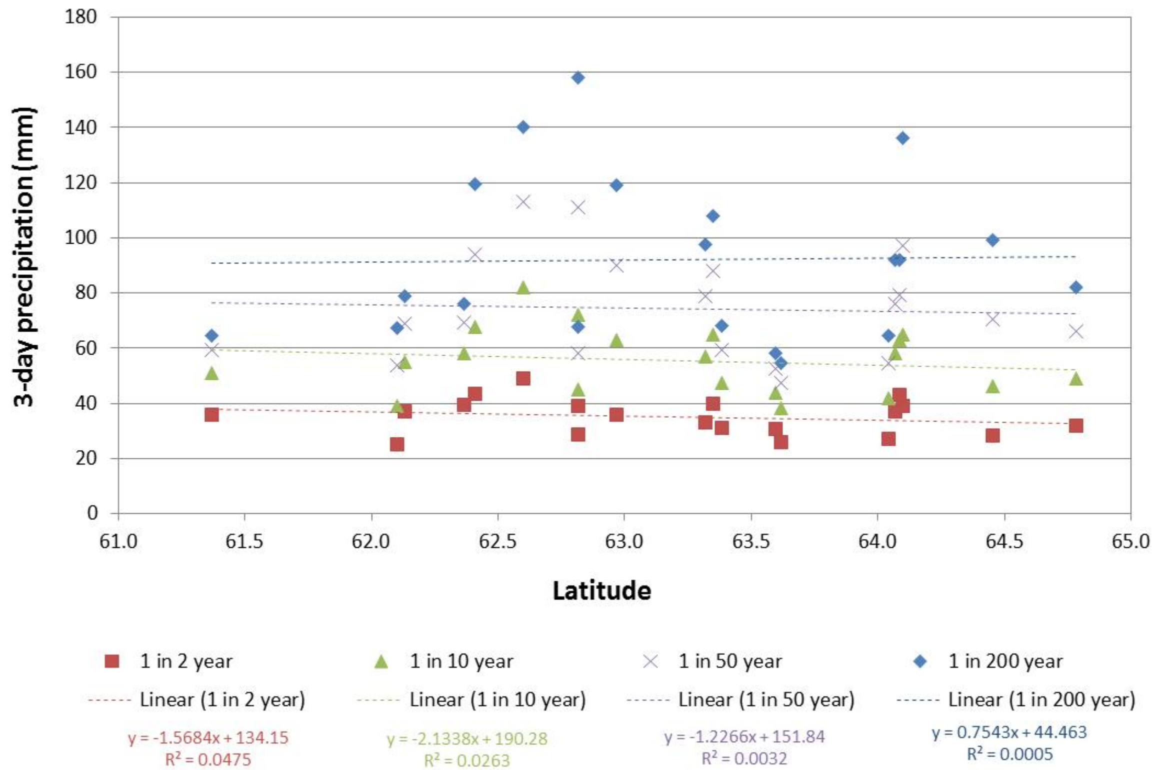

Figure B3.1: Frequency analysis results for 3-day maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station latitude.

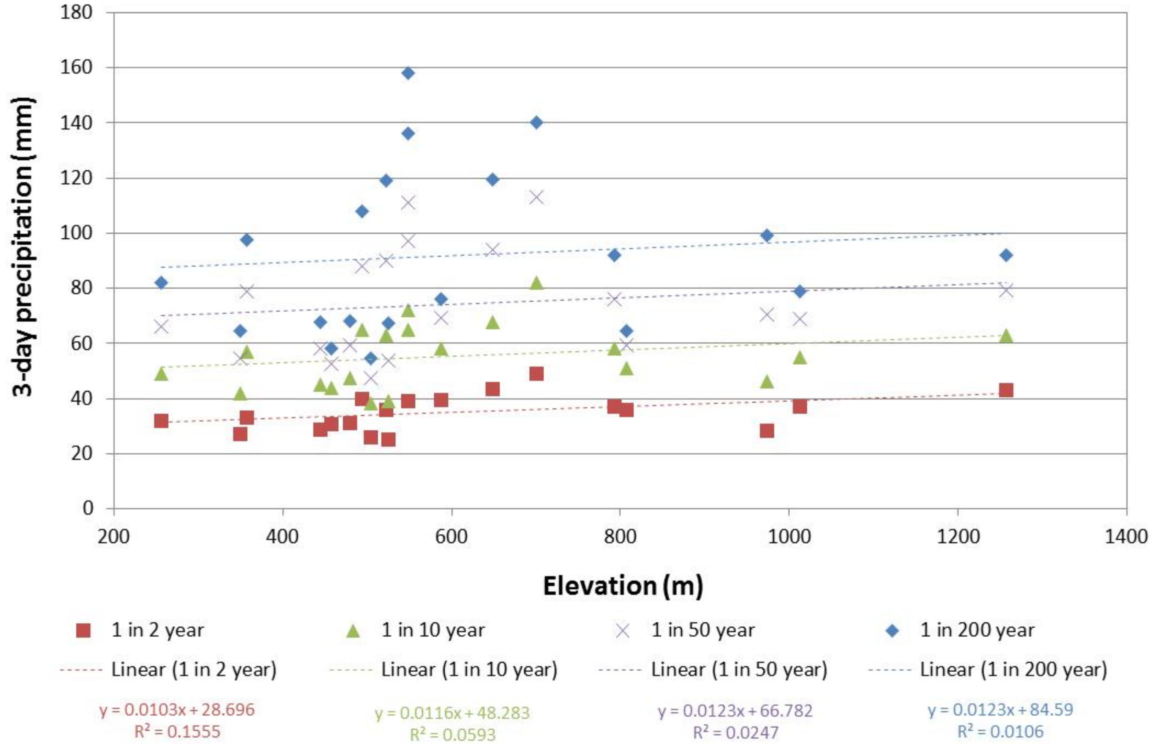

Figure B3.2: Frequency analysis results for 3-day maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station elevation (m).

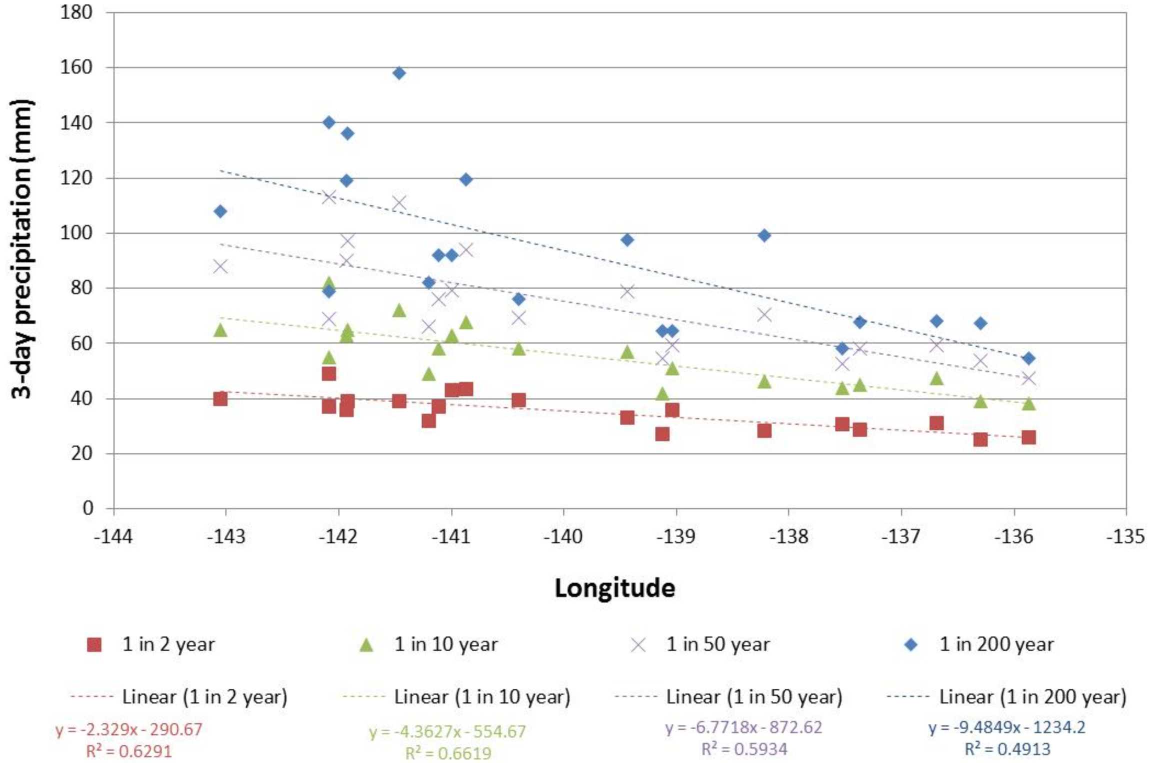

Figure B3.3: Frequency analysis results for 3-day maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station latitude.

B4. 10-day, maximum precipitation

Table B4.1:
Frequency analysis results for 10-day maximum precipitation for climate stations situated near Coffee Creek, YK.

				Annual exceedance probability (1:n years, 3-day)						
Station	**Elevation (m)**	**Latitude**	**Longitude**	**1:2 yr**	**1:5 yr**	**1:10 yr**	**1:25 yr**	**1:50 yr**	**1:100 yr**	**1:200 yr**
EAGLE	256	64.78	-141.20	46	60	69	80	89	98	108
CHICKEN	548	64.10	-141.92	57	77	92	115	135	158	190
BOUNDARY	793	64.07	-141.12	54	73	85	101	113	125	138
ALCAN HWY	549	62.82	-141.47	56	80	98	123	145	168	196
NORTHWAY AP	522	62.97	-141.93	50	71	85	105	121	137	156
JATAHMUND	701	62.60	-142.08	70	97	116	141	161	181	204
TOK	494	63.35	-143.05	51	69	81	96	108	120	132
CHISANA	1012	62.13	-142.08	48	63	73	85	94	102	110
BEAVER CREEK A	649	62.41	-140.87	63	84	98	115	128	141	153
SNAG A	587	62.37	-140.40	56	72	83	95	104	112	120
STEWART CROSSING	480	63.38	-136.68	44	57	64	72	78	83	87
STEWART RIVER	358	63.32	-139.43	48	64	72	80	85	89	93
BURWASH A	807	61.37	-139.04	53	66	73	80	84	88	90
CARMACKS	525	62.10	-136.30	39	52	59	68	74	79	85
DAWSON A	350	64.04	-139.13	38	51	59	71	80	89	98
LITTLE GOLD CREEK	1257	64.08	-141.00	69	86	98	114	127	140	154
KLONDIKE	973	64.45	-138.22	48	62	73	89	103	119	136
MAYO A	504	63.62	-135.87	39	49	55	62	68	72	77
MCQUESTEN	458	63.59	-137.52	45	57	64	72	78	83	87
PELLY RANCH	445	62.82	-137.37	42	56	65	76	85	93	101

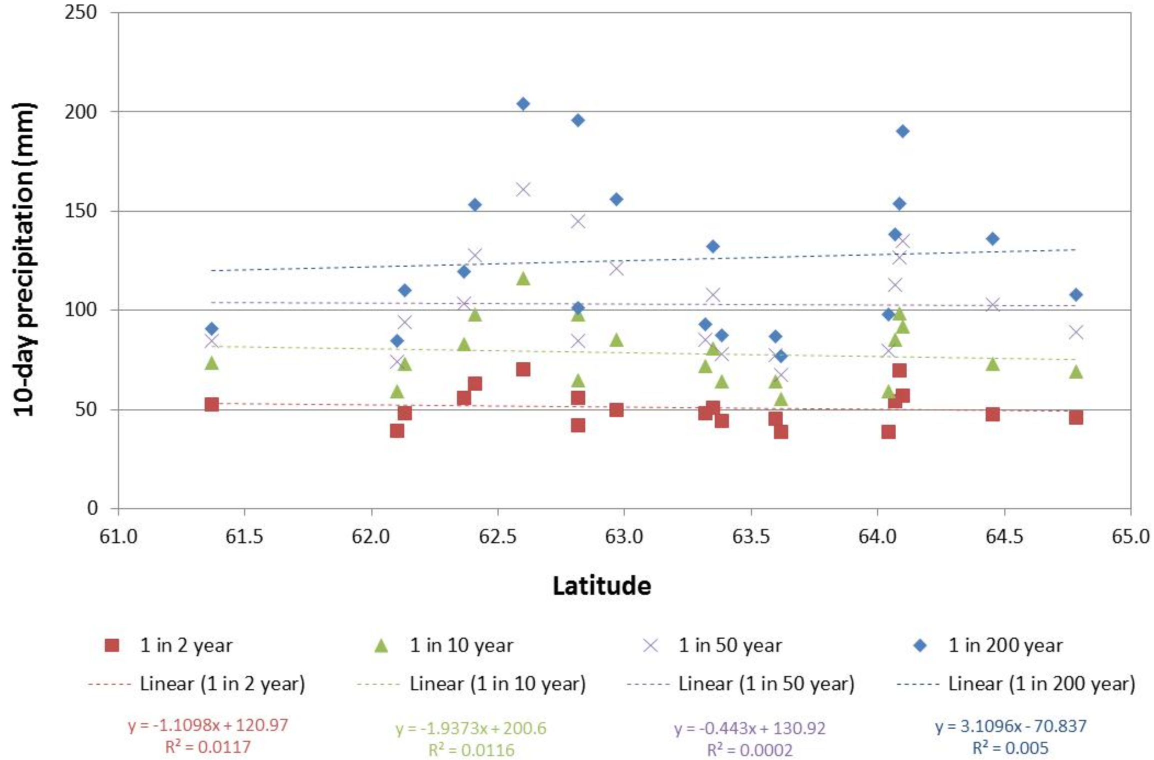

Figure B4.1: Frequency analysis results for 10-day maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station latitude.

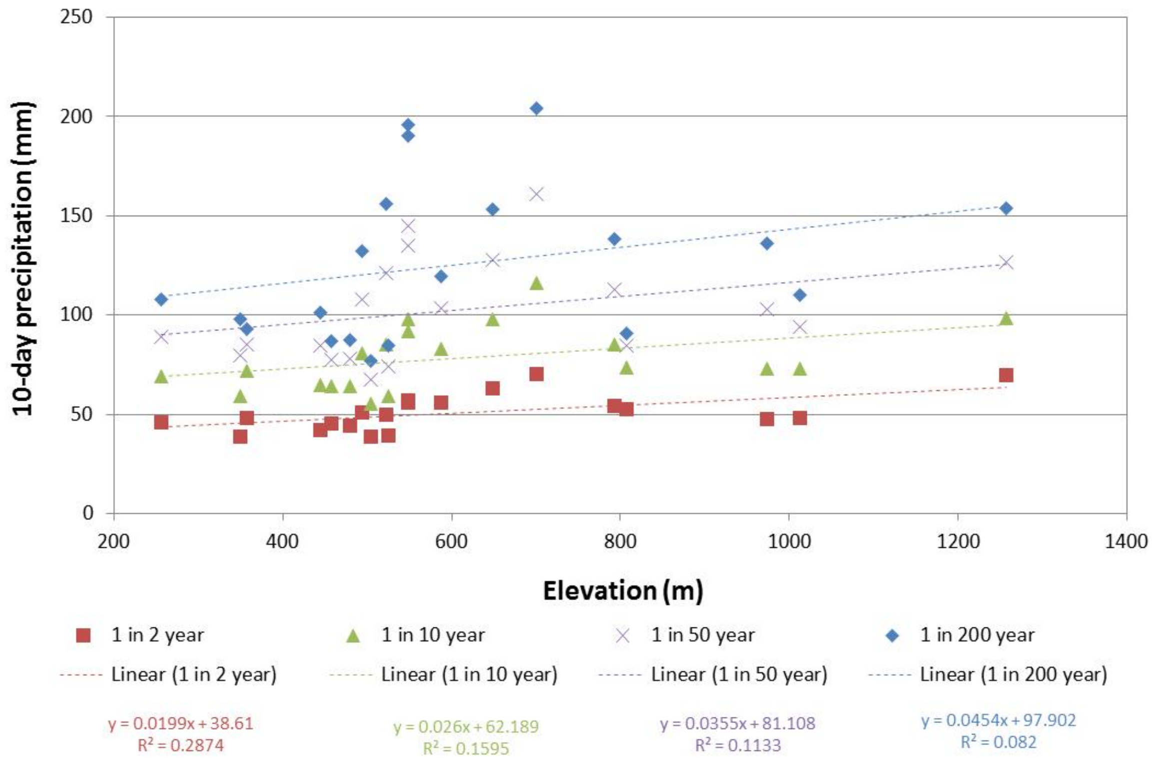

Figure B4.2: Frequency analysis results for 10-day maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station elevation (m).

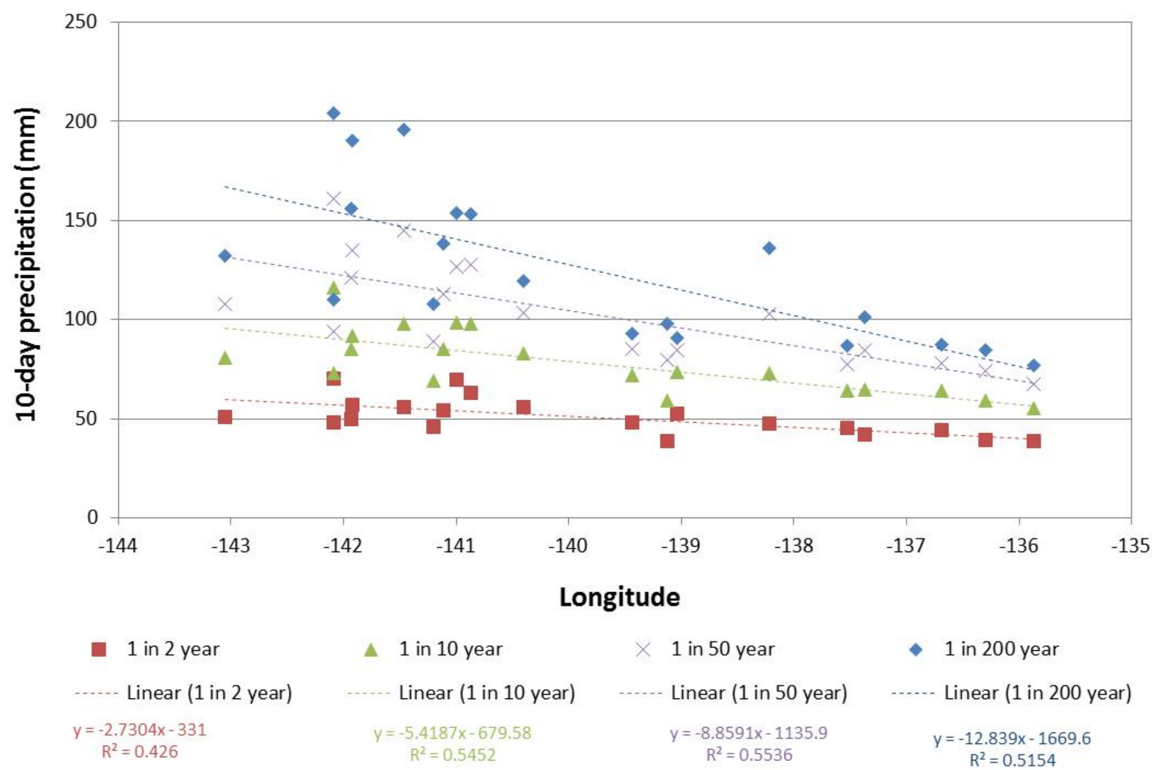

Figure B4.3: Frequency analysis results for 10-day maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station latitude.

B5. 30-day, maximum precipitation

Table B5.1:
Frequency analysis results for 30-day maximum precipitation for climate stations situated near Coffee Creek, YK.

				Annual exceedance probability (1:n years, 30-day)						
Station	**Elevation (m)**	**Latitude**	**Longitude**	**1:2 yr**	**1:5 yr**	**1:10 yr**	**1:25 yr**	**1:50 yr**	**1:100 yr**	**1:200 yr**
EAGLE	256	64.78	-141.20	80	102	115	131	143	154	165
CHICKEN	548	64.10	-141.92	97	128	152	187	218	254	300
BOUNDARY	793	64.07	-141.12	97	128	148	174	193	212	231
ALCAN HWY	549	62.82	-141.47	95	133	159	194	220	248	279
NORTHWAY AP	522	62.97	-141.93	85	118	140	168	190	212	235
JATAHMUND	701	62.60	-142.08	120	164	194	232	262	291	318
TOK	494	63.35	-143.05	78	104	121	143	159	175	191
CHISANA	1012	62.13	-142.08	75	101	117	136	150	163	175
BEAVER CREEK A	649	62.41	-140.87	123	162	184	210	226	241	254
SNAG A	587	62.37	-140.40	99	129	144	161	171	179	186
STEWART CROSSING	480	63.38	-136.68	80	95	102	108	111	114	116
STEWART RIVER	358	63.32	-139.43	73	91	99	106	109	112	114
BURWASH A	807	61.37	-139.04	62	77	87	100	110	120	130
CARMACKS	525	62.10	-136.30	71	92	104	118	128	136	144
DAWSON A	350	64.04	-139.13	70	88	100	115	126	137	147
LITTLE GOLD CREEK	1257	64.08	-141.00	117	144	163	190	212	236	262
KLONDIKE	973	64.45	-138.22	94	116	127	139	146	152	157
MAYO A	504	63.62	-135.87	70	88	99	112	121	130	137
MCQUESTEN	458	63.59	-137.52	78	101	116	134	146	158	170
PELLY RANCH	445	62.82	-137.37	72	93	106	122	134	144	155

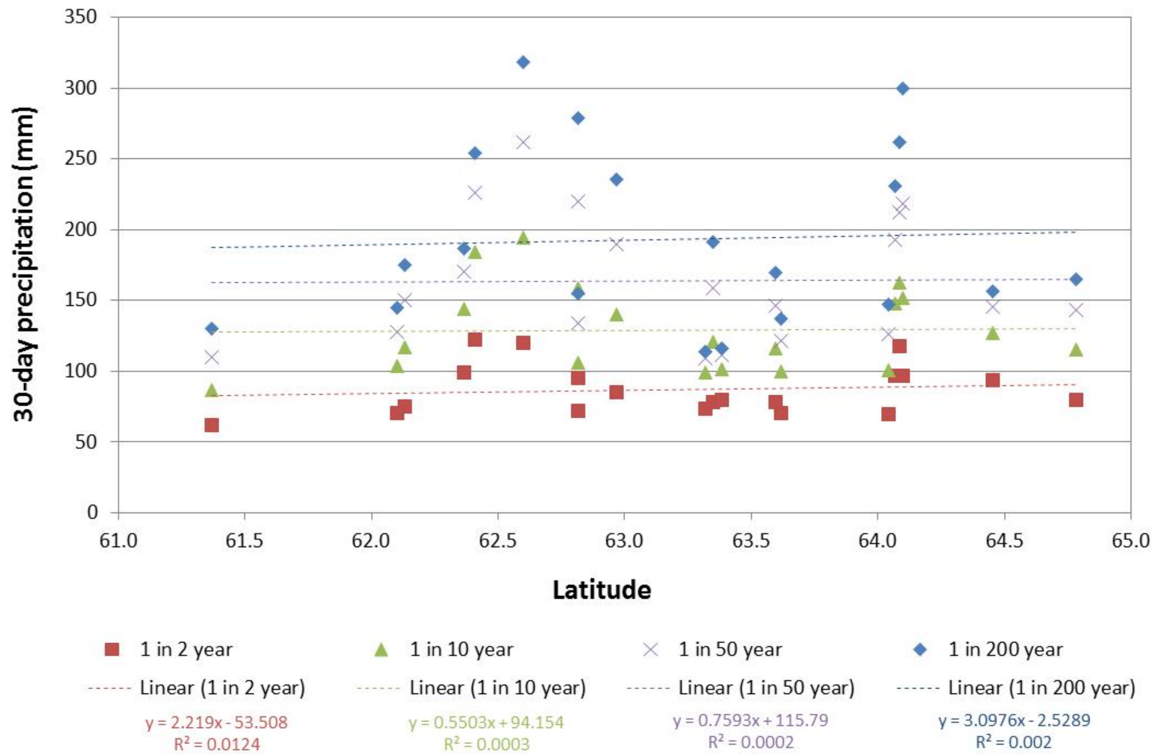

Figure B5.1: Frequency analysis results for 30-day maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station latitude.

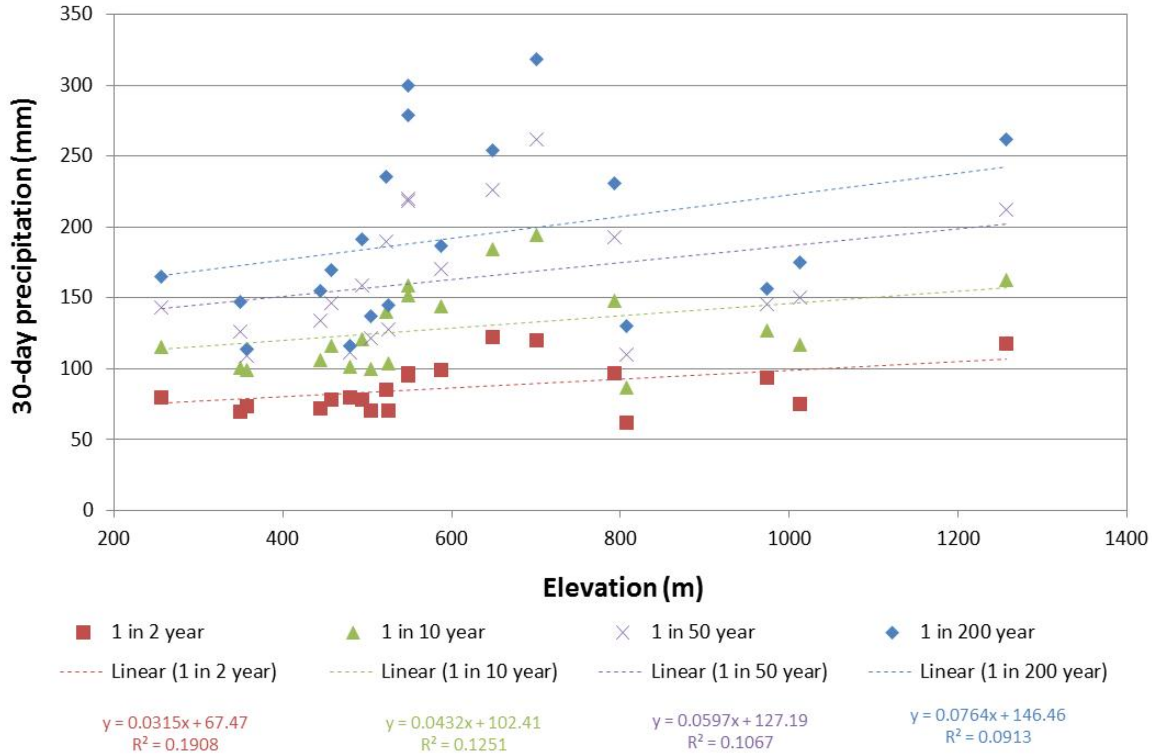

Figure B5.2: Frequency analysis results for 30-day maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station elevation (m).

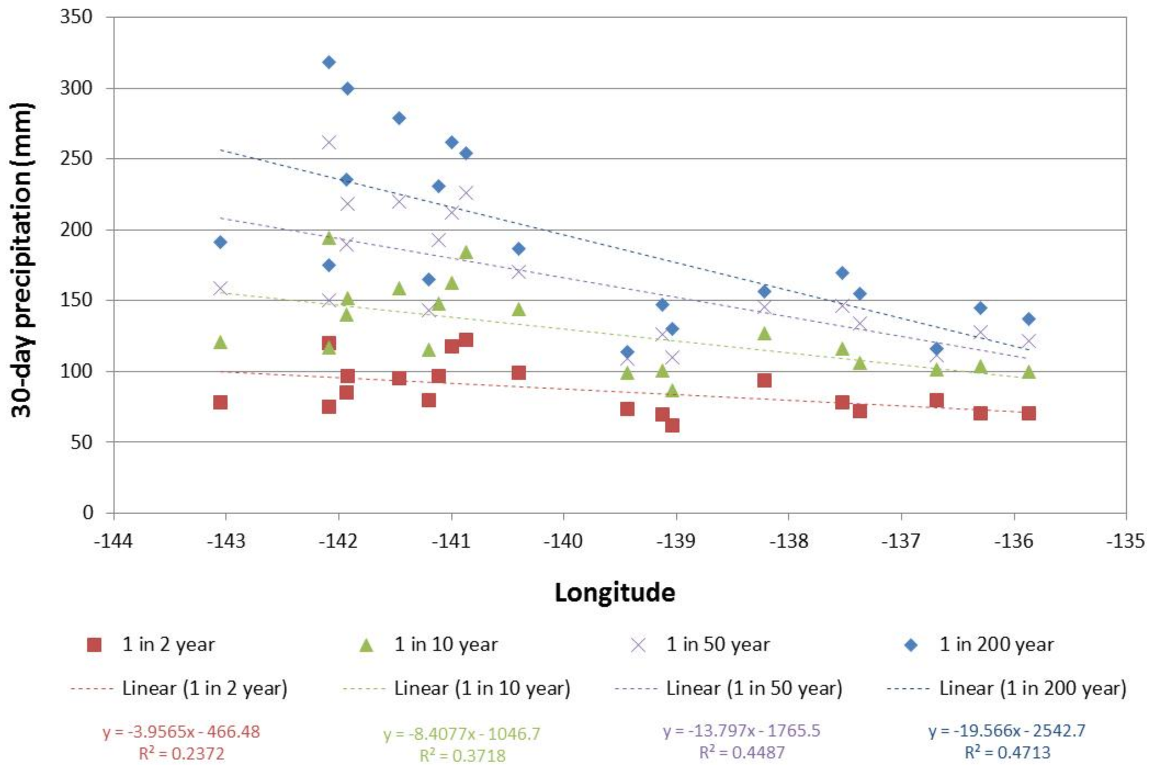

Figure B5.3: Frequency analysis results for 30-day maximum precipitation for climate stations situated near Coffee Creek, YK. In the plot, precipitation is regressed against station latitude.

Appendix C
Probable Maximum Precipitation Technical Memo

GOLDCORP

MEMORANDUM

To:	**Allison Rippon Armstrong, Kaminak Gold Corp**	**Date: 26 Aug, 2015**
From:	**Scott Jackson and Colin Fraser**	**Project #: A362-3**
Subject:	**Probable Maximum Precipitation Estimate – Coffee Creek**	

1. Introduction

1.1 Memo Objectives and Layout

This memo presents an estimate of the 24-hour Probable Maximum Precipitation (PMP) for the Coffee Gold Project.

This precipitation estimate is intended for use in infrastructure design and engineering studies at the Project Site, as well as the site-wide water balance model – as appropriate.

Methods for this analysis are presented in Section 2 below. This section describes the climate stations considered in the analysis, the statistical method used to derive the PMP estimates for all relevant regional stations, and the scaling factors used to adjust valley bottom estimates to the heap leach facility elevation of 1,300 m asl. Results are presented in Section 3 of the memo.

2. Methods

2.1 Sources of Data

The Coffee Creek property is situated ~80 km from the Alaska border. Two main sources of climate data were used to assemble this memo:

1) NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 7 Version 2.0: Alaska, and;
2) Environment Canada daily climate station data (within 200 km radius of proposed heap leach facility).

Further details on the datasets, information used in the frequency analyses and assumptions are provided in Lorax (2015a).

State of Alaska and Yukon Territory climate stations situated near the Coffee Creek property are listed in Table 2-1. Of these 20 stations (*i.e.*, Coffee Creek location excluded), 10 showed period of record ≥30 years and were included in a frequency analysis. Three of the 10 climate stations are situated in Alaska with the remaining seven being in the Yukon Territory. A map showing the location of relevant climate stations is provided as Figure 2-1.

Prior to conducting the PMP analysis on the available datasets, raw climate data files were inspected and explored to identify spatial, temporal and orographic patterns within. Some preliminary findings from this initial data inspection are presented in Section 3.1, noting that Alaska and Yukon climate stations are also described and compared to Coffee Creek baseline climate measurements under a separate cover (see Lorax 2015b).

The download and QA/QC of the raw datasets is described in detail in Lorax (2015a), and the same time series of annual daily precipitation maxima data described therein were used for the PMP analysis presented here. The tabulated 1-day annual maximum precipitation amounts from both the Alaskan and Yukon stations were adjusted upward by a factor of 1.12, as recommended by Hershfield (1961), and consistent with NOAA (2012). This scalar accounts for the fact that daily precipitation amounts calculated based on a fixed start and end of a 24-hour period (*i.e.*, midnight) will be lower than a rolling 24-hour total of the same event.

Table 2-1:
Alaska and Yukon Climate Stations near the Coffee Creek Property

Station	State, Prov	Elevation (m)	Latitude	Longitude	Distance to Site (km)	Period of Record*
EAGLE	AK	256	64.783	-141.200	225	1902 to present (82)
CHICKEN	AK	548	64.100	-141.917	180	1911 to present (20)
BOUNDARY	AK	793	64.067	-141.117	160	1948-1957 (10)
ALCAN HWY	AK	549	62.817	-141.467	105	1990 to present (20)
NORTHWAY AP	AK	522	62.967	-141.933	125	1943 to present (63)
JATAHMUND	AK	701	62.600	-142.083	140	1991 to present (20)
TOK	AK	494	63.350	-143.050	190	1959 to present (41)
CHISANA	AK	1,012	62.133	-142.083	160	1988 to present (19)
BEAVER CREEK A	YK	649	62.410	-140.868	90	1968 to present (37)
SNAG A	YK	587	62.367	-140.400	80	1943-1966 (23)
STEWART CROSSING	YK	480	63.383	-136.683	150	1963-2008 (24)
STEWART RIVER	YK	358	63.317	-139.433	50	1976-1993 (18)
BURWASH A	YK	807	61.371	-139.040	170	1966 to present (45)
CARMACKS	YK	525	62.100	-136.300	180	1963 to present (41)
DAWSON A	YK	350	64.043	-139.128	130	1897 to present (114)
LITTLE GOLD CREEK	YK	1,257	64.083	-141.000	155	1974 to 1999 (17)
KLONDIKE	YK	973	64.453	-138.216	185	1966 to 2010 (37)
MAYO A	YK	504	63.617	-135.867	195	1924 to present (88)
MCQUESTEN	YK	458	63.594	-137.523	120	1986 to present (28)
PELLY RANCH	YK	445	62.817	-137.367	100	1952 to present (59)
COFFEE GOLD	YK	975	62.877	-139.300	0	2012 (July) to present

*Bracketed values indicate number of years (n) incorporated into the PMP analysis. Stations in **bold** were included in the PMP analysis.

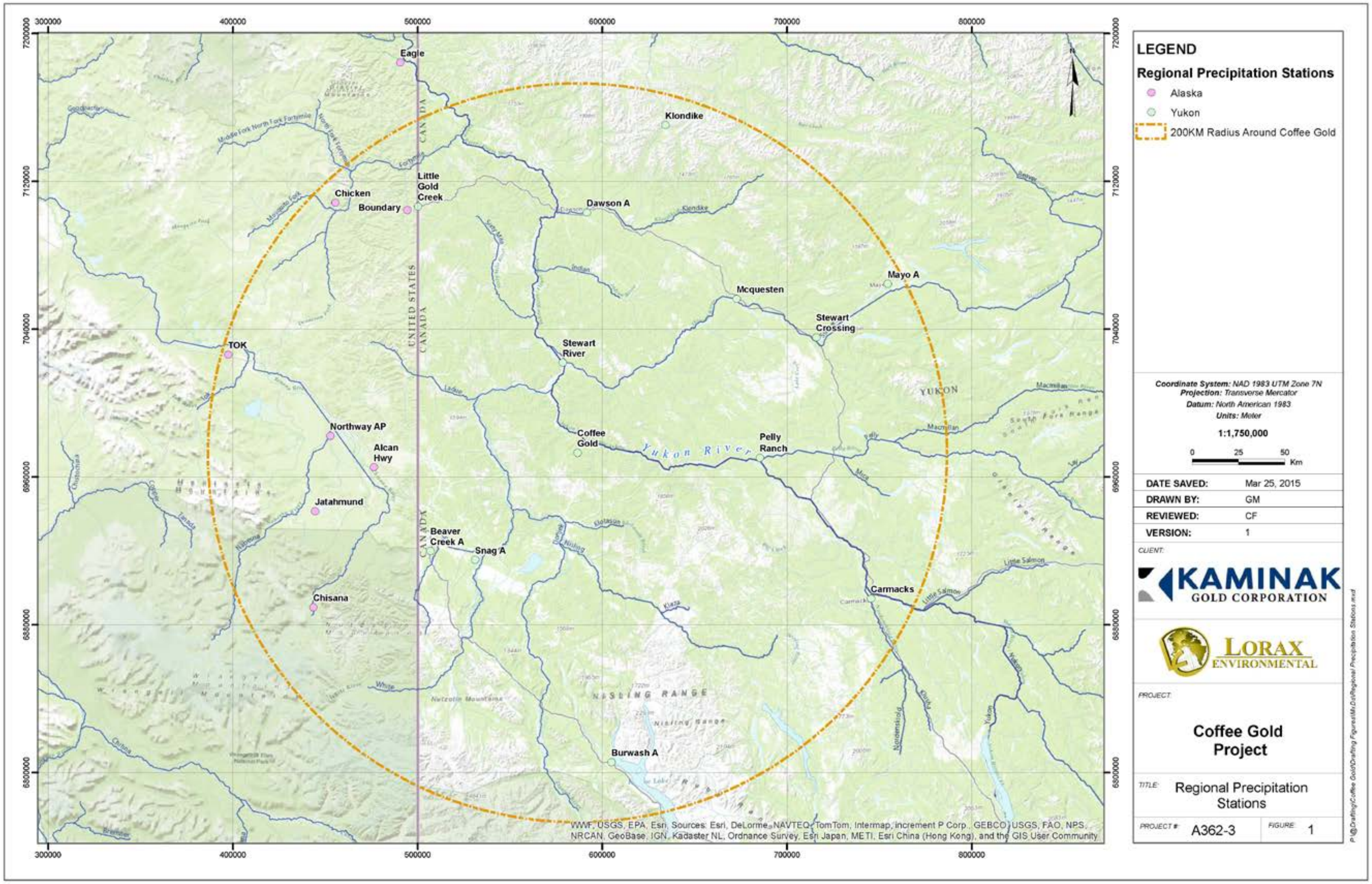

Figure 2-1: Alaska and Yukon climate station location map.

2.2 Probable Maximum Precipitation Analysis

The probable maximum precipitation is defined as the greatest depth of precipitation for a given duration possible for a design watershed or a given storm area at a particular location at a particular time of year, with no allowance made for long-term climatic trends (WMO, 2009). Estimation methods are categorized as either statistical or hydro-meteorological (moisture maximization and storm transposition).

The statistical method is much simpler than the hydro-meteorological method, and does not have the same data requirements (*e.g.*, dew points and wind vectors). It is based on extensive analyses of thousands of station records, which provide the enveloping value (K_m) on which the method is based. It should be noted that the procedure will only provide a point estimate (as opposed to a basin-wide average), and so must be scaled using an area-reduction curve for application to basins larger than 1000 km^2 (WMO, 2009). Given that the contributing areas for Project infrastructure are much lower than this, the application of area-reduction curves is not necessary.

The statistical procedure follows the methodology presented in Hershfield (1961), and as summarized by the WMO (2009). It is based on the general frequency equation:

$$X_t = \bar{X}_n + K\sigma_n \qquad [1]$$

where X_t is the rainfall for return period t, $\bar{X}_n$ and σ_n are the mean and standard deviation (respectively) of the series (n) of annual daily precipitation maxima, and K is a variable that varies with the frequency distribution fit to the annual maxima series.

K_m represents the empirical factor that substitutes for K in Equation 1 to estimate the point PMP. Originally, it was thought that K_m = 15, but was later found to be a function of event duration and the mean annual maximum rainfall (Hershfield, 1997). The function to derive K_m for a 24-hour storm duration is presented in Hogg and Carr (1985):

$$K_{m24} = 19(10)^{-0.000965\bar{X}} \qquad [2]$$

K_{m24} was calculated for all regional stations (range of 17.3 to 18.2 was determined), and then inserted into Equation 1 to calculate the PMP value for each station. For reference, the K_{m24} value calculated from the isoline map in Hogg and Carr (1985) is 18.2.

Variation with Elevation

Lorax (2015b) presents the regional elevation gradient for summer precipitation (4%/100 m). Since the issuance of that report, two additional tipping bucket rainfall gauges were installed at the camp (425 m), and at ridge top ~1,200 m). The data collected to date in 2015 suggest a site-specific gradient of 3%/100 m for rainfall. For the purposes of this analysis, the more conservative gradient (4%/100 m) was used to scale the 24-hour PMP estimates derived for the valley bottom stations to the elevation of the proposed heap leach facility at 1300 m (Table 3-1).

3. Results

3.1 Extreme precipitation – Processes, patterns, record length

Processes

Cassano and Cassano (2010) analysed sea level pressure patterns for the Yukon River basin and found that the winter circulation patterns are dominated by the strong Aleutian Low. By comparison, summer patterns are characterized by low pressure systems over land and the Beaufort/Chukchi Sea and weak high pressure cells to the north - resulting in easterly/northeasterly circulation into the Basin.

The authors found that in the summer, largest daily precipitation events (*i.e.*, top 10th and 1st percentile daily totals, on an annual basis) were associated with an increased frequency of cyclones and over-land convective events. Evapotranspiration rates are highest during the summer, and therefore additional moisture is recycled and available to precipitate. Synoptic patterns and mechanisms governing summer and winter precipitation near the Coffee Creek property are discussed further in Lorax (2015b).

Monthly Patterns of Extreme Precipitation

Lorax (2015a) presents the monthly distribution of maximum 1-day precipitation for the study area (refer to Table 3.1-1 and Figure 3.1-1 in that memo). Period of record monthly maximum 1-day precipitation depths are presented again for nearest climate stations in Table 3.1 below. Consistent with the synoptic understanding of precipitation distribution, the largest 1-day precipitation events consistently occur in the months of June, July and August.

Figure 3-1 shows the 24-hour annual maxima series for the Dawson A, Eagle, Mayo A and Northway AP stations. These data show evidence for inter-decadal variability in annual maxima. There are two periods with generally larger precipitation events: 1) 1930 to 1960; and 2) 1990 to the present. Currently, the timing and phase of long-term climate cycles (*e.g.*, Pacific Decadal Oscillation [PDO], Arctic Oscillation [AO], and El Niño Southern Oscillation [ENSO]) are thought to influence the magnitude and frequency of extreme precipitation events in this region (*e.g.*, Papineau, 2015).

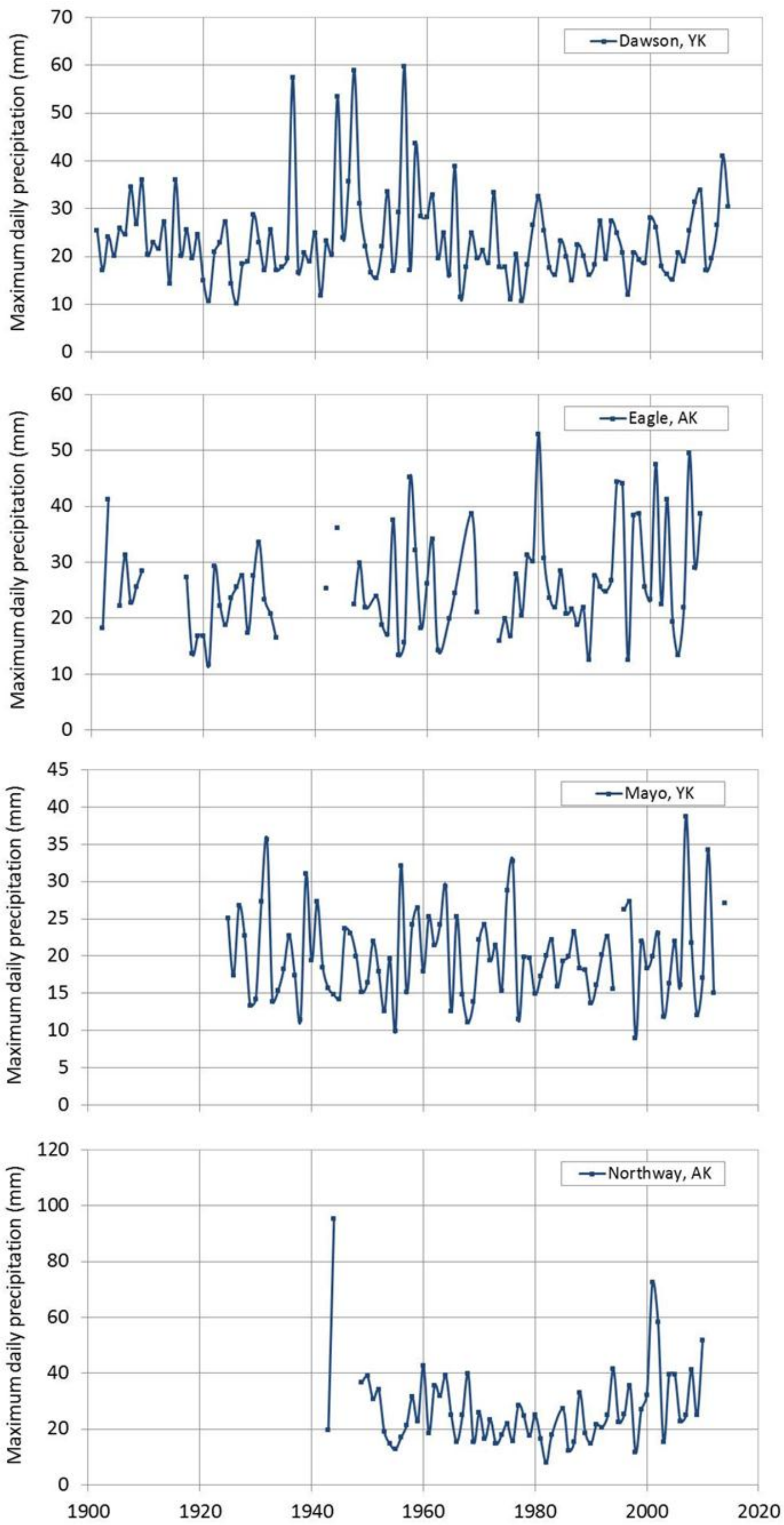

Figure 3-1: 24-hour, maximum precipitation records for Dawson, YK; Eagle, AK; Mayo, YK; and Northway, AK. Source: Lorax, (2015a).

3.2 PMP estimates

The results of the regional PMP analysis for all stations with >30 years of annual maxima data are presented in Table 3-1.

Table 3-1: PMP estimates for Alaskan and Yukon stations

Station	Elevation (m)	Longitude (°)	n	Maximum	Mean	σ	K_{m24}	PMP (mm)	Scaled to 1300 m
TOK	494	-143.050	41	64.0	32.0	13.1	17.7	263.5	361.5
NORTHWAY AP	522	-141.933	63	106.7	30.8	16.4	17.7	322.5	437.5
EAGLE	256	-141.200	82	52.9	26.0	9.3	17.9	192.8	290.3
BEAVER CREEK A	649	-140.868	37	51.1	30.8	8.4	17.7	179.9	232.2
DAWSON A	350	-139.128	114	59.1	21.7	9.4	18.1	192.4	279.2
BURWASH A	807	-139.040	50	51.5	27.6	9.3	17.9	193.1	234.3
KLONDIKE	973	-138.216	37	56.0	23.9	10.0	18.0	204.2	232.1
MCQUESTEN	458	-137.523	28	38.5	22.6	7.4	18.1	155.5	216.4
PELLY RANCH	445	-137.367	57	39.0	22.3	7.6	18.1	159.2	222.7
CARMACKS	525	-136.300	41	38.1	20.1	6.3	18.2	135.1	183.1
MAYO A	504	-135.867	88	38.8	20.1	6.1	18.2	130.9	178.8
Minimum	256	-143.050	28	38.1	20.1	6.1	17.7	130.9	178.8
Maximum	973	-135.867	114	106.7	32.0	16.4	18.2	322.5	437.5
Mean	544	-139.136	58	54.2	25.3	9.4	18.0	193.5	260.7

Variation with Longitude

As outlined in Lorax (2015a), a strong longitudinal precipitation gradient is evident, and this holds true for the PMP estimates as well (Figure 3-2). Higher values are located further west closer to the coast, and lower values in the eastern portion of the region, as the climate becomes more continental.

As a result, a PMP estimate for the Coffee Gold site would be biased higher (lower) if it includes results from stations that are located in the western (eastern) portion of the study area. Therefore, a similar approach to that taken in Lorax (2015a) was employed here, and the stations closest to the Project site (-139.3°W) were assumed to best represent the Project site. These stations are highlighted in bold in Table 3-1. The McQuesten record was not included, as it had 28 years of data. However, its inclusion would not substantially affect the final result (X_t = 236 mm if included).

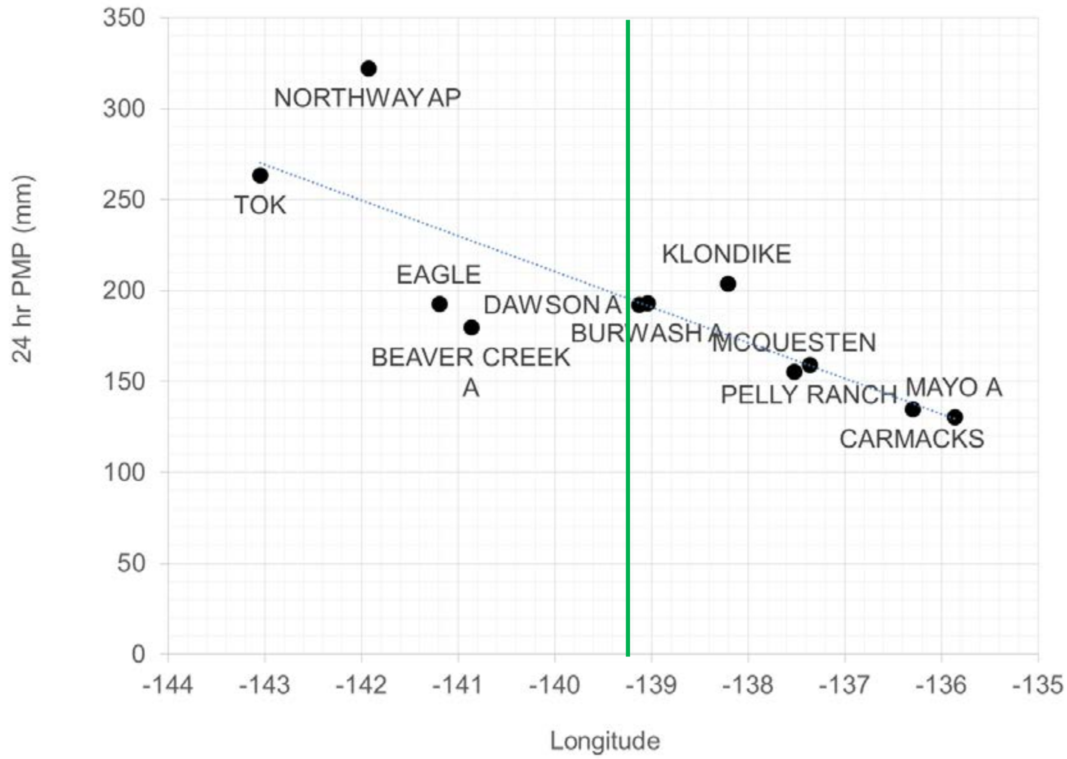

Figure 3-2: 24-hour PMP estimates for regional stations, plotted by longitude. The longitude of Coffee Gold Project is shown by the green line.

24-hour PMP Estimate

The average of the scaled 24-hour PMP estimate from the five representative stations is 240 +/- 22 mm (Table 3-2). For reference, the estimates derived from the isoline maps provided in Hogg and Carr (1985) and NOAA (1963) have also been included. When estimating the magnitude of low-frequency hydro-meteorological events, it is best practice to utilize the longest record period possible, to ensure that the sample (*n*) is adequately representative of the population (all precipitation events). Consistent with the estimates of extreme precipitation presented in Lorax (2015a), it is recommended that the upper-bound estimate be carried forward as the design value. In this case, it is the value based on the Dawson A climate record (279 mm). This is the longest record available for the Project region, with 114 years of data used in this analysis. It captures a period of relatively higher annual precipitation maxima (1940s-1960s) that may not be adequately represented by the records of the other stations included in Table 3-2.

Table 3-2: PMP estimates for near-Project stations (scaled to 1,300 m).

Station	24-hour PMP (mm)
DAWSON A	280
PELLY RANCH	223
MCQUESTEN	216
BURWASH A	234
BEAVER CREEK A	232
KLONDIKE	232
AVERAGE	240
σ	22
Hogg and Carr (1985)	221*
NOAA No.47 (1963)	254

*The value derived from the isolines was adjusted by a factor of 1.5 to account for orographic enhancement in mountainous terrain (in non-coastal mountains above 800 m and for events >12 hours), as recommended.

4. Summary

Twenty regional precipitation records were considered in the development of the 24-hour PMP estimate for the Coffee Gold Project. Of these, ten stations had sufficient record lengths to be carried forward for statistical analysis. A strong gradient (decreasing from west to east) was noted in the PMP estimates, and a sub-set of stations closer to the Project site were carried forward. The estimates derived for the regional (low-elevation) climate stations were scaled to the elevation of the proposed heap leach facility (1,300 m), consistent with the available information on precipitation gradients for the Coffee Creek site. The 24-hour PMP value recommended for use going forward is 280 mm.

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Appendices

GOLDCORP

Appendix D
Climate Change

Appendix D1: Climate Change Scenarios for Coffee Creek

Appendix D2: Additional Trend Analyses

GOLDCORP

APPENDIX D1: CLIMATE CHANGE SCENARIOS FOR COFFEE CREEK

Coffee Gold Project

Climate Change Projections for Coffee Creek Region, Yukon

September 2015

Prepared for:

KAMINAK GOLD CORPORATION

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LORAX ENVIRONMENTAL

KAMINAK
GOLD CORPORATION

Coffee Gold Project

Climate Change Projections for Coffee Creek Region, Yukon

September 2015

LORAX ENVIRONMENTAL

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1. Introduction

Kaminak Gold Corporation (Kaminak) is in the process of developing and permitting the Coffee Gold Project (Project), a proposed heap leach operation located in west-central Yukon, approximately 180 km south of Dawson City. The Project is located within the traditional territory of the Tr´ondëk Hwëch´in and the asserted traditional territory of the White River First Nation. A portion of Kaminak's claim block is located in Selkirk First Nation's traditional territory. Currently the Project is undergoing a detailed Feasibility Study with project engineering and design progressing with full consideration of environmental conditions within the project area.

Climate, meteorological conditions and attendant hydrological systems at the Coffee Gold Project influence engineering design parameters, in particular the heap leach design, heap leach water balance, site wide water balance and ultimately comprehensive site wide water management systems. Existing climate conditions at the Coffee Gold Project are unlikely to remain static and consideration of potential climate change scenarios are being incorporated into project planning. Kaminak commissioned Lorax Environmental Services Ltd. (Lorax) to conduct a climate change analysis for the Coffee Gold Project. The analysis, the subject of the following report, was prepared by Dr. Thomas Pedersen, Director, Lorax and current Director, Pacific Institute for Climate Solutions, University of Victoria; Dr. Pedersen also serves as Chair, Canadian Climate Forum.

Within a few to several decades global warming is projected to have a profound impact at high latitudes in both hemispheres. Impacts are already being widely felt: in the polar and sub-polar regions of northern Canada, average annual temperatures are rising—dramatically in some areas; regional snow cover is declining; glaciers are retreating; permafrost is thawing, particularly at lower elevations; and the areal coverage and frequency of wildfires are both on the rise. Such phenomena are summarized in the 2014 Yukon State of the Environment Report (http://www.env.gov.yk.ca/publications-maps/documents/SOE_2014_Web.pdf).

Climate-model projections suggest that the character of seasonal climate will also change significantly over the course of this century: winters on the whole will be warmer and wetter in the North while summers will be hotter and drier. Weather extremes, including heat waves and intense rainfall events are projected to become more frequent. There will also be, and already are, associated biological and ecological changes. Biomes are moving north, while optimal habitats for some plant and animal species are moving upward to higher-elevation (thus, cooler) areas. Each of these physical and biological impacts will have effects across the Coffee Creek region that need to be considered in planning over the longer term.

As discussed in the following sections, if human society continues to follow the greenhouse-gas emissions pathway that is currently in place, within several decades the climate of the North, including the south-central Yukon, will be notably different. By the year 2100, average temperatures at the Coffee Creek Project site can reasonably be expected to be 3°C to 5°C warmer relative to the waning decades of the last century. Average annual precipitation at Coffee Creek may not change so notably. However, summer and winter can be expected to be slightly wetter in the future, with spring and fall seasons projected to see little net change in precipitation abundance.

Overall, warming is anticipated to be particularly pronounced in the summer at Coffee Creek and this will lead to a later freeze-up in fall and an earlier thaw in spring, according to the model results. In tandem, this yields a growing season that is as much as one month longer by the end of the century and implies a significantly lengthened duration for above-zero temperatures and consequent negative implications for permafrost integrity in the region.

2. Background to Climate Change Projections

Global climate models (GCMs) use a physical representation of the ocean-land-atmosphere system under various climate-forcing scenarios to project future mean climatic states. Over the last two decades, the international modeling community has established two sets of potential emissions pathways, the first published in 2000 by the Intergovernmental Panel on Climate Change (IPCC), as a Special Report on Emissions Scenarios (SRES). Four 'scenario families' (A1, A2, B1, B2) were outlined in that report that spanned possible 21st Century (and beyond) emissions pathways resulting from different global population and economic growth trajectories, varying emphases on energy sources (renewables versus fossil fuels) and materials energy intensities, and variable emphasis on local to global solutions (IPCC SRES, 2000). The A2 scenarios encompassed continuously increasing population and regional economic development in a world of independent, self-reliant nations. These defined the most rapid increases in emissions trajectories over the next 100 years.

A more recent set of scenarios, 'Representative Concentration Pathways' (RCPs) was produced for the Fifth Assessment Report of the IPCC released in 2014. RCPs describe four potential emissions trajectories (RCP2.6, RCP4.5, RCP6.0 and RCP8.5, Figure 2-1) that, like SRES pathways, could be possible depending on future international climate mitigation policies and primary socioeconomic influences including economic and population growth, fossil-fuel-derived energy intensity per unit of GDP, and technological advances.

The number associated with each RCP refers to an assumed change in radiative forcing by the year 2100 in Watts/m^2, relative to pre-industrial time. RCP 8.5 (*i.e.,* 8.5 W/m^2 of additional forcing by 2100) represents the "worst-case" scenario, and includes all greenhouse gas contributions, not just that from carbon dioxide. Two key points emerge when all four RCP scenarios are considered. First, regardless of which pathway is chosen, there is little difference in impact on global average surface temperature prior to mid-century, but after that point, the divergence is progressive and striking. By the year 2100, for example, should we follow the RCP 8.5 scenario, global average surface temperature increases relative to pre-industrial time will be on the order of 4-5°C (Figure 2-2). This outcome is very similar to that projected by the SRES A2 scenario. In contrast, temperature change can be held to <2°C by 2100 (Figure 2-2) if global society instead follows the RCP 2.6 pathway (the green curve in Figure 2-1, and the royal blue curve in Figure 2-2). Second, current emissions rates define a trajectory that is actually slightly *worse* than the RCP 8.5

pathway (note the labelled star in Figure 2-1). Given that, and considering the need to be conservative in forecasting potential future climatic changes, we adopt the worst-case scenario here. The SRES A2 pathway is very similar to the more recent RCP 8.5 trajectory, and is used in the future-climate projections that follow.

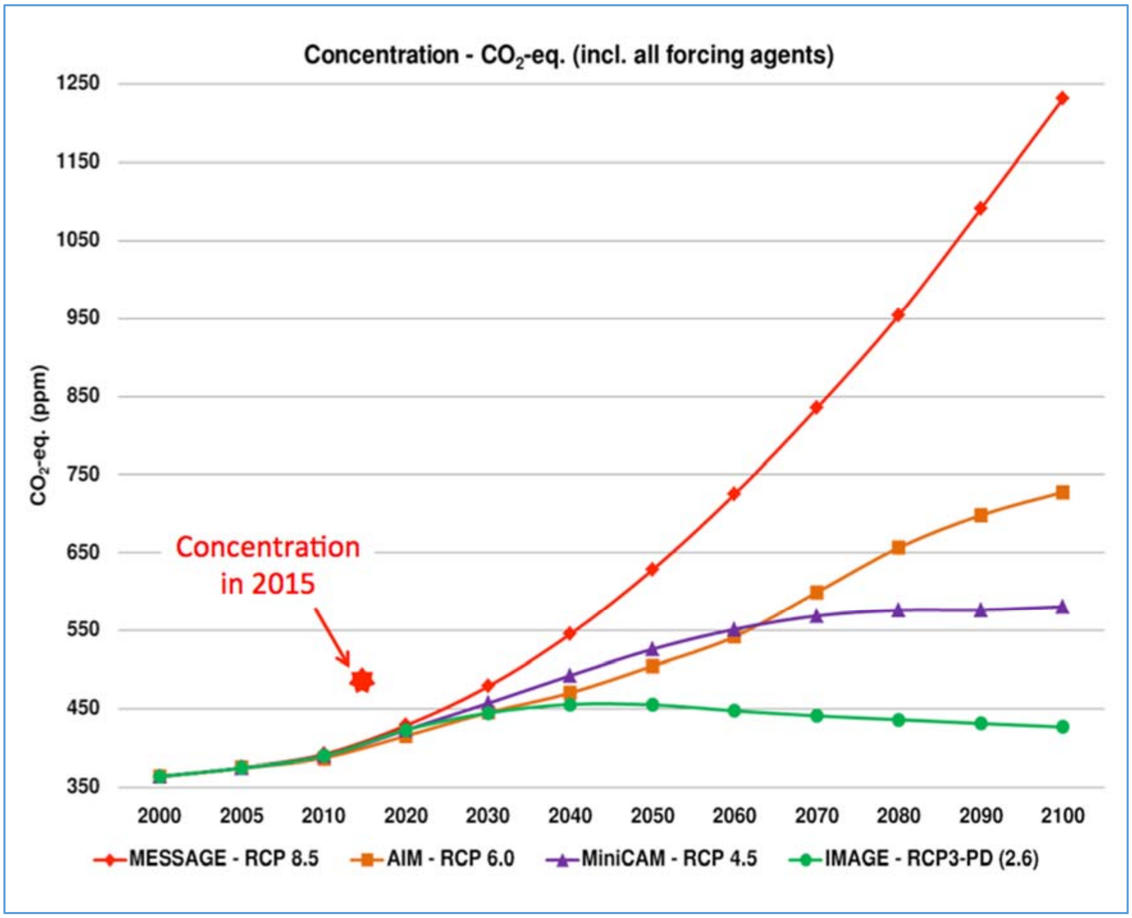

Figure 2-1: Adapted from Moss et al. (2008), and https://en.wikipedia.org/wiki/Representative_Concentration_Pathways#/media/File:All_forcing_agents_CO2_equivalent_concentration.png. The red star illustrates the approximate concentration of all greenhouse gases at present, scaled as CO2-equivalent, equal to about 480 ppm of carbon dioxide in the atmosphere. The four IPCC Representative Concentration Pathways are shown to the year 2100 by the four coloured lines, each of which was calculated based on sets of socioeconomic and population growth assumptions

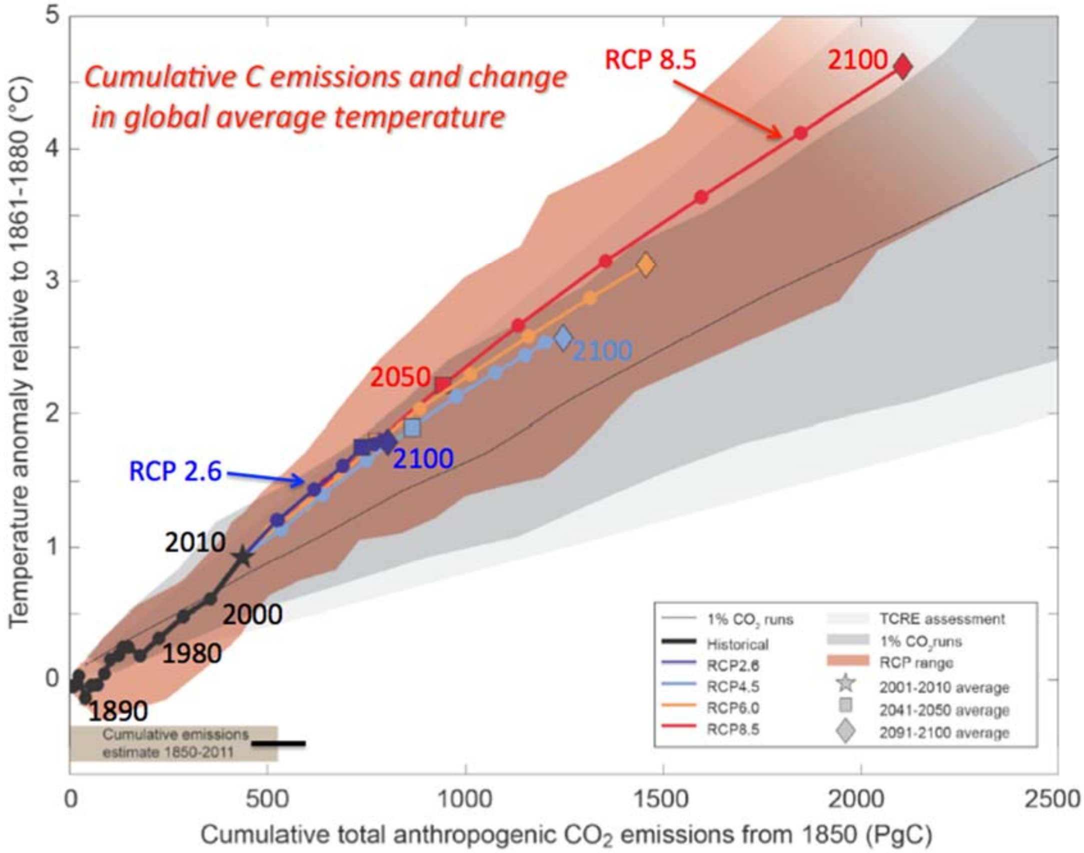

Figure 2-2: Projected global average temperature changes to the end of the Twenty-first Century relative to the late 19th Century, as a function of CO_2 emissions and time. Change in global temperature from 1870 to 2010 as a function of estimate emissions is shown by the black line. Dots for each pathway mark decade endpoints. If humanity follows the RCP 8.5 pathway, average global temperature at the end of this century will be ~4.5 ± 1.5 °C higher than in the 1861-1880 period. The figure has been modified from Figure 10 of: www.ipcc.ch/pdf/presentations/ar5/wg1/pc270913_appr_spm_stocker.pdf.

3. Methods and Data Sources

The two principal climate variables, temperature and precipitation, are discussed here for the region approximately bounded by longitudes 138.6 and 139.8°W and 62.7 and 63.0°N. The Coffee Creek heap leach site sits near the centre of this ~2300 km^2 quadrant. Projected dates of spring thaw and fall freeze are also included in the following discussion.

Modeled historical climate averages and future projections were obtained from the Scenarios Network for Alaska and Arctic Planning (SNAP) at the University of Alaska, Fairbanks, which produces climate information for Alaska and the Yukon region. All parameters specified for the projections that follow (Figure 4-1 through Figure 6-3). The following periods have been selected from the SNAP data to represent key phases of the proposed Coffee Gold Project:

- Historical (1961-1990)
- End of operations/closure (2030-2039)
- Post-closure (2060-2069)
- End of projections (2090-2099)

SNAP uses a statistical downscaling approach to apply baseline climate states projected by general circulation models (GCMs) onto high-resolution topography. The approach used––"the delta method", descriptions of which can be found at https://www.snap.uaf.edu/methods/downscaling and http://www.ccafs-climate.org/statistical_downscaling_delta/ - draws on a suite of five top-ranked climate models of both past and future climate. Outputs discussed here are based on downscaled five-model averages.

Data sources, described at https://www.snap.uaf.edu/methods/data, yield a 2 km spatial resolution for the Yukon region that relies on PRISM (Parameter-Elevation Relationships on Independent Slopes Model) data and technology developed originally by Daly *et al.* (2008) at Oregon State University. PRISM technology is considered by regional climate modelers internationally to be state of the art. As noted above, the projections below are based on the IPCC SRES (2000) A2 scenario, which can be considered to be the 'worst case' future emissions trajectory. It must be emphasized, however, that global emissions today and over the previous decade *exceed* the pathway assigned by the constructed A2 scenario. "Worst case" may, therefore, prove to be an understatement.

4. Temperature Projections

Average annual temperatures are projected to rise significantly in the Coffee Creek region over the course of this century. The current annual average, about -3°C at the Coffee Gold Project site (Lorax, 2015), is forecast to rise by 3 to 5 degrees C by the end of the century, to on the order of +1 ± 1°C (Figure 4-1).

Average seasonal temperatures are projected to increase by a similar amount in spring, fall and winter, but will likely rise more dramatically in summer (compare Figure 4-2, Figure 4-4 and Figure 4-5 with Figure 4-3). Lorax (2015) estimated that June-July-August temperature for the project site at present is +11.3°C. By the end of the century, that 'summer average' temperature is projected to be between 14.9 and 16.5°C using the A2 scenario (Figure 4-3), an increase of some 3 to 5°C relative to average conditions today. Note that this projection is scenario dependent and therefore uncertain. Should greenhouse gas emissions increase at a rate less than that proscribed by SRES A2, end-of-century temperature increases in all seasons across the North would likely be lower. However, current global practices, as described above, do not support grounds for optimism: it is certain to warm at Coffee Creek over the course of this century, with a high probability that the increase will be several degrees across all seasons, with summer showing the largest change.

There is one caveat that applies at the seasonal level: episodic temperature inversions are common in Yukon valleys in winter, particularly January, as noted by Lorax (2015). Anecdotally, these can lower temperatures by as much as 15°C on a valley floor relative to nearby elevations upslope (personal communications, S. Mooney, Yukon Research Centre, Whitehorse, and Prof. David Atkinson, University of Victoria). PRISM-based reconstructions take into account such abrupt climatic shifts with elevation across Alaska and the Yukon by assigning two layers to the atmosphere: the boundary layer and the free atmosphere above it (Simpson *et al.*, 2005). Inversions are determined in the PRISM database by comparing surface station data with the Global Gridded Upper Air Statistics data set, as noted by Simpson *et al* (2005), and are taken into account in the SNAP projections (personal communication, Dr. Faron Anslow, Pacific Climate Impacts Consortium, University of Victoria). Thus, winter average temperatures along the Yukon River projected by SNAP for the Coffee Creek region incorporate the statistical likelihood that inversions will continue to occur episodically.

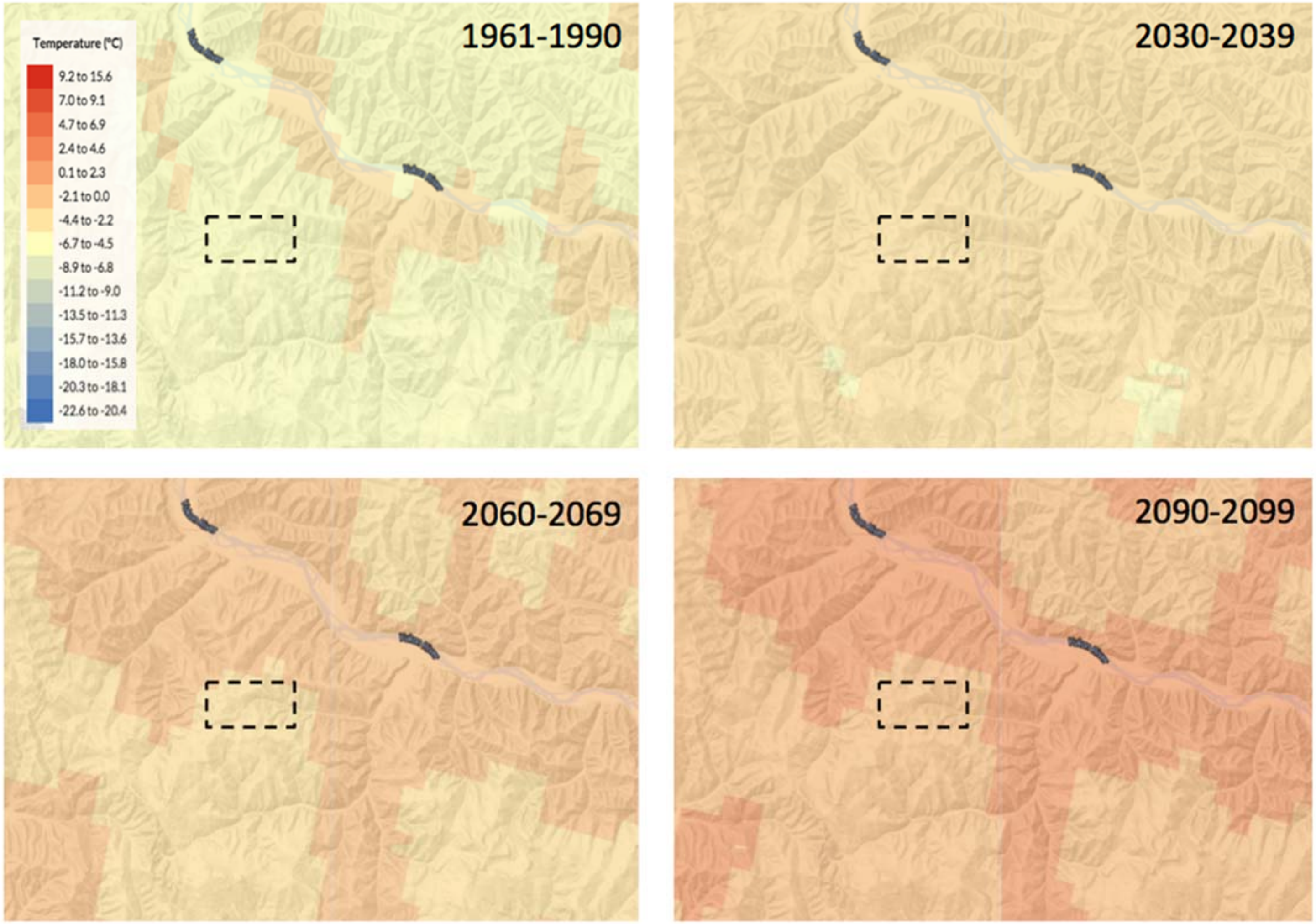

Figure 4-1: Temperature averages modeled using SNAP (see text) across the Coffee Creek region for both the past (1961-1990) and three future decades (2030-2039 – End of operations/Closure; 2060-2069 – Post-closure; and 2090-2099 – End of projections). The dashed rectangle marks the project site. The Yukon River (labelled) runs across the northeast corner of each panel. The 1961-1990 average is scaled using PRISM technology (see text) from data collected at multiple Yukon weather stations, and the constructions for three future decades are based on the SRES A2 scenario (see text). Spatial resolution of the model output is 2 km, as illustrated by the square grid cells (2 km per side).

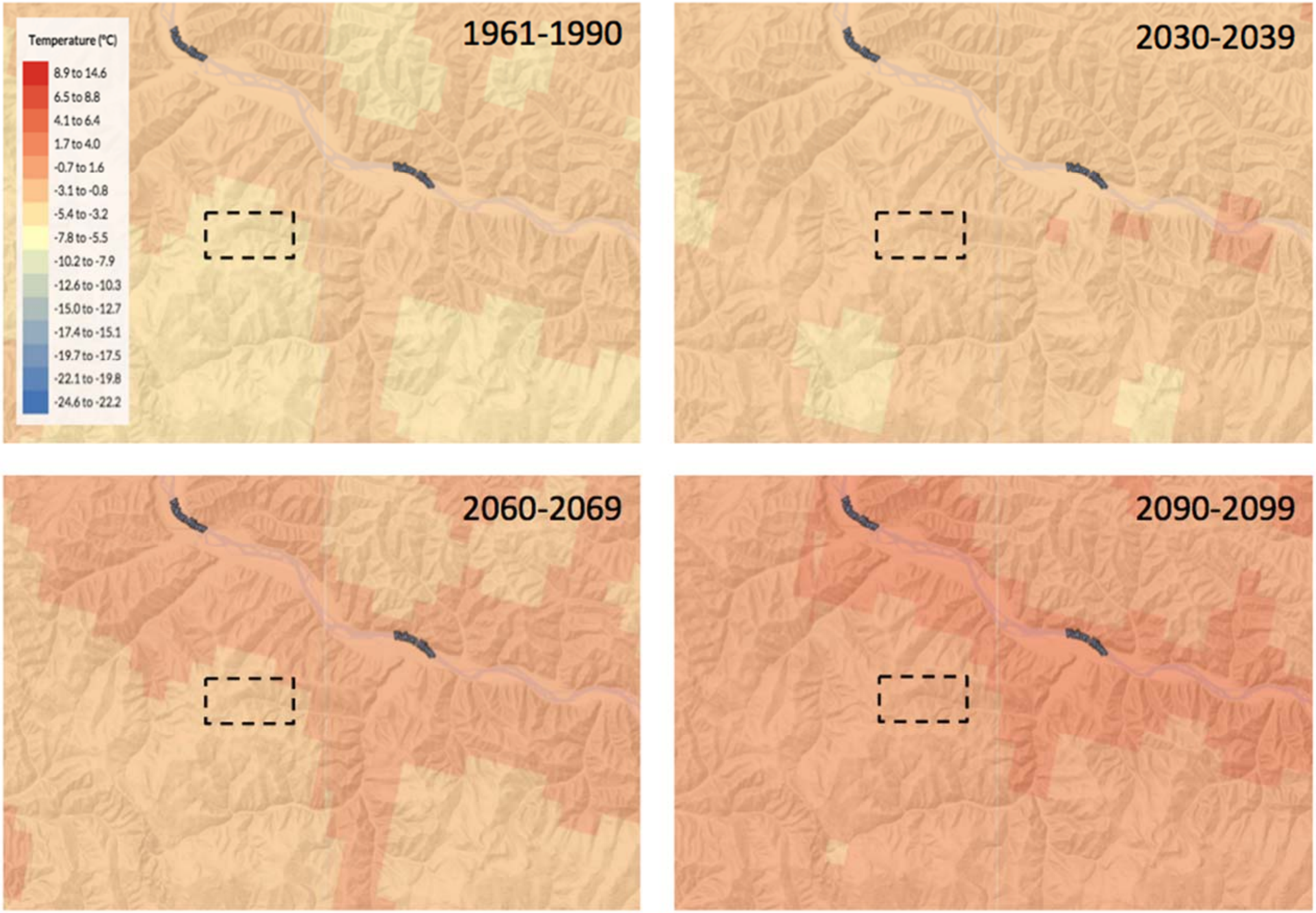

Figure 4-2: Temperature averages for Spring across the Coffee Creek region for both the past (1961-1990) and three future decades. The dashed rectangle marks the project site. Spatial resolution of the model output is 2 km. Data shown are from SNAP. See Figure 4-1 caption for additional details.

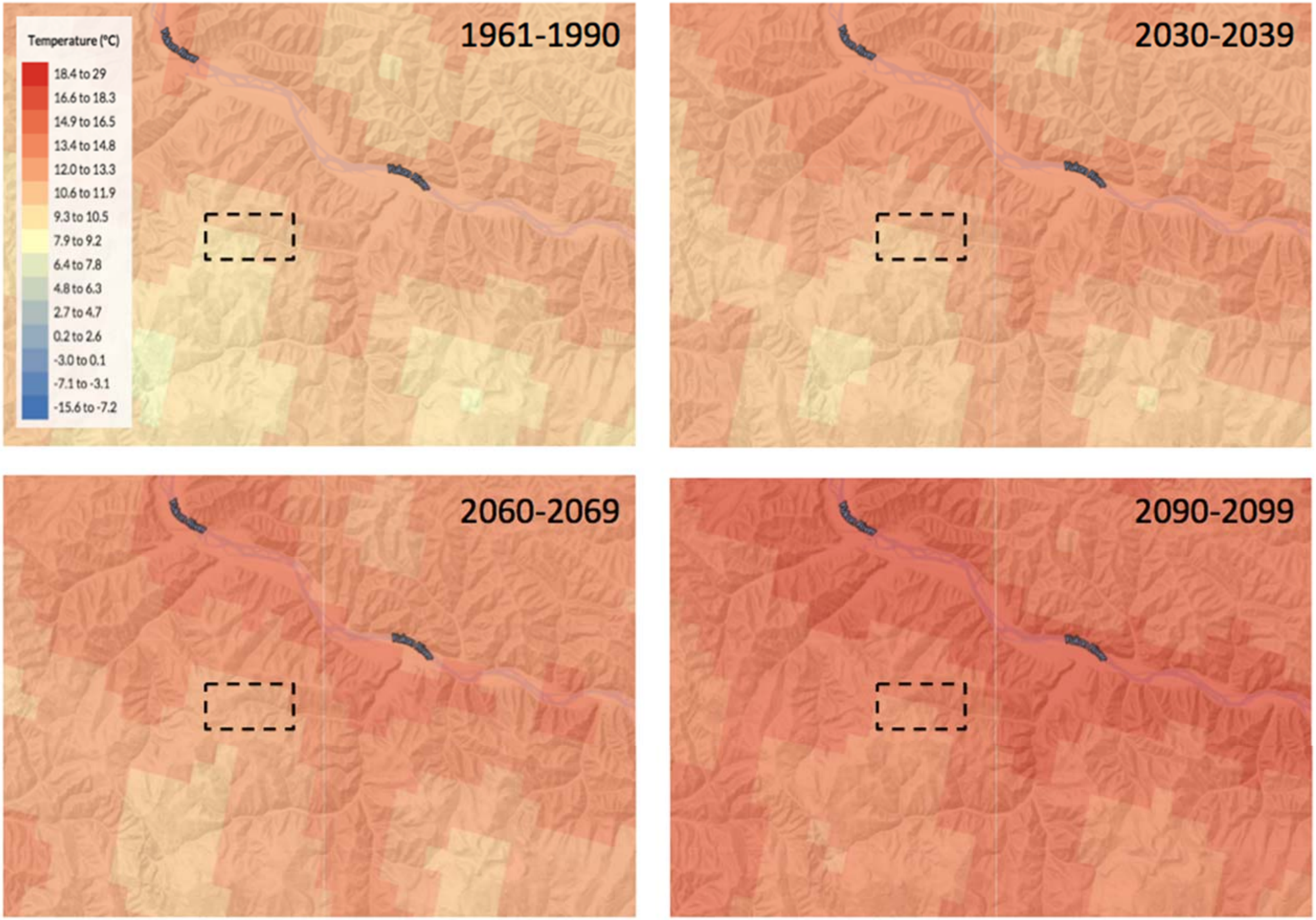

Figure 4-3: Temperature averages for Summer across the Coffee Creek region for both the past (1961-1990) and three future decades. The dashed rectangle marks the project site. Spatial resolution of the model output is 2 km. Data shown are from SNAP. See Figure 4-1 caption for additional details.

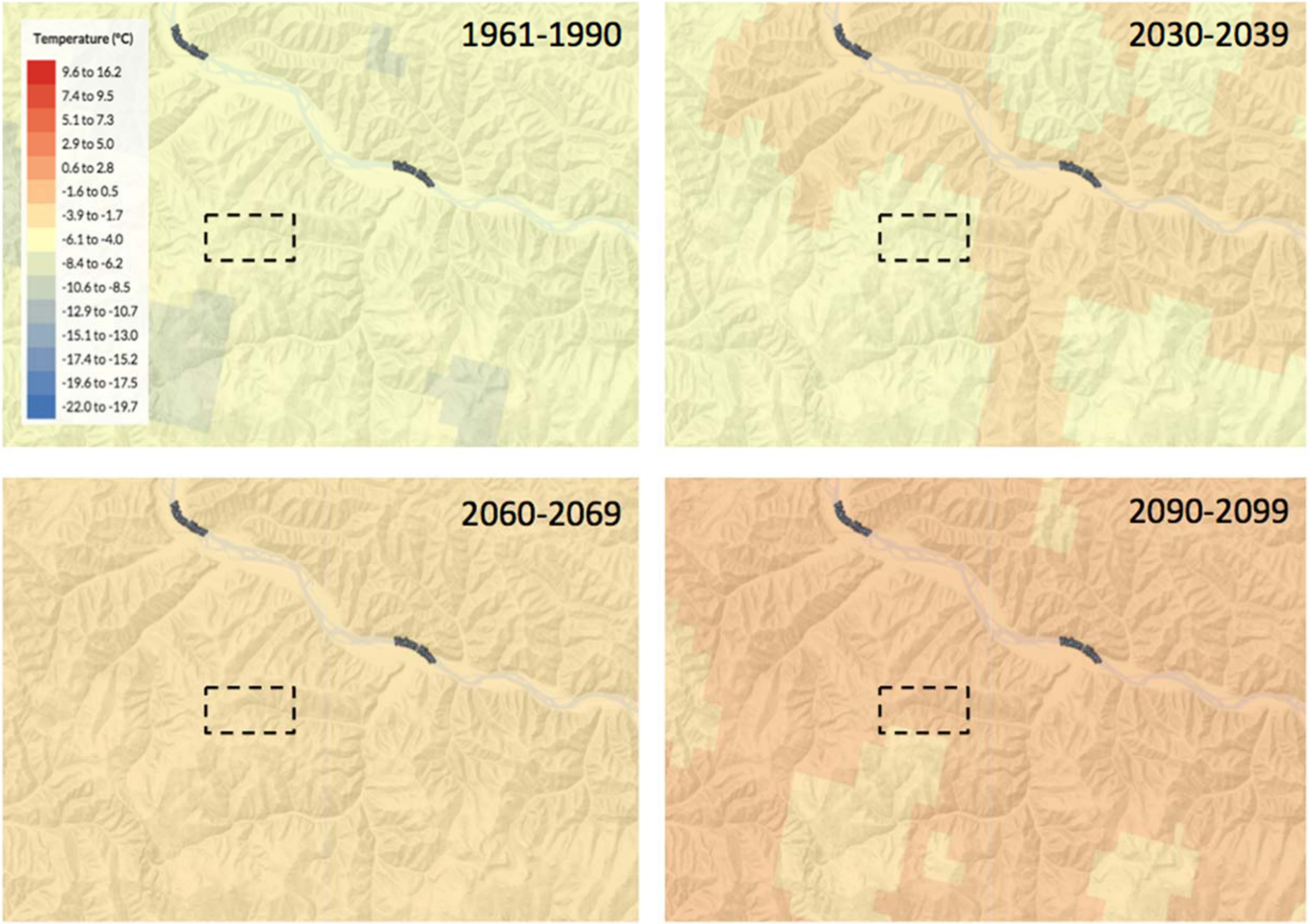

Figure 4-4: Temperature averages for Fall across the Coffee Creek region for both the past (1961-1990) and three future decades. The dashed rectangle marks the project site. Spatial resolution of the model output is 2 km. Data shown are from SNAP. See Figure 4-1 caption for additional details.

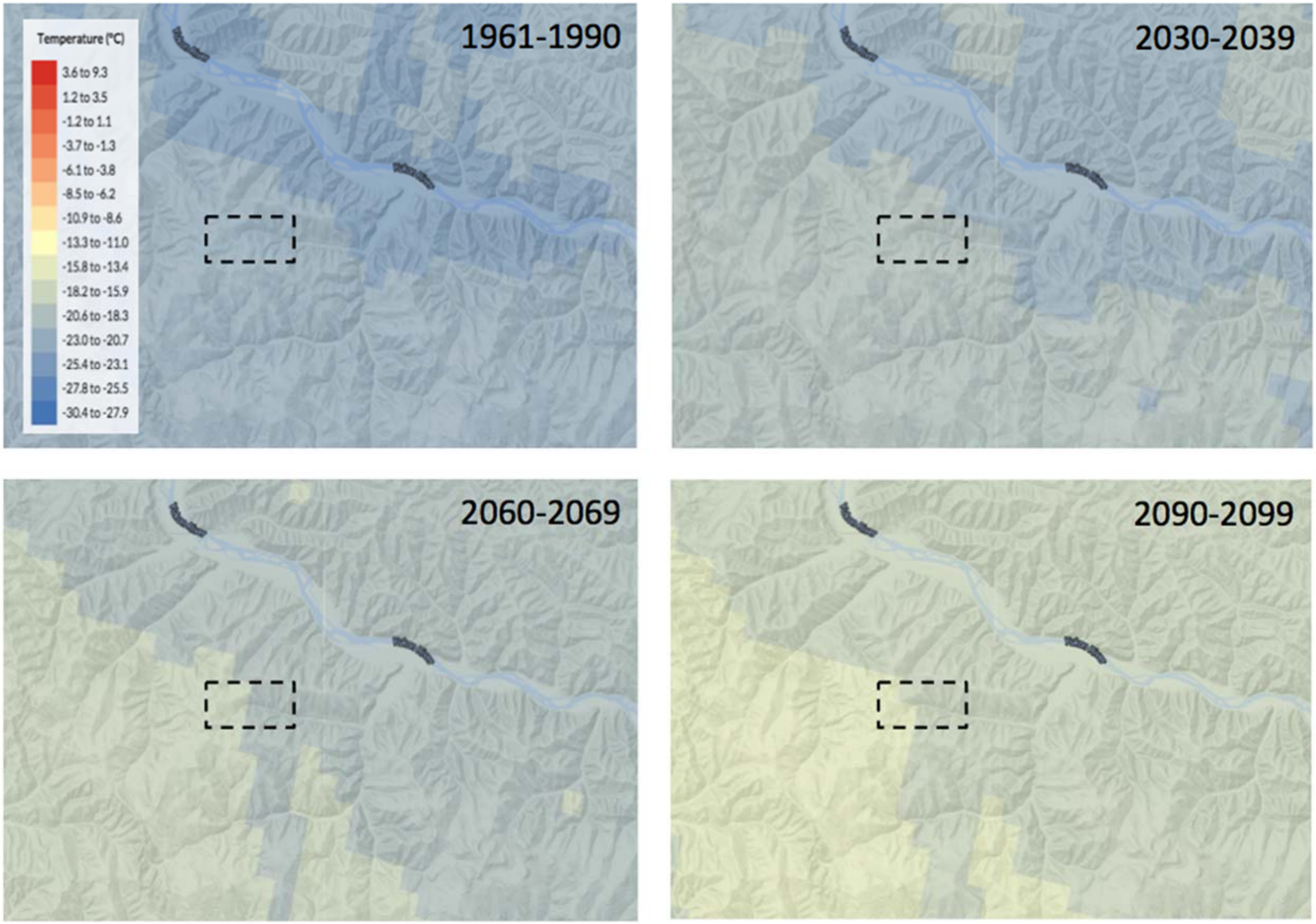

Figure 4-5: Temperature averages for Winter across the Coffee Creek region for both the past (1961-1990) and three future decades. The dashed rectangle marks the project site. Spatial resolution of the model output is 2 km. Data shown are from SNAP.

Colder valley-bottom temperatures in winter notwithstanding, implications of the projected temperature increases for permafrost integrity in the region are obvious. The active layer can be expected to grow in thickness in the warmer months of coming decades, while the depth to intersection with permanently frozen ground will slowly increase. But how fast such changes will be witnessed remains a question largely dependent on the rate of change in radiative forcing with time.

5. Precipitation Projections

As for mean temperature, net precipitation in the Coffee Creek region overall is projected to increase over the course of this century (Figure 5-1). Lorax (2015) computed an average precipitation rate of 485 mm yr^{-1} for the project site at present, slightly higher than the 428-476 mm yr^{-1} modeled at the valley floor as the average over the 1961-1990 interval (Figure 5-1). At that same valley-floor elevation, average annual precipitation by the end of this century is projected to increase marginally to 477-525 mm yr^{-1}, while across much of the broader region, an increase of some 20% to some 574-670 mm yr^{-1} can be anticipated by the year 2100 (compare the lower right and upper left panels of Figure 5-1), given the emissions pathway specified by the SRES A2 scenario.

At present, the bulk of annual precipitation at Coffee Creek falls between May and September, with March and April, being particularly dry months (Lorax, 2015, Table 3-1). This contrasting pattern is projected to persist over the course of the century, albeit with Summer and Winter receiving greater precipitation than historically at the project site (compare Figure 5-2 through Figure 5-5; note that legend scales differ for each season), and little change being witnessed in Spring or Fall.

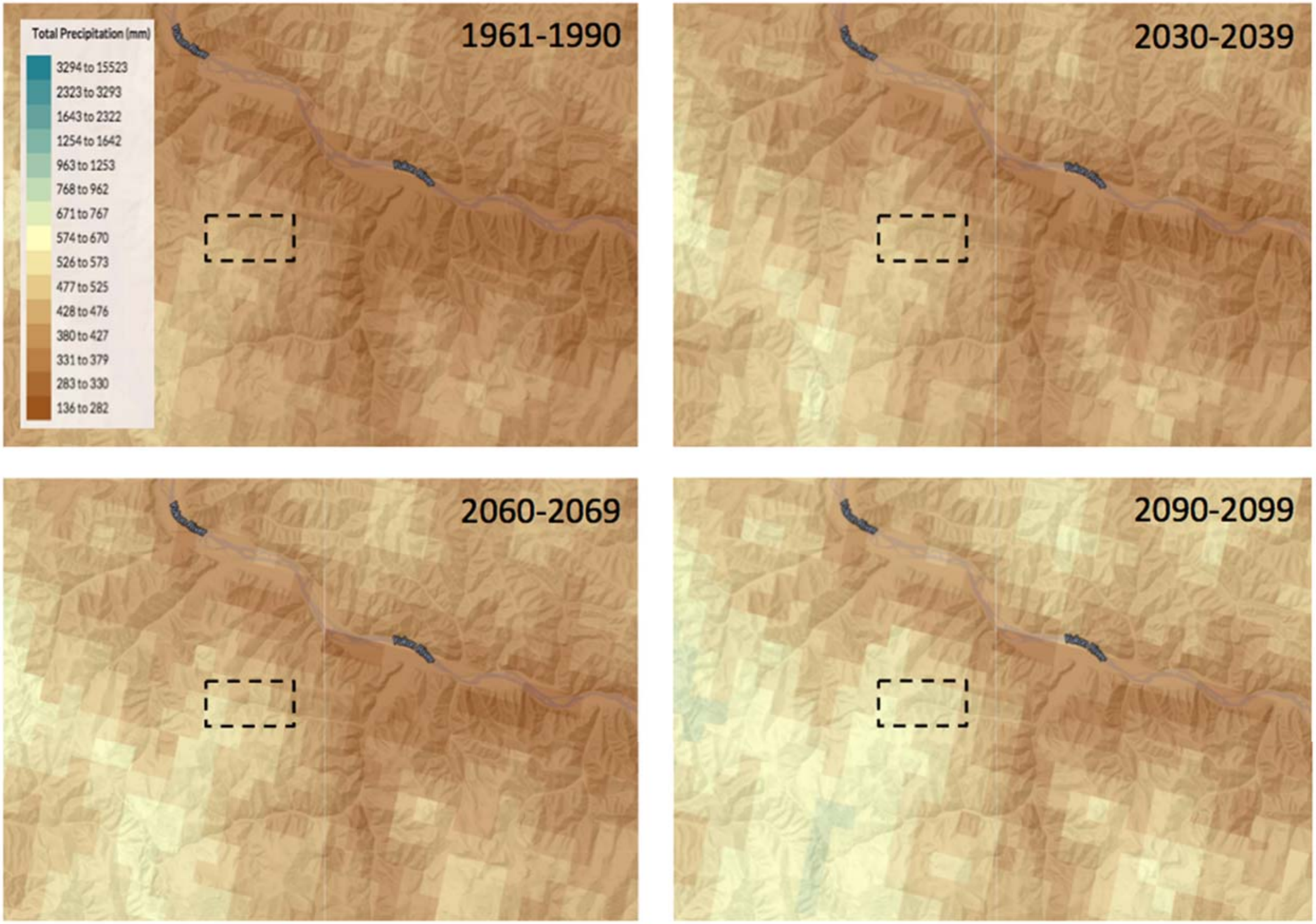

Figure 5-1: Annual precipitation averages in millimeters of water equivalent modeled using SNAP (see text) across the Coffee Creek region for both the past (1961-1990) and three future decades. The dashed rectangle marks the project site. Spatial resolution of the model output is 2 km. Data shown are from SNAP. See Figure 4-1 caption for additional details.

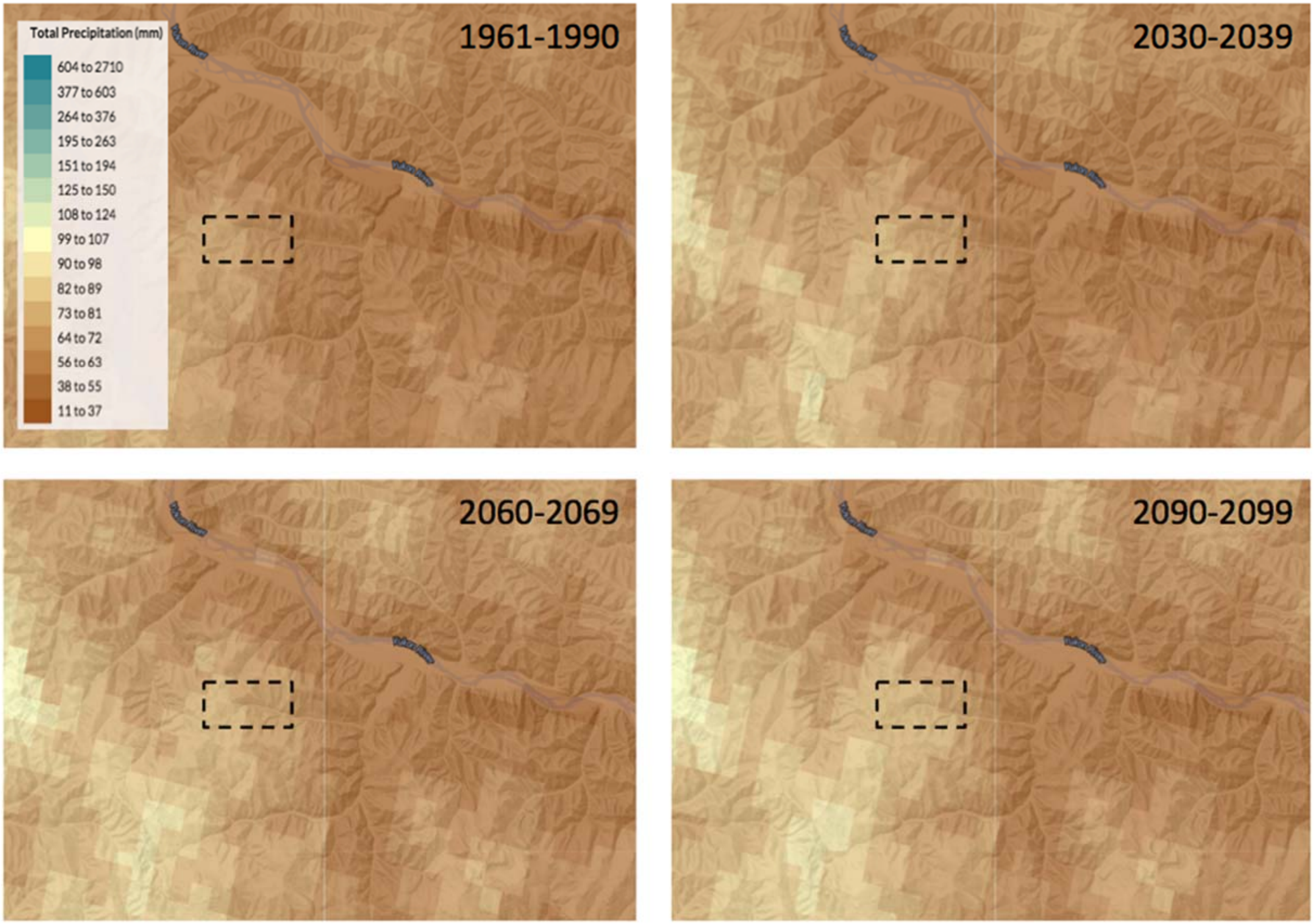

Figure 5-2: Precipitation averages for Spring in millimeters of water equivalent across the Coffee Creek region for both the past (1961-1990) and three future decades. The dashed rectangle marks the project site. Spatial resolution of the model output is 2 km. Data shown are from SNAP.

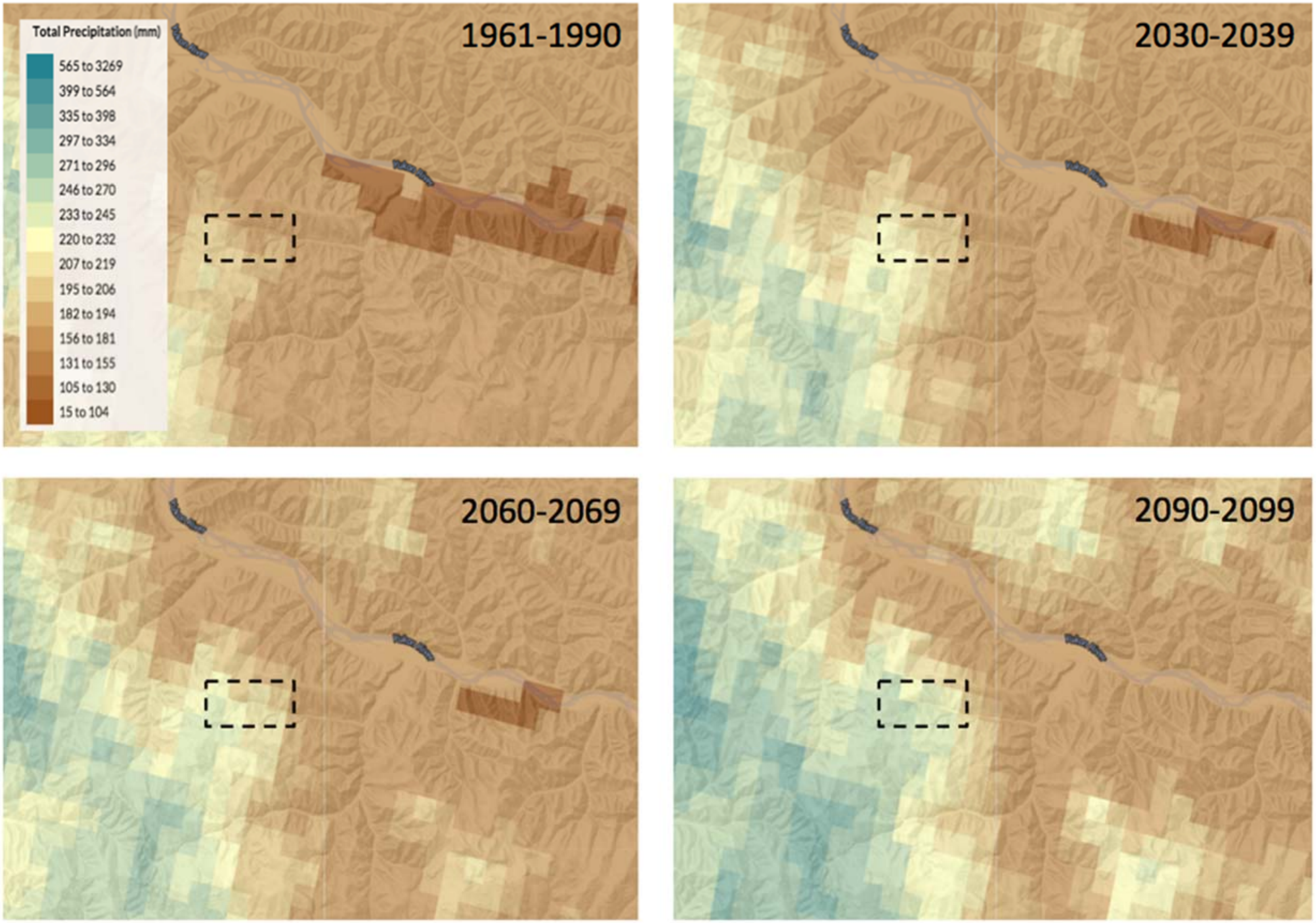

Figure 5-3: Precipitation averages for Summer in millimeters of water equivalent across the Coffee Creek region for both the past (1961-1990) and three future decades. The dashed rectangle marks the project site. Spatial resolution of the model output is 2 km. Data shown are from SNAP.

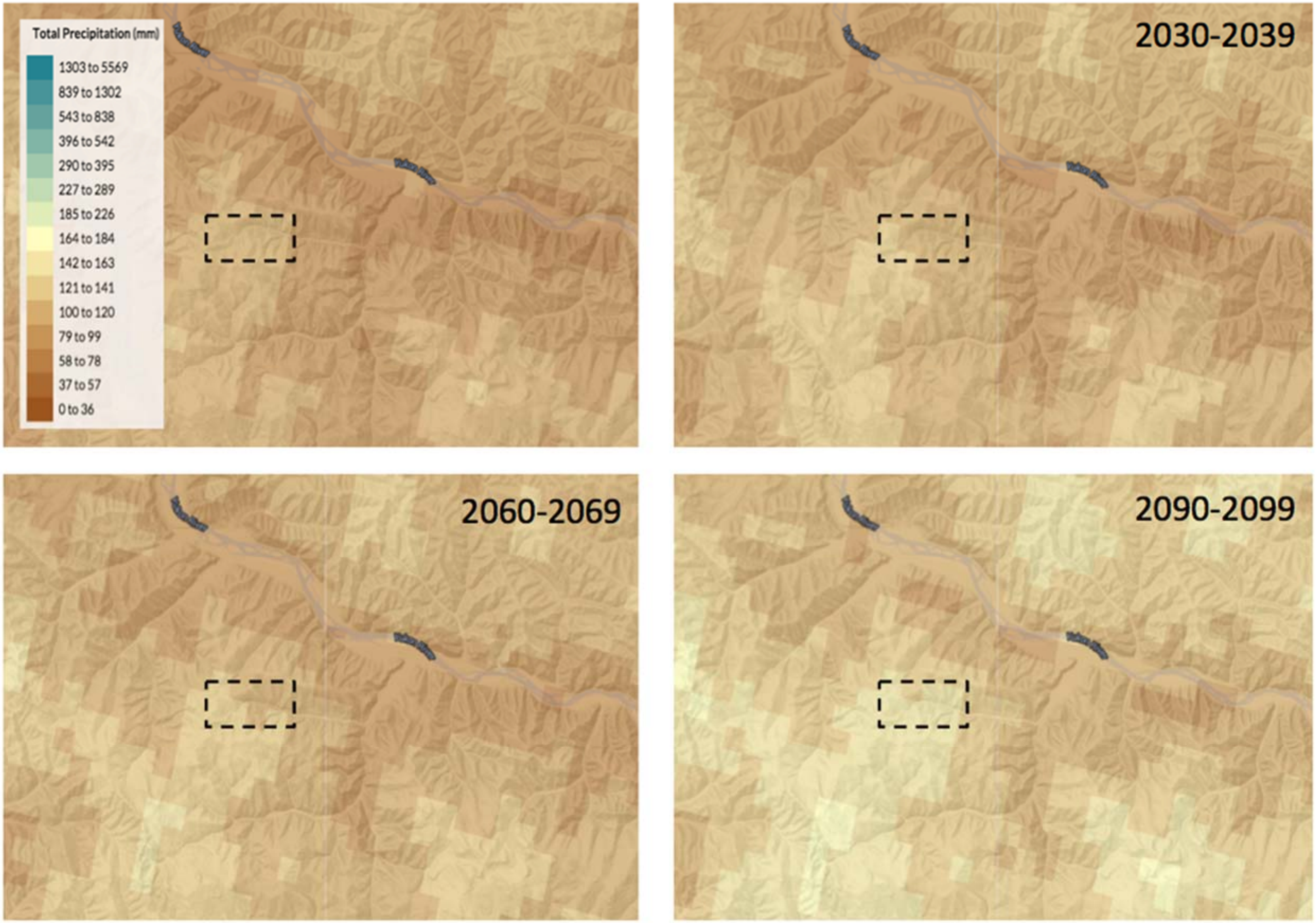

Figure 5-4: Precipitation averages for Fall in millimeters of water equivalent across the Coffee Creek region for both the past (1961-1990) and three future decades. The dashed rectangle marks the project site. Spatial resolution of the model output is 2 km. Modeled using SNAP.

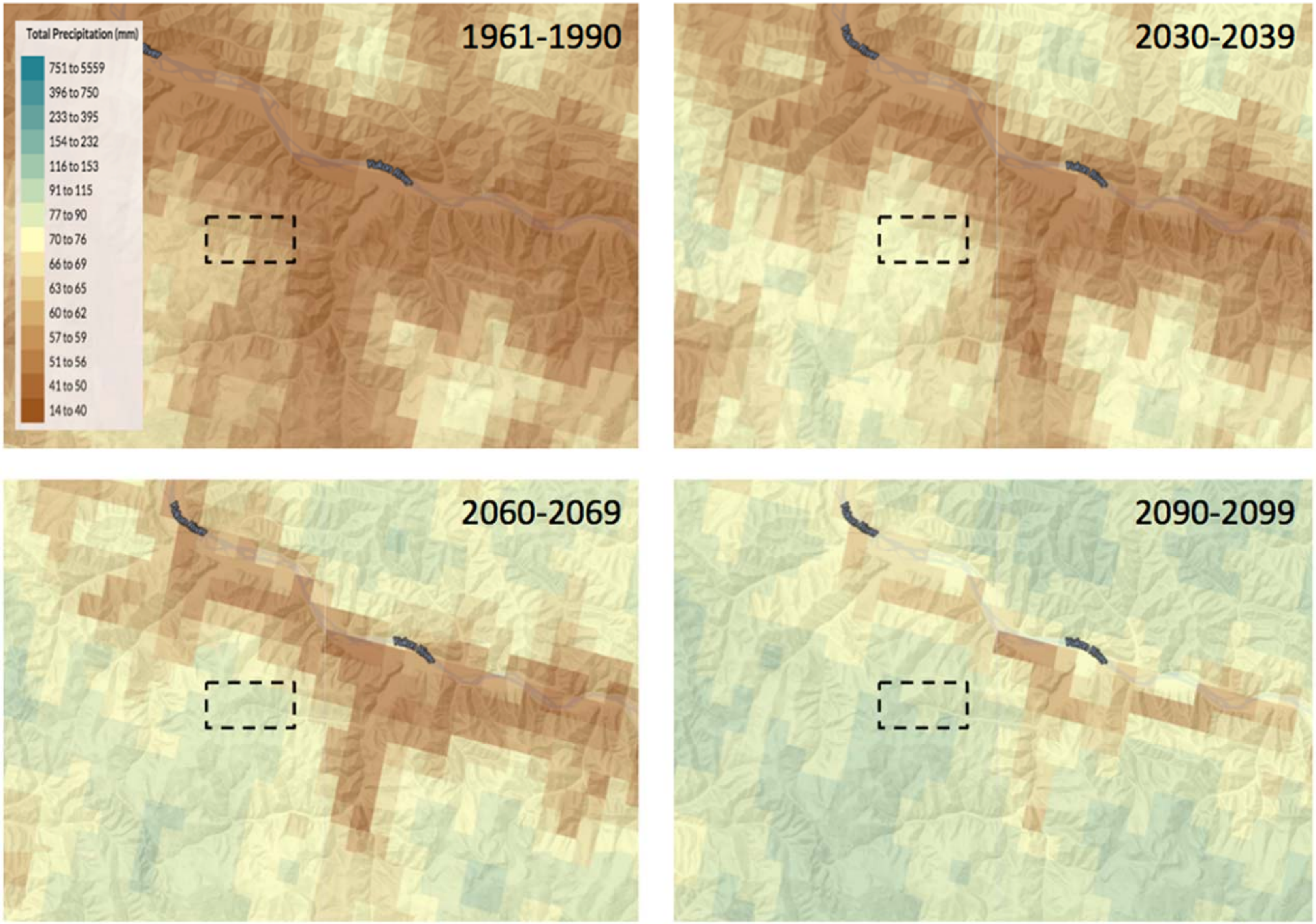

Figure 5-5: Precipitation averages for Winter in millimetres of water equivalent across the Coffee Creek region for both the past (1961-1990) and three future decades. The dashed rectangle marks the project site. Spatial resolution of the model output is 2 km. Data shown are from SNAP.

6. Freeze and Thaw Dates and Growing-Season Length Projections

SNAP defines the Day of Freeze (Day of Thaw) as "the day when consecutive monthly mid-point temperatures transition from positive to negative (negative to positive)." As average annual and seasonal temperatures rise as the century progresses, the projections under SRES A2 indicate that the historical Day of Freeze at the elevation of the Yukon River will shift from about the first to the third week of October by the 2030s (Figure 6-1). Similarly, as mean conditions warm, by the year 2100 the Day of Thaw is projected to shift about a fortnight earlier to near the beginning of April (Figure 6-2). These changes—later freeze-up and earlier thaw—increase the length of the growing season (*i.e.*, the number of days between the Day of Thaw and Day of Freeze) in the Coffee Creek region by nearly a month by the end of this century (Figure 6-3).

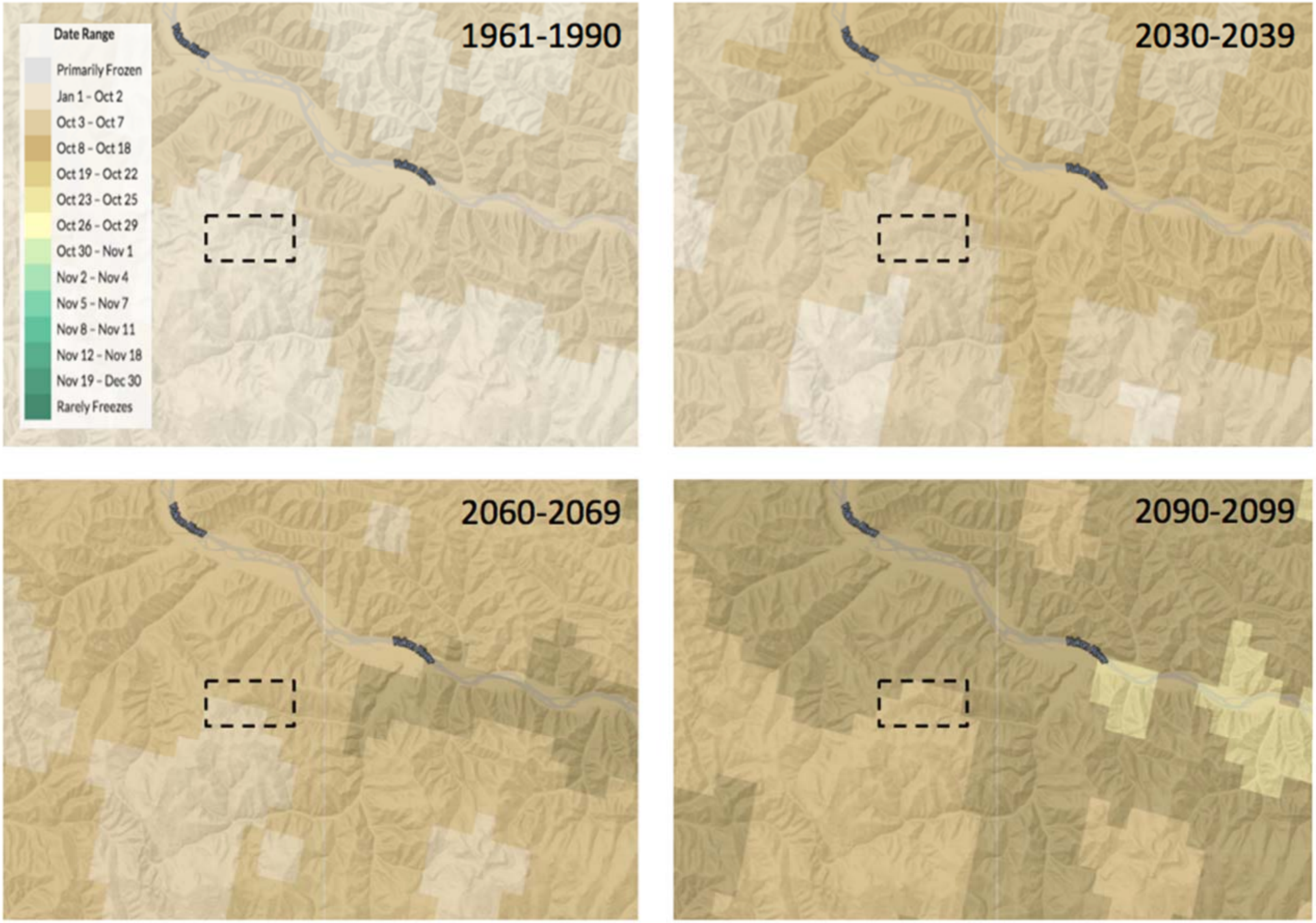

Figure 6-1: Estimated Day of Freeze for the Coffee Creek region for both the past (1961-1990) and three future decades. The dashed rectangle marks the project site. Spatial resolution of the model output is 2 km. Data shown are from SNAP.

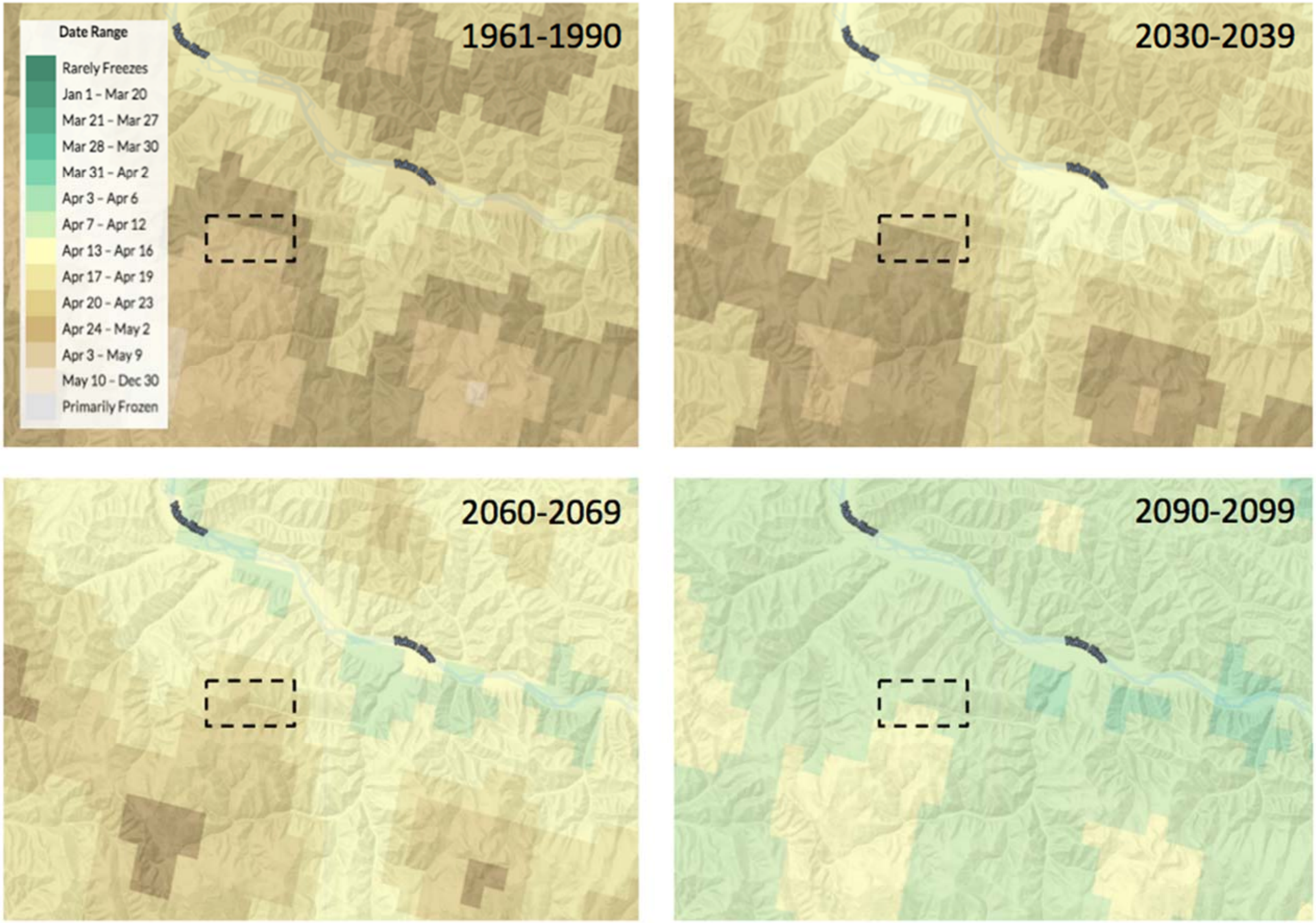

Figure 6-2: Estimated Day of Thaw for the Coffee Creek region for both the past (1961-1990) and three future decades. The dashed rectangle marks the project site. Spatial resolution of the model output is 2 km. Data shown are from SNAP.

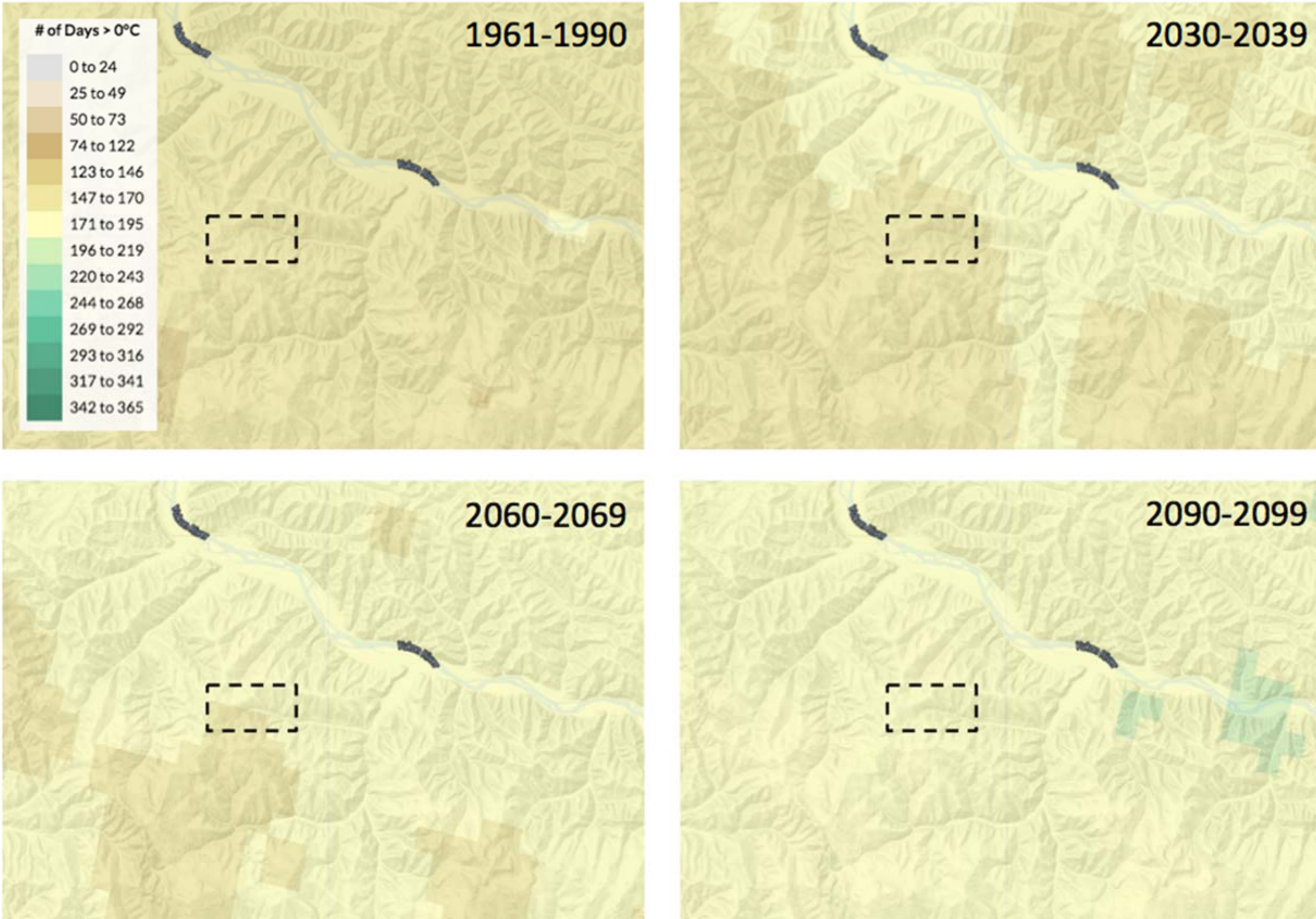

Figure 6-3: Estimated length of the growing season for the Coffee Creek region for both the past (1961-1990) and three future decades. The growing season length is defined as the number of days where the average temperature exceeds 0°C, and is equal to the number of days between the Day of Thaw and the Day of Freeze, shown respectively in Figures 6-1 and 6-2.

7. Summary and Conclusions

The pace at which climate is changing in the high latitudes of the Northern Hemisphere North is already amongst the highest in the world. There is every reason to believe that this trend will continue. Without exception, the best global climate models project ongoing warming and a progressively wetter climate at these latitudes. Seasonality will also be enhanced with, on average, drier summers and wetter conditions in the colder half of the year.

By the year 2100, average temperatures at the Coffee Creek Project site can reasonably be expected to be 3 to 5°C warmer relative to the waning decades of the last century. The warming is anticipated to be particularly pronounced in the summer. In contrast, average annual precipitation at Coffee Creek may not change dramatically. Summer and Winter can be expected to be slightly wetter, but the Spring and Fall seasons are projected to see little net change in precipitation abundance.

The warming will lead to a later freeze-up in fall and an earlier thaw in spring, according to the model results. In tandem, this will yield a growing season that is as much as one month longer by the end of the century. This implies a significantly lengthened duration for above-zero temperatures, with consequent negative implications for permafrost integrity in the region.

References

Daly, C., M. Halbleib *et al.* (2008) Physiographically sensitive mapping of climatological temperature and precipitation across the conterminous United States. Int. J. Climatol. (2008) Published online in Wiley InterScience (www.interscience.wiley.com) DOI: 10.1002/joc.1688.

IPCC SRES (2000), Nakićenović, N., and Swart, R., ed., Special Report on Emissions Scenarios: A special report of Working Group III of the Intergovernmental Panel on Climate Change, Cambridge University Press, ISBN 0-521-80081-1, 978-052180081-5 (pb: 0-521-80493-0, 978-052180493-6).

Lorax (2015). Synthetic Daily Climate Records for the Coffee Gold Project. Lorax memo to Kaminak Gold Corp., April 2, 2015.

Moss, R., M. Babiker *et al.* (2008). Towards New Scenarios for Analysis of Emissions, Climate Change, Impacts, and Response Strategies. Intergovernmental Panel on Climate Change, Geneva, 132 pp.

Simpson, J.J., G. L. Hufford *et al.* (2005). Comparing Maps of Mean Monthly Surface Temperature and Precipitation for Alaska and Adjacent Areas of Canada Produced by Two Different Methods, Arctic 58, 137– 161.

Appendix A: SNAP Scenario URLs

All climate projections and historical climate maps used in this document were obtained from:

Scenarios Network for Alaska and Arctic Planning (SNAP), University of Alaska. [2015]. Retrieved on August 21, 25, 25 and September 2, 3, and 8, 2015.

Average Temperature, Historical, 1961-1990:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.84103923632299&longitude=-139.1300392150879&range=&scenario=&variable=observedTemperature&zoom=10

Average Temperature, 2030-2039, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2030-2039&scenario=A2&variable=temperature&zoom=10

Average Temperature, 2060-2069, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2060-2069&scenario=A2&variable=temperature&zoom=10

Average Temperature, 2090-2099, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2090-2099&scenario=A2&variable=temperature&zoom=10

Average Precipitation, Historical Annual, 1961-1990:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.84103923632299&longitude=-139.1300392150879&range=&scenario=&variable=observedPrecipitation&zoom=10

Average Precipitation, Annual, 2030-2039, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2030-2039&scenario=A2&variable=precipitation&zoom=10

Average Precipitation, Annual, 2060-2069, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2060-2069&scenario=A2&variable=precipitation&zoom=10

Average Precipitation, Annual, 2090-2099, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2090-2099&scenario=A2&variable=precipitation&zoom=10

Average Precipitation, Historical Spring, 1961-1990:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=spring&latitude=62.84103923632299&longitude=-139.1300392150879&range=&scenario=&variable=observedPrecipitation&zoom=10

Average Precipitation, Spring, 2030-2039, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=spring&latitude=62.85420021129549&longitude=-139.1300392150879&range=2030-2039&scenario=A2&variable=precipitation&zoom=10

Average Precipitation, Spring, 2060-2069, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=spring&latitude=62.85420021129549&longitude=-139.1300392150879&range=2060-2069&scenario=A2&variable=precipitation&zoom=10

Average Precipitation, Spring, 2090-2099, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=spring&latitude=62.85420021129549&longitude=-139.1300392150879&range=2090-2099&scenario=A2&variable=precipitation&zoom=10

Average Precipitation, Historical Summer, 1961-1990:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=summer&latitude=62.84103923632299&longitude=-139.1300392150879&range=&scenario=&variable=observedPrecipitation&zoom=10

Average Precipitation, Summer, 2030-2039, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=summer&latitude=62.85420021129549&longitude=-139.1300392150879&range=2030-2039&scenario=A2&variable=precipitation&zoom=10

Average Precipitation, Summer, 2060-2069, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=summer&latitude=62.85420021129549&longitude=-139.1300392150879&range=2060-2069&scenario=A2&variable=precipitation&zoom=10

Average Precipitation, Summer, 2090-2099, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=summer&latitude=62.85420021129549&longitude=-139.1300392150879&range=2090-2099&scenario=A2&variable=precipitation&zoom=10

Average Precipitation, Historical Fall, 1961-1990:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=fall&latitude=62.84103923632299&longitude=-139.1300392150879&range=&scenario=&variable=observedPrecipitation&zoom=10

Average Precipitation, Fall, 2030-2039, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=fall&latitude=62.85420021129549&longitude=-139.1300392150879&range=2030-2039&scenario=A2&variable=precipitation&zoom=10

Average Precipitation, Fall, 2060-2069, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=fall&latitude=62.85420021129549&longitude=-139.1300392150879&range=2060-2069&scenario=A2&variable=precipitation&zoom=10

Average Precipitation, Fall, 2090-2099, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=fall&latitude=62.85420021129549&longitude=-139.1300392150879&range=2090-2099&scenario=A2&variable=precipitation&zoom=10

Average Precipitation, Historical Winter, 1961-1990:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=winter&latitude=62.84103923632299&longitude=-139.1300392150879&range=&scenario=&variable=observedPrecipitation&zoom=10

Average Precipitation, Winter, 2030-2039, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=winter&latitude=62.85420021129549&longitude=-139.1300392150879&range=2030-2039&scenario=A2&variable=precipitation&zoom=10

Average Precipitation, Winter, 2060-2069, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=winter&latitude=62.85420021129549&longitude=-139.1300392150879&range=2060-2069&scenario=A2&variable=precipitation&zoom=10

Average Precipitation, Winter, 2090-2099, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=winter&latitude=62.85420021129549&longitude=-139.1300392150879&range=2090-2099&scenario=A2&variable=precipitation&zoom=10

Day of Freeze, Historical, 1961-1990:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.84103923632299&longitude=-139.1300392150879&range=&scenario=&variable=observedDayOfFreeze&zoom=10

Day of Freeze, 2030-2039, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2030-2039&scenario=A2&variable=dayOfFreeze&zoom=10

Day of Freeze, 2060-2069, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2060-2069&scenario=A2&variable=dayOfFreeze&zoom=10

Day of Freeze, 2090-2099, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2090-2099&scenario=A2&variable=dayOfFreeze&zoom=10

Day of Thaw, Historical, 1961-1990:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.84103923632299&longitude=-139.1300392150879&range=&scenario=&variable=observedDayOfThaw&zoom=10

Day of Thaw, 2030-2039, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2030-2039&scenario=A2&variable=dayOfThaw&zoom=10

Day of Thaw, 2060-2069, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2060-2069&scenario=A2&variable=dayOfThaw&zoom=10

Day of Thaw, 2090-2099, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2090-2099&scenario=A2&variable=dayOfThaw&zoom=10

Length of Growing Season, Historical:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.84103923632299&longitude=-139.1300392150879&range=&scenario=&variable=observedLengthOfGrowingSeason&zoom=10

Length of Growing Season, 2030-2039, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2030-2039&scenario=A2&variable=lengthOfGrowingSeason&zoom=10

Length of Growing Season, 2060-2069, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2060-2069&scenario=A2&variable=lengthOfGrowingSeason&zoom=10

Length of Growing Season, 2090-2099, A2:

https://www.snap.uaf.edu/sites/all/modules/snap_map_tool/maps.html#interval=decadalAverages&latitude=62.85420021129549&longitude=-139.1300392150879&range=2090-2099&scenario=A2&variable=lengthOfGrowingSeason&zoom=10

APPENDIX D2: ADDITIONAL TREND ANALYSES

TECHNICAL MEMORANDUM

To:	**Allison Rippon Armstrong, Kaminak Gold Corp**	**Date: March 1, 2016**
From:	**Scott Jackson and Colin Fraser**	**Project #: A362-3**
Subject:	**Regional Hydro-meteorological Trend Analysis – Coffee Creek**	

1. Introduction

1.1 Memo Objectives and Layout

This memo presents the results of a trend analysis exercise carried out to characterize current rates of change for hydro-meteorological parameters relevant to the Coffee Gold Project (hereafter, 'the Project').

Many operational and regulatory decisions related to water quantity, and secondarily water quality (*e.g.*, loading calculations) are based on limited site-specific streamflow and climate data. Such decisions then often necessitate the review of, and integration, of long-term regional hydrometric and climate data analogues showing longer record periods. This approach is commonly adopted for a regional frequency analysis that targets pertinent hydro-meteorology variables (*e.g.*, mean annual precipitation and runoff, 7-day low flow, peak flows).

Two important questions related to usage of regional data are: 1) the regional hydro-meteorological record(s) are transferable to the site being studied; and 2) are the regional (and site specific) data of sufficient length to adequately represent long-term variability. The latter assumption often implies that the streamflow records being utilized are statistically stationary. In other words, a metric calculated from the historic record will retain the same value when re-calculated from future data.

As the understanding of anthropogenic and climatic influences on hydro-meteorological variables improves, it is apparent that this latter assumption is often not valid. An assessment of the potential influences of long-term change in climate/streamflow metrics was undertaken to ensure that estimates of future streamflow conditions are as robust as possible. The goal of this analysis is to present the current trends for several ($n = 45$) streamflow and climate variables of interest, where the objectives are two-fold:

1. Calculate trends in various streamflow and climate variables for the region in which the Project is situated, and;
2. Determine whether the calculated trends are statistically significant at $p < 0.05$;

2. Methods

2.1 Sources of Data

2.1.1 Climate Data

The Coffee Creek property is situated ~80 km from the Alaska border. Two main sources of climate data were used to assemble this memo:

1) Environment Canada daily climate station data (within 200 km radius of proposed heap leach facility) from the Adjusted and Homogenized Canadian Climate Dataset.
2) Daily average streamflow data from hydrometric stations located within the same radius of the Project. Data were sourced from the Water Survey of Canada and the United States Geological Survey hydrometric networks.

Further details on the datasets, information used in the frequency analyses and assumptions are provided in Lorax (2016).

State of Alaska and Yukon Territory climate stations situated near the Coffee Creek property are listed in Table 2-1 of the EIA Baseline Hydro-meteorology report (Lorax, 2016). Of these 20 stations (*i.e.*, Coffee Creek location excluded), three were selected for the climate trend analysis. The Pelly Ranch and Dawson A stations are located close to the property and possess long-term, high quality records. For comparative purposes, the Dawson A record was truncated to 1955 and 1952, for temperature and precipitation, respectively, to match the available record from the Pelly Ranch station.

Also selected was the McQuesten station record which is shorter, beginning in 1982, and therefore, a corrected AHCCD dataset was not available. However, as this station's record forms the basis of the reconstructed climate data set used as the primary input to the site-wide water balance model, it was necessary to determine the extent of non-stationarity present in the temperature and precipitation data.

2.1.2 Streamflow Data

Streamflow records of average daily discharge were downloaded from HYDAT (WSC, 2015), for the twelve stations listed in Table 2-4 in Lorax (2016). The criteria used in the station selection were as follows:

- Station active as of 2010;
- Record period of >10 consecutive years;
- Basin is non-regulated (*i.e.*, no major diversions or impoundments).

Missing data or incomplete records were accounted for using the following methods:

- Discharge time-series were truncated to ensure annual time-series was continuous (*i.e.*, a minimum of 5 years of data was present before and after a missing year, gaps greater than one year were disallowed);
- Where a month had > 5 days of missing data, this month was removed from the time-series, and;
- No missing data were estimated or infilled.

The following streamflow timing metrics were calculated in addition to the various discharge metrics:

- PULSE_DATE – The date of freshet initiation calculated as the day when the cumulative departure from that years mean annual discharge is most negative (Cayan *et al.*, 2001). The cut-off date is set as August 31, to ensure that autumn rain events in mixed rainfall/snowmelt driven regimes are not inadvertently counted as the freshet date.
- DATE_CM – Date of centre of hydrograph mass (calendar year), calculated following Stewart *et al.* (2005).

In the context of mine effluent management, regulatory criteria are often based on concentrations in the effluent and the receiving environment. Concentration is a mass of a given contaminant in a given volume of water, and thus any reduction in the volume of water without a concurrent reduction in loadings will result in higher concentrations. This means that periods of sustained low flows in the receiving environment are often the constraining factor in an effluent discharge regime.

Low flows are most commonly assessed for two time periods: annual (usually representative of winter flows in nival and glacial regimes); and summer (*e.g.,* June-September). Low flow indices are commonly based on a rolling 7-day average of discharge (7Q) or, less commonly, a rolling 30-day average (30Q) (Smakhtin, 2001). The minimum 7- or 30-day averages are then tabulated on an annual basis, and recurrence interval analyses conducted (*e.g.*, $7Q_{10}$). In this assessment, time series for low flow indices were examined, to determine whether water balance estimates may need to consider potential shifts in these metrics over time. In some cases, where winter flow data was limited or non-existent (*e.g.,* Wade Creek Tributary near Chicken, AK), the winter metrics were not calculated.

While every attempt has been made to ensure that the identified trends are reflective of long-term changes in streamflow, trends may be influenced by several complicating factors, including, but not limited to:

- Land cover change (*e.g.*, urbanization, forestry, linear development, *etc*.);

- Large scale climate cycles (*e.g.*, Pacific Decadal Oscillation [PDO], El Niño Southern Oscillation [ENSO]; Cayan and Peterson, 1989; Stewart *et al*., 2005), and;
- Changes in measurement techniques, QA/QC practices, rating curves, *etc.*

These impact of these factors must be carefully contemplated when results are assessed and conclusions drawn.

2.2 Trend Analysis Methodology

Annual time-series of these parameters were analysed for trend using the *zyp* package in R (Bronaugh and Werner, 2013). The full details of the calculations performed by this package are provided in the reference above, but in brief, initial trend slopes were estimated using the Theil-Sen approach. To address serial correlation effects on statistical hypothesis tests for trend, if a trend was noted, the time-series was detrended using the slope (Yue *et al*., 2002). The trend and residuals are then blended, and the Mann-Kendall's test for trend significance (p-value) is then applied. The *zyp* package re-inflates the values that trend significance are calculated by dividing by (1-AR(1)). All trends are presented as annual values (*i.e.*, rate of change per year in the variable of interest).

Discharge trends (calculated in m^3/s) were converted to unit runoff (in $L/s/km^2$) prior to plotting to account for the influence of basin area on relative trend magnitude. Table 1 lists the complete suite of variables considered in this assessment.

3. Results

3.1 Temperature

The results of the temperature trend analysis are presented in Table 2.

All trends are positive (*i.e.*, warming over time), and significant at $p < 0.05$. For the Dawson A and Pelly Ranch climate stations (1955-2013; 59 years), the largest positive trends are noted in the winter season (December through February), and are on the order of 1°C/decade. The smallest positive trends occur in the summer and autumn seasons (0.3°C/decade), and for autumn, only the trend in minimum temperatures is significant at all stations. The results for the Dawson A and Pelly Ranch stations are presented in Figure 1.

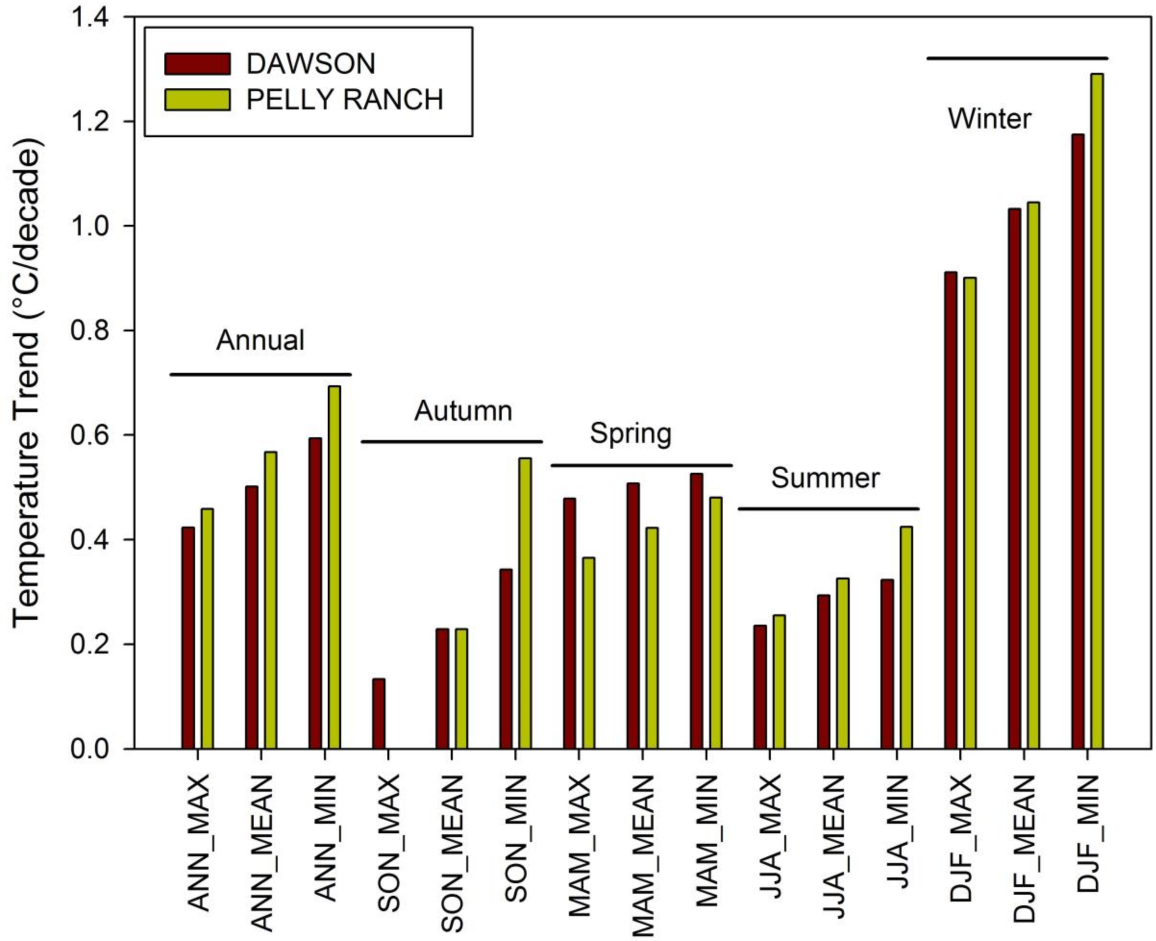

Figure 1: Temperature trends by season for the Dawson A and Pelly Ranch climate stations.

3.2 Precipitation

The results of the temperature trend analysis are presented in Table 3. The trends in seasonal and annual precipitation totals are mixed, although in general, precipitation is increasing across the Project area. For the Dawson A and Pelly Ranch climate stations (1952-2013; 62 years), the largest seasonal trends are noted in the autumn season (September through November), and are on the order of +4-6 mm/decade. The signal is mixed for summer precipitation, with the Dawson A station recording a negative trend of -6 mm/decade, and the Pelly Ranch summer totals increasing by +5 mm/decade. The annual precipitation trends for the Dawson A and Pelly Ranch stations are presented in Figure 2. Only one of the seasonal trends was significant at $p < 0.05$ (autumn total precipitation at Dawson A), while three more trends were significant at $p < 0.10$ (summer total precipitation at Dawson A, and annual and autumn total precipitation at Pelly Ranch).

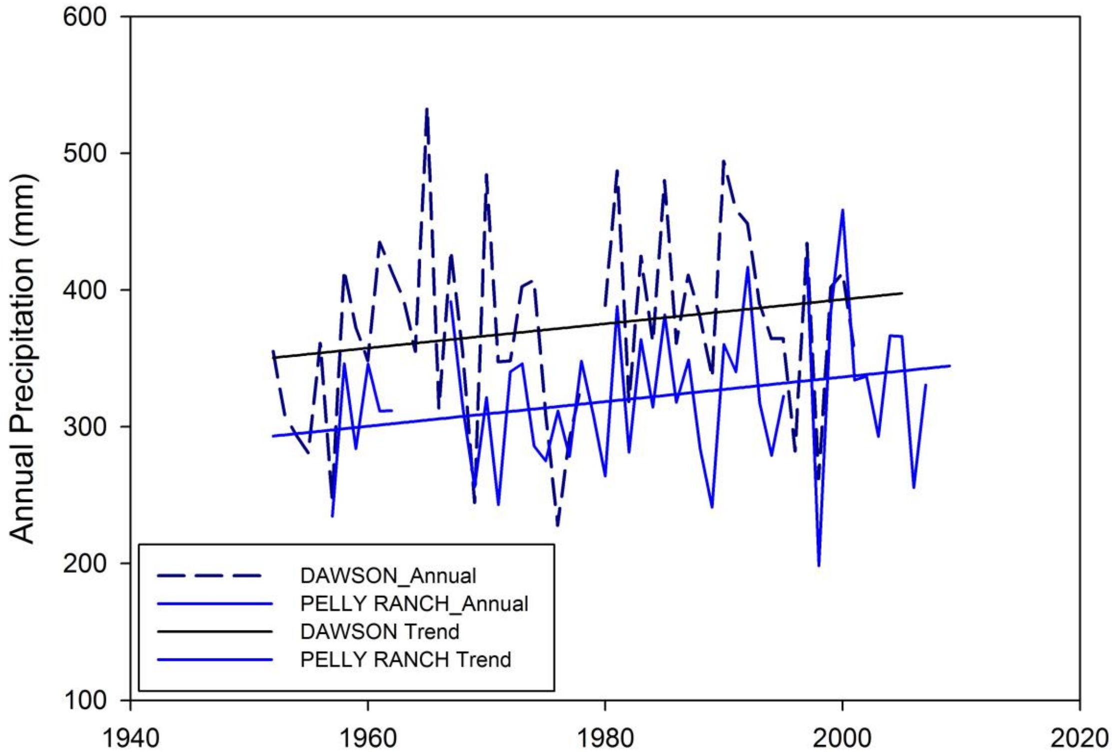

Figure 2: Annual total precipitation trends for the Dawson A and Pelly Ranch climate stations.

3.3 McQuesten Climate Record

The data from the McQuesten climate station was used as the basis for the reconstructed site climate data time-series described in the Hydro-meteorological Baseline Report. The results for the McQuesten climate record are presented in Table 4.

It is notable that this record does not show any evidence of significant trends ($p < 0.10$) for the parameters analysed, which is not consistent with the longer records from the Dawson A and Pelly Ranch stations. The reason for this is not clear, but it is possible that it is an artefact of the shorter record available for this station (28 years).

3.4 Streamflow

The results of the streamflow trend analysis are presented in Table 5. The regional basins analysed have basin areas that span five orders of magnitude (11 – 149,000 km^2). In general, streamflow is increasing across the region, regardless of the metric analysed, which is consistent with the precipitation trends presented here. Low-flows in particular are increasing, and the slope of the trends in summer low-flows are approximately four times higher than those for winter baseflows. An example of the winter baseflow trends is presented in Figure 3.

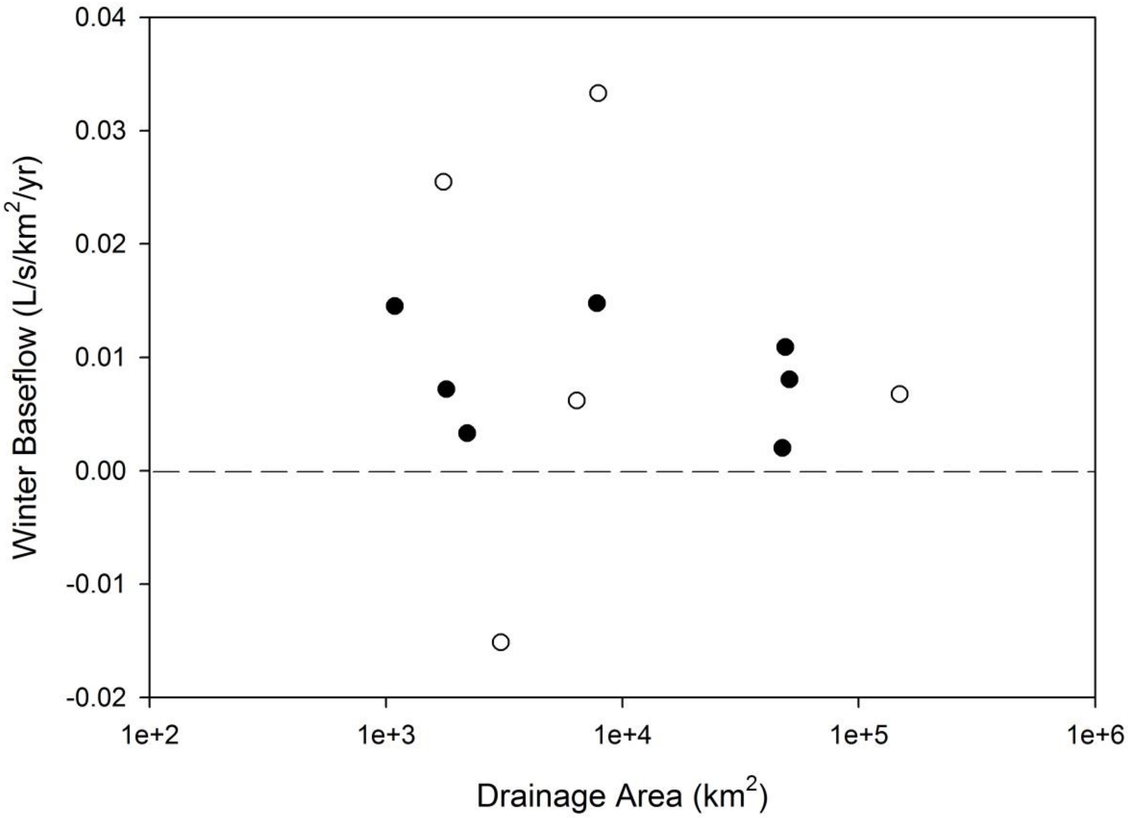

Figure 3: Winter baseflow trends for the regional hydrometric stations. Trends that are significant at p < 0.05 are denoted by black markers, and those stations that do not show a significant trend are shown with open circles.

In addition to the broad ranging increases in winter and early spring streamflows, the only other metric that showed a significant trend (at $p < 0.05$) was the date of freshet initiation (PULSE DATE). Freshet is occurring earlier at several stations (negative trend), which is consistent with similar studies conducted in snowmelt and mixed snow/rain dominated streamflow regimes in North America (Cayan *et al*., 2001, Stewart *et al*., 2005), and likely a result of warming spring temperatures.

It is possible that the increase in winter baseflows is a result of both increased autumn precipitation and warmer winter temperatures, although the fact that winter temperatures are still often well below freezing would add support to the former mechanism. However, the most likely cause is the increased rate of permafrost melt that has been observed throughout the discontinuous permafrost zone (*e.g.,* Walvoord and Striegl, 2007; Janowicz, 2008; and Brabets and Walvoord, 2009).

4. Summary

A suite of hydro-meteorological parameters were analysed for trends using standard statistical tests. Statistical significance of the trends was identified where present.

Overall, temperatures are warming across the Project area, and with the greatest warming occurring during the winter months. Precipitation is increasing on an annual basis, and most strongly in the autumn, but the signal is somewhat mixed for the other seasons, and summer in particular. The climate record used as the basis for the reconstructed site climate data time-series (McQuesten) does not show any evidence of significant trends for the parameters analysed, but it is not clear whether this is an artefact of the shorter record.

Annual streamflow minima are increasing at almost every hydrometric station included in this analysis, and several stations show evidence of an earlier start to the freshet over time. These results are consistent with those presented in Appendix D.1 of the Hydro-meteorological Baseline Report (Lorax, 2016), and with similar analyses conducted in the region.

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Table 1:
Hydro-meteorological metrics analysed for trends

Variable[1]	Description
Streamflow (m^3/s)	
MIN_Q	Minimum annual average daily discharge
MAX_Q	Maximum annual average daily discharge
AVG_Q	Average annual average daily discharge (calendar year)
MED_Q	Median annual average daily discharge (calendar year)
AVG_WAT_YR	Average water year discharge (Oct. 1 - Sept. 30)
MED_WAT_YR	Median water year discharge (Oct. 1 - Sept. 30
MAX_Q_DATE	Date of maximum annual average daily discharge
PULSE_DATE	Date of freshet pulse initiation
DATE_CM	Date of hydrograph centre of mass - calendar year
ANN_7Q_MIN	Annual minimum 7-day average low flow
ANN_30Q_MIN	Annual minimum 30-day average low flow
BASEFLOW	Average winter flow (Dec. 1 – Mar. 31)
JUN-SEP_7Q_MIN	Annual June-September minimum 7-day average low flow
JUN-SEP_30Q_MIN	Annual June-September minimum 30-day average low flow
All months (n = 12)	Median daily discharge
Temperature (°C)	
ANN_MAX	Annual maximum daily temperature
ANN_MEAN	Annual mean daily temperature
ANN_MIN	Annual minimum daily temperature
DJF_MAX	Winter (Dec.-Jan.) maximum daily temperature
DJF_MEAN	Winter (Dec.-Jan.) mean daily temperature
DJF_MIN	Winter (Dec.-Jan.) minimum daily temperature
MAM_MAX	Spring (Mar.-May) maximum daily temperature
MAM_MEAN	Spring (Mar.-May) mean daily temperature
MAM_MIN	Spring (Mar.-May) minimum daily temperature
JJA_MAX	Summer (Jun.-Jul.) maximum daily temperature
JJA_MEAN	Summer (Jun.-Jul.) mean daily temperature
JJA_MIN	Summer (Jun.-Jul.) minimum daily temperature
SON_MAX	Autumn (Sept.-Nov.) maximum daily temperature
SON_MEAN	Autumn (Sept.-Nov.) mean daily temperature
SON_MIN	Autumn (Sept.-Nov.) minimum daily temperature
Precipitation (mm)	
ANN_TOT	Annual total precipitation
DJF_TOT	Winter (Dec.-Jan.) total precipitation
MAM_TOT	Spring (Mar.-May) total precipitation
JJA_TOT	Summer (Jun.-Jul.) total precipitation
SON_TOT	Autumn (Sept.-Nov.) total precipitation

[1]*All streamflow variables calculated from the mean daily discharge values provided in the HYDAT database.*

Table 2:
Seasonal and annual trends in air temperature for the Dawson A and Pelly Ranch climate stations.

Station	Variable	Lower Bound	Trend Slope	Upper Bound	Significance (p)	nruns	autocor	valid_frac	linear	intercept
Dawson A	ANN_MIN	0.0320	0.0594	0.0898	0.0001	4	0.1908	0.9322	0.0583	-12.96
	DJF_MIN	0.0591	0.1175	0.1762	0.0007	2	0.0483	1.0000	0.1116	-34.60
	MAM_MIN	0.0173	0.0526	0.0941	0.0065	4	0.0773	1.0000	0.0555	-11.52
	JJA_MIN	0.0214	0.0323	0.0427	0.0000	3	-0.0192	1.0000	0.0324	5.31
	SON_MIN	-0.0059	0.0343	0.0696	0.0822	1	0.0188	0.9667	0.0271	-11.91
	ANN_MEAN	0.0257	0.0501	0.0775	0.0001	4	0.1227	0.9322	0.0509	-6.23
	DJF_MEAN	0.0461	0.1032	0.1637	0.0017	2	0.0289	1.0000	0.0970	-29.17
	MAM_MEAN	0.0138	0.0508	0.0872	0.0060	3	0.0378	1.0000	0.0530	-3.83
	JJA_MEAN	0.0168	0.0293	0.0427	0.0000	3	-0.0097	1.0000	0.0296	12.90
	SON_MEAN	-0.0111	0.0229	0.0571	0.1668	1	-0.0365	0.9667	0.0156	-6.40
	ANN_MAX	0.0200	0.0423	0.0661	0.0001	3	0.0369	0.9322	0.0440	0.61
	DJF_MAX	0.0266	0.0911	0.1520	0.0051	3	0.0147	1.0000	0.0828	-23.45
	MAM_MAX	0.0150	0.0478	0.0784	0.0035	3	-0.0252	1.0000	0.0508	4.25
	JJA_MAX	0.0064	0.0235	0.0430	0.0038	3	0.0407	1.0000	0.0262	20.52
	SON_MAX	-0.0212	0.0133	0.0409	0.4129	1	-0.0905	0.9667	0.0045	-1.23
Pelly Ranch	ANN_MIN	0.0417	0.0693	0.1026	0.0000	4	0.0819	0.8475	0.0722	-12.32
	DJF_MIN	0.0523	0.1291	0.2089	0.0019	3	0.0549	0.9322	0.1351	-33.72
	MAM_MIN	0.0075	0.0480	0.0871	0.0198	3	-0.0453	0.9322	0.0545	-10.24
	JJA_MIN	0.0310	0.0424	0.0530	0.0000	3	0.0024	0.9492	0.0412	5.17
	SON_MIN	0.0115	0.0556	0.0903	0.0179	1	0.0005	0.9167	0.0500	-10.78
	ANN_MEAN	0.0280	0.0568	0.0862	0.0004	4	0.0621	0.7797	0.0542	-5.44
	DJF_MEAN	0.0299	0.1045	0.1953	0.0168	3	0.0189	0.8814	0.1106	-27.31
	MAM_MEAN	0.0070	0.0422	0.0796	0.0178	3	-0.0509	0.8983	0.0514	-2.19
	JJA_MEAN	0.0191	0.0326	0.0472	0.0000	4	0.0726	0.9492	0.0320	12.99
	SON_MEAN	-0.0192	0.0229	0.0621	0.2726	1	-0.1000	0.9000	0.0209	-4.56
	ANN_MAX	0.0154	0.0459	0.0748	0.0060	4	0.0722	0.7797	0.0399	1.55
	DJF_MAX	0.0117	0.0901	0.1718	0.0325	3	0.0088	0.8814	0.0911	-20.78
	MAM_MAX	0.0047	0.0365	0.0661	0.0227	3	-0.0713	0.8983	0.0467	5.87
	JJA_MAX	0.0040	0.0255	0.0442	0.0119	5	0.0703	0.9492	0.0227	20.54
	SON_MAX	-0.0357	0.0000	0.0378	0.9702	1	-0.1137	0.9000	-0.0032	1.25

***NOTE**: Variables highlighted in green are significant at $p < 0.05$, and those highlighted in yellow are significant at $p < 0.10$.*

Table 3:
Seasonal and annual trends in total precipitation for the Dawson A and Pelly Ranch climate stations.

Station	Variable	Lower Bound	Trend Slope	Upper Bound	Significance (p)	nruns	autocor	valid_frac	linear	intercept
Dawson A	ANN_TOT	-0.4172	0.8893	2.2452	0.1754	1	-0.0336	0.7937	0.8886	349.87
	DJF_TOT	-0.1707	0.3320	0.8625	0.1769	4	0.1304	0.8871	0.3161	61.25
	MAM_TOT	-0.0621	0.1750	0.4111	0.1559	1	0.0433	0.9365	0.1675	43.33
	JJA_TOT	-1.2583	-0.6139	0.0517	0.0757	1	-0.1336	0.9048	-0.5812	163.32
	SON_TOT	0.0905	0.5892	1.1082	0.0260	2	-0.0449	0.8226	0.5016	85.57
Pelly Ranch	ANN_TOT	-0.0071	0.9000	1.9350	0.0533	1	-0.2002	0.7937	0.8997	289.15
	DJF_TOT	-0.4364	-0.0798	0.2779	0.4950	4	0.1542	0.8871	0.0838	55.76
	MAM_TOT	-0.2692	0.0217	0.3333	0.9168	1	-0.1134	0.8571	0.0877	43.37
	JJA_TOT	-0.1333	0.4857	1.1789	0.1276	1	-0.0384	0.9365	0.5887	114.13
	SON_TOT	-0.0800	0.3676	0.7867	0.0898	1	0.0210	0.8889	0.3610	63.19

***NOTE**: Variables highlighted in green are significant at $p < 0.05$, and those highlighted in yellow are significant at $p < 0.10$.*

Table 4:
Seasonal and annual trends in total precipitation for the McQuesten climate station.

Station	Variable	Lower Bound	Trend Slope	Upper Bound	Significance (p)	nruns	autocor	valid_frac	linear	intercept
MCQUESTEN Temperature	ANN_MAX	-0.0882	-0.0274	0.0610	0.4158	1	-0.2807	1.0000	-0.0032	22.93
	ANN_MEAN	-0.0392	0.0158	0.0740	0.6593	3	0.0726	0.9630	0.0084	-2.75
	ANN_MIN	-0.1469	0.0769	0.2157	0.3780	4	0.3082	0.9630	0.0143	-38.31
	DJF_MAX	-0.1242	0.0559	0.2714	0.4655	4	0.0369	1.0000	0.2106	2.01
	DJF_MEAN	-0.0736	0.0529	0.1581	0.3137	1	0.0262	1.0000	0.0572	-18.50
	DJF_MIN	-0.0792	0.0575	0.1894	0.5454	4	0.0644	1.0000	0.0235	-36.67
	MAM_MAX	-0.0248	0.0577	0.1488	0.1581	1	-0.0957	1.0000	0.0498	16.09
	MAM_MEAN	-0.1438	-0.0696	0.0158	0.1607	1	-0.0201	1.0000	-0.0570	0.53
	MAM_MIN	-0.2331	0.0000	0.2092	0.9842	1	-0.4160	1.0000	-0.0238	-26.63
	JJA_MAX	-0.0882	-0.0274	0.0529	0.4389	1	-0.3702	1.0000	-0.0195	22.93
	JJA_MEAN	-0.0430	-0.0110	0.0200	0.6495	1	-0.2841	1.0000	-0.0071	11.49
	JJA_MIN	-0.0324	0.0000	0.0832	0.6450	1	-0.1365	1.0000	0.0383	-0.02
	SON_MAX	-0.0882	0.0265	0.1323	0.6600	1	0.0161	0.9643	-0.0080	13.35
	SON_MEAN	-0.0453	0.0463	0.1294	0.2430	1	-0.0421	0.9643	0.0320	-4.25
MCQUESTEN Precipitation	SON_MIN	-0.2590	0.0583	0.3885	0.8185	1	0.0404	0.9643	0.0328	-28.09
	ANN_TOT	-5.0082	0.1657	5.9974	1.0000	3	0.1493	0.9630	-1.0927	481.48
	DJF_TOT	-2.3662	-0.0229	2.7550	1.0000	8	0.3685	1.0000	0.1207	91.83
	MAM_TOT	-2.4830	-0.8375	0.3643	0.1689	3	-0.0203	1.0000	-1.4003	73.05
	JJA_TOT	-1.8226	1.6158	5.0188	0.4283	3	0.2238	1.0000	1.5693	159.44
	SON_TOT	-3.1768	-1.4068	0.3498	0.1334	1	-0.0086	0.9643	-1.6095	138.49
	ANN_TOT	-5.0082	0.1657	5.9974	1.0000	3	0.1493	0.9630	-1.0927	481.48

***NOTE**: Variables highlighted in green are significant at $p < 0.05$, and those highlighted in yellow are significant at $p < 0.10$.*

Table 5:
Streamflow trends for the Coffee Gold Project area.

Station	Variable	Lower Bound	Trend Slope	Upper Bound	Significance (p)	nruns	autocor	valid_frac	linear	intercept
15320100 - Wade Creek Tributary near Chicken AK	AVG_Q	-0.0093	-0.0030	0.0034	0.4047	5	0.3576	0.3529	-0.0031	0.19
	MAX_Q	-0.0749	0.0178	0.1222	0.6494	4	0.2033	0.3529	0.0429	0.01
	MAX_Q_DATE	-3.0000	0.7222	3.0000	0.6746	1	-0.0965	0.3654	0.3158	138.61
	MAY	-0.0161	-0.0056	0.0030	0.1978	4	0.0603	0.3529	-0.0076	0.33
	JUNE	-0.0056	-0.0012	0.0025	0.7049	4	0.0904	0.3529	-0.0009	0.09
	JULY	-0.0019	0.0010	0.0065	0.4954	7	0.1592	0.3529	0.0030	-0.02
	AUGUST	-0.0030	0.0008	0.0051	0.4415	1	-0.0457	0.3654	0.0012	0.00
	SEPTEMBER	-0.0031	-0.0005	0.0032	0.8796	4	0.1887	0.3529	0.0006	0.07
	OCTOBER	-0.0005	0.0002	0.0011	0.6192	1	-0.1827	0.2692	0.0004	0.00
	JUN-SEP_30Q_MIN	-0.0014	0.0011	0.0029	0.2758	4	-0.1095	0.2157	0.0011	-0.03
	JUN-SEP_7Q_MIN	-0.0008	0.0001	0.0016	0.7317	3	0.1256	0.2353	0.0006	0.00
	MIN_Q	-0.0003	0.0000	0.0000	0.1433	3	0.2602	0.3529	-0.0005	0.00
09AH003 - Big Creek near the Mouth	AVG_Q	-0.0541	0.0384	0.1647	0.3738	4	0.1540	0.6667	0.0622	5.98
	WAT_YR_Q	-14.1293	20.6307	62.5923	0.2328	4	0.1713	0.6471	23.3875	1975.52
	MIN_Q	-0.0013	0.0053	0.0208	0.1463	5	0.4906	0.6667	0.0127	-0.06
	MAX_Q	-1.0267	0.7000	2.2130	0.4138	1	-0.1431	0.7308	0.5362	78.50
	MAX_Q_DATE	-2.0622	-0.8512	0.4924	0.1920	4	0.1348	0.6667	-0.7947	184.41
	DATE_CM	-1.0000	-0.4464	0.2692	0.2389	1	-0.0661	0.7115	-0.4109	194.71
	PULSE_DATE	-0.4988	-0.2540	-0.0428	0.0216	4	0.0260	0.6667	-0.5786	130.57
	ANN_30Q_MIN	-0.0025	0.0053	0.0210	0.2850	5	0.4489	0.6471	0.0134	-0.02
	ANN_7Q_MIN	-0.0019	0.0061	0.0218	0.2328	6	0.4459	0.6471	0.0135	-0.05
	BASEFLOW	0.0049	0.0129	0.0231	0.0019	1	-0.0111	0.7115	0.0276	-0.07
	JUN-SEP_30Q_MIN	-0.0201	0.0645	0.1481	0.1410	2	0.0359	0.6471	0.0518	3.11
	JUN-SEP_7Q_MIN	-0.0272	0.0383	0.1217	0.2580	3	0.0298	0.6471	0.0427	2.62
	JANUARY	0.0008	0.0093	0.0252	0.0372	6	0.2575	0.7059	0.0166	-0.05
	FEBRUARY	-0.0003	0.0066	0.0177	0.0701	4	0.3552	0.7059	0.0150	-0.01
	MARCH	-0.0016	0.0064	0.0204	0.1606	7	0.4400	0.7059	0.0132	-0.06
	APRIL	0.0011	0.0153	0.0516	0.0283	4	0.4133	0.7059	0.0348	-0.22
	MAY	0.0553	0.4689	0.8371	0.0192	4	0.0741	0.6667	0.3722	5.28
	JUNE	-0.1954	0.0355	0.2571	0.8821	3	0.0875	0.6667	0.0371	9.60
	JULY	-0.4192	-0.1254	0.1450	0.2943	8	0.2231	0.7059	-0.0128	14.85
	AUGUST	-0.1776	0.0239	0.2098	0.8595	4	0.0859	0.7059	0.0619	9.29
	SEPTEMBER	-0.0139	0.1225	0.2781	0.0696	1	0.0369	0.7500	0.1325	5.49
	OCTOBER	-0.0109	0.0478	0.1149	0.1077	4	0.1811	0.7255	0.0582	2.28
	NOVEMBER	0.0207	0.0468	0.0657	0.0007	4	0.0920	0.7255	0.0437	0.10
	DECEMBER	0.0077	0.0243	0.0390	0.0030	4	0.1459	0.7255	0.0252	-0.14
09AH004 - Nordenskiold River below Rowlinson Creek	AVG_Q	-0.3381	0.0444	0.4385	0.6833	3	0.3266	0.6078	0.0401	12.18
	WAT_YR_Q	-113.1329	24.6199	178.2945	0.7481	6	0.3895	0.5882	9.0834	3678.08
	MIN_Q	-0.0160	0.0619	0.1391	0.1179	6	0.4933	0.6078	0.0213	0.61
	MAX_Q	-1.5900	0.3533	2.0556	0.5593	1	-0.0698	0.6154	0.2737	76.73
	MAX_Q_DATE	-1.3333	-0.5000	0.2500	0.1775	1	-0.0190	0.6154	-0.5189	160.50
	DATE_CM	-0.8750	-0.1064	1.0000	0.8839	1	-0.1821	0.6154	-0.2150	176.37
	PULSE_DATE	-0.3750	-0.0455	0.2500	0.6961	1	-0.0080	0.6154	-0.5299	121.52
	ANN_30Q_MIN	-0.0304	0.0340	0.1234	0.3008	3	0.3960	0.5882	0.0305	1.66
	ANN_7Q_MIN	-0.0252	0.0364	0.1219	0.2687	3	0.3859	0.5882	0.0337	1.48
	BASEFLOW	-0.0676	0.0397	0.1624	0.6174	4	0.3936	0.5882	0.0214	2.20
	JUN-SEP_30Q_MIN	-0.2810	0.0939	0.4778	0.5925	3	0.2951	0.5882	0.0431	6.60
	JUN-SEP_7Q_MIN	-0.1688	0.1395	0.4275	0.3177	4	0.3367	0.5882	0.0655	2.69
	JANUARY	-0.0760	0.0626	0.1963	0.4118	5	0.3960	0.5882	0.0289	1.13
	FEBRUARY	-0.0423	0.0417	0.1282	0.3177	6	0.3603	0.5882	0.0195	1.51
	MARCH	-0.0408	0.0093	0.1098	0.7212	5	0.4273	0.5882	0.0193	2.64
	APRIL	-0.0475	0.0143	0.1330	0.6174	4	0.1551	0.5882	0.0248	3.60
	MAY	-0.2083	0.5545	1.3609	0.1392	1	-0.0310	0.5962	0.6003	19.54
	JUNE	-0.5313	0.4247	1.4203	0.5207	500	0.3242	0.5882	0.0932	6.03
	JULY	-0.4756	-0.1300	0.3383	0.6101	3	0.0910	0.6078	-0.1221	20.92
	AUGUST	-0.3884	0.0405	0.4105	0.8650	3	0.0677	0.6078	0.0468	10.01
	SEPTEMBER	-0.4247	-0.0318	0.4091	0.8119	4	0.0652	0.6078	0.0714	17.09
	OCTOBER	-0.2777	0.0387	0.4069	0.7857	3	0.1629	0.6078	0.0585	10.15
	NOVEMBER	-0.1604	0.0661	0.2795	0.6586	4	0.2215	0.6078	0.0491	4.82
	DECEMBER	-0.0903	0.0336	0.2285	0.6586	4	0.3407	0.6078	0.0380	3.46

Station	Variable	Lower Bound	Trend Slope	Upper Bound	Significance (p)	nruns	autocor	valid_frac	linear	intercept
09BC001 - Pelly River at Pelly Crossing	AVG_Q	-2.3932	0.5408	3.2187	0.6328	3	0.1818	0.7451	0.6519	358.37
	WAT_YR_Q	-833.8041	474.3745	1641.7874	0.3809	5	0.2666	0.7255	186.9035	133683.12
	MIN_Q	-0.0601	0.3198	0.7021	0.1076	4	0.2116	0.7451	0.2451	40.47
	MAX_Q	-17.1429	0.0000	15.8065	1.0000	1	-0.0353	0.7500	0.1812	1740.00
	MAX_Q_DATE	-0.3007	0.0677	0.4035	0.7724	5	0.1798	0.7451	-0.0532	152.95
	DATE_CM	-0.3750	0.0000	0.2667	0.9807	1	-0.0410	0.7500	-0.1385	181.00
	PULSE_DATE	-0.2051	-0.0322	0.1443	0.7533	4	0.1060	0.7451	-0.2383	126.52
	ANN_30Q_MIN	-0.1038	0.2965	0.7140	0.1326	4	0.1954	0.7255	0.2809	43.41
	ANN_7Q_MIN	-0.0749	0.3359	0.7449	0.0967	4	0.1942	0.7255	0.3047	40.06
	BASEFLOW	0.1175	0.5327	1.0192	0.0125	3	0.0022	0.7255	0.6148	57.61
	JUN-SEP_30Q_MIN	-1.9877	1.6473	5.4841	0.4250	2	0.0400	0.7255	1.6058	336.56
	JUN-SEP_7Q_MIN	-2.1152	1.7156	5.2961	0.4719	3	0.0406	0.7255	1.5819	298.62
	JANUARY	0.0288	0.5648	1.0939	0.0400	4	0.0582	0.7255	0.6689	56.85
	FEBRUARY	-0.0928	0.3125	0.7246	0.1135	5	0.0639	0.7255	0.3761	48.73
	MARCH	-0.1780	0.2292	0.6439	0.2552	3	0.1562	0.7255	0.2415	46.94
	APRIL	-0.0784	0.3806	0.8830	0.1021	5	0.2804	0.7255	0.3246	48.37
	MAY	-13.2500	-6.5385	1.5714	0.1590	1	-0.0527	0.7308	-3.4597	915.19
	JUNE	-9.1000	2.0833	10.4688	0.6897	1	-0.0250	0.7500	1.6349	1112.92
	JULY	-10.4610	-0.7873	8.8269	0.8015	500	0.2427	0.7451	0.1662	715.92
	AUGUST	-6.4181	-1.0206	4.1506	0.8015	4	0.0718	0.7451	-1.0468	507.21
	SEPTEMBER	-1.4664	2.8509	7.8566	0.1745	2	0.0075	0.7451	3.9114	359.58
	OCTOBER	-2.4737	0.3636	3.2727	0.8465	1	-0.0669	0.7500	0.9901	320.55
	NOVEMBER	-0.5469	0.5227	1.6944	0.4532	1	-0.0092	0.7500	0.6356	129.07
	DECEMBER	0.4514	1.0093	1.6069	0.0026	3	-0.1309	0.7451	1.0525	75.48
09CA006 - Nisling River below Onion Creek	AVG_Q	-0.4119	1.6234	3.1692	0.0957	6	0.1577	0.3137	1.1035	-31.25
	WAT_YR_Q	-209.6904	717.9317	1272.5607	0.1982	6	0.2464	0.2941	433.6255	-17980.09
	MIN_Q	0.0967	0.2993	0.5224	0.0046	7	0.2394	0.3137	0.1671	-6.69
	MAX_Q	-8.8594	3.5110	19.6825	0.6494	6	0.1084	0.3529	8.8949	138.44
	MAX_Q_DATE	-4.0000	-0.6000	2.6250	0.6217	1	-0.2680	0.3462	-0.6930	216.70
	DATE_CM	-3.0909	-0.7143	1.8571	0.3240	1	-0.1991	0.3462	-0.5474	237.21
	PULSE_DATE	-3.6058	-0.8194	1.5631	0.6204	5	0.2198	0.3137	-2.3105	154.36
	ANN_30Q_MIN	0.0097	0.2327	0.4951	0.0294	4	0.1386	0.2941	0.2265	-2.86
	ANN_7Q_MIN	0.0046	0.1974	0.4034	0.0478	4	0.1194	0.2941	0.2075	-1.75
	BASEFLOW	-0.1191	0.2635	0.7261	0.2661	4	0.3133	0.3333	0.2234	-2.20
	JUN-SEP_30Q_MIN	-1.3836	1.7639	3.6562	0.2763	8	0.2030	0.2941	0.8544	-49.62
	JUN-SEP_7Q_MIN	-1.1991	0.9243	2.1235	0.3731	5	0.1832	0.2941	0.9385	-19.16
	JANUARY	-0.1208	0.3114	0.7576	0.1740	8	0.3538	0.3333	0.2067	-4.63
	FEBRUARY	-0.0379	0.3666	0.7435	0.1275	13	0.3663	0.3333	0.2603	-8.20
	MARCH	0.0070	0.2966	0.5728	0.0357	6	0.2051	0.3333	0.2600	-5.64
	APRIL	0.1957	0.3538	0.5118	0.0002	4	-0.2622	0.3333	0.4118	-7.28
	MAY	1.0333	5.1000	8.0333	0.0064	1	-0.1827	0.3462	4.5102	-142.90
	JUNE	-2.9086	0.9407	4.5653	0.7731	2	0.0370	0.3333	1.6096	7.74
	JULY	-1.1145	2.6263	5.9702	0.1376	4	0.1027	0.2941	2.0387	-73.54
	AUGUST	-4.2947	1.3223	6.3127	0.5584	4	0.0502	0.3137	0.5056	7.79
	SEPTEMBER	-1.6250	1.7385	4.0000	0.2889	1	-0.0100	0.3462	1.2076	-18.90
	OCTOBER	0.2944	1.2149	2.0615	0.0124	4	0.1196	0.3529	0.9131	-24.07
	NOVEMBER	-0.2981	0.4216	1.0513	0.1978	6	0.2682	0.3529	0.3322	-3.62
	DECEMBER	-0.2375	0.3434	0.9130	0.2558	5	0.3207	0.3529	0.2372	-3.53
09CD001 - Yukon River above White River	AVG_Q	-5.0671	2.7650	9.8908	0.5462	5	0.3075	0.7451	0.0689	1125.10
	WAT_YR_Q	-1610.2818	1165.1951	3855.3601	0.5562	6	0.3475	0.7255	425.8179	415434.73
	MIN_Q	-1.5889	-0.1955	0.9964	0.6691	5	0.1015	0.7451	-0.7202	323.78
	MAX_Q	-30.0316	1.5709	28.4204	0.9599	4	0.1718	0.7451	3.0324	3499.17
	MAX_Q_DATE	-0.5000	0.0000	0.3077	0.9132	1	-0.0360	0.7500	-0.1121	162.00
	DATE_CM	-0.3750	-0.1000	0.1111	0.3828	1	-0.0028	0.7500	-0.2024	200.50
	PULSE_DATE	-0.2181	0.0817	0.3563	0.6151	6	0.1220	0.7451	-0.1498	129.54
	ANN_30Q_MIN	-1.8620	-0.4531	0.9209	0.5738	3	0.0855	0.7255	-0.3891	343.21
	ANN_7Q_MIN	-1.9641	-0.5557	0.8050	0.4560	3	0.0955	0.7255	-0.4099	344.07
	BASEFLOW	-0.5808	1.0064	2.8585	0.1779	4	0.0576	0.7255	1.3383	377.06
	JUN-SEP_30Q_MIN	-1.3048	8.2549	17.6865	0.0867	4	0.1690	0.7255	5.9467	1159.48
	JUN-SEP_7Q_MIN	0.1864	9.3486	17.9110	0.0454	9	0.1590	0.7255	6.6441	1138.41
	JANUARY	-0.3773	2.2013	4.3956	0.1135	4	0.1897	0.7255	2.2193	346.04
	FEBRUARY	-1.0000	0.9583	2.5682	0.3205	1	0.0438	0.7308	0.8898	354.02

Station	Variable	Lower Bound	Trend Slope	Upper Bound	Significance (p)	nruns	autocor	valid_frac	linear	intercept
	MARCH	-1.8792	-0.4426	1.2517	0.5562	4	0.1384	0.7255	-0.3438	354.47
	APRIL	-1.5000	-0.2708	1.3333	0.6874	1	0.0456	0.7308	-0.1932	366.91
	MAY	-19.4737	-4.0000	15.4545	0.6238	1	0.0137	0.7308	0.4902	1519.00
	JUNE	-17.6893	4.0183	26.6525	0.7061	3	0.1104	0.7451	5.4615	2798.44
	JULY	-25.1732	-4.7113	18.2735	0.7248	4	0.2017	0.7451	-4.8300	2343.56
	AUGUST	-17.2722	-4.9608	9.6567	0.4814	4	0.1866	0.7451	-5.3785	1880.56
	SEPTEMBER	-5.9583	4.7906	17.2834	0.3522	4	0.0874	0.7451	7.1078	1455.56
	OCTOBER	-3.7515	4.2796	12.0706	0.3268	3	0.0669	0.7451	3.8759	1136.93
	NOVEMBER	-6.2879	-2.3167	1.4000	0.2084	1	0.0013	0.7500	-3.6204	738.18
	DECEMBER	-0.2222	2.1875	4.7692	0.0575	1	0.0270	0.7500	2.5455	409.69
09DD003 - Stewart River at the mouth	AVG_Q	0.0565	1.8415	3.4799	0.0412	1	-0.1660	0.9615	1.4550	420.86
	WAT_YR_Q	-138.8900	468.2052	1072.9032	0.1033	1	0.0404	0.9423	337.8059	158900.45
	MIN_Q	-0.0215	0.2409	0.5120	0.0740	3	0.1782	0.9412	0.0214	55.96
	MAX_Q	-10.0000	5.1351	20.7317	0.5087	1	-0.2492	0.9615	2.0739	2163.78
	MAX_Q_DATE	-0.1860	0.0000	0.2333	0.8868	1	0.0471	0.9615	-0.0845	159.50
	DATE_CM	-0.2400	-0.0400	0.1667	0.6876	1	-0.0197	0.9615	-0.2434	183.06
	PULSE_DATE	-0.3736	-0.2289	-0.0543	0.0128	4	0.1061	0.9412	-0.4353	132.20
	ANN_30Q_MIN	0.0329	0.2526	0.4768	0.0265	4	0.0717	0.9216	0.2064	56.57
	ANN_7Q_MIN	0.0236	0.2775	0.5057	0.0252	5	0.0672	0.9216	0.2232	54.89
	BASEFLOW	0.1329	0.4106	0.6895	0.0043	2	0.0219	0.9608	0.3392	72.90
	JUN-SEP_30Q_MIN	-0.1000	2.3532	4.8833	0.0568	1	-0.0591	0.9423	2.3799	406.00
	JUN-SEP_7Q_MIN	-1.0882	1.5393	4.0714	0.2376	1	0.0104	0.9423	1.6973	380.66
	JANUARY	0.2422	0.5284	0.8564	0.0011	3	0.0177	0.9608	0.4523	70.83
	FEBRUARY	0.1221	0.4311	0.6485	0.0026	3	0.0483	0.9608	0.2911	61.73
	MARCH	0.0536	0.2829	0.4990	0.0151	5	0.0562	0.9608	0.2058	57.70
	APRIL	-0.0521	0.2760	0.6083	0.0962	3	0.0727	0.9608	0.2474	62.75
	MAY	-5.0455	2.1297	9.6667	0.5693	1	-0.0422	0.9423	4.2022	782.15
	JUNE	-9.2308	-1.7054	5.9524	0.5989	1	-0.0414	0.9423	-4.3566	1559.46
	JULY	-6.2941	-0.4615	4.7045	0.8606	1	0.0429	0.9615	-0.9441	804.88
	AUGUST	-4.2000	0.1111	3.9259	0.9600	1	-0.1254	0.9615	0.6572	621.39
	SEPTEMBER	0.4677	4.2083	8.0429	0.0329	1	-0.0457	0.9615	3.8942	503.92
	OCTOBER	-0.6667	1.6053	3.7143	0.2022	1	-0.1211	0.9808	2.3479	280.24
	NOVEMBER	-0.1190	0.7632	1.4444	0.1008	1	0.0169	0.9808	0.8365	139.24
	DECEMBER	-0.0614	0.4717	1.0656	0.0790	4	0.0536	0.9804	0.4387	100.44
09DD004 - McQuesten River near the Mouth	AVG_Q	-0.0066	0.1980	0.4390	0.0827	4	0.0671	0.6275	0.1670	30.89
	WAT_YR_Q	-5.9012	89.2532	152.2741	0.0716	4	0.0294	0.6078	84.4263	11079.69
	MIN_Q	0.0335	0.0814	0.1344	0.0041	4	0.0409	0.6275	0.0773	3.98
	MAX_Q	-2.8473	0.0980	3.2693	0.9527	3	0.0665	0.6667	0.2216	260.90
	MAX_Q_DATE	-0.5118	-0.0690	0.3834	0.8840	4	0.2462	0.6275	-0.0730	147.57
	DATE_CM	-0.4286	0.0000	0.4167	0.9172	1	0.0477	0.6538	0.0936	167.50
	PULSE_DATE	-0.3636	-0.0870	0.1053	0.3723	1	-0.0269	0.6538	-0.1251	124.33
	ANN_30Q_MIN	0.0290	0.0945	0.1363	0.0039	5	0.0321	0.6078	0.0660	4.00
	ANN_7Q_MIN	0.0299	0.0834	0.1301	0.0037	4	-0.0021	0.6275	0.0731	4.05
	BASEFLOW	0.0208	0.0954	0.1401	0.0088	5	0.1307	0.6471	0.0728	5.37
	JUN-SEP_30Q_MIN	-0.2320	0.1990	0.6978	0.2773	4	0.1699	0.6275	0.1975	23.10
	JUN-SEP_7Q_MIN	-0.1669	0.1816	0.5406	0.2365	4	0.1504	0.6275	0.1734	22.00
	JANUARY	-0.0051	0.0670	0.1228	0.0660	4	0.1052	0.6667	0.0667	6.26
	FEBRUARY	-0.0026	0.0667	0.1224	0.0540	3	0.0339	0.6667	0.0747	5.24
	MARCH	-0.0061	0.0522	0.1180	0.0802	4	0.0933	0.6667	0.0508	5.23
	APRIL	-0.0186	0.0463	0.1243	0.1683	1	-0.1135	0.6731	0.0436	6.69
	MAY	-0.5198	0.7829	2.7330	0.2726	5	0.1534	0.6667	0.6367	84.31
	JUNE	-1.7001	-0.2176	1.1468	0.8821	4	0.2243	0.6667	-0.1465	90.07
	JULY	-0.2702	0.3911	1.0536	0.1583	2	0.0323	0.6275	0.1931	35.84
	AUGUST	-0.3211	0.1857	0.8000	0.4408	1	-0.0408	0.6538	0.3904	29.86
	SEPTEMBER	-0.0732	0.4983	1.0687	0.0949	3	-0.0456	0.6275	0.4308	26.69
	OCTOBER	-0.1594	0.2678	0.7098	0.1726	4	0.1430	0.6667	0.1379	16.39
	NOVEMBER	-0.0308	0.1406	0.3143	0.1231	3	0.2348	0.6667	0.0575	10.67
	DECEMBER	0.0523	0.1330	0.2157	0.0049	5	0.1545	0.6667	0.0999	6.30
09EA003 - Klondike River above Bonanza Creek	AVG_Q	-0.0607	0.1987	0.4366	0.1331	1	-0.1353	0.9231	0.1182	59.91
	WAT_YR_Q	2.8455	85.1145	161.9826	0.0436	1	-0.0843	0.9038	85.7311	21435.88
	MIN_Q	0.0361	0.0932	0.1468	0.0023	5	0.3042	0.9020	0.0741	6.15
	MAX_Q	-1.9750	0.2113	2.4118	0.8428	1	0.0154	0.9423	0.7792	411.77

Station	Variable	Lower Bound	Trend Slope	Upper Bound	Significance (p)	nruns	autocor	valid_frac	linear	intercept
	MAX_Q_DATE	-0.3846	-0.0728	0.1333	0.3970	1	-0.0425	0.9231	-0.0987	155.60
	DATE_CM	-0.2308	0.0000	0.2727	0.9361	1	-0.0407	0.9231	-0.0272	171.00
	PULSE_DATE	-0.1843	-0.0467	0.0997	0.4717	3	0.0414	0.9020	-0.1447	123.11
	ANN_30Q_MIN	0.0366	0.0868	0.1367	0.0012	4	0.1560	0.8824	0.0835	6.90
	ANN_7Q_MIN	0.0402	0.0920	0.1441	0.0005	4	0.1453	0.8824	0.0891	6.46
	BASEFLOW	0.0637	0.1152	0.1602	0.0001	5	0.1380	0.9216	0.1014	8.73
	JUN-SEP_30Q_MIN	-0.1427	0.1781	0.5422	0.3416	1	-0.1153	0.9231	0.1498	48.71
	JUN-SEP_7Q_MIN	-0.0181	0.2414	0.5365	0.0783	1	-0.1024	0.9038	0.2507	42.51
	JANUARY	0.0622	0.1186	0.1773	0.0002	4	0.1321	0.9216	0.1094	8.39
	FEBRUARY	0.0577	0.1026	0.1504	0.0001	4	0.0881	0.9216	0.0971	7.73
	MARCH	0.0357	0.0863	0.1412	0.0012	4	0.1101	0.9216	0.0770	7.78
	APRIL	0.0143	0.0805	0.1433	0.0135	1	0.0026	0.9231	0.0803	9.37
	MAY	-0.6111	0.4404	1.5600	0.4392	1	-0.0575	0.9231	0.6071	143.69
	JUNE	-2.5442	-0.8746	0.4438	0.1728	5	0.0582	0.9020	-0.9675	216.31
	JULY	-0.5200	0.2384	0.9412	0.4770	1	-0.0730	0.9231	0.2537	81.54
	AUGUST	-0.4480	0.2180	0.8480	0.4937	1	-0.1768	0.9231	0.2037	66.07
	SEPTEMBER	0.0581	0.6200	1.1405	0.0336	1	-0.1471	0.9231	0.4259	57.14
	OCTOBER	-0.0261	0.2639	0.6310	0.0944	1	0.0389	0.9423	0.2998	32.46
	NOVEMBER	-0.0106	0.1189	0.2466	0.0965	4	0.0748	0.9412	0.1280	17.60
	DECEMBER	0.0661	0.1420	0.2169	0.0006	3	0.0183	0.9412	0.1186	10.95
09EA004 - North Klondike River near the Mouth	AVG_Q	-0.0756	0.0013	0.0847	0.9099	1	-0.2544	0.7308	0.0110	12.52
	WAT_YR_Q	-29.2878	-7.2135	18.0694	0.5387	1	-0.1957	0.7115	-3.5656	4959.24
	MIN_Q	0.0065	0.0153	0.0211	0.0003	3	-0.0842	0.7059	0.0124	1.51
	MAX_Q	-1.0065	-0.0154	0.9778	0.9699	1	-0.0568	0.7308	0.0031	87.49
	MAX_Q_DATE	-0.5882	-0.3077	0.0526	0.1098	1	-0.0423	0.7308	-0.2726	169.54
	DATE_CM	-0.4000	0.0000	0.2222	0.8010	1	-0.0303	0.7308	-0.2152	178.00
	PULSE_DATE	-0.4211	-0.1176	0.1613	0.4425	1	-0.0355	0.7308	-0.2533	131.91
	ANN_30Q_MIN	0.0035	0.0130	0.0206	0.0062	1	-0.0838	0.6923	0.0118	1.71
	ANN_7Q_MIN	0.0045	0.0140	0.0215	0.0073	1	-0.0303	0.7115	0.0126	1.61
	BASEFLOW	0.0058	0.0158	0.0247	0.0021	5	0.0617	0.7255	0.0147	2.24
	JUN-SEP_30Q_MIN	-0.1107	0.0055	0.1125	0.9479	1	-0.0928	0.7115	-0.0153	11.28
	JUN-SEP_7Q_MIN	-0.0827	0.0212	0.0986	0.7436	1	-0.0776	0.7115	-0.0024	10.21
	JANUARY	-0.0008	0.0119	0.0240	0.0775	4	0.1253	0.7255	0.0134	2.39
	FEBRUARY	0.0070	0.0177	0.0250	0.0030	3	0.0373	0.7255	0.0156	1.94
	MARCH	0.0009	0.0100	0.0181	0.0357	1	-0.0367	0.7308	0.0080	1.92
	APRIL	-0.0019	0.0133	0.0234	0.0916	3	0.0812	0.7255	0.0146	2.04
	MAY	-0.1455	0.1363	0.3322	0.3138	1	0.0144	0.7115	0.1530	16.29
	JUNE	-1.0197	-0.5886	-0.1680	0.0093	5	0.1535	0.7059	-0.3781	56.19
	JULY	-0.2955	-0.0462	0.1706	0.6782	1	-0.1737	0.7308	-0.0134	22.77
	AUGUST	-0.1293	0.0526	0.2202	0.5953	3	0.0854	0.7059	0.0539	13.65
	SEPTEMBER	-0.0269	0.0990	0.2217	0.1413	1	-0.0180	0.7308	0.0892	10.13
	OCTOBER	-0.0800	0.0100	0.0835	0.8370	1	-0.0480	0.7500	-0.0033	7.97
	NOVEMBER	-0.0178	0.0170	0.0473	0.2310	1	-0.0997	0.7500	0.0155	4.00
	DECEMBER	0.0030	0.0221	0.0425	0.0252	1	-0.0777	0.7500	0.0191	2.69
09EB003 - Indian River above the Mouth	AVG_Q	-0.0243	0.0900	0.1985	0.1718	6	0.1020	0.5098	0.0582	3.07
	WAT_YR_Q	-14.0840	29.3177	70.7212	0.2525	4	0.1361	0.4902	19.8422	1337.70
	MIN_Q	-0.0010	0.0008	0.0028	0.3319	3	0.3594	0.5098	0.0026	-0.02
	MAX_Q	-0.9154	0.4842	2.1667	0.4243	1	-0.0066	0.5962	1.0093	58.44
	MAX_Q_DATE	-1.0000	-0.5385	0.1538	0.0984	1	-0.0887	0.5577	-0.3760	151.77
	DATE_CM	-0.4737	0.4000	1.1739	0.3673	1	-0.3950	0.5577	0.3552	148.60
	PULSE_DATE	-0.6713	-0.2285	0.2419	0.2901	4	0.0670	0.5098	-0.3552	124.06
	ANN_30Q_MIN	-0.0008	0.0011	0.0047	0.3383	3	0.1371	0.4902	0.0030	-0.02
	ANN_7Q_MIN	-0.0006	0.0007	0.0037	0.3431	3	0.1403	0.5098	0.0036	-0.01
	BASEFLOW	0.0010	0.0073	0.0152	0.0185	3	-0.0459	0.5882	0.0097	-0.14
	JUN-SEP_30Q_MIN	-0.0478	0.0569	0.1429	0.3780	1	-0.0280	0.5577	0.0466	1.90
	JUN-SEP_7Q_MIN	-0.0145	0.0761	0.1537	0.0778	3	0.0287	0.5098	0.0516	0.51
	JANUARY	0.0005	0.0056	0.0120	0.0271	5	-0.0219	0.6078	0.0087	-0.10
	FEBRUARY	0.0000	0.0026	0.0070	0.0527	5	0.0876	0.6078	0.0059	-0.04
	MARCH	-0.0004	0.0012	0.0046	0.1634	4	0.1134	0.6078	0.0041	-0.02
	APRIL	0.0003	0.0127	0.0409	0.0379	1	-0.0616	0.6154	0.0491	-0.18
	MAY	-0.6582	-0.0441	0.6997	0.9005	4	0.1351	0.5294	0.3700	24.73
	JUNE	-0.1645	0.0429	0.1681	0.6833	500	0.1095	0.6078	-0.1126	7.34

Station	Variable	Lower Bound	Trend Slope	Upper Bound	Significance (p)	nruns	autocor	valid_frac	linear	intercept
	JULY	-0.0500	0.0748	0.2150	0.2365	1	-0.0191	0.6154	0.1003	4.20
	AUGUST	-0.0376	0.1317	0.3350	0.1534	1	-0.0248	0.5962	0.1393	1.90
	SEPTEMBER	-0.0107	0.1367	0.2655	0.0744	3	-0.0077	0.5882	0.1497	2.56
	OCTOBER	0.0288	0.1015	0.1774	0.0144	3	-0.0130	0.6078	0.1076	-0.17
	NOVEMBER	0.0237	0.0505	0.0728	0.0011	3	-0.2668	0.6078	0.0492	-0.69
	DECEMBER	0.0050	0.0166	0.0281	0.0075	1	0.0118	0.6154	0.0187	-0.33
09EB004 - Sixty Mile River near the Mouth	AVG_Q	-0.1539	0.3885	0.7603	0.1501	1	0.0047	0.3462	0.2959	-1.63
	WAT_YR_Q	-122.3009	176.1795	317.5928	0.2241	9	0.2176	0.3137	53.9088	-1763.39
	MIN_Q	-0.0538	0.0184	0.0620	0.7108	16	0.3548	0.3333	-0.0061	-0.60
	MAX_Q	-8.5000	2.0000	9.1538	0.8202	1	-0.2973	0.3462	0.7033	89.00
	MAX_Q_DATE	-2.3333	-0.2500	1.2500	0.6485	1	-0.2277	0.3462	-0.1517	158.00
	DATE_CM	-2.9293	-0.3674	1.8620	0.7731	4	0.0572	0.3333	-0.1548	178.29
	PULSE_DATE	-1.1429	-0.5000	0.2727	0.4247	1	-0.1719	0.3462	-0.3013	140.50
	ANN_30Q_MIN	-0.0772	-0.0192	0.0465	0.5584	6	0.2176	0.3137	-0.0150	1.24
	ANN_7Q_MIN	-0.0851	-0.0006	0.0565	0.9016	5	0.3351	0.3333	-0.0067	0.43
	BASEFLOW	-0.0943	-0.0463	0.0166	0.1151	3	0.2710	0.3137	-0.0210	3.01
	JUN-SEP_30Q_MIN	-0.5665	0.0217	0.6507	0.7731	4	0.1448	0.3333	0.1670	11.76
	JUN-SEP_7Q_MIN	-0.3248	0.1756	0.6455	0.4838	7	0.1061	0.3333	0.2578	-0.19
	JANUARY	-0.1121	-0.0389	0.0558	0.3434	5	0.3842	0.3333	-0.0026	2.62
	FEBRUARY	-0.0830	-0.0210	0.0482	0.5923	5	0.3164	0.3333	-0.0037	1.41
	MARCH	-0.0873	-0.0079	0.0584	0.7731	6	0.3342	0.3333	-0.0070	0.78
	APRIL	-0.0420	0.0464	0.1667	0.1978	1	-0.1237	0.3462	0.1427	-0.76
	MAY	-1.2286	0.4667	2.3933	0.5445	1	-0.0061	0.3462	0.7908	30.87
	JUNE	-1.6887	0.0764	1.3564	0.9016	7	0.3138	0.3333	-0.2075	19.99
	JULY	-0.2277	0.7000	2.1929	0.1501	1	0.0276	0.3462	1.1257	-15.63
	AUGUST	-0.9820	0.4036	1.6850	0.4260	1	-0.1693	0.3462	0.2984	-2.94
	SEPTEMBER	-0.9573	-0.2899	0.8582	0.7108	9	0.1734	0.3333	0.3134	31.42
	OCTOBER	-0.3272	-0.1223	0.0579	0.3031	6	0.1379	0.3333	0.0234	12.43
	NOVEMBER	-0.3682	-0.2074	0.0395	0.1275	5	0.1782	0.3333	-0.0644	12.01
	DECEMBER	-0.1668	-0.1060	-0.0284	0.0074	7	0.2757	0.3333	-0.0396	6.27

***NOTE**: Variables highlighted in green are significant at $p < 0.05$, and those highlighted in yellow are significant at $p < 0.10$.*

Appendix E
Regional Hydrometric Data

Appendix E1: Summary Tables-Regional Hydrometric Stations

Appendix E2: Summary Plots for Yukon and Stewart Rivers

GOLDCORP

APPENDIX E1: SUMMARY TABLES-REGIONAL HYDROMETRIC STATIONS

09AH003 - Big Creek near the Mouth

YEAR	MAX	MIN	AVG	START FRESHET	MAX Q DATE	DATE CM[1]	ANN 7QMIN	JUN-SEP 7QMIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL RUNOFF*
1974	--	0.07	--	--	--	105	--	2.9	--	--	--	--	--	--	--	19.6	4.5	2.2	0.6	0.1	NA
1975	147.0	0.04	10.0	128	131	188	0.0	6.4	0.1	0.1	0.1	0.4	37.3	14.6	23.9	23.1	13.8	4.1	0.4	0.2	174.5
1976	206.0	0.06	8.7	123	197	187	0.1	2.4	0.1	0.1	0.1	0.4	23.4	25.7	42.5	5.9	2.9	1.7	0.8	0.3	153.1
1977	40.8	0.05	5.4	121	185	176	0.1	2.7	0.2	0.2	0.2	0.5	17.6	17.9	15.8	3.9	4.3	2.8	0.7	0.1	94.4
1978	175.0	0.02	9.0	135	195	199	0.0	3.7	0.0	0.0	0.0	0.0	7.0	20.8	40.1	23.4	7.7	4.8	1.8	0.6	156.8
1979	55.9	0.07	7.0	122	174	191	0.1	5.4	0.3	0.1	0.1	0.2	18.0	18.4	19.6	12.0	10.3	3.5	1.1	0.4	123.5
1980	91.2	0.09	6.0	129	260	228	0.1	3.4	0.2	0.2	0.2	0.3	7.8	4.7	16.6	11.0	22.1	7.7	0.8	0.2	105.2
1981	62.3	0.16	5.3	126	185	200	0.2	3.2	0.2	0.2	0.2	0.2	12.8	4.7	18.4	14.0	5.9	4.8	1.6	0.4	93.7
1982	78.1	0.10	6.0	130	214	160	0.1	2.3	0.2	0.1	0.1	0.2	24.0	20.1	4.9	16.0	2.7	1.9	0.8	0.3	105.1
1983	113.0	0.00	7.4	141	154	204	0.0	4.2	0.1	0.1	0.1	0.1	8.5	21.3	17.9	27.3	8.9	3.3	0.4	0.0	129.3
1984	--	--	--	131	132	148	0.0	2.6	0.0	0.0	0.0	0.1	--	--	19.6	4.3	13.8	2.6	0.4	0.1	NA
1985	90.0	0.01	8.2	134	139	180	0.0	6.0	0.0	0.0	0.0	0.1	25.9	23.4	20.1	11.7	10.8	3.5	1.3	0.8	143.8
1986	117.0	0.04	7.0	142	209	184	0.0	5.1	0.5	0.3	0.1	0.1	21.6	18.4	17.2	10.9	9.3	3.5	0.7	0.6	122.4
1987	109.0	0.03	6.6	125	156	157	0.0	2.6	0.4	0.2	0.1	0.7	26.8	18.6	7.0	12.0	7.8	3.3	1.0	0.4	115.2
1988	64.5	0.15	7.5	122	130	193	0.2	4.3	0.2	0.2	0.2	0.5	26.7	11.0	23.0	15.7	6.1	3.2	1.7	0.8	131.8
1989	22.7	0.06	3.2	124	134	181	0.1	2.4	0.4	0.2	0.1	0.2	10.6	7.9	6.1	4.7	4.0	2.5	1.1	0.5	56.3
1990	142.0	0.03	12.9	110	120	135	0.0	1.4	0.3	0.1	0.1	21.8	76.8	17.0	8.5	3.7	19.0	5.9	1.0	0.3	226.8
1991	98.7	0.18	12.1	118	141	172	0.2	8.8	0.2	0.3	0.4	2.8	49.6	23.1	18.1	18.0	20.5	5.7	3.6	2.2	212.5
1992	214.0	0.34	13.6	122	148	173	0.3	7.8	1.1	0.4	0.5	1.4	52.2	33.7	36.2	12.4	16.5	4.9	2.0	1.1	239.1
1993	64.6	0.18	7.6	113	138	157	0.2	3.5	0.5	0.2	0.2	5.3	36.0	10.0	12.6	13.5	7.2	2.0	1.9	1.3	133.9
1994	--	0.15	--	188	189	213	0.2	2.3	0.7	0.3	0.2	7.9	19.1	9.0	--	--	3.0	2.3	0.5	0.3	NA
1995	--	--	--	--	--	183	0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	NA
1996	79.7	0.00	6.1	139	185	214	0.0	2.4	0.2	0.0	0.0	0.0	6.3	6.0	22.5	21.2	12.1	2.9	0.7	0.1	106.3
1997	108.0	0.02	11.4	129	211	183	0.0	8.4	0.0	0.0	0.0	0.0	28.7	38.8	26.5	24.4	11.0	3.8	1.8	0.7	199.6
1998	18.0	0.03	2.2	122	170	168	0.1	1.7	0.2	0.1	0.1	0.2	8.6	8.3	2.7	1.9	2.4	1.2	0.2	0.0	38.0
1999	98.6	0.02	4.6	133	156	172	0.0	2.4	0.0	0.0	0.0	0.2	9.6	22.0	6.3	4.2	8.9	3.1	0.4	0.1	80.1
2000	140.0	0.02	16.0	121	129	198	0.0	10.5	0.0	0.0	0.0	0.7	53.2	26.6	27.8	30.6	34.2	11.8	4.1	2.4	281.6
2001	243.0	0.56	11.1	135	208	198	0.6	8.5	1.3	0.7	0.6	1.8	15.3	35.4	33.9	19.5	14.8	5.4	2.5	1.1	194.1
2002	48.1	0.21	6.6	127	244	212	0.2	2.5	0.5	0.3	0.2	0.7	19.4	9.1	9.2	14.8	16.4	4.6	1.9	1.0	115.0
2003	131.0	0.12	6.8	115	170	186	0.1	5.8	0.5	0.3	0.1	4.0	12.3	18.5	20.1	11.7	7.1	4.7	1.6	0.7	119.8
2004	117.0	0.34	6.3	118	129	140	0.3	2.7	0.4	0.4	0.4	2.4	40.2	6.3	4.8	7.1	6.1	4.8	1.3	0.6	110.5
2005	41.0	0.26	6.8	114	118	206	0.3	4.5	0.4	0.4	0.3	7.0	14.8	8.6	11.8	12.8	16.4	6.1	2.1	0.4	119.2
2006	54.0	0.00	4.8	129	135	163	0.2	2.0	0.2	0.2	0.2	0.6	20.2	10.6	9.6	5.9	4.9	2.9	1.2	0.3	83.5
2007	42.3	0.00	5.5	115	185	173	0.0	4.3	0.0	0.0	0.0	2.8	23.3	8.9	11.0	6.8	7.6	3.7	0.9	0.3	96.2
2008	249.0	0.11	10.1	120	239	204	0.1	4.2	0.1	0.1	0.1	1.3	42.4	11.6	6.7	31.8	16.6	5.9	2.4	1.3	177.9
2009	127.0	0.53	7.2	119	127	145	0.6	2.2	0.9	0.7	0.6	1.7	45.1	19.0	3.6	4.3	4.8	2.8	1.6	0.8	126.2
2010	156.0	0.22	10.2	110	183	202	0.2	3.5	0.4	0.3	0.2	8.7	17.7	7.7	38.0	23.0	16.7	4.7	2.4	1.3	178.6
2011	123.0	0.84	15.1	121	140	186	0.8	8.7	1.2	1.3	0.9	3.7	44.2	31.8	37.2	36.8	12.0	5.4	3.0	1.7	263.9
2012	73.6	0.86	10.9	113	146	184	0.9	9.9	1.1	0.9	1.0	8.7	28.2	24.9	19.2	20.2	16.0	6.1	2.6	1.5	191.3
2013	145.0	1.14	10.7	126	133	164	1.1	4.7	1.4	1.3	1.2	1.2	46.3	18.3	17.7	10.6	15.0	9.1	3.2	1.7	186.7
2014	46.0	0.48	6.1	115	127	191	0.5	3.2	1.3	1.0	0.7	2.8	23.9	4.8	8.8	7.0	12.3	6.2	2.5	1.3	107.0

**All values in m^3/s, except Start Freshet, Max Q Date and Date CM - in Julian Days, and Annual Runoff - in mm.*

[1] *Date of centre of hydrograph mass (Stewart et al., 2001)*

09AH004 - Nordenskiold River below Rowlinson Creek

YEAR	MAX	MIN	AVG	START FRESHET	MAX Q DATE	DATE CM[1]	ANN 7QMIN	JUN-SEP 7QMIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL RUNOFF*
1982	--	4.22	--	--	--	92	--	8.8	--	--	--	--	--	--	11.2	25.0	16.4	11.6	8.0	4.8	NA
1983	185.0	2.30	18.6	117	155	163	2.5	14.4	3.6	3.4	2.7	8.4	58.6	51.4	24.8	28.5	19.2	11.3	6.6	3.4	91.5
1984	55.5	2.19	9.0	126	157	173	2.2	6.9	2.3	2.7	2.9	3.7	21.4	25.9	16.3	7.4	10.3	7.1	4.0	3.3	44.2
1985	96.7	2.36	14.9	133	147	174	2.4	11.9	3.1	2.6	3.0	4.0	42.6	42.2	18.7	18.8	19.6	12.7	6.8	4.3	73.4
1986	118.0	2.80	19.1	132	151	177	2.8	16.0	4.5	4.4	3.0	3.5	45.3	58.3	23.8	20.7	23.7	23.8	9.7	7.3	93.8
1987	71.2	2.00	10.9	119	138	160	2.0	6.5	3.7	2.6	2.1	5.0	38.1	29.3	13.0	9.9	9.6	7.7	5.1	4.2	53.6
1988	103.0	2.30	20.1	124	199	205	2.3	15.9	2.8	2.6	4.0	5.1	43.1	26.2	56.6	43.9	21.6	16.3	9.5	7.1	98.9
1989	119.0	3.50	14.3	112	121	144	3.6	7.5	4.1	4.0	4.7	20.4	58.3	19.1	22.4	11.1	8.0	8.1	6.0	4.8	70.5
1990	59.0	3.11	14.0	116	121	172	3.1	7.4	3.5	3.3	3.7	8.0	44.3	28.8	20.3	8.9	21.0	13.8	6.8	4.7	68.8
1991	114.0	2.72	23.2	116	126	207	2.7	17.1	3.1	2.9	3.6	10.5	64.0	28.7	32.8	29.8	48.0	27.2	15.5	10.9	114.3
1992	199.0	5.50	27.0	122	149	171	5.5	20.8	8.5	6.8	6.1	8.4	71.4	79.3	45.5	26.6	32.3	18.9	12.2	7.8	133.3
1993	94.0	4.25	18.8	114	150	173	4.3	14.6	5.8	4.6	4.4	16.2	56.9	31.2	16.8	21.1	22.6	19.9	15.1	10.3	92.6
1994	39.6	2.87	9.3	109	136	150	3.2	5.2	6.9	4.8	3.5	9.5	32.4	16.2	9.8	5.6	7.9	7.8	4.0	3.1	45.9
1995	35.9	1.66	8.0	116	123	211	1.7	4.2	2.7	2.1	1.8	4.1	24.0	5.8	7.8	10.7	16.1	9.9	5.7	5.1	39.6
1996	47.7	2.50	9.4	115	199	199	2.5	5.6	3.9	3.1	2.7	6.0	21.4	9.3	21.3	19.1	11.6	6.0	4.9	3.2	46.5
1997	89.1	1.97	12.3	122	140	158	2.0	6.3	2.7	2.4	2.1	3.3	52.1	32.0	11.9	16.7	9.0	6.5	4.4	3.5	60.5
1998	39.6	1.26	5.8	112	126	148	2.7	3.2	3.1	2.8	2.7	5.2	23.8	12.8	5.0	3.5	4.1	3.4	1.7	1.3	28.6
1999	83.7	1.19	8.8	125	157	166	1.2	5.0	1.2	1.2	1.3	2.8	24.5	35.6	14.3	5.5	8.1	5.5	3.0	1.9	43.1
2000	120.0	1.35	28.5	127	236	238	1.4	22.1	1.5	1.4	1.4	5.6	39.7	40.1	36.1	63.8	84.9	41.6	16.6	8.2	140.5
2001	90.5	4.36	20.4	128	155	195	4.4	22.2	5.9	4.8	4.4	7.2	29.4	56.7	36.5	35.2	25.6	17.9	11.6	8.3	100.3
2002	71.7	2.56	11.6	128	138	168	2.6	9.3	6.2	4.2	2.7	3.5	37.6	21.8	11.7	14.2	17.5	9.5	5.9	3.9	57.2
2003	46.0	2.56	7.9	113	121	175	2.8	5.9	3.0	2.8	2.8	8.0	17.7	17.5	16.7	7.4	6.4	5.2	4.0	2.9	38.9
2004	96.3	1.52	10.2	120	130	147	2.2	5.3	2.3	2.3	2.5	4.1	57.3	18.7	6.6	6.3	8.5	7.1	4.7	2.0	50.6
2005	59.6	1.36	10.2	116	119	195	1.4	10.3	1.4	1.4	2.5	8.9	22.0	15.6	17.8	12.2	16.1	10.9	8.5	4.4	50.2
2006	71.9	2.36	9.9	127	142	161	2.4	6.8	2.9	2.5	2.5	4.1	34.5	25.7	17.6	9.5	7.4	5.4	3.1	3.0	48.7
2007	63.7	2.63	11.2	118	139	175	2.7	8.8	3.0	2.7	2.7	5.3	37.3	19.5	17.9	11.4	12.5	12.4	5.9	3.0	55.1
2008	115.0	2.50	19.7	122	240	199	2.5	13.8	2.6	2.5	2.9	4.4	56.2	34.5	24.8	33.2	36.4	17.9	13.0	7.8	97.4
2009	206.0	3.75	16.7	119	128	139	4.2	7.4	5.1	4.3	4.2	7.7	108.1	26.9	10.7	7.9	8.0	6.6	5.1	4.1	82.2
2010	47.1	3.20	10.8	116	121	193	3.2	9.5	3.5	3.3	3.3	7.2	27.9	12.4	16.5	11.3	16.4	11.4	9.2	6.9	53.2
2011	131.0	3.77	23.0	125	141	197	3.8	21.3	4.9	4.3	4.0	3.9	66.3	40.3	28.8	47.9	31.5	20.9	12.4	9.2	113.3
2012	96.4	4.95	22.2	115	147	181	5.0	23.6	6.6	5.3	5.2	13.2	57.5	46.8	32.0	30.6	29.1	18.1	12.1	8.7	109.3
2013	144.0	5.56	21.8	129	134	169	5.6	12.3	7.5	6.6	6.0	5.7	64.4	53.4	28.5	27.4	23.1	18.6	10.2	9.3	107.4
2014	95.7	4.09	16.5	118	126	160	4.1	10.6	8.1	6.5	4.9	6.5	64.7	19.8	12.4	12.2	21.3	20.7	10.7	9.4	81.3

**All values in m^3/s, except Start Freshet, Max Q Date and Date CM - in Julian Days, and Annual Runoff - in mm.*
[1] Date of centre of hydrograph mass (Stewart et al., 2001)

09BC001 - Pelly River at Pelly Crossing

YEAR	MAX	MIN	AVG	START FRESHET	MAX Q DATE	DATE CM[1]	ANN 7QMIN	JUN-SEP 7QMIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL RUNOFF*
1974	--	62.60	--	--	--	119	--	281.6	--	--	--	--	--	980.3	508.3	598.1	343.4	221.4	112.8	75.7	NA
1975	2590.0	50.40	458.6	131	158	178	50.7	344.7	55.5	55.0	51.4	60.9	883.2	1827.7	916.0	456.6	478.9	428.5	167.9	105.7	295.8
1976	1420.0	56.40	380.0	125	159	180	56.4	303.4	71.5	60.5	57.2	59.7	935.6	1194.0	940.0	463.0	323.1	250.5	108.8	81.0	245.6
1977	1980.0	48.40	370.8	127	151	178	49.0	321.9	68.1	62.0	53.6	54.4	878.0	1214.8	671.5	435.5	416.5	344.0	156.9	76.4	239.2
1978	1510.0	35.10	352.5	128	158	195	35.6	289.4	57.1	43.9	36.5	40.5	547.0	1082.0	726.3	655.4	346.1	368.0	197.4	108.0	227.3
1979	2180.0	44.70	419.1	121	159	177	45.7	250.7	61.8	49.8	54.0	60.2	869.6	1629.0	933.9	607.1	281.5	260.1	118.5	81.5	270.3
1980	1270.0	47.90	313.4	131	140	200	48.4	371.6	64.2	52.1	50.8	70.8	626.5	760.7	557.6	455.6	442.1	376.4	198.8	95.3	202.7
1981	1440.0	55.40	316.4	122	150	177	55.8	240.6	71.1	61.2	57.4	69.3	931.6	801.3	540.5	338.8	351.8	315.2	146.1	90.9	204.0
1982	1740.0	28.00	305.7	133	163	177	28.5	257.4	46.6	32.6	33.6	38.6	527.6	1260.1	544.5	368.2	284.1	291.1	140.2	90.4	197.1
1983	2700.0	39.90	410.4	126	158	177	40.4	406.7	66.7	62.5	47.8	66.1	793.3	1583.7	666.0	571.1	547.3	299.6	135.1	73.8	264.6
1984	1610.0	35.50	343.7	130	166	183	36.1	290.4	50.8	43.7	38.0	62.0	684.8	1160.5	738.4	429.1	440.6	243.3	142.8	84.8	222.2
1985	2480.0	44.00	421.5	137	159	186	44.8	446.3	64.8	51.1	46.4	49.5	559.0	1582.4	1035.9	623.8	476.1	335.5	116.5	98.5	271.8
1986	2360.0	38.60	488.5	133	162	185	39.1	463.3	81.0	62.0	46.4	41.4	707.1	1872.0	910.8	674.6	619.6	481.8	234.6	115.7	315.0
1987	2110.0	54.20	412.3	129	155	182	55.0	426.7	84.4	70.7	56.7	68.1	789.1	1387.5	769.3	509.6	499.6	424.7	150.1	119.9	265.9
1988	1910.0	57.00	430.3	125	139	186	57.2	392.4	85.6	67.4	61.4	79.3	1033.6	1164.6	969.6	600.5	420.7	361.3	163.6	135.5	278.2
1989	1620.0	46.50	287.7	119	132	161	46.5	163.0	98.8	64.4	49.0	78.8	1093.0	900.9	401.4	243.7	174.5	159.0	95.3	75.5	185.6
1990	1980.0	39.00	431.9	122	155	185	39.0	347.7	65.2	43.0	43.5	75.8	954.4	1274.0	673.8	405.1	898.0	497.9	142.2	93.1	278.5
1991	1520.0	60.00	522.0	120	142	197	60.0	577.1	72.6	62.9	60.5	89.7	1250.1	1172.7	992.4	838.4	790.5	514.0	237.5	145.5	336.7
1992	2830.0	80.00	506.4	129	160	178	80.1	380.3	107.0	90.1	81.9	103.8	652.8	2308.3	1240.8	560.5	455.9	256.1	121.7	102.7	327.5
1993	2910.0	55.00	474.7	124	156	166	55.3	378.7	82.1	67.2	59.9	90.5	1364.5	1777.2	764.5	473.6	419.5	322.3	127.2	124.9	306.1
1994	1490.0	67.30	351.1	120	146	172	67.6	217.7	91.9	73.7	68.3	122.4	900.7	1143.3	542.5	262.1	262.7	438.6	164.0	125.6	226.4
1995	1020.0	53.90	323.7	119	136	192	54.1	374.6	91.0	71.6	58.0	118.2	771.4	663.1	447.8	480.8	613.3	326.5	133.8	92.4	208.8
1996	1590.0	47.40	398.5	121	150	194	47.6	472.0	72.8	58.5	50.0	88.1	795.1	1049.2	766.1	686.9	635.2	293.2	174.5	101.7	257.7
1997	1570.0	39.50	342.0	126	146	181	39.7	326.3	69.9	51.1	41.0	60.6	867.9	966.3	627.7	604.7	382.2	173.6	132.4	103.6	220.5
1998	1550.0	37.10	261.0	120	151	167	37.2	207.3	64.3	44.3	37.7	84.3	788.8	817.1	345.7	262.4	254.3	213.8	124.8	80.6	168.3
1999	1430.0	39.00	354.2	129	168	192	39.0	428.3	53.2	41.3	39.3	60.2	579.0	1097.8	595.0	579.3	496.3	362.5	205.3	125.6	228.5
2000	1440.0	49.80	496.5	129	163	223	50.6	567.3	75.2	55.0	51.9	53.4	535.5	1194.4	766.0	904.9	930.2	847.4	352.4	181.2	321.1
2001	2300.0	65.30	416.6	136	159	179	65.7	359.6	124.1	91.1	70.3	79.1	466.0	1783.0	888.0	449.5	460.2	314.8	150.0	117.9	268.7
2002	1300.0	37.30	334.8	130	144	202	37.5	313.0	81.6	55.7	40.1	44.2	746.1	769.9	385.9	562.7	712.9	312.2	157.5	133.5	215.9
2003	1210.0	58.30	282.0	121	164	181	58.4	242.7	95.6	72.1	61.9	78.5	494.4	909.0	549.6	277.5	318.3	304.8	97.9	112.6	181.8
2004	2390.0	58.20	351.5	125	153	164	58.2	204.9	82.1	61.3	58.5	61.7	1048.7	1531.1	459.1	256.9	228.4	230.9	116.9	81.1	227.3
2005	2340.0	60.00	452.5	120	142	172	60.0	424.9	67.4	61.8	60.0	92.7	1504.9	1159.0	647.2	517.2	535.2	407.0	184.7	160.2	291.8
2006	1490.0	53.00	356.2	132	149	179	53.0	369.1	95.0	65.9	54.4	66.1	698.5	1235.9	569.7	418.8	448.7	369.7	124.1	114.3	229.7
2007	1860.0	44.50	372.8	124	160	186	44.5	356.3	89.0	60.1	45.5	84.6	681.8	1172.6	788.6	506.9	464.0	319.0	140.6	102.1	240.4
2008	2090.0	54.00	514.5	127	152	200	54.0	519.3	70.1	58.0	54.6	79.7	1094.6	1192.4	914.6	708.7	977.6	619.2	226.4	162.6	332.7
2009	2000.0	67.40	400.4	125	160	166	67.4	259.3	111.0	85.6	71.4	73.6	1151.3	1511.9	532.7	312.1	402.2	285.7	140.8	112.5	258.2
2010	920.0	55.40	257.6	118	163	179	55.4	210.4	69.7	58.7	55.8	91.6	569.9	750.3	568.8	266.4	253.3	189.6	115.0	88.6	166.1
2011	2100.0	46.10	461.2	133	148	190	46.4	541.9	66.4	56.9	49.5	50.7	878.6	1291.1	1046.9	793.3	615.2	363.5	158.4	134.0	297.5
2012	2460.0	64.50	495.2	130	170	183	65.1	438.9	93.9	74.8	68.3	95.9	701.9	1955.0	1264.8	632.7	493.1	279.6	163.3	116.0	320.3
2013	3320.0	65.60	451.2	135	155	174	66.0	345.6	97.6	84.4	75.9	68.6	873.5	1756.9	594.7	441.8	637.1	424.8	210.2	140.9	291.0
2014	1660.0	54.70	396.9	124	144	183	55.6	427.7	110.7	87.7	69.2	66.9	1074.4	912.8	632.2	463.5	514.8	479.6	184.0	139.7	255.9

**All values in m^3/s, except Start Freshet, Max Q Date and Date CM - in Julian Days, and Annual Runoff - in mm.*
[1] Date of centre of hydrograph mass (Stewart et al., 2001)

09CA006 - Nisling River below Onion Creek

YEAR	MAX	MIN	AVG	START FRESHET	MAX Q DATE	DATE CM[1]	ANN 7QMIN	JUN-SEP 7QMIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL RUNOFF*
1995	--	9.24	--	--	--	113	--	39.5	--	--	--	--	--	--	--	--	59.7	23.7	13.4	10.1	NA
1996	160.0	4.57	26.8	184	199	217	4.6	8.7	8.5	6.4	5.2	5.4	23.7	18.0	77.4	92.6	45.3	17.7	10.7	8.4	107.1
1997	334.0	6.10	40.0	129	213	209	6.1	28.8	7.4	6.6	6.2	7.4	80.0	73.7	86.1	115.2	42.7	23.8	15.3	11.6	159.4
1998	39.6	1.89	9.3	115	126	148	6.0	7.4	8.6	6.7	6.1	7.7	29.0	18.2	9.4	7.8	7.4	5.6	2.8	2.1	37.1
1999	215.0	1.72	17.1	123	158	169	1.7	9.5	1.8	1.7	2.0	5.3	41.5	65.4	21.1	14.4	21.6	16.3	8.5	5.7	68.3
2000	384.0	3.64	65.6	140	197	233	3.6	51.3	4.3	3.8	3.7	4.7	68.1	103.8	123.8	181.5	180.9	74.4	20.6	15.1	262.2
2001	455.0	8.18	50.5	148	208	210	8.2	34.6	11.5	9.3	8.3	12.4	39.0	116.4	126.6	106.7	92.1	35.4	27.2	19.0	201.5
2002	354.0	7.16	35.3	128	210	210	7.2	16.2	14.1	10.4	7.7	7.7	89.6	41.8	59.1	67.2	66.2	28.4	16.0	13.1	140.8
2003	370.0	6.07	31.6	169	186	193	6.1	18.1	10.2	8.5	7.4	10.7	30.8	56.1	95.4	60.2	37.6	22.9	21.5	15.2	125.8
2004	--	5.48	--	184	185	217	5.5	17.5	8.4	6.3	5.6	7.9	115.6	38.9	--	--	--	28.0	16.3	9.3	NA
2005	229.0	5.63	38.5	114	119	210	5.6	24.9	6.7	5.9	5.7	40.3	55.3	42.8	81.2	66.2	91.0	40.6	15.0	9.3	153.5
2006	197.0	5.88	23.0	129	180	190	5.9	12.7	7.3	6.3	6.0	8.2	52.5	47.1	40.0	33.3	30.7	22.0	12.1	8.5	91.5
2007	194.0	6.02	29.2	119	185	188	6.0	19.1	7.0	6.4	6.1	11.2	87.3	27.1	60.0	43.5	44.3	30.8	14.5	9.6	116.5
2008	572.0	7.00	43.2	118	240	236	7.0	21.8	8.1	7.4	7.1	16.5	84.9	57.7	49.8	126.1	101.2	29.7	16.1	12.0	172.6
2009	360.0	7.50	30.0	119	127	145	7.8	14.4	9.4	8.3	7.8	9.7	171.2	57.1	21.9	18.0	19.9	14.6	10.3	8.5	119.5
2010	253.0	5.39	39.2	181	232	231	5.4	11.1	6.8	6.0	5.5	15.5	38.5	15.6	106.8	102.6	102.0	35.0	18.3	13.7	156.1
2011	310.0	7.19	64.3	123	141	200	7.4	47.4	11.6	10.5	10.1	9.6	149.5	124.0	135.7	185.9	66.7	30.7	17.5	13.6	256.4
2012	242.0	9.68	50.5	113	187	207	9.7	51.0	11.0	10.1	9.8	29.5	78.7	77.4	101.1	107.8	104.9	44.1	16.6	13.0	201.8
2013	435.0	8.50	56.1	129	208	204	8.5	35.8	12.9	12.6	10.6	8.7	142.8	97.4	140.1	86.5	65.6	49.3	23.8	17.0	223.5
2014	170.0	7.80	31.4	114	143	190	7.8	19.5	12.0	9.9	8.5	18.6	102.6	27.9	41.1	38.4	51.8	32.9	17.9	12.4	125.1

**All values in m^3/s, except Start Freshet, Max Q Date and Date CM - in Julian Days, and Annual Runoff - in mm.*

[1] Date of centre of hydrograph mass (Stewart et al., 2001)

09CD001 - Yukon River above White River

YEAR	MAX	MIN	AVG	START FRESHET	MAX Q DATE	DATE CM[1]	ANN 7QMIN	JUN-SEP 7QMIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL RUNOFF*
1974	2660.0	436.00	--	177	221	200	--	--	--	--	--	--	--	1192.8	2142.9	2248.1	1603.3	1205.5	932.6	508.6	NA
1975	3790.0	317.00	1316.4	132	157	199	317.0	1614.3	411.7	389.5	347.9	328.5	1590.1	3109.7	2978.1	2055.5	1815.7	1587.1	691.3	424.5	278.6
1976	3850.0	345.00	1236.7	125	198	194	345.9	1105.7	367.5	360.0	351.2	374.8	1835.6	2976.0	3038.7	1929.7	1404.7	988.3	703.8	470.3	262.3
1977	3230.0	371.00	1234.2	130	157	195	373.4	1501.4	440.5	421.9	392.1	433.0	1516.8	3005.7	2568.1	2008.7	1627.3	1250.5	630.6	461.4	261.2
1978	2680.0	276.00	1044.1	128	160	202	278.4	1067.1	390.8	341.9	296.0	299.5	1267.5	2300.3	2122.3	1896.8	1254.7	1050.0	808.2	449.2	221.0
1979	3750.0	320.00	1279.9	123	160	196	323.3	1255.7	375.7	337.1	339.1	367.9	1546.0	3264.3	3119.0	2231.9	1421.0	1159.0	683.9	442.7	270.9
1980	2490.0	377.00	1109.7	135	201	210	381.0	1461.4	416.2	401.7	389.6	420.8	1184.7	2099.0	1944.8	1839.7	1625.7	1427.1	998.5	545.6	235.5
1981	3010.0	348.00	1173.6	130	154	199	350.4	1352.9	452.2	381.7	367.1	399.8	1706.9	2410.3	2129.0	1599.0	1529.0	1461.9	1036.5	554.5	248.4
1982	3310.0	360.00	969.1	138	164	192	364.3	1101.4	443.5	455.5	380.8	369.2	906.7	2648.0	1784.5	1389.0	1160.0	1027.6	618.7	425.1	205.1
1983	4210.0	320.00	1105.4	132	158	195	324.3	1292.9	367.2	354.0	332.7	354.0	1311.3	3051.3	1976.5	1685.5	1551.0	1075.3	714.6	458.8	234.0
1984	3030.0	310.00	1009.3	145	168	200	310.0	1228.6	390.4	356.4	315.8	359.3	788.2	2491.7	2187.7	1495.5	1515.3	1066.8	615.2	517.4	214.2
1985	4850.0	400.00	1259.0	141	160	195	400.9	1325.7	464.5	419.9	418.3	417.8	1090.4	3385.3	3029.0	2065.5	1511.3	1133.7	658.6	462.6	266.5
1986	4200.0	307.00	1512.8	142	161	207	308.3	1648.6	420.5	401.2	359.6	318.1	1115.7	3767.3	3229.4	2471.9	2086.3	1672.6	1349.3	902.0	320.2
1987	4280.0	347.00	1242.3	135	156	193	347.9	1474.3	595.3	443.4	362.6	382.8	1417.0	3267.0	2488.7	1782.9	1580.3	1360.6	735.9	446.3	262.9
1988	4050.0	295.00	1339.7	133	201	201	340.9	1450.0	406.5	357.6	342.9	399.7	1761.3	3027.7	3277.7	2506.8	1665.3	1265.8	683.5	331.9	284.3
1989	2820.0	295.00	1040.3	122	162	188	295.0	1182.9	306.8	379.5	375.0	382.3	2079.0	2358.0	1659.7	1434.2	1231.3	1074.5	678.2	476.7	220.2
1990	4000.0	296.00	1299.7	128	180	193	296.9	1521.4	375.0	317.5	303.0	418.1	1728.9	3487.7	2525.5	1618.7	2124.7	1482.7	700.5	469.0	275.1
1991	3230.0	316.00	1384.2	132	214	209	317.3	1914.3	370.0	328.2	324.8	424.0	1761.6	2722.0	2685.8	2368.7	2434.7	1844.2	707.4	561.4	293.0
1992	5440.0	362.00	1603.7	144	174	192	365.3	1624.3	467.4	385.1	392.2	470.3	1446.1	5100.3	4104.5	2517.1	1932.7	1262.3	655.2	488.7	340.4
1993	4330.0	356.00	1296.4	134	156	188	356.9	1364.3	440.7	426.9	394.6	445.5	2107.1	3463.3	2324.8	1768.7	1494.7	1304.2	785.5	548.6	274.4
1994	2980.0	385.00	1195.9	127	166	193	387.9	1335.7	493.9	451.0	406.3	539.3	1650.0	2725.7	2184.2	1536.5	1380.7	1648.1	758.2	525.2	253.1
1995	2060.0	300.00	969.1	121	138	200	300.9	1330.0	412.8	320.9	302.5	407.2	1656.1	1781.3	1509.4	1450.0	1590.0	1179.8	496.1	473.3	205.1
1996	2460.0	285.00	952.7	138	154	203	286.4	1311.4	407.6	329.9	291.9	353.7	1144.2	1981.7	1809.4	1520.0	1538.7	932.1	642.6	463.5	202.2
1997	3030.0	259.00	1104.3	128	162	197	260.1	1288.6	334.3	283.7	262.3	290.7	1850.6	2584.7	2068.4	1912.9	1446.3	988.0	795.0	378.5	233.7
1998	2680.0	271.00	831.9	130	153	184	276.1	886.4	344.8	411.4	317.8	350.2	1363.9	2072.3	1354.2	1094.8	940.2	753.8	514.2	442.5	176.1
1999	2720.0	300.00	971.1	130	170	205	300.0	1340.0	319.0	302.1	300.5	324.6	1099.7	2158.3	1731.3	1728.4	1440.0	1097.8	652.2	456.6	205.5
2000	3430.0	307.00	1476.8	149	275	227	307.1	1687.1	344.3	314.8	308.3	334.1	1254.3	2559.0	2661.6	2705.8	2944.3	2444.5	1081.6	726.2	313.4
2001	4320.0	380.00	1288.4	140	170	194	381.1	1584.3	557.5	471.0	394.5	435.8	1124.7	3512.7	2853.2	1948.7	1626.7	1192.0	740.1	562.4	272.7
2002	2740.0	328.00	1154.1	130	247	212	328.0	1467.1	426.5	361.3	337.2	330.4	1581.2	2237.7	1681.3	1837.1	2157.0	1310.3	890.8	654.3	244.3
2003	2220.0	288.00	936.7	132	165	199	289.7	1137.1	480.1	379.6	307.1	359.5	1061.7	1941.0	1865.5	1368.4	1211.0	1150.1	558.9	514.0	198.3
2004	4050.0	318.00	1180.6	135	163	189	319.0	1288.6	434.8	368.6	329.0	375.4	1856.2	3294.0	1970.6	1468.7	1307.0	1222.9	734.2	785.7	250.6
2005	4110.0	366.00	1393.2	120	143	186	366.9	1694.3	600.6	480.0	384.2	502.1	2833.9	3208.0	2312.6	1847.7	1826.0	1460.3	603.3	589.4	294.9
2006	3640.0	307.00	1196.6	137	171	197	307.0	1505.7	465.8	405.5	331.9	315.7	1244.7	3125.0	2434.8	1788.7	1680.3	1391.5	670.0	461.0	253.3
2007	3900.0	295.00	1267.1	138	160	200	318.4	1745.7	400.4	368.9	337.8	334.5	1352.0	3128.3	2648.1	2235.8	1813.3	1506.8	645.2	374.5	268.2
2008	3610.0	313.00	1437.2	130	153	204	297.3	1781.4	463.0	409.4	333.0	413.5	1886.9	3042.7	2866.1	2165.2	2401.3	1722.3	820.8	686.0	305.0
2009	3990.0	378.00	1319.2	123	161	182	378.7	1430.0	601.4	510.2	439.5	405.6	2363.1	3563.0	2148.7	1491.3	1566.3	1477.7	770.7	447.5	279.2
2010	2340.0	346.00	986.9	117	184	194	346.4	1120.0	495.1	425.3	362.7	506.0	1394.5	1880.7	1905.2	1335.8	1256.3	997.4	635.5	604.3	208.9
2011	3390.0	304.00	1279.4	138	157	199	304.9	1802.9	482.8	383.6	321.0	419.8	1624.5	2897.7	2542.3	2126.5	1930.0	1391.2	653.9	518.6	270.8
2012	4780.0	352.00	1393.8	146	168	196	352.3	1731.4	458.9	414.0	378.2	443.6	1311.0	3781.3	3475.5	2157.4	1833.3	1359.1	602.4	482.2	295.8

**All values in m^3/s, except Start Freshet, Max Q Date and Date CM - in Julian Days, and Annual Runoff - in mm.*

[1] Date of centre of hydrograph mass (Stewart et al., 2001)

09DD003 - Stewart River at the Mouth

YEAR	MAX	MIN	AVG	START FRESHET	MAX Q DATE	DATE CM[1]	ANN 7QMIN	JUN-SEP 7QMIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL RUNOFF*
1974	1280.0	105.00	--	--	221	130	--	368.6	--	--	--	--	--	992.2	643.2	890.6	443.5	247.7	166.9	123.1	NA
1975	3960.0	58.60	595.4	130	159	176	59.2	446.1	85.2	73.8	65.8	60.9	1090.0	2552.3	1140.7	635.0	598.7	516.5	186.0	122.5	368.2
1976	1760.0	59.20	369.8	124	128	179	59.5	292.4	90.4	73.7	62.8	64.2	992.5	1062.3	758.0	494.1	337.3	299.3	115.8	70.9	229.2
1977	2570.0	57.20	407.0	128	155	170	58.8	286.7	64.1	74.7	63.0	68.7	0.7	1673.3	674.4	480.9	353.9	259.7	79.0	78.1	199.2
1978	2160.0	43.30	396.4	128	163	190	44.2	299.3	62.8	55.4	48.4	53.3	509.8	1303.4	1102.6	603.9	324.6	351.9	194.1	122.7	245.1
1979	2110.0	53.50	519.7	121	155	185	53.8	386.0	82.5	60.7	63.4	66.2	1079.3	1629.0	1245.1	758.8	460.9	422.6	209.9	122.3	321.3
1980	2040.0	66.50	441.2	126	164	191	67.3	458.1	82.4	70.4	71.9	90.9	834.0	1288.0	761.1	740.6	565.1	453.1	197.8	127.1	273.6
1981	1530.0	62.00	420.6	127	152	191	62.9	378.9	92.8	76.7	67.2	77.9	961.4	947.5	847.7	643.1	626.2	420.5	150.3	106.1	260.1
1982	1850.0	45.50	390.7	134	167	181	46.0	277.7	89.5	54.5	48.9	56.3	601.5	1525.0	853.7	638.3	320.6	250.2	143.8	88.4	241.6
1983	3840.0	57.00	466.3	126	158	181	58.1	440.3	79.3	77.0	61.9	71.7	709.0	1836.7	724.4	798.4	608.3	319.4	188.5	111.1	288.4
1984	1680.0	58.50	374.2	123	169	178	59.5	245.1	69.8	61.8	68.0	108.9	885.2	1222.2	820.9	450.1	325.6	222.5	139.5	105.9	232.0
1985	3740.0	53.50	482.2	135	161	182	53.8	460.9	88.9	74.5	56.3	58.5	687.9	1916.7	1167.3	645.1	536.1	339.9	122.8	75.6	298.2
1986	3030.0	64.00	516.4	132	163	181	64.0	376.1	70.9	67.2	66.7	66.4	745.4	2122.3	1032.5	906.9	631.1	271.4	110.5	90.3	319.3
1987	3300.0	40.80	461.0	130	156	183	41.1	419.1	83.3	74.5	52.0	56.8	747.2	1714.7	813.4	531.0	647.7	545.7	140.5	111.1	285.1
1988	2370.0	65.50	548.1	124	139	185	65.7	519.3	80.3	71.2	68.3	116.3	1357.6	1512.7	1036.6	856.0	665.4	436.2	215.7	139.8	339.8
1989	1950.0	65.90	364.7	120	162	163	66.0	224.0	99.9	76.9	67.0	101.5	1212.9	1334.9	571.0	304.1	233.6	160.4	114.9	82.4	225.5
1990	2670.0	53.50	495.8	124	156	186	53.6	382.3	65.7	56.9	54.4	100.0	971.7	1577.7	660.4	578.0	1047.2	594.1	134.8	94.7	306.6
1991	1830.0	63.80	527.5	121	142	180	64.1	414.4	86.4	80.3	71.1	80.9	1376.5	1539.7	1070.5	788.1	597.4	388.6	123.5	90.8	326.2
1992	3870.0	83.20	645.5	146	174	182	83.4	474.3	87.3	84.3	89.5	118.9	578.9	2992.0	1558.4	878.0	765.8	336.3	161.5	105.9	400.2
1993	3600.0	60.80	554.9	120	154	165	60.8	396.0	81.5	66.8	62.6	147.7	1573.2	2182.0	878.6	469.3	470.2	331.4	216.9	156.5	343.1
1994	2030.0	49.80	430.5	118	146	170	50.0	242.1	93.3	56.8	51.0	152.3	1234.5	1560.3	840.6	393.2	275.3	298.2	100.9	85.3	266.2
1995	1620.0	63.00	399.4	119	137	187	63.1	461.3	71.4	65.4	63.4	128.0	1040.9	919.2	532.9	554.2	764.6	370.8	174.1	88.4	247.0
1996	1840.0	52.50	416.4	142	152	198	52.7	537.6	63.0	54.4	54.2	77.7	603.0	1302.5	793.0	705.2	753.3	290.1	190.1	108.3	258.2
1997	2270.0	47.50	492.1	120	162	179	47.6	516.6	74.0	57.2	48.9	80.1	1281.3	1501.9	801.1	829.6	560.6	310.5	205.6	124.4	304.3
1998	2240.0	68.00	359.0	124	152	169	68.1	318.0	89.7	76.2	69.4	106.9	946.5	1249.0	502.0	373.6	344.3	267.3	163.3	106.3	222.0
1999	1760.0	47.10	403.2	128	168	189	47.2	465.1	62.5	51.9	48.5	55.0	733.4	1312.9	619.5	578.9	667.2	418.8	160.9	113.3	249.3
2000	2710.0	76.40	624.0	128	169	197	76.4	836.0	88.3	80.4	77.1	80.4	800.8	1990.0	1227.6	1200.1	898.6	593.7	262.8	176.3	386.9
2001	3830.0	72.30	587.5	136	171	178	72.5	501.4	121.5	93.1	75.4	84.5	678.0	2665.0	1275.7	737.9	695.4	326.8	166.6	123.4	363.3
2002	2310.0	60.00	--	120	240	211	60.0	486.6	90.4	74.0	64.3	60.9	--	--	706.1	1245.2	910.2	361.6	187.9	174.5	NA
2003	2280.0	75.00	421.8	131	164	186	75.0	367.1	113.5	88.9	76.8	98.1	646.7	1368.8	793.1	490.4	655.1	390.8	182.4	145.1	260.8
2004	2870.0	73.80	371.4	128	151	164	74.0	199.4	108.3	84.5	76.2	77.3	1012.1	1637.6	464.4	335.3	212.9	176.8	147.4	123.9	230.3
2005	3160.0	61.40	609.5	122	141	170	61.5	598.6	96.4	77.1	63.0	99.5	2022.3	1673.3	850.6	716.2	704.2	561.0	229.1	178.4	376.9
2006	2400.0	51.00	473.6	132	172	182	51.2	510.0	127.2	91.3	65.6	53.5	893.7	1615.3	856.7	576.6	674.0	452.0	151.6	107.4	292.8
2007	2940.0	56.50	492.9	120	161	186	57.0	425.9	78.2	64.2	58.1	92.1	1034.1	1457.6	1144.9	668.4	691.9	335.7	155.1	106.9	304.8
2008	1830.0	60.70	519.1	127	242	217	60.7	672.3	78.3	63.5	61.9	102.7	929.1	863.9	899.5	1053.3	1024.2	773.5	220.7	133.1	321.8
2009	2370.0	75.80	499.5	123	161	173	75.9	350.3	102.6	88.2	80.1	80.0	1296.9	1758.0	608.0	521.1	754.5	415.0	159.0	115.3	308.9
2010	1640.0	72.70	374.7	114	162	177	72.7	255.4	96.4	85.2	74.8	186.1	823.3	1141.1	831.4	492.1	356.2	198.7	100.3	92.4	231.7
2011	2790.0	61.00	596.9	130	147	194	61.0	654.6	87.5	78.0	68.0	70.2	1163.0	1519.7	1470.6	1068.9	785.3	468.3	187.8	151.0	369.1
2012	2880.0	84.80	538.4	116	165	179	85.0	547.9	125.3	106.9	92.8	240.5	978.6	1869.3	1154.0	654.1	599.5	351.8	165.4	118.4	333.8
2013	3480.0	71.70	532.7	137	153	187	71.7	466.0	98.5	84.8	74.8	72.2	934.3	1769.0	781.6	613.6	950.1	607.0	263.5	129.7	329.4
2014	1390.0	71.40	467.7	122	133	196	71.5	556.7	111.0	91.4	76.2	109.9	1022.8	982.5	724.3	802.8	722.9	598.9	183.7	154.2	289.2

**All values in m^3/s, except Start Freshet, Max Q Date and Date CM - in Julian Days, and Annual Runoff - in mm.*

[1] Date of centre of hydrograph mass (Stewart et al., 2001)

09DD004 - McQuesten River near the Mouth

YEAR	MAX	MIN	AVG	START FRESHET	MAX Q DATE	DATE CM[1]	ANN 7QMIN	JUN-SEP 7QMIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL RUNOFF*
1979	229.0	5.64	50.3	122	146	189	--	43.5	7.6	5.8	6.8	8.1	143.0	110.5	109.4	56.6	52.9	50.7	33.2	14.5	333.9
1980	183.0	6.88	38.7	123	139	179	7.4	37.4	8.9	8.5	8.7	12.4	109.8	89.2	45.5	50.0	46.3	42.7	27.5	13.4	257.5
1981	152.0	4.98	33.6	131	139	191	5.1	35.8	10.4	5.9	5.4	6.3	75.9	71.4	56.5	42.9	58.8	38.7	18.2	10.3	222.8
1982	237.0	5.19	32.6	131	150	164	5.3	21.0	6.7	6.1	5.6	5.7	93.0	130.0	53.1	28.2	22.3	18.2	11.8	9.2	216.4
1983	269.0	5.60	34.4	121	152	173	5.7	22.6	7.8	7.4	6.0	7.7	99.5	97.8	43.5	57.1	42.8	18.7	13.9	9.4	228.7
1984	192.0	5.75	31.3	120	141	165	5.8	21.9	7.3	6.7	7.7	12.0	109.4	94.6	48.1	25.5	26.2	17.7	10.2	8.9	208.3
1985	290.0	5.94	37.9	135	159	167	6.0	27.6	7.7	6.5	6.2	6.3	95.2	163.8	49.2	38.4	34.2	24.7	13.3	7.8	251.3
1986	314.0	6.60	35.9	132	149	161	6.6	22.1	7.6	7.2	6.8	6.8	105.3	153.9	40.4	37.3	29.8	16.7	10.0	7.6	238.1
1987	315.0	7.18	39.7	125	152	167	7.2	21.6	7.5	7.3	7.2	7.8	118.1	130.7	41.9	24.2	54.9	41.8	18.1	15.2	263.5
1988	--	8.07	--	175	176	219	8.1	35.2	10.8	8.5	8.3	19.7	--	--	--	--	--	29.6	14.4	10.2	NA
1989	205.0	6.18	29.5	115	130	152	6.3	17.1	8.2	7.3	6.6	17.8	132.3	74.8	32.0	21.8	18.2	14.2	11.0	8.2	196.1
1990	162.0	5.20	30.6	119	139	169	5.2	18.8	6.2	5.5	5.9	11.4	115.5	62.5	24.4	28.4	45.0	33.8	16.6	10.0	203.1
1991	420.0	5.50	38.7	117	125	160	6.5	31.2	7.8	6.8	6.9	17.0	165.0	76.3	51.7	55.4	36.0	19.6	8.3	9.7	256.8
1992	404.0	6.30	45.5	143	150	167	5.7	24.7	8.0	7.4	7.1	18.1	110.1	213.8	66.4	36.7	34.9	17.7	15.7	11.3	303.2
1993	334.0	6.90	37.9	119	138	156	6.9	23.5	8.6	7.3	7.1	13.9	164.6	99.9	49.8	29.0	30.2	18.1	12.7	10.8	251.6
1994	270.0	7.00	33.5	122	145	159	7.0	20.0	8.5	7.3	7.0	9.3	143.6	78.6	47.0	24.9	27.3	21.5	14.1	9.9	222.3
1995	190.0	4.75	31.2	112	135	169	4.8	28.5	7.0	5.3	5.1	23.7	104.5	64.5	36.3	36.2	44.1	28.3	11.3	6.3	207.3
1996	221.0	5.49	34.3	127	149	191	5.5	29.8	5.8	5.5	5.7	8.8	79.7	91.8	49.5	42.0	64.6	27.3	18.7	11.7	228.2
1997	334.0	4.65	46.5	121	136	170	4.7	43.1	7.7	5.8	4.8	9.6	161.8	128.7	75.3	58.5	48.3	24.0	19.3	10.8	308.6
1998	175.0	5.81	23.6	117	147	156	6.0	16.3	8.0	6.6	6.1	12.6	91.4	62.6	25.8	17.2	19.9	13.0	11.2	7.8	156.8
1999	226.0	4.17	32.6	125	156	165	4.2	23.3	5.1	4.4	4.2	7.9	99.5	115.4	34.1	26.3	39.8	28.3	14.1	10.6	216.2
2000	273.0	6.17	55.5	125	162	178	6.2	50.5	7.7	6.6	6.2	8.8	121.5	205.6	104.3	72.0	65.0	37.0	16.6	13.7	369.4
2001	268.0	9.48	48.9	133	160	174	9.5	44.5	11.8	10.7	9.7	10.3	91.7	185.6	82.8	53.9	59.4	33.0	22.5	14.4	324.7
2002	162.0	6.00	35.4	126	141	189	6.0	32.3	9.7	7.4	6.3	7.1	99.3	73.3	39.3	66.4	55.6	27.3	18.3	13.1	235.3
2003	224.0	8.15	36.7	122	146	176	8.2	33.1	10.0	8.8	8.3	13.8	97.6	90.4	49.3	38.0	57.1	34.6	16.8	13.6	243.3
2004	277.0	8.47	33.1	124	140	156	8.5	20.5	11.6	10.1	9.0	9.3	136.8	87.6	32.0	31.9	22.8	21.3	13.3	9.8	220.2
2005	335.0	5.76	51.9	118	137	161	5.8	43.4	7.7	6.4	5.8	14.1	224.2	108.2	56.0	58.1	57.5	49.2	18.5	12.5	344.7
2006	223.0	8.89	43.9	128	142	173	8.9	32.6	9.9	9.2	9.0	10.3	122.9	129.1	60.0	36.4	62.2	46.3	17.6	12.3	291.6
2007	265.0	6.92	42.9	121	148	168	6.9	37.9	11.1	9.5	7.4	9.3	147.1	99.0	83.3	45.0	48.6	27.2	13.0	10.9	284.7
2008	160.0	6.16	41.8	120	142	218	6.2	30.6	8.5	6.8	6.3	15.4	110.7	42.0	51.1	83.3	62.4	63.0	33.0	16.4	278.3
2009	257.0	7.90	39.4	121	127	162	7.9	22.1	8.9	8.1	8.3	10.7	153.9	94.1	34.3	26.4	57.6	35.6	19.7	12.7	261.4
2010	162.0	8.83	33.7	114	141	171	8.8	24.9	9.7	8.9	8.9	23.3	97.8	78.1	61.3	39.1	31.4	18.0	14.8	10.9	223.6
2011	--	6.73	67.5	135	358	242	6.7	45.8	7.7	7.0	6.9	6.9	131.3	72.2	87.3	86.5	72.0	38.8	15.0	269.6	448.4
2012	191.0	9.37	41.8	120	147	170	9.4	35.4	13.6	11.9	10.3	13.5	112.6	123.9	77.4	45.4	39.7	22.6	16.4	12.9	278.1
2013	413.0	8.97	38.0	133	150	161	9.0	21.5	10.6	9.3	9.1	9.0	118.7	123.4	40.2	25.7	44.7	29.2	20.3	13.9	252.0
2014	195.0	6.48	35.9	121	128	196	6.5	32.2	11.2	8.9	7.1	7.9	95.9	62.1	40.0	63.3	51.8	45.0	18.8	16.5	238.6

**All values in m^3/s, except Start Freshet, Max Q Date and Date CM - in Julian Days, and Annual Runoff - in mm.*

[1] Date of centre of hydrograph mass (Stewart et al., 2001)

09EA004 - North Klondike River near the Mouth

YEAR	MAX	MIN	AVG	START FRESHET	MAX Q DATE	DATE CM[1]	ANN 7QMIN	JUN-SEP 7QMIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL RUNOFF*
1974	--	2.15	--	--	--	90	--	7.4	--	--	--	--	--	--	9.9	11.6	9.1	4.8	3.3	2.6	NA
1975	85.8	1.78	15.0	123	155	177	1.8	14.6	2.0	2.2	2.1	2.0	28.9	59.7	26.7	18.6	17.8	11.2	5.3	3.1	434.0
1976	80.1	1.64	10.5	120	171	174	1.7	7.5	2.7	2.2	1.8	2.3	18.5	47.1	18.1	13.6	8.5	5.8	3.2	1.9	303.6
1977	77.9	1.84	12.2	123	154	170	1.8	8.1	2.3	2.7	2.1	2.7	22.2	59.3	20.1	11.9	9.3	7.7	4.0	2.6	353.9
1978	52.7	1.87	9.8	137	168	181	1.9	8.6	2.5	2.2	2.0	2.6	12.4	38.6	19.4	10.4	11.2	8.7	4.5	3.2	284.7
1979	83.6	1.70	15.5	121	189	186	1.7	13.2	2.4	1.8	1.9	2.3	27.9	51.4	43.4	19.1	14.8	11.0	5.5	3.4	447.9
1980	96.7	1.68	13.3	130	159	183	1.9	12.6	2.6	2.2	2.1	2.1	24.5	46.4	22.8	24.0	15.5	10.6	4.7	2.0	386.3
1981	87.2	1.73	15.1	132	148	202	1.7	17.6	2.4	2.3	2.9	2.8	28.2	29.1	32.2	26.5	23.8	15.7	8.4	5.4	436.3
1982	137.0	2.17	12.5	134	159	172	2.2	8.8	2.7	2.4	2.3	2.6	16.2	63.6	22.6	12.0	11.4	6.6	4.2	3.0	360.2
1983	140.0	2.08	10.8	144	152	182	2.1	10.1	2.5	2.3	2.2	2.3	14.1	41.7	17.9	15.1	12.1	8.6	6.5	4.1	312.1
1984	68.4	1.76	10.4	136	165	177	1.8	7.7	2.9	1.9	1.9	2.4	16.6	42.3	21.6	13.4	9.2	6.0	3.4	2.7	300.3
1985	131.0	1.80	14.3	134	156	176	1.8	13.2	2.2	2.0	2.2	2.2	22.4	63.8	28.9	18.3	14.3	8.5	3.6	2.6	413.1
1986	113.0	2.13	11.8	133	159	186	2.1	8.2	2.6	2.5	2.3	2.2	11.4	46.4	23.5	23.6	12.2	6.7	4.6	3.3	341.1
1987	90.7	2.10	11.5	139	151	180	2.1	10.8	2.7	2.4	2.1	2.2	17.8	44.2	17.2	13.8	12.5	12.2	6.8	4.5	334.2
1988	94.0	2.06	17.2	122	134	173	2.1	10.0	3.1	2.3	2.1	4.4	46.8	58.1	27.5	20.8	20.3	10.6	6.1	4.0	499.1
1989	45.2	1.88	9.0	117	176	172	1.9	7.5	2.9	2.3	1.9	4.4	24.8	25.5	13.1	9.8	8.3	6.5	4.5	3.5	260.2
1990	118.0	2.18	15.6	133	152	180	2.2	14.1	2.9	2.5	2.2	4.1	32.2	51.5	18.8	26.6	25.9	11.7	4.6	3.2	450.1
1991	60.8	1.45	12.6	119	217	193	2.6	13.7	2.8	2.6	2.6	4.0	26.1	29.4	19.1	30.0	19.2	9.9	2.1	2.2	363.4
1992	176.0	1.48	17.4	143	165	178	1.5	9.4	1.7	1.7	2.3	3.9	21.0	82.3	35.1	27.5	18.4	7.1	4.7	3.4	504.8
1993	118.0	2.22	14.9	118	148	167	2.2	12.4	2.6	2.5	2.3	4.7	40.7	52.8	21.8	14.0	15.3	11.1	6.6	3.8	431.0
1994	65.3	2.17	13.0	117	164	184	2.2	14.2	2.7	2.3	2.2	4.7	21.5	42.3	26.2	15.8	18.2	9.7	6.1	3.4	375.2
1995	103.0	1.70	15.0	109	162	172	1.7	12.6	2.1	1.7	1.8	10.0	37.2	47.5	21.9	16.6	20.5	13.2	4.2	2.9	434.7
1996	36.3	2.48	8.0	140	149	184	2.6	9.7	2.7	2.7	2.7	3.3	12.1	24.4	12.6	11.1	12.5	5.6	4.0	3.1	233.5
1997	126.0	1.47	12.6	122	161	173	1.5	11.0	2.6	2.2	1.8	2.6	28.0	46.0	17.9	20.4	15.5	5.4	4.7	3.5	363.6
1998	--	1.86	--	111	112	188	2.4	11.1	2.9	2.6	2.5	--	--	--	--	--	--	6.9	3.7	2.5	NA
1999	84.8	1.51	10.9	128	162	176	1.5	11.6	1.7	1.5	1.6	2.5	16.0	46.8	14.3	15.9	13.2	8.8	5.1	3.7	316.4
2000	122.0	2.01	18.6	126	163	179	2.0	9.8	2.9	2.4	2.0	2.6	23.0	87.8	46.5	25.1	12.5	9.5	5.6	3.4	539.5
2001	115.0	2.45	13.8	136	166	180	2.5	10.8	2.9	2.7	2.5	2.6	10.7	64.2	32.4	18.6	14.3	7.1	4.3	3.4	399.7
2002	65.5	2.52	13.8	129	162	196	2.5	15.6	2.9	2.8	2.7	2.7	22.8	38.9	19.8	27.0	21.9	11.5	7.1	5.1	399.7
2003	88.6	2.06	14.0	143	159	191	2.1	14.8	3.6	2.7	2.2	3.7	15.7	47.7	26.4	17.3	24.7	12.9	6.9	4.4	405.7
2004	111.0	2.54	10.8	122	147	162	2.6	5.8	3.7	3.3	2.9	2.6	34.7	38.2	12.3	10.6	7.0	5.5	4.7	3.4	311.9
2005	80.7	2.06	14.3	116	136	164	2.1	11.6	3.5	2.9	2.4	5.3	49.3	39.6	17.6	14.4	15.2	12.4	5.0	3.3	414.0
2006	84.9	1.84	12.2	129	167	179	1.8	11.7	3.0	2.8	2.1	2.2	21.3	46.3	18.8	13.4	15.3	11.7	5.7	4.0	353.9
2007	86.8	2.23	10.0	122	157	167	2.2	10.5	3.3	2.9	2.4	3.5	23.6	31.8	13.6	12.0	12.8	7.8	3.2	2.4	288.5
2008	78.8	2.17	13.0	128	190	209	2.2	13.7	2.3	2.5	2.4	3.9	16.9	17.4	37.6	27.7	17.0	14.5	8.2	4.5	376.3
2009	52.0	1.97	11.1	118	157	185	2.0	6.6	2.8	2.5	2.1	3.5	25.9	28.2	10.6	12.6	25.5	10.8	4.9	4.0	321.9
2010	52.4	2.55	11.4	135	150	184	2.6	8.8	2.9	2.6	2.6	4.2	22.5	31.2	24.7	18.6	13.3	5.8	4.1	3.4	328.5
2011	93.4	2.51	12.9	137	143	187	2.5	12.0	2.7	2.6	2.6	2.5	31.1	30.4	28.4	20.0	16.9	7.8	4.7	3.9	372.4
2012	97.4	2.17	12.0	139	160	179	2.2	10.8	2.9	2.4	2.2	4.5	18.7	44.9	22.4	15.8	12.2	8.9	5.6	3.6	348.0
2013	148.0	1.77	13.1	136	153	174	1.8	11.1	2.7	2.3	2.0	1.8	26.1	51.8	15.7	13.5	19.7	11.3	6.0	4.4	380.3
2014	65.6	1.83	12.2	122	177	205	1.9	12.4	3.3	2.6	2.2	3.4	15.4	28.4	24.7	28.7	17.5	9.4	6.2	3.7	352.6

**All values in m^3/s, except Start Freshet, Max Q Date and Date CM - in Julian Days, and Annual Runoff - in mm.*

[1] Date of centre of hydrograph mass (Stewart et al., 2001)

09EB003 - Indian River above the Mouth

YEAR	MAX	MIN	AVG	START FRESHET	MAX Q DATE	DATE CM[1]	ANN 7QMIN	JUN-SEP 7QMIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL RUNOFF*
1982	79.9	0.01	4.8	134	141	160	0.0	2.3	0.0	0.0	0.0	0.0	22.9	21.8	4.5	3.2	2.7	1.6	0.5	0.1	68.7
1983	71.1	0.01	5.4	116	119	150	0.0	3.5	0.0	0.0	0.0	7.3	25.7	9.4	5.9	7.9	5.7	1.9	0.5	0.1	77.3
1984	--	0.00	--	127	128	143	0.0	2.3	0.0	0.0	0.0	1.7	--	--	8.3	4.0	6.1	1.7	0.4	0.0	NA
1985	102.0	0.00	8.6	135	142	167	0.0	5.9	0.0	0.0	0.0	0.0	33.5	26.3	11.8	15.3	9.7	5.6	0.4	0.0	123.0
1986	53.9	0.00	3.2	135	148	160	0.0	1.8	0.0	0.0	0.0	0.0	13.6	11.7	4.6	4.5	3.0	0.4	0.0	0.0	45.4
1987	51.2	0.00	6.0	127	142	164	0.0	2.8	0.0	0.0	0.0	0.0	27.6	12.9	9.8	7.5	5.7	5.3	1.3	0.7	85.1
1988	106.0	0.02	7.5	114	136	150	0.0	4.3	0.1	0.0	0.0	6.0	40.7	11.2	9.1	8.5	9.1	3.6	0.4	0.1	106.8
1989	46.9	0.00	3.9	107	130	138	0.0	1.2	0.0	0.0	0.0	6.2	21.9	8.8	2.4	2.7	2.5	1.8	0.3	0.1	55.8
1990	72.0	0.00	6.0	111	124	139	0.0	1.5	0.1	0.0	0.0	10.3	30.2	8.9	3.4	6.9	9.6	1.5	0.2	0.0	85.1
1991	130.0	0.00	7.9	119	217	217	0.0	3.2	0.0	0.0	0.0	0.8	27.6	9.2	6.9	24.7	16.5	6.3	2.0	0.6	113.4
1992	123.0	0.37	9.2	123	148	153	0.3	4.7	0.6	0.5	0.7	1.5	49.2	23.7	11.7	9.0	7.9	3.1	0.9	0.5	131.1
1993	58.0	0.27	7.0	109	135	149	0.3	2.6	0.3	0.3	0.3	6.8	35.4	11.9	5.5	4.2	8.8	5.7	3.2	1.2	100.2
1994	--	0.05	--	120	121	136	0.0	2.2	0.4	0.1	0.1	2.5	--	10.8	13.7	3.0	4.3	2.8	0.5	0.2	NA
1995	78.4	0.02	5.7	114	135	160	0.0	3.9	0.1	0.0	0.1	5.4	24.2	8.5	8.4	7.7	7.0	4.9	1.0	0.2	80.9
1996	59.8	0.00	3.7	115	164	165	0.0	2.0	0.0	0.0	0.0	3.2	12.6	12.8	7.5	2.4	3.4	1.6	0.6	0.1	52.8
1997	58.0	0.01	5.1	122	165	166	0.0	2.6	0.0	0.0	0.0	0.0	18.1	17.9	5.1	10.0	4.9	2.1	1.7	0.7	72.4
1998	40.2	0.01	3.4	106	129	143	0.0	1.2	0.2	0.1	0.1	4.2	17.9	11.0	2.4	1.5	1.9	0.8	0.3	0.0	48.4
1999	39.7	0.00	3.6	130	142	170	0.0	1.8	0.0	0.0	0.0	0.0	14.2	10.9	3.5	5.6	5.8	2.6	0.3	0.1	51.4
2000	89.1	0.01	9.5	119	130	174	0.0	7.5	0.0	0.0	0.0	1.8	42.0	16.8	18.1	10.5	14.0	5.4	2.4	1.6	135.2
2001	110.0	0.14	8.1	131	138	164	0.5	3.9	1.2	0.9	0.7	0.6	32.5	18.1	12.0	13.0	11.9	4.4	1.0	0.3	115.8
2002	89.4	0.02	7.7	124	163	175	0.0	3.7	0.1	0.0	0.0	0.1	25.3	21.8	7.7	17.1	11.2	5.0	2.6	1.1	110.3
2003	54.4	0.29	5.4	112	146	166	0.3	2.7	0.7	0.4	0.3	3.3	22.7	7.0	10.0	4.0	5.9	6.3	2.9	1.1	77.3
2004	83.7	0.26	5.8	121	129	150	0.4	2.3	0.6	0.4	0.4	0.8	33.6	6.7	4.8	8.2	4.7	7.2	1.3	0.4	83.2
2005	146.0	0.06	10.6	114	119	184	0.1	5.2	0.2	0.1	0.1	13.9	33.3	15.3	13.3	16.7	20.0	9.5	2.9	1.2	151.4
2006	124.0	0.00	7.0	129	136	152	0.0	5.0	0.5	0.1	0.0	0.0	40.3	12.5	8.1	7.7	9.3	4.2	0.3	0.0	99.7
2007	64.2	0.00	6.2	113	125	148	0.0	3.0	0.0	0.0	0.0	7.9	30.9	6.6	6.1	4.7	12.6	3.6	1.2	0.4	88.4
2008	56.1	0.03	6.4	120	190	204	0.0	3.4	0.2	0.1	0.0	1.1	20.2	4.4	17.8	13.1	9.9	5.9	3.0	0.5	91.4
2009	190.0	0.01	6.6	115	124	131	0.0	1.1	0.1	0.0	0.0	4.0	44.5	9.9	2.5	2.4	9.3	3.1	1.6	0.6	93.7
2010	46.0	0.03	5.0	114	120	204	0.0	4.4	0.1	0.0	0.0	5.1	11.5	7.4	9.5	11.2	10.2	2.8	1.5	0.5	71.7
2011	65.7	0.04	9.4	114	140	178	0.0	7.2	0.2	0.1	0.1	5.2	37.4	19.3	16.1	15.8	10.8	4.1	1.9	0.9	134.3
2012	75.5	0.29	8.0	107	114	143	0.3	5.1	0.4	0.3	0.4	23.5	29.6	11.9	9.2	5.9	6.2	5.2	2.8	0.7	114.7
2013	--	0.28	--	225	226	244	0.3	3.9	0.3	0.3	0.3	0.7	68.1	16.6	8.3	--	--	8.2	1.8	0.8	NA
2014	71.6	0.17	7.5	110	123	173	0.2	4.8	0.6	0.4	0.2	13.6	26.1	8.6	8.2	9.6	8.8	9.4	2.6	1.1	107.1

**All values in m^3/s, except Start Freshet, Max Q Date and Date CM - in Julian Days, and Annual Runoff - in mm.*

[1] Date of centre of hydrograph mass (Stewart et al., 2001)

09EB004 - Sixty Mile River near the Mouth

YEAR	MAX	MIN	AVG	START FRESHET	MAX Q DATE	DATE CM[1]	ANN 7QMIN	JUN-SEP 7QMIN	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL RUNOFF*
1996	97.5	0.03	5.2	111	162	163	0.0	2.4	0.0	0.0	0.0	4.8	17.6	20.0	10.4	3.7	3.5	1.2	0.4	0.0	53.3
1997	386.0	0.03	19.0	125	161	166	0.0	4.9	0.0	0.0	0.0	0.2	50.0	85.0	29.6	34.3	17.0	6.1	3.3	1.8	196.1
1998	125.0	0.75	11.3	117	143	155	0.8	4.5	1.1	0.8	0.9	5.2	56.4	27.8	6.3	7.6	14.1	5.6	5.9	2.8	116.3
1999	106.0	0.00	12.0	129	146	205	0.0	6.0	0.5	0.0	0.0	0.0	38.0	25.0	12.5	20.8	25.5	10.7	7.0	2.6	123.3
2000	210.0	0.38	20.5	122	145	167	0.4	13.4	0.9	0.5	0.4	2.5	78.9	79.4	22.6	22.2	23.8	8.6	3.9	2.5	212.3
2001	262.0	1.08	23.4	126	206	189	1.1	9.8	1.8	1.3	1.1	1.9	74.4	53.0	62.8	31.7	34.6	9.2	4.6	2.4	241.2
2002	167.0	0.63	16.2	127	162	207	0.6	7.9	1.4	0.9	0.7	0.7	54.1	28.2	22.8	39.7	26.1	9.3	5.4	3.1	166.6
2003	83.5	1.20	8.8	113	145	158	1.2	3.1	1.9	1.4	1.2	5.0	37.2	21.3	11.4	3.9	9.2	6.7	4.1	2.2	91.1
2004	235.0	0.33	13.8	121	147	145	0.8	3.5	1.2	0.8	1.1	3.0	98.0	14.6	11.7	13.2	9.1	8.0	2.3	0.6	142.3
2005	200.0	0.06	15.3	112	119	146	0.1	8.4	0.3	0.1	0.1	34.5	63.2	18.5	18.2	12.2	21.7	9.7	3.1	1.5	158.1
2006	203.0	0.04	15.6	122	137	148	0.1	6.8	0.9	0.5	0.1	0.5	95.6	26.4	14.9	21.8	16.0	8.0	0.9	0.1	161.2
2007	95.3	0.00	11.6	114	159	160	0.0	5.4	0.0	0.0	0.0	8.2	51.0	18.7	16.2	12.8	22.9	5.6	2.3	1.1	120.0
2008	154.0	0.14	17.7	117	203	198	0.1	10.8	0.5	0.2	0.2	6.7	55.7	16.3	58.5	37.2	18.9	9.2	5.0	1.6	182.4
2009	185.0	0.16	13.2	113	124	153	0.2	3.8	0.5	0.3	0.2	10.0	65.6	29.3	5.9	7.8	27.8	6.2	2.4	1.6	135.9
2010	211.0	0.40	21.4	114	205	204	0.4	13.4	0.8	0.5	0.4	19.3	41.6	39.4	48.9	52.7	37.8	7.3	5.0	1.9	220.8
2011	149.0	0.28	19.4	118	140	183	0.3	13.6	0.7	0.4	0.3	5.2	55.9	51.1	49.0	36.7	21.2	7.2	2.6	1.2	200.4
2012	139.0	0.36	16.7	108	146	169	0.4	10.7	0.8	0.6	0.4	21.1	57.7	30.8	39.7	16.6	13.8	12.0	4.1	2.1	172.8
2013	329.0	0.40	17.7	129	147	150	0.4	4.6	0.8	0.4	0.4	0.4	111.7	49.6	14.1	8.8	16.9	8.3	1.9	0.9	185.5

**All values in m^3/s, except Start Freshet, Max Q Date and Date CM - in Julian Days, and Annual Runoff - in mm.*

[1] *Date of centre of hydrograph mass (Stewart et al., 2001)*

APPENDIX E2: SUMMARY PLOTS FOR YUKON AND STEWART RIVERS

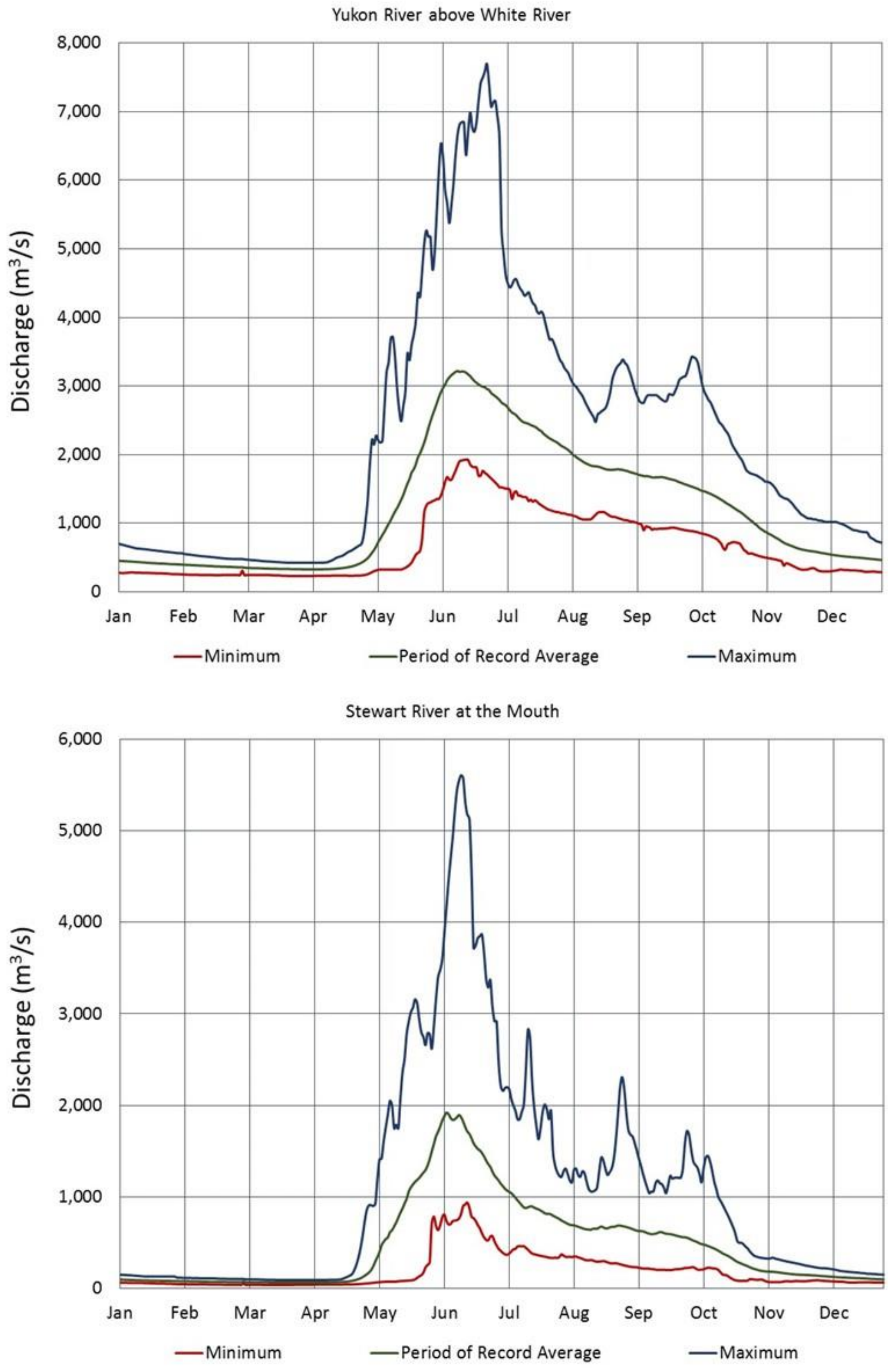

Figure E.2-1: Period of record discharge data for Yukon River above White River (1956-present) and Stewart River at the Mouth (1951-2016). Period of record discharges are reported at daily time step for the following statistics: Mimimum discharge; Average discharge; and Maximum discharge.

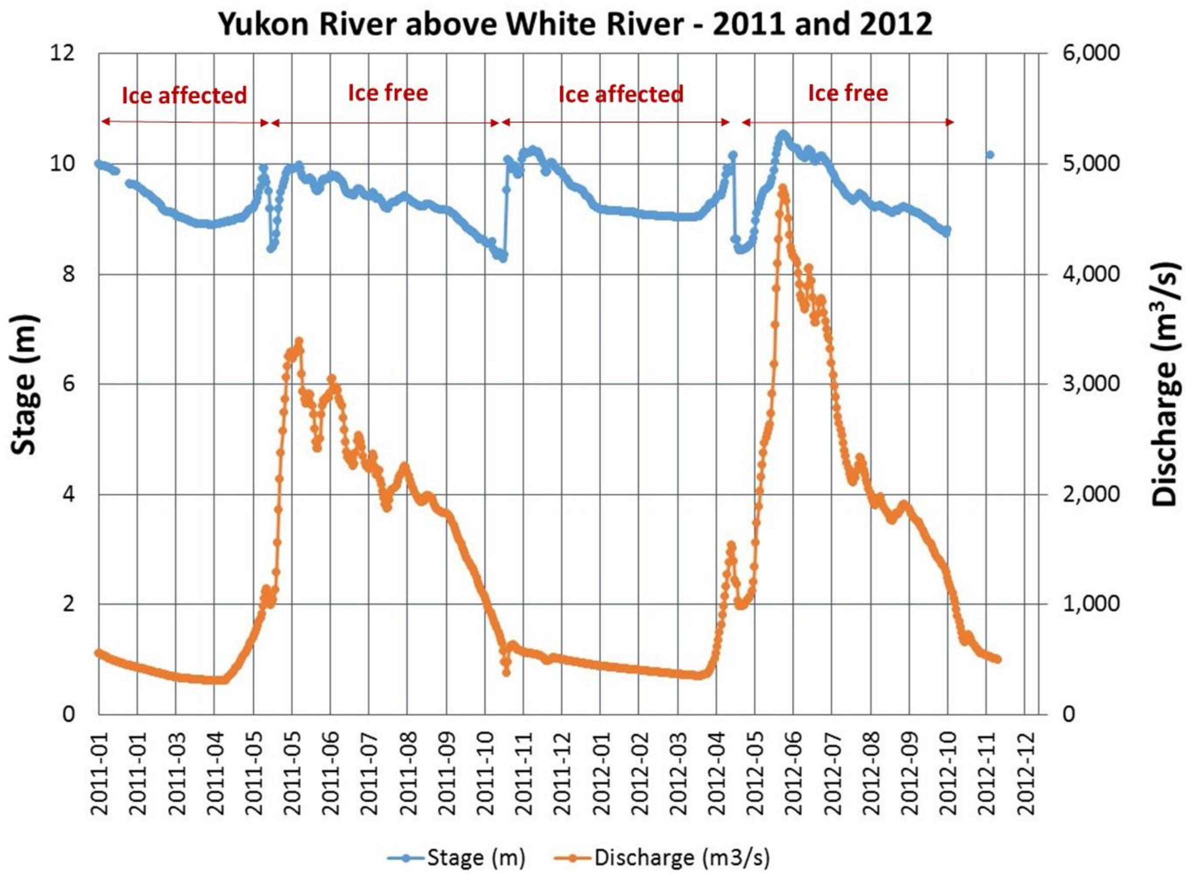

Figure E2.2: Stage- and corresponding discharge measurements for the Yukon River above White River. Two years of stage data (2011 and 2012) have been published for this hydrometric station.

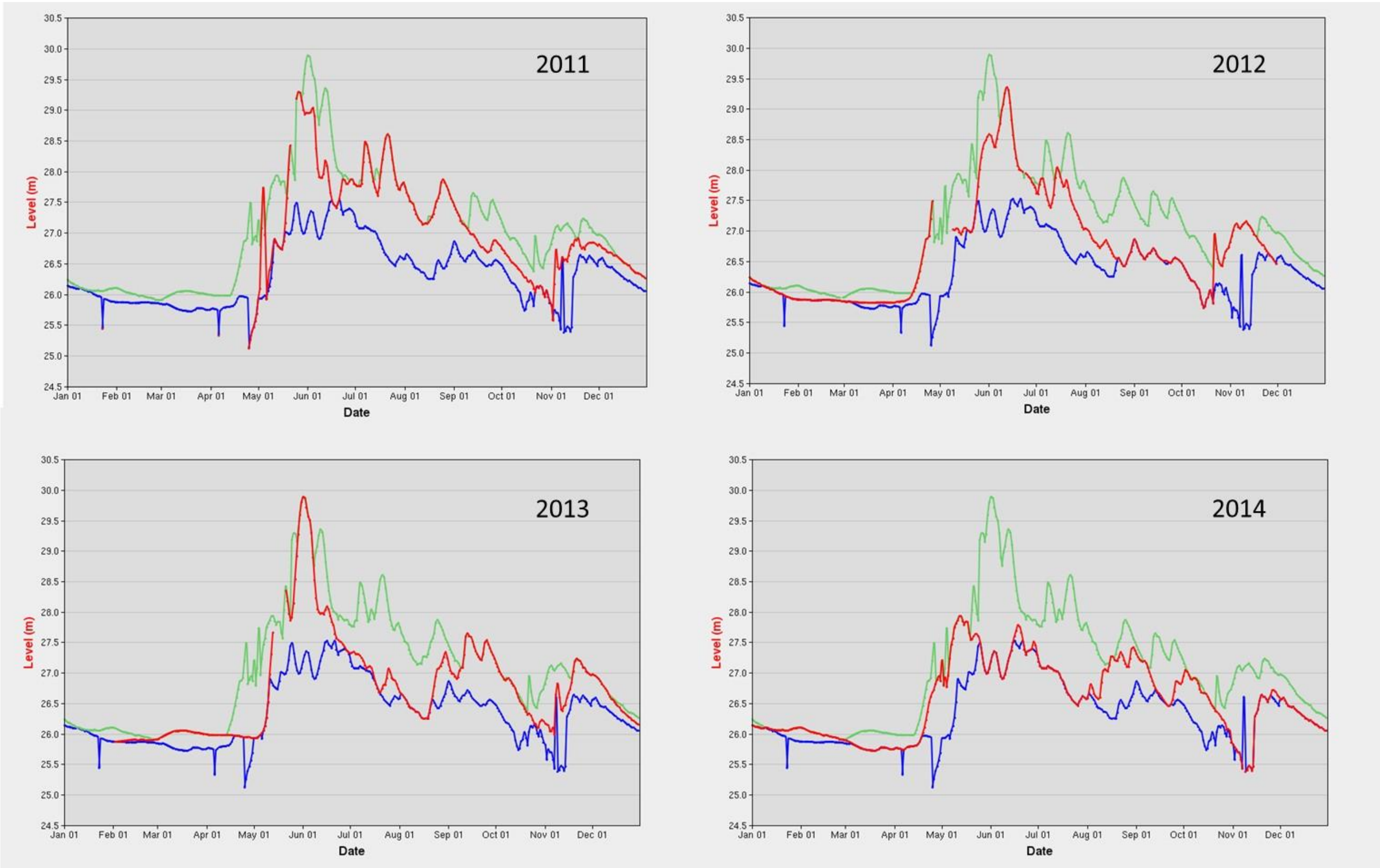

Figure E2.3: Annual stage record for the Stewart River at the Mouth. Four years of stage data (2011 through 2014) have been published for this hydrometric station. In each plot, the green line indicates period of record maximum stage, the blue line indicates period of record minimum stage, whereas the red line indicates measured stage for a given year.