2020 Elk Valley Regional Water Quality Model Update – Annex B

Hydrology Modelling – Set-up, Calibration and Future Projections Report

Rev1

May 2022

Teck

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Executive Summary

This report, Annex B of the 2020 Regional Water Quality Model Update, describes the set-up and calibration of the Flow Component (FC) of the 2020 Regional Water Quality Model (RWQM). It includes a description of the methods used to generate future flows and the resulting future flow estimates. The RWQM was initially developed in 2014 to support the development of the Elk Valley Water Quality Plan. It was subsequently updated in 2017 pursuant to Section 9.9 of *Environmental Management Act* (EMA) permit 107517 and used to develop the 2019 Implementation Plan Adjustment (2019 IPA). Section 9.9 of EMA Permit 107517 identifies the need to update the RWQM every three years; hence, the 2020 RWQM Update has been undertaken to continue to meet this permit condition.

Updates to the FC carried out as part of the 2020 RWQM Update include, but are not limited to:

- changing from an analogue-driven modelling approach to one based directly on climate (i.e., the 2020 RWQM uses climate data as the primary input, as opposed to the flow-based analogues used in the 2017 RWQM);
- developing and including a waste rock hydrology module to simulate water flow through waste rock spoils;
- developing and including a snowmelt runoff module to simulate water flow from undisturbed areas and to estimate infiltration rates into waste rock spoils;
- increasing the spatial scale and level of detail to better represent sub-catchments within each mine site and within the larger mine-affected tributaries;
- using the same mine site, water management and mine plan information as that used in site water balance models to improve consistency among the different planning tools used by Teck;
- accounting for groundwater – surface water partitioning at monitoring locations and locations where intakes or other water collection systems may be required for water quality management; and
- extending the historical period considered in the model to include data collected from 2017 to 2019.

Following completion of the updates, the FC was calibrated using a systematic approach, and model performance was evaluated at tributary mouths and locations in the Fording River, Line Creek and Michel Creek mainstems by comparing measured and modelled flows. The number of nodes included in the calibration was similar to that in the 2017 RWQM Update.

Performance of the FC was evaluated using a combination of standard goodness-of-fit statistics (e.g., Nash-Sutcliffe Efficiency) and graphical techniques (e.g., mean flow hydrographs). Overall, model performance has improved relative to that of the 2017 RWQM. Estimated water flows through mine-affected tributaries tend to more closely match measured flows, with reasonable replication of both winter low flows and freshet high flows at most tributary locations. Performance at some tributary locations continues to be rated as “poor” or “poor but improved”; however, such performance ratings do not impede overall model function and effectiveness. Mainstem performance continues to be strong, with some incremental improvements being achieved in areas where model performance was already good. The

model is fit for purpose and can be effectively used to support mitigation planning, project planning, and assessment.

The approach to estimating flows in the Elk River remains unchanged; it continues to be based on a scaling method, whereby monitored data are scaled based on watershed area to represent instream flow. This approach continues to be used in the Elk River, because the Elk River watershed is largely undisturbed by mining activity and mining activities are expected to have a negligible influence on the current flow regime and available flow data records are strong and considered to be representative of both historical and future flow conditions.

Estimates for future flows through mine-influenced tributaries and river mainstems are generated using historical climate records, with a focus on the 2000 to 2019 period. The chosen information is repeatedly fed into the model in an iterative, multi-realization fashion to generate a range of future flow estimates for each week of each future year. Three statistics from the resulting weekly dataset, the 10th percentile, median and 90th percentile, are pulled forward and provided to the Water Quality Component for the simulation of constituent concentrations under high (90th percentile), low (10th percentile) and median flow conditions.

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1 Introduction

The set-up and calibration of the Flow Component of the 2020 Regional Water Quality Model (RWQM) is described in this report. It also includes a description of the methods used to generate future flows and the resulting future flow estimates. The RWQM was initially developed in 2014 to support the development of the Elk Valley Water Quality Plan. It was subsequently updated in 2017 pursuant to Section 9.9 of *Environmental Management Act* (EMA) permit 107517 and used to develop the 2019 Implementation Plan Adjustment (2019 IPA). Section 9.9 of EMA Permit 107517 identifies the need to update the RWQM every three years; hence, the 2020 RWQM Update has been undertaken to continue to meet this permit condition.

The 2020 RWQM is a regional planning and assessment tool, which is used to estimate concentrations of selenium, nitrate, sulphate, cadmium and other water quality constituents at Compliance Points, Order Stations and other locations within the Fording River and Elk River watersheds. It has been calibrated to historical information and used to evaluate how water quality constituent concentrations may change in future as a result of mining in the Elk Valley and the implementation of water quality management and mitigation.

This report (Annex B) is one of five documents included in the March 2021 submission to the British Columbia (BC) Ministry of Environment and Climate Change Strategy and the BC Ministry of Energy, Mines and Low Carbon Innovation (EMLI). The other four documents consist of:

- The 2020 RWQM Update Report, which is the main report and includes a description of the 2020 RWQM Update, a discussion of model performance, future projections based on the management measures included in the 2019 IPA and a consolidated set of monitoring recommendations to support future model updates.
- Annex A: Geochemical Source Term Methods and Inputs for the 2020 Update of the Elk Valley Regional Water Quality Model, which details updates made to the geochemical source terms used to define constituent loading rates in the Elk Valley.
- Annex C: 2020 RWQM Update: Water Quality Modelling - Set-up and Calibration Report, which outlines updates made to the Water Quality Component of the 2020 RWQM and describes its performance in terms of replicating measured concentrations of Order constituents in the Elk River and Fording River mainstems, as well as to the mouths of selected tributaries.
- Annex D: 2020 RWQM Update: Water Quality - Model Projections Comparison Report, which describes the methods used to generate projections of future concentrations of selenium, nitrate, sulphate and cadmium at Compliance Points, Order Stations and other selected locations in the Elk Valley, along with the resulting projections based on permitted development and the mitigation measures included in the 2019 IPA.

2 Overview

The 2020 RWQM is a regional planning and assessment tool. Its purpose is to estimate how water quality conditions in the Elk Valley could change as a result of mining and water quality management activity.

At its core, the 2020 RWQM consists of four components:

- a hydrology component (known as the Flow Component; FC) that is used to estimate total water flow in tributary watersheds of the Fording River, and Elk River,
- geochemical source terms that describe the release of selenium, sulphate, nitrate and other constituents from waste rock, pit walls and other mine areas (e.g., tailings and coarse coal rejects).
- mine information, including historical mine site data and future-looking life of mine plans; and
- a water quality constituent transport component (known as the Water Quality Component; WQC) that is used to estimate constituent concentrations in mine-affected tributaries, the Elk River, Fording River, and the Koocanusa Reservoir.

The 2014 RWQM and the 2017 RWQM included these same four components, although the content of each component has been refined with each model update. The hydrologic setting and conceptual basis for the FC are outlined in Section 3 while the set-up and calibration of the FC is presented in Sections 4 and 5, respectively. The geochemical source terms and the WQC are described in Annexes A and C, respectively.

The FC is a sub-catchment-scale water balance model developed using a commercially available, general-purpose simulation software platform called GoldSim (GoldSim Technology Group 2014). A detailed description of the model set-up is provided in Section 4. Inputs to the FC include mine site information, meteorological data and hydrometric monitoring information from the Elk Valley. The FC-generated flow information is an input to the WQC to estimate constituent concentrations in mine affected tributaries, the Fording River and the Elk River

The FC is calibrated to historical conditions, as described in Section 5. This process involves simulating historical flows in the Elk Valley and comparing model output to monitoring results. The model is then adjusted as required, in an iterative fashion, to achieve a suitable fit to the measured data. Adjustments typically involve changes to the calibration factors and modifications to assumptions in model inputs. During the calibration process, data gaps and areas for potential future refinement are identified. These considerations form the basis for future monitoring recommendations and key uncertainties, which are summarized in the 2020 RWQM Update Report.

Once calibrated, the FC can be used to project future flows in the Elk Valley and used as an input to the WQC to support the generation of future water quality projections. The process to generate future flow projections is described in Section 4, with resulting projections discussed in Section 5, while the approach to generate future water quality projections and associated results are outlined in Annex D.

The 2020 RWQM Update included several focus areas of improvement for the FC. These included:

- increased spatial discretization, which results in an improved ability to represent water management activities and to evaluate the potential effects of smaller scale (within catchment) changes at each operation
- parameterization of water balance inputs and outputs to support the shift to a climate-drive model framework, as well as accounting for surface water – groundwater partitioning where relevant to facilitate model calibration and potential mitigation planning
- developing an alternative method for modelling flow from waste rock spoils to help remove the previous dependence on a single waste rock hydrograph developed using data from Cataract Creek
- improving flow calibration in tributaries that have been targeted for mitigation where model performance was previously classified as poor

The relevant updates to the FC of the RWQM to address these focus areas are summarized in Table 2-1 and illustrated in Figure 2-1 and Figure 2-2.

Table 2-1: Summary of Key Changes to the Flow Component of the 2020 Regional Water Quality Model

Description	2017 RWQM	2020 RWQM	Rationale for Change / Intended Improvement
Spatial Scale and Level of Spatial Detail	• Model domain spans from the Elk River upstream of GHO through to the Koocanusa Reservoir, inclusive of Fording River watershed and the reservoir itself • All five operations (FRO, GHO, LCO, EVO and CMO) explicitly represented in the model framework • Model contains a total of 96 individual sub-catchments	• Model domain unchanged • Four of five operations (FRO, GHO, LCO and EVO) explicitly represented in the model framework • CMO no longer included in model framework; flow and loads from CMO defined using outputs from the CMO Water and Load Balance Model • Level of spatial detail increased at each operation; model contains a total of 154 individual sub-catchments	• Flows were generated at a sub-catchment scale within each mine site to improve the ability of the RWQM to simulate within site across sub-catchment variability • Enables the RWQM to be used to evaluate changes to within site water management and local scale changes to mining. • Increased consistency between the RWQM and site models.
Historical Period Considered in Model Set-up	• 1995 to 2015	• 1970 to 2018, with calibration focused on period from 2004 to 2018	• The model starts with data from 1970 and runs to 2018. The model calibration focuses on the period from 2004 to 2018. • Three additional years of data were available for model calibration relative to the 2017 RWQM (i.e., 2016 through 2018), so the model performance period was adjusted to include the additional years of data. • Data from 2019 were preliminary and not considered for calibration.
Simulation Time Step	• Weekly	• Daily	• Meteorological data inputs are daily, allowing the model to complete calculations at a daily time step. • Daily input data supports integration with local site water balance models.
Reporting Time Period	• Weekly or Monthly	• Weekly or Monthly	• Not applicable (no change)
Meteorological data	• Not used, except as input to the LCO Dry Creek UBCWM, which was used to generate a representative hydrograph for undisturbed areas in the Fording River watershed	• RWQM is now climate-driven, and no longer relies on representative hydrographs • Precipitation and air temperature data from two representative regional climate stations are applied across the model domain, scaled based on elevation within each individual sub-catchment • Precipitation and air temperature data from several local climate stations considered for comparisons against the modelled data (where available)	• Climate-driven model framework allows for a more mechanistic approach to the simulation of flow and water quality in the Elk Valley • Allows for greater flexibility, in terms of looking at the effects of different climatic patterns on receiving water quantity and quality.
Hydrometric data	• Flow data from relevant flow monitoring stations used as an input for analogue catchments and regional (mainstem) stations • Flow data from selected tributary and mainstem monitoring stations used for model performance evaluation	• Flow data from flow monitoring stations on Elk River used as model input • Flow data from tributary and mainstem monitoring stations used for model performance evaluation	• Reduced reliance on flow monitoring data as an input to the model because of the transition to a climate-driven model for tributary catchments and waste rock spoils. • Additional flow data were available for calibration (relative to the 2017 RWQM Update).
Waste rock deposition	• Based on available data records for historical actuals (up to 2016 year-end) • Waste rock allocation by drainage (i.e., spreadsheet of annual and cumulative volumes by year)	• Based on available data records (up to 2018 year-end) • Checked and adjusted to match current drainage delineations with aerial photography and survey information • Waste rock allocation by drainage (i.e., spreadsheet of annual and cumulative volumes by year)	• Historical and future waste rock deposition information was required for the revised approach to modelling flows from waste rock spoils.
Mine plan information	• 2016 permitted mine plans • 5-year snapshots of surface contours for most areas (i.e., dxf files) • 5-year snapshots of mined-out contours (i.e., dxf files) • Details on sequencing (e.g., status maps)	• 2019 permitted mine plans • 5-year snapshots of surface contours for most areas (i.e., dxf files) • 5-year snapshots of mined-out contours (i.e., dxf files) • Details on sequencing (e.g., status maps)	• The latest available permitted mine plans were incorporated into the 2020 RWQM.

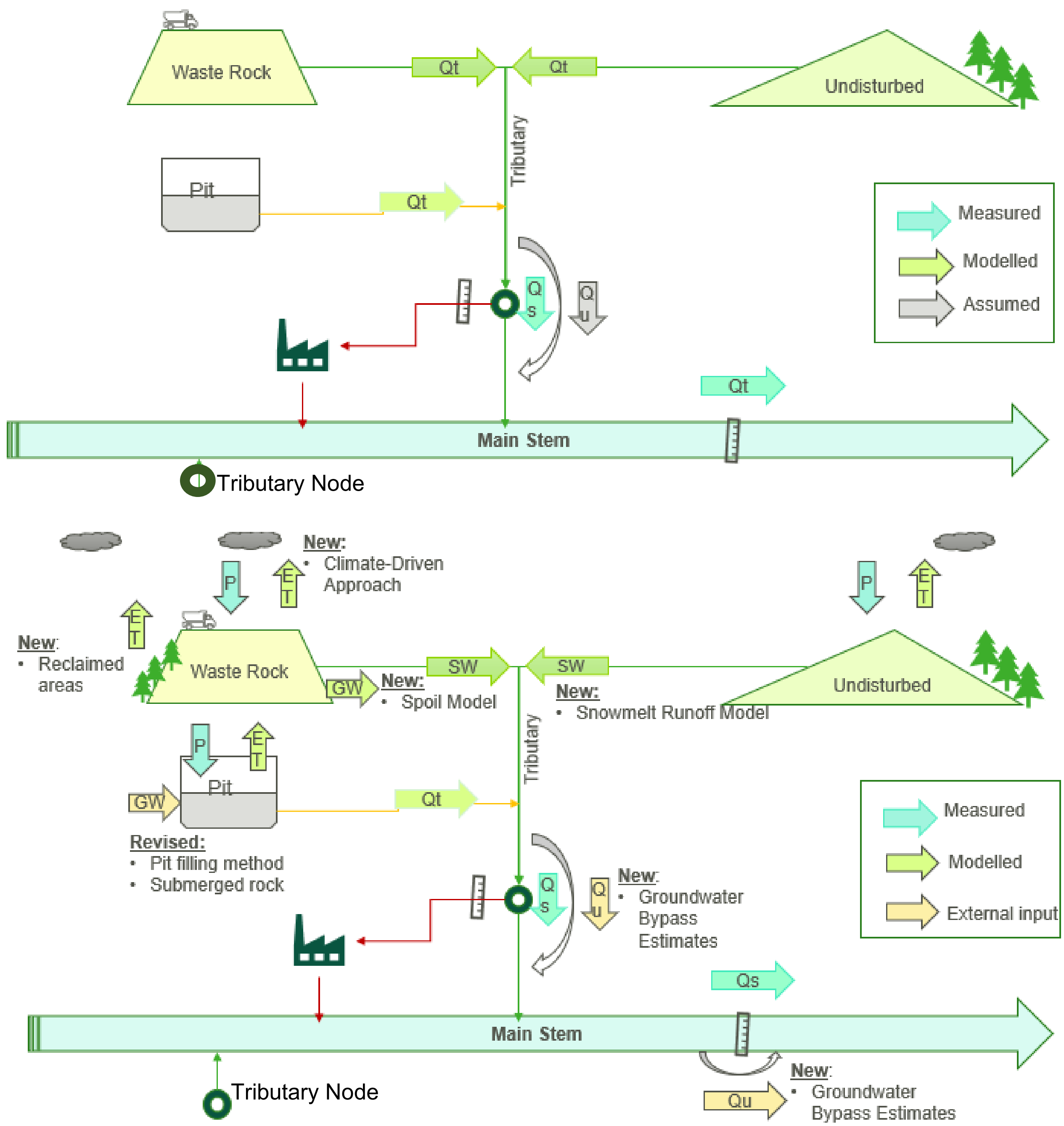
Table 2-1: Summary of Key Changes to the Flow Component of the 2020 Regional Water Quality Model

Description	2017 RWQM	2020 RWQM	Rationale for Change / Intended Improvement
Water management information	• Water flow diagrams developed through discussions with site water leads to represent best understanding of historical and future water management activities • Existing and planned water management infrastructure data (i.e., shapefiles of alignments of diversions, ditches, rock drains, ponds and pipelines) • Description of tailings water management facilities and wash plant water use • Pit dewatering pumping data and pit pumping plans • Existing water management plans	• Expanded water flow diagrams showing a greater level of on-site detail related to historical and future water management activities • Existing and planned water management infrastructure data (i.e., shapefiles of alignments of diversions, ditches, rock drains, ponds and pipelines) • Description of tailings water management facilities and wash plant water use • Pit dewatering pumping data and pit pumping plans • Existing water management plans • Dust suppression information	• Water flow diagrams were developed collaboratively with the teams working on the site water balance models, achieving greater consistency between models. • Input information was developed collaboratively with the teams working on the site water balance models.
Flows from undisturbed (non-mine affected) areas of tributary catchments	• Various analogue catchments were used (e.g., Harmer, Line, LCO Dry, Hosmer) for all	• The Snowmelt Runoff Model (SRM) adopted to model non-mine affected (undisturbed) areas in all sub-catchments.	• SRM allows for tributary-specific calibration at more locations. • SRM facilitates easier tracking of the overall water balance in individual sub-catchments. • SRM uses the same input data as the waste rock hydrology module. • SRM is used in the site water balance models, achieving consistency in approach among different Teck water models.
Flows from mine-affected (disturbed) areas (excluding waste rock spoils)	• Analogue catchment – Cataract Creek (i.e., the same analogue used for waste rock areas was also used for hard mine areas)	• SRM adopted for modelling hard mine surfaces (i.e., pit walls, haul roads, and plant areas) and coarse coal reject spoils, although SRM set-up altered to reflect different characteristics of land types being modelled.	• The use of a single mine analogue for all mine disturbance areas (i.e., both waste rock spoils and hard mining surfaces) was identified as a limitation of the 2017 RWQM. • The revised approach to model hard mine surfaces is consistent with the method to model non-mine affected areas. • The change is consistent with the current approach for the site water balance model.
Flows from waste rock spoils	• Analogue catchment – Cataract Creek	• Climate-driven waste rock hydrology module developed and implemented for all waste rock spoils.	• The waste rock hydrology module achieves greater consistency with the conceptual model for movement of water through waste rock spoils. • The inclusion of a waste rock module into the model framework eliminates the limitations associated with using a single analogue for the Elk Valley.
Water stored in flooded, backfilled pits	• Pits modelled to fill up to the decant elevation at varying rates (depending on the flow scenario being modelled). • Submerged waste rock volumes not tracked.	• Pits modelled to fill up at rates dictated by climate conditions. • For pits where flooding is modelled under future and historical conditions, submerged waste rock volumes estimated for the end-of-mining pit configurations.	• The proposed change overcomes a previous model limitation wherein pits filled either unrealistically slow or fast depending on the flow scenario chosen. • Accounting for submerged waste rock volumes allows application of the source terms for submerged waste rock in the water quality model.
Mine water management activities represented in the model framework	• Pit pumping • Clean water diversions • Mine water diversions • Consumptive water use in coal processing	• Pit pumping • Clean water diversions • Mine water diversions / pumping • Consumptive water use in coal processing • Use of water for dust suppression	• Dust suppression withdrawal information was incorporated where available. • Water management activities cross-checked with representation within site water balance model to confirm consistency
Effects of reclamation	• Not considered	• Long-range reclamation plans included • Evaluated the effects of reclamation by modelling projected decreases in net percolation rates in waste rock spoils.	• The change incorporates the current best understanding of the effect of reclamation on reduced percolation rates at waste rock spoils and overall changes to the water balance and future water quality.

Table 2-1: Summary of Key Changes to the Flow Component of the 2020 Regional Water Quality Model

Description	2017 RWQM	2020 RWQM	Rationale for Change / Intended Improvement
Baseflow changes due to pit seepage	• Pit seepage rates incorporated relative to baseline conditions, using results from project-specific groundwater models that were developed for environmental assessments or permit amendment applications (e.g., Swift, Cougar Pit Extension, Baldy Ridge Extension)	• Methods from the 2017 RWQM retained. • Latest available data considered where available.	• Not applicable
Sub-catchment water balance	• Not considered	• Annual water balance calculations for individual sub-catchments.	• Annual water balance calculations allow for quality assurance checks and support the identification and resolution of uncertainties (e.g., estimates of local precipitation or evapotranspiration rates).
Sub-catchment yield (Total flows at tributary nodes)	• Modelled flows are equivalent to total flows	• Modelled flows are equivalent to the total flows • In selected locations, partitioning between surface water and groundwater flows incorporated (see the row titled "Surface water - Groundwater partitioning at nodes")	• The development of an improved understanding of sub-catchment yield is important at locations that support model calibration, as well as at locations where water is targeted for capture or diversion. • Quantification of groundwater flow can be used to support the calibration and validation of the model, derivation of total loads, and interpretation of model projections.
Flows at mainstem nodes – Fording River	• Total flows summed from upstream tributary contributions to the Fording River	• No changes to the method from the 2017 RWQM (i.e., summing flows from upstream tributaries).	• Not applicable
Flows at mainstem nodes – Michel Creek	• Total flows summed from upstream tributary contributions to Michel Creek	• Scaling method and ranked regression equations used to estimate flows in Michel Creek upstream of Elkview Operations (at EV_MC3), except for CM_MC2. • Flows at CM_MC2 (i.e., Michel Creek CMO compliance point) estimated from the CMO Water and Load Balance Model • Flows at modelling nodes adjacent to and downstream of Elkview Operations calculated as the sum of flow at EV_MC3 plus simulated inputs entering Michel Creek between EV_MC3 and the node in question.	• Using a ranked-regression approach to estimate flows in Michel Creek upstream of Elkview Operations at EV_MC3 for numerical simplicity and to avoid having to simulate the production of flow from the relatively large undisturbed area present upstream of EV_MC3.
Flows at mainstem nodes – Elk River	• Scaling methods or direct data inputs from hydrometric stations for the Elk River nodes	• No fundamental changes to the methods from the 2017 RWQM • Minor adjustments to the scaling equations were made	• Adjustments were primarily informed by efforts to improve water quality calibration in the Elk River upstream of the Fording River confluence.
Surface water - groundwater partitioning at nodes	• Not quantified or considered explicitly during model calibration • Implicitly accounted for in mitigation planning through the use of water availability (defined as the proportion of total catchment flow that is accessible at a given intake)	• Total flow divided into surface water and groundwater components where relevant to model calibration and supported by available field data • Flows were calibrated taking into consideration both measured surface flows and total watershed yield (as required to produce sufficient flow to meet surface and subsurface components).	• Quantifying groundwater flow components at monitoring stations that support model calibration helps support the quantification of overall loading rates to downstream systems. • Quantifying groundwater flow components at locations where water is targeted for capture or diversion supports mitigation planning and facilitates a better understanding of potential groundwater capture requirements.
Future flow projections	• Use of three statistical flow scenarios (average weekly flow, 1-in-10-year weekly low and weekly high flow) • Future flow statistics are based on historical period between 1995 and 2015.	• Estimates of future flow conditions developed using climate data from 2000 to 2019, and running that climate dataset repeatedly through the model framework • Statistics from the resulting dataset generated for comparison to 2017 RWQM output.	• A change to the approach was necessitated through the change from an analogue catchment approach to a climate-driven hydrological model. • Climate-driven approach allows for greater model flexibility, including the potential to examine how changes to climate may affect water quantity and quality in the receiving environment.
Water quality management measures	• Not explicitly considered in the FC of the RWQM (only included in the WQC)	• Existing water quality management measures incorporated in the FC • Future mitigation and water quality management measures were not incorporated in the FC.	• Existing measures were incorporated as they may influence model calibration of the FC. • Future measures are only implemented in the WQC to limit iteration between the FC and WQC and facilitate the efficient examination of multiple scenarios.

CMO = Coal Mountain Operations, EVO = Elkview Operations, FRO = Fording River Operations, GHO = Greenhills Operations, LCO = Line Creek Operations, FC = Flow Component, RWQM = Regional Water Quality Model, SRM = Snowmelt Runoff Model, UBCWM = University of British Columbia Watershed Model, WQC = Water Quality Component.



Acronyms: Qt = Total Flow; Qs = Surface Flow, Qu = Subsurface Flow, P = Precipitation, ET = Evapotranspiration, GW = Groundwater, SW = Surface Water.

Figure 2-1: Flow Component Comparisons: 2017 RWQM (top – analogue catchment and scaling methods) and the 2020 RWQM (bottom – climate-driven modules and scaling methods)

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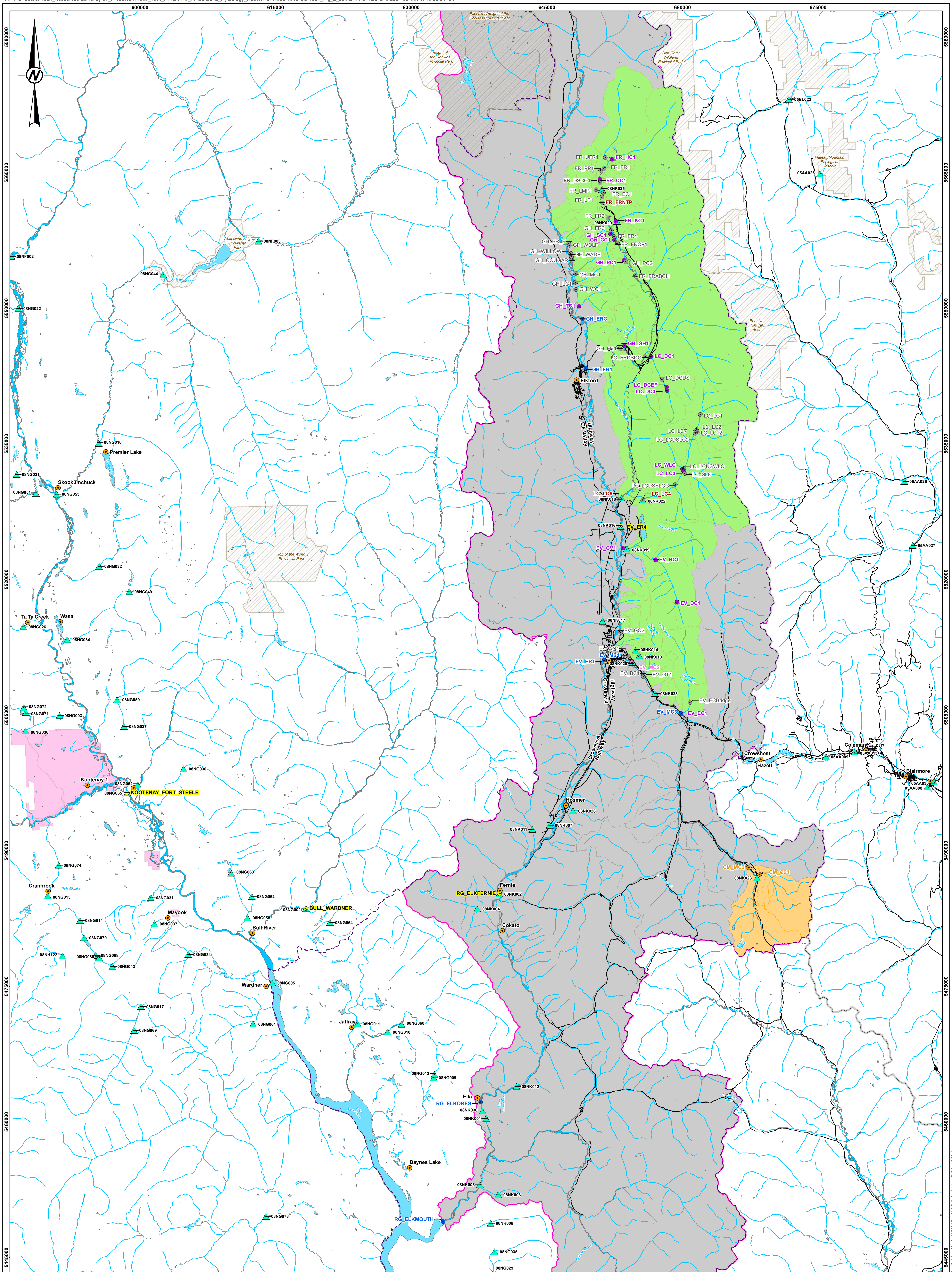

LEGEND

- CITY/TOWN/COMMUNITY
- ENVIRONMENT CANADA HYDROMETRIC STATION
- ROAD
- CANADIAN PACIFIC RAILWAY
- WATERCOURSE
- LAKE
- RIVER
- BRITISH COLUMBIA - ALBERTA PROVINCIAL BOUNDARY
- PROVINCIAL PARK PROVINCIAL PARK
- FIRST NATION RESERVE
- DESIGNATED AREA (ELK VALLEY WATER QUALITY PLAN)
- ELK RIVER WATERSHED BOUNDARY

STATION METHOD

- CALIBRATION
- DIRECT INPUT
- SCALING METHOD
- SCALING METHOD / DIRECT INPUT
- COMPARISONS
- CMO SITE MODEL

WATERSHED METHOD

- DIRECT DATA / RANKED REGRESSION / SCALING METHOD
- SNOWMELT RUNOFF MODEL AND WASTE ROCK HYDROLOGY MODULE METHODS
- CMO SITE MODEL

0 5 10 15 20

1:200,000 KILOMETRES

NOTE(S)

REFERENCE(S)

1. BASE DATA: CANVEC, 2018
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 11N

CLIENT TECK COAL LIMITED		PROJECT 2020 REGIONAL WATER QUALITY MODEL UPDATE	
CONSULTANT GOLDER	YYYY-MM-DD: 2020-12-01 DESIGNED: PR PREPARED: PR/RRD REVIEWED: AS APPROVED: SK	TITLE HYDROLOGY METHODS FOR 2020 RWQM UPDATE BY SUB-CATCHMENT	
		PROJECT NO. 18111630	CONTROL 0012 · REV. 0 · FIGURE 2-2

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3 Hydrologic Setting and Conceptual Model

3.1 Introduction

This section includes a general description of the hydrologic setting and conceptual hydrology model upon which the flow component of the 2020 RWQM is based. The hydrologic setting (Section 3.1) is a description of the general mechanisms responsible for the hydroclimatic regime of the Elk Valley. The sub-catchment conceptual hydrology model (Section 3.2) is a description of the processes responsible for the generation of flows from mine operations, tributaries and mainstem locations, and overall water balance components. The waste rock spoil conceptual model (Section 3.4) is a description of the water flow dynamics through these features and their potential influence on downstream hydrographs.

An understanding of the setting and conceptual model allows for the development of a defensible numerical representation of the conceptual model, including reasonable assumptions and simplifications to meet modelling objectives. The translation of the conceptual model described below into a numerical framework is discussed in Section 4.

3.2 Hydrologic Setting

3.2.1 Geographic Setting

The Elk River watershed (British Columbia Watershed Code 349-248100) is a mountainous watershed in the interior continental regions of British Columbia and has its headwaters at Elk Pass in Elk Lakes Provincial Park at the British Columbia-Alberta border (Figure 3-1). The Elk River watershed area is approximately 4,450 km^2 at the Environment and Climate Change Canada (ECCC) hydrometric monitoring station at Phillips Bridge near the river mouth. The watershed ranges in elevation from approximately 750 metres above sea level (masl) at the mouth of the Elk River to 3,450 masl at the summit of Mount Joffre. Characterized by rugged terrain of the Front and Border Ranges of the Rocky Mountain, the Elk River watershed is north-south oriented, and the Elk River flows generally south-southwest through the towns of Elkford, Sparwood and Fernie, discharging into Koocanusa Reservoir approximately 120 km downstream of Teck's mining operations. Koocanusa Reservoir is located partly in British Columbia and partly in the State of Montana; it was formed by the construction of the Libby Dam on the Kootenay River. Major tributaries to the Elk River include the Fording River, Michel Creek, and the Wigwam River.

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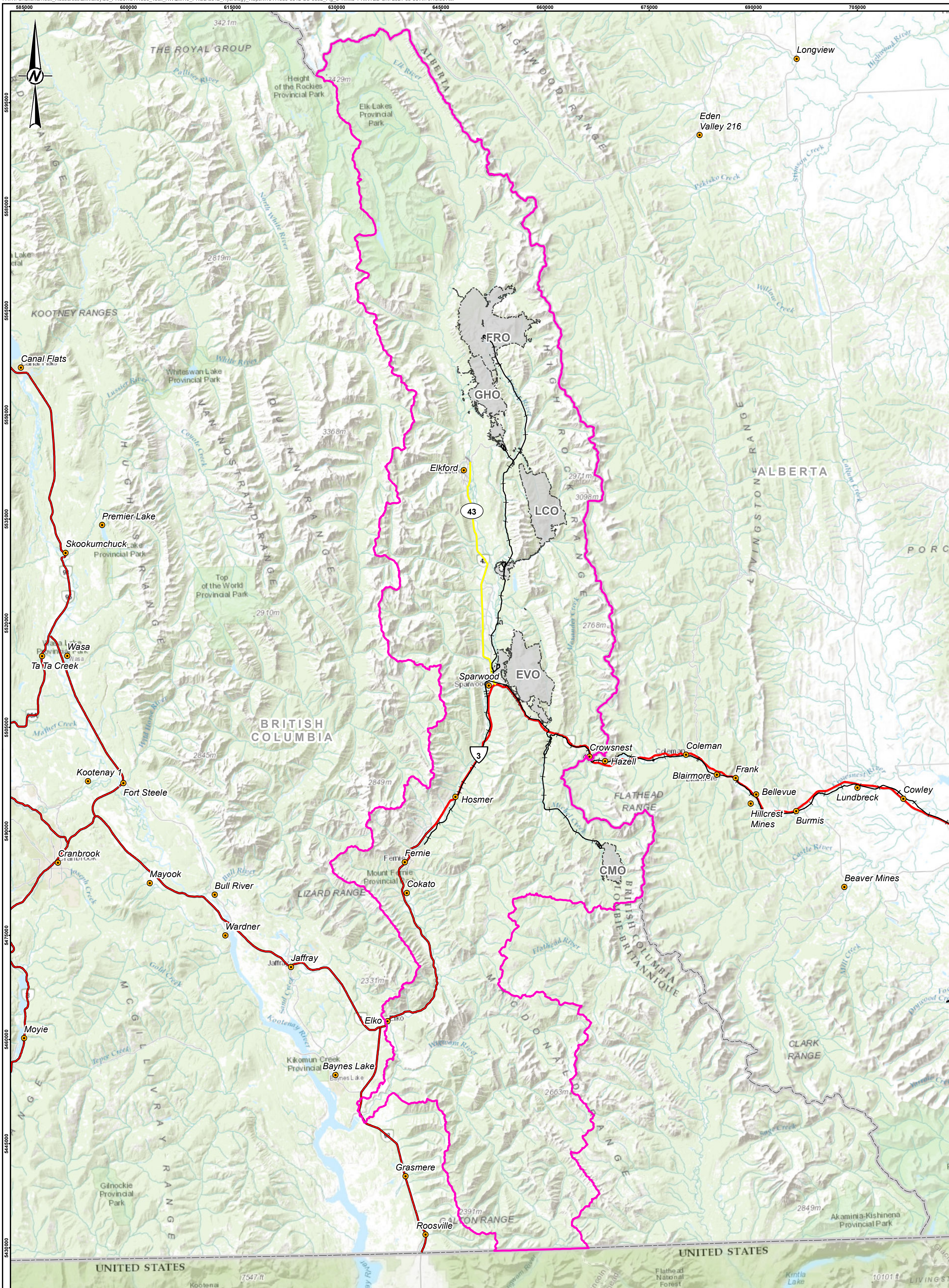

LEGEND

- CITY/TOWN/COMMUNITY
- CANADIAN PACIFIC RAILWAY
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- MINE PERMIT BOUNDARY
- ELK RIVER WATERSHED BOUNDARY

0 10 20

1:525,000 KILOMETRES

NOTE(S)

REFERENCE(S)

1. BASE DATA: CANVEC, 2018
2. TECK WATER NETWORK AND WATER MANAGEMENT DATA, 2019-09-26
3. BASEMAP: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 11N

TECK COAL LIMITED

Teck

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PROJECT

2020 REGIONAL WATER QUALITY MODEL UPDATE

TITLE

GEOGRAPHIC SETTING OF THE ELK RIVER WATERSHED

PROJECT NO.	CONTROL	REV.	FIGURE
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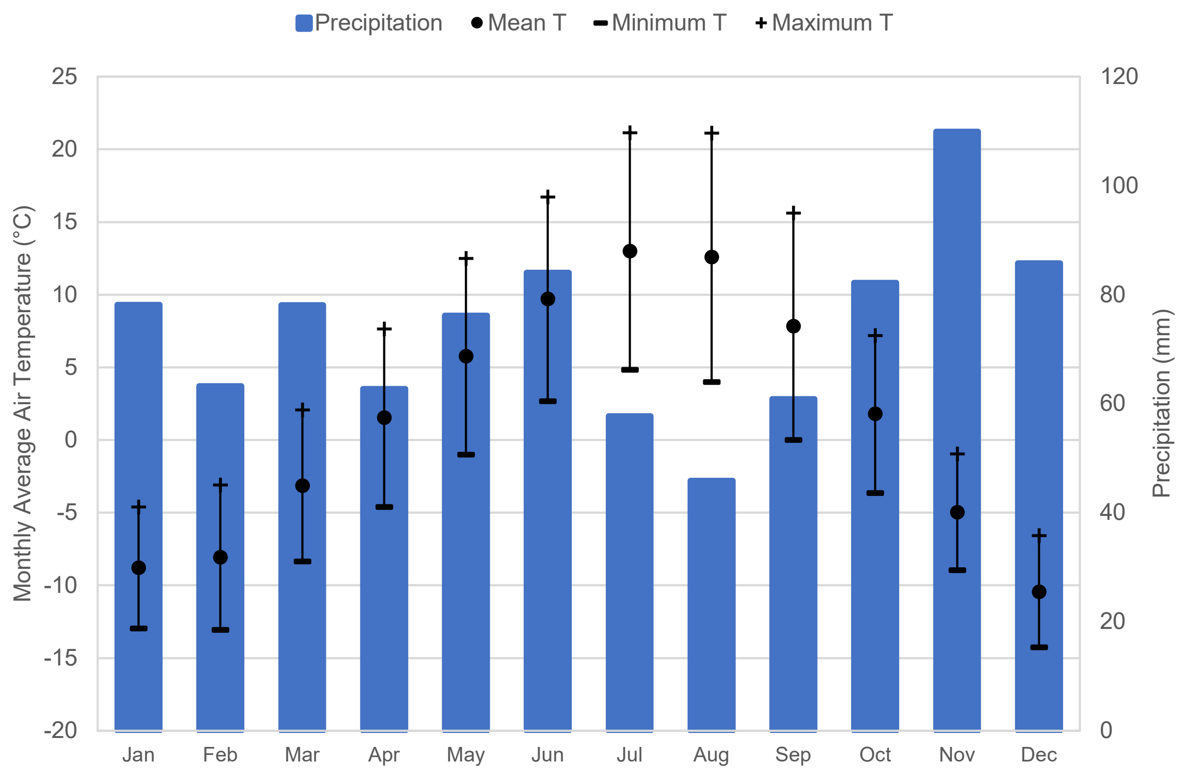
3.2.2 Climatic Regime

The climatic regime of the Elk River watershed is characterized by a continental climate with strong seasonality in precipitation and temperature (Figure 3-2). Accordingly, snow accumulates through the winter season and melts over the spring months (March, April and June), with the rate of melt influenced by local variation in elevation, hillslope, aspect and land cover. Warmer temperatures in the summer are typically accompanied by relatively low precipitation, and fall months are characterized by moderate temperatures and increased precipitation (Figure 3-2).



Based on data recorded at the Sparwood climate station from 1980 to 2019, in-filled, and then adjusted to account for elevation differences between Sparwood climate station (1,138 masl) and the average elevation of the Elk River watershed (1,777 masl).
°C = degrees Celsius, T = Temperature.

Figure 3-2: Monthly Mean, Minimum and Maximum Average Air Temperature and Mean Monthly Precipitation for the Elk River Watershed

3.3 Sub-Catchment Conceptual Model

3.3.1 Sub-Catchment Water Balance Components

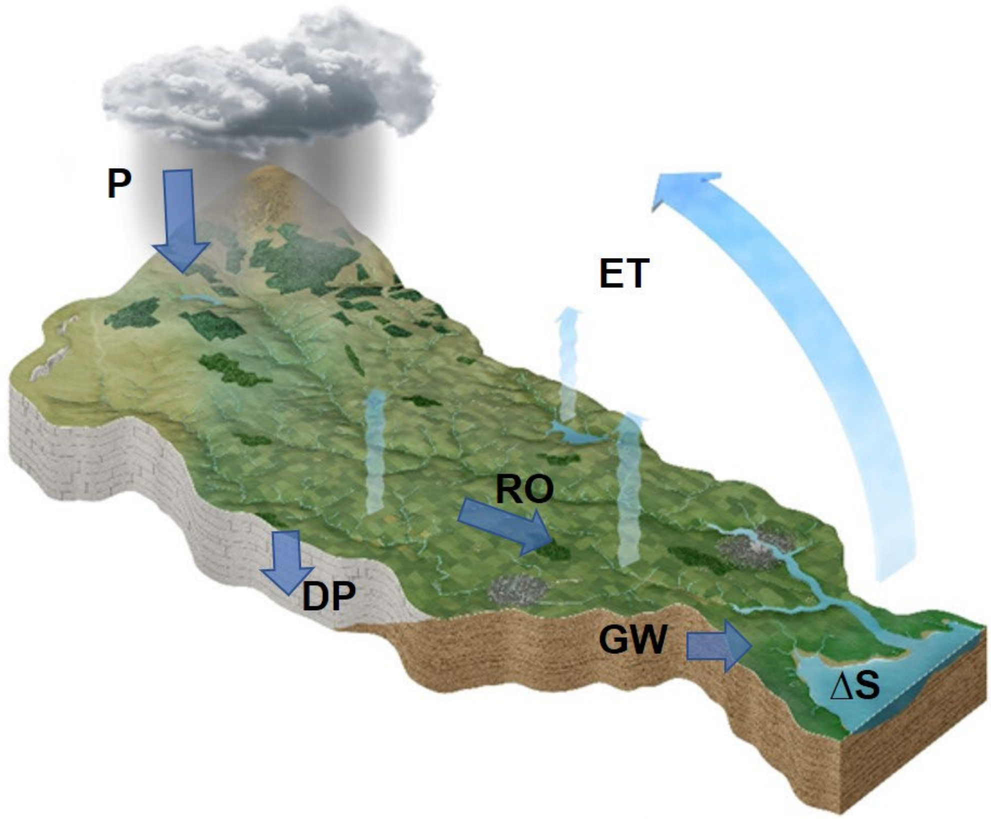
Exclusive of water balances applied to waste rock spoils (discussed in later sections), the water balance for a typical sub-catchment is illustrated in Figure 3-3 and can be expressed as follows:

$$P + \Delta S = RO + ET + DP - GW \qquad \text{Eq. 1}$$

Where:

P	=	Precipitation, including rainfall and snowfall
ΔS	=	Change in water stored within the sub-catchment (e.g., in lakes, ponds or as snow accumulation)
RO	=	Surface and shallow subsurface discharge (i.e., water leaving the sib-catchment by means other than deep percolation or evapotranspiration)
ET	=	Evapotranspiration (including evaporation and sublimation losses to the atmosphere)
DP	=	Loss to groundwater through deep percolation
GW	=	Discharge of groundwater flow that originates from outside the sub-catchment

RO and GW together define watershed or sub-catchment yield, and the terms of the water balance equation can be expressed as units of volume / time (e.g., m^3/day) or as units of depth / time (e.g., mm/year). The former can be useful in understanding the total magnitude of flow through a watershed (e.g., surface water discharge), while the latter can be more useful to compare hydrological processes between watersheds. Each component of the water balance equation is discussed further below.



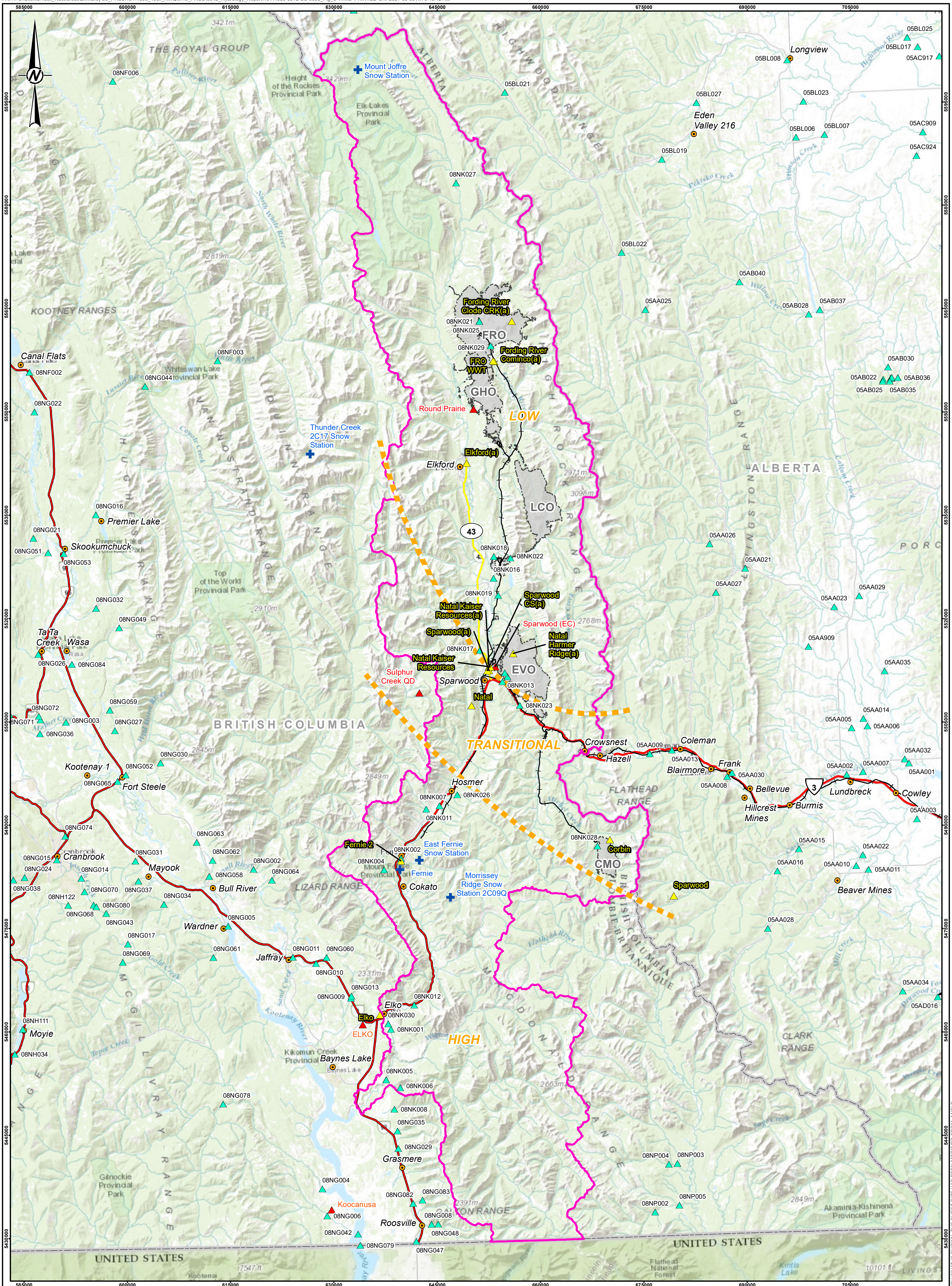
Adapted from https://i1.wp.com/www.catchments.ie

Figure 3-3: Conceptual Sub-Catchment Water Balance Diagram

3.3.2 Precipitation

Precipitation in the Elk Valley occurs as rain and snow. The mean annual precipitation for the watershed is estimated at 885 mm (at 1777 masl), with the range between 560 mm and 1270 mm (from 1980 to 2019). The year-to-year variability in precipitation and the associated variability in snowpack can substantially change the magnitude and, to a lesser extent, timing of the freshet peak. Mean annual temperature for the watershed is estimated to be 1.4 °C, with mean monthly variability between -10.5 and 13 °C. Climate data summary tables are included in Section 4.2.

Local precipitation patterns are affected by latitude, elevation, aspect, and local topography, most notably due to the rain shadow effect of high mountains (i.e., less precipitation on the leeward side). Ground elevation (altitude) is a major factor influencing air temperature and precipitation in mountainous areas of the Elk River watershed, also known as the orographic effect. According to Barbour et al. (2016), total annual precipitation and average temperature in the Elk Valley have approximate lapse rates of +21 mm/100 m and -0.48 °C/100 m, respectively. In addition to the orographic effect, a precipitation gradient is also observed in in the Elk Valley wherein annual precipitation increases in a southerly direction (Obedkoff 1985; Figure 3-4).



LEGEND

- CITY/TOWN/COMMUNITY
- CLIMATE STATION OPERATED BY ENVIRONMENT AND CLIMATE CHANGE CANADA
- SNOW STATION LOCATION
- ENVIRONMENT CANADA HYDROMETRIC STATION
- ACTIVE WEATHER STATIONS OPERATED BY BC WILDFIRE
- RUNOFF AND PRECIPITATION SUB-REGIONAL BOUNDARY
- CANADIAN PACIFIC RAILWAY
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- MINE PERMIT BOUNDARY
- ELK RIVER WATERSHED BOUNDARY

0 10 20

1:525,000 KILOMETRES

NOTE(S)

REFERENCE(S)

1. BASE DATA: CANVEC, 2018
2. TECK WATER NETWORK AND WATER MANAGEMENT DATA, 2019-09-26
3. BASEMAP: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 11N

TECK COAL LIMITED

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APPROVED	SK

PROJECT

2020 REGIONAL WATER QUALITY MODEL UPDATE

TITLE

CLIMATOLOGICAL ZONES IN THE ELK RIVER WATERSHED (ADAPTED FROM OBEDKOFF 1985)

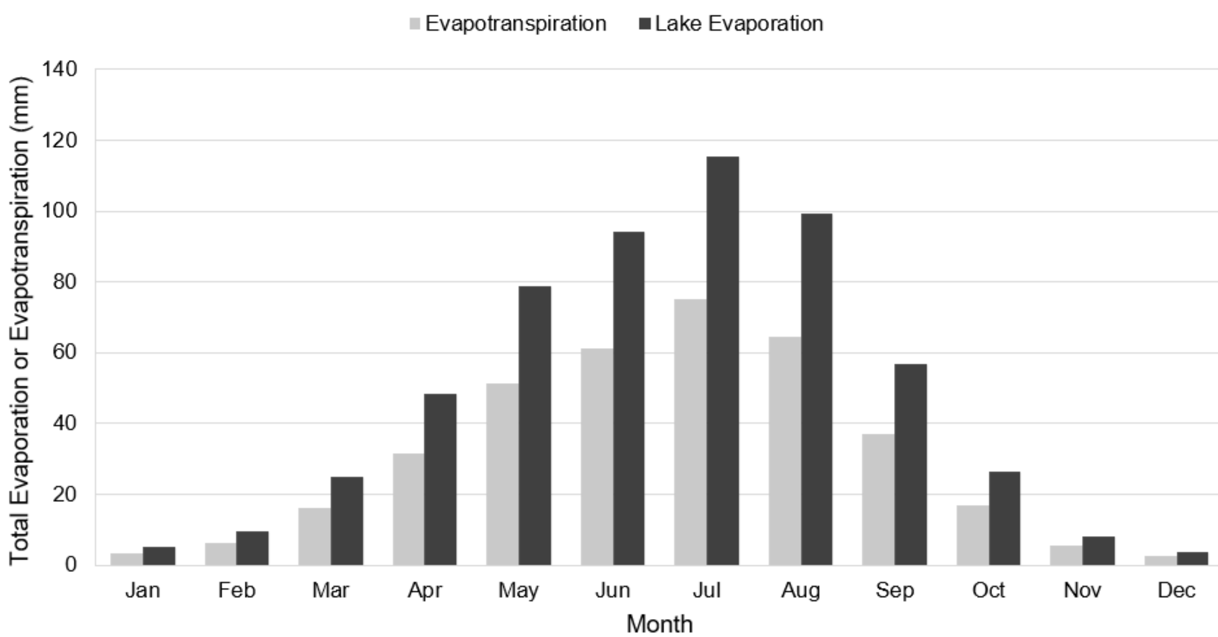
PROJECT NO.	CONTROL	REV.	FIGURE
18111630	0012	0	3-4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

3.3.3 Evapotranspiration and Sublimation

Losses to the atmosphere, such as lake evaporation and evapotranspiration, are a substantive component of the overall water balance and influence the total yield from a watershed or sub-catchment. In snow-dominated mountainous areas like the Elk Valley, sublimation is another form of atmospheric loss, as it influences the accumulated snowpack, representing a fraction of precipitation that does not contribute to melt. In comparison to precipitation, atmospheric losses are less sensitive to elevation differences and have relatively low inter-annual variability for a given site and are more sensitive to land cover and aspect.

Actual evaporation / evapotranspiration rates are generally lower than potential evaporation / evapotranspiration rates, with several site-specific factors used to determine the actual rates. Over land, factors such as soil and vegetation type influence actual evapotranspiration rates. Fetch length, water temperature, relative humidity and wind influence lake evaporation rates. In smaller lakes, wind effects can dominate and increase the relative humidity gradient, leading to increased actual evaporation rates. In large lakes with long fetch lengths in the along-wind direction, the effect of wind on relative humidity (partial pressure gradient) is minimal on an area-averaged basis, and the cooling effect of winds can offset the local changes in humidity gradients. Estimated mean monthly lake evaporation and evapotranspiration rates for the Elk Valley calculated using the Hargreaves-Samani equation are shown on Figure 3-5. As further detailed in Section 4.5.2.4, the Hargreaves-Samani method uses daily air temperature as an input and therefore accounts for a small amount of winter evaporation (Figure 3-5).



Based on data recorded at the Sparwood climate station from 1980 to 2019, in-filled, and then adjusted to account for elevation differences between Sparwood climate station (1,138 masl) and the average elevation of the regional study area (1,777 masl).

Figure 3-5: Monthly Mean Lake Evaporation and Evapotranspiration Estimates for the Elk River Watershed

Sublimation of snow and ice is driven by the vapour pressure gradient (i.e., sublimation occurs if ambient saturation vapour pressure is greater than the vapour pressure at the immediate snow/ice surface). The process is spatially variable and difficult to directly measure. However, sublimation rates have been found to be similar to evaporation rates (Jambon-Puilett et al. 2018). Based on guidance in available literature (Hood et al. 1999, Strasser et al. 2008), sublimation estimates for the Sparwood climate station could be up to 22% of the mean annual snowfall.

3.3.4 Runoff, Streamflow and Surface Water Yield

Mean annual runoff, or surface water yield from long-term mainstem hydrometric stations in the Elk River watershed range from 400 mm to 600 mm, with trends that are consistent with those observed for precipitation (i.e., elevation and north-south gradients). The increasing trend in surface water yield from upstream to downstream is consistent with the increasing precipitation trend from north to south, which generally supports the understanding that the lower Elk River watershed contributes a higher proportion of flow per unit area compared to the upper watershed. Hydrometric data summaries from monitoring stations in the Elk River watershed are included in Section 4.2.

Streamflow generated from a sub-catchment includes surface runoff and baseflow components, as conceptually illustrated in Figure 3-6. In literature, a third component of the hydrograph, defined as interflow, represents water that flows in the unsaturated zone between the ground surface and the top of the groundwater table, and then discharges to surface. For the RWQM conceptual model, interflow is not distinguished as a separate component of the hydrograph as this component interacts along the length of the watercourse with the relative proportion at surface or in below ground varying substantially from one location to another within a watercourse.

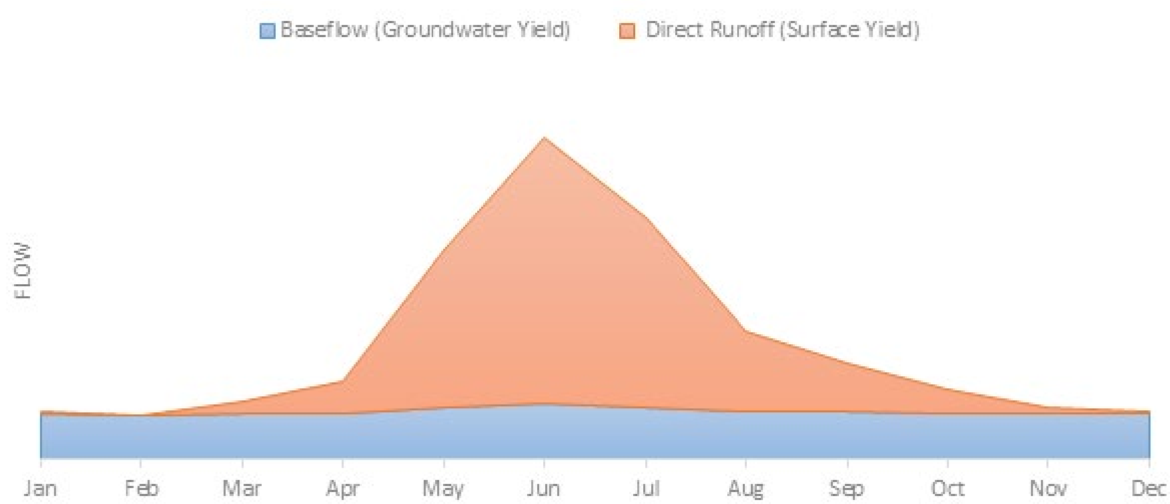


Figure 3-6: Conceptual Hydrograph Illustrating Seasonal Fluctuations in the Contributions of Groundwater Baseflow and Surface Runoff to the Measured Streamflow Hydrograph

The division of streamflow into contributions from surface runoff and baseflow is dependent on sub-catchment characteristics such as slope, land use, land cover and permeability of surficial materials. Although the rate of baseflow, expressed in absolute terms (e.g., m^3/day) is typically consistent over the year (Figure 3-6), its relative contribution to overall stream flow is temporally variable. Streamflow during winter months can, in many cases, be attributed almost entirely to baseflow, while streamflow during freshet is comprised predominantly of surface runoff from snowmelt (Figure 3-6). In the Elk Valley, baseflow comprises between 20% and 50% of the total surface water yield.

3.3.5 Shallow Groundwater Recharge and Discharge

In upland areas of the Elk Valley, rainfall and snowmelt infiltrates into the ground and recharges shallow groundwater systems at higher elevations. The shallow groundwater systems in the Elk Valley, which are conceptually illustrated in Figure 3-7, are local in the context that most of the groundwater recharge travels through colluvial deposits and overburden materials and discharges as surface flow to the tributaries along valley flanks, through valley fill or alluvial sediments. Colluvium deposits in the Elk Valley catchments are often thin, have a patchy distribution and experience ephemeral saturation conditions. As a result, the residence time of water that travels through these unconsolidated overburden materials and sediments on hillslopes is relatively short, with flow velocities in the order of hundreds of metres per year.

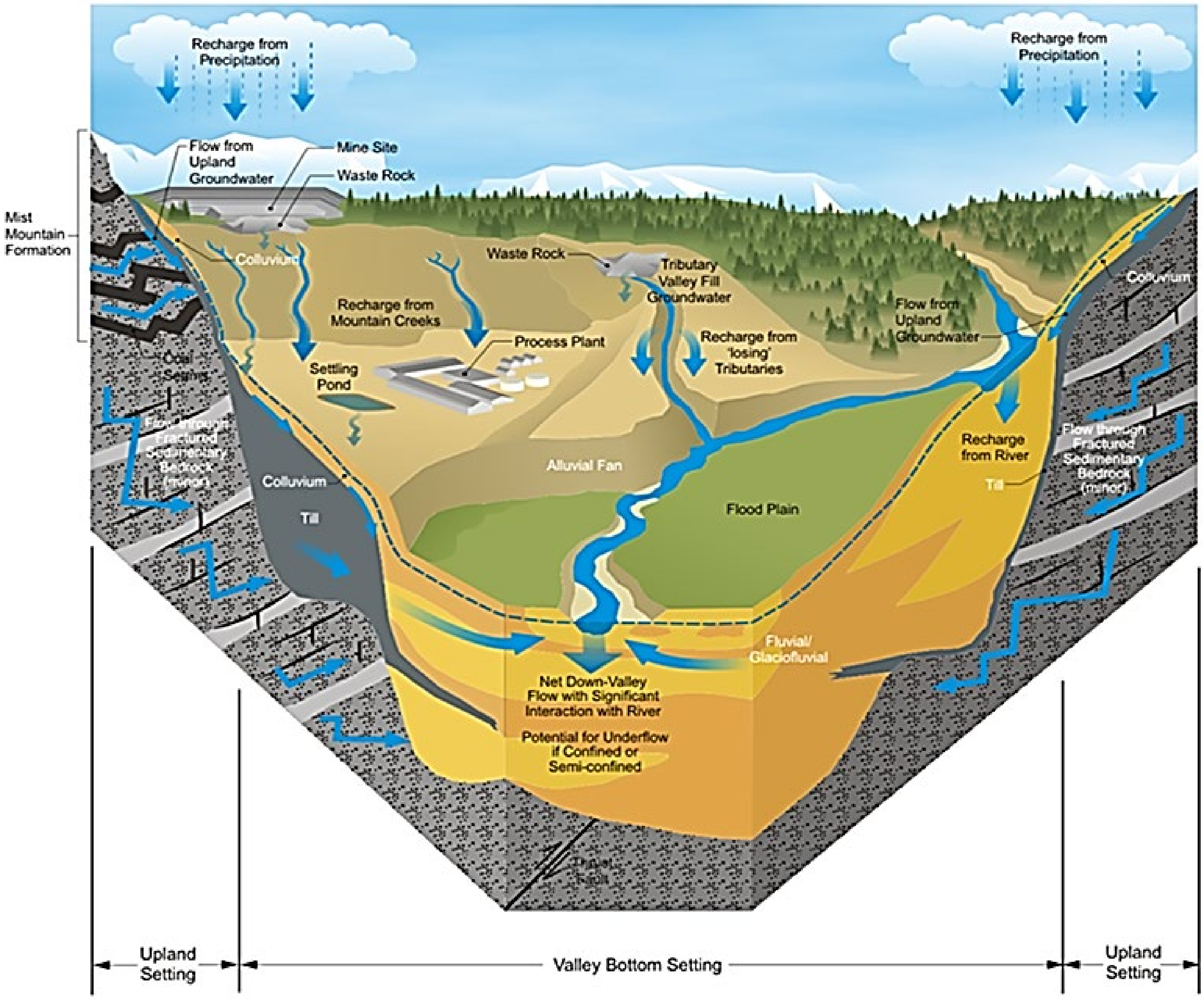


Figure 3-7: Conceptual Model of Groundwater Flow at a Tributary Scale in the Elk Valley (SNC 2017)

Conceptually, groundwater recharge from tributary catchments is equivalent to groundwater discharge as it eventually reports to the tributary or regional mainstems (topographic low points within the catchment or watershed). Several methods of estimating groundwater recharge defined in the literature are based on an analysis of streamflow records. While groundwater recharge can also be estimated using first principles (e.g., a catchment-scale water balance), recharge amounts in upland areas are highly variable and depend on the hydraulic conductivity of the various surface materials, land use (e.g., pits, spoils, roads) and water management practices. As such, estimates from first principles are not readily available.

Regional estimates of groundwater recharge in mountainous regions notably vary, as illustrated by the following examples:

- a few percent up to 40% of the total annual precipitation (Atwater 1994)
- 15 to 20% of total annual precipitation in the Meager Mountain area of south-central British Columbia (Jamieson and Freeze 1983)
- 20 to 30% of total annual precipitation in the Weary Ridge area in the Elk Valley (Harrison et al. 2000a)
- 2 to 30% of the average annual precipitation depth in the Elk Valley (SNC Lavalin 2017).

Groundwater recharge values based on winter stream flow estimates quoted in baseline reports for environment assessments for coal projects in the Elk Valley are summarized below:

- Line Creek Phase II (Teck 2011): 15 to 24% of total annual precipitation (637 to 837 mm depending on location)
- Swift Project (Teck 2014b): 10 to 15% based on flow measurements in Fording River and 10 to 35% of annual precipitation based on measurements in Cataract Creek.
- Elkview Operations, Baldy Ridge Extension (Teck 2015b): 9 to 21% based on winter stream flow measurements near the Project footprint

3.3.6 Deep Percolation of Groundwater

In contrast to groundwater flow through colluvium or alluvial deposits, residence time of water that travels through deep groundwater systems (i.e., bedrock) is of the order of one metre per year (SNC 2017). Relatively low bedrock hydraulic conductivity (decreasing trend with depth) limits the groundwater flow in the deeper bedrock. Percolation to deep groundwater systems, relative to the other components of the land-based hydrological cycle, is typically small to negligible, recognizing that the presence of karst topography or bedrock fractures can result in more appreciable deep groundwater flow. As deep groundwater flow is typically small to negligible, it is not included in the 2020 RWQM.

3.3.7 Interaction between Surface Water and Groundwater in Watercourses (Losing and Gaining Reaches)

Local tributary watercourses in the Elk Valley are generally characterized by relatively shallow glacial deposits and steep gradients. Water moves downgradient through tributary watercourses into the Fording River and the Elk River, which are regional topographical lows that generally gain flow with downstream distance (i.e., are gaining systems). The primary interactions between surface water and groundwater in a tributary watercourse in the Elk Valley are summarized as follows:

- Groundwater may discharge to surface where topographic lows or geological constraints (e.g., shallow bedrock) are present, which results in the phreatic surface rising above grade. These areas are commonly referred to as ***gaining*** stream reaches.

- Localized groundwater recharge may also occur whereby surface water from the stream channel infiltrates into the underlying alluvium; this typically occurs where the water surface elevation is higher than the underlying phreatic surface, and can lead to areas where surface streams go “dry” (as can be observed under low flow conditions in Line Creek Operations [LCO] Dry Creek). Areas where this flow pattern occurs are commonly referred to as ***losing*** stream reaches.

The presence of surface and subsurface flow components in a watercourse can make it a challenge to accurately measure total runoff from tributary catchments. Monitored water flows may underestimate total runoff from the upstream areas, because a portion of the total runoff is travelling subsurface at that particular location in the catchment. This concept is illustrated on Figure 3-8. In this figure, the subsurface flow component is reflective of ground conditions and flow paths at a specific location along the watercourse (such as a hydrometric monitoring station), and the partitioning of the surface and subsurface flow components is determined by the unique physical characteristics of the section of interest (e.g., gradient, cross-section width, substrate materials, thickness and permeability of underlying sediments).

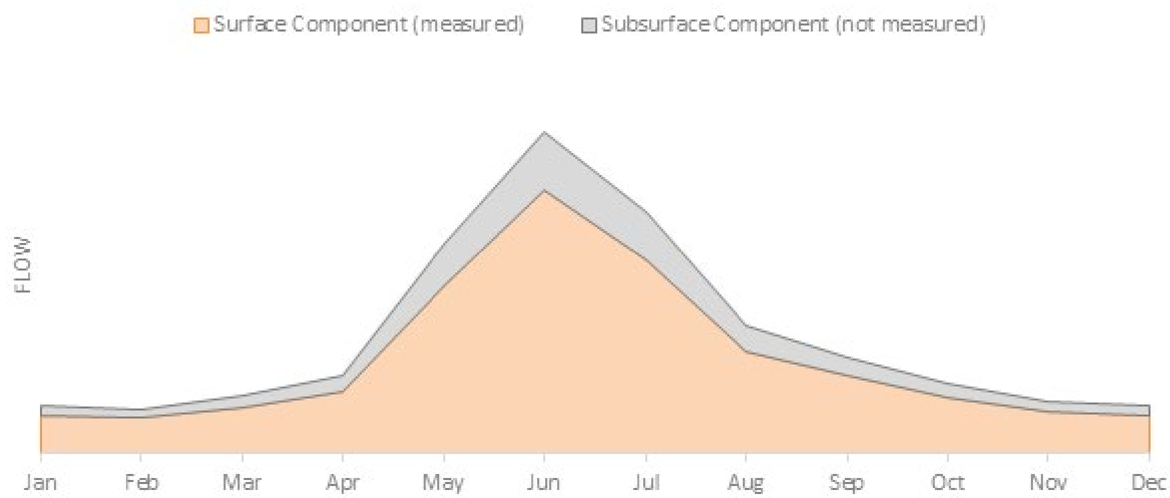


Figure 3-8: Conceptual Hydrograph Illustrating Contributions of Measured Surface Flows and Unaccounted Subsurface Flows to Total Flow (Catchment Yield)

3.3.8 Storage

Water storage in a catchment without large waterbodies is negligible, and inter-annual changes in most tributary catchments under steady state conditions or over a hydrologic year is also negligible. In catchments with waterbodies, or with large groundwater aquifer storage potential, storage changes occur seasonally and can attenuate peak flows from the catchment. There are few naturally occurring storage features in tributary catchments of the Elk Valley. At the mine site scale, storage features of significance to the overall hydrological regime include filling and flooded pits, as well as water stored within waste rock spoils, all of which are accounted for in the RWQM. Section 4.8 describes the approach for modelling water storage in pits, and Section 4.7 describes the approach for modelling waste rock spoil water storage in the 2020 RWQM.

3.4 Waste Rock Spoil Conceptual Model

3.4.1 Overview

This section consists of a summary of the conceptual model for movement of water through waste rock spoils. Understanding how water flows through waste rock spoils informs chemical transport mechanisms and the conceptual model supporting the development of geochemical source terms (as described in Annex A). Thus, an understanding of the physical processes governing flow within the spoils is necessary to simulate constituent release from these features. The conceptual model outlined below is informed by field studies and associated publications. Field studies on waste rock hydrology have been conducted at Teck sites by researchers at the University of Saskatchewan and McMaster University (e.g., Barbour et al. 2016; Hendry et al. 2015). Ongoing field studies and monitoring at Teck sites as part of annual water balance reporting are carried out by Okane Consultants Inc. (e.g., OKC 2018).

Waste rock spoils tend to be heterogeneous, and their hydrological behaviour is difficult to replicate using standard hydrologic models. Vertical water movement through the spoil occurs as infiltration into spoils, percolation through the spoils and toe discharge at the base of the spoil, with some water being retained through “wet-up” and/or temporary storage (Figure 3.9). The hydrologic response of a waste rock spoil is slower than that of an undisturbed hillslope catchment; they tend to attenuate freshet peaks and result in increase winter baseflow.

Hydrologic input into waste rock spoils can include run-on from upstream catchment and sub-catchment areas, which typically flows through the base of the waste rock spoil via a rock drain (i.e., a zone of higher permeability created through the natural segregation of waste rock when end-dumping). Research (e.g., Wellen et al. 2018) indicates that constituent transport is driven by vertical rather than horizontal flow through waste rock, and that flow through waste rock drains contributes little to overall constituent release from waste rock spoils to downstream watercourses and waterbodies.

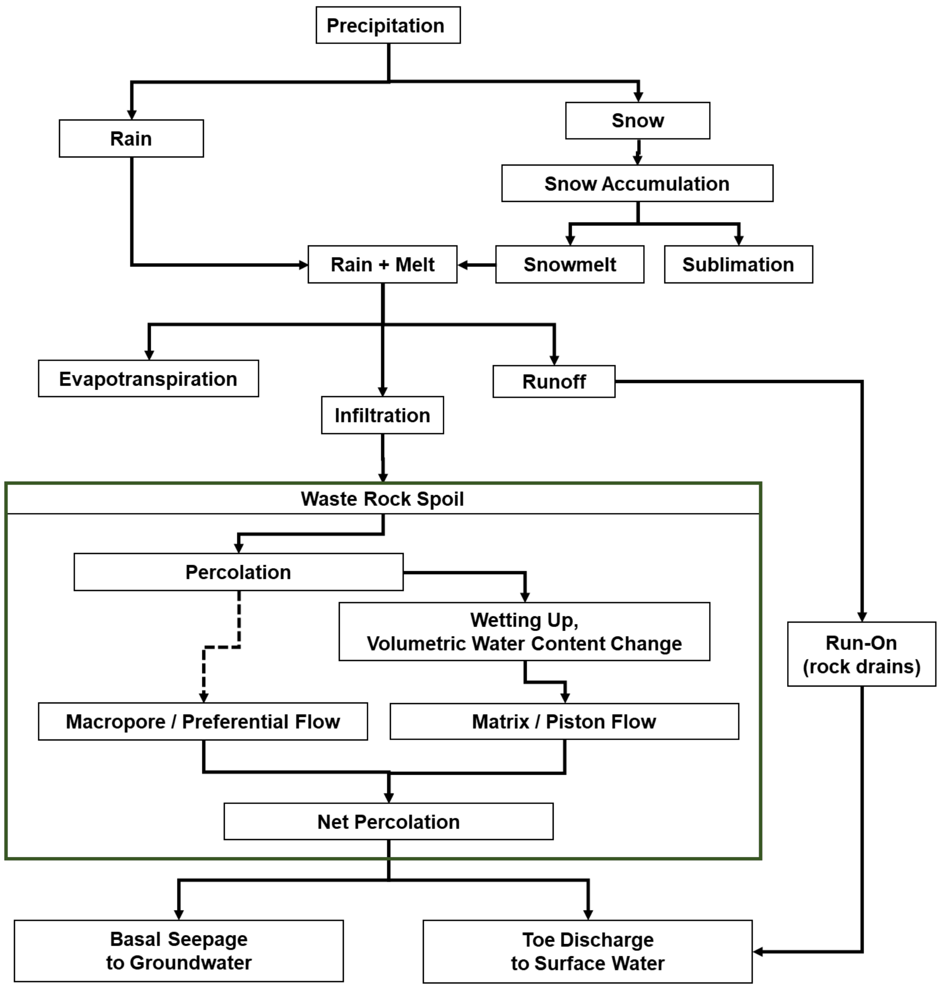


Figure 3-9: Conceptual Model of Flow into and through a Waste Rock Spoil

3.4.2 Waste Rock Water Balance

As with natural overburden deposits, the hydrology of a waste rock spoil can be conceptualized as a feature that collects and releases accumulated precipitation. The water balance of a waste rock spoil can be expressed as:

$$\Delta S = Inf - Q_{WR} \quad \text{Eq. 2}$$

Where:

Inf = water that infiltrates the surface of the spoil after evapotranspiration and sublimation are removed from rainfall and snowmelt.

Q_{WR} = discharge from the spoil, in terms of water passing vertically through the spoil and being released from its base. This is commensurate with net percolation.

ΔS = change in the volume of water stored within the spoil (i.e., the water holding content) which is influenced by the net of inflows and outflows, and the physical properties of the placed material.

Runoff from the surface of the spoil is assumed to be zero, due to the high permeability of waste rock (O'Kane et al. 2015). Further, run-on from upstream catchment and sub-catchment areas has not been included in the water balance equation, because run-on typically moves through the waste rock drain located at the base of the spoil, with limited influence on within spoil storage volumes and little to no influence on constituent release.

3.4.3 Physical Properties and Water Storage

Analogous to natural overburden deposits, waste rock piles can store water in their pore spaces due to capillarity action and textural breaks in the spoil. Storage can be defined as volumetric water content (VWC) based on the ratio of water volume to total bulk volume, which is limited by porosity (overall pore volume). Typical steady state drainage VWC of sampled waste rock spoils at EVO were estimated to range from 5% to 10%, and were up to 25% at LCO samples taken (Barbour et al. 2016). Studies by Okane (OKC 2018) identified water contents of spoils in the Elk Valley ranging between 8% and 20% on a volumetric basis, with median values around 12 to 14%.

An average waste rock porosity of 0.24 was calculated for EVO and LCO waste rock spoils based on dry density and specific gravity assumptions (Barbour et al. 2016), though values for waste rock of similar properties can reach up to 0.3 (Steinpreis 2018, Cash 2014). For reference, porosity values in this range are similar to a gravel or coarse sand deposit (Freeze and Cherry 1979).

After placement, there is typically a "wetting up" period which depends on initial VWC, spoil texture (i.e., particle size distribution), climate conditions, spoil height, and spoil porosity. The time for the wetting up process to reach steady state has been reported to range from one high flow season or freshet event to tens of years (Swanson et al. 2000, Steinpreis 2018). In the Elk Valley, wet up times tend to be short, in the order of one to two years (OKC 2018, Barbour et al. 2016); as a result, spoils created in the Elk Valley begin to release water shortly after placement, with each successive lift placed in a spoil taking in the order of one to two years to reach sufficient saturation to be able to conduct water through capillary action.

3.4.4 Evaporation, Infiltration and Percolation

Active waste rock spoils typically have limited to no vegetative cover, resulting in reduced evapotranspiration (ET) rates compared to non-mine affected areas (Birkham et al. 2014, Birkham 2017). Whether active or under rehabilitation, runoff is generally assumed to be zero from a waste rock spoil (O'Kane et al. 2015); thus, water that is not lost to evaporation or sublimation tends to infiltrate into the spoil.

Infiltrated water that percolates below the influence of ET is subject to groundwater flow dynamics as it moves through the waste rock spoil. Flow pathways through waste rock spoils are variable, both spatially and temporally, due to the textural heterogeneity of the waste rock (Nichol et al. 2005). For example, water can move through the waste rock via capillary dominated pores (matrix) as well as non-capillary pores (macropores). Percolation rates near the surface of the spoil can be high (e.g., rapid snow melt or larger rainfall event), implying that preferential (macropore) flow pathways dominate; However, percolation rates are dampened with depth, and water migration transitions increasingly from macropore flow pathways to matrix flow (Barbour et al. 2016). This suggests that as a waste rock spoil matures (i.e., grows in size over time and consolidates underlying deposits), the proportion of water influenced by matrix flow increases relative to the water influenced by macropore flow.

The simplest interpretation of a system with predominantly matrix flow is that of 'piston' where water moves at the same rate throughout the spoil. Interpretations of piston type matrix flow have been estimated in the Elk Valley waste rock spoils at velocities of meters to tens of metres per year (i.e., it can take in the order of one year for water to move vertically through 10 m of spoil) (Barbour et al. 2016). In contrast, macropore flow tends to be faster, with velocities of metres per hour. However, these relatively rapid macropore flow paths tend to account for a small amount of constituent transport, whereas matrix flow typically accounts for most of the mass displacement (Nichol et al. 2005). In other words, transport of constituents through and out of waste rock spoils is understood to be primarily driven by matrix, rather than macropore, flow due to greater residence time and increased contact of water with the fine-grained material (Neuner et al. 2013).

3.4.5 Waste Rock Discharge

Net percolation is the water available for discharge once it has infiltrated and moved through the waste rock spoil. It can be released as a combination of:

1. Toe Discharge
2. Basal Seepage

The proportion of net percolation being released as toe discharge compared to basal seepage depends on the geology underlying the spoil. In the Elk Valley, the local geology is such that net percolation released through either pathway tends to report to the nearest stream or creek, mixing with surface runoff from other areas of the catchment as it moves towards the catchment outlet.

Nichol et al. (2005) indicates that most seepage from the base of a waste rock spoil is older water that is displaced from the lower portion of the spoil. This behaviour can be approximated as a dampened piston type displacement driven by a pressure wave resulting from infiltration. The pressure wave has been observed to travel through the spoil on a time scale in the order of months (Barbour et al. 2016), while a single drop of water may take decades to move through the entire height of a waste rock spoil.

4 Numerical Model - Part I: Model Set-Up

4.1 Introduction

The geographic extent of the 2020 RWQM is shown in Figure 4-1. Modelling nodes in the Elk River and Fording River mainstems, as well as some of those located in tributaries to each river, are shown in Figures 4-1 to 4-6 and summarized in Table 4-1. The 2020 RWQM contains approximately 100 modelling nodes, not all of which are shown in Figures 4-1 to 4-6 or listed in Table 4-1. Instead, only those most relevant to the discussion of model calibration are shown / listed. The other modelling nodes are included in the model to allow it to be used at both a local and regional scale.

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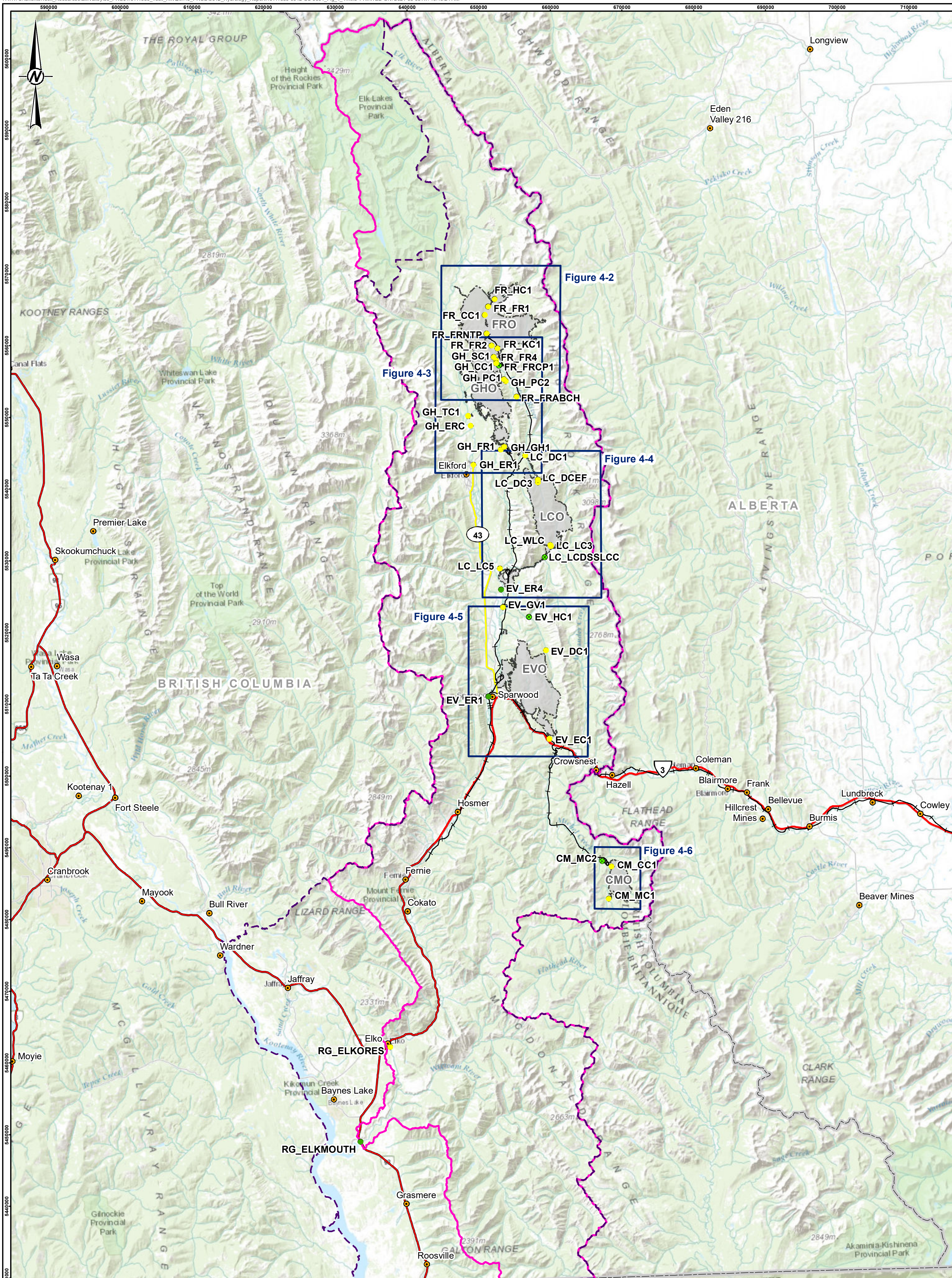

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- EMA PERMIT 107517 COMPLIANCE STATION
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- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- MINE PERMIT BOUNDARY
- ELK RIVER WATERSHED BOUNDARY
- DESIGNATED AREA (GEOGRAPHIC EXTENT OF THE MODEL)

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NOTE(S)

REFERENCE(S)

1. BASE DATA: CANVEC, 2018
2. TECK WATER NETWORK AND WATER MANAGEMENT DATA, 2019-09-26
3. BASEMAP: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 11N

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APPROVED	SK

PROJECT
2020 REGIONAL WATER QUALITY MODEL UPDATE

TITLE
GEOGRAPHIC EXTENT OF THE REGIONAL WATER QUALITY MODEL AND LOCATION OF SOME OF THE FLOW MODELLING NODES INCLUDED IN THE MODEL

PROJECT NO.	CONTROL	REV.	FIGURE
18111630	0012	0	4-1

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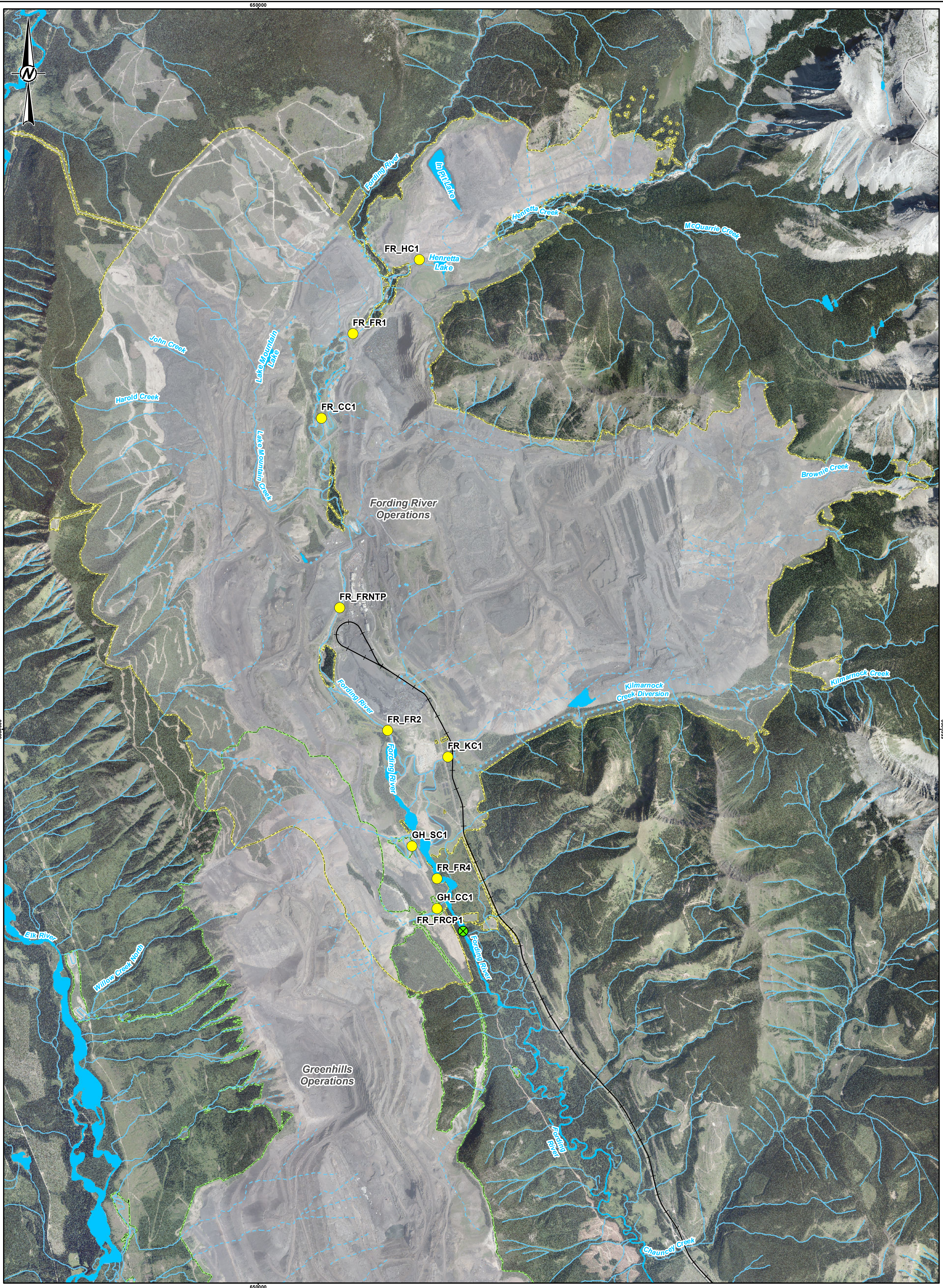

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- EMA PERMIT 107517 COMPLIANCE STATION
- MODELLING NODE
- CANADIAN PACIFIC RAILWAY
- CANAL OR DITCH
- SURFACE FLOW WATERCOURSE
- SUBSURFACE FLOW WATERCOURSE
- WATERBODY
- C-3 PERMIT BOUNDARY - FRO
- C-137 PERMIT BOUNDARY - GHO

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1:50,000 METRES

NOTE(S)

REFERENCE(S)
1. BASE DATA: CANVEC, 2018
2. TECK WATER NETWORK AND WATER MANAGEMENT DATA PROVIDED BY TECK. 2019-09-26
3. IMAGERY: ORTHO IMAGERY PROVIDED BY TECK, 2019. ADDITIONAL IMAGERY BY MICROSOFT BING © 2018 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS.
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 11N

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PROJECT
2020 REGIONAL WATER QUALITY MODEL UPDATE

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APPROVED	SK

TITLE
FORDING RIVER OPERATIONS – SOME OF THE MAINSTEM AND TRIBUTARY MODELLING NODES INCLUDED IN THE MODEL

PROJECT NO.	CONTROL	REV.	FIGURE
18111630	0012	0	4-2

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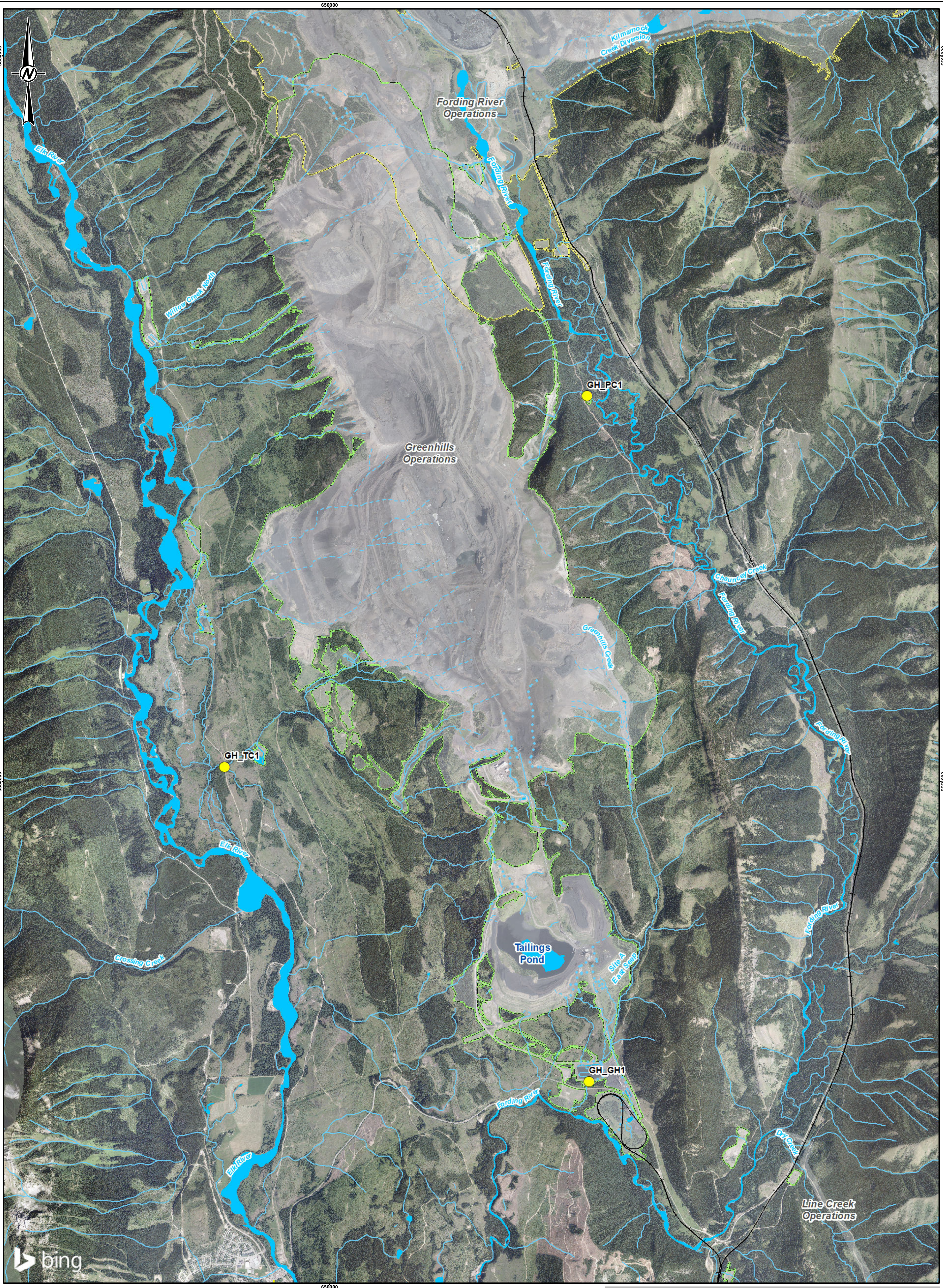

LEGEND

- MODELLING NODE
- CANADIAN PACIFIC RAILWAY
- SECONDARY HIGHWAY
- CANAL OR DITCH
- SURFACE FLOW WATERCOURSE
- SUBSURFACE FLOW WATERCOURSE
- WATERBODY
- C-3 PERMIT BOUNDARY - FRO
- C-137 PERMIT BOUNDARY - GHO

0 1,000 2,000

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NOTE(S)

REFERENCE(S)

1. BASE DATA: CANVEC, 2018
2. TECK WATER NETWORK AND WATER MANAGEMENT DATA PROVIDED BY TECK. 2019-09-26
3. IMAGERY: ORTHO IMAGERY PROVIDED BY TECK, 2019. ADDITIONAL IMAGERY BY MICROSOFT BING © 2018 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS.
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 11N

TECK COAL LIMITED

PROJECT

2020 REGIONAL WATER QUALITY MODEL UPDATE

Teck

YYYY-MM-DD	2020-12-01
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REVIEWED	AS
APPROVED	SK

TITLE

GREENHILLS OPERATIONS - SOME OF THE MAINSTEM AND TRIBUTARY MODELLING NODES INCLUDED IN THE MODEL

PROJECT NO.	CONTROL	REV.	FIGURE
18111630	0012	0	4-3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

0

LEGEND

- EMA PERMIT 107517 COMPLIANCE STATION
- MODELLING NODE
- CANADIAN PACIFIC RAILWAY
- CANAL OR DITCH
- SURFACE FLOW WATERCOURSE
- SUBSURFACE FLOW WATERCOURSE
- WATERBODY
- C-129 PERMIT BOUNDARY

0 1,000 2,000

1:55,000 METRES

NOTE(S)

REFERENCE(S)

1. BASE DATA: CANVEC, 2018
2. TECK WATER NETWORK AND WATER MANAGEMENT DATA PROVIDED BY TECK. 2019-09-26
3. IMAGERY: ORTHO IMAGERY PROVIDED BY TECK, 2019. ADDITIONAL IMAGERY BY MICROSOFT BING © 2018 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS.
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2020 REGIONAL WATER QUALITY MODEL UPDATE

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PREPARED	PR/RRD
REVIEWED	AS
APPROVED	SK

TITLE

LINE CREEK OPERATIONS - SOME OF THE MAINSTEM AND TRIBUTARY MODELLING NODES INCLUDED IN THE MODEL

PROJECT NO.	CONTROL	REV.	FIGURE
18111630	0012	0	4-4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

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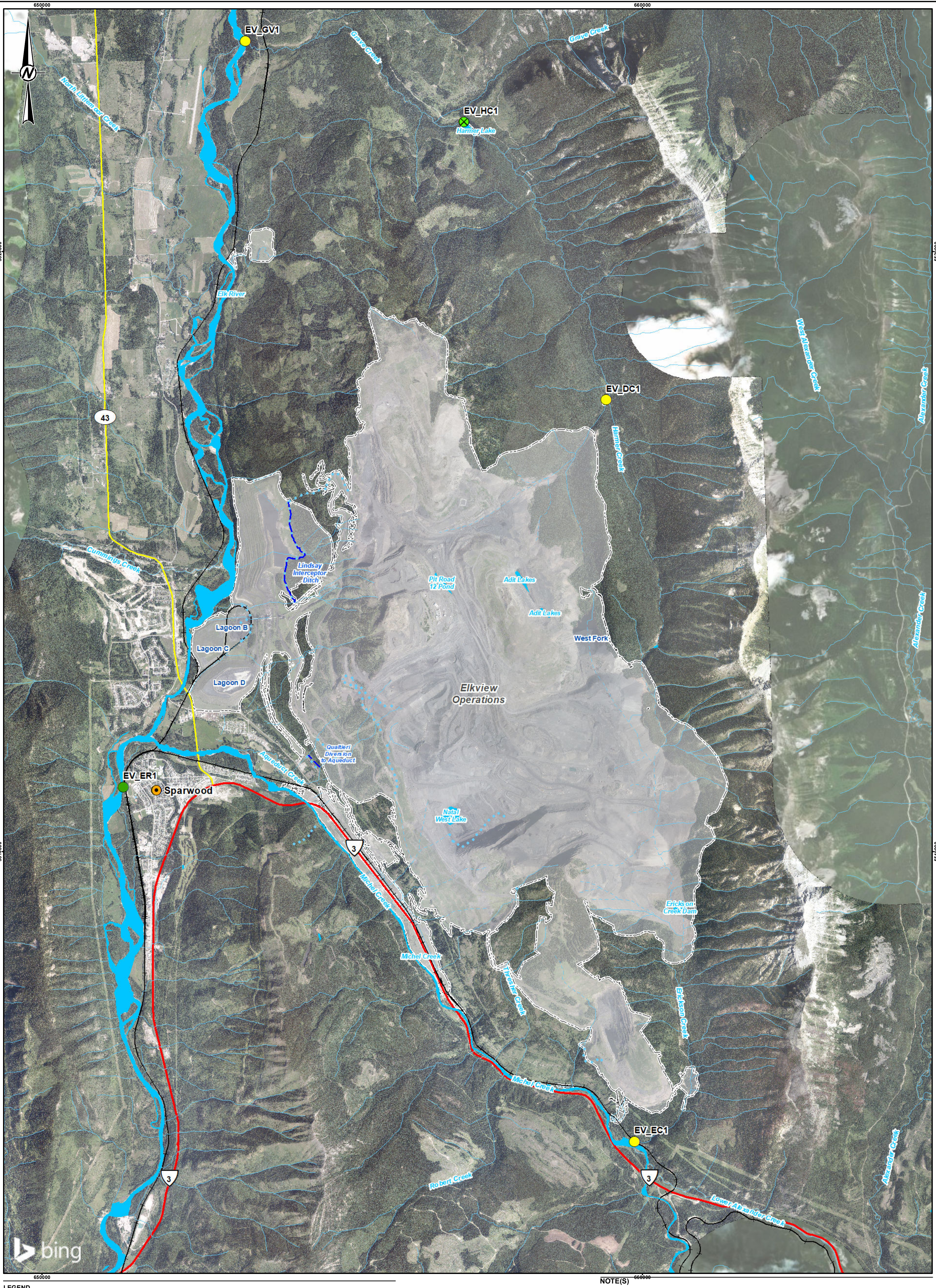

LEGEND

- EMA PERMIT 107517 ORDER STATION
- EMA PERMIT 107517 COMPLIANCE STATION
- MODELLING NODE
- CITY/TOWN/COMMUNITY
- CANADIAN PACIFIC RAILWAY
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- CANAL OR DITCH
- SURFACE FLOW WATERCOURSE
- SUBSURFACE FLOW WATERCOURSE
- WATERBODY
- ELKVIEW OPERATIONS C-2 PERMIT BOUNDARY

0 1,000 2,000

1:60,000 METRES

NOTE(S)

REFERENCE(S)

1. BASE DATA: CANVEC, 2018
2. TECK WATER NETWORK AND WATER MANAGEMENT DATA PROVIDED BY TECK. 2019-09-26
3. IMAGERY: ORTHO IMAGERY PROVIDED BY TECK, 2019. ADDITIONAL IMAGERY BY MICROSOFT BING © 2018 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS.
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 11N

TECK COAL LIMITED

PROJECT

2020 REGIONAL WATER QUALITY MODEL UPDATE

YYYY-MM-DD	2020-12-01
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TITLE

ELKVIEW OPERATIONS - SOME OF THE MAINSTEM AND TRIBUTARY MODELLING NODES INCLUDED IN THE MODEL

PROJECT NO.	CONTROL	REV.	FIGURE
18111630	0012	0	4-5

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LEGEND

- EMA PERMIT 107517 COMPLIANCE STATION
- MODELLING NODE
- CANADIAN PACIFIC RAILWAY
- CANAL OR DITCH
- SURFACE FLOW WATERCOURSE
- SUBSURFACE FLOW WATERCOURSE
- WATERBODY
- COAL MOUNTAIN OPERATIONS C-84 PERMIT BOUNDARY

0 500 1,000
1:25,000 METRES

NOTE(S)

REFERENCE(S)
1. BASE DATA: CANVEC, 2018
2. TECK WATER NETWORK AND WATER MANAGEMENT DATA PROVIDED BY TECK. 2019-09-26
3. IMAGERY: ORTHO IMAGERY PROVIDED BY TECK, 2019. ADDITIONAL IMAGERY BY MICROSOFT BING © 2018 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS.
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 11N

CLIENT: TECK COAL LIMITED

PROJECT: 2020 REGIONAL WATER QUALITY MODEL UPDATE

Teck

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APPROVED	SK

TITLE
COAL MOUNTAIN OPERATIONS - SOME OF THE MAINSTEM AND TRIBUTARY MODELLING NODES INCLUDED IN THE MODEL

PROJECT NO.	CONTROL	REV.	FIGURE
18111630	0012	0	4-6

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25mm
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Table 4-1: Flow Modelling Nodes in the Elk River and Fording River Mainstems and their Tributaries that are of Most Relevance to the Discussion of Model Performance

Operation or General Location	Node ID	Node Description	Location[a]	
			Easting	Northing
Fording River Operations	FR_HC1	Henretta Creek u/s of Fording River (E216778)	652219	5566469
	FR_CC1	Clode Creek Sediment Pond Decant (E102481)	650871	5564287
	FR_KC1	Kilmarnock Creek d/s of Rock Drain (0200252)	652612	5559619
	GH_SC1	Swift Creek Settling Pond Decant (E221329)	652024	5558252
	GH_CC1	Cataract Creek Sediment Pond Decant (0200384)	652464	5557531
Greenhills Operations	GH_PC1	Porter Creek Sediment Pond Decant (0200385)	653547	5555316
	GH_GH1	Greenhills Creek Sediment Pond Decant (E102709)	653577	5545871
	GH_TC1	Thompson Creek at LRP Road (E102714)	648550	5550218
Line Creek Operations	LC_DC3	LCO Dry Creek u/s of East Tributary (E288273)	658294	5540918
	LC_DCEF	East Tributary of Dry Creek (E288274)	658259	5541296
	LC_DC1	LCO Dry Creek near mouth (at bridge) (E288270)	656379	5544775
	LC_WLC	West Line Creek (E261958)	660004	5532209
	LC_LCDSSLCC	**LCO Compliance Point - Line Creek immediately downstream of South Line Creek confluence (E297110)**	**659218**	**5530522**
	LC_LC3	Line Creek downstream of West Line Creek (E261958)	660089	5532024
Elkview Operations	EV_EC1	Erickson Creek at Mouth (0200097)	659868	5505171
	EV_GV1	Grave Creek at Bridge	653388	5523508
	EV_DC1	EVO Dry Creek Sediment Pond Decant (E298590)	659398	5517530
	EV_HC1	**EVO Harmer Compliance Point – Harmer Spillway (E102682)**	**657031**	**5522167**
Fording River	FR_FR1	Fording River downstream of Henretta Creek (0200251)	651304	5565451

Table 4-1: Flow Modelling Nodes in the Elk River and Fording River Mainstems and their Tributaries that are of Most Relevance to the Discussion of Model Performance

Operation or General Location	Node ID	Node Description	Location[(a)]	
			Easting	Northing
	FR_FRNTP	Fording River at North Tailings Pond	651121	5561676
	FR_FR2	Fording River upstream of Kilmarnock Creek (0200201)	651781	5559984
	FR_FR4	Fording River between Swift and Cataract creeks (0200311)	652503	5558088
	FR_FRCP1	**FRO Compliance Point - Fording River, 525 m d/s of Cataract Creek (E300071)**	**652823**	**5557220**
	FR_FRABCH	Fording River above Chauncey Creek	655293	5552865
	GH_PC2	Fording River downstream of Porter Creek (E287431)	653751	5555147
	GH_FR1	**GHO Fording River Compliance Point - Upper Fording River, 205 m d/s of Greenhills Creek (0200378)**	**653111**	**5545516**
	LC_LC5	**Fording River downstream of Line Creek (0200028)**	**652977**	**5528919**
Michel Creek	**CM_MC2**	**CMO Compliance Point - Michel Creek d/s of CMO near Andy Goode Creek Junction (E258937)**	**667186**	**5488211**
	EV_MC3	Michel Creek upstream of Erickson Creek (0200203)	659833	5505120
	EV_MC2	**EVO Michel Creek Compliance Point (E300091)**	**654378**	**5510851**
	EV_MC1	Michel Creek upstream of Highway 43 Bridge (0200425)	653590	5511060
Elk River	**GH_ER1**	**Elk River u/s of Boivin Creek (u/s of Fording River) (E206661)**	**649295**	**5543393**
	GH_ERC	**GHO Elk River Compliance Point - Elk River, 220 m d/s of Thompson Creek (E300090)**	**648926**	**5548802**
	EV_ER4	**Elk River u/s of Grave Creek (from Fording River to Michel Creek) (0200389)**	**653149**	**5525960**
	EV_ER1	**Elk River downstream of Michel Creek (0200393)**	**651354**	**5511080**
	RG_ELKORES	**Elk River at Elko Reservoir (E294312)**	**637661**	**5492190**

Table 4-1: Flow Modelling Nodes in the Elk River and Fording River Mainstems and their Tributaries that are of Most Relevance to the Discussion of Model Performance

Operation or General Location	Node ID	Node Description	Location[a]	
			Easting	Northing
	RG_ELKMOUTH	Elk River at Highway 93 near Elko; ECCC station BC08NK0003	633583	5449048
Koocanusa Reservoir	**RG_DSELK**	**Koocanusa Reservoir - South of the Elk River (E300230)**	**627022**	**5445670**

a) NAD 83, Zone 11.

ID = Identification; CMO = Coal Mountain Operations; EVO = Elkview Operations; LCO = Line Creek Operations; LRP = Lower Round Prairie, FRO = Fording River Operations; GHO = Greenhills Operations; d/s = downstream; u/s = upstream; m = metre.

Note: Sites in bold correspond to Order Stations and Compliance Points listed in EMA Permit 107517; Order Stations are also underlined.

4.2 Model Structure

The FC is a sub-catchment-scale water balance model developed using a commercially available, general-purpose simulation software platform called GoldSim (GoldSim Technology Group 2014). The FC relies on mine site information, together with meteorological data and hydrometric monitoring information to estimate flows in mine-affected tributaries, in the Elk River and Fording River. The FC-generated flow information is used as an input to the WQC to estimate constituent concentrations in the receiving environment downstream of mine operations.

At its core, the FC is a modular, sub-catchment scale water balance model that is interconnected at model nodes to function as a watershed-scale flow model. The FC is used to estimate total flows at a given location by adding together contributions from upstream mine-affected and undisturbed sub-catchment areas, while accounting for atmospheric losses, water stored within the sub-catchment areas, mine water management activities, and groundwater interactions.

The FC includes the following modules and calculations, each of which are replicated at individual sub-catchments:

- global climate module
- sub-catchment climate module
- snowmelt runoff module
- waste rock hydrology module
- pit module
- pit seepage calculations
- water management module
- reclamation calculations
- water balance module

Flows from each sub-catchment are linked together in a flow network. This flow network includes a series of model nodes that represent locations with hydrometric monitoring information, confluences with other tributaries and mainstem watercourses, and points of diversion. At model nodes, the following calculations are completed:

- estimates of total flows reporting from sub-catchments to the downstream tributary or mainstem node
- estimates of surface water and groundwater partitioning at tributary or mainstem nodes, where applicable

The flow estimates from the FC involve the development of historical flow predictions. These flow predictions are relied on to calibrate the model. The FC is also used to generate three sets of weekly statistical flow estimates from a multi-realization simulation iteratively using historical climate data. These three sets of flow estimates are used as an input to the WQC to generate a range of future water quality projections.

Existing water quality mitigation facilities are accounted for in the FC. However, future changes to water flows to support future water quality mitigation are modelled using the WQC alone relying on FC-generated flows from individual sub-catchments for a future flow scenario without mitigation.

Each aspect of the FC is discussed in more detail in the sub-sections below.

4.3 Model Input Information

4.3.1 Overview

Data sources considered in the FC consist of:

- meteorological data
- flow data
- sub-catchment and land use data
- mine plan and water management plan information
- surface water – groundwater information
- hydrogeological information
- water quality mitigation information

Each data source is discussed in more detail below.

4.3.2 Meteorological Data

Available meteorological data from the Elk Valley were compiled and reviewed for potential use in the 2020 RWQM. This data compilation and review was focused on the following climate variables: precipitation, air temperature, and snow water equivalent (SWE). The sources of this climate data are summarized in Table 4-2, and the relevant meteorological stations are shown on Figure 4-7.

Table 4-2: Meteorological Data Reviewed and Compiled for the 2020 RWQM

Name	Operated By	Station ID	Coordinates [(a)]		Elevation (masl)	Period of Record
			Easting	Northing		
Elkford	ECCC	1152653	648,999	5,542,927	1370	1972 to 1993
Fernie	ECCC	1152850	639,771	5,483,719	1001	1913 to 2019
Fording Cominco	ECCC	1152899	652,883	5,557,501	1585	1970 to 2017
Sparwood	ECCC	1157630	652,714	5,512,991	1138	1980 to 2019
Sparwood CS	ECCC	1157631	679,345	5,479,791	1138	1980 to 2019
Morrissey Ridge	BC	2C09Q	647,132	5,479,462	1966	1983 to 2019
FRO C Spoil	Teck (Okane)	n/a	651,547	5,559,029	1690	2013 to 2019
FRO Turn Creek Spoil	Teck (Okane)	n/a	652,272	5,566,069	1800	2012 to 2019
FRO Brownie	Teck (RWDI)	n/a	655,866	5,563,061	2253	2013 to 2019
FRO A Spoil	Teck (RWDI)	n/a	650,661	5,562,744	1744	2013 to 2019
FRO Wastewater Treatment	Teck (RWDI)	n/a	653,101	5,557,395	1576	2014 to 2019
GHO North Thompson Creek	Teck (Okane)	n/a	651,875	5,550,651	1800	2012 to 2019
GHO North Thompson Creek	Teck (Okane)	n/a	651,835	5,550,564	1800	2012 to 2019
GHO Rosebowl	Teck (Okane)	n/a	652,174	5,550,429	1920	2012 to 2019

Table 4-2: Meteorological Data Reviewed and Compiled for the 2020 RWQM

Name	Operated By	Station ID	Coordinates [(a)]		Elevation (masl)	Period of Record
			Easting	Northing		
GHO Elkford Elementary School	Teck	n/a	648,056	5,541,543	1335	2010 to 2019
GHO Office	Teck	n/a	652,319	5,550,197	1972	2013 to 2019
LCO West Line Creek	Teck (Okane)	n/a	660,001	5,532,210	1451	2012 to 2019
LCO Mine Service Area	Teck	n/a	661,135	5,535,906	1595	2010 to 2019
LCO Plant Weather Station	Teck	n/a	654,736	5,528,744	1296	2010 to 2019
LCO WLC Bare High Elevation	Teck (Okane)	n/a	658,258	5,535,363	2150	2012 to 2019
LCO WLC Reclaimed Mid Elevation	Teck (Okane)	n/a	658,139	5,535,020	2075	2012 to 2019
EVO Harmer	Teck	n/a	656,284	5,514,206	1915	2013 to 2019
EVO Sparwood Heights	Teck	n/a	679,345	5,479,791	1135	2018 to 2019
EVO Bodie Rock Drain	Teck	n/a	655,908	509,545	1470	2011 to 2019
EVO Erickson Creek	Teck	n/a	660,652	5,506,402	1347	2019 to 2019
EVO Andy Good Spoil	Teck	n/a	667,586	5,488,250	1490	2011 to 2019
Hosmer	Teck	n/a	647,490	5,495,075	1060	2013 to 2019

a) Universal Transverse Mercator (UTM) NAD83, Zone 11N.

BC = British Columbia, ECCC = Environment and Climate Change Canada, EVO = Elkview Operations, FRO = Fording River Operations, GHO = Greenhills Operations, LCO = Line Creek Operations.

n/a = not available.

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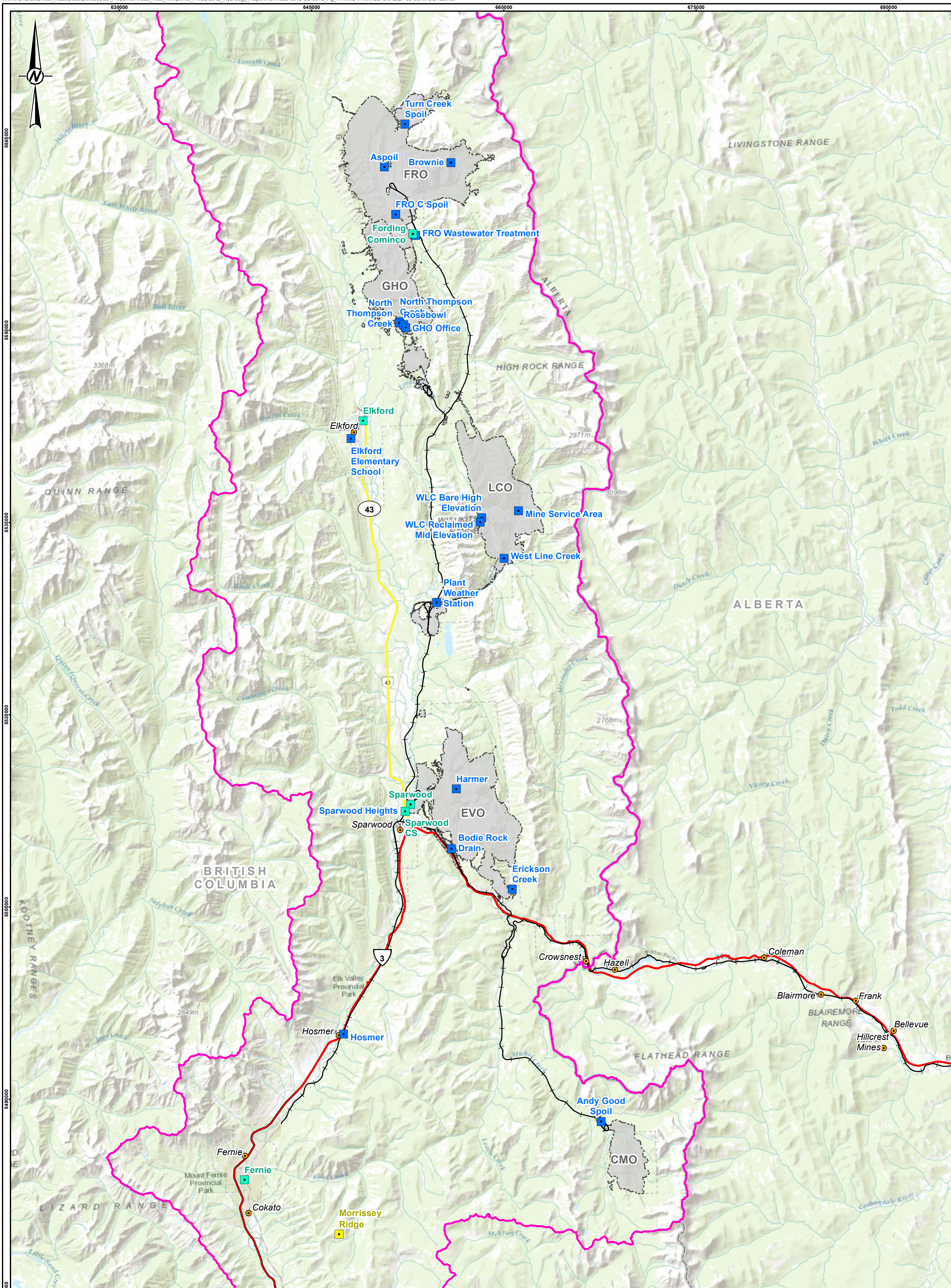

LEGEND

METEOROLOGICAL STATION

- TECK COAL LIMITED STATION
- ENVIRONMENT CANADA STATION
- BC STATION
- CITY/TOWN/COMMUNITY
- CANADIAN PACIFIC RAILWAY
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- MINE PERMIT BOUNDARY
- ELK RIVER WATERSHED BOUNDARY

0 5 10
1:285,000 KILOMETRES

NOTE(S)

REFERENCE(S)
1. BASE DATA: CANVEC, 2018
2. TECK WATER NETWORK AND WATER MANAGEMENT DATA, 2019-09-26
3. BASEMAP: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 11N

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APPROVED	SK

PROJECT
2020 REGIONAL WATER QUALITY MODEL UPDATE

TITLE
METEOROLOGICAL STATIONS IN THE ELK RIVER WATERSHED

PROJECT NO.	CONTROL	REV.	FIGURE
18111630	0012	0	4-7

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As shown in Table 4-2, available data for the Elk Valley include records from a network of regional and local climate stations. This network includes climate stations that are operated by ECCC, BC Wildfire, and Teck (including consultants such as Okane Consultants Inc. [OKC] and Rowan Williams Davies and Irwin [RWDI]). There are eight ECCC climate stations that include historical year-round daily data for the Elk River watershed, with periods of record ranging from 12 to 50 years. The methods to incorporate the available information in the 2020 RWQM are described in Section 4.4 and Section 4.5.

4.3.3 Flow Data

Available hydrometric (surface flow) data from the Elk Valley were compiled and reviewed for potential use in the 2020 RWQM. The surface flow data are available from active and discontinued hydrometric stations, primarily from two data sources:

- Environment and Climate Change Canada – continuous flow data from regional Water Survey of Canada hydrometric stations (Figure 4-8).
- Teck – continuous and/or instantaneous flow data from hydrometric stations at local tributaries near the mining operations (Figure 4-9).

The Environment and Climate Change Canada flow records are summarized in Table 4-3. Teck measures flows in several watersheds, as listed in Table 4-4 (Fording River Operations), Table 4-5 (Greenhills Operations), Table 4-6 (Line Creek Operations), Table 4-7 (Elkview Operations), and Table 4-8 (Coal Mountain Operations). Teck's five operations in the Elk Valley have over 120 permitted monitoring stations with flow monitoring requirements. Many Teck-operated hydrometric stations are equipped with staff gauges (or water level recorders) and rely on stage (level) - discharge (flow) relationships to estimate flow (KWL 2017). Other Teck-operated hydrometric stations are not instrumented. Instantaneous (spot) flow measurements are collected at these locations (typically along with water quality sampling). For each Teck station in the following tables, comments have been included to address the specific requirements of Section 10.9 of EMA Permit 107517, including frequency of flow measurements, completeness of data record, and method of use in the FC. Measurement frequency may be instantaneous (collected weekly or monthly) or continuous (sub-hourly or daily) and can vary from year to year and by season. The completeness of the data record for the purpose of modelling is defined as "poor" if the data record contains many gaps that span several consecutive weeks or months, "fair" if some good data years are interspersed with data gaps, or "good" if there are few or no gaps at a weekly / monthly frequency.

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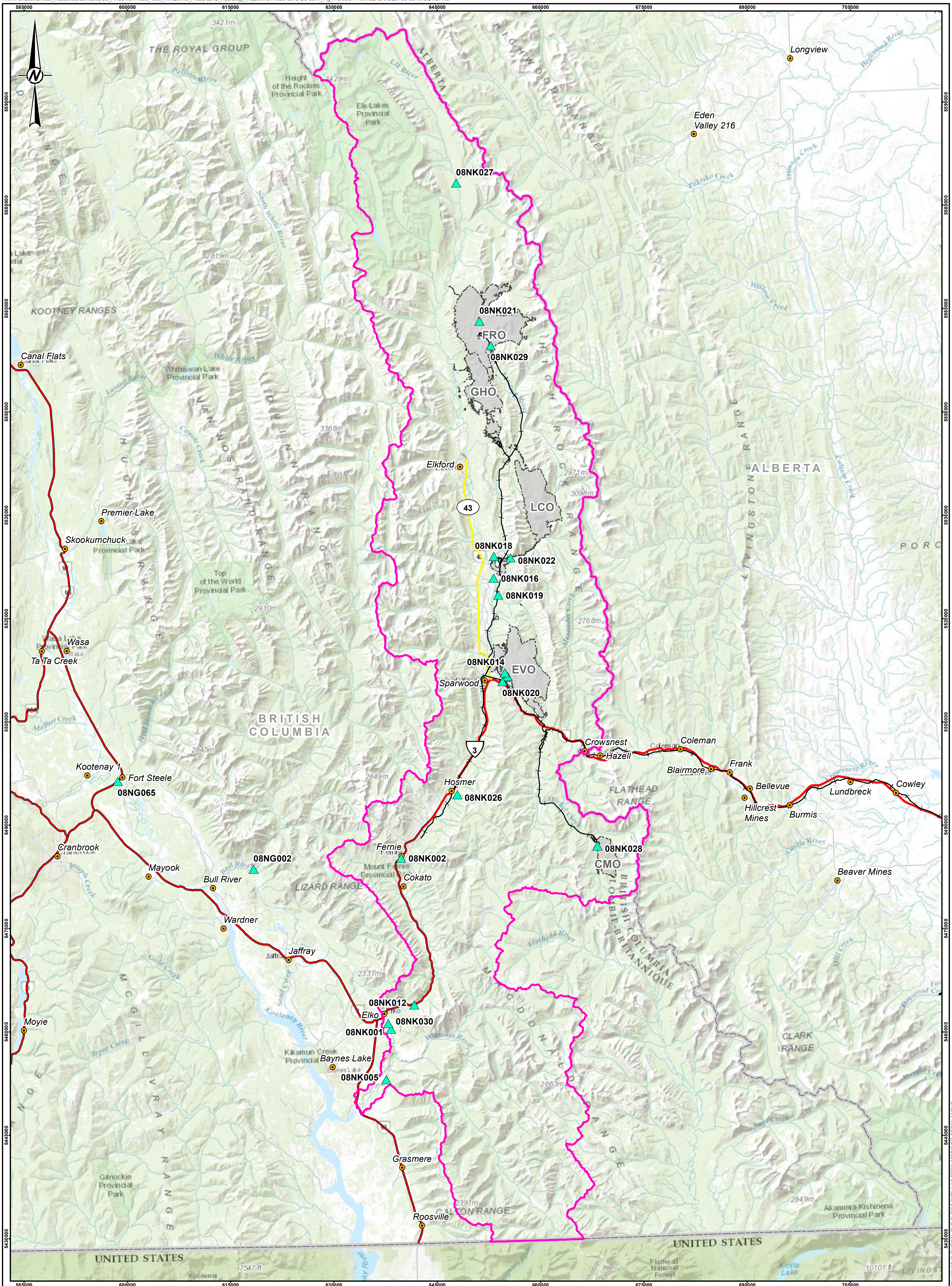

LEGEND

- ▲ ENVIRONMENT CANADA HYDROMETRIC STATION
- ● CITY/TOWN/COMMUNITY
- CANADIAN PACIFIC RAILWAY
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- MINE PERMIT BOUNDARY
- ELK RIVER WATERSHED BOUNDARY

0 10 20

1:525,000 KILOMETRES

NOTE(S)

REFERENCE(S)
1. BASE DATA: CANVEC, 2018
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3. BASEMAP: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 11N

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PROJECT
2020 REGIONAL WATER QUALITY MODEL UPDATE

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TITLE
ENVIRONMENT AND CLIMATE CHANGE CANADA FLOW MONITORING STATIONS IN THE ELK RIVER WATERSHED

PROJECT NO.	CONTROL	REV.	FIGURE
18111630	0012	0	4-8

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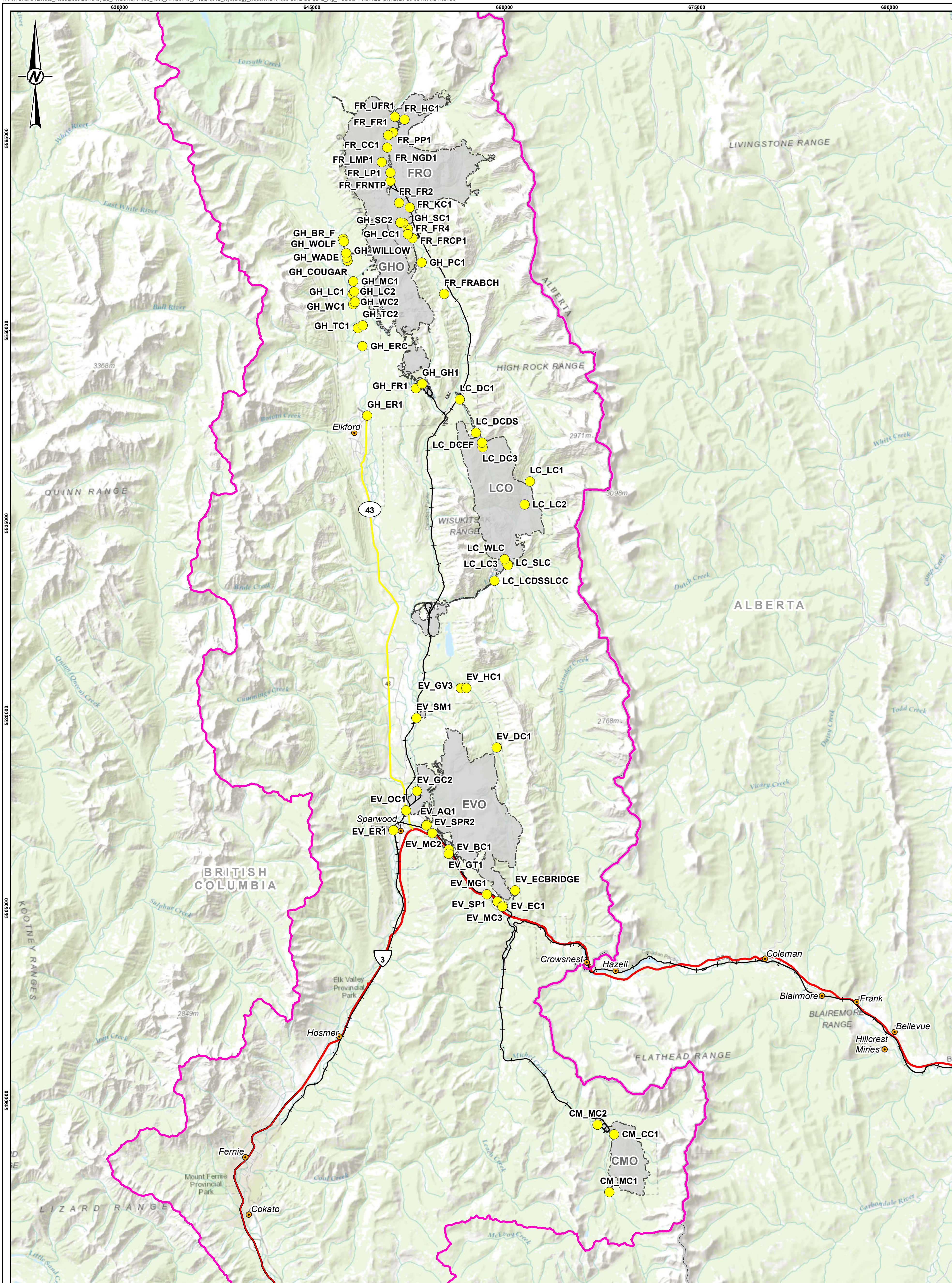

LEGEND

- TECK FLOW MONITORING STATIONS
- CITY/TOWN/COMMUNITY
- CANADIAN PACIFIC RAILWAY
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- MINE PERMIT BOUNDARY
- ELK RIVER WATERSHED BOUNDARY

0 5 10

1:285,000 KILOMETRES

NOTE(S)

REFERENCE(S)

1. BASE DATA: CANVEC, 2018
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3. BASEMAP: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 11N

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PROJECT
2020 REGIONAL WATER QUALITY MODEL UPDATE

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TITLE
SOME OF THE TECK FLOW MONITORING STATIONS IN THE ELK RIVER WATERSHED

PROJECT NO.	CONTROL	REV.	FIGURE
18111630	0012	0	4-9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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Table 4-3: Long-term (>5 years) Environment Canada and Climate Change Flow Monitoring Data in the Elk River Watershed

Station ID	Station Description	Teck Station ID (EMS ID) (a)	Order / Compliance Station?	Type	Drainage Area (km^2)	Status	Start of Record	End of Record (b)	Number of Years	Frequency	Data Completeness (%)	Data Use
08NK001	Elk River at Elko	N/A	Yes	Regulated	3550	Discontinued	1914	1944	27	Continuous	83%	Not used; available data record does not overlap with time period of interest.
08NK002	Elk River at Fernie	RG_ELKFERNIE	No	Unregulated	3090	Active	1970	2019	50	Continuous	100%	Regional input for scaling methods
08NK005	Elk River at Phillips Bridge	RG_ELKPHILLIPS (E294311)	No	Regulated	4450	Discontinued	1924	1996	73	Continuous	98%	Regional input for scaling methods
08NK012	Elk River at Stanley Park	N/A	No	Unregulated	3520	Discontinued	1944	1969	26	Miscellaneous	100%	Not used; available data record does not overlap with time period of interest.
08NK013	Aqueduct Creek near Natal	N/A	No	Unregulated	1.19	Discontinued	1947	1952	6	Seasonal	31%	Not used; available data record does not overlap with time period of interest.
08NK014	Qualtieri Creek near Natal	N/A	No	Unregulated	0.62	Discontinued	1947	1951	5	Seasonal	52%	Not used; available data record does not overlap with time period of interest.
08NK016	Elk River near Natal	EV_ER4 (200027)	Yes	Unregulated	1840	Active	1950	2019	70	Continuous	98%	Regional input for scaling methods
08NK018	Fording River at the Mouth	LC_LC5 (0200396)	Yes	Unregulated	621	Active	1970	2019	49	Continuous	100%	Model calibration
08NK019	Grave Creek at the Mouth	EV_GV1	No	Unregulated	83.9	Discontinued	1970	1999	30	Continuous	99%	Model calibration
08NK020	Michel Creek below Natal	EV_MC2 (E300091)	Yes	Unregulated	637	Discontinued	1970	1996	27	Continuous	98%	Regional input for ranked regression method
08NK021	Fording River below Clode Creek	FR_DSCC1	No	Unregulated	104	Discontinued	1971	1995	24	Continuous	96%	Not used; dataset with greater overlap with time period of interest available from FR_FRNTP
08NK022	Line Creek at the Mouth	LC_LC4	No	Unregulated	138	Active	1971	2019	47	Continuous	100%	Model calibration
08NK026	Hosmer Creek above Diversion	N/A	No	Unregulated	6.4	Active	1981	2018	36	Continuous	98%	Not used; flows through Hosmer Creek are not explicitly simulated in the 2020 RWQM.
08NK027	Elk River below Weary Creek	N/A	No	Unregulated	334	Discontinued	1982	1996	15	Continuous	99%	Not used; datasets with greater overlap with time period of interest available from other Elk River stations
08NK028	Michel Creek above Corbin Creek	CM_MC1	No	Unregulated	35.9	Discontinued	1984	1995	12	Seasonal	52%	Not used; Coal Mountain Operation not explicitly included in 2020 RWQM
08NK029	Kilmarnock Creek near the Mouth	FR_KC1	No	Unregulated	43	Discontinued	1984	1995	12	Seasonal	68%	Model calibration
08NK030	Elk River below Elk Dam Diversion	RG_ELKORES (E294312)	Yes	Regulated	N/A	Active	2009	2015	7	Continuous	14%	Not used; available data record is limited.
08NG002	Bull River near Wardner	N/A	No	Unregulated	1520	Active	1914	2019	103	Continuous	93%	Regional input
08NG065	Kootenay River near Fort Steele	N/A	No	Unregulated	11500	Active	1963	2019	57	Continuous	99%	Regional input

a) EMS = Environmental Monitoring Station.
b) 2019 data are preliminary.
N/A - not applicable.

Table 4-4: Teck Fording River Operations Flow Monitoring Data Reviewed for the Flow Component

Teck Station ID	Station Description	Order / Compliance Station?	2018YE Drainage Area (km^2)	2018YE Disturbed Area (km^2)	Status	Period of Record	Number of Years	Frequency [a]	Data Completeness [b]	Surficial Conditions [c]	Data Use
FR_UFR1	Fording River upstream of Henretta Creek (E216777)	No	39.1	0.0	Active	2008-2019	12	Instantaneous (spot)	Poor - 2012, 2013, and 2014 are the only complete years, limited winter flows.	Alluvial valley-bottom sediments	Model Performance Evaluation
FR_HC1	Henretta Creek upstream of Fording River (E216778)	No	49.3	4.5	Active	1996-2019	24	Mix of instantaneous and continuous daily flows	Fair - (good peak data but limited winter flows)	Alluvial valley-bottom sediments	Model Performance Evaluation
FR_PP1	Post Sediment Pond Decant (E304750)	No	4.1	1.5	Active	2018-2019	1	Instantaneous (spot)	Fair - gaps in the winter months	Pond decant in tributary upland setting	Model Performance Evaluation
FR_CC1	Clode Creek Sediment Pond Decant (E102481)	No	8.7	6.2	Active	1995-2019	25	Mix of instantaneous and continuous daily flows	Good - less than 6% of months missing data	Pond decant in Fording alluvial valley-bottom sediments	Model Performance Evaluation
FR_LMP1	Lake Mountain Sediment Ponds (E306924)	No	10.7	4.1	Active	2016-2019[e]	3	Instantaneous (spot)	Fair - gaps in the winter months	Pond decant in tributary upland setting	Model Performance Evaluation
FR_NGD1	North Greenhills Diversion Ditch	No	-	-	Discontinued	1995-2018	24	Instantaneous (spot)	Fair - gaps in the winter months	Pond outlet in tributary valley-bottom setting	Model Performance Evaluation
FR_LP1	Liverpool Sediment Pond Decant (E304835)	No	5.4	5.3	Active	2016-2019[e]	3	Instantaneous (spot)	Fair - gaps in the winter months	Pond decant in tributary upland setting	Model Performance Evaluation
GH_SC1 and GH_SC2	Swift Creek Settling Pond Discharge and Sediment Pond Bypass (E221329 and E105061)	No	5.1	3.8	Active	1995-2019	25	Instantaneous (spot)	Fair - winter gaps (October to March; GH_SC1). Fair – summer data gaps (May to October; GH_SC2)	Pond decant in tributary valley bottom setting	Model Performance Evaluation
FR_KC1	Kilmarnock Creek downstream of Rock Drain (0200252)	No	43.6	13.3	Active	1995-2019	25	Mix of instantaneous and continuous daily flows	Fair - good peak data but limited historical winter flows. Recent years have winter flow data.	Tributary alluvial valley bottom sediments	Model Performance Evaluation
GH_CC1	Cataract Creek Sediment Pond Decant (0200384)	No	3.6	3.4	Active	1993-2019	27	Instantaneous (spot)	Good - only 6% of months without a flow measurement	Pond decant in tributary valley bottom setting	Model Performance Evaluation
FR_FR1	Fording River downstream of Henretta Creek (0200251)	Yes	89.0	4.5	Active	1996-1998, 2009-2019	14	Instantaneous (spot)	Fair - gaps in the winter months	Fording alluvial valley bottom sediments	Model Performance Evaluation
FR_FRNTP	Fording River at North Tailings Pond	No	126.4	26.0	Active	1997-2019	23	Mix of instantaneous and continuous daily flows	Fair - most winter flows missing, no winter flows from 1999 to 2007	Fording alluvial valley bottom sediments	Model Performance Evaluation
FR_FR2	Fording River upstream of Kilmarnock Creek (0200201)	No	131.1	30.8	Active	1996-2019	24	Instantaneous (spot)	Fair - gaps in the winter months	Fording alluvial valley bottom sediments	Model Performance Evaluation
FR_FR4	Fording River downstream of Swift Creek, upstream of Cataract Creek	No	182.4	47.9	Active	2008-2019	12	Instantaneous (spot)	Poor - many gaps in the winter months	Fording alluvial valley bottom sediments	Model Performance Evaluation
FR_FRCP1	FRO Compliance Point- Fording River downstream of Cataract Creek (E300071)	Yes	187.9	51.8	Active	2015-2019	5	Instantaneous (spot)	Fair - gaps in the winter months	Fording alluvial valley bottom sediments	Model Performance Evaluation
FR_FRABCH	Fording River upstream of Chauncey Creek	No	214.5	53.2	Active	2017-2019	3	Instantaneous (spot)	Fair - gaps in the winter months	Fording alluvial valley bottom sediments	Model Performance Evaluation

a) **Frequency** of flow measurements at a station may be instantaneous measurements collected at a weekly or monthly frequency, or continuous daily measurements. Frequency may vary from year to year and by season.
b) **Completeness** of data record is defined as "poor" (spotty data record with many gaps extending several consecutive weeks or months), "fair" (a combination of some gaps and some good data years) or "good" (few or no gaps at a weekly / monthly frequency)

Table 4-5: Teck Greenhills Operations Flow Monitoring Data in the Elk River Watershed Reviewed for the Flow Component

Teck Station ID	Station Description	Order / Compliance Station?	2018YE Drainage Area (km^2)	2018YE Disturbed Area (km^2)	Status	Period of Record	Number of Years	Frequency [a]	Data Completeness [b]	Surficial Conditions	Data Use
GH_BR_F	Branch F Creek at LRP Road (E287437)	No	1.3	0.0	Active	2009-2019	11	Instantaneous (spot)	Poor - Few winter flows, short data record	Tributary valley bottom setting	Model Performance Evaluation
GH_WOLF	Wolf Creek at LRP Road (E287436)	No	0.9	0.0	Active	2009-2019	11	Instantaneous (spot)	Poor - Few winter flows, short data record	Tributary valley bottom setting	Model Performance Evaluation
GH_WILLOW	Willow Creek at LRP Road (E287434)	No	2.3	0.0	Active	2009-2019	11	Instantaneous (spot)	Poor - Few winter flows, short data record	Tributary valley bottom setting	Model Performance Evaluation
GH_WADE	Wade Creek at LRP Road (E287433)	No	0.6	0.0	Active	2009-2019	11	Instantaneous (spot)	Poor - Few winter flows, short data record	Tributary valley bottom setting	Model Performance Evaluation
GH_COUGAR	Cougar Creek at LRP Road (E287432)	No	0.8	0.1	Active	2009-2019	11	Instantaneous (spot)	Poor - Few winter flows, short data record	Tributary valley bottom setting	Model Performance Evaluation
GH_MC1	Mickelson Creek (0200388)	No	1.3	0.3	Active	1993-2019	27	Instantaneous (spot)	Fair - Adequate data in high flow months but gaps in winter flows	Tributary valley bottom setting	Model Performance Evaluation
GH_LC1	Leask Creek Sediment Pond Decant (E257796)	No	5.4	4.9	Active	1993-2019	27	Instantaneous (spot)	Fair - Adequate data in high flow months but gaps in winter flows	Pond decant in Elk River alluvial valley bottom sediments	Model Performance Evaluation
GH_LC2	Leask Creek u/s of Pond Inlet	No	5.4	4.9	Active	2005-2019	15	Instantaneous (spot)	Fair - Adequate data in high flow months but gaps in winter flows	Tributary valley bottom setting	Model Performance Evaluation
GH_WC1	Wolfram Creek Sediment Pond Decant (E257795)	No	6.2	5.3	Active	1993-2019	27	Instantaneous (spot)	Fair - Adequate data in high flow months but gaps in winter flows	Pond decant in Elk River alluvial valley bottom sediments	Model Performance Evaluation
GH_WC2	Wolfram Creek upstream of Sediment Pond inflow	No	6.2	5.3	Active	2005-2019	15	Instantaneous (spot)	Fair - Adequate data in high flow months but gaps in winter flows	Tributary valley bottom setting	Model Performance Evaluation
GH_TC1	Thompson Creek at LRP Road (E102714)	No	12.1	2.8	Active	2006-2019	14	Instantaneous (spot)	Good - Adequate data, gaps in 17% of months, mostly in winter	Tributary valley bottom setting	Model Performance Evaluation
GH_TC2	Lower Thompson Creek Sediment Pond Decant (E207436)	No	12.1	2.8	Active	1994-2019	26	Instantaneous (spot)	Fair - Adequate data in high flow months but gaps in winter flows	Pond decant in Elk River alluvial valley bottom sediments	Model Performance Evaluation
GH_PC1	Porter Creek Sediment Pond Decant (0200385)	No	1.8	1.0	Active	1993-2019	27	Instantaneous (spot)	Good - only 6% of months without a flow measurement	Tributary valley bottom setting	Model Performance Evaluation
GH_GH1	Greenhills Creek Sediment Pond Decant (E102709)	No	15.2	3.8	Active	1993-2016	23	Mix of instantaneous and continuous daily flows	Good - Adequate data, gaps in 16% of months, mostly in winter	Pond decant in Fording alluvial valley bottom sediments	Model Performance Evaluation
GH_FR1	Fording River downstream of Greenhills Creek (0200378)	No	407.5	59.5	Discontinued	2017-2018	2	Continuous	Poor - No winter flows, short data record	Fording alluvial valley bottom sediments	Model Performance Evaluation

Table 4-5: Teck Greenhills Operations Flow Monitoring Data in the Elk River Watershed Reviewed for the Flow Component

Teck Station ID	Station Description	Order / Compliance Station?	2018YE Drainage Area (km²)	2018YE Disturbed Area (km²)	Status	Period of Record	Number of Years	Frequency [a]	Data Completeness [b]	Surficial Conditions	Data Use
GH_ERC	Elk River downstream of Thompson Creek / GHO Elk River Compliance Point (E300090)	No	903.0	13.5	Discontinued	2017-2018	2	Continuous	Poor - No winter flows, short data record	Elk River alluvial valley bottom sediments	Model Performance Evaluation
GH_ER1	Elk River upstream of Boivin Creek (E206661)	No	977.0	13.7	Discontinued	2017-2018	2	Continuous	Poor - No winter flows, short data record	Elk River alluvial valley bottom sediments	Model Performance Evaluation

a) **Frequency** of flow measurements at a station may be instantaneous measurements collected at a weekly or monthly frequency, or continuous daily measurements. Frequency may vary from year to year and by season.
b) **Completeness** of data record is defined as "poor" (spotty data record with many gaps extending several consecutive weeks or months), "fair" (a combination of some gaps and some good data years) or "good" (few or no gaps at a weekly / monthly frequency).

Table 4-6: Teck Line Creek Operations Flow Monitoring Data in the Elk River Watershed Reviewed for the Flow Component

Teck Station ID	Station Description	Order / Compliance Station?	2018YE Drainage Area (km²)	2018YE Disturbed Area (km²)	Status	Period of Record	Number of Years	Frequency [a]	Data Completeness [b]	Surficial Conditions	Data Use
LC_LC1	Upper Line Creek upstream of MSA North Pit (E126142)	No	27.9	0.0	Active	2011-2019	8	Mix of instantaneous and continuous daily flows	Poor - gaps in winter months, missing 2013 data, limited number of years of data	Tributary valley bottom setting	Model Performance Evaluation
LC_LC2	Line Creek upstream of Rock Drain (0200335)	No	27.9	0.0	Active	2007-2019	13	Mix of instantaneous and continuous daily flows	Good – since 2014	Tributary valley bottom setting	Model Performance Evaluation
LC_WLC	West Line Creek (E261958)	No	10.0	2.7	Active	2001-2019	19	Mix of instantaneous and continuous daily flows	Good - since 2009	Tributary valley bottom setting / Line Creek alluvial sediments	Model Performance Evaluation
LC_LC3	Line Creek downstream of West Line Creek (0200337)	No	71.2	18.7	Active	2005-2019	15	Mix of instantaneous and continuous daily flows	Good – since 2012	Tributary valley bottom / Line Creek alluvial sediments	Model Performance Evaluation
LC_SLC	South Line Creek West Side of Main Rock Drain (E282149)	No	40.6	0.0	Active	2015-2019	5	Instantaneous (spot) from 2015	Poor- gaps throughout monitoring period	Tributary valley bottom setting	Model Performance Evaluation
LC_LCDSSLCC	Line Creek downstream of South Line Creek confluence (E297110)	Yes	111.8	18.7	Active	2015-2019	5	Mix of instantaneous and continuous daily flows	Poor – data is not continuous	Tributary valley bottom setting	Model Performance Evaluation
LC_DC3	Dry Creek upstream of East Tributary Creek (E288273)	No	8.3	2.0	Active	2015-2019	5	Instantaneous (spot)	Fair	Upland tributary channel	Model Performance Evaluation
LC_DCEF	East Tributary of Dry Creek (E288274)	No	7.0	0.0	Active	2012-2019	8	Mix of instantaneous and continuous daily flows	Fair - few winter gaps in 2012-2014 and 2018	Tributary valley bottom setting	Model Performance Evaluation
LC_DCDS	Dry Creek downstream of Ponds (E295210)	No	15.3	2.0	Active	2014-2019	6	Instantaneous (spot)	Poor - few years of data, many gaps during winter months	Tributary valley bottom setting	Model Performance Evaluation
LC_DC1	Dry Creek near the Mouth (at bridge) (E288270)	No	25.6	2.1	Active	2011-2019	9	Mix of instantaneous and continuous daily flows	Fair - few years of data, many gaps in daily data, especially in winter (December to May). Missed peak flows in years 2014 to 2016.	Tributary valley bottom / Fording alluvial valley bottom sediments	Model Performance Evaluation

a) **Frequency** of flow measurements at a station may be instantaneous measurements collected at a weekly or monthly frequency, or continuous daily measurements. Frequency may vary from year to year and by season.
b) **Completeness** of data record is defined as "poor" (spotty data record with many gaps extending several consecutive weeks or months), "fair" (a combination of some gaps and some good data years) or "good" (few or no gaps at a weekly / monthly frequency)

Table 4-7: Teck Elkview Operations Flow Monitoring Data in the Elk River Watershed Reviewed for the Flow Component

Teck Station ID	Station Description	Order / Compliance Station?	2018YE Drainage Area (km^2)	2018YE Disturbed Area (km^2)	Status	Period of Record	Number of Years	Frequency [a]	Data Completeness [b]	Surficial Conditions	Data Use
EV_DC1	EVO Dry Creek Sediment Pond Decant (E298590)	No	8.6	4.7	Active	2005-2019	15	Mix of instantaneous and continuous daily flows	Poor - records started in 2005 but there is no data from 2006 to 2008, with no winter flows from 2009 to 2012.	Pond decant in tributary valley bottom setting	Model Performance Evaluation
EV_GV3	Grave Creek upstream of Harmer Creek	No	24.4	0.0	Discontinued	2013-2015	3	Instantaneous (spot)	Poor – monthly measurements only. Winter flow data missing	Tributary valley bottom setting	Not used; available dataset is limited.
EV_HC1	EVO Harmer Creek Compliance Point – Harmer Spillway (E102682)	Yes	38.3	4.9	Active	1992-2019	24	Mix of instantaneous and continuous daily flows	Fair – good recent dataset (after 2001) missing 1997 to 2000 data.	Pond spillway in tributary valley bottom setting	Model Performance Evaluation
EV_SM1	Six Mile Creek Sediment Pond Decant (E102681)	No	3.9	0.4	Active	1992-2019	28	Instantaneous (spot)	Fair – Good recent dataset from 2009. Mostly weekly flow measurements	Pond decant in tributary valley bottom / Elk River alluvial sediments	Not used; small tributary of limited relevance to model calibration.
EV_GC2	Goddard Creek Sediment Pond Decant (E208043)	No	7.3	4.1	Active	1992-2019	27	Mix of instantaneous and continuous daily flows	Good - few winter gaps, daily data from 2009 onwards. Limited data from 1998 to 2000.	Pond decant in tributary valley bottom / Elk River alluvial sediments	Model Performance Evaluation
EV_OC1	Otto Creek Sediment Pond Decant (E102679)	No	3.6	1.5	Active	1992-2019	20	Instantaneous (spot)	Fair– data missing 1997-2004. Data more consistent from 2005 onwards	Pond decant in tributary valley bottom / Elk River alluvial sediments	Not used; small tributary of limited relevance to model calibration.
EV_ECBridge	Erickson Creek at the Bridge	No	28.9	9.4	Active	2018-2019	2	Instantaneous (spot)	Fair- monthly measurements in 2018. weekly flow measurements in 2019	Upland tributary valley bottom setting	Model Performance Evaluation
EV_EC1	Erickson Creek at Mouth (0200097)	No	31.9	9.7	Active	1996-2019	16	Mix of instantaneous and continuous daily flows	Fair - major data gaps and missing years 1997 to 2004 but recent data are consistent. Before 2011 some high flows were not measured due to safety issues at the measuring section.	Open channel in tributary valley bottom sediments	Model Performance Evaluation
EV_SP1	South Pit Creek Sediment Pond Decant (E296311)	No	1.4	1.1	Active	2007-2019	13	Instantaneous (spot)	Fair – Good recent dataset from 2015. Mostly weekly flow measurements	Pond decant in tributary valley bottom / Michel Creek alluvial sediments	Not used; small tributary of limited relevance to model calibration
EV_MG1	Milligan Creek Sediment Pond Decant (E208057)	No	2.0	0.4	Active	1992-2019	26	Instantaneous (spot)	Fair – Good recent dataset from 2009. Mostly weekly flow measurements	Pond decant in tributary valley bottom / Michel Creek alluvial sediments	Not used; small tributary of limited relevance to model calibration
EV_GT1	Gate Creek Sediment Pond Decant (E206231)	No	4.3	2.7	Active	1993-2019	19	Instantaneous (spot)	Poor - data before 2005 is uncharacteristically low or missing altogether. 1997-2003 and 2013 missing	Pond decant in Michel Creek alluvial valley bottom sediments	Model Performance Evaluation
EV_BC1	Bodie Creek Sediment Pond Decant (E102685)	No	11.5	11.2	Active	1992-2019	27	Instantaneous (spot)	Fair - winter gaps from 1997 to 1999, missing 2008 data	Pond decant in Michel Creek alluvial valley bottom sediments	Model Performance Evaluation
EV_AQ1 (replaced by EV_AQ6)	Aqueduct Creek at GN Road (E210369, E312170)	No	3.2	0.5	Active	2009-2019	9	Instantaneous (spot)	Poor - Missing most 2009 to 2013 data	Lined pond decant in Michel Creek alluvial valley bottom sediments	Model Performance Evaluation

Table 4-7: Teck Elkview Operations Flow Monitoring Data in the Elk River Watershed Reviewed for the Flow Component

Teck Station ID	Station Description	Order / Compliance Station?	2018YE Drainage Area (km^2)	2018YE Disturbed Area (km^2)	Status	Period of Record	Number of Years	Frequency [a]	Data Completeness [b]	Surficial Conditions	Data Use
EV_SPR2	Spring Creek at Mouth (E298594)	No	0	0	Active	2014-2019	6	Instantaneous (spot)	Good data from 2014-2019. Monthly flow measurements in recent years	Spring in upland tributary	Regional input
EV_MC3	Michel Creek upstream of Erickson Creek (0200203)	No	557.7	9.2	Active	2019	1	Instantaneous (spot)	Fair- winter data missing, weekly flows measurements Mar - Oct	Michel Creek alluvial valley bottom sediments	Model Performance Evaluation
EV_MC2	EVO Michel Creek Compliance Point - Michel Creek at Hwy 3 Bridge (E300091)	Yes	637.0	34.3	Active	2013-2019	7	Continuous daily flow year-round since February 2013.	Fair - missing Jul to Dec 2013; gaps in winter data.	Michel Creek alluvial valley bottom sediments	Model Performance Evaluation
EV_ER1	Elk River downstream of Michel Creek (0200393)	Yes	2813.0	142.6	Discontinued	2017-2018	2	**Continuous daily flow**	Fair- missing some winter 2018 data	Elk River alluvial valley bottom sediments	Model Performance Evaluation

a) **Frequency** of flow measurements at a station may be instantaneous measurements collected at a weekly or monthly frequency, or continuous daily measurements. Frequency may vary from year to year and by season.
b) **Completeness** of data record is defined as "poor" (spotty data record with many gaps extending several consecutive weeks or months), "fair" (a combination of some gaps and some good data years) or "good" (few or no gaps at a weekly / monthly frequency).

Table 4-8: Teck Coal Mountain Operations Data in the Elk River Watershed Reviewed for the Flow Component

Teck Station ID	Station Description	Order / Compliance Station?	2018YE Drainage Area (km^2)	2018YE Disturbed Area (km^2)	Status	Period of Record	Number of Years	Frequency [a]	Data Completeness [b]	Surficial Conditions	Data Use
CM_CC1	Corbin Creek downstream of CMO (0200209)	No	28.6	9.2	Active	2003-2019	13	Mix of instantaneous and continuous daily flows	Fair - missing years 2005 to 2007 but daily flow after 2012 is reliable	Pond outlet in tributary valley bottom sediments	Model Performance Evaluation
CM_MC1	Michel Creek upstream of CMO (E258175)	No	35.6	0.0	Active	2008-2019	12	Mix of instantaneous and continuous daily flows	Fair - missing most 2008 and winter flows from 2013 to 2014 but daily flow after 2012 is reliable	Tributary valley bottom sediments	Model Performance Evaluation
CM_MC2	Michel Creek downstream of CMO near Andy Goode Cr. Junction (E258937)	Yes	67.7	9.2	Active	2008-2019	12	Instantaneous (spot)	Poor – missing most winter flows, short period of record.	Michel Creek alluvial valley bottom sediments	Model Performance Evaluation

a) **Frequency** of flow measurements at a station may be instantaneous measurements collected at a weekly or monthly frequency, or continuous daily measurements. Frequency may vary from year to year and by season.
b) **Completeness** of data record is defined as "poor" (spotty data record with many gaps extending several consecutive weeks or months), "fair" (a combination of some gaps and some good data years) or "good" (few or no gaps at a weekly / monthly frequency).

4.3.4 Mine Plan Information, Sub-Catchment and Land Use Information

Changes over time in sub-catchment areas, land use and land cover are accounted for in the 2020 RWQM. These changes rely on information from several data sources, including:

- Historical topography
- LiDAR data
- Air photos
- Mine plans (e.g., mined out surfaces from mine plans)
- Historical waste rock spoil progression

The identified information was used to delineate sub-catchment areas, delineate land types within sub-catchments, develop pit characteristics, characterize waste rock spoils, and account for the effects of reclamation.

4.3.5 Mine Water Management Information

The 2020 RWQM considers the influence of site water management infrastructure, including diversion channels and/or pipelines for clean and mine-influenced water, pumps for pit dewatering, water stored in flooded pits, and water used on site for dust suppression, coal washing and other industrial uses. This information was obtained from several sources, including:

- Mine water management plans (Teck 2020a, Teck 2020b, Teck 2020c, Teck 2020d)
- Discussions with site personnel
- Historical data records
- Water licences

The identified information was used to develop a conceptual understanding of water movement at the site, which was relied on to model the movement of water between sub-catchments, pit pumping (dewatering, make-up water use), consumption for dust suppression, process water use, and flooding of pits (at closure).

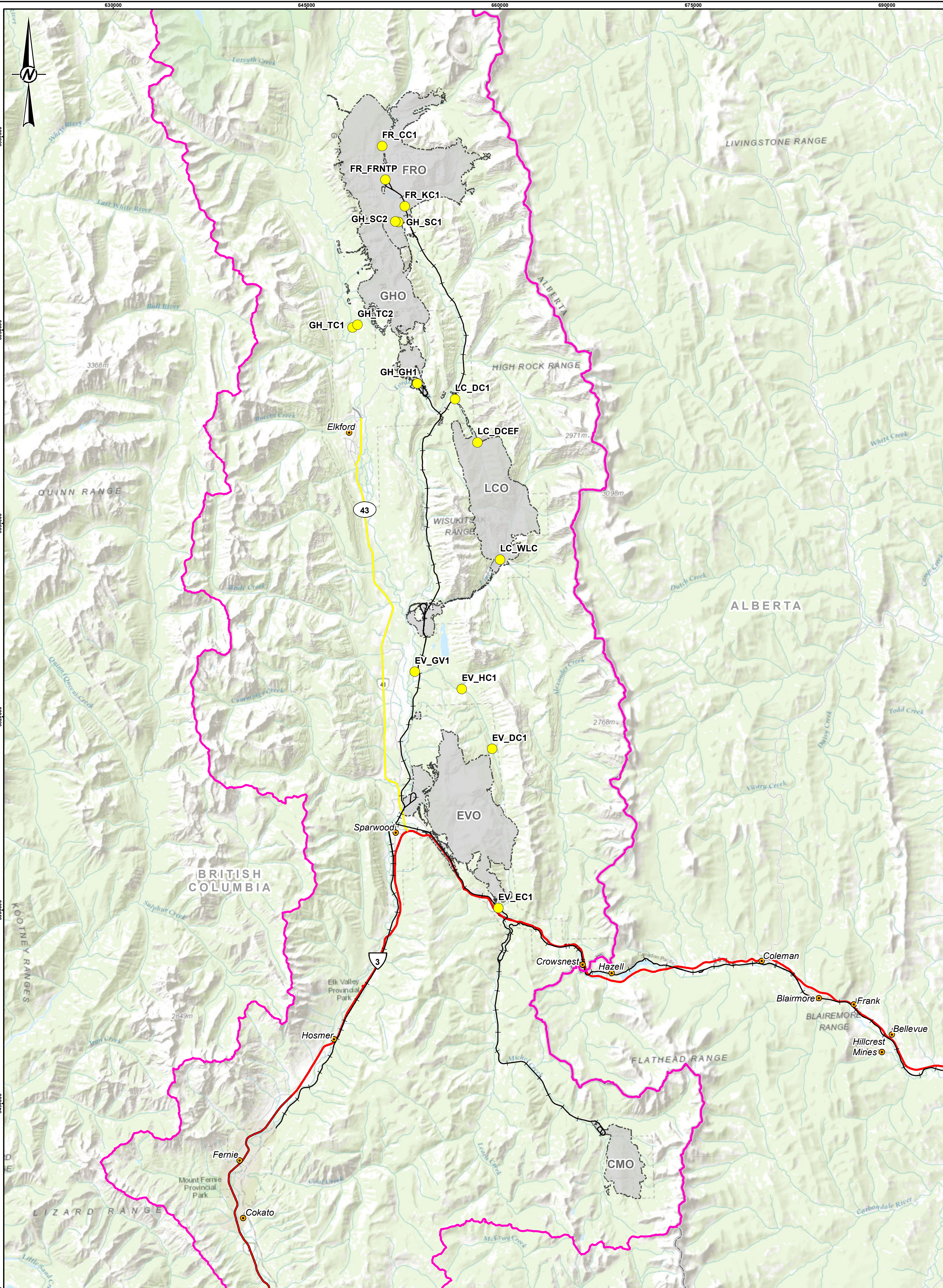
4.3.6 Surface Water - Groundwater Partitioning Information

The 2020 RWQM relies on input from a number of site-specific groundwater studies and related field investigations that have been used to develop estimates of surface water – groundwater partitioning at specific locations, including several monitoring locations and points of flow diversion (e.g., intakes for water treatment facilities). The information was compiled for the following tributary catchments with input from groundwater consultants working in the Elk Valley (see Appendix A):

- Kilmarnock Creek
- Clode Creek

- Swift Creek
- Cataract Creek
- Elk River tributaries at GHO (Greenhills Operations)
- Greenhills Creek
- LCO Dry Creek
- East Tributary of LCO Dry Creek
- West Line Creek
- Erickson Creek
- EVO Dry Creek
- Harmer Creek

At other model nodes, partitioning of surface water and groundwater was either not explicitly represented in the model framework. The model nodes in the 2020 RWQM that included the partitioning of surface water and groundwater flows are depicted on Figure 4-10.



LEGEND

- TECK FLOW MONITORING STATIONS
- CITY/TOWN/COMMUNITY
- CANADIAN PACIFIC RAILWAY
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- MINE PERMIT BOUNDARY
- ELK RIVER WATERSHED BOUNDARY

0 5 10

1:285,000 KILOMETRES

NOTE(S)

REFERENCE(S)

1. BASE DATA: CANVEC, 2018
2. TECK WATER NETWORK AND WATER MANAGEMENT DATA, 2019-09-26
3. BASEMAP: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 11N

TECK COAL LIMITED

PROJECT

2020 REGIONAL WATER QUALITY MODEL UPDATE

YYYY-MM-DD	2020-12-01
DESIGNED	PR
PREPARED	PR/RRD
REVIEWED	AS
APPROVED	SK

TITLE

MODEL NODES WITH PARTITIONING OF SURFACE WATER AND GROUNDWATER IN THE 2020 RWQM

PROJECT NO.	CONTROL	REV.	FIGURE
18111630	0012	0	4-10

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

4.3.7 Information from Hydrogeological Models

Information from available hydrogeological modelling studies are incorporated into the 2020 RWQM to account for the influence of future changes to pit seepage rates and the associated changes to baseflow in the mainstem and tributary watercourses. A list of the sources for the hydrogeological modelling seepage rate inputs is provided below:

- FRO Swift Pit seepage rates: Groundwater modelling results from the FRO (Fording River Operations) Swift Project Environmental Assessment Certificate (EAC) Application (Teck 2014b).
- FRO Turnbull Tailings Storage Facility seepage rates: Groundwater modelling results from the FRO Turnbull West Mines Act Permit Amendment Application (Teck 2018).
- GHO Phase 6 and Phase 7 Pits seepage rates: Groundwater modelling results from the GHO Cougar Pit Extension Permit Amendment Application (Teck 2015a)
- EVO Baldy Ridge Pit, Natal Pit, Adit Ridge Pit and Cedar Pit seepage rates: Groundwater modelling results from the EVO Baldy Ridge Extension (Teck 2015b).

4.3.8 Water Quality Mitigation Information

The FC of the 2020 RWQM incorporates water quality mitigation measures only if they are currently in existence, as they may influence model calibration. The two main water quality mitigation features that are included in the FC are the West Line Creek Active Water Treatment Facility and the EVO F2 Pit Saturated Rock Fill Treatment Facility.

Planned (future) mitigation information is not incorporated in the FC of the 2020 RWQM. The approach used to incorporate these measures into the WQC of the 2020 RWQM is described in further detail in Annex C.

4.4 Processing Meteorological Inputs (Global Climate Module)

4.4.1 Purpose

The global climate module from the FC of the 2020 RWQM is described in this section. The global climate module is used to process regional meteorological data inputs from reference stations and set up the model with climate input parameters that are applicable across the model domain.

4.4.2 Methods

4.4.2.1 Selection of Representative Stations

Historical climate data from the Elk Valley were compiled for potential use in the 2020 RWQM, as outlined in Section 4.2. This involved the development of representative daily air temperature and precipitation records for each operation using long-term data from the Fording Cominco and Sparwood climate stations for the period of 1970 to 2019.

- Fording Cominco was selected as the representative station at FRO, GHO and LCO.

- Sparwood was selected as the representative station at EVO.

The above selections were checked through the correlation of concurrent daily temperature and precipitation data at a regional level with local data. Gaps in the historical climate records at the reference monitoring stations were infilled using data from other stations. The methods for infilling data gaps are described in the sub-sections below.

4.4.2.2 Infilling Data Gaps

The climate records for the Fording Cominco and Sparwood stations includes years with major data gaps (i.e., years with less than 340 days of available data) and years with minor data gaps (i.e., incomplete year with more than 340 days of available data). A cut-off of 340 days was chosen to differentiate years with larger data gaps from years with smaller data gaps based on a review of regional datasets. Missing precipitation and air temperature data (corrected for elevation differences) were transferred from other regional stations in a specified order of preference, depending on proximity and the availability of data. The source of precipitation and air temperature data for infilling gaps in the Fording River Cominco station data is shown in Figure 4-11 and Figure 4-12. The source of precipitation and air temperature data for infilling gaps in the Sparwood station data is shown in Figure 4-13 and Figure 4-14. Each climate station is represented by a colour in these figures and indicate the specific station that is used as a data source as a function of time.

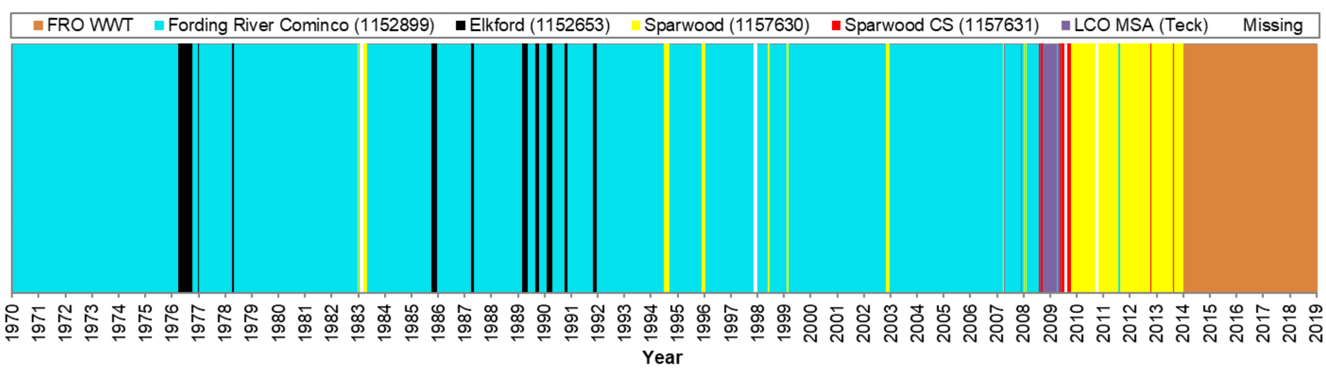


Figure 4-11: Source of Precipitation Data for Infilling Gaps in the Fording River Cominco Station Data Record

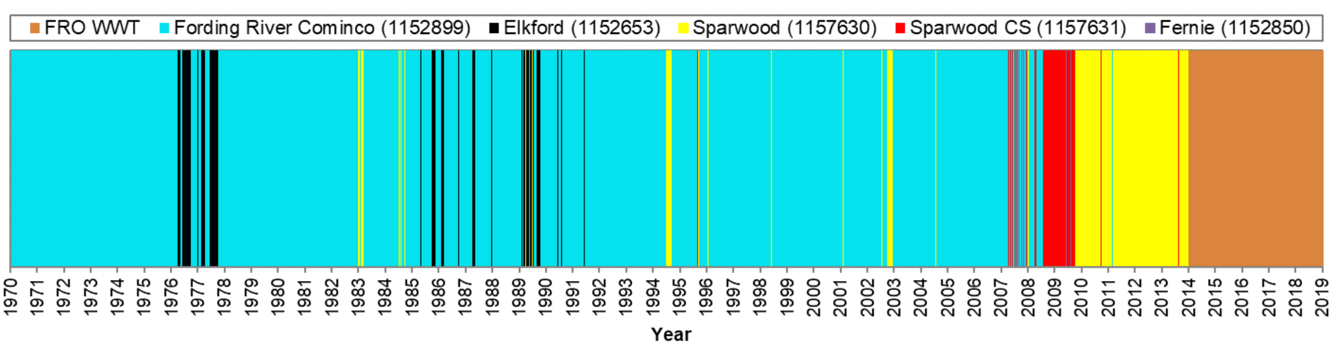


Figure 4-12: Source of Temperature Data for Infilling Gaps in the Fording River Cominco Station Data Record

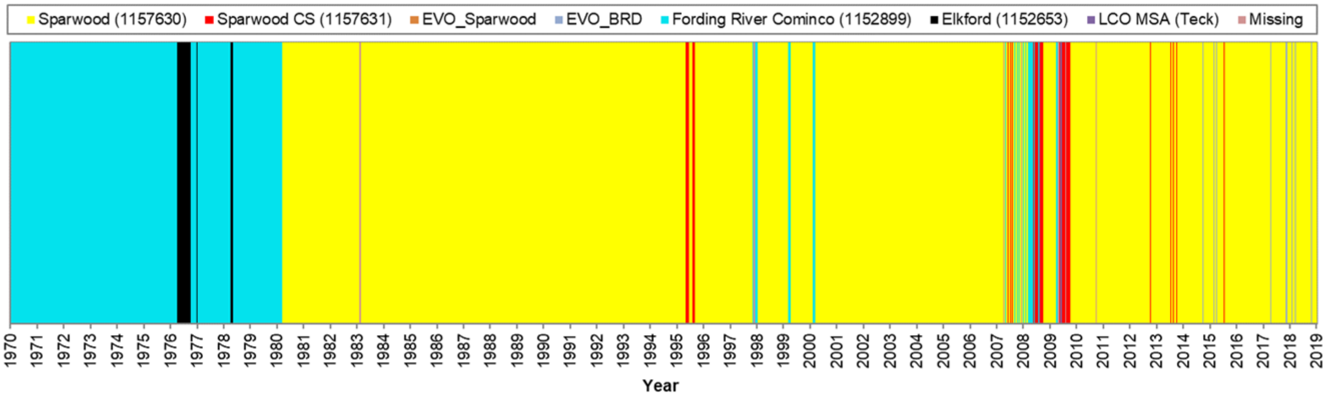


Figure 4-13: Source of Precipitation Data for Infilling Gaps in the Sparwood Station Data Record

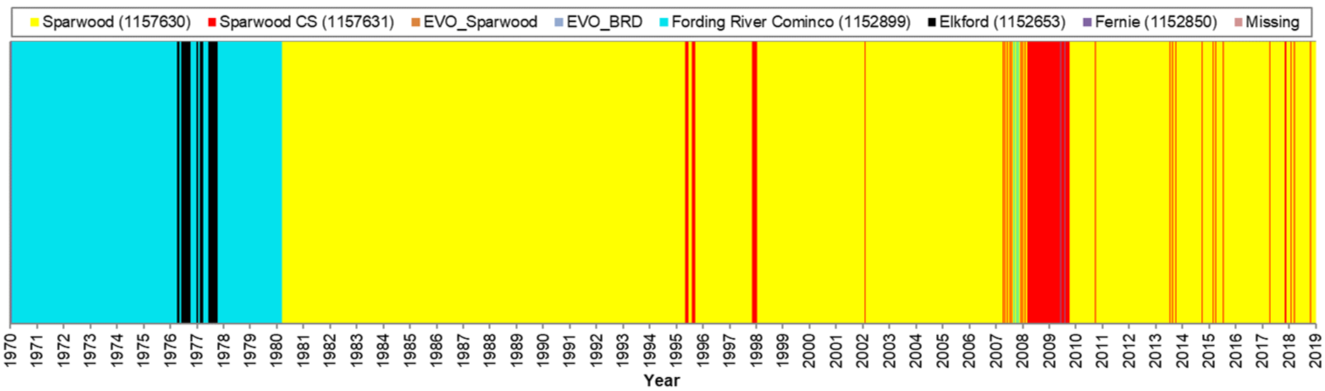


Figure 4-14: Source of Temperature Data for Infilling Gaps in the Sparwood Station Data Record

The relationships used to derive the infilled Fording River Cominco and Sparwood precipitation and air temperature records are summarized in Table 4-9.

Table 4-9: Regression Relationships used to Infill Data Gaps

Parameter	Infilling Station	Relationship used to infill Fording Cominco Data Gaps	Relationship used to infill Sparwood Data Gaps
Precipitation	Fording Cominco	• No adjustment	• $P_{Sparwood} = P_{Fording}$ * 0.848 (May to September); • $P_{Sparwood} = P_{Fording}$ * 1.099 (October to April)
	Elkford	• $P_{Fording} = P_{Elkford}$ * 1.11 (May to September); • $P_{Fording} = P_{Elkford}$ * 1.129 (October to April)	• $P_{Sparwood} = P_{Elkford}$ * 0.866 (May to September); • $P_{Sparwood} = P_{Elkford}$ * 0.794 (October to April)

Table 4-9: Regression Relationships used to Infill Data Gaps

Parameter	Infilling Station	Relationship used to infill Fording Cominco Data Gaps	Relationship used to infill Sparwood Data Gaps
	Sparwood	• $P_{Fording} = P_{Sparwood}$ * 1.18 (May to September); • $P_{Fording} = P_{Sparwood}$ * 0.91 (October to April)	• No adjustment
	Sparwood CS	• $P_{Fording} = P_{SparwoodCS}$ * 1.106	• No adjustment
	LCO MSA	• No adjustment	• $P_{Sparwood} = P_{MSA}$ * 0.953
Temperature	Fording Cominco	• No adjustment	• $T_{Sparwood} = T_{Fording}$ + 2.2 °C (May to September); • $T_{Sparwood} = T_{Fording}$ + 2.1 °C (October to April)
	Elkford	• $T_{Fording} = T_{Elkford}$ - 1.1°C (From May to September); • $T_{Fording} = T_{Elkford}$ - 0.97°C (From October to April)	• $T_{Sparwood} = T_{Elkford}$ + 1.2 °C (May to September); • $T_{Sparwood} = T_{Elkford}$ + 1.1 °C (October to April)
	Sparwood	• $T_{Fording} = T_{Sparwood}$ - 2.2°C (May to September); • $T_{Fording} = T_{Sparwood}$ - 2.0°C (October to April)	• No adjustment
	Sparwood CS	• $T_{Fording} = T_{SparwoodCS}$ - 2.2°C (May to September); • $T_{Fording} = T_{SparwoodCS}$ - 2.0°C (October to April)	• No adjustment
	Fernie	• $T_{Fording} = T_{Fernie}$ - 2.9°C (May to September); • $T_{Fording} = T_{Fernie}$ - 2.7°C (October to April)	• $T_{Sparwood} = T_{Fernie}$ - 0.7 °C (May to September); • $T_{Sparwood} = T_{Fernie}$ - 0.6 °C (October to April)

T = Temperature, LCO = Line Creek Operations, P = Precipitation.
No adjustments were made to the FRO WWT station data for infilling the Fording Cominco data record.
No adjustments were made to the EVO BRD and EVO_Sparwood station data for infilling the Sparwood data record.

4.4.2.3 Climate Input Data Summaries

Climate data statistics for the infilled data series from the two main reference stations (Fording Cominco and Sparwood) are summarized in Table 4-10 and Table 4-11, as well as in Figure 4-15 through Figure 4-20. It should be noted that local undercatch[1] factors at the reference stations are unknown. Undercatch was, therefore, not considered in the analysis.

Table 4-10: Fording Cominco Infilled Climate Data Summary

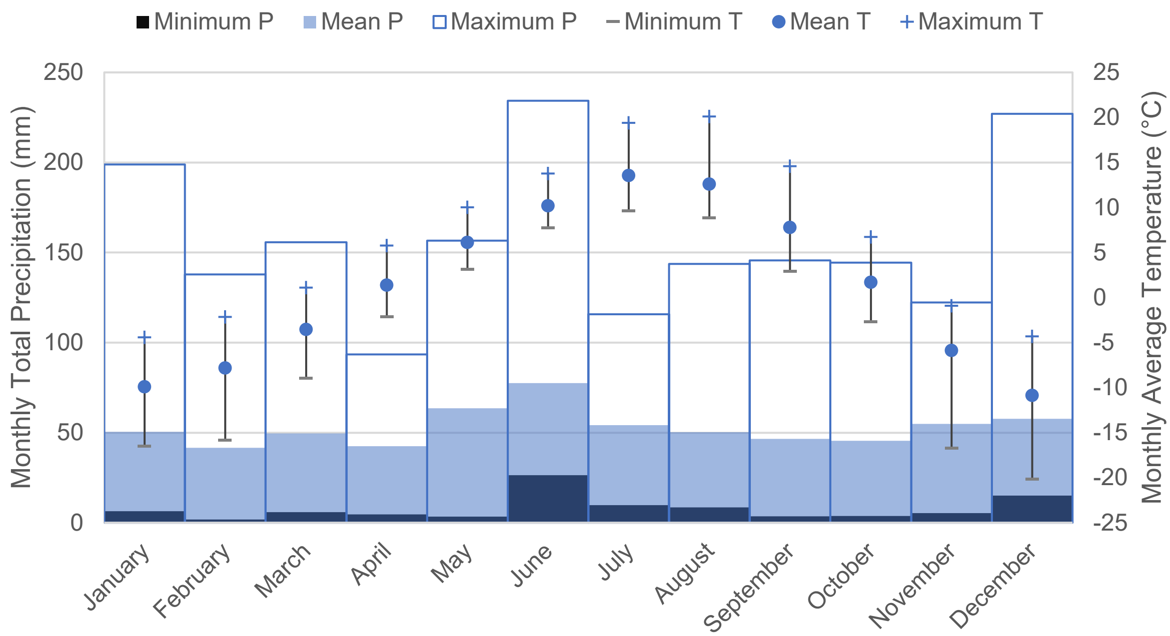
Month	Average Air Temperature[a] (°C)			Total Precipitation[b] (mm)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
January	-16	-9.9	-4.4	6	50	199
February	-16	-7.8	-2.1	2	42	138
March	-8.9	-3.5	1.1	6	50	156
April	-2.1	1.4	5.8	5	43	94
May	3.2	6.1	10	3	64	157
June	7.8	10	14	26	77	234
July	9.7	14	19	10	54	116
August	8.9	13	20	9	50	144
September	2.9	7.8	15	4	46	146
October	-2.7	1.7	6.8	4	45	144
November	-17	-5.8	-0.9	5	55	122
December	-20	-11	-4.3	15	58	227
Annual	**-1.1**	**1.3**	**3.1**	**440**	**634**	**984**

a) Air temperature and precipitation were derived based on data recorded at the Fording Cominco climate station from 1970 to 2019, in-filled using WWT, Elkford, Sparwood, Sparwood CS and Fernie climate station data.

b) Precipitation was derived based on data recorded at the Fording Cominco climate station from 1970 to 2019, in-filled using WWT, Elkford, Sparwood, Sparwood CS and LCO MSA climate station data.

c) Annual statistics are calculated independently and do not equate to the sum of the equivalent monthly statistics.

[1] The common installation of rain gauges with rims above the ground surface results in a difference between the rainfall caught and the amount reaching ground level, termed "undercatch."



T = Temperature P = Precipitation.

Figure 4-15: Fording Cominco Monthly Climate Data Summary (1970 to 2019)

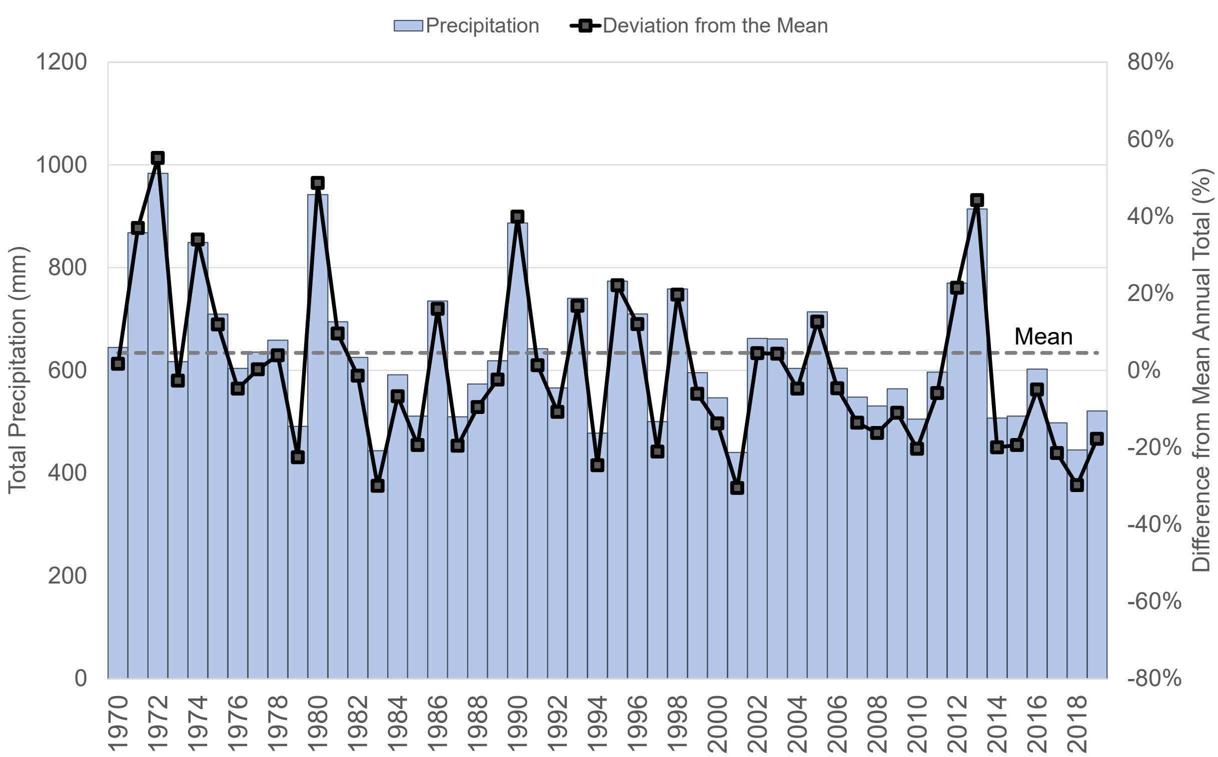


Figure 4-16: Annual Precipitation for the Infilled Fording Cominco Station (1970 to 2019)

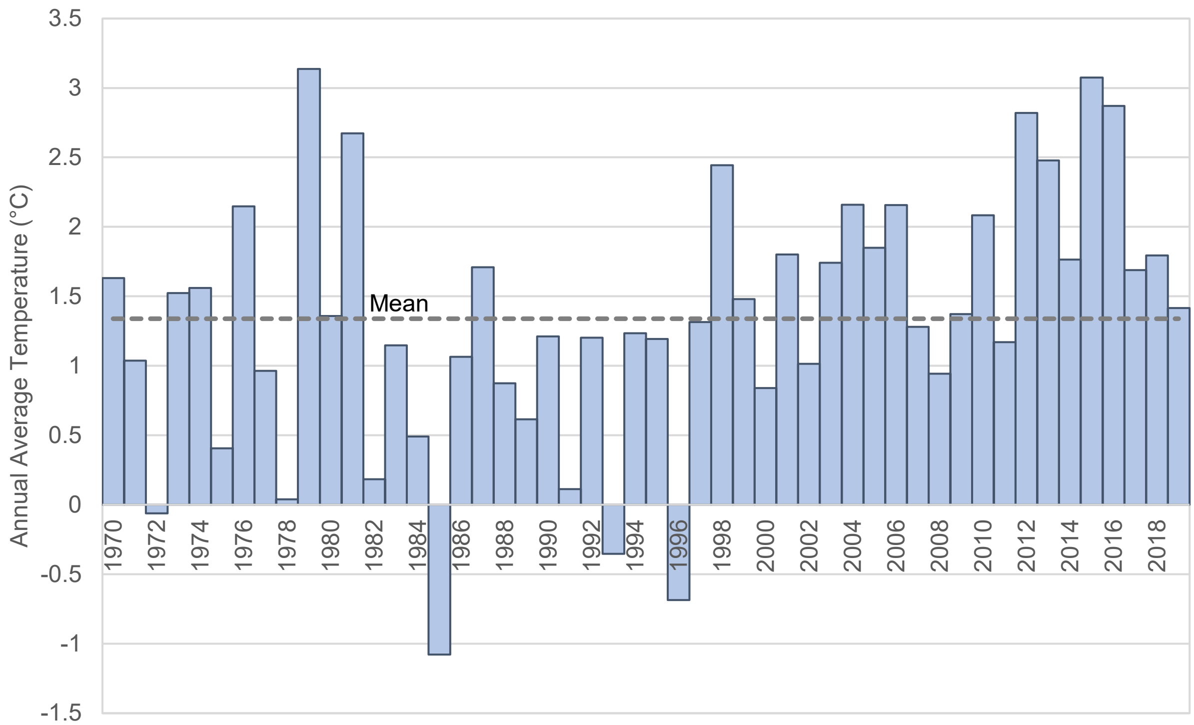


Figure 4-17: Annual Average Air Temperatures from the Infilled Fording Cominco Station (1970 to 2019)

Table 4-11: Sparwood Climate Data Summary

Month	Average Air Temperature[a] (°C)			Total Precipitation[b] (mm)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
January	-14	-7.0	-0.6	3	59	219
February	-14	-4.8	0.5	2	44	152
March	-5.7	-0.3	3.8	4	52	171
April	0.4	4.5	8.8	5	41	103
May	5.7	9.2	13	3	59	148
June	9.8	13	16	17	61	163
July	12	16	22	3	44	119
August	12	16	22	7	39	116
September	6.1	11	17	9	45	148
October	1.0	4.5	8.8	9	50	119
November	-13	-2.5	2.5	5	66	175
December	-18	-7.5	-2.1	7	66	250
Annual	**2.0**	**4.3**	**6.1**	**382**	**626**	**1007**

a) Air temperature and precipitation were derived based on data recorded at the Sparwood climate station from 1970 to 2019, in-filled using Fording Cominco, Elkford, Sparwood CS, Fernie, EVO Sparwood, and EVO BRD climate station data.

b) Precipitation was derived based on data recorded at the Sparwood climate station from 1970 to 2019, in-filled using Fording Cominco, Elkford, Sparwood CS, EVO Sparwood and EVO BRD climate station data.

c) Annual statistics are calculated independently and do not equate to the sum of the equivalent monthly statistics.

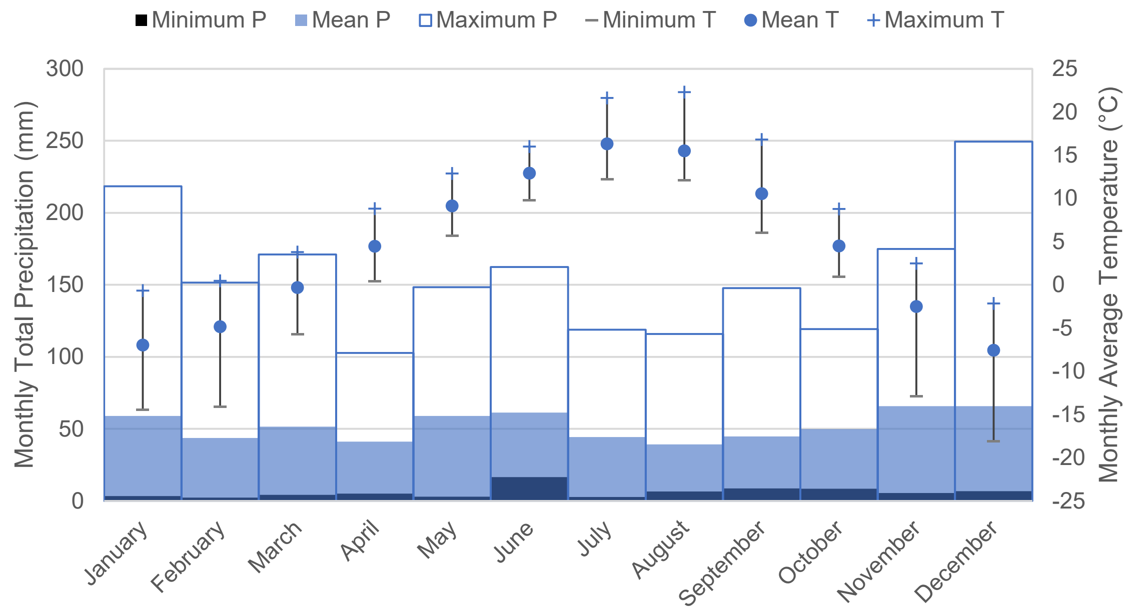


Figure 4-18: Sparwood Monthly Climate Data Summary (1970 to 2019)

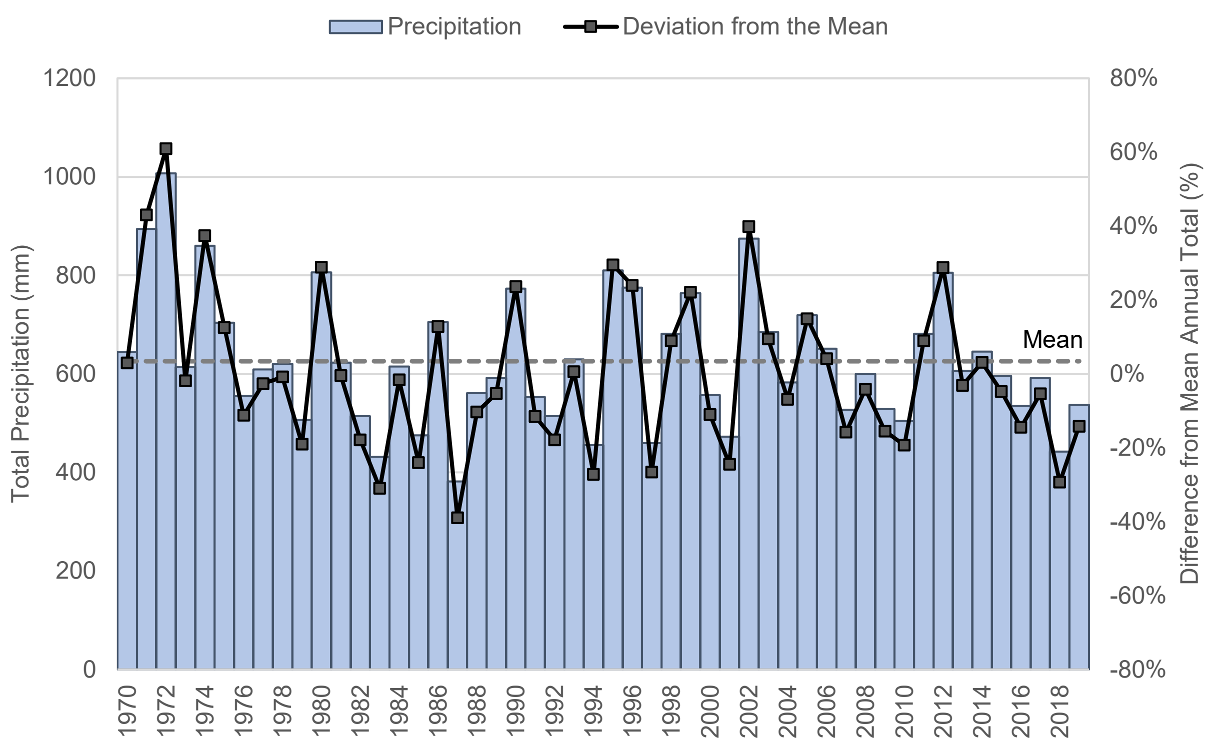


Figure 4-19: Annual Precipitation from the Infilled Sparwood Station (1970 to 2019)

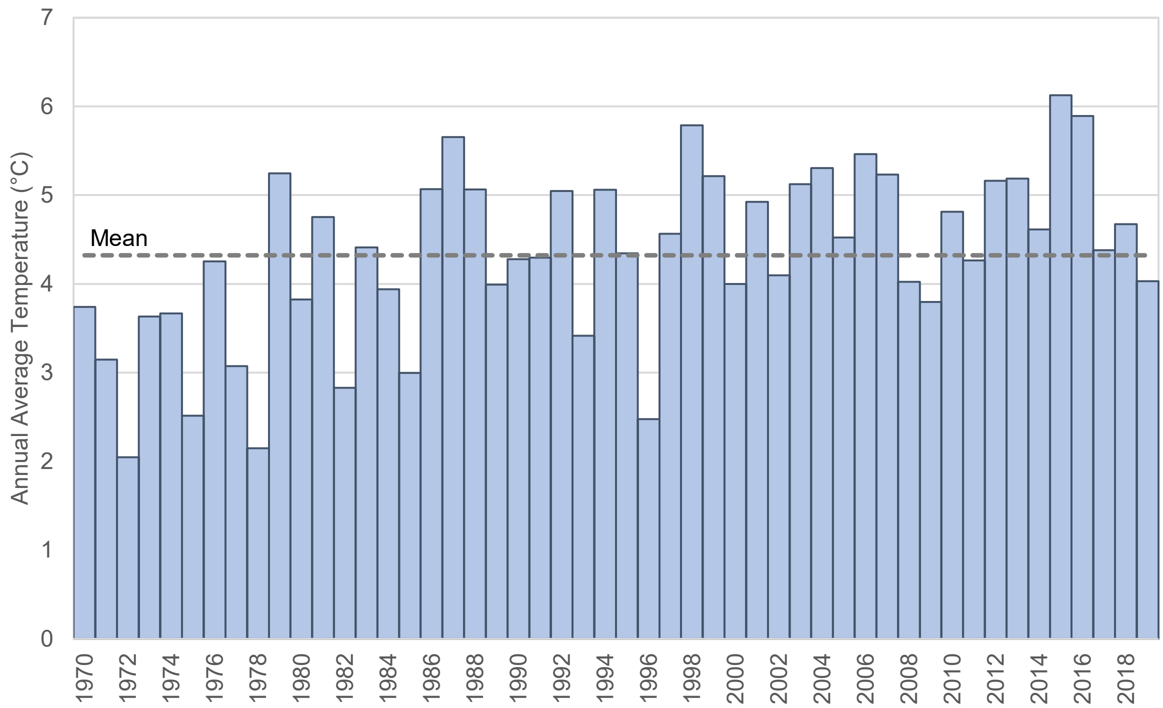


Figure 4-20: Mean Air Temperatures from the Infilled Sparwood Station (1970 to 2019)

4.5 Generating Sub-Catchment-Specific Climate Information (Sub-Catchment Climate Module)

4.5.1 Purpose

The sub-catchment climate module in the flow component of the 2020 RWQM is described in this section. The sub-catchment climate module is used to adjust the regional meteorological data inputs from reference stations to individual sub-catchments. This information is then used as the primary forcing functions for estimating sub-catchment-specific evapotranspiration and lake evaporation rates, and for generating flows from areas within the sub-catchment.

4.5.2 Methods

In the sub-catchment climate module, air temperature and precipitation records from the global sub-climate module are adjusted for elevation differences between the reference station and the mean elevation of the sub-catchment using regional regression relationships (developed for baseline studies in the Elk Valley, including FRO Swift and EVO Baldy Ridge Extension). The specific adjustments are described in the subsections below.

4.5.2.1 Adjustment to Air Temperature

Daily average, minimum and maximum air temperatures were decreased by approximately 0.5 °C for every 100 m gain in elevation based on the regression relationship among several stations in the Elk Valley, as shown on Figure 4-21. The same adjustment was applied year-round.

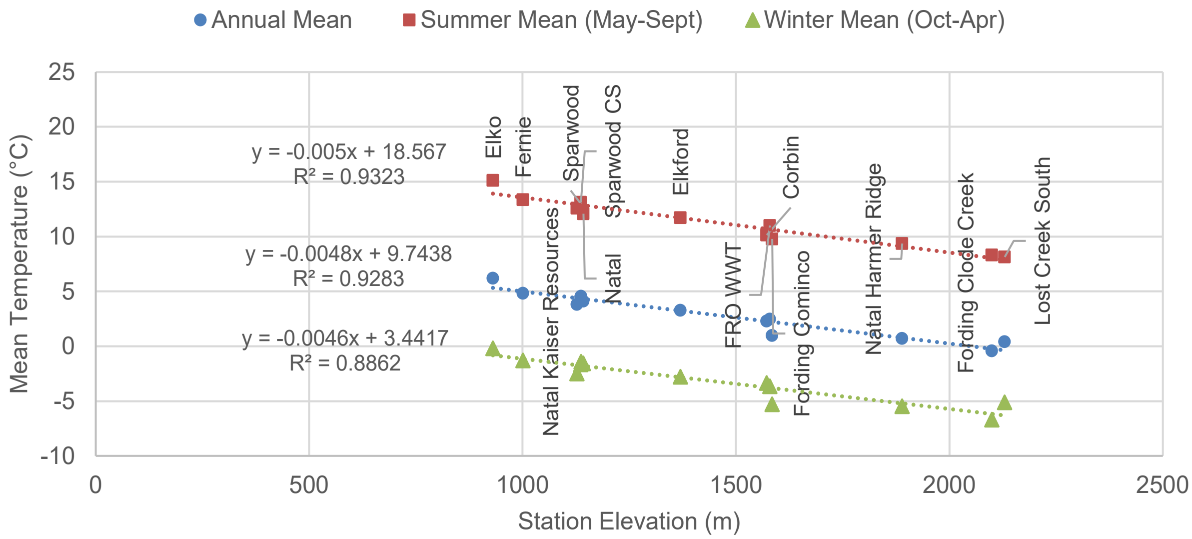


Figure 4-21: Regression Relationships to Derive a Temperature Lapse Rate

4.5.2.2 Adjustment to Precipitation

Average total precipitation was increased by 25 mm per 100 m gain in elevation, with seasonal differences of 11.5 mm (summer) and 32.0 mm (winter) for every 100 m gain in elevation (Figure 4-22). These adjustments are similar to those presented in Barbour et al. (2016) and are a function of the mean elevation of each model sub-catchment (i.e., each sub-catchment area receives the same adjusted precipitation input). Total precipitation was divided into rainfall and snowfall components using a threshold temperature.

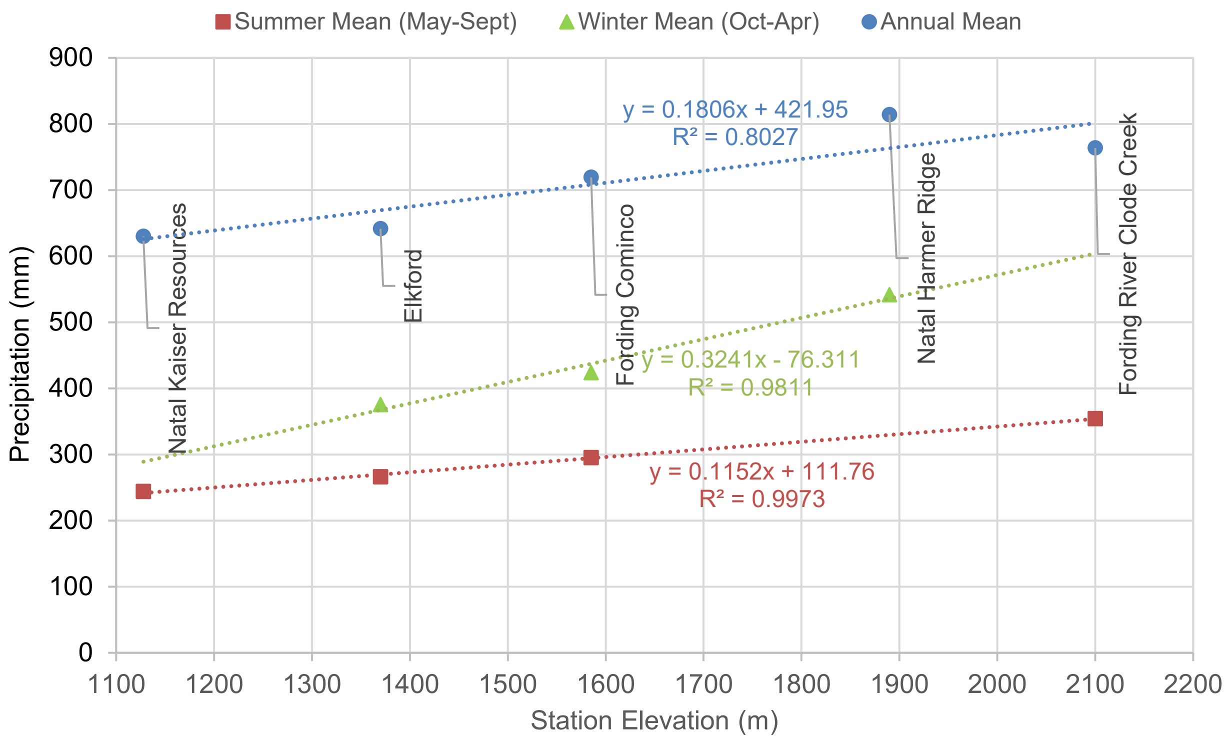


Figure 4-22: Regression Relationship to Derive a Precipitation Lapse Rate

Where applicable, the adjusted/divided precipitation records for each sub-catchment area were verified against comparable records from local and regional stations. This verification step is described as part of the model calibration process in Section 5.1.

4.5.2.3 Snowpack (Snow Water Equivalent)

Snowpack accumulation (based on local-scale measurements from the ECCC snow pillow stations at Fernie and Morrisey Ridge stations, as shown in Figure 4-23) were used to calibrate the modelled snowpack accumulation, as well as to calibrate the threshold temperatures.

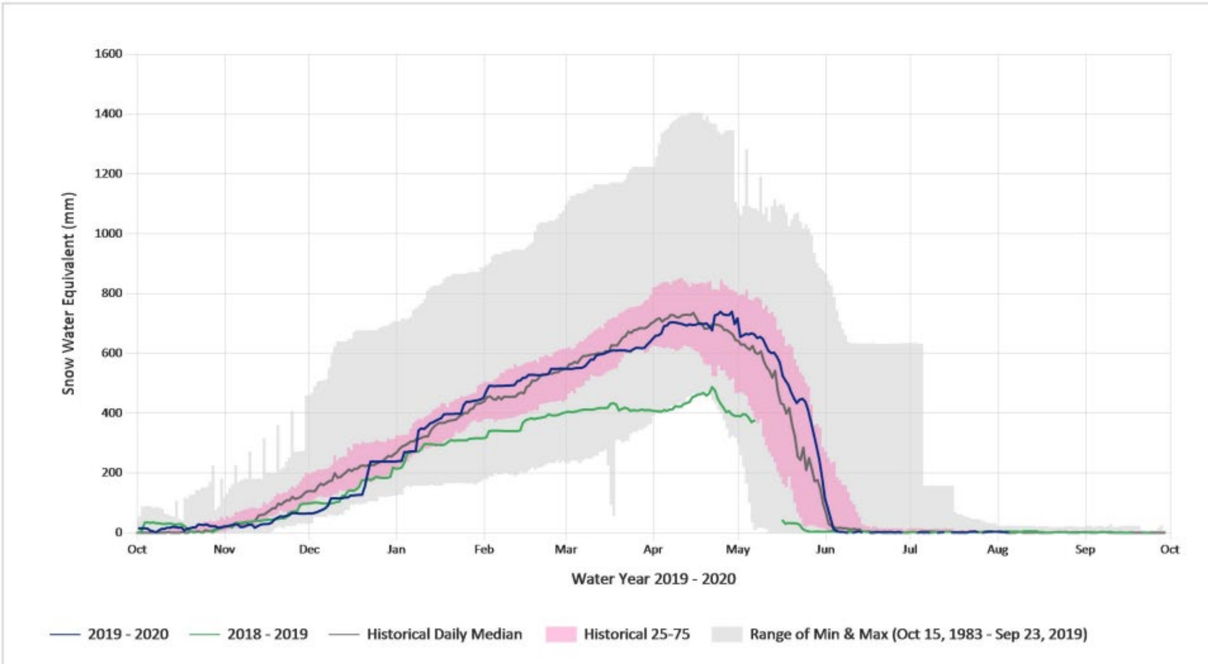


Figure 4-23: Snowpack Data Summary from the Morrissey Ridge Snow Pillow Station (accessed from Data BC, August 2020)

4.5.2.4 Estimating Potential Evapotranspiration

Potential evapotranspiration (PET) rates were calculated using the Hargreaves-Samani method. This approach relies on the minimum and maximum daily air temperature records (adjusted based on the sub-catchment elevation), the solar constant (equal to 0.082 MJ/m^{2}min), and a coefficient (Kc). Kc is used to calculate evapotranspiration, bare soil evaporation, or open water evaporation from reference evapotranspiration (Hargreaves and Samani 1982). Figure 4-24 shows the annual PET values from 2012 to 2017 as reported in water balances completed at various Elk Valley sites (OKC 2018). The Kc factor used in the Hargreaves-Samani equation was estimated for specific sub-catchments by comparing the calculated PET values with the values in Figure 4-24.

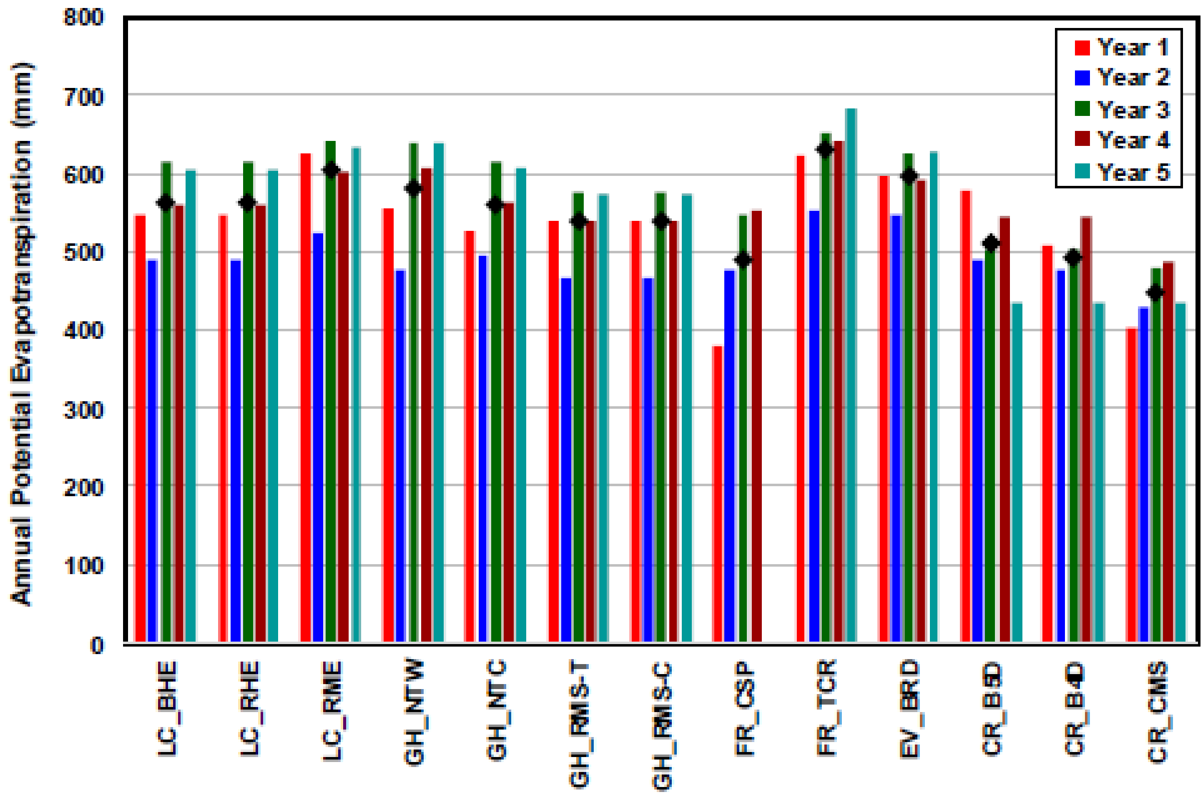


Figure 4-24: Potential Evapotranspiration Rates at Elk Valley Sites (source: OKC 2018)

4.5.2.5 Estimating Actual Evapotranspiration

The sub-catchment PET values were adjusted to actual evapotranspiration (AET) based on conversion factors that consider the ratio or partitioning of AET to PET from Okane (OKC 2018; Figure 4-25) (i.e., concurrent records of AET and PET for bare and reclaimed waste rock spoils that include a combination of waste rock and revegetated areas ranging from grasses to 25-year old coniferous trees). As a result, a different conversion factor was applied for each land type within the sub-catchment (i.e., undisturbed areas, hard mine surfaces and waste rock spoils).

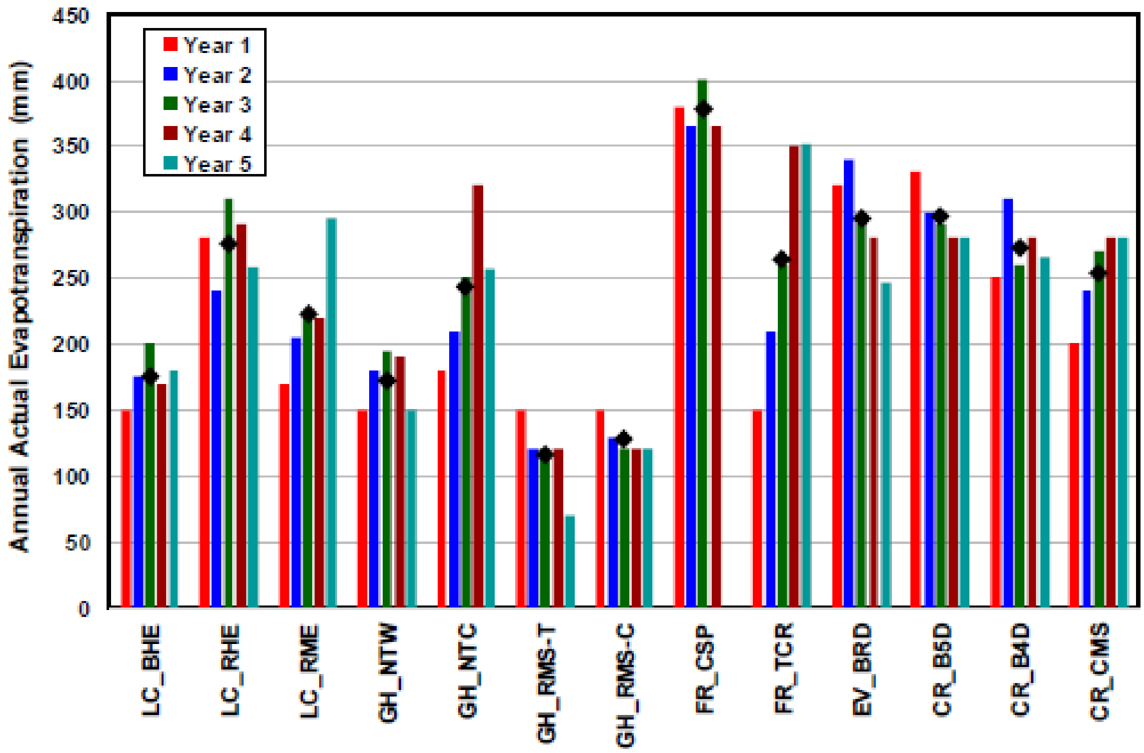


Figure 4-25: Actual Evapotranspiration Rates at Elk Valley Waste Rock Spoils (source: OKC 2018)

4.6 Estimating Flow from Undisturbed and Disturbed, Non-Spoil Areas (Snowmelt Runoff Module)

4.6.1 Purpose

The Snowmelt Runoff Module (SRM) in the FC of the 2020 RWQM is described in this section. The SRM in the FC is used to estimate flows from undisturbed and mine-influenced areas at individual sub-catchments, except for waste rock spoils. The outputs from the SRM are ultimately used to calculate total flows at downstream tributary nodes and support calculations of loads from different areas within a sub-catchment in the WQC.

4.6.2 Methods

4.6.2.1 SRM Description

The SRM (Martinec et al. 2008) is a lumped, empirical model that is designed to simulate and forecast daily streamflow for mountainous areas with substantial snow cover and associated snowmelt processes on a seasonal basis. The SRM is considered computationally simple, given that the model has comparatively minimal data requirements (Abudu et al. 2012). The primary input variables for the model are temperature, precipitation, and snow cover area. This information is used in the model, along with several other input parameters (i.e., temperature lapse rate, runoff coefficient [for rain and snow], degree-day factor, recession coefficient, critical temperature, rainfall-contributing area, and lag time) to track snow accumulation and compute flow (discharge) as an output. The surface discharge estimate from this model is typically calibrated to measured flows for gauged sub-catchments or assumed to represent total basin yield for ungauged and uncalibrated sub-catchments.

SRM generates daily discharge based on the following equation:

$$Q_{n+1} = [c_{Sn}.a_n(T_n + \Delta T_n)S_n + c_{Rn}P_n]\,\frac{A.10000}{86400}\,(1 - k_{n+1}) + Q_n k_{n+1} \qquad \text{Eq. 3}$$

Where:

Q	=	average daily discharge (m^3/s)
n	=	the day during the discharge computation period
A	=	area of the basin or zone (km^2)
T	=	degree-days (°Cday)
ΔT	=	adjusted (or lapse rate) temperature to account for the difference between the elevation of the climate station and the average hypsometric elevation of the subject basin or zone (°Cday)
P	=	precipitation that contributes to runoff (cm), or is stored/accumulated until melting conditions occur based on temperature;
S	=	ratio of snow-covered area to total area (assumed to be 1 if there is snow on the ground)
c	=	runoff coefficient that identifies the surface water contribution as a ratio of rainfall to runoff (c_R) or snowmelt to runoff (c_S)
a	=	degree-day factor (cm/°Cday) that identifies the characteristic snowmelt depth from 1 degree-day
k	=	recession coefficient that identifies the decline of discharge in a period without snowmelt or rainfall

Several modifications were completed to the latest publicly available SRM version from the GoldSim model library. This included adjustments to the snowmelt calculations to include a reservoir for tracking snow accumulation, and to allow for seasonal inputs, such as a varying runoff coefficient, and the use of a single elevation for each sub-catchment.

The parameter for snow cover area (S) was determined to be either 0 or 1 using the following equation from Essery and Pomeroy (2004):

$$S = \min\left(\frac{\bar{S}}{a}, 1\right) \qquad \text{Eq. 4}$$

Where:

a = roughness length of the surface, which is interpreted to be a snow depth of sufficient magnitude to conclude that the ground is indeed snow covered (set to a fixed value of 5 mm throughout the model domain)

$\bar{S}$ = long-term monthly average SWE that was estimated based on available SWE records from the ECCC Morrisey Ridge climate station

4.6.2.2 SRM Input Data

The SRM was integrated within the 2020 RWQM for individual sub-catchments (excluding waste rock areas) using the following input information:

- sub-catchment areas, divided into undisturbed (non-mine affected) areas, hard mine surfaces (e.g., pit walls, roads) and coarse coal reject areas.
- average elevation of the sub-catchment, to support orographic adjustments.
- sub-catchment-specific daily temperature and precipitation, and climate station elevation, as discussed in the sub-catchment climate module.

4.7 Estimating Flow from Waste Rock Spoils (Waste Rock Hydrology Module)

4.7.1 Purpose

The waste rock hydrology module in the FC of the 2020 RWQM is described in this section. The waste rock hydrology module in the FC is used to estimate flows from waste rock spoils at individual sub-catchments. The waste rock hydrology module achieves greater consistency with the conceptual model described in Section 3.4 than the 2017 RWQM; it includes functionality that allows for the evaluation of the effects of reclamation on flow and represents a first step to a more mechanistic or process-based approach to the simulation of constituent release from waste rock spoils. The outputs from the waste rock hydrology module are used to calculate total flows at downstream tributary nodes, and support calculations of seasonal and interannual loads from waste rock spoils in the WQC.

4.7.2 Methods

The waste rock hydrology module was developed in GoldSim as a linked component of the SRM. It relies on a characterization of historical waste rock spoil progression and mining in the sub-catchment and includes a numerical representation of the following conceptual components of the hydrology of a waste rock spoil:

i) **Precipitation** – Rainfall, snow fall, snow accumulation and snow melt on the surface of the spoil

ii) **Evapotranspiration and Sublimation** – Atmospheric losses from the surface of the spoil

iii) **Infiltration –** Amount of water on the surface that enters the spoil

iv) **Percolation** – Movement of water through the spoil, primarily as matrix flow

v) **Internal Storage** – Changes to the VWC within the spoil

vi) **Net Percolation** – Water released from spoil as toe discharge

The key components of the model set-up for the waste rock hydrology module are further described below and illustrated in the schematic in Figure 4-26.

Elements included in the conceptual model for waste rock hydrology that are not explicitly accounted for in the waste rock hydrology module consist of the following:

- Runoff – assumed to be zero, consistent with the modelling approaches used by others (Keller et al. 2015, Martin et al. 2004)
- Wet-up – a short-term process in Elk Valley spoils that appears to have limited influence on total waste rock flow (Barbour et al. 2016)
- Macropore flow – a flow path of minor relevance with respect to constituent transport (Nichol et al. 2005)
- Basal seepage – in waste rock sub-catchments, constituent concentrations tend to be consistent between surface water and shallow groundwater monitoring points, indicating that constituents released from waste rock spoils tend to report to local watercourses in short order, thus, negating the need to track the two discharge pathways separately within the numerical model framework upstream of the first sub-catchment monitoring point.

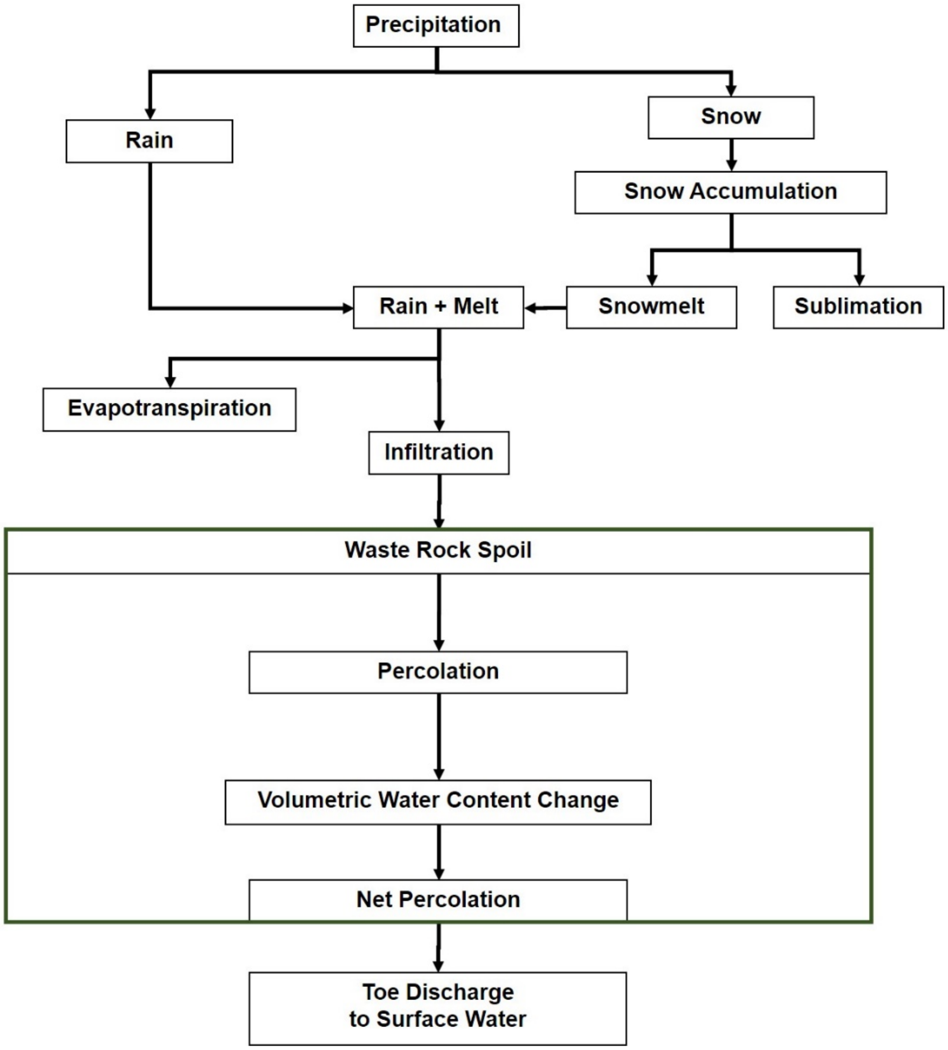


Figure 4-26: Key Components of the Model Set Up for the 2020 Waste Rock Hydrology Module

The model calculates infiltration to the spoil as follows:

- Rain and snow (accumulation, sublimation, and snowmelt) as calculated by SRM are applied to the surface of the waste rock spoil.
- Actual evapotranspiration rates from the near surface layer of the spoil are estimated using the Hargreaves-Samani equation and a calibration factor for bare waste rock spoils, with the calibration factor being determined through comparisons with actual evapotranspiration rate estimates from OKC (2018).
- Remaining rainfall and calculated snowmelt infiltrate into the waste rock spoil.
- Water infiltrating into the spoil enters a reservoir element. The maximum volume assigned to the reservoir element is determined by multiplying the volume of the waste rock spoil, expressed as

bank cubic meters by a porosity of 0.3. Percolation through the spoil is controlled by an outflow rate from the reservoir element, which is set to 2.5% per week of the total storage held in the spoil. The water exiting the reservoir (net percolation) is directed to the nearest downstream modelling node, wherein it mixes with runoff from other sub-catchment areas, including that which would travel through the rock drain associated with the spoil in question.

4.8 Tracking Water Volumes and Levels in Backfilled, Flooded Pits (Pit Module)

4.8.1 Purpose

The pit module in the FC of the 2020 RWQM is described in this section. The pit module in the FC is used to model inflows, outflows, and water stored within pits. The pit module is intended for application to larger existing and future pits, the filling of which can have a meaningful effect on downstream flow and/or water quality. The module was developed to support (1) the tracking of water levels and volumes within flooded pits, and (2) calculations of pit dewatering, groundwater seepage and withdrawal of water for consumptive or process use. The corresponding outputs from the pit module are used to calculate total flows at downstream tributary nodes, and to support calculations of loads from pits in the WQC.

4.8.2 Methods

The approach to model the filling of mine pits in the FC of the 2020 RWQM is consistent with the associated approach that was used in the *Elk Valley Water Quality Plan 2019 Implementation Plan Adjustment* (2019 IPA; Teck 2019). Pits are modelled using pool elements within GoldSim. Each pool element has a set volume defined as the maximum amount of water the pit can hold below the decant elevation, and they begin to store water once activity in each pit is complete. The pits begin to release water to the receiving environment once full. Information on the characteristics of these pits was obtained from a review of available mine plan information.

Each pool element requires the following information:

- **Inflows**, which include direct precipitation on the open water surface of the pit, runoff from contributing pit sub-catchment areas, water transfers into the pit from other sub-catchments, and groundwater seepage into the pit.
- **Pit characteristics**, which include pit dimensions, backfill material, backfill volumes and backfill porosity, all of which is used to define the maximum capacity of the pit to store water.
- **Outflows**, which include evaporation, groundwater seepage out of the pit, pit pumping (dewatering, make-up water, dust suppression), and overflow, noting that outflows are allocated from the available water stored in the pit using a defined priority sequence.

The FC of the 2020 RWQM accounts for water stored within the following pits under historical conditions (i.e., up to December 31, 2019) using predicted modelled inflows:

- FRO: Turnbull South Pit Tailings Storage Facility (TSF), Eagle 6 West Pit, Eagle 4 Pit, and Shandley Pit
- GHO: Phases 3 Pit and Phase 6 Pit

- LCO: North Line Creek (NLC) Pit, Mine Services Area (MSA) West Pit and Horseshoe Ridge (HSR) Pit
- EVO: Natal West Pit, South Pit and F2 Pit

In addition, the FC of the 2020 RWQM accounts for water stored within the following pits under future conditions (i.e., from January 1, 2020):

- FRO: Eagle 6 Pit to Clode, Eagle 6 Pit to Kilmarnock, and Swift Pit
- GHO: Phases 3 to 6 Pit and Phase 7 Pit
- LCO: NLX Pit and Burnt Ridge North 3 pit
- EVO: Baldy Ridge Pit, Cedar Pit and Natal Pit

The configuration of the pit module in the FC of the 2020 RWQM is conceptually represented on Figure 4-27.

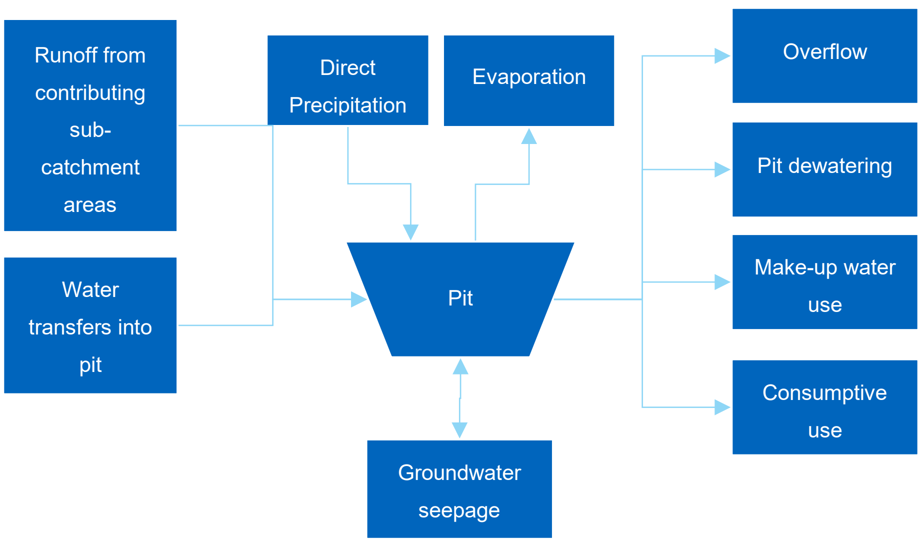


Figure 4-27: Tracking Water Volumes and Levels in Pits in the FC of the RWQM

4.9 Accounting for Changes to Pit Seepage and Groundwater Flows (Pit Seepage Calculations)

4.9.1 Purpose

The pit seepage calculations in the FC of the 2020 RWQM is described in this section. The pit seepage calculations in the FC are used to model the projected changes to instream flow in relevant tributary catchments as a result of future pit development. These calculations are incorporated for pits previously analyzed in support of permit applications. The calculations affect estimates of projected total flows at downstream tributary nodes.

4.9.2 Methods

The bottom elevations of the mine pits listed below are or may in the future become low enough for those pits to act as local groundwater sinks, drawing water away from surrounding areas. As mining progresses, seepage into the pits is assumed to increase linearly to the end of mining. Maximum groundwater inflows to the pits are expected to occur when the pits are fully mined out and do not hold any water. These groundwater inflows will then diminish over time during pit filling as the pits reach equilibrium conditions. Seepage calculations for the following pits are included in the FC of the 2020 RWQM:

- FRO: Turnbull South Pit and Swift Pit
- GHO: Phases 3 to 6 pits and Phase 7 pit
- EVO: Adit Pit, Baldy Ridge Pit, Cedar Pit, and Natal Pit

Groundwater inflows to the identified pits at FRO, GHO, and EVO are modelled as incremental changes relative to conditions prior to pit development. The effects of pit development on groundwater flows are therefore mostly applicable to modelling future conditions. The modelled groundwater inflows to each of the relevant pits are provided in Tables 4-12 4-13, and 4-14, respectively.

Table 4-12: Estimated Groundwater Flows from Fording River Operations Sub-Catchments Reporting to Turnbull Tailings Storage Facility (Turnbull South Pit) and Swift Pit[(a,b)]

Period[(c)]	Net Groundwater Inflow to Turnbull Pit [m^3/day]	Net Groundwater Inflow to Swift Pit[(c)] [m^3/day]
Conditions Prior to Pit Development	0	0
Pit Mining Ends, filling begins	831	17,733
Pit Full	473	10,031

a) Based on groundwater modelling conducted for the Swift Project (Teck 2014b) and the Turnbull West Project (Teck 2018).
b) Includes baseline recharge over the pit footprints in addition to groundwater inflows to pits.
c) Linear interpolation was used to estimate values between time periods.
m^3/day = cubic metres per day.

Table 4-13: Estimated Groundwater Flows from Greenhills Operations Sub-Catchments Reporting to Phase 3 to 6 Pits and Phase 7 Pit [a,b]

Period[c]	Net Groundwater Inflow to Phase 3 to 6 Pit [m^3/day]	Net Groundwater Inflow to Phase 7 Pit [m^3/day]
Conditions Prior to Pit Development	0	0
Pit Mining Ends, filling begins	2121	499
Pit Full	1412	286

a) Based on groundwater modelling conducted for the CPX Project (Teck 2015a).
b) Includes baseline recharge over the pit footprints in addition to groundwater inflows to pits.
c) Linear interpolation was used to estimate values between time periods.
m^3/day = cubic metres per day.

Table 4-14: Estimated Groundwater Flows from Elkview Operations Sub-Catchments Reporting to Natal Pit, Baldy Ridge Pit, Cedar Pit and Adit Ridge Pit[a,b]

Period[b]	Net Inflows to Natal Pit [m^3/day]	Net Inflows to Baldy Pits [m^3/day]	Net Inflows to Cedar Pit [m^3/day]	Net Inflows to Adit Ridge Pit [m^3/day]
Conditions Prior to Pit Development[c]	0	0	0	0
Mining Ends, filling begins	605	485	61	22
Pits Full	574	464	130	210

a) Based on groundwater modelling conducted for the EVO BRE Project EAC (Teck 2015b).
b) Includes baseline recharge over the pit footprints in addition to groundwater inflows to pits.
c) Linear interpolation was used to estimate values between time periods.
m^3/day = cubic metres per day.

4.10 Accounting for Water Management Activities (Water Management Module)

4.10.1 Purpose

The water management module in the FC of the 2020 RWQM is described in this section. The water management module in the FC is used to model the transfer of flows between individual sub-catchments (e.g., via pumping or diversion channels) and to account for the associated changes to water management activities over time (e.g., commissioning of new diversions, decommissioning a pond). The outputs from this module are used to support calculations of total flows at sub-catchment nodes, downstream tributary nodes, and calculations of loads at specific nodes in the WQC.

4.10.2 Methods

4.10.2.1 Non-Consumptive Transfer Flows

Non-consumptive water transfers include diversions, pumping for make-up water supply to the process plant, and process flows (e.g., water in dredged tailings or tailings slurry). The FC accounts for the movement of water between sub-catchments as a result of these activities. Total flow within a given sub-catchment is estimated based on the different outflows and transfers from or to a sub-catchment. The withdrawals from a sub-catchment are based on an order of priority specified within FC that reflects on-site water management practices. After accounting for all water transfer demands and consumptive withdrawals (described further below), the net water remaining in the sub-catchment is directed to the downstream model node as discharge.

The water transfers in the FC are summarized in Table 4-15, noting that water transfers from water quality management measures are excluded from this list (see Section 4.19).

Table 4-15: Non-consumptive Water Transfers Included the 2020 RWQM

Operation	Process and Tailings	Diversions and Pumping (ex-pit)	Pit Pumping
FRO	• Wash plant tailings to South Tailings Pond (STP) • Dredged tailings to Turnbull TSF • Reclaim water from STP to wash plant	• Clode rock drain • Post Ponds rock drain • North and East Tributary rock drain • Tower Diversion • Tower Diversion Extension • Swift Creek Upper Diversion • Cataract Creek Diversion to Swift Ponds • Britt Creek Diversion • North Spoil Clean Water Diversion	• Eagle 6 to Clode Creek • Eagle 6 to Kilmarnock Creek • Eagle 6 to Eagle 4 Pit • Lake Mountain Pit to Lake Mountain Ponds • Swift Pits to Liverpool Ponds
GHO	• Process plant tailings to TSF • Reclaim water from TSF to process plant	• None	• Phase 3 Pit to Thompson, Wolfram Creek • Phase 4/5 Pit to Wolfram Creek • Phase 6 Pit to Cataract, Mickelson, Leask and Wolfram Creek • Phase 7 Pit to Willow Creek, Phase 6 Pit
LCO	• None	• No Name Creek to NLC Pit • No Name Creek rock drain,	• NLX Pit to HSR Pit • HSR Pit to Line Creek • MSAW to HSR Pit • BRN Pits to LCO Dry, No Name Creek • MTM Pits to LCO Dry, Upper Line Creek
EVO	• Process plant tailings to Lagoon D • Process plant tailings to West Fork Tailings Facility	• Cedar Pit / Breaker Lake to EVO Dry Creek • Bodie Control Pond to Gate Creek	• Natal Pit to Bodie rock drain • Cedar Pit to Tunnel • Baldy Ridge Pits to Natal Pit • Baldy Ridge Pits to Aqueduct Creek

4.10.2.2 Consumptive Withdrawals

The FC includes a consumptive loss term for dust suppression activities at FRO, GHO, LCO and EVO. Water for dust suppression is diverted from the following locations:

- FRO: Kalmikoff Pond, Eagle 4 Pit, Shandley Pit, Liverpool Ponds, and Kilmarnock Settling Ponds
- GHO: Phase 3, Phase 4/5, Phase 6 and Phase 7 pits
- LCO: Horseshoe Ridge Pit, Burnt Ridge South Pit, Mine Services Area West Pit, and North Line Extension Pit
- EVO: Breaker Lake, Natal Pit, Bodie Creek, Adit Pit, Baldy Ridge Pit, and the EVO SRF

Rates of water use for dust suppression are estimated based on site information.

The FC includes a consumptive loss term for use in coal processing at FRO, GHO, and EVO. Make-up water for process uses are diverted from the following locations:

- FRO: Shandley Pit. Eagle 4 Pit, Turnbull TSF reclaim line, Kilmarnock Creek, and groundwater wells
- GHO: Phase 3 Pit, Phase 6 Pit, and groundwater wells
- LCO: None
- EVO: Cedar Pit (Tunnel) and Elk River

The consumptive water losses at FRO (e.g., water lost with clean coal as a result of dryer usage and other mechanisms within the process plant) are estimated at 3,000 m^3/d based on the water balance results for the South Tailings Pond (STP). In comparison, the consumptive water losses at GHO and EVO are estimated at 3,000 m^3/d and 2,700 m^3/d, respectively, based on the water balance results for the process plant/tailings storage facility.

4.11 Accounting for the Effects of Reclamation

4.11.1 Purpose

The *Reclamation Calculations* in the FC of the 2020 RWQM are described in this section. These calculations are used to model projected decreases in infiltration rates and associated increases in evapotranspiration rates at waste rock spoils once they are reclaimed, as well as the overall decrease in flows from reclaimed areas (relative to disturbed areas prior to reclamation). The effects of reclamation are mostly applicable to the modelling of closure conditions but can be applied wherever reclamation activities are undertaken. These calculations result in a progressive decrease in catchment yields from reclaimed areas and affect projected estimates of total flows from sub-catchments and at downstream tributary nodes.

4.11.2 Methods

Information from Teck's long-range reclamation plans and reclamation research and development program was considered to support the modelling of reclamation activities in the FC of the 2020 RWQM. The long-range reclamation plans specify the extent of reclamation having been completed in each mine area by a given time (i.e., at each snapshot interval), consistent with future permitted development activities at each Teck operation. The plans also identify the type of reclamation being considered (i.e., the prescription), and the start date of reclamation. Information from Teck's research and development program (OKC 2018) includes estimates of the duration for each reclamation prescription to reach maturity, and an empirical relationship to model the expected change to evapotranspiration rates as vegetation cover matures.

User inputs defined for estimating effects of reclamation in the 2020 RWQM include:

- Reclamation start date

  The start date of reclamation was set to begin after the end of active operations, consistent with the last date of seeding noted in the long-range reclamation plan at each site. These dates are as follows: 2055 year-end (YE) for FRO, 2042YE for GHO, 2043YE for LCO, and 2059YE for EVO.

- Reclamation prescription

  Four options are built into the FC: bare ground, natural revegetation, grasses, and seedlings. Consistent with information noted in the long-range reclamation plan at each site, all areas were modelled with seedlings as the reclamation prescription. Reclamation prescriptions were applied to all mine-affected areas, including waste rock areas, hard mine areas, and CCR areas.

- Reclamation period, which corresponds to the length of time it will take for the reclamation efforts to be fully realized (i.e., vegetation is fully matured and effects to evapotranspiration and infiltration are fully realized)

  Reclamation period varies by reclamation prescription, ranging from 2 years to 30 years. Seedlings were modelled with a period of maturity of 30 years.

Once the above inputs were defined for each sub-catchment, the effect of progressive reclamation is calculated in the FC of the 2020 RWQM. The numerical approach differs between waste rock areas and other mine-affected areas (i.e., hard mine and CCR areas), because flows from waste rock areas are generated using the waste rock hydrology module and flows from hard mine areas are generated using SRM.

For waste rock areas, the Kc value (the coefficient to scale evaporation from open water to land surface) for waste rock areas is modelled to progressively increase over the reclamation period, beginning on the reclamation start date. The increase in the Kc value is defined as a function of leaf area index (LAI). The LAI increases from a value of zero (bare surfaces) to a defined maximum value at maturity. Increasing the Kc value from the start of the reclamation period results in an incremental increase in the evapotranspiration losses, which in turn decreases the infiltration into the waste rock spoil.

For hard mine and CCR areas, the runoff coefficient for a given sub-catchment was modelled to progressively decrease over the reclamation period. The runoff coefficient was approximately matched to that of natural areas at the end of the reclamation period (Figure 4-28). This approach reflects the temporal increase in the evapotranspiration losses from the change in land cover and results in an incremental decrease in runoff from the start of the reclamation period.

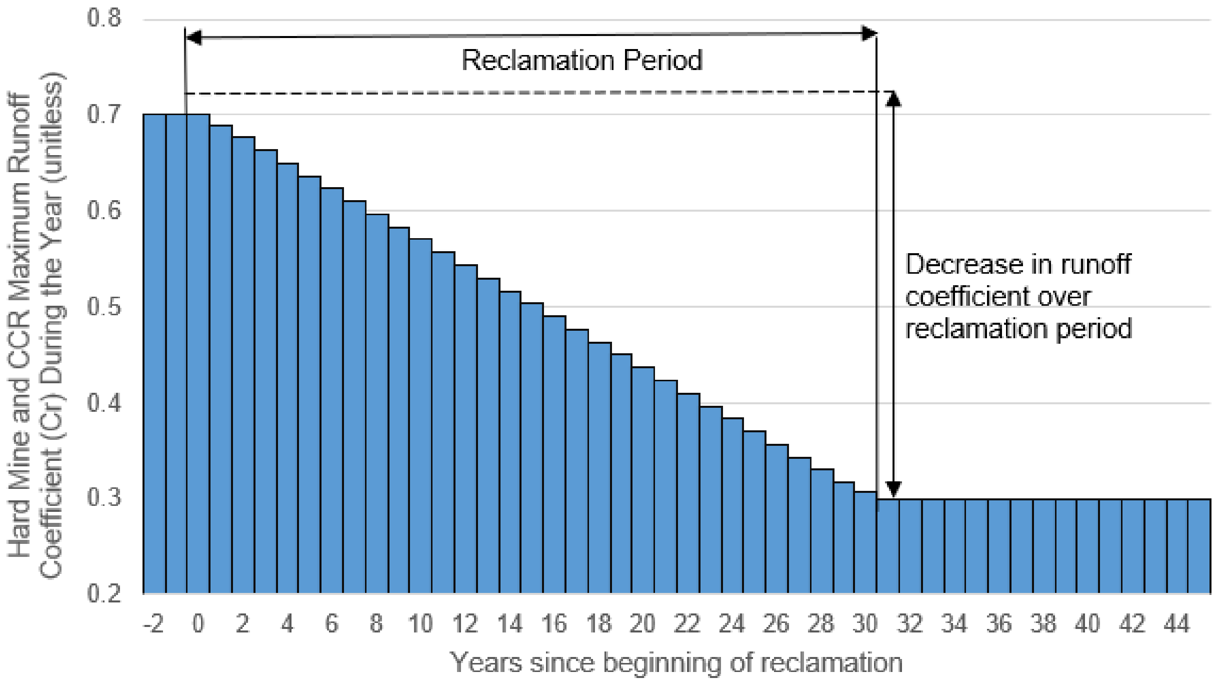


Figure 4-28: Effect of Reclamation on Modelled Yield from the Hard Mine and CCR Runoff Coefficient

4.12 Verifying the Sub-Catchment Water Balance (Water Balance Module)

4.12.1 Purpose

The water balance module in the flow component of the 2020 RWQM is described in this section. This module was developed to allow a basis for completing quality assurance checks of the modelled estimates at individual sub-catchments.

4.12.2 Methods

The water balance module estimates annual water volumes for individual water balance components, including precipitation, evapotranspiration, total flow (or sub-catchment yield), and water storage. In sub-catchments that include water management activities, water transfers and consumptive uses are also accounted for in the overall water balance estimates. Calculations in the module are completed based on the hydrological year (from October 1 to September 30) to consider the entire snow accumulation and snowmelt within the same annual cycle. The application of the water balance module in the model calibration process is discussed further in Section 5.1.

4.13 Estimating Total Flows at Tributary Nodes

4.13.1 Purpose

The tributary-scale estimates of total flow in the FC of the 2020 RWQM are described in this section. These estimates of total flows at tributary nodes are required during model calibration to evaluate model performance, allow for comparisons against estimates of sub-catchment yield, and to verify the overall water balance of the sub-catchment.

4.13.2 Methods

The approach to estimate total flows at tributary nodes in the FC generally involves adding up the flows from the contributing sub-catchment areas. This process accounts for the influences of the relevant water management activities through mining operations and closure, including pit water storage, diversions, consumptive uses, groundwater baseflow changes due to pit development, and reclamation activities. The total flows at tributary nodes represent the net flows generated using the SRM for undisturbed (non-mine affected) areas, hard mine areas and coarse coal reject areas, and the net flows generated using the waste rock hydrology module for waste rock spoils. The tributary nodes in the FC that include estimates of total flows are presented in Table 4-1 of Section 4.1.

At tributary nodes in the FC, the estimated total flows are subsequently partitioned into surface and groundwater flow components, to account for the site-specific channel conditions. The approach to flow partitioning is discussed further in Section 4.17.

4.14 Estimating Flows at the Fording River Mainstem Nodes

4.14.1 Purpose

The mainstem flow calculations in the FC of the 2020 RWQM for the Fording River mainstem nodes are described in this section. Estimates of total flows at mainstem nodes are required to evaluate model performance at mainstem nodes with available flow monitoring data, as well as to support WQC-calculated loads at mainstem Order Stations and compliance points.

4.14.2 Methods

The approach in the FC for estimating flows at mainstem Fording River nodes involves adding up the flows from the contributing upstream tributary nodes. The mainstem Fording River nodes that include estimates of total flows are presented in Table 4-16.

Table 4-16: Estimating Flows at Fording River Nodes

Model Node	Description	Formula used	Comments
FR_FR1	Fording River downstream of Henretta Creek (0200251)	FR_HC1 + FR_UFR1 + Turn Creek	Flow from Henretta Creek, Turn Creek and Fording River above Henretta Creek
FR_FRNTP	Fording River at the North Tailings Pond	FR_FR1 + FR_PP1 + FR_CC1 + FR_LMP1 + FR_LP1 + FR_EC1 + Turnbull Bridge Spoil	Additional flow from Post Ponds and Turnbull Bridge Spoils, Lake Mountain Creek, Clode Creek, Turnbull TSF decant, Eagle Ponds, Eagle Pits and Liverpool Ponds (Swift Pit)
FR_FR2	Fording River upstream of Kilmarnock Creek (0200201)	FR_FRNTP + Fording LF2 Lower + South Tailings Pond Seepage	Additional flow from Fording LF2 Lower, South Tailings Pond Seepage
FR_FR4	Fording River downstream of Swift Creek and upstream of Cataract Creek (0200311)	FR_FR2 + Swift Creek Upper Diversion + GH_SC1	Additional flow from Swift Creek Upper Diversion and Swift Creek
FR_FRCP1	FRO Compliance Point - Fording River approximately 525 m downstream of Cataract Creek (E300071)	FR_FR4 + GH_CC1 + other areas	Additional flow from Cataract Creek, a portion of Kilmarnock Creek flow and other areas, including a portion of the Castle Mountain sub-catchment and other areas not associated with a named tributary between FR_FR4 and FR_FRCP1.
GH_PC2	Fording River downstream of Porter Creek (E287431)	FR_FRCP1 + GH_PC1 + other areas	Additional flow from Porter Creek, remaining flow from Kilmarnock Creek and other areas not associated with a named tributary between FR_FRCP1 and GH_PC2, including a portion of the Castle Mountain sub-catchment
FR_FRABCH	Fording River above Chauncey Creek	GH_PC2 + other areas	Additional flow from other areas include a portion of the Castle Mountain sub-catchment and other areas not associated with a named tributary between GH_PC2 and FR_FRABCH.
GH_FR1	GHO Fording River Compliance Point – Upper Fording River, approximately 205 m downstream of Greenhills Creek (0200378)	FR_FRABCH + Chauncey Creek + Ewin Creek + Todhunter Creek + LCO Dry Creek + Grace Creek + GH_GH1 + other areas	Additional flow from Chauncey Creek, Ewin Creek, Todhunter Creek, LCO Dry Creek, Grace Creek, Greenhills Creek and other areas not associated with a named tributary between FR_FRABCH and GH_FR1.
LC_LC5	Fording River downstream of Line Creek (at the Mouth)	GH_FR1 + LC_LC4 + other areas	Additional flow from Line Creek and other areas not associated with a named tributary between GH_FR1 and LC_LC5.

4.15 Estimating Flows at Michel Creek Mainstem Nodes

4.15.1 Purpose

The mainstem flow calculations in the FC of the 2020 RWQM for the Michel Creek mainstem node are described in this section. As indicated in Section 4.14, estimates of total flows at mainstem nodes are required to evaluate model performance at mainstem nodes with available flow monitoring data and to support WQC-calculated loads at mainstem Order Stations and compliance points.

4.15.2 Methods

The methods for deriving flows at Michel Creek mainstem nodes in the FC of the 2020 RWQM include a combination of approaches, as described below:

- Flows at Michel Creek downstream of CMO (CM_MC2) originate from the CMO Water and Load Balance Model. The methods for estimating flows at CM_MC2 are described in SRK (2021).
- Flows at Michel Creek upstream of Erickson Creek (EV_MC3) are estimated using a ranked regression equation developed at EV_MC2 and a scaling equation to account for the differences in drainage area and elevation between EV_MC3 and EV_MC2.
- Flows at all nodes downstream of EV_MC3 to the mouth of Michel Creek (i.e., at nodes EV_MC3a, EV_MC2a, EV_MC2 and EV_MC1) are then estimated by adding up the individual upstream flow contributions from sub-catchments of EVO, as modelled using the SRM and the waste rock hydrology module in the FC. The equations for each of these nodes are provided in Table 4-17.

Table 4-17: Estimating Flows at Michel Creek Nodes

Model Node	Description	Method / Formula used	Comments
CM_MC2	Michel Creek, approximately 50 m upstream of Andy Goode Creek (E258937)	CMO Water and Load Balance Model	Flow from the entire Coal Mountain Operations site, the Corbin Creek sub-catchment, and other areas of the Michel Creek catchment above Corbin Creek were obtained from the CMO Water and Load Balance Model.
EV_MC3	Michel Creek upstream of Erickson Creek (0200203)	Ranked regression equation to estimate flow at EV_MC2, scaled (prorated) to drainage area at EV_MC3, with a baseflow adjustment for groundwater flow component	Represents flow from several tributaries including the CMO site, Andy Goode Creek, Leach Creek, Carbon Creek, Snowslide Creek, Wheeler Creek, and Alexander Creek, and other unnamed tributaries between CM_MC2 and EV_MC3.
EV_MC3a	Michel Creek downstream of Erickson Creek	EV_MC3 + EV_EC1	Additional flow from Erickson Creek are estimated using the SRM and waste rock hydrology modules and added to the flow at EV_MC3.
EV_MC2a	Michel Creek upstream of Gate Creek	EV_MC3a + EV_SP1 + EV_MG1 + EV_TC1 + other areas	Additional flow from South Pit Creek, Milligan Creek, Thresher Creek and other unnamed areas of the Michel Creek catchment between EV_MC3a and EV_MC2a are estimated using the SRM and waste rock hydrology modules and added to EV_MC3a.
EV_MC2	EVO Michel Creek Compliance Point (at the Highway 3 bridge) (E300091)	EV_MC2a + EV_BC1 + EV_GT1 + other areas	Additional flow from Gate Creek, Bodie Creek and other unnamed areas of the Michel Creek catchment between EV_MC2a and EV_MC2 are estimated using the SRM and waste rock hydrology modules and added to EV_MC2a.
EV_MC1	Michel Creek upstream of Highway 43 Bridge (at the Mouth) (0200425)	EV_MC2 + EV_AQ1 + other areas	Additional flow from Aqueduct Creek and other unnamed areas of the Michel Creek catchment between EV_MC2 and EV_MC1 are estimated using the SRM and waste rock hydrology modules and added to EV_MC2.

CMO = Coal Mountain Operations, EVO = Elkview Operations, SRM = Snowmelt Runoff Module.

The ranked regression or empirical frequency pairing (EFP) method is an alternate to conventional regression techniques and can be used to generate relationships to estimate flows, particularly at locations with short-term data using stations with long-term data (Butt 2013). Historical flows between 1970 and 1996 from the discontinued ECCC hydrometric station (Michel Creek below Natal, Station 08NK020) were used along with concurrent data records at the Elk River at Fernie (08NK002) and Elk River near Natal (08NK016) hydrometric stations with the EFP method to generate a ranked regression relationship. These relationships were then applied to generate a synthetic daily flow record at the EVO Michel Creek Compliance Point (EV_MC2) for the entire historical period (i.e., 1970 to 2019). The steps followed are described in further detail below:

- Flow data for the period of 1970 to 2018 from the aforementioned ECCC stations and Teck's EV_MC2 station were complied. The source dataset used to develop the regression relationship was derived as the difference in flow between the Elk River at Fernie and the Elk River near Natal.
- A regression analysis was conducted on the concurrent dataset, which was limited by the Michel below Natal station (08NK020) data record from 1970 to 1995. The data record from 1970 to 1995 was split into two: the period from 1970 to 1983 (14 years) was used for developing the regression relationships, and the period from 1984 to 1995 (12 years) was used for validation.
- To develop the regression relationships, the dataset was first divided into quarters as follows: Quarter 1 (January – March), Quarter 2 (April – June), Quarter 3 (July – September), and Quarter 4 (October – December). Quarter 2 was further split into two: April, and May to June, in recognition of the rapid transition in flow that can occur in this period with the onset of spring freshet.
- The data in each quarter was ranked for each dataset (i.e., the difference in flow between the Elk River at Fernie and the Elk River near Natal formed one dataset while the Michel Creek below Natal station formed the other).
- Regression was performed on the ranked (frequency paired) data for each quarter. Various regression types were then tested to pick the best fit.
- Ultimately, the best fit relationship was applied to the source dataset to generate a long-term data record at EV_MC2.

The derived long-term data record at EV_MC2 was scaled to the EV_MC3 node in the FC of the 2020 RWQM, with the scaling adjustment a function of the drainage area and elevation differences between EV_MC2 and EV_MC3, as noted in Table 4-17. The approach to scaling was adopted to allow the FC to continue to rely on the SRM and waste rock hydrology modules for flow estimates from EVO tributary catchments. In other words, the model domain of the FC for the Michel Creek catchment effectively begins at EV_MC3 and does not explicitly model upstream catchment flows. Loads from the upstream catchment are defined in the WQC using output from the CMO Water and Load Balance Model.

Finally, a baseflow adjustment was also applied to EV_MC3 as part of the model calibration process. This adjustment is further explained in Section 5.

4.16 Estimating Flows at the Elk River Mainstem Nodes

4.16.1 Purpose

The mainstem flow calculations in the FC of the 2020 RWQM for the Elk River mainstem nodes as well as tributary inflows to the Koocanusa Reservoir are described in this section. As indicated in Section 4.14, estimates of total flows at mainstem nodes are required to evaluate model performance at mainstem nodes with available flow monitoring data and support WQC-calculated loads at mainstem Order Stations and compliance points.

4.16.2 Methods

A specific method of flow derivation was used to estimate flows for the Elk River nodes and other tributary inflows to Koocanusa Reservoir (relative to the associated mainstem flow calculations for the Fording River and Michel Creek nodes). Estimating flows at these nodes consisted of the direct use of available monitoring data (at gauged locations) or by pro-rating flows from gauged stations to the modelling nodes (at ungauged locations). This method was applied to the Elk River, as well as to inflows to the Koocanusa Reservoir from other tributaries (i.e., the Bull River and Kootenay River). There are long-term stream gauge records for these watercourses and the flow regimes are not expected to change substantially due to future mining activity, meaning that flows at the subject watercourses can be characterized using existing flow records and pro-rated as required to reflect contributing sub-catchment area.

Table 4-18: Flows at Regional Mainstem Nodes (Locations where Scaling Methods are Applied)

Node	Description	Method	Formula used to derive flows
GH_ERC	GHO Elk River Compliance Point – Elk River, 220 m downstream of Thompson Creek (E300090)	Derived by calculating the amount of flow measured at Environment Canada hydrometric gauge 08NK016 (Elk River at Natal) that would originate from the Elk River watershed excluding the Fording River, and pro-rating the result using a ratio of watershed areas. Fording River flows are defined for the purposes of this calculation using measured data,	(EV_ER4 - LC_LC5) * 0.72
GH_ER1	Elk River upstream of Boivin Creek (upstream of Fording River confluence, near Elkford) (E206661)	Same as above.	(EV_ER4 - LC_LC5) * 0.78
EV_ER4	Elk River upstream of Grave Creek (from Fording River to Michel Creek (0200027) (downstream of Fording River confluence, near Natal)	Located at Environment Canada hydrometric gauge 08NK016 (Elk River at Natal). Gauged flows were used.	EV_ER4 = 08NK016

Table 4-18: Flows at Regional Mainstem Nodes (Locations where Scaling Methods are Applied)

Node	Description	Method	Formula used to derive flows
EV_ER1	Elk River downstream of Michel Creek confluence (0200393)	Derived by summing the modelled flow at Michel Creek at the mouth (EV_MC1) and pro-rating the gauged flow at 08NK016 (EV_ER4).	EV_MC1 + EV_ER4*1.164
RG_ELKFERNIE	Elk River at Fernie (West Fernie Bridge)	Located at Environment Canada hydrometric gauge 08NK004 (Elk River at Fernie). Gauged flows were used.	RG_ELKFERNIE = 08NK004
RG_ELKORES	Elk River at Elko Reservoir (E294312)	Derived using Elk River at Fernie (08NK004) and prorated using a ratio of watershed areas.	RG_ELKORES = RG_ELKFERNIE x 1.14
RG_ELKMOUTH	Elk River at Highway 93 near Elko (the mouth)	Derived using Environment Canada hydrometric gauges Elk River at Phillips Bridge (08NK005), and Elk at Fernie after 1996. Prorated flow based on a relationship between monthly flows (from scatterplot).	RG_ELKMOUTH = 08NK005 (until 1996) RG_ELKMOUTH = RG_ELKFERNIE × 1.53 (after 1996)
RG_BULL	Bull River near Wardner	Located at Environment Canada hydrometric gauge 08G002 (Bull River near Wardner) Gauged flows were used.	RG_BULL = 08NG002
RG_KOOTENAY	Kootenay River near Fort Steele	Located at Environment Canada hydrometric 08NG065 (Kootenay River near Fort Steele). Gauged flows were used.	RG_KOOTENAY = 08NG065

4.17 Accounting for Surface Water-Groundwater Partitioning at Model Nodes

4.17.1 Purpose

The approach to partitioning the surface and groundwater flow components at model nodes in the FC of the 2020 RWQM is described in this section. As noted in the conceptual model, total sub-catchment yield, as estimated by the FC, flows via surface and groundwater pathways. Explicit representation of these two flow pathways was not included in previous versions of the RWQM. Focus was placed on tracking total sub-catchment yield (i.e., total flow), and it was assumed that constituents released from mine operations and other areas mixed completely in the total flow. Surface water – groundwater partitioning is explicitly built into the 2020 RWQM to assist with the calibration of the FC and to support a more accurate representation of the hydrologic system because of the relevance of mine-impacted water flow pathways to water quality mitigation planning, in terms of capturing mine-influenced water.

4.17.2 Methods

The FC of the RWQM is used to estimate and then track total flow. At specific locations, explicit representation of the division of flow between surface and groundwater pathways has been included to more accurately support flow tracking and mitigation planning. The volume of water traveling through the ground at any point in time is calculated based on flow thresholds that are expressed as a percentage of total flow up to a maximum flow rate.

The flow thresholds are defined based on available monitoring information, including knowledge of the local geology. The flow thresholds are summarized in Table 4-19. These thresholds relied on information from various sources, as summarized in Section 4.3 and Appendix B. In some instances, the defined partitioning was adjusted as part of the model calibration process. The need for adjustments was determined based on the sub-catchment water balance and comparisons of modelled and monitored flows on a mean annual basis. This process is discussed further in Section 5.1.

Table 4-19: Flow Thresholds Used to Define Surface Water - Groundwater Partitioning in the 2020 Regional Water Quality Model

Operation	Node ID	Description	Groundwater Flow	
			Percentage of Total Flow	Maximum Flow Rate (m^3/d)
FRO	FR_CC1	Clode Creek Sediment Pond Decant (E102481)	60%	4,000
	FR_KC1	Kilmarnock Creek d/s of Rock Drain (0200252)	Flows <60,000 m^3/d: 100%; Flows >60,000 m^3/d: 30%	Flows <60,000 m^3/d: 16,500; Flows >60,000 m^3/d: 26,900
	FR_FRNTP	Fording River at North Tailings Pond	3%	10,000
	GH_SC1 and GH_SC2	Swift Creek Sediment Pond Decant (E221329)	2%	1,000
GHO	GH_GH1	Greenhills Creek Sediment Pond Decant (E102709)	30%	6,000
	GH_TC1 and GH_TC2	Thompson Creek at LRP Road (E102714)	80%	5,000
LCO	LC_DCEF[(a)]	East Tributary of LCO Dry Creek (E288274)	80%	69,120
	LC_WLC	West Line Creek (E261958)	60%	10,000
	LC_DC1	LCO Dry Creek near mouth (at bridge) (E288270)	50%	8,000

Table 4-19: Flow Thresholds Used to Define Surface Water - Groundwater Partitioning in the 2020 Regional Water Quality Model

Operation	Node ID	Description	Groundwater Flow	
			Percentage of Total Flow	Maximum Flow Rate (m^3/d)
EVO	EV_DC1	EVO Dry Creek Sediment Pond Decant (E298590)	Flows <20,000 m^3/d: 100%, Flows >20,000 m^3/d: 10%	Flows <20,000 m^3/d: 2,000; Flows >20,000 m^3/d: 5,000
	EV_HC1	EVO Harmer Compliance Point – Harmer Spillway (E102682)	5%	5,000
	EV_GV1	Grave Creek at bridge	5%	5,000
	EV_EC1	Erickson Creek at Mouth (0200097)	10%	34,560

a) Groundwater partitioning occurs in downstream reach after LC_DCEF, not at LC_DCEF.
EVO = Elkview Operations; FRO = Fording River Operations; GHO = Greenhills Operations; LCO = Line Creek Operations; ID = identification; m^3/d = cubic metres per day;% = percent.

4.18 Generating Future Flow Projections

4.18.1 Purpose

The methods to generate future flow projections in the flow component of the 2020 RWQM are described in this section. These methods are used to generate flows that are representative of future site conditions, through operations and closure, at each mine site. Future flow projections in the FC of the 2020 RWQM are generated for a range of climatic conditions encompassing wet and dry years. The resulting information is summarized and used to produce three representative flow conditions (i.e., 10^{th} percentile, median and 90^{th} percentile weekly flows) that are then used in the WQC of the RWQM to generate future water quality projections.

4.18.2 Methods

Future climate projections are generated within GoldSim using a multi-realization simulation approach. More specifically, the FC is set-up to loop through the 2000 to 2019 historical climate dataset to develop potential future flow projections. The FC loops through the historical climate dataset 20 times, with the starting date of the historical climate dataset being offset by one year from that used in the previous realization. For example, during the first realization, the climate information starts in 2000 and ends with that from 2019. In the next realization, the climate information starts in 2001 and ends with that from 2000, and so on through the 20 realizations. When the duration of the simulation exceeds 20 years, the climate information is repeated. For example, the first realization of a 40-year simulation will begin with climate information from 2000 and run through the 2000 to 2019 climate dataset twice over the course of the simulation. Using this approach, every future year uses each of the 20 years of climate data during the 20 realizations (Figure 4-29).

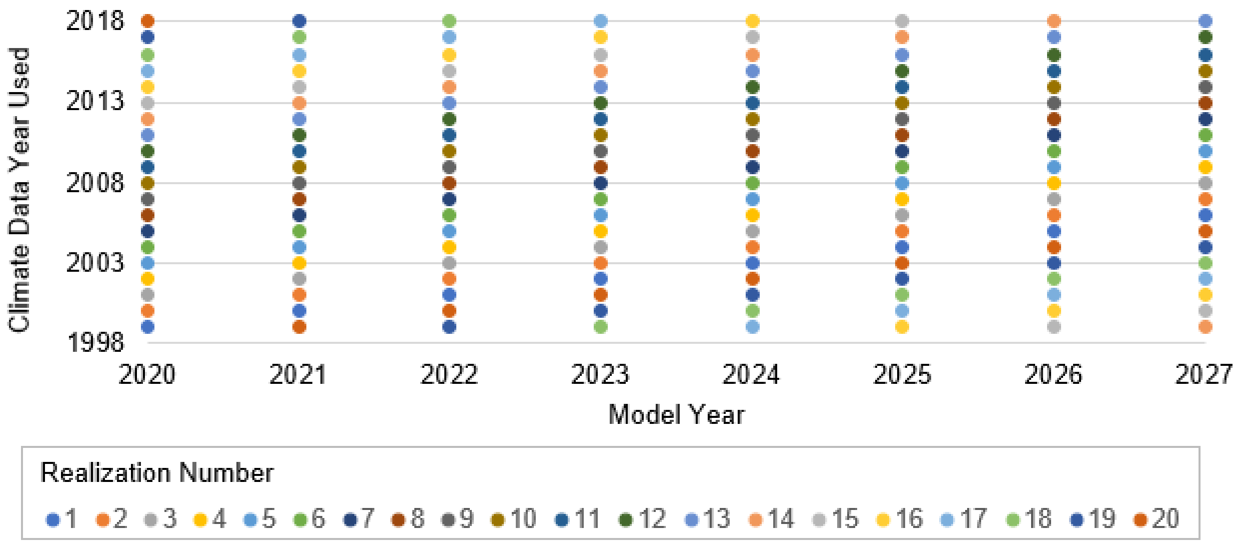


Figure 4-29: Example of Time Shifting Climate Data Years for 20 Realizations

Based on its current set-up, the FC produces 20 weekly average flow estimates for each week of each year included in the simulation period. A 20 year climate record, as opposed to a 30 or 40 year climate record, was selected for use to manage model runtimes and output file size. The 1999 to 2019 time period was selected for use in generating future flow projections, it being most representative of recent conditions. As shown in Figures 4-30 and 4-31, it is characterized as a period of less total winter precipitation and greater summer precipitation, relative to the longer period of record.

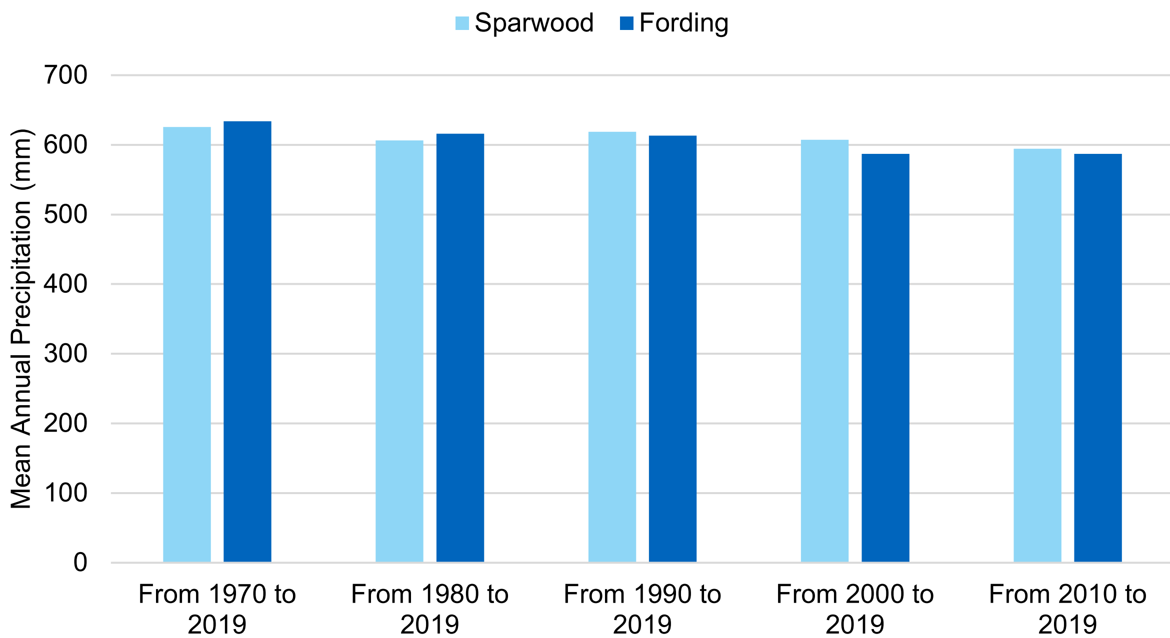


Figure 4-30: Mean Annual Precipitation Comparisons for Different Historical Periods

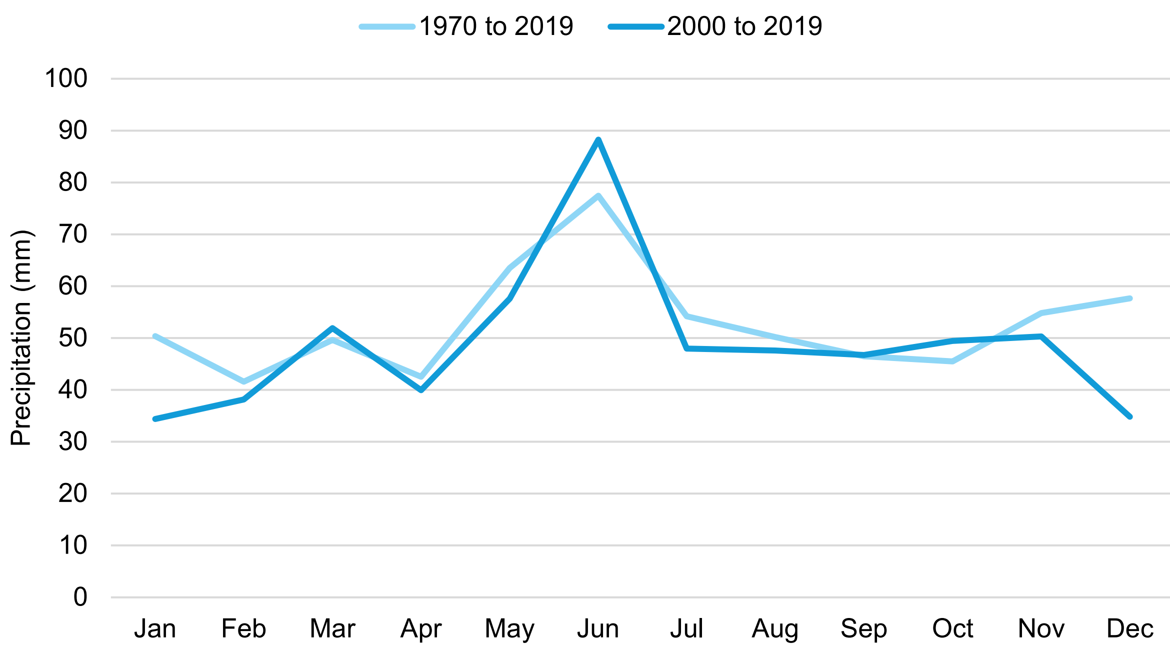


Figure 4-31: Comparisons of Mean Monthly Total Precipitation for Different Climate Data Periods at Fording Cominco Station

A sensitivity analysis was conducted to evaluate how future flow projections may change if a longer climate dataset were used to generate future flow projections. Three configurations were tested:

- Climate data from 1999 to 2019 (20 realizations)
- Climate data from 1989 to 2019 (30 realizations)
- Climate data from 1979 to 2019 (40 realizations)

Resulting future flow estimates at the mouth of the Fording River were compared. Differences were found to be small to negligible, as shown in Table 4-20.

Table 4-20: Comparison of the Characteristics of Future Flow Timeseries (2020 to 2060) Developed for the Mouth of the Fording River Using Different Climate Datasets

	Climate data from 1999 - 2019			Climate data from 1989 - 2019			Climate data from 1979 - 2019		
	Flow Time Series			Percentile			Percentile		
Summary Statistics	**P10**	**P50**	**P90**	**10%**	**50%**	**90%**	**10%**	**50%**	**90%**
Minimum flow (m^3/s)	0.4	0.8	1.3	0.4	0.8	1.3	0.4	0.8	1.3
Average flow (m^3/s)	1.4	2.8	5.4	1.4	2.7	5.4	1.4	2.7	5.3
75^{th} percentile flow (m^3/s)	1.7	3.1	5.2	1.8	3.0	5.2	1.8	3.0	5.2
95^{th} percentile flow (m^3/s)	3.7	7.9	17.3	3.5	7.8	16.7	3.5	7.9	16.6
Maximum flow (m^3/s)	5.9	12.3	24.2	5.2	11.5	22.8	5.0	11.0	21.7

4.19 Accounting for Water Quality Management Measures

4.19.1 Purpose

The FC of the 2020 RWQM incorporates water quality management measures that are currently in operation, as they may influence model calibration. Future planned mitigation information is not incorporated into the FC of the 2020 RWQM. Changes to water flows that may occur in support of, or as a result of, future water quality mitigation are modelled using the WQC. This approach is used to facilitate the evaluation of different potential mitigation scenarios efficiently, without having to loop back and forth between the FC and WQC.

4.19.2 Methods

The water quality management measures incorporated into the FC are:

- existing active water treatment (i.e., the West Line Creek AWTF);
- existing water treatment using SRFs (i.e., the F2 Pit SRF);
- existing conveyance of mine-affected water associated with existing treatment facilities; and

- existing and projected consumptive water use (at all sites).

Other measures such as blasting practices and reduction of selenium and nitrate concentrations via tailings are considered to have no influence on flow projections and were not modelled in the FC. The approach used to incorporate these measures into the WQC of the 2020 RWQM is described in further detail in Annex C. Only existing water quality management measures that affect flow projections are represented in the FC. As noted above, this approach was adopted to allow for flexibility in using the WQC to examine the potential influence of a number of different water quality management and mitigation scenarios on water quality without having to rely on the FC for inputs to each scenario, thereby limiting iteration between the FC and WQC and facilitating the examination of multiple scenarios in a shorter amount of time.

4.20 Assumptions

The main assumptions incorporated into the setup and configuration of the FC of the 2020 RWQM are summarized in Table 4-21. The assumptions reflect, where relevant, the conceptual model discussed in Section 3. The assumptions in Table 4-21 are organized by subject, with a cross-reference to the report section in which they are discussed.

Table 4-21: Summary of Assumptions Relevant to the FC 2020 RWQM

Subject	Assumptions	Report Section
Site Conditions	• Runoff flows are driven by the topography of the underlying mined-out or original surface; therefore, the placement of backfill and waste rock spoils (and current reclamation practice) does not affect drainage paths or decant elevations of flooded pits and backfilled pits. • Sub-catchment areas are generally constant from 1970 to 2018 (fixed to 2018 sub-catchment areas). There is generally high confidence in the topographic snapshot in 2018 used to delineate the areas. This confidence is lower at the beginning of the historical period. Mining areas (areas disturbed by mining activity including pit waste rock dumps, coarse coal reject dumps plant areas, tailings storage areas, roads and pond and spoil areas) before 2018 are assumed to be proportional to historical waste rock volumes. The change in future sub-catchment and spoil areas is linearly interpolated between snapshot years. • Non-mine affected l areas may include forested areas, flood plains, undisturbed bare ground and other areas not substantially altered by mining activity. • Short-term, temporary watershed events (e.g., ice jams) and upsets that may affect flows will have a limited effect on water quality planning; as a result, they have not been explicitly considered.	4.3.4, 4.3.5
Climate	• Precipitation and temperature patterns are predominantly affected by latitude and elevation within the Elk Valley. Localized influence of topographic features (e.g., aspect) are negligible at a sub-catchment-scale. • Orographic temperature gradients (lapse rates) are constant regionally (throughout the Elk Valley) and do not vary substantially seasonally. • Orographic precipitation gradients vary seasonally (between winter and summer) but show less variability regionally (i.e., from one operation to another). • Data collected at a nearby reference station for sub-catchments in each operation are representative of the climatic patterns and trends at the entire operation once the appropriate adjustments for elevation differences are implemented. • All land types within a sub-catchment receive the same meteorological inputs. • Snow accumulation and snow cover in a sub-catchment is not influenced by land cover and is primarily a function of elevation, air temperature and the rate of ablation. • The rate of potential evaporation and evapotranspiration is primarily a function of air temperature, relative humidity (correlated with the diurnal variability in temperature) and solar radiation (correlated with latitude). • The potential rate of sublimation is constant and uniformly applies to the entire snow-covered area in a sub-catchment. • Actual rates of atmospheric losses (evapotranspiration, evaporation and sublimation) are influenced by land cover and elevation but localized influences of aspect are negligible at the sub-catchment-scale.	4.4, 4.5

Table 4-21: Summary of Assumptions Relevant to the FC 2020 RWQM

Subject	Assumptions	Report Section
Snowmelt Runoff Module (SRM)	• The snow cover fraction in a sub-catchment follows a similar trend each year. Runoff generation • Snowmelt and runoff patterns within a sub-catchment follow the same pattern for each land type (i.e., are independent of elevation differences within the sub-catchment). • Snowmelt runoff and rainfall runoff coefficients are constant for a given sub-catchment, with seasonal differences between warm and cold months.	4.6
Waste Rock Hydrology Module	• Spoil properties are consistent for all waste rock placed within a sub-catchment. • Water flow through the waste rock spoils are governed both by the overall volume of waste rock and the area of waste rock (effective spoil height). The influence of dump construction techniques on water flows is not considered. • Runoff from the surface of the spoil is negligible. • The predominant flow pathway for percolation through is a spoil is matrix flow. • Run-on and rock drain flows at the base of the spoil are not attenuated and mix completely with the toe discharge from the waste rock spoil.	4.7
Pit Module	• The decant elevation of a pit is the lowest outlet elevation from the mined topography. • Backfilled in-pit waste rock spoils store water within the void spaces, up to the porosity of the waste rock spoil (0.30).	4.3.5, 4.8
Water Management	• Consumptive uses result in a complete loss of water (i.e., water used for dust suppression is removed from the sub-catchment and does not report to other sub-catchments or downstream model nodes). • Water diversion infrastructure (e.g., pipes, open channels, rock drains) function effectively with minimal leakage.	4.3.5, 4.10
Effects of Reclamation	• Historical reclamation has a negligible influence on the overall sub-catchment yield. • The effects of reclamation on flows are seen progressively over a period of 30 years, beginning once all mining operations are completed at each site. • Reclamation prescriptions are similar at all sites, meaning that the duration for complete revegetation and the relative effect of the revegetation is expected to be similar throughout the Elk Valley.	4.3.4, 4.11
Sub-Catchment Water Balance	• Change in the amount of water stored within undisturbed sub-catchments (e.g., in lakes, ponds or as snow accumulation) is negligible on an annual scale. • Deep percolation to bedrock groundwater aquifers is a negligible component of the overall water balance.	4.12
Travel time	The travel time for flows between two nodes is of the order of hours or within the same day.	4.13, 4.14, 4.15, 4.16
Groundwater Flow, Pit Seepage and Groundwater Partitioning at Nodes	• Groundwater recharge from tributary catchments travels through shallow flow pathways and reports to tributary mouths, with few exceptions. • Groundwater flow through deep bedrock systems is, in general, a small to negligible component of the overall water balance. • Interactions of surface water and shallow groundwater flow in watercourses are localized and occur as losing and gaining reaches within a watercourse, with limited interaction with deeper bedrock groundwater flow. • The volume of water that can be conveyed through shallow subsurface flow paths is limited (i.e., is subject to a maximum flow capacity). • The ability for mine pits to act as local groundwater sinks is at its maximum potential when they are empty and fully mined out. • Seepage rates decrease as pits reach decant elevation and stabilize to an equilibrium. • Seepage rates vary linearly between these conditions (i.e., pit empty and pit full).	4.3.6, 4.3.7, 4.9, 4.17
Future Flow Projections	Future flows are based on the climate variability observed between 2000 and 2019.	4.18
Water Quality Management Measures	There are no consumptive losses at water treatment facilities, or through the conveyance infrastructure associated with water quality management measures.	4.3.8, 4.19

5 Numerical Model - Part II: Calibration and Future Projections

5.1 Overview of the Calibration Process

The FC of the 2020 RWQM has changed from that included in the 2017 RWQM. The FC now relies on meteorological inputs, rather than flow data from analogue catchments, to initiate the generation of flows in mine-influenced tributaries throughout the Elk River Valley and in both natural and mine-influenced areas of the Fording River watershed. The FC also now uses a ranked regression approach and monitored flow data to simulate flows in Michel Creek and the Elk River, respectively.

Like the 2017 RWQM, the FC of the 2020 RWQM was calibrated to historical conditions. The period of record for calibration was from January 2004 to December 2018, with consideration given to information collected in 2019, if and where available. Available data from 2019 were still classified as draft and preliminary at the time the model calibration was largely undertaken; hence, the primary focus on conditions between 2004 and 2018. In some instances, older data records were also considered. The rationale for the selected calibration period is discussed further below.

The calibration process involved simulating historical flows in the Elk Valley and comparing model output to monitoring results for the coincident period (i.e., evaluating model performance). The goal of calibration was to obtain a good visual and statistical fit between modelled and measured flows at both tributary and mainstem nodes. Model variables were adjusted as required, in an iterative fashion, within a reasonable range to achieve a suitable fit to the measured data. Adjustments typically involved changes to runoff coefficients and model variables controlling the magnitude and duration of runoff.

Once calibrated, the FC was used to project future flows in the Elk Valley and support the generation of future water quality projections. The future flow projections from the FC were compared with flows from the 2017 RWQM as outlined in Section 5.6.

This section consists of:

1. A list of the nodes selected for evaluating model performance as part of the calibration process (Section 5.1.1).
2. A discussion of the model calibration period (Section 5.1.2).
3. A description of the model calibration process (Section 5.2).
4. A description of the metrics used to evaluate model performance over the calibration period (Section 5.3).
5. A discussion of model performance over the calibration period (i.e., results of the model calibration) (Section 5.4 and Appendix B).

5.1.1 Quality Assurance Checks: Review Model Inputs

The FC of the 2020 RWQM was calibrated with a focus on nodes positioned in both tributaries and river mainstems (i.e., nodes in Michel Creek, Fording River and Elk River). Although the approach used to evaluate model performance was similar throughout the model domain, the calibration process differed depending on location. As previously noted, the FC now relies on meteorological inputs to initiate the generation of flows in mine-influenced tributaries throughout the Elk Valley and in both natural and mine-influenced areas of the Fording River watershed. In contrast, a ranked regression approach is used to initiate the simulation of flow through the mainstem of Michel Creek, while monitored data are scaled to estimate flows in the Elk River mainstem. Consequently, model calibration nodes are organized into three groups:

- Fording River watershed and mine-influenced tributaries elsewhere in the Elk Valley
- Michel Creek mainstem
- the Elk River mainstem

Each group is discussed in more detail below.

5.1.1.1 Fording River Watershed and Mine-Influenced Tributaries Elsewhere in the Elk Valley

In the Fording River watershed, as well as mine-influenced tributaries that contribute to the Elk Valley, model calibration nodes were positioned in sub-watersheds that generate runoff at FRO, GHO, LCO and EVO, as well as in the mainstem of the Fording River (Table 5-1). These locations were selected for availability of monitored data record completeness, record length and measurement through the model calibration period of 2004 – 2018 (Section 4.3).

Table 5-1: Calibration Nodes in the Fording River Watershed and Mine-Influenced Tributaries Elsewhere in the Elk Valley

Operation	Node Name	Node Description
Fording River Operations (FRO)	FR_HC1	Henretta Creek upstream of Fording River (E216778)
	FR_CC1	Decant from Clode Sediment Pond (E102481)
	FR_FRNTP	Fording River at North Tailings Pond
	GH_SC1	Swift Creek Sediment Pond Decant (E221329)
	GH_SC2	Swift Creek Sediment Pond Bypass (E105061)
	FR_KC1	Kilmarnock Creek downstream of Rock Drain (0200252)
	GH_CC1	Cataract Creek Sediment Pond Decant (0200384)
	FR_UFR1	Fording River upstream of Henretta Creek
	FR_LMP1	Lake Mountain Sediment Pond Decant
	FR_LP1	Liverpool Sediment Pond Decant
	FR_FR1	Fording River downstream of Henretta Creek (0200251)

Table 5-1: Calibration Nodes in the Fording River Watershed and Mine-Influenced Tributaries Elsewhere in the Elk Valley

Operation	Node Name	Node Description
	FR_FR2	Fording River upstream of Kilmarnock Creek (0200201)
	FR_FR4	Fording River between Swift and Cataract creeks (0200311)
	FR_FRABCH	Fording River above Chauncey Creek
Greenhills Operations (GHO)	GH_PC1	Porter Creek Sediment Pond Decant (0200385)
	GH_TC1	Thompson Creek at LRP Road (E102714)
	GH_TC2	Lower Thompson Creek Sediment Pond Decant (E207436)
	GH_GH1	Greenhills Creek Sediment Pond Decant (E102709)
	GH_FR1	GHO Fording River Compliance Point - Upper Fording River, 205 m d/s of Greenhills Creek (0200378)
	GH_LC1	Leask Creek Sediment Pond Decant (E257796)
	GH_LC2	Leask Creek u/s of Pond Inlet
	GH_WC1	Wolfram Creek Sediment Pond Decant (E257795)
	GH_WC2	Wolfram Creek u/s Pond Inflow
	GH_FR1	GHO Fording River Compliance Point - Upper Fording River, 205 m d/s of Greenhills Creek (0200378)

Table 5-1: Calibration Nodes in the Fording River Watershed and Mine-Influenced Tributaries Elsewhere in the Elk Valley

Operation	Node Name	Node Description
Line Creek Operation (LCO)	LC_LC4	Line Creek upstream of Process Plant (0200044) (near the mouth)
	LC_LC1	Upper Line Creek upstream of MSA North Pit (E126142)
	LC_WLC	West Line Creek (E261958)
	LC_LC3	Line Creek downstream of West Line Creek (0200337)
	LC_DC3	LCO Dry Creek upstream of East Tributary Creek (E288273)
	LC_DCEF	East Tributary of LCO Dry Creek (E288274)
	LC_DC1	LCO Dry Creek near the Mouth (at bridge) (E288270)
	LC_DCDS	LCO Dry Creek d/s of Sedimentation Ponds (E295210)
	LC_LCUSWLC	Line Creek u/s of West Line Creek (E293369)
	LC_LCDSSLCC	LCO Compliance Point - Line Creek immediately downstream of South Line Creek confluence (E297110)
	LC_LC5	Fording River downstream of Line Creek (0200028)
Elkview Operations (EVO)	EV_GT1	Gate Creek Sediment Pond Decant (E206231)
	EV_BC1	Bodie Creek Sediment Pond Decant (E102685)
	EV_DC1	EVO Dry Creek Sediment Pond Decant (E298590)
	EV_HC1	EVO Harmer Compliance Point – Harmer Spillway (E102682)
	EV_GV1	Grave Creek at Bridge (near the mouth)
	EV_EC1	Erickson Creek at Mouth (0200097)

5.1.1.2 Michel Creek Mainstem

Model calibration for flows in the mainstem of Michel Creek was conducted with a focus on the two model nodes outlined in Table 5-2. Discharge at these locations were developed by applying the ranked regression method at upstream locations (EV_MC3; Section 4.15.2) and sequentially adding simulated tributaries downstream (Section 4.14.2). As per Section 4.15.2, the FC model of Michel Creek effectively begins at EV_MC3 and does not explicitly model upstream catchment flows. For these flows, the WQC relies on the CMO Site Model for the upstream mine-influenced flows and loads.

Table 5-2: Calibration Nodes in the Mainstem of Michel Creek

Operation	Node Name	Node Description
Elkview Operations (EVO)	EV_MC2	EVO Michel Creek Compliance Point - Michel Creek at Hwy 3 Bridge (E300091)
Elkview Operations (EVO)	EV_MC3	Michel Creek upstream of Erickson Creek (0200203)

5.1.1.3 Elk River Mainstem

Modelled flows at Elk River nodes were compared to measured flow data following a discharge pro-rating approach applied to these locations (Section 4.16.2; Table 5-3). An additional comparison on total watershed yield was completed as well (Section 5.4.3).

Table 5-3: Elk River – Model Performance Nodes

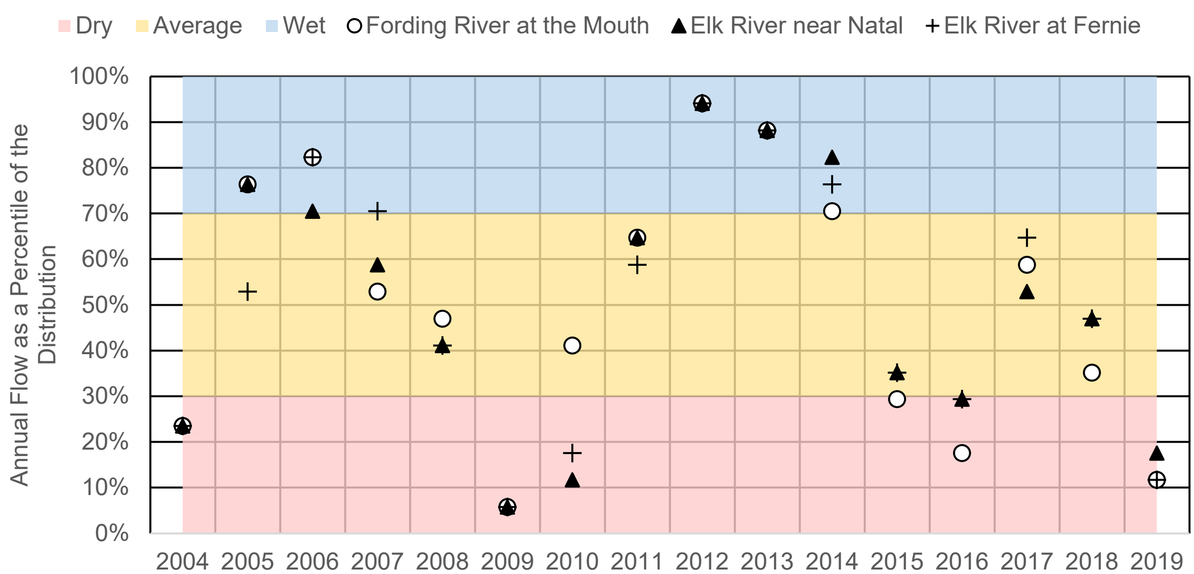
Operation	Node Name	Node Description
Greenhills Operations (GHO)	GH_ERC	GHO Elk River Compliance Point - Elk River, 220 m d/s of Thompson Creek (E300090)
Elkview Operations (EVO)	GH_ER1	Elk River u/s of Boivin Creek (u/s of Fording River) (E206661)
Elkview Operations (EVO)	EV_ER4	Elk River u/s of Grave Creek (from Fording River to Michel Creek) (0200389)
Elkview Operations (EVO)	EV_ER1	Elk River downstream of Michel Creek (0200393)
Elkview Operations (EVO)	RG_ELKORES	Elk River at Elko Reservoir (E294312)

5.1.2 Review and Refine Operation-Specific Climate Input Adjustments

The FC of the 2020 RWQM has been configured to simulate stream flow for a 49-year period between 1970 and 2019. However, a shorter period of time was used for model calibration. Specifically, the FC was calibrated with a focus on 2004 to 2018, consistent with the time period considered in the calibration of the WQC of the 2020 RWQM. This time period also corresponds to that in which a higher volume of monitored data are available with which to both drive the model and evaluate its performance; confidence in the accuracy of the available data is also higher than that associated with older information. Flow data from 2019 was preliminary during the FC model development and are provided herein as a point of reference and comparison, but they were not explicitly considered when evaluating model performance over the calibration period (e.g., not included when generating calibration statistics or annual average hydrographs).

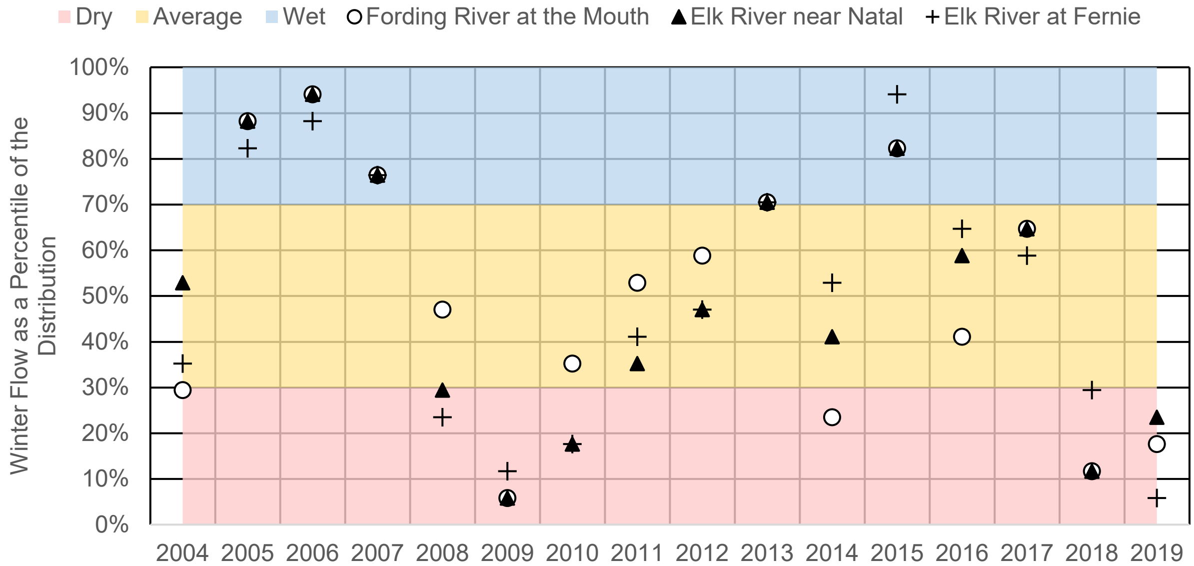
The calibration period includes recorded wet, dry and average flow conditions. The prevalence of each, and seasonal variation, is illustrated in Figure 5-1 and Figure 5-2 using flow measurements taken from stations at i) Fording River at the Mouth, ii) Elk River near Natal and iii) Elk River at Fernie.

As per Figure 5-1, the hydrologic years 2005, 2006, 2012, 2013 and 2014 can be considered wet years, whereas 2004, 2009, 2010, 2016 and 2019 can be considered dry years. This pattern is similar, but not identical, when limiting this analysis to winter flow periods (December to March; Figure 5-2). The antecedent winter flow conditions can influence the magnitude of spring runoff and total annual flow. Therefore, the variation in the annual and winter flows over the calibration period was considered to be a reasonable representation of the range of historical hydrological conditions recorded in Elk Valley watersheds.



Annual flows were calculated for hydrologic years (e.g., 2004 represents the period from October 2003 to September 2004). Dry, Average and Wet bands are indicative of flow conditions. 'Dry' is defined as flows below the 30th percentile, 'Average' is defined as flows between the 30th and 70th percentile, and 'Wet' is defined as flows greater than the 70th percentile.

Figure 5-1: Classification of Flow Conditions in each Hydrologic Year (i.e., October to September) from 2004 to 2019, Based on Annual Average Flows



Winter flows were calculated for the months of December to March (e.g., 2004 represents the period from December 2003 to March 2004). Dry, Average and Wet bands are indicative of flow conditions. 'Dry' is defined as flows below the 30th percentile, 'Average' is defined as flows between the 30th and 70th percentile, and 'Wet' is defined as flows greater than the 70th percentile.

Figure 5-2: Classification of Flow Conditions in each Hydrologic Year from 2004 to 2019, Based on Average Winter Flow (i.e., December to March)

5.2 Overview of the Calibration Process

The FC of the 2020 RWQM was calibrated following the process depicted in Figure 5-3, which is further described in the sections that follow. Although depicted as a linear process, the review of the fit between modelled and recorded data necessitated an iterative process where model performance improvements were made by returning to earlier steps, making adjustments, and repeating the subsequent steps.

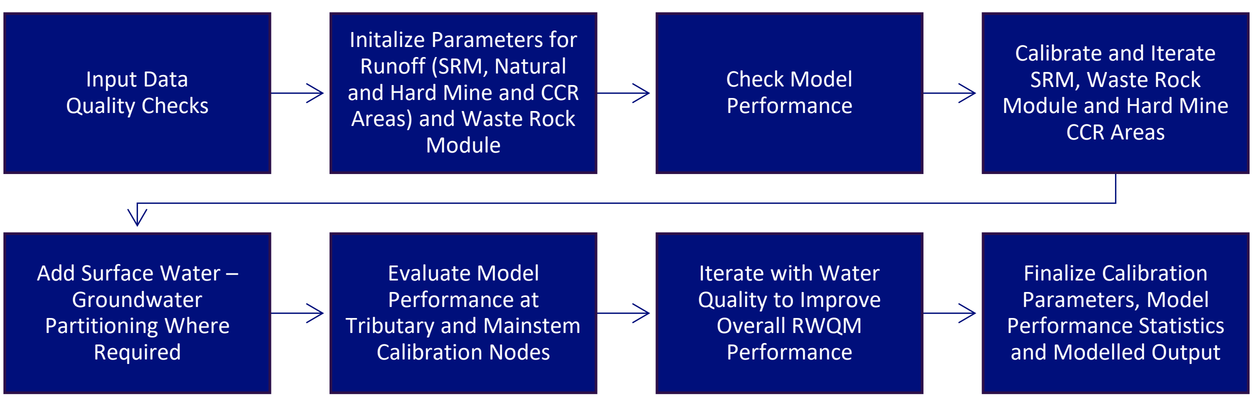


Figure 5-3: Calibration Process for the Flow Component of the 2020 RWQM

5.2.1 Input Data Quality Checks

The primary means by which model performance was altered and improved (i.e., accurate replication of the magnitude and timing of measured surface water flows) occurred through adjustments to runoff parameters, as described starting in Section 5.2.2. However, model output is only as good as the input information used to drive it. Thus, the calibration process started with data quality checks on FC model inputs. Specifically, these checks consisted of:

- Sub-catchment areas and classification of land uses were reviewed to confirm that the area balance of the model domain was maintained and consistent with mine plan information.
- Waste rock spoil volumes, footprints and calculated spoil heights were reviewed to confirm that the modelled values were consistent with mine plan information.
- Key dates used to represent changes to water management activities in the model were compared against information in water management plans and conceptual flow diagrams. Examples of these data are the applied start and end dates for site pumping activities, or the projected filling and discharge of open pit areas.
- Pit characteristic inputs to the model (e.g., water storage volumes, decant elevations, backfilled waste rock volumes) were extracted from mine plan information. Where required, adjustments were made to account for additional information such as aerial photographs and discussions with site personnel to improve estimated volumes and surface areas.
- Dates for pit dewatering and pit filling at closure were compared against water management plans and mine plans.
- Climate inputs developed from regional data were compared, as outlined below, to available information from local climate stations.

5.2.1.1 Precipitation and Air Temperature

Following the development of long-term representative climate datasets and lapse rates for air temperature and precipitation as per the process outlined in Section 4.4, further checks against recorded meteorological data at specific Teck monitoring locations were completed. Typically, data records at site locations were less than 10 years in duration and recorded only rainfall reliably. To account for the differences in elevation between the developed long-term climate datasets and the site-specific measurements, the estimated lapse rate for temperature (ºC/m) and precipitation (mm/m) was applied up to the average elevation of the subject sub-watershed. The resulting comparisons are provided in Figures 5-4 (Monthly Average Air Temperature), Figure 5-5 (Summer Precipitation) and Figure 5-6 (Total Annual Precipitation).

The monthly distribution of air temperature extrapolated from the long-term representative climate dataset matched the range of and seasonal pattern of recorded data across the sub-watersheds. A greater degree of discrepancy was observed when comparing precipitation estimates, most notably at LCO. This discrepancy may be due to localized undercatch (e.g., wind effects on precipitation). Consequently, the lapse rate for summer and winter precipitation were altered for the LCO and EVO sub-watersheds to improve model performance from the initial rates displayed in Figure 5-6 and Figure 5-7. The final lapse rates used in the FC are listed in Appendix A.

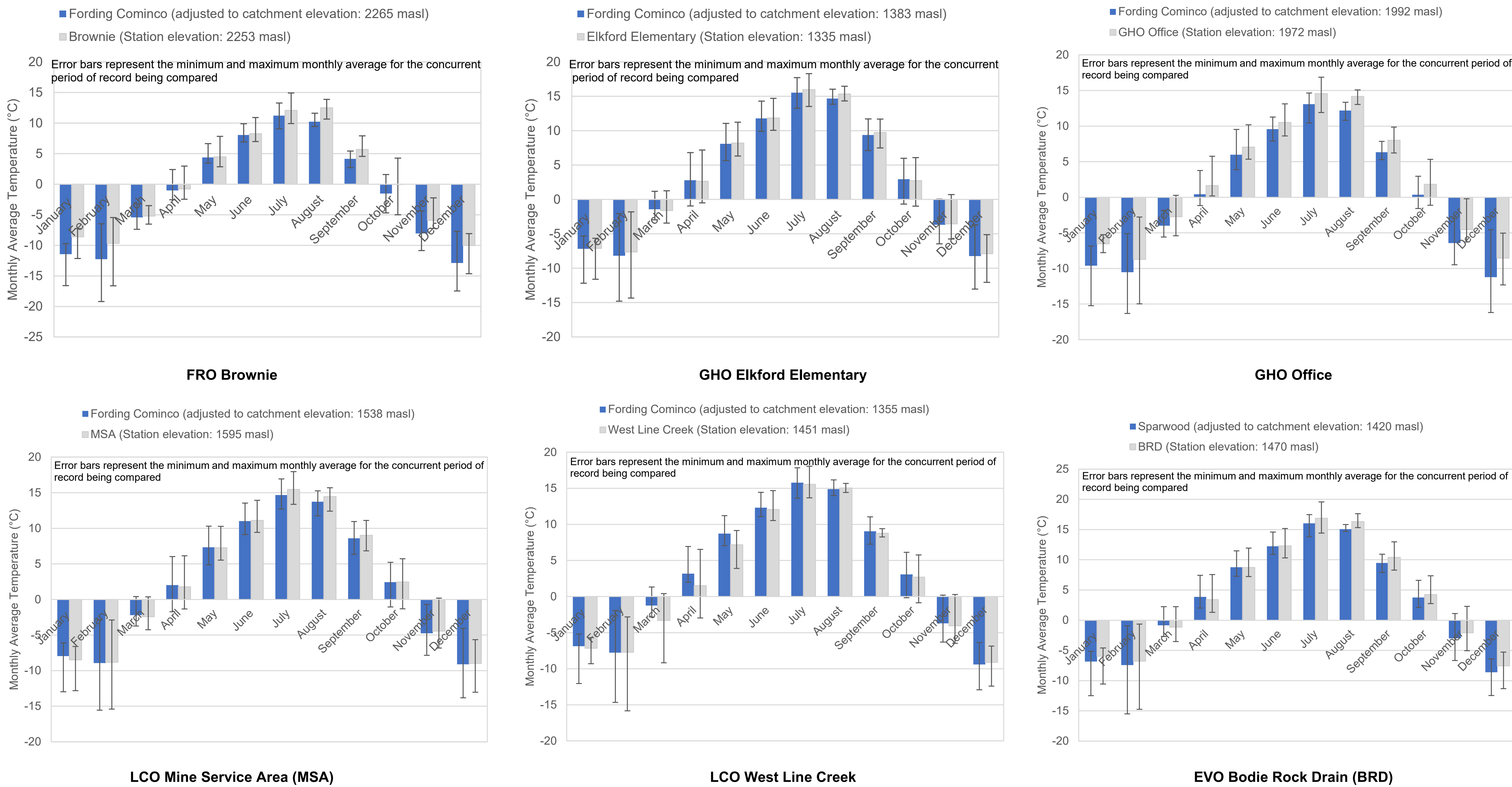


Figure 5-4: 2020 RWQM Climate Dataset Compared Against Local Stations Operated by Teck (Air Temperature)

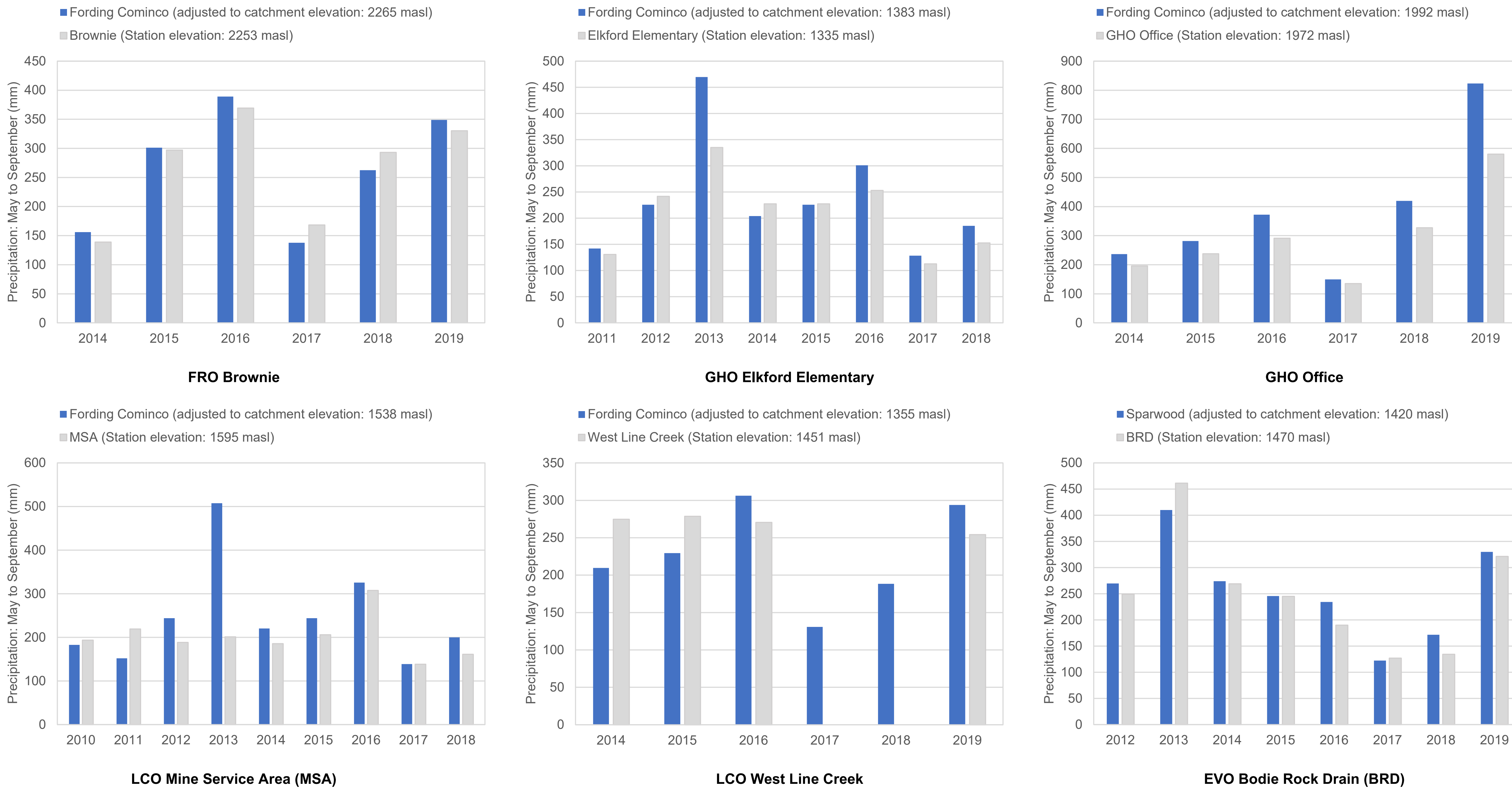
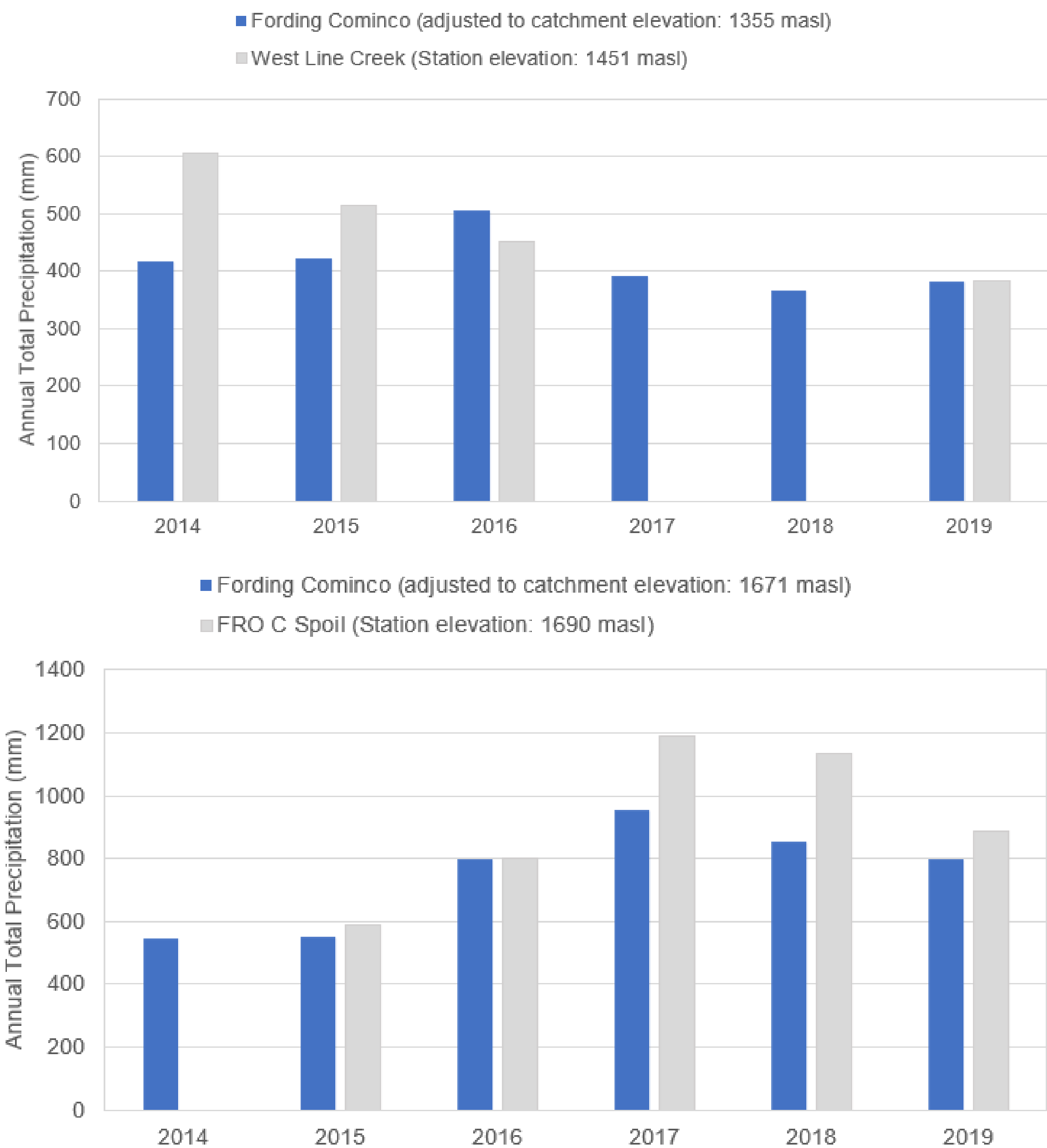


Figure 5-5: 2020 RWQM Climate Dataset Compared Against Local Stations Operated by Teck (Summer Precipitation)



Data were not available at West Line Creek for 2017 and 2018. Data were not available at FRO C Spoil in 2014.

Figure 5-6: 2020 RWQM Climate Dataset Compared Against Local Stations Operated by Teck (Total Precipitation)

5.2.1.2 Evapotranspiration

Evapotranspiration was calculated for open water and bare waste rock surfaces in the FC using the Hargreaves – Samani PET method (Section 4.5.2.4). For waste rock, AET was refined by adjusting PET using the coefficient K_c and subsequently reviewed against data collected by Okane (2015; Table 5-4). The final K_c applied to operational waste rock spoils are summarized in Appendix A. For comparison, PET, or open water evaporation, during the typical open water season of April through October is approximately 520 mm (Section 3.3.3).

Table 5-4: Calculated Measurand Simulated AET for Waste Rock Spoils

Operation	Measured AET (O'kane et al. 2015)		Simulated AET (2004 – 2018)	
	Range (mm)	Average (mm)	Range (mm)	Average (mm)
FRO	150 - 320	230	148-235	185
GHO	150 - 180	165	148-235	185
LCO	150 - 280	200	143-163	152
EVO	n/a[a]	320	143-163	152
Overall	150 - 320	214	143-235	168

a) one study site selected.

5.2.2 Calibration of Runoff Components

Runoff coefficients, recessions rates and other parameters used to estimate runoff from different land types were identified in the following sequence:

1. Input parameters for runoff from waste rock (i.e., those used in the waste rock hydrology module)
2. Input parameters for runoff from natural areas (SRM module)
3. Input parameters for runoff from hard mine and CCR areas (SRM module)

Adjusting the input parameters was done iteratively at each step, with model performance evaluated after each model run. The evaluation involved comparing the 2020 RWQM modelled surface and total flows at nodes to monitored data (i.e., measured surface flows) as well as the modelled total flows from the 2017 RWQM. The fit between modelled and measured flows was evaluated to confirm the desired change (e.g., increase peak flows, decrease low flows, adjust slope of the hydrograph's receding limb). The evaluation of model fit considered potential flow measurement errors and outliers. For instance, extreme low or high flow measurements, as well as flows outside of typical trends (e.g., single-event water management activities) were identified during an evaluation of visual fit to explain differences between measured and modelled flows. The input parameters were then adjusted until there was little improvement in the model performance metrics from one model run to the next. The final calibration parameters are detailed in Appendix A, and the process in selecting these are further described in the sections that follow.

5.2.2.1 Calibration of Waste Rock Spoil Runoff at Cataract Creek

The input parameters governing waste rock flow were estimated using one sub-catchment (Catarack Creek) and then applying those input parameters to other SRM sub-catchments. Cataract Creek sub-watershed was used to set the input parameters governing runoff from waste rock, with a focus on model performance through the 2009 to 2018 time period, because:

- more than 75 percent of the sub-watershed was covered by waste rock
- pit water from Phase 6 at GHO was no longer discharging to Cataract Creek (i.e., this activity stopped in 2009)
- it is the only sub-catchment above the GH_CC1 monitoring node.

Thus, flows recorded at GH_CC1 should be represented primarily by runoff from the upstream waste rock area during that period of time. The input parameters were adjusted to replicate outflow from a spoil based on the conceptual understanding that there is little to no surface runoff, little to no loss to deep groundwater systems, and virtually all water reports out as toe drainage. The primary model parameter influencing the rate of flow out of a spoil is the spoil drawdown rate, which is defined as the amount of water held in the spoil that is released each week, expressed as a percent of the stored volume.

5.2.2.2 Calibration of SRM Runoff for Natural Areas

Input parameters governing flows generated from natural areas (i.e., using the SRM) were adjusted once the waste rock parameters were defined. Parameters were systematically adjusted within a range of reasonable values, relying on a sensitivity analysis that was performed on a test sub-catchment prior to calibrating the FC. The calibration procedure adopted was consistent with the recommended approach in Chernos et al. (2017) and is outlined below:

- Isolation and exclusion of known insensitive parameters (e.g., initial runoff and precipitation threshold).
- Adjusting snowmelt factors (e.g., degree day factor, month to begin snowmelt) to the adjust the timing of the freshet.
- Adjusting the runoff coefficients, routing and baseflow terms (i.e., Cr, Cs, x and y recession constants) to adjust the magnitude of the freshet, magnitude of the fall/winter flows, and hydrograph shape.

The input parameters for runoff from natural areas were estimated for each group of sub-catchments that are above a monitoring node with flow data from 2004 to 2018. The groups (one or more sub-catchments) were defined based on the first upstream node to which they contribute flows. The approach to grouping sub-catchments was used to minimize the number of unique configurations of input parameters. These adjustments were conducted group by group, starting with the most upstream node in a tributary catchment. The input parameters for all sub-catchments in each group were assigned the same value. If a sub-catchment did not contribute to a tributary node, then it was assigned the same input values as an adjacent sub-catchment.

5.2.2.3 Calibration of SRM Runoff for Hard Mine and CCR Areas

Calibration of the hard mine and CCR area input parameters required a slightly different approach, because there was little information available to directly calibrate these areas. There is no node that has a single sub-catchment that is predominately hard mine or CCR area available that could be used to calibrate these land types similar to the approach used for waste rock. In addition, the flow from most sub-catchments is dominated by runoff from natural areas, so adjusting the hard mine and CCR inputs had little influence on the overall model performance. Therefore, the input parameters for hard mine and CCR areas were estimated relative to the inputs used for the natural areas for each sub-catchment. More specifically, the runoff coefficients were assumed to be larger than natural areas to reflect flashier runoff from bare areas. These inputs should be reviewed and re-evaluated as more land-type specific data become available, and if and as the RWQM is applied at smaller spatial scales in areas dominated by either CCR or hard mine land types.

5.2.2.4 Calibration of Fording and Line Creek Mainstem Streamflows

The Fording River and Line Creek mainstem streamflows are the sum of the runoff from upstream sub-catchments. Model performance at mainsteam nodes was evaluated and adjustments made to the input parameters for the sub-catchments in the tributaries as required to achieve reasonable fit to measured data in the mainstem and at tributary mouths. This step also provided a means to evaluate the inputs assigned to sub-catchments not otherwise directly monitored. In some instances, calibration involved application of groundwater bypass estimates in combination to modification to sub-catchment input parameters, particularly in areas where performance in upstream sub-catchments was reasonable. Adjustments to groundwater bypass estimates is discussed in the next section.

5.2.3 Adjust Groundwater Partitioning

Surface water-groundwater partitioning was modelled at nodes where site-specific information was available to support this approach and where doing so improved the calibration of flows. Partitioning of groundwater was based on the information compiled in Appendix B. In the FC of the RWQM, as described in Section 4.17, these estimates were expressed as a percentage of the total yield up to an initial threshold, then as another percentage of the total yield up to a maximum threshold. This approach reflects the concept that water will move preferentially into the ground until conditions become saturated, at which point additional flow into shallow subsurface pathways only occurs as the wetted width of the stream expands.

Modelled surface flow and total flow yields were checked against the corresponding cumulative monitored surface water yield. The results of this check were used to inform potential adjustments to the partitioning of total flow into surface and groundwater components at the calibration node. Changes to groundwater partitioning were then considered, working to remain within the range of values provided in Appendix B. For example, Figure 5-7 shows the surface flow plot at West Line Creek (LC_WLC) generated using an initial set of values for groundwater partitioning (15% up to a maximum of 9,500 m^3/d) versus calibrated values (60% up to a maximum of 10,000 m^3/d), relative to measured flows at this node.

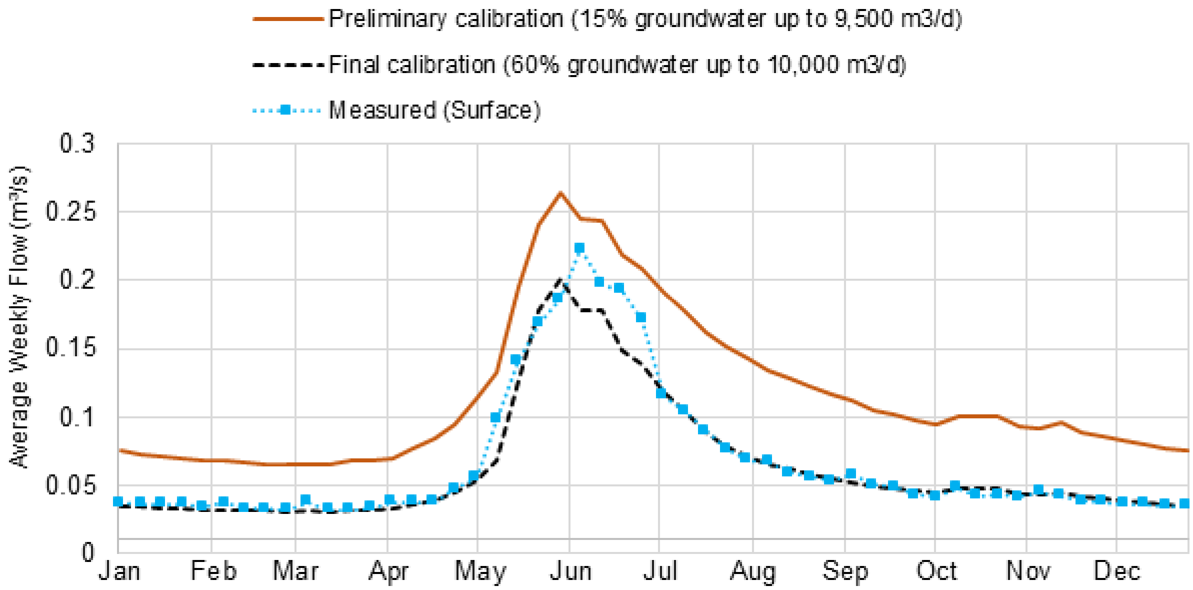


Figure 5-7: Adjustment to Groundwater Partitioning as part of Model Calibration (West Line Creek Example)

5.2.4 Iteration with Water Quality Component of RWQM

This step was iterative, whereby model input parameters and other variables in the FC were adjusted, if and where warranted, to support improvements in simulating constituent concentrations in the receiving environment. Examples of changes made during this step of the calibration process are refinement of groundwater / surface water partitioning, modifications to the destination of pit dewatering water and refinement of assumptions around water use for dust suppression.

5.3 Model Performance Metrics

In evaluating the performance of a flow or hydrological model for its designated purpose, it is standard practice to apply statistics and graphical techniques to define the reliability and representativeness of the modelling results. These items include “goodness-of-fit” statistics, absolute error measures, and graphical tools such as flow exceedance curves and time series plots. A summary of the statistics and graphical techniques that were used to describe the performance of the FC is presented in Table 5-5, with further detail on the statical methods provided in Appendix C. The model performance metrics in Table 5-5 were applied at the calibration nodes tabulated above.

Table 5-5: Model Performance Evaluation Measures

Performance Measure	Measure	Notation	Worst	Best	Comments
Statistical	Nash-Sutcliffe Efficiency	E	-∞	1	Widely used measure for hydrologic models (Moriasi *et al.* 2007). Values =>0.75 are very good Values =>0.65 are good Values =>0.5 are acceptable Values <0.5 are poor Values <0 indicate that the measured mean is a better predictor than the model. Tends to overweight spring freshet / flood peaks.
	Modified Nash-Sutcliffe Efficiency	E_1	-∞	1	Reduces the overweighting of flood peaks compared to E. The modification relies on the absolute value instead of the square power.
	Index of Agreement	d	0	1	Relatively high values (>0.65) could still be possible for poor model fits. Tends to overweight flood peaks and extreme low flows.
	Modified Index of Agreement	d_1	0	1	Reduces the overweighting of flood peaks compared to d.
	Mean Absolute Error	MAE	∞	0	Simple, often used to compare performance between models
	Root Mean Square Error	RMSE	∞	0	Absolute indicator of difference, often used to compare performance between models
	Coefficient of Determination	R^2	0	1	Describes proportion of variance in measured data explained by model output
Graphical	Weekly Time Series	n/a	n/a	n/a	A simple, visual time series comparison
	Mean Flow Hydrographs	n/a	n/a	n/a	Used to identify systematic differences in the hydrograph (over/under prediction, timing and magnitude of freshet flows, recession, baseflow)
	Flow Duration Curves	n/a	n/a	n/a	Used to identify the frequency (percentage of time) with which flows of a certain magnitude are exceeded.
	Mean Seasonal Flows	n/a	n/a	n/a	Used to identify opposing bias in hydrograph distribution (e.g., instances of positive bias in winter vs. negative bias during freshet).

Note: Comparisons of unequal data distributions (e.g., instantaneous measured flow vs. weekly or monthly model results) have an inherent bias. To limit bias, the best available concurrent data record for a given node was used to evaluate model performance.

5.4 Results of Model Calibration

Final model calibration parameters for each simulated sub-watershed are available in Appendix A. Model performance over the calibration period is presented in this section, with figures and other details provided in Appendix D.

5.4.1 Fording River Watershed and Mine-Influenced Tributaries Elsewhere in the Elk Valley

A summary of model performance through the Fording River watershed and in mine-influenced tributaries elsewhere the Elk Valley is presented in Table 5-6. Model performance is presented as:

- Comparisons of modelled to monitored, mean annual runoff, summary goodness-of-fit statistics, with reference to the plots and tables included in this section and in Appendix D.
- Comparisons of modelled to monitored yields, in mm/year.
- Comments on node specific model performance

In the Fording River watershed and in other mine-influenced tributaries, model performance was generally equivalent to, or improved from, the 2017 RWQM. The ability of the model to simulate the variability in annual runoff and the timing and magnitude of hydrograph rise and recession were considered appropriate across a range of climate and sub-watershed land cover conditions (Appendix D).

Table 5-6: Model Performance Summary for the Fording River Watershed and in Other Mine-Influenced Tributaries, Based on the Calibrated FC of the 2020 RWQM

Station ID	Station Description	Flow Modelling Method	Evaluation Period	Groundwater Component	Approximate mean annual runoff (mm)			Statistics			Comments on Model Performance
					Measured (surface)	Modelled (surface)	Modelled (total)	E	E1	Rating	
FR_HC1	Henretta Creek upstream of Fording River (E216778)	SRM and waste rock hydrology module in the sub-catchments of Henretta, McSlide, McDonald, McMillan and Moore Creeks.	2004 to 2018	Not implemented	650	n/a	620	0.73	0.58	Good	• Flow data were available throughout the evaluation period, with some gaps in winter between 2004 and 2009 • Good match with low flows; fall flows overestimated in some years • Modelled high flows underestimated compared to monitored data in some years • An improvement compared to the 2017 RWQM
FR_CC1	Decant from Clode Sediment Pond (E102481)	SRM and waste rock hydrology module in the sub-catchments of Clode Creek Upper, Clode Creek Lower, Eagle 6 to Clode. Eagle 6 West Pit and Eagle 4 Pit, modelled using the pit module.	2004 to 2018	60% up to 4,000 m^3/d	280	280	440	0.12	0.12	Poor but improved	• Flow data were available throughout the evaluation period, with some gaps in winter between 2004 and 2009. Flow regime influenced by water management activity • Modelled mean annual runoff matches monitored • Modelled fall flows overestimated compared to monitored data in some years • An improvement compared to the 2017 RWQM
FR_FRNTP	Fording River at North Tailings Pond	FR_FR1 + FR_PP1 + Turnbull Bridge Spoil + FR_CC1 + FR_LMP1 + FR_LP1 + FR_EC1 (Sum of modelled flows)	2004 to 2018	3% up to 10,000 m^3/d	480	440	450	0.71	0.57	Good	• Flow data were available throughout the evaluation period, with gaps in winter between 2004 and 2013. Limited data in 2013 • Good match with low flows; fall flows overestimated in some years • Modelled high flows underestimated compared to monitored data in some years prior to 2014 • A comparable but improved fit relative to the 2017 RWQM

Table 5-6: Model Performance Summary for the Fording River Watershed and in Other Mine-Influenced Tributaries, Based on the Calibrated FC of the 2020 RWQM

Station ID	Station Description	Flow Modelling Method	Evaluation Period	Groundwater Component	Approximate mean annual runoff (mm)			Statistics			Comments on Model Performance
					Measured (surface)	Modelled (surface)	Modelled (total)	E	E1	Rating	
GH_SC1 / GH_SC2	Swift Creek Sediment Pond Decant (E221329) / Swift Creek Sediment Pond Bypass (E105061)	SRM and waste rock hydrology module in the sub-catchment Swift Spoil	2004 to 2018	2% up to 1,000 m^3/d	300	390	390	0.32	0.28	Poor but improved	• Significant gaps in monitored flow data between August and April prior to 2016 at GH_SC1; combined data record with GH_SC2 was used to evaluate performance • Modelled moderate and low flows overestimated compared to monitored data • Good match with high flows in most years, noting that monitored data between 2012 and 2014 have abnormally high peaks. • Statistics were calculated in comparison to a combined data record (GH_SC1 and GH_SC2), and model fit is improved compared to the 2017 RWQM
FR_KC1	Kilmarnock Creek downstream of Rock Drain (0200252)	SRM and waste rock hydrology module in the sub-catchments of Kilmarnock Upper, Kilmarnock Lower, Brownie Creek	2004 to 2018	Flows <60,000 m^3/d: 100%, maximum of 16,500 m^3/d Flows >60,000 m^3/d: 30%, maximum of 26,900 m^3/d	460	490	650	0.70	0.52	Good	• Flow data were available throughout the evaluation period, with some gaps in winter between 2004 and 2009; continuous flows from 2012 onward. • Good match with moderate and low flows in most years. Some overestimation of late summer/fall flows. • Good match with high flows • A comparable fit of flows relative to the 2017 RWQM
GH_CC1	Cataract Creek Sediment Pond Decant (0200384)	SRM and waste rock hydrology module in the sub-catchment of Cataract Creek; flows from Phase 6 Pit at GHO prior to 2009	2004 to 2018	0%	530	580	580	0.36	0.29	Poor	• Flow data were available throughout the evaluation period, with some gaps in winter data between 2009 and 2015. • Model performance improves following 2009 changes to water management. • Underestimated low flows in 2014-2015, and fall flows overestimated in several years • Good match with high flows • A comparable fit of flows relative to the 2017 RWQM

Table 5-6: Model Performance Summary for the Fording River Watershed and in Other Mine-Influenced Tributaries, Based on the Calibrated FC of the 2020 RWQM

Station ID	Station Description	Flow Modelling Method	Evaluation Period	Groundwater Component	Approximate mean annual runoff (mm)			Statistics			Comments on Model Performance
					Measured (surface)	Modelled (surface)	Modelled (total)	E	E1	Rating	
FR_UFR1	Fording River upstream of Henretta Creek	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchment of Upper Fording	2004 to 2018	Not implemented	630	n/a	400	0.45	0.34	Poor but improved	• Flow data were available from 2008 onwards, with gaps in winter during much of the data record. Irregular elevated winter flow patterns observed between 2011 and 2013 • Modelled low flows appear underestimated between 2011 and 2013 due to irregular monitored data • Modelled high flows underestimated compared to monitored flows between 2011 and 2014 • An improvement compared to the 2017 RWQM
FR_LMP1	Lake Mountain Sediment Pond Decant	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchments of John Creek, Lake Pit, Lake Mountain Pit, Tower Diversion, Tower Diversion Extension	2004 to 2018	Not implemented	430	n/a	400	0.69	0.54	Good	• Flow data is limited to 2017 onwards • Good match with low flows • Modelled high flows underestimated compared to monitored flows. Some overestimation of late summer/fall flows. • An improvement compared to the 2017 RWQM
FR_LP1	Liverpool Sediment Pond Decant	Snowmelt Runoff Module, Waste Rock Module, Pit Module in sub-catchments of Swift Pit, Fording LF2 Upper	2004 to 2018	Not implemented	70	n/a	80	0.80	0.71	Very Good	• Flow data is limited to 2017 onwards • Model logic at this location has been modified to maintain sufficient makeup supply at Swift Pit for use at the wash plant. As a result, modelled flows prior to 2020 are limited • Very good fit with available monitored data • An improvement compared to the 2017 RWQM
FR_FR1	Fording River downstream of Henretta Creek (0200251)	FR_HC1 + FR_UFR1 + Turn Creek (Sum of modelled flows)	2004 to 2018	Not implemented	500	n/a	540	0.57	0.44	Acceptable	• Flow data were available from 2010 onwards, with gaps in winter data in some years and gaps in peak flow data in 2017-2018 • Good match with low flows • Modelled fall flows overestimated compared to monitored data in some years • A comparable fit of flows relative to the 2017 RWQM

Table 5-6: Model Performance Summary for the Fording River Watershed and in Other Mine-Influenced Tributaries, Based on the Calibrated FC of the 2020 RWQM

Station ID	Station Description	Flow Modelling Method	Evaluation Period	Groundwater Component	Approximate mean annual runoff (mm)			Statistics			Comments on Model Performance
					Measured (surface)	Modelled (surface)	Modelled (total)	E	E1	Rating	
FR_FR2	Fording River upstream of Kilmarnock Creek (0200201)	FR_FRNTP + Fording LF2 Lower + South Tailings Pond Seepage (sum of modelled flows)	2004 to 2018	Not implemented	430	n/a	470	0.57	0.42	Acceptable	• Flow data were available from 2010 onwards, with gaps in winter data in some years and gaps in peak flow data in 2017-2018 • Good match with low flows • Modelled fall flows overestimated compared to monitored data in some years • An improvement compared to the 2017 RWQM
FR_FR4	Fording River between Swift and Cataract creeks (0200311)	FR_FR2 + GH_SC1 + Swift Creek Upper Diversion + FR_SKP1 (sum of modelled flows)	2004 to 2018	Not implemented	470	n/a	390	0.56	0.47	Acceptable	• Flow data were available from 2008 onwards, with significant gaps throughout the year from 2008-2010 and 2016 onwards • Good match with fall and winter flows • Modelled high flows underestimated compared to monitored data from 2010-2013 • A comparable fit of flows relative to the 2017 RWQM
FR_FRABCH	Fording River above Chauncey Creek	GH_PC2 + a portion of the Castle Mountain watershed and unnamed areas between GH_PC2 and FR_FRABCH (Sum of modelled flows)	2004 to 2018	Not implemented	380	n/a	430	0.91	0.64	Very Good	• Flow data were only available from late 2017 onwards • Good match with fall and winter flows • Modelled fall flows overestimated compared to monitored data • An improvement compared to the 2017 RWQM
GH_PC1	Porter Creek Sediment Pond Decant (0200385)	SRM and waste rock hydrology module in the sub-catchment of Porter Creek	2004 to 2018	Not implemented	1010	n/a	620	-0.01	0.19	Poor	• Flow data were available throughout the evaluation period, with some gaps in winter data between 2004 and 2018 • Underestimation of high, moderate and low flows compared to monitored data in some years. • A worse fit relative to the 2017 RWQM, noting that a yield reduction factor was used in the 2017 RWQM at this node

Table 5-6: Model Performance Summary for the Fording River Watershed and in Other Mine-Influenced Tributaries, Based on the Calibrated FC of the 2020 RWQM

Station ID	Station Description	Flow Modelling Method	Evaluation Period	Groundwater Component	Approximate mean annual runoff (mm)			Statistics			Comments on Model Performance
					Measured (surface)	Modelled (surface)	Modelled (total)	E	E1	Rating	
GH_TC1	Thompson Creek at LRP Road (E102714)	SRM and waste rock hydrology module in the sub-catchments of Thompson Creek Upper & Lower, Phase 3 pit dewatering	2004 to 2018	80% to a maximum of 5,000 m^3/d	200	220	360	0.45	0.37	Poor but improved	• Flow data were available between 2006 and 2018, with gaps in winter flows throughout and larger gaps in data between 2006 and 2009. • Good match with moderate and low flows • Overestimation of high flows in some years • An improvement relative to the 2017 RWQM
GH_TC2	Lower Thompson Creek Sediment Pond Decant (E207436)	SRM and waste rock hydrology module in the sub-catchments of Thompson Creek Upper & Lower, plus Phase 3 pit dewatering flows	2004 to 2018	80% to a maximum of 5,000 m^3/d	200	190	340	0.30	0.33	Poor	• Flow data were available throughout the evaluation period, with some gaps in winter data between 2005 and 2015 • Good match with moderate and low flows • Overestimation of high flows in some years • A comparable fit of flows relative to the 2017 RWQM
GH_GH1	Greenhills Creek Sediment Pond Decant (E102709)	SRM and waste rock hydrology module in the sub-catchment of Greenhills Creek North & South, plus process plant and tailings storage facilities flows	2004 to 2018	30% to a maximum of 6,000 m^3/d	320	300	380	0.40	0.36	Poor but improved	• Flow data were available throughout the evaluation period, with some gaps in winter data between 2007 and 2014. Limited data in 2014. • Good match with moderate and low flows in most years • Timing of modelled freshet delayed in some years, with peak flows underestimated • An improvement relative to the 2017 RWQM
GH_FR1	Fording River downstream of Greenhills Creek (200378)	FR_FRABCH + Chauncey + Ewin + Todhunter + LCO Dry + Grace + GH_GH1 + unnamed areas between FR_FRABCH and GH_FR1 (Sum of modelled flows)	2004 to 2018	Not implemented	410	n/a	390	0.69	0.65	Good	• Scaled ECCC data available throughout the evaluation period • Modelled moderate and low flows good fit with monitored flows • Modelled high flows underestimated relative to monitored flows in 2013 • A comparable fit of flows relative to the 2017 RWQM

Table 5-6: Model Performance Summary for the Fording River Watershed and in Other Mine-Influenced Tributaries, Based on the Calibrated FC of the 2020 RWQM

Station ID	Station Description	Flow Modelling Method	Evaluation Period	Groundwater Component	Approximate mean annual runoff (mm)			Statistics			Comments on Model Performance
					Measured (surface)	Modelled (surface)	Modelled (total)	E	E1	Rating	
GH_LC1	Leask Creek Sediment Pond Decant (E257796)	SRM and waste rock hydrology module in the sub-catchments Wolfram Creek North & South Upper & Lower, Phase 3, 4, 6 Pit dewatering	2004 to 2018	Not implemented	170	n/a	250	0.02	-0.29	Poor but improved	• Limited flow data available throughout evaluation period • Flow regime influenced by water management activities between 2015 and 2018 • An improvement relative to the 2017 RWQM
GH_LC2	Leask Creek u/s of Pond Inlet	SRM and waste rock hydrology module in the sub-catchments Wolfram Creek North & South Upper & Lower, Phase 3, 4, 6 Pit dewatering	2004 to 2018	Not implemented	160	n/a	250	0.19	0.11	Poor but improved	• Flow data available from 2005 onwards with significant gaps in winter flows throughout the period of record • Flow regime influenced by water management activities between 2015 and 2018 • An improvement relative to the 2017 RWQM
GH_WC1	Wolfram Creek Sediment Pond Decant (E257795)	SRM and waste rock hydrology module in the sub-catchments Wolfram Creek North & South Upper & Lower, Phase 3, 4, 6 Pit dewatering	2004 to 2018	Not implemented	180	n/a	190	-0.16	0.03	Poor but improved	• Flow data available throughout evaluation period with some gaps in winter flows throughout the period of record • Flow regime influenced by water management activities • Modelled high flows underestimated and fall flows overestimated compared to monitored flows in some years • An improvement relative to the 2017 RWQM
GH_WC2	Wolfram Creek u/s Pond Inflow	SRM and waste rock hydrology module in the sub-catchments Wolfram Creek North & South Upper & Lower, Phase 3, 4, 6 Pit dewatering	2004 to 2018	Not implemented	200	n/a	180	-0.21	0.00	Poor but improved	• Flow data available throughout evaluation period with some gaps in winter flows throughout the period of record • Flow regime influenced by water management activities • Modelled high flows underestimated compared to monitored flows in some years • An improvement relative to the 2017 RWQM

Table 5-6: Model Performance Summary for the Fording River Watershed and in Other Mine-Influenced Tributaries, Based on the Calibrated FC of the 2020 RWQM

Station ID	Station Description	Flow Modelling Method	Evaluation Period	Groundwater Component	Approximate mean annual runoff (mm)			Statistics			Comments on Model Performance
					Measured (surface)	Modelled (surface)	Modelled (total)	E	E1	Rating	
LC_LC5	Fording River downstream of Line Creek (0200028)	GH_FR1 + LC_LC4 + unnamed areas between GH_FR1 and LC_LC5 (Sum of modelled flows)	2004 to 2018	Not implemented	420	n/a	450	0.84	0.69	Very Good	• Flow data were available throughout the evaluation period. • Good match with monitored flows • Overestimation of flows in some years • A comparable fit of flows relative to the 2017 RWQM
LC_LC4	Line Creek upstream of Process Plant (0200044)	LC_LCDSSLC + undisturbed lower Line Creek sub-catchments modelled using SRM (Sum of modelled flows)	2004 to 2018	Not implemented	490	n/a	490	0.84	0.67	Very Good	• Flow data were available throughout the evaluation period. • Good match with monitored flows • A comparable fit of flows relative to the 2017 RWQM
LC_LC1	Line Creek upstream of MSA North Pit (E126142)	SRM and waste rock hydrology module in the sub-catchment of Upper Line Creek 1	2004 to 2018	Not implemented	510	n/a	560	0.64	0.47	Acceptable	• Flow data were available from 2008 to 2018, with gaps in winter flows throughout, and significant data gaps between 2008 and 2014 • Modelled peak and fall flows overestimated relative to monitored flows in some years • A comparable fit of flows relative to the 2017 RWQM
LC_WLC	West Line Creek (E261958)	SRM and waste rock hydrology module in the sub-catchment of West Line Creek	2004 to 2018	60% up to a maximum of 10,000 m^3/d	210	210	440	0.74	0.55	Good	• Flow data were available from 2005 to 2018, with gaps in winter flows between 2013 and 2014, in addition to significant data gaps between 2005 and 2010 • Good match with monitored flows • A comparable fit of flows relative to the 2017 RWQM
LC_LC3	Line Creek downstream of West Line Creek (0200337)	LC_LCUSWLC + LC_WLC (sum of modelled flows)	2004 to 2018	Not implemented	490	n/a	500	0.75	0.60	Very Good	• Flow data were available from 2005 to 2018, with gaps in winter flows between 2006 and 2011, in addition to significant data gaps between 2005 and 2009 • Good match with monitored flows • A comparable fit of flows relative to the 2017 RWQM
LC_DC3	Dry Creek upstream of East Tributary Creek (E288273)	SRM and waste rock hydrology module in the sub-catchments of Upper LCO Dry Creek, MTM 1-3 Pits	2004 to 2018	0%	390	400	400	0.80	0.62	Very Good	• Flow data were available from 2015 to 2018, with gaps in late summer and winter flows throughout period of record • Good match with monitored flows • An improvement relative to the 2017 RWQM

Table 5-6: Model Performance Summary for the Fording River Watershed and in Other Mine-Influenced Tributaries, Based on the Calibrated FC of the 2020 RWQM

Station ID	Station Description	Flow Modelling Method	Evaluation Period	Groundwater Component	Approximate mean annual runoff (mm)			Statistics			Comments on Model Performance
					Measured (surface)	Modelled (surface)	Modelled (total)	E	E1	Rating	
LC_DCEF	East Tributary of Dry Creek (E288274)	SRM and waste rock hydrology module in the sub-catchment of East Tributary of LCO Dry Creek	2004 to 2018	Not implemented	460	n/a	480	0.16	0.46	Poor but improved	• Flow data were available from 2012 to 2018, with gaps between 2012 and 2014 • Modelled high flows underestimated compared to monitored flows in some years • An improvement relative to the 2017 RWQM
LC_DC1	Dry Creek near the Mouth (at bridge) (E288270)	SRM and waste rock hydrology module in the sub-catchments of East Tributary of LCO Dry Creek, Upper LCO Dry Creek, Lower LCO Dry Creek to DC4, Lower LCO Dry Creek to DC1	2004 to 2018	50% up to a maximum of 8,000 m^3/d	250	340	420	0.25	0.36	Poor but improved	• Flow data were available from 2004 to 2018, with significant gaps between 2004 and 2015 • Good match with moderate and low flows • Modelled high flows overestimated compared to monitored flows prior to 2018 • An improvement relative to the 2017 RWQM
LC_DCDS	LCO Dry Creek d/s of Sedimentation Ponds (E295210)	Snowmelt Runoff Module, Waste Rock Module of subcatchments East Tributary of LCO Dry Creek, Upper LCO Dry Creek	2004 to 2018	80% of LC_DCEF in downstream reach, maximum of 69,100 m^3/d	560	260	260	0.32	0.52	Poor	• Flow data were available from 2015 onwards, with some gaps in 2015 • Modelled high flows underestimated compared to monitored flows in 2017 and 2018 • A comparable fit of flows relative to the 2017 RWQM
LC_LCUSWLC	Line Creek u/s of West Line Creek (E293369)	Snowmelt Runoff Module, Waste Rock Module of subcatchments Centre Line Creek, North Line Creek, HSR Pit, MSA West, Horseshoe Creek (1 & 2), Upper Line Creek (1 & 2), No Name Creek (Diversion, NLX Pit, Access Road Spoils)	2004 to 2018	Not implemented	510	530	530	0.74	0.60	Good	• Flow data were available from 2005 to 2018, with significant gaps between 2005 and 2011 • Good match with high and low flows • Modelled fall flows overestimated compared to monitored flows in some years • A worse fit relative to the 2017 RWQM
LC_LCDSSLCC	Line Creek downstream of South Line Creek / LCO Compliance Point (E297110)	LC_LC3 + South Line Creek (LC_SLC)	2004 to 2018	Not implemented	480	n/a	480	0.81	0.53	Very Good	• Flow data were available between 2015 and 2018 • Modelled flows match measured flows well • An improved fit relative to the 2017 RWQM

Table 5-6: Model Performance Summary for the Fording River Watershed and in Other Mine-Influenced Tributaries, Based on the Calibrated FC of the 2020 RWQM

Station ID	Station Description	Flow Modelling Method	Evaluation Period	Groundwater Component	Approximate mean annual runoff (mm)			Statistics			Comments on Model Performance
					Measured (surface)	Modelled (surface)	Modelled (total)	E	E1	Rating	
EV_GT1	Gate Creek Sediment Pond Decant (E206231)	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchment of Gate Creek, dewatering of Natal Pit (diverted via Bodie Control Pond) and Natal Pit 2	2004 to 2018	Not implemented	610	n/a	990	-2.83	-0.62	Poor	• Flow data were available from 2004 to 2018, with significant gaps between 2005 and 2014 • Flow regime influenced by water management activities • Modelled flows generally overestimated relative to monitored flows • A comparable fit of flows relative to the 2017 RWQM
EV_BC1	Bodie Creek Sediment Pond Decant (E102685)	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchments of Bodie Creek and dewatering of Natal Pits (via Bodie Control Pond)	2004 to 2018	Not implemented	170	250	250	-1.17	-0.08	Poor but improved	• Flow data were available from 2004 to 2018, with some gaps in data throughout the period of record • Flow regime influenced by water management activities • Modelled flows generally overestimated relative to monitored flows • An improved fit relative to the 2017 RWQM
EV_DC1	EVO Dry Creek Sediment Pond Decant (E298590)	SRM and waste rock hydrology module in the sub-catchment of EVO Dry Creek	2004 to 2018	Flows <20,000 m^3/d: 100%, maximum of 2,000 m^3/d Flows >20,000 m^3/d: 10%, maximum of 5,000 m^3/d	460	420	510	0.59	0.46	Acceptable	• Flow data were available from 2009 to 2018, with gaps in winter flows throughout, and significant data gaps between 2009 and 2013 • Overestimation of moderate and relative to monitored flows • Underestimation of high flows in some years • A worse fit relative to the 2017 RWQM
EV_HC1	Harmer Creek Dam Spillway (E102682)	SRM and waste rock hydrology module in the sub-catchments of Harmer above EVO Dry Creek, Upper and Lower Harmer Creek	2004 to 2018	5%, up to a maximum of 5,000 m^3/d	460	430	450	0.78	0.61	Very Good	• Flow data were available throughout the evaluation period, with gaps in winter flows • Good match with moderate and low flows relative to monitored flows • Underestimation of high flows in some years • A comparable fit of flows relative to the 2017 RWQM

Table 5-6: Model Performance Summary for the Fording River Watershed and in Other Mine-Influenced Tributaries, Based on the Calibrated FC of the 2020 RWQM

Station ID	Station Description	Flow Modelling Method	Evaluation Period	Groundwater Component	Approximate mean annual runoff (mm)			Statistics			Comments on Model Performance
					Measured (surface)	Modelled (surface)	Modelled (total)	E	E1	Rating	
EV_GV1	Grave Creek at Bridge	SRM and waste rock hydrology module in the sub-catchments of Dry Creek, Upper and Lower Harmer Creek, Grave above Harmer Creek, Lower Grave Creek	2004 to 2018	5%, up to a maximum of 5,000 m^3/d	n/a	n/a	n/a	-0.96	-0.24	n/a	• Performance was not assessed since limited flow data are available (spot measurements in 2015 and 2016 alone)
EV_EC1	Erickson Creek at Mouth (0200097)	SRM and waste rock hydrology module in the sub-catchments of Erickson Creek (Lower, Bridge and Upper), Adit Ridge Pit plus West Fork Tailings Facility flows	2004 to 2018	10%, up to a maximum of 34,560 m^3/d	240	250	300	0.51	0.33	Acceptable	• Flow data were available for most of the evaluation period, with gaps in flows between 2004 and 2009, and continuous flows from 2013 • Good match with low flows relative to monitored flows • Modelled moderate flows overestimated relative to monitored flows • Reasonable match with high flows, with instances of both underestimation and overestimation • An improvement in fit relative to the 2017 RWQM

E = Nash Sutcliffe Efficiency; E1 = Modified Nash Sutcliffe Efficiency; SRM = Snowmelt Runoff Module; RWQM = Regional Water Quality Model;
n/a = Not applicable (e.g., surface runoff was only calculated at nodes with partitioning of surface water and groundwater flow components).

5.4.2 Michel Creek

Table 5-7 summarizes the final calibration parameters and model performance for the Michel Creek mainstem nodes. These results are presented as:

- Comparisons of modelled to monitored, mean annual runoff, summary goodness-of-fit statistics, with reference to the plots and tables included in this section and in Appendix D.
- Comparisons of modelled to monitored yields, in mm/year.
- Comments on node specific model performance.

For these model locations, the statistical fit was considered to be equivalent to or better than the 2017 RWQM. The ability of the model to simulate the variability in annual runoff and the timing and magnitude of hydrograph rise and recession were considered appropriate across the range of climate and sub-watershed land cover conditions. (Appendix D).

Table 5-7: Model Performance Summary at Michel Creek Mainstem Nodes for the FC of the 2020 RWQM

Station ID	Station Description	Flow Modelling Method	Evaluation Period	Groundwater component	Approximate mean annual runoff (mm)			Statistics			Comments on Model Performance
					Measured (surface)	Modelled (surface)	Modelled (total)	E	E1	Rating	
EV_MC2	**Michel Creek downstream of Hwy 3 Bridge (E300091)**	**EV_MC3 + EV_EC1 + South Pit + Milligan + Thresher + EV_GT1 + EV_BC1 + other unnamed tributaries between EV_MC3 and EV_MC2 (sum of modelled flows)**	**2004 to 2018**	**Not implemented**	**560**	**n/a**	**530**	**0.77**	**0.72**	**Very Good**	• **Flow data were available from 2012 onwards, with gaps in 2013 and 2014.** • **Good match high flows relative to monitored flows** • **An improved fit relative to the 2017 RWQM**
EV_MC3	Michel Creek upstream of Erickson Creek (0200203)	Scaling equation using flows estimated at EV_MC2 using a ranked regression relationship based on ECCC data at Elk River at Fernie and Elk River at Natal	2004 to 2018	Not implemented	n/a	n/a	n/a	n/a	n/a	n/a	• Flow data not available to evaluate model performance • High flows have generally decreased while low flows increased compared to the 2017 RWQM

E = Nash Sutcliffe Efficiency; E1 = Modified Nash Sutcliffe Efficiency; SRM = Snowmelt Runoff Module; RWQM = Regional Water Quality Model;
n/a = Not applicable (e.g., surface runoff was only calculated at nodes with partitioning of surface water and groundwater flow components).

5.4.3 Elk River

Model calibration and model performance metrics for the Elk River nodes are presented in Table 5-8. These results are presented as:

- Comparisons of modelled to monitored, mean annual runoff, summary goodness-of-fit statistics, with reference to the plots and tables included in this section and in Appendix D.
- Comparisons of modelled to monitored yields, in mm/year.
- Comments on node specific model performance.

The use of monitored streamflow data to develop the simulated discharge results in a strong statistical fit, and the timing and magnitude of hydrograph limb rise and recession were considered as reasonable for the locations (Appendix D).

Flows from some natural catchments along the Elk River are calculated in the RWQM as a difference of flows between two mainstem nodes (i.e., flows at mainstem nodes are either a direct input to the model or estimated using a scaling equation, as described in Section 4.16). To check the reasonableness of the calculated flows from these natural areas, yield checks were undertaken at three Elk River mainstem nodes, to confirm that the annual yields from the undefined natural areas were comparable to corresponding annual yields from areas being modelled or from nodes where gauge data were used directly. The three points of comparison were:

- Flows to the Elk River upstream of the Fording River confluence (i.e., GH_ERC vs. RG_ELKFERNIE)
- Flows to the Elk River downstream of the Fording River confluence and upstream of the Michel Creek confluence (i.e., EV_ER4 to EV_ER2 vs EV_ER4)
- Flows to the Elk River downstream of the Michel Creek confluence and upstream of Fernie (i.e., EV_ER1 to RG_ELKFERNIE vs. RG_ELKFERNIE)

Results of each of these yield comparisons is outlined below.

Table 5-8: Model Performance Summary at Elk River Nodes in the FC of the 2020 RWQM

Station ID	Station Description	Flow Modelling Method	Evaluation Period	Groundwater component	Approximate mean annual runoff (mm)			Statistics			Comments on Model Performance
					Measured (surface)	Modelled (surface)	Modelled (total)	E	E1	Rating	
GH_ERC	Elk River 220 m downstream of Thompson Creek / GHO Elk River Compliance Point (E300090)	Scaling of flows from ECCC station at Elk River near Natal and Fording River at the Mouth	2004 to 2018	Not Implemented	460[a]	n/a	460	1	1	Very good	• Flow data were only available in 2018; comparisons for the entire evaluation period are based on calculated flows (scaling equation) • Modelled flows are based on the calculated flows • A comparable fit relative to the 2017 RWQM
GH_ER1	Elk River upstream of Boivin Creek (E206661)	Scaling of flows from ECCC station at Elk River near Natal and Fording River at the Mouth	2004 to 2018	Not Implemented	460[a]	n/a	460	1	1	Very Good	• Flow data were only available in 2018; comparisons for the entire evaluation period are based on calculated flows (scaling equation) • Modelled flows are based on the calculated flows • A comparable fit relative to the 2017 RWQM
EV_ER4	Elk River upstream of Grave Creek (0200027)	ECCC station at Elk River near Natal	2004 to 2018	Not implemented	440	440	440	1	1	Very Good	• Data from a hydrometric station is used directly at this location
EV_ER1	Elk River downstream of Michel Creek (0200393)	EV_MC1 + EV_ER2 (estimated by scaling flows at EV_ER4)	2004 to 2018	Not implemented	510[a]	n/a	470	0.91	0.80	Very Good	• Flow data were only available in 2018; comparisons for the entire evaluation period are based on calculated flows (scaling equation) • Modelled flows are based on the calculated flows • A comparable fit relative to the 2017 RWQM
RG_ELKORES	Elk River at Elko Reservoir (E294312)	Scaling of flows from ECCC station at Elk River at Fernie	2004 to 2018	Not implemented	n/a	n/a	n/a	n/a	n/a	n/a	• Flow data not available to evaluate model performance • High flows have increased in some years relative to the 2017 RWQM

ECCC = Environment and Climate Change Canada; E = Nash Sutcliffe Efficiency; E1 = Modified Nash Sutcliffe Efficiency; SRM = Snowmelt Runoff Module; RWQM = Regional Water Quality Model
n/a = Not applicable (e.g., surface runoff was only calculated at nodes with partitioning of surface water and groundwater flow components)
At GH_ERC, GH_ER1 and EV_ER1, comparisons of modelled flows are with calculated flows based on a scaling equation that relies on measured data at other mainstem hydrometric stations.
a) Estimated using scaling equation.

5.4.4 GH_ERC

The yield check at GH_ERC was completed through a comparison of modelled annual yields (mm) at GH_ERC and EV_ER4 (gauged flows at Environment Canada station 08NK016; Figure 5-8). The relationship suggests that there is slightly higher yield from watersheds in the upper Elk River compared to the Fording and in the catchments between GH_ERC and EV_ER4. The comparative annual yield between these stations was considered acceptable.

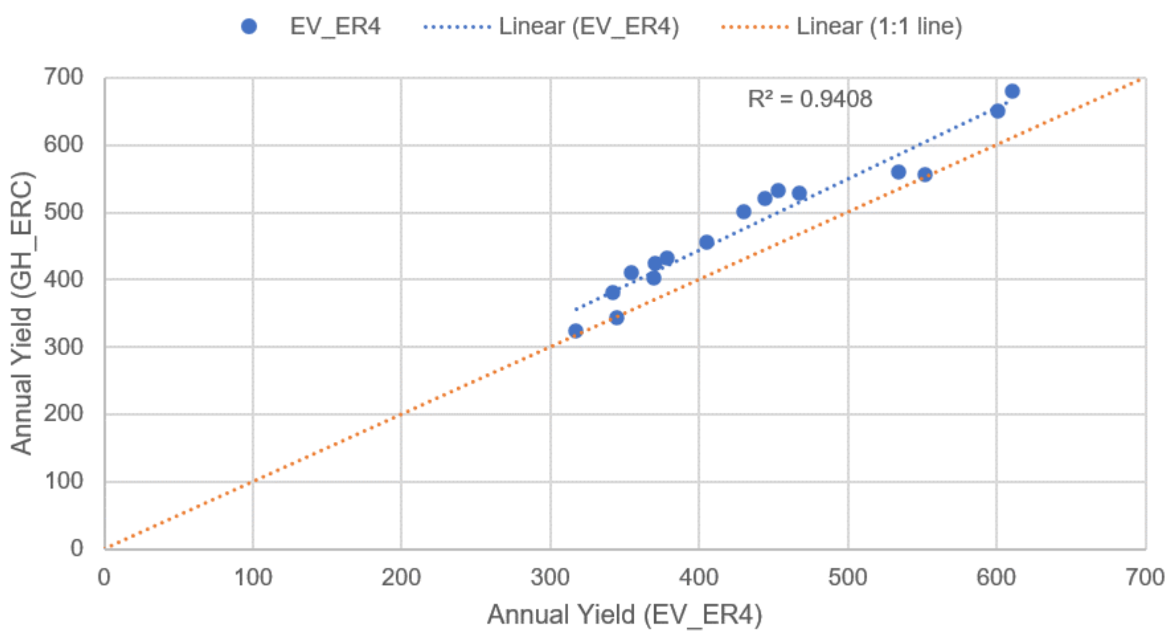


Figure 5-8: Comparison of Annual Yields (mm) – GH_ERC and EV_ER4, 2004 – 2019

5.4.5 EV_ER4 to EV_ER2

The yield check for EV_ER4 (1,840 km²) to EV_ER2 (2,170 km²) considers the contributing simulated flows from the Elk River tributaries at EVO. Modelled flows at EV_ER4 are based on measured flows at the ECCC station 08NK016, while modelled flows at EV_ER2 are calculated using a scaling equation, based on flows at EV_ER4. The contributing flow from the undefined area (229 km²) was estimated using the following formula:

Flow from undefined natural area between EV_ER2 and EV_ER4 = Elk River upstream of Michel Creek (EV_ER2) – Elk River downstream Fording (EV_ER4) – Grave Creek (EV_GV1) – Six Mile Creek (EV_SM1) – Balmer Creek (EV_BLM2)– Fennelon Creek (EV_FC1) – Lindsay Creek (EV_LC1) – Goddard Creek (EV_GC2) – Cossarini-Otto Creek (EV_OC1)

The results of the yield check are presented on Figure 5-9, which demonstrates that yields from the undefined area are generally proportionate to corresponding modelled yields at EV_ER4.

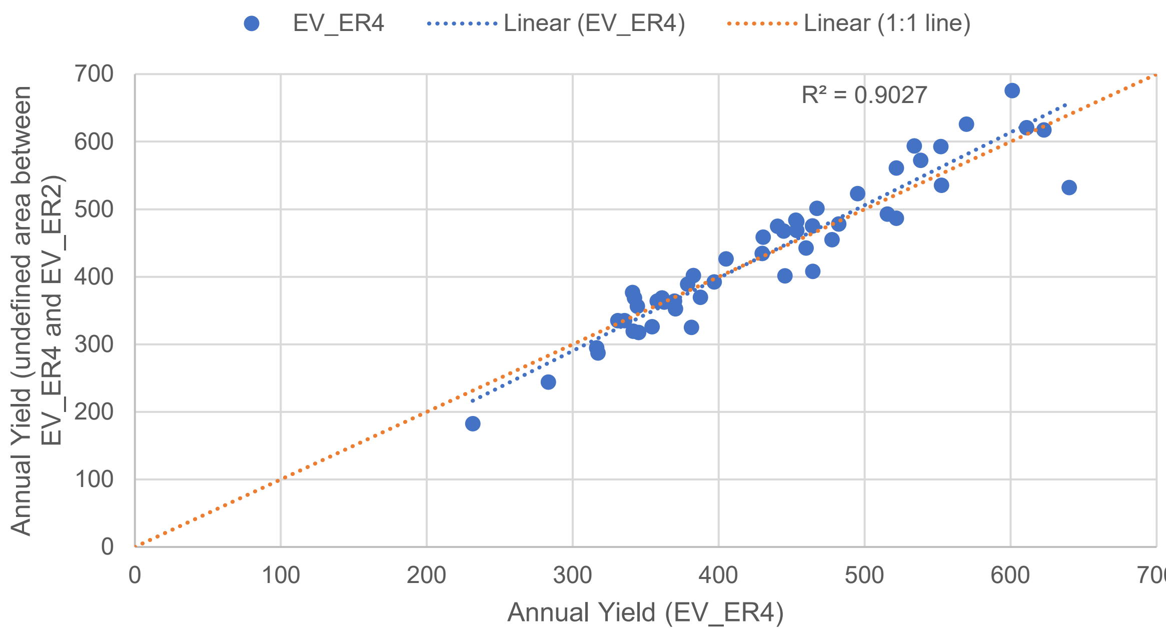


Figure 5-9: Comparison of Annual Yield (mm) from Ungauged Areas Reporting to the Elk River Between EV_ER4 and EV_ER2 to that at EV_ER4 (1970 to 2019)

5.4.6 EV_ER1 to RG_ELKFERNIE

The yield check for EV_ER1 (2,813 km^2) to RG_ELKFERNIE (3,090 km^2) considers the contributing simulated flows from the Elk River tributaries downstream of Michel Creek at EVO. Flows at RG_ELKFERNIE are based on measured flows at ECCC station 08NK002; flows at EV_ER1 are calculated as the sum of flows at EV_ER2 (calculated as described in the previous section) and modelled flows at the mouth of Michel Creek at EV_MC1. The flow from the undefined area (277 km^2) was estimated using the following formula:

Flow from undefined natural area between EV_ER1 and RG_ELKFERNIE = Elk River near Fernie (RG_ELKFERNIE) – Elk River downstream Michel (EV_ER1)

The results of the yield check are presented on Figure 5-10. The check demonstrates that yields from the undefined area are generally proportionate to, but higher than, corresponding yields at RG_ELKFERNIE.

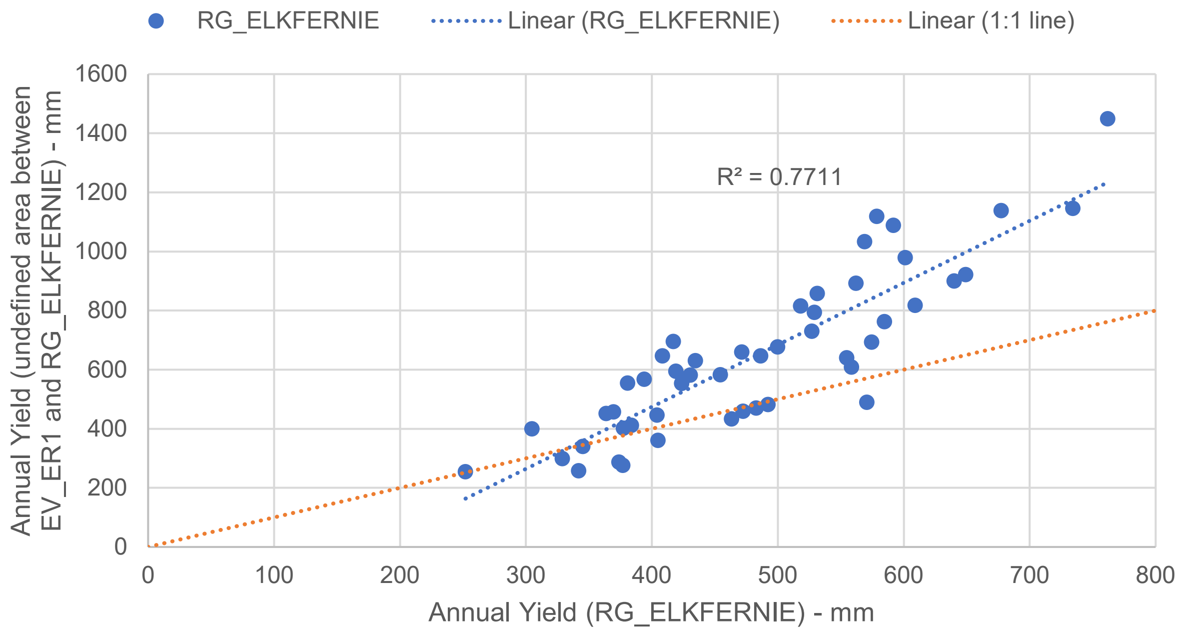


Figure 5-10: Comparison of Annual Yield (mm) from Ungauged Areas Reporting to EV_ER1 and that at RG_ELKFERNIE (1970 – 2019)

5.5 Future Flow Projections

As noted in Section 4.18, future flow projections were developed using a 20-year climate dataset (1999 to 2019) that was run repeatedly through the FC using a multi-realization approach. The results from the 20 realizations were exported directly for use in the WQC. They were also used to produce three timeseries of weekly average flows, one based on each of the following statistics: 10th percentile (P10), median (P50) and 90th percentile (P90). The 10th percentile timeseries is intended to be representative of low flow conditions, whereas the 90th percentile is intended to be representative of high flow conditions. Neither timeseries corresponds directly to 1-in-10 year events, because each timeseries is created by knitting together independent weekly results that may originate from different climate years. For example, the 10th percentile for week 1 may be the result of 2001 climate conditions, whereas that in week 2 may be the result of 2004 climate conditions. As a result, they tend to be more restrictive than flow conditions calculated based on an annual 1-in-10 year return period. These three flow timeseries can be used as an input to the WQC to account for variability in hydrologic patterns in projecting a corresponding range of water quality conditions. However, for this submission, they were generated to allow for comparison of future flow conditions between the 2020 RWQM and the 2017 RWQM, which only provides future flow projections in terms of low, average, and high flows. The purpose of the comparison is to demonstrate how the changes to the RWQM modelling approach influence future flow projections, which can then affect future water quality projections. The magnitude of flows projected to occur at different locations in the Elk Valley in future is presented in Annex D, Appendix D.

The comparison of simulated average weekly flow statistics from the 2020 RWQM to those generated with the 2017 RWQM was completed with a focus on the following locations:

- Cataract Creek (GH_CC1)
- Henretta Creek (FR_HC1)
- Harmer Creek (EV_HC1)
- Line Creek upstream of Process Plant (LC_LC4)
- Mouth of Fording River (LC_LC5)
- Michel Creek EVO Compliance Point (at the Highway 3 bridge) (EV_MC2)
- Elk River downstream of Michel Creek (EV_ER1)

These locations were selected, as they represent a range of mining influence and geographic scale. For example, Cataract Creek is a small watershed covered almost entirely with waste rock, Henretta Creek is a moderately-size watershed containing a small amount of waste rock coverage, and the Elk River is a large regional system with waste rock coverage representing a very small proportion of the overall watershed area.

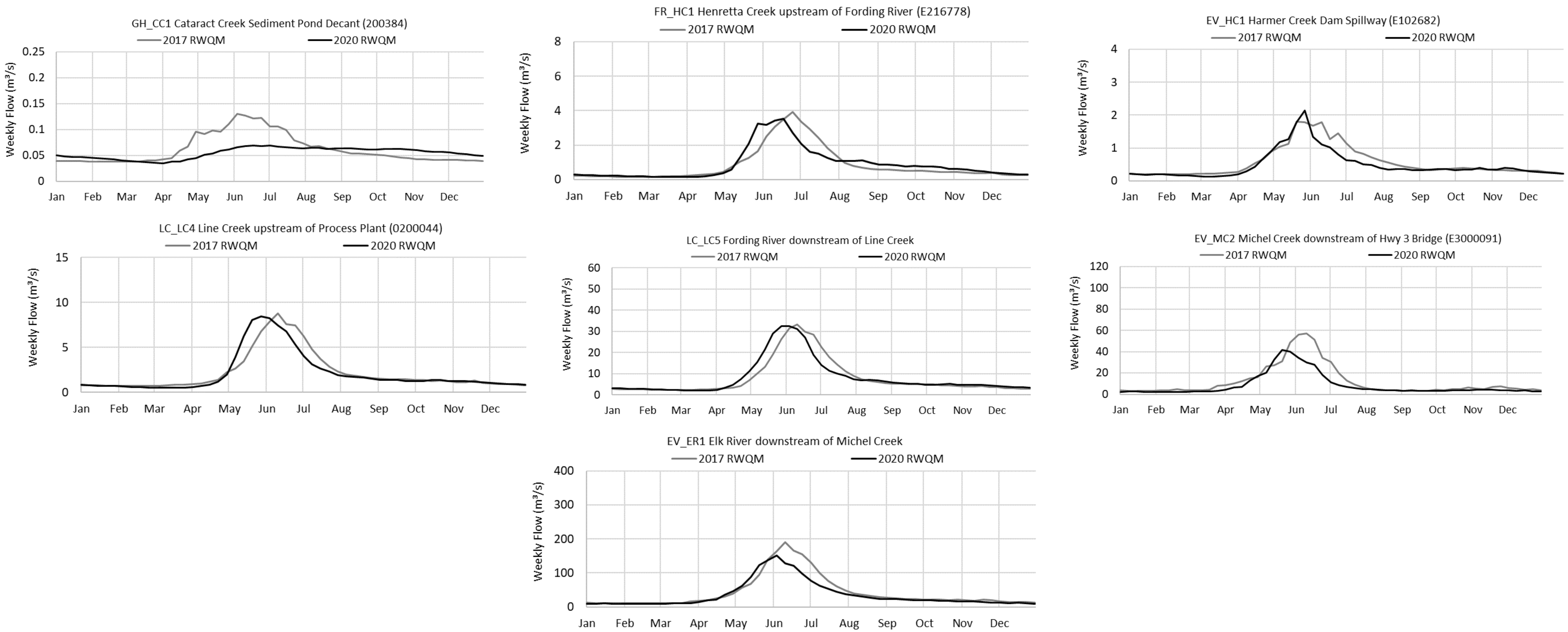
The flow comparison was completed using a representative future year (i.e., 2032) and locations where groundwater partitioning is assumed to be small to negligible (i.e., where there is expected to be little difference between surface flow and total watershed flow).

The same conceptual model to describe waste rock hydrology was applied in both the 2017 and 2020 RWQM. Waste rock spoils result in dampened hydrographs, with less spring runoff and higher volumes in late summer through winter flow relative to that occurring in undisturbed watersheds. In the 2017 RWQM, this dampening effect was numerically represented within the model using a representative unit hydrograph for waste rock developed using monitoring data from Cataract Creek. In the 2020 RWQM, the representative hydrograph has been replaced by the waste rock hydrology module described in Section 4,7.2.1. Both approaches produced a damped hydrograph; however, as shown in Cataract Creek in Figures 5-23 to 5-25, the dampening effect is more pronounced when using the waste rock hydrology module. The reason for the difference relates to the time period considered in the development of the representative unit hydrograph for waste rock.

The representative unit hydrograph for waste rock was developed in 2017 using measured flow data collected from Cataract Creek from 1995 to 2015. This time period includes flows influenced by pit pumping and early spoil development when more of the Cataract Creek watershed was behaving like an undisturbed watershed. Both factors influence the shape of the resulting unit hydrograph, resulting in higher freshet flow and lower fall / winter flow than would otherwise be expected from a waste rock spoil. Consequently, the results produced using the waste rock hydrology module are considered more representative and accurate than those developed using the 2017 representative unit hydrograph.

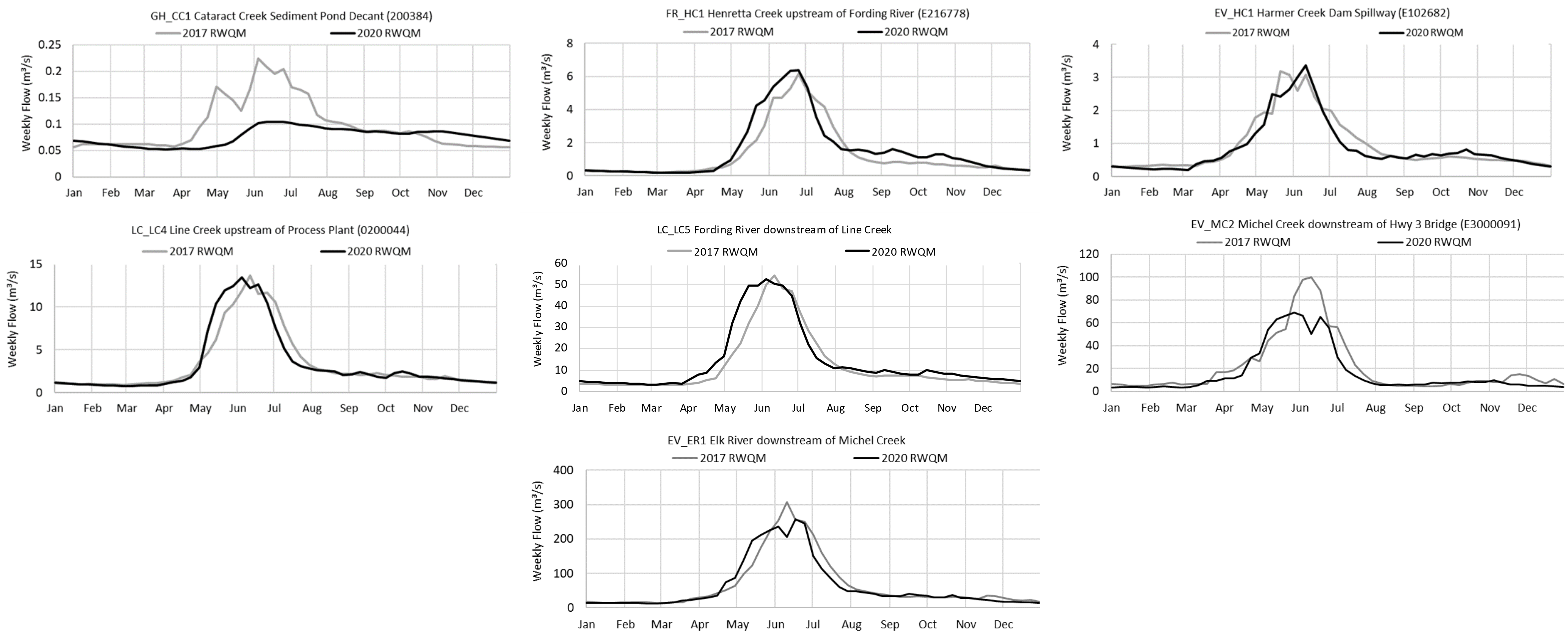
Although the differences in future flow projections from waste rock are notable, when comparing output from the 2017 RWQM to that produced using the 2020 RWQM, they tend to have limited influence on future flow projections in tributaries and the Fording River and Elk River mainstems, as illustrated by the hydrographs for the other locations shown in Figures 5-23 to 5-25. In general, future flow projections produced by the 2020 RWQM are similar to those produced using the 2017 RWQM, in terms of overall hydrograph shape and flow magnitude. That said, there are differences in the timing of freshet flows in some locations, and the comparison of average to median flow conditions in Figure 5-11 is somewhat affected by the different flow statistics being used.

Nevertheless, an outcome of the change in approach to the simulation of waste rock hydrology and its consequential effect on projected waste rock flows is that the proportion of water originating from waste rock spoils in late fall and winter will be higher in the 2020 RWQM flow projections than in those produced using the 2017 RWQM. The opposite being true for spring freshet, given the more dampened waste rock hydrograph now being produced by the RWQM.



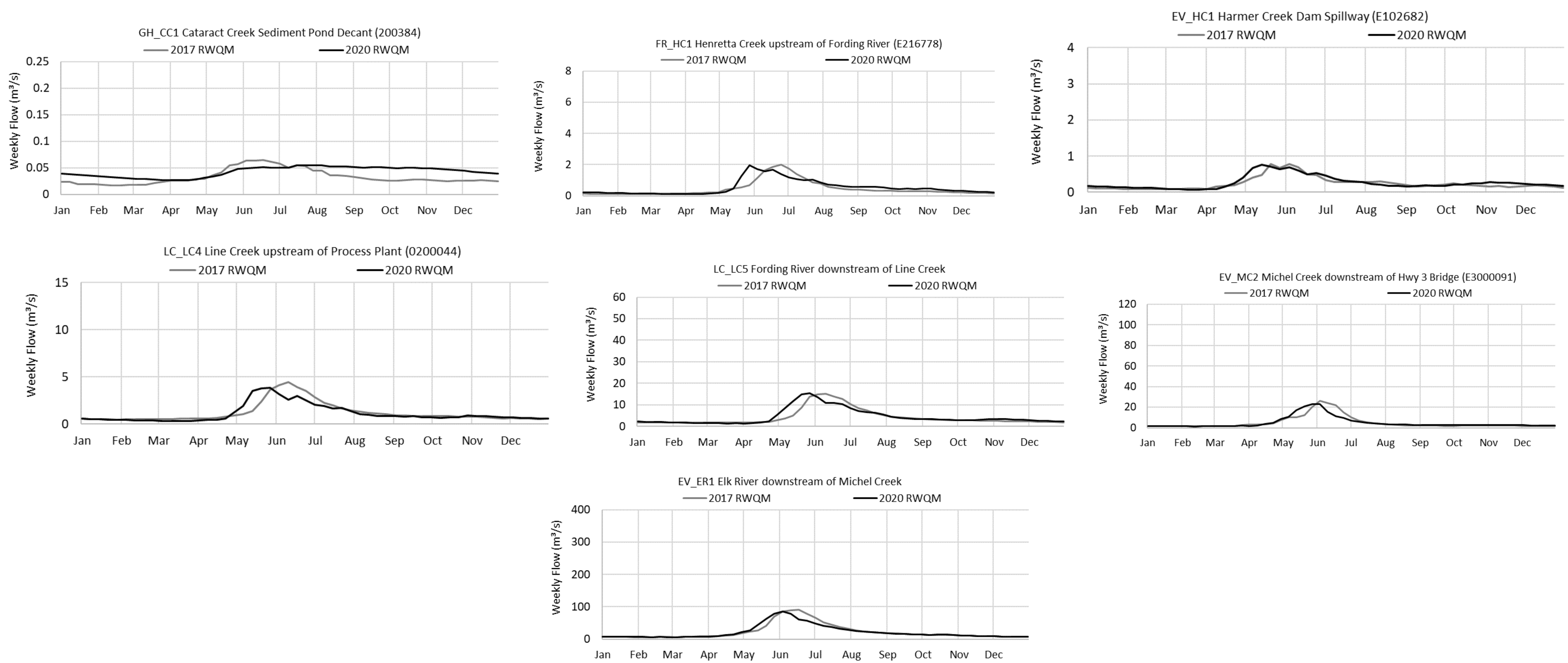
1. Data from the 2020 RWQM originate from the surface flow component; however, groundwater partitioning at each of the monitoring locations shown in this figure is assumed to be small to negligible (i.e., ≤ 5%); thus, surface flow and total watershed flow at these locations are effectively equivalent. The 2017 RWQM was set-up and configured to model total watershed flow, assuming groundwater partitioning was negligible at all monitoring locations.

Figure 5-11: Comparison of Future Flow Projections, expressed as average weekly flows in Year 2032, between the 2017 RWQM (mean) and 2020 RWQM (median)[1]



1. Data from the 2020 RWQM originate from the surface flow component; however, groundwater partitioning at each of the monitoring locations shown in this figure is assumed to be small to negligible (i.e., ≤ 5%); thus, surface flow and total watershed flow at these locations are effectively equivalent. The 2017 RWQM was set-up and configured to model total watershed flow, assuming groundwater partitioning was negligible at all monitoring locations.

Figure 5-12: Comparison of Future Flow Projections, expressed as average weekly flows in Year 2032, between the 2017 RWQM (1-in-10 year high) and 2020 RWQM (90th percentile)[1]



1. Data from the 2020 RWQM originate from the surface flow component; however, groundwater partitioning at each of the monitoring locations shown in this figure is assumed to be small to negligible (i.e., ≤ 5%); thus, surface flow and total watershed flow at these locations are effectively equivalent. The 2017 RWQM was set-up and configured to model total watershed flow, assuming groundwater partitioning was negligible at all monitoring locations.

Figure 5-13: Comparison of Future Flow Projections between the 2017 RWQM (1-in-10 year low) and 2020 RWQM (10th percentile)[1]

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Appendix A

Calibration Settings

2020 Elk Valley Regional Water Quality Model Update – Appendix A of Annex B

Calibration Settings

Rev1

May 2022

Teck

Contents

Tables

1 Introduction

This appendix contains tabulated calibration parameters for each sub-catchment in the Flow Component (FC) of the 2020 Regional Water Quality Model (RWQM).

2 Calibration Settings

A compilation of the final model calibration parameters by model sub-catchment are presented in this section. Table A-1 contains parameters that are applied at a broader scale (e.g., throughout the model domain or throughout a particular mining operation). Table A-2 through Table A-5 contain sub-catchment-specific calibration parameters for actual evapotranspiration rates, the snowmelt runoff module and the waste rock hydrology module. For definitions of the parameters, see the main report or the glossary of terms.

Table A-1: Summary of Operation-Specific Model Calibration Parameters

Parameter	Units	FRO	GHO	LCO	EVO
Reference Climate Station	-	Fording Cominco	Fording Cominco	Fording Cominco	Sparwood
Lapse Rate Precipitation (Summer)	mm/m	0.115	0.115	0.09	0.0805
Lapse Rate Precipitation (Winter)	mm/m	0.32	0.32	0.32	0.224
Lapse Rate Temperature	°C/m	0.005	0.005	0.005	0.005
Degree Day Factor	mm/°C-d	2	2	2	1.5
Snowfall Threshold Temperature	°C	0.6	0.6	0.6	0.6
Snowmelt Threshold Temperature	°C	-1	-1	-1	-1
Precipitation Threshold	cm/d	6	6	6	6
Sublimation Constant	mm/d	0.3	0.3	0.3	0.3
Solar Constant	MJ/m^2-min	0.082	0.082	0.082	0.082
Snow Water Equivalent (SWE) Equation Choice	-	3	3	3	3
SWE roughness length factor	-	5	5	5	5

See the glossary of terms for parameter definitions.
"-" Unitless parameter.
FRO = Fording River Operations, GHO = Greenhills Operations, LCO = Line Creek Operations, EVO = Elkview Operations;
SWE equations from Essery and Pomeroy (2004), as presented in the Snowmelt Runoff Module setup section of the report.

Table A-2: Summary of Model Calibration Parameters by Sub-Catchment: Fording River Operations

Category		Snowmelt Runoff Module (SRM)																				Waste Rock Hydrology Module										
Units		-	-	m³/s	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	m	-	-	d/m	-	-	d	-	-
ID	Sub-Catchment	Begin Freeze Month	Begin Melt Month	Initial Runoff	Lag Time	X_cold_n	X_Warm_n	Y_Cold_n	Y_warm_n	Cr_Summer_n	Cr_Winter_n	Cs_Summer_n	Cs_Winter_n	X_Cold_p	X_Warm_p	Y_Cold_p	Y_warm_p	Cr_Summer_p	Cr_Winter_p	Cs_Summer_p	Cs_Winter_p	K (waste rock)	Porosity	Height Threshold	Volumetric Moisture Capacity	Initial Moisture	QP_Delay	QP_Erlang	QP Fraction	SP_Delay	SP_Erlang	SP_Exp_Decay
1	Henretta_Ck	10	3	0	0.5	0.95	0.95	0.02	0.02	0.8	0.75	0.85	0.95	1	0.89	0.018	0.018	0.35	0.7	0.6	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
2	McSlide_Ck	10	3	0	0.5	0.95	0.95	0.02	0.02	0.8	0.75	0.85	0.95	1	0.89	0.018	0.018	0.35	0.7	0.6	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
3	McDonald_Ck	10	3	0	0.5	0.95	0.95	0.02	0.02	0.8	0.75	0.85	0.95	1	0.89	0.018	0.018	0.35	0.7	0.6	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
4	McMillan_Ck	10	3	0	0.5	0.95	0.95	0.02	0.02	0.8	0.75	0.85	0.95	1	0.89	0.018	0.018	0.35	0.7	0.6	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
5	Moore_Ck	10	3	0	0.5	0.95	0.95	0.02	0.02	0.8	0.75	0.85	0.95	1	0.89	0.018	0.018	0.35	0.7	0.6	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
6	Upper_Fording	10	3	0	0.5	1	0.9	0.02	0.02	0.75	0.2	0.55	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
7	Post_Ponds_Rock_Drain	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
8	SwiftNorthWest	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
9	Turnbull_Bridge_Spoil	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
10	North_East_Trib_Rock_Drain	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
11	John_Creek	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
12	Lake_Pit	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
13	Tower_Diversion	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
14	Tower_Diversion_Ext	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
15	Lake_Mountain_Pit	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
16	Turn_Ck	10	3	0	0.5	1	0.9	0.02	0.02	0.75	0.2	0.55	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
17	Turnbull_South_Pit	10	3	0	0.5	1	0.93	0.02	0.02	0.3	0.3	0.75	0.85	1	0.89	0.018	0.018	0.35	0.7	0.6	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
18	Clode_Ck_Upper	10	3	0	0.5	1	0.93	0.02	0.02	0.3	0.3	0.75	0.85	1	0.89	0.018	0.018	0.35	0.7	0.6	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
19	Clode_Ck_Lower	10	3	0	0.5	1	0.93	0.02	0.02	0.3	0.3	0.75	0.85	1	0.89	0.018	0.018	0.35	0.7	0.6	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
20	Eagle_6_North_Pit	10	3	0	0.5	1	0.93	0.02	0.02	0.3	0.3	0.75	0.85	1	0.89	0.018	0.018	0.35	0.7	0.6	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
21	Eagle_6_South_Pit	10	3	0	0.5	1	0.93	0.02	0.02	0.3	0.3	0.75	0.85	1	0.89	0.018	0.018	0.35	0.7	0.6	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
22	Eagle_6_West_Pit	10	3	0	0.5	1	0.93	0.02	0.02	0.3	0.3	0.75	0.85	1	0.89	0.018	0.018	0.35	0.7	0.6	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
23	Eagle_4_Pit	10	3	0	0.5	1	0.93	0.02	0.02	0.3	0.3	0.75	0.85	1	0.89	0.018	0.018	0.35	0.7	0.6	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
24	Fording_EC1_EaglePonds	10	3	0	0.5	1	0.93	0.02	0.02	0.3	0.3	0.75	0.85	1	0.89	0.018	0.018	0.35	0.7	0.6	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
25	Add_FR_FRNTP	10	5	0	0.5	1	0.93	0.02	0.02	0.65	0.2	0.75	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004

Table A-2: Summary of Model Calibration Parameters by Sub-Catchment: Fording River Operations

Category		Snowmelt Runoff Module (SRM)																				Waste Rock Hydrology Module										
Units		-	-	m^3/s	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	m	-	-	d/m	-	-	d	-	-
ID	Sub-Catchment	Begin Freeze Month	Begin Melt Month	Initial Runoff	Lag Time	X_cold_n	X_Warm_n	Y_Cold_n	Y_warm_n	Cr_Summer_n	Cr_Winter_n	Cs_Summer_n	Cs_Winter_n	X_Cold_p	X_Warm_p	Y_Cold_p	Y_warm_p	Cr_Summer_p	Cr_Winter_p	Cs_Summer_p	Cs_Winter_p	K (waste rock)	Porosity	Height Threshold	Volumetric Moisture Capacity	Initial Moisture	QP_Delay	QP_Erlang	QP Fraction	SP_Delay	SP_Erlang	SP_Exp_Decay
26	Swift_Pit	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
27	Swift_Bens_Pit	10	5	0	0.5	0.95	0.9	0.02	0.02	0.3	0.2	0.55	0.85	1	0.89	0.018	0.018	0.35	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
28	Fording_STP	10	5	0	0.5	0.95	0.9	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
29	Wash_Plant_NLP	10	5	0	0.5	0.95	0.9	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
30	Fording_LF2_Upper	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
31	Fording_LF2_Lower	10	5	0	0.5	0.95	0.9	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
32	Swift_Ck_Upper_Diversion	10	5	0	0.5	0.95	0.9	0.02	0.02	0.3	0.2	0.55	0.85	1	0.89	0.018	0.018	0.35	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
33	Swift_Spoil	10	5	0	0.5	0.95	0.9	0.02	0.02	0.3	0.2	0.55	0.85	1	0.89	0.018	0.018	0.35	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
34	Brownie_Ck	10	5	0	0.5	1	0.95	0.02	0.01	0.8	0.75	0.85	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
35	Kilmarnock_Upper	10	5	0	0.5	1	0.95	0.02	0.01	0.8	0.75	0.85	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
36	Kilmarnock_Lower	10	5	0	0.5	1	0.95	0.02	0.01	0.8	0.75	0.85	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
37	Cataract_Ck	10	5	0	0.5	0.95	0.9	0.02	0.02	0.65	0.2	0.55	0.85	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
38	Castle_FR_FRCP1_A	10	5	0	0.5	1	0.9	0.02	0.02	0.75	0.2	0.55	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
39	Castle_FR_FRCP1_B	10	5	0	0.5	1	0.9	0.02	0.02	0.75	0.2	0.55	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
40	Add_GH_PC2	10	5	0	0.5	1	0.9	0.02	0.02	0.75	0.2	0.55	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
41	Castle_GH_PC2_A	10	5	0	0.5	1	0.9	0.02	0.02	0.75	0.2	0.55	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
42	Castle_GH_PC2_B	10	5	0	0.5	1	0.9	0.02	0.02	0.75	0.2	0.55	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
43	Castle_FR_FRABCH_A	10	5	0	0.5	1	0.9	0.02	0.02	0.75	0.2	0.55	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
44	Castle_FR_FRABCH_B	10	5	0	0.5	1	0.9	0.02	0.02	0.75	0.2	0.55	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
45	Castle_FR_FRABCH_Upper	10	5	0	0.5	1	0.9	0.02	0.02	0.75	0.2	0.55	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
46	Add_FR_FRABCH	10	5	0	0.5	1	0.9	0.02	0.02	0.75	0.2	0.55	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004
47	Chauncey_Ck	10	5	0	0.5	1	0.9	0.02	0.02	0.75	0.2	0.55	0.95	1	0.89	0.018	0.018	0.7	0.35	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	0	1000	0.004

See the glossary of terms for parameter definitions; "-" Unitless parameter.

Table A-3: Summary of Model Calibration Parameters by Sub-Catchment: Greenhills Operations

Category		Snowmelt Runoff Module (SRM)																				Waste Rock Hydrology Module										
Units		-	-	m³/s	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	m	-	-	d/m	-	-	d	-	-
ID	Sub-Catchment	Begin Freeze Month	Begin Melt Month	Initial Runoff	Lag Time	X_cold_n	X_Warm_n	Y_Cold_n	Y_warm_n	Cr_Summer_n	Cr_Winter_n	Cs_Summer_n	Cs_Winter_n	X_Cold_p	X_Warm_p	Y_Cold_p	Y_warm_p	Cr_Summer_p	Cr_Winter_p	Cs_Summer_p	Cs_Winter_p	K (waste rock)	Porosity	Height Threshold	Volumetric Moisture Capacity	Initial Moisture	QP_Delay	QP_Erlang	QP Fraction	SP_Delay	SP_Erlang	SP_Exp_Decay
1	Unnamed_Elk_Tribs_4	10	3	0	0.5	0.95	0.85	0.02	0.02	0.2	0.1	0.55	0.85	1	0.89	0.018	0.018	0.3	0.2	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
2	Unnamed_Elk_Tribs_3	10	3	0	0.5	0.95	0.85	0.02	0.02	0.2	0.1	0.55	0.85	1	0.89	0.018	0.018	0.3	0.2	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
3	Unnamed_Elk_Tribs_2	10	3	0	0.5	0.95	0.85	0.02	0.02	0.2	0.1	0.55	0.85	1	0.89	0.018	0.018	0.3	0.2	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
4	Unnamed_Elk_Tribs_1	10	3	0	0.5	0.95	0.85	0.02	0.02	0.2	0.1	0.55	0.85	1	0.89	0.018	0.018	0.3	0.2	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
5	Branch_F_Ck	10	3	0	0.5	0.95	0.85	0.02	0.02	0.2	0.1	0.55	0.85	1	0.89	0.018	0.018	0.3	0.2	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
6	Wolf_Ck	10	3	0	0.5	0.95	0.85	0.02	0.02	0.2	0.1	0.55	0.85	1	0.89	0.018	0.018	0.3	0.2	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
7	Phase_9_10_Pits	10	5	0	0.5	0.95	0.9	0.02	0.02	0.2	0.2	0.55	0.85	1	0.89	0.018	0.018	0.3	0.3	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
8	Phase_8_Pit	10	5	0	0.5	0.95	0.9	0.02	0.02	0.2	0.2	0.55	0.85	1	0.89	0.018	0.018	0.3	0.3	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
9	Phase_7_North	10	5	0	0.5	0.95	0.9	0.02	0.02	0.2	0.2	0.55	0.85	1	0.89	0.018	0.018	0.3	0.3	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
10	Phase_7_South	10	5	0	0.5	0.95	0.9	0.02	0.02	0.2	0.2	0.55	0.85	1	0.89	0.018	0.018	0.3	0.3	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
11	Willow_Ck_North	10	3	0	0.5	0.95	0.85	0.02	0.02	0.2	0.1	0.55	0.85	1	0.89	0.018	0.018	0.3	0.2	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
12	Willow_Ck_South	10	3	0	0.5	0.95	0.85	0.02	0.02	0.2	0.1	0.55	0.85	1	0.89	0.018	0.018	0.3	0.2	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
13	Wade_Ck	10	5	0	0.5	0.95	0.85	0.02	0.02	0.2	0.1	0.95	0.85	1	0.89	0.018	0.018	0.3	0.2	1	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
14	Cougar_Ck	10	3	0	0.5	0.95	0.85	0.02	0.02	0.2	0.1	0.55	0.85	1	0.89	0.018	0.018	0.3	0.2	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
15	Phase_6_Pit	10	5	0	0.5	0.95	0.9	0.02	0.02	0.2	0.2	0.55	0.85	1	0.89	0.018	0.018	0.3	0.3	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
16	Phase_4_5_Pits	10	5	0	0.5	0.95	0.9	0.02	0.02	0.2	0.2	0.55	0.85	1	0.89	0.018	0.018	0.3	0.3	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
17	West_Spoil_Ph3_A	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.95	1	0.89	0.018	0.018	0.75	0.3	0.65	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
18	West_Spoil_Ph3_B	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.95	1	0.89	0.018	0.018	0.75	0.3	0.65	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
19	West_Spoil_Ph3_C	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.95	1	0.89	0.018	0.018	0.75	0.3	0.65	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
20	Mickelson_Ck	10	3	0	0.5	0.95	0.85	0.02	0.02	0.2	0.1	0.55	0.85	1	0.89	0.018	0.018	0.3	0.2	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
21	Leask_Ck_Upper	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.95	1	0.89	0.018	0.018	0.75	0.3	0.65	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
22	Leask_Ck_Lower	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.95	1	0.89	0.018	0.018	0.75	0.3	0.65	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
23	Phase_3_Pit	10	5	0	0.5	0.95	0.9	0.02	0.02	0.2	0.2	0.55	0.85	1	0.89	0.018	0.018	0.3	0.3	0.65	0.95	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
24	Wolfram_Ck_W	10	3	0	0.5	0.95	0.9	0.02	0.02	0.2	0.2	0.75	0.95	1	0.89	0.018	0.018	0.3	0.3	0.85	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004

Table A-3: Summary of Model Calibration Parameters by Sub-Catchment: Greenhills Operations

Category		Snowmelt Runoff Module (SRM)																				Waste Rock Hydrology Module										
Units		-	-	m^3/s	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	m	-	-	d/m	-	-	d	-	-
ID	Sub-Catchment	Begin Freeze Month	Begin Melt Month	Initial Runoff	Lag Time	X_cold_n	X_Warm_n	Y_Cold_n	Y_warm_n	Cr_Summer_n	Cr_Winter_n	Cs_Summer_n	Cs_Winter_n	X_Cold_p	X_Warm_p	Y_Cold_p	Y_warm_p	Cr_Summer_p	Cr_Winter_p	Cs_Summer_p	Cs_Winter_p	K (waste rock)	Porosity	Height Threshold	Volumetric Moisture Capacity	Initial Moisture	QP_Delay	QP_Erlang	QP Fraction	SP_Delay	SP_Erlang	SP_Exp_Decay
25	Wolfram_Ck_N_Upper	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.95	1	0.89	0.018	0.018	0.75	0.3	0.65	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
26	Wolfram_Ck_N_Lower	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.95	1	0.89	0.018	0.018	0.75	0.3	0.65	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
27	Wolfram_Ck_S_Upper	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.95	1	0.89	0.018	0.018	0.75	0.3	0.65	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
28	Wolfram_Ck_S_Lower	10	3	0	0.5	0.95	0.85	0.02	0.02	0.65	0.2	0.55	0.95	1	0.89	0.018	0.018	0.75	0.3	0.65	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
29	Thompson_Upper	10	3	0	0.5	0.95	0.9	0.02	0.02	0.2	0.2	0.75	0.95	1	0.89	0.018	0.018	0.3	0.3	0.85	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
30	Thompson_Lower	10	3	0	0.5	0.95	0.9	0.02	0.02	0.2	0.2	0.75	0.95	1	0.89	0.018	0.018	0.3	0.3	0.85	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
31	Fowler_Ck	10	3	0	0.5	0.95	0.9	0.02	0.02	0.2	0.2	0.75	0.95	1	0.89	0.018	0.018	0.3	0.3	0.85	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
32	Rush_Ck	10	3	0	0.5	0.95	0.9	0.02	0.02	0.2	0.2	0.75	0.95	1	0.89	0.018	0.018	0.3	0.3	0.85	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
33	Greenhills_North	10	3	0	0.5	0.95	0.9	0.02	0.02	0.65	0.2	0.75	0.8	1	0.89	0.018	0.018	0.75	0.3	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
34	Greenhills_South	10	3	0	0.5	0.95	0.9	0.02	0.02	0.65	0.2	0.75	0.8	1	0.89	0.018	0.018	0.75	0.3	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
35	Add_GH_FR1	10	3	0	0.5	0.95	0.9	0.02	0.02	0.65	0.2	0.75	0.8	1	0.89	0.018	0.018	0.75	0.3	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
36	Porter_Ck	10	3	0	0.5	0.95	0.9	0.02	0.02	0.85	0.85	0.95	0.95	1	0.89	0.018	0.018	0.95	0.95	1	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
37	Porter_Upper	10	3	0	0.5	0.95	0.9	0.02	0.02	0.85	0.85	0.95	0.95	1	0.89	0.018	0.018	0.95	0.95	1	1	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004
38	Additional_LC_LC5_GHO	10	3	0	0.5	0.95	0.9	0.02	0.02	0.65	0.2	0.75	0.8	1	0.89	0.018	0.018	0.75	0.3	0.85	0.9	0.95	0.3	40	0.16	0.16	3	50	0	365	15	0.004

See the glossary of terms for parameter definitions; "-" Unitless parameter.

Table A-4: Summary of Model Calibration Parameters by SubCatchment: Line Creek Operations

Category		Snowmelt Runoff Module (SRM)																				Waste Rock Hydrology Module										
Units		-	-	m^3/s	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	m	-	-	d/m	-	-	d	-	-
ID	Sub-Catchment	Begin Freeze Month	Begin Melt Month	Initial Runoff	Lag Time	X_cold_n	X_Warm_n	Y_Cold_n	Y_warm_n	Cr_Summer_n	Cr_Winter_n	Cs_Summer_n	Cs_Winter_n	X_Cold_p	X_Warm_p	Y_Cold_p	Y_warm_p	Cr_Summer_p	Cr_Winter_p	Cs_Summer_p	Cs_Winter_p	K (waste rock)	Porosity	Height Threshold	Volumetric Moisture Capacity	Initial Moisture	QP_Delay	QP_Erlang	QP Fraction	SP_Delay	SP_Erlang	SP_Exp_Decay
1	Todhunter_Ck_Ewin_Ck	10	3	0	0.5	1	0.91	0.012	0.015	0.4	0.1	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
2	Additional_LC_FRDSDC	10	3	0	0.5	1	0.91	0.012	0.015	0.4	0.1	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
3	East_Trib_LCO_Dry_Ck	10	3	0	0.5	1	0.91	0.012	0.015	0.4	0.1	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
4	Upper_LCO_Dry_Ck	10	3	0	0.5	1	0.91	0.012	0.015	0.4	0.1	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
5	BRN_1_Pit	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
6	BRN_2_Pit	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
7	BRN_3_Pit	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
8	MTM_1_Pit	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
9	MTM_2_Pit	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
10	MTM_3_Pit	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
11	Lower_LCO_Dry_Ck_DC4	10	3	0	0.5	1	0.91	0.012	0.015	0.4	0.1	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
12	Lower_LCO_Dry_Ck_DC1	10	3	0	0.5	1	0.91	0.012	0.015	0.4	0.1	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
13	Lower_LCO_Dry_Ck_to_ Fording_River	10	3	0	0.5	1	0.91	0.012	0.015	0.4	0.1	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
14	Upper_Line_Ck_1	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
15	Upper_Line_Ck_2	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
16	Horseshoe_Ck_1	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
17	Horseshoe_Ck_2	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
18	Horseshoe_Ridge_Pit	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
19	No_Name_Ck_Diversion	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
20	No_Name_Ck_NLX_Pit	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
21	No_Name_Ck_ Access_Road_Spoils	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
22	MSA_West	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
23	MSAW_Backfilled_Pit	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004

Table A-4: Summary of Model Calibration Parameters by SubCatchment: Line Creek Operations

Category		Snowmelt Runoff Module (SRM)																				Waste Rock Hydrology Module										
Units		-	-	m^3/s	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	m	-	-	d/m	-	-	d	-	-
ID	Sub-Catchment	Begin Freeze Month	Begin Melt Month	Initial Runoff	Lag Time	X_cold_n	X_Warm_n	Y_Cold_n	Y_warm_n	Cr_Summer_n	Cr_Winter_n	Cs_Summer_n	Cs_Winter_n	X_Cold_p	X_Warm_p	Y_Cold_p	Y_warm_p	Cr_Summer_p	Cr_Winter_p	Cs_Summer_p	Cs_Winter_p	K (waste rock)	Porosity	Height Threshold	Volumetric Moisture Capacity	Initial Moisture	QP_Delay	QP_Erlang	QP Fraction	SP_Delay	SP_Erlang	SP_Exp_Decay
24	North_Line_Ck	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
25	Centre_Line_Ck	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
26	West_Line_Ck	10	5	0	0.5	1	0.95	0.012	0.015	0.4	0.6	0.45	0.6	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
27	South_Line_Ck	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
28	Lower_Line_Ck_LC_LC4	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
29	Lower_Line_Ck_Mouth	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
30	Add_LC_LC5	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004
31	LCO_Processing_Plant_Area	10	5	0	0.5	1	0.935	0.012	0.01	0.65	0.3	0.9	1	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	40	0.12	0.12	3	50	0	365	15	0.004

See the glossary of terms for parameter definitions; “-” Unitless parameter.

Table A-5: Summary of Model Calibration Parameters by Sub-Catchment: Elkview Operations

Category		Snowmelt Runoff Module (SRM)																				Waste Rock Hydrology Module										
Units		-	-	m^3/s	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	m	-	-	d/m	-	-	d	-	-
ID	Sub-Catchment	Begin Freeze Month	Begin Melt Month	Initial Runoff	Lag Time	X_cold_n	X_Warm_n	Y_Cold_n	Y_warm_n	Cr_Summer_n	Cr_Winter_n	Cs_Summer_n	Cs_Winter_n	X_Cold_p	X_Warm_p	Y_Cold_p	Y_warm_p	Cr_Summer_p	Cr_Winter_p	Cs_Summer_p	Cs_Winter_p	K (waste rock)	Porosity	Height Threshold	Volumetric Moisture Capacity	Initial Moisture	QP_Delay	QP_Erlang	QP Fraction	SP_Delay	SP_Erlang	SP_Exp_Decay
1	Grave_above_Harmer_Ck	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
2	Harmer_above_EVO_Dry_Ck	10	3	0	5	0.95	0.9	0.016	0.016	0.75	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
3	EVO_Dry_Ck	10	3	0	5	0.95	0.9	0.016	0.016	0.75	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.007
4	Lower_Harmer_Ck	10	3	0	5	0.95	0.9	0.016	0.016	0.75	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
5	Lower_Grave_Ck	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
6	Six_Mile_Ck	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
7	Unnamed_Ck_below_6_Ck	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
8	Balmer_Ck	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
9	Fennelon_Ck	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
10	Upper_Lindsay_Ck	10	3	0	5	0.95	0.8	0.02	0.02	0.1	0.1	0.2	0.3	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
11	Lower_Lindsay_Ck	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
12	Goddard_Ck	10	3	0	5	0.95	0.8	0.02	0.02	0.1	0.1	0.2	0.3	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
13	Cedar_BR6_Pits	10	5	0	5	0.95	0.9	0.016	0.016	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
14	Breaker_Lake	10	5	0	5	0.95	0.9	0.016	0.016	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
15	Cossarini_Otto_Ck	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
16	Plant_Area	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
17	Alexander_Ck	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
18	Add_EV_MC3	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
19	Adit_Ridge_Pit	10	5	0	5	0.95	0.95	0.02	0.02	0.1	0.1	0.2	0.3	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
20	Erickson_Ck_Upper	10	5	0	5	0.95	0.95	0.02	0.02	0.1	0.1	0.2	0.3	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
21	Erickson_Ck_Bridge	10	5	0	5	0.95	0.95	0.02	0.02	0.1	0.1	0.2	0.3	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
22	Erickson_Ck_Lower	10	5	0	5	0.95	0.95	0.02	0.02	0.1	0.1	0.2	0.3	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
23	South_Pit_Ck	10	5	0	5	0.95	0.9	0.016	0.016	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
24	Milligan_Ck	10	5	0	5	0.95	0.9	0.016	0.016	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004

Table A-5: Summary of Model Calibration Parameters by Sub-Catchment: Elkview Operations

Category		Snowmelt Runoff Module (SRM)																				Waste Rock Hydrology Module										
Units		-	-	m^3/s	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	m	-	-	d/m	-	-	d	-	-
ID	Sub-Catchment	Begin Freeze Month	Begin Melt Month	Initial Runoff	Lag Time	X_cold_n	X_Warm_n	Y_Cold_n	Y_warm_n	Cr_Summer_n	Cr_Winter_n	Cs_Summer_n	Cs_Winter_n	X_Cold_p	X_Warm_p	Y_Cold_p	Y_warm_p	Cr_Summer_p	Cr_Winter_p	Cs_Summer_p	Cs_Winter_p	K (waste rock)	Porosity	Height Threshold	Volumetric Moisture Capacity	Initial Moisture	QP_Delay	QP_Erlang	QP Fraction	SP_Delay	SP_Erlang	SP_Exp_Decay
25	Thresher_Ck	10	5	0	5	0.95	0.9	0.016	0.016	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
26	Natal_Pit_South	10	5	0	5	0.95	0.9	0.016	0.016	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
27	Natal_Pit_North	10	5	0	5	0.95	0.9	0.016	0.016	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
28	Natal_Pit_2	10	5	0	5	0.95	0.9	0.016	0.016	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
29	Gate_Creek	10	5	0	5	0.95	0.9	0.016	0.016	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
30	F2_Pit	10	5	0	5	0.95	0.9	0.016	0.016	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
31	Baldy_Ridge_PitS	10	5	0	5	0.95	0.9	0.016	0.016	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
32	Bodie_Ck	10	5	0	5	0.95	0.9	0.016	0.016	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
33	Add_EV_MC2	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
34	Upper_Aqueduct_Ck	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
35	Lower_Aqueduct_Ck	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
36	Qualtieri_Ck	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004
37	Add_EV_MC1	10	5	0	5	0.95	0.95	0.012	0.02	0.6	0.35	0.6	0.8	1	0.9	0.01	0.01	0.75	0.3	0.9	1	0.8	0.3	50	0.12	0.12	3	50	0	365	15	0.004

See the glossary of terms for parameter definitions; "-" Unitless parameter.

Appendix B

Surface Water – Groundwater Interactions

2020 Elk Valley Regional Water Quality Model Update – Appendix B of Annex B

Surface Water – Groundwater Partitioning Information

Rev1

May 2022

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Tables

Figures

1 Introduction

This appendix to the Hydrology Modelling Report (i.e., Annex B of the 2020 Regional Water Quality Model Update) contains an overview of the surface water - groundwater partitioning information incorporated into the Flow Component (FC) of the 2020 Regional Water Quality Model (RWQM). This information was used to estimate the volume of water that may be present in the subsurface and travelling as interflow / shallow groundwater at noted monitoring stations. This information was incorporated into the 2020 RWQM to aid in the simulation of total watershed yield, while also facilitating a comparison of modelled flow at surface with measured surface flow.

Groundwater monitoring and site-specific investigations are on-going activities in the Elk Valley, with new information being regularly generated. The new information can result in updates to the conceptual understanding of interflow / shallow groundwater flow in the vicinity of individual flow monitoring stations. During the completion of the 2020 RWQM Update, efforts were made to incorporate new information and reflect updates to localized understanding of interflow / shallow groundwater flow at individual monitoring points as it was being generated up until February 2021.

Surface water – groundwater partitioning is site-specific, and the values outlined herein are those applied at existing flow monitoring stations to support model calibration and an understanding of the system as it currently exists. Values are also discussed with reference to two established intake locations: those on Kilmarnock Creek and Erickson Creek. Assumptions related to water availability for treatment at intake locations will be discussed and outlined in the next Implementation Plan Adjustment, similar to the approach used in the 2019 IPA.

2 Background Information

2.1 Water Balance Components

A catchment water balance consists of four main components:

- precipitation
- surface losses (i.e., evaporation, evapotranspiration, sublimation)
- total runoff (i.e., direct runoff, interflow and groundwater discharge)
- deep percolation (i.e., groundwater recharge to deep aquifers)

Surface losses involve the loss of water from a catchment to the atmosphere through the processes identified above (i.e., evaporation, evapotranspiration and/or sublimation). Deep percolation is a different form of water loss, involving the downward movement of water from the surface or near surface zone to deep aquifers that do not readily interact with local watercourses or waterbodies within the catchment. The remaining component, total runoff, consists of water that effectively moves laterally downgradient through the catchment, reporting to local watercourses or waterbodies within the catchment and then to catchment outlets. Total runoff, which can also be referred to as total watershed yield, includes water traveling at surface (direct runoff), interflow and shallow groundwater flow that readily interacts with and discharges to local watercourses and waterbodies.

Interflow is precipitation that infiltrates the ground, flows in the near surface unsaturated zone (vadose zone), then discharges back to surface. The division of total runoff into direct runoff, interflow, and shallow groundwater discharge is dependent on local-scale spatial variations in slope angle, near-surface permeability, and precipitation patterns, as well as temporal variations in precipitation events.

In a catchment with mining disturbance (i.e., waste rock spoils, pits), the division of total runoff into its three sub-components follows the same principles as in an undisturbed catchment. However, it is complicated by local-scale variations introduced by mining activity, such as changes to catchment boundaries induced through pit development and changes to surface permeability related to waste rock spoiling / pit backfilling.

2.2 Contribution of Groundwater / Interflow to Total Runoff in the Elk Valley

In the Elk Valley, total runoff (or total watershed yield) computed from water balances and measured flows at regional hydrometric stations (e.g., the mouth of the Fording River) equates to approximately 50% to 60% of annual precipitation. The shallow groundwater / interflow component typically ranges between 20% and 50% of the total watershed yield (or 10% to 30% of annual precipitation). The fraction of total runoff represented by the shallow groundwater / interflow component varies notably throughout the year. Total runoff during winter months can, in many cases, be attributed almost entirely to interflow and groundwater discharge, while total runoff during freshet is comprised predominantly of direct runoff (Figure B-1). The relative contributions of groundwater discharge / interflow and direct runoff to surface flows in a watercourse can vary along the length of the watercourse depending on flow pathways inherent in the local catchments and the extent of mining disturbance.

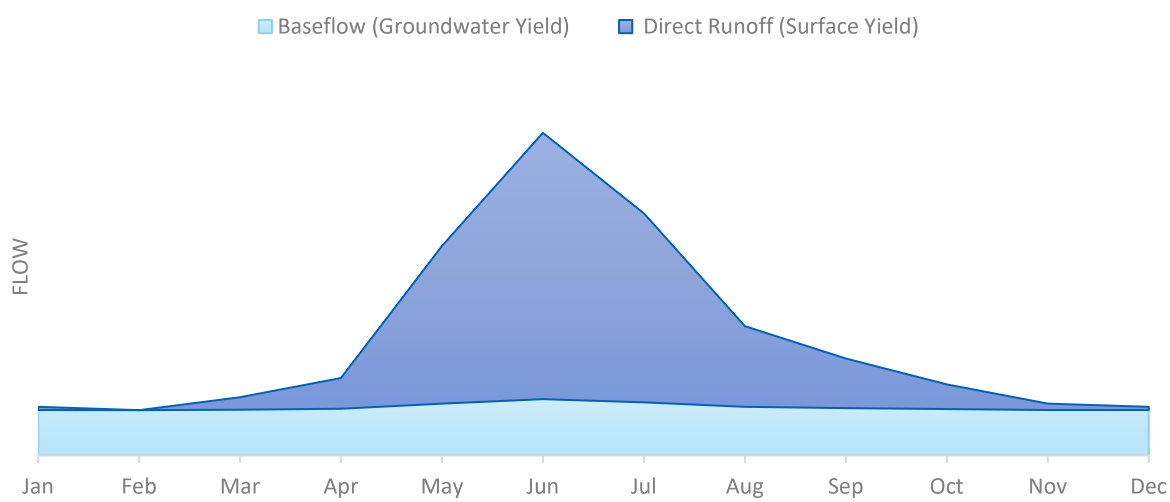

Figure B-1: Conceptual Hydrograph Illustrating Seasonal Fluctuations in the Contributions of Groundwater Discharge / Interflow and Direct Runoff to Total Runoff (Watershed Yield)

2.3 Subsurface Flow Paths and Their Effect on Estimating Total Runoff from Measured Flows

Local tributary catchments in the Elk Valley are generally characterized by relatively shallow glacial deposits and steep gradients. Losses to deep percolation are small, and total runoff tends to report to surface watercourses either as direct runoff or as shallow groundwater / interflow moving along short travel paths. Water moves downgradient through tributary catchments into the Fording River and the Elk River, which are regional topographical lows that generally gain flow with downstream distance (i.e., are gaining systems), as discussed for example in SNC (2017).

The Fording River floodplain contains permeable sediments and a valley bottom aquifer. Some of the total tributary runoff reporting to the Fording River travels subsurface and initially reports to the valley bottom aquifer. Groundwater flow in the valley bottom aquifer is directed to and eventually discharges into the Fording River, which, as previously identified, is a regional topographic low. There are small, local areas where groundwater flow is directed parallel to the river (SNC 2021a), which is referred to as an underflow-dominated section. However, on a regional basis, the direction of shallow groundwater flow is towards and into the Fording River.

Flows into the Elk River occur in a similar fashion, particularly in the vicinity of Leask Creek, Wolfram Creek and Thompson Creek. Water moves from tributary streams into the Elk River through surface and subsurface flow paths, which ultimately discharge into the Elk River mainstem (SNC 2021a).

The presence of surface and subsurface flow paths can make it a challenge to accurately measure total runoff from tributary catchments. Unless a monitoring station is placed in an area of local groundwater discharge (i.e., in a gaining reach), monitored water flows may underestimate total runoff from the upstream areas, because a portion of the total runoff is travelling subsurface at that particular location in the catchment. This concept is illustrated in Figure B-2.

The subsurface flow component in Figure B-2 is reflective of ground conditions and flow paths at a specific location along the watercourse, defined by the unique physical characteristics of the section of interest (e.g., gradient, cross-section width, substrate materials, thickness and permeability of underlying sediments). These characteristics are taken into consideration when evaluating model performance at a given monitoring station; they also become relevant when siting and designing intake structures and quantifying flows that may not be captured by a given intake structure.

In contrast, the relative size of the groundwater / interflow components of total runoff (as illustrated in Figure B-1) is reflective of broader catchment characteristics and the pathways by which water moves through the catchment. It is defined by the physical characteristics of the catchment rather than the watercourse itself. An understanding of the relative size of these two flow components (shallow groundwater and interflow) does not directly inform mitigation planning, but informs certain aspects of the RWQM, such as potential adjustments to runoff characteristics between catchments.

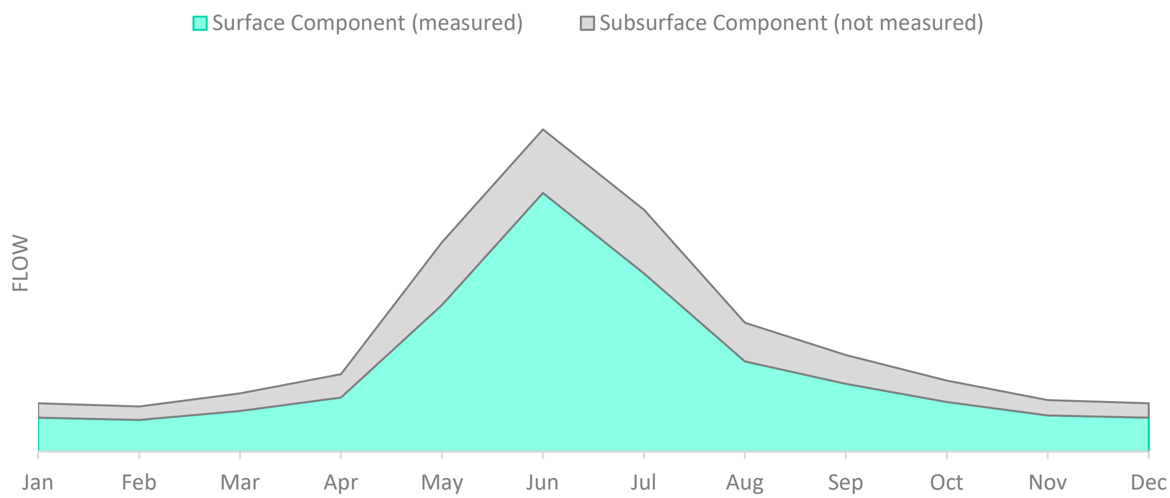

Figure B-2: Conceptual Hydrograph Illustrating Contributions of Measured Surface Flows and Unaccounted Subsurface Flows to Total Runoff (Watershed Yield)

3 Information to Inform Surface Water – Groundwater Partitioning Assumptions

3.1 Clode Creek

Explicit representation of the partitioning of total flow into surface water and groundwater components was implemented at the Clode Creek Sediment Pond Decant (FR_CC1, E102481). It was informed by the information outlined in Golder (2021a). The values used to define the division of total flow into surface and subsurface components at this location, along with a summary of the supporting lines of evidence, are summarized in Table B-1.

Table B-1: Surface Water – Groundwater Partitioning at Clode Creek Sediment Pond Decant (FR_CC1, E102481)

Category	Information
Location	• Clode Creek Sediment Pond Decant (FR_CC1, E102481)
Contributing Sub-catchments	• Upper and lower Clode Creek, Eagle 4, Eagle 6 West, Eagle 6 (portion to Clode)
Setting	• Settling pond located at the toe of existing waste rock spoils • Underlying sediments are Fording River valley-bottom alluvium • Surface discharge from the settling pond occurs year-round
Lines of Evidence	☒ Surface water level and flow monitoring data ☒ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☐ Field studies: pumping tests ☒ Field studies: flow accretion ☒ Field studies: groundwater monitoring data (levels, quality) ☒ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☒ Catchment water balance / water budget ☒ Analytical estimate of groundwater flow ☒ Numerical groundwater modelling
Groundwater Flow Estimates	• Estimated to be between 520 and 5,500 m^3/d
Groundwater Flow Value in 2020 RWQM	• 60% of total simulated catchment flow, up to a maximum of 4,000 m^3/d
Notes	• Values implemented in the 2020 RWQM are within the range estimated from groundwater investigations. • Flow accretion studies upstream of pond are not possible; pond abuts an existing waste rock spoil, with flow discharging to the pond through a rock drain positioned under 50+ meters of waste rock.

3.2 Swift Creek

Explicit representation of the partitioning of total flow into surface water and groundwater components was implemented at the Swift Creek Sediment Pond Decant (GH_SC1, E221329). It was informed by the information outlined in AMEC (2018). The values used to define the division of total flow into surface and subsurface components at this location, along with a summary of the supporting lines of evidence, are summarized in Table B-2

Table B-2: Surface Water – Groundwater Partitioning at the Swift Creek Sediment Pond Decant (GH_SC1, E221329)

Category	Information
Location	• Swift Creek Sediment Pond Decant (GH_SC1, E221329)
Contributing Sub-catchments	• Swift Spoil
Setting	• Settling pond located downstream of the toe of waste rock spoils • Surficial materials underlying settling pond characterized as thin overburden overlying bedrock • Consistent surface discharge
Lines of Evidence	☒ Surface water level and flow monitoring data ☒ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☐ Field studies: pumping test ☐ Field studies: flow accretion ☒ Field studies: groundwater monitoring data (levels, quality) ☐ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☒ Catchment water balance / water budget ☐ Analytical estimate of groundwater flow ☒ Numerical groundwater modelling
Groundwater Flow Estimates	• Estimated at ~100 m^3/d
Groundwater Flow Value in 2020 RWQM	• 2% of total simulated catchment flow, up to a maximum of 1,000 m^3/d
Notes	• The Swift Creek intake for the FRO AWTF-S is located close to the settling pond; same surface water – groundwater partitioning assumed to apply at the intake.

AWTF-S: Active Water Treatment Facility- South; FRO = Fording River Operations.

3.3 Kilmarnock Creek

3.3.1 Flow Monitoring Station

Explicit representation of the partitioning of total flow into surface water and groundwater components was implemented at Kilmarnock Creek downstream of the rock drain monitoring station (FR_KC1, 0200252). It was informed by the information outlined in Golder (2020). The values used to define the division of total flow into surface and subsurface components at this location, along with a summary of the supporting lines of evidence, are summarized in Table B-3.

Table B-3: Surface Water – Groundwater Partitioning at Kilmarnock Creek Downstream of the Rock Drain (FR_KC1, 0200252)

Category	Information
Location	• Kilmarnock Creek downstream of the rock drain (FR_KC1, 0200252)
Contributing Sub-catchments	• Brownie Creek, Upper Kilmarnock Creek, Lower Kilmarnock Creek, Eagle 6 to Kilmarnock Creek
Setting	• Open channel downstream of the toe of a large waste rock spoil and intake location • Underlying surficial materials are Kilmarnock Creek valley-bottom alluvial sediments • Consistent surface discharge year-round
Lines of Evidence	☒ Surface water level and flow monitoring data ☒ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☒ Field studies: pumping tests ☒ Field studies: flow accretion ☒ Field studies: groundwater monitoring data (levels, quality) ☒ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☒ Catchment water balance / water budget ☒ Analytical estimate of groundwater flow ☒ Numerical groundwater modelling
Groundwater Flow Estimates	• Estimated to be 16,500 m^3/d during lower flow conditions and up to 26,900 m^3/d during higher flow conditions
Groundwater Flow Value in 2020 RWQM	• When total flow < 60,000 m^3/d, 100% to bypass to a max of 16,500 m^3/d • When total flow > 60,000 m^3/d, then 30% to bypass to a max of 26,900 m^3/d
Notes	• Formulas used in 2020 RWQM acknowledge preference for water to go to ground and provide a gradual transition in groundwater flow rates as one moves from lower to higher flow conditions. • Pumping tests and groundwater modelling activities have so far been primarily focused on the upstream intake location, with the results generated therefrom informing groundwater estimates at this location.

3.3.2 Intake Location

Explicit representation of the partitioning of total flow into surface water and groundwater components was implemented at the Kilmarnock Creek Intake (KC_Intake) to the FRO South Active Water Treatment Facility (AWTF-S). It was informed by the information outlined in Golder (2020). The values used to define the division of total flow into surface and subsurface components at this location, along with a summary of the supporting lines of evidence, are summarized in Table B-4.

Table B-4: Surface Water – Groundwater Partitioning at the Kilmarnock Creek Intake

Category	Information
Location	• Kilmarnock Creek Intake to the FRO AWTF-S
Contributing Sub-catchments	• Brownie Creek, Upper Kilmarnock Creek, Lower Kilmarnock Creek, Eagle 6 to Kilmarnock Creek
Setting	• Open channel downstream of the toe of a large waste rock spoil but upstream of monitoring location • Underlying surficial materials are Kilmarnock Creek valley-bottom alluvial sediments • Consistent surface discharge year-round
Lines of Evidence	☐ Surface water level and flow monitoring data ☐ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☒ Field studies: pumping tests ☒ Field studies: flow accretion ☒ Field studies: groundwater monitoring data (levels, quality) ☒ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☒ Catchment water balance / water budget ☒ Analytical estimate of groundwater flow ☒ Numerical groundwater modelling
Groundwater Flow Estimates	• Estimated to be 8,000 m^3/d during lower flow conditions and up to 15,000 m^3/d during higher flow conditions
Groundwater Flow Value in 2020 RWQM	• Currently described using water availability assumptions, which are set as per the 2019 IPA

AWTF-S: Active Water Treatment Facility- South; FRO = Fording River Operations.

3.4 Cataract Creek

Partitioning of total flow into surface water and groundwater components does not appear to be occurring at the Cataract Creek Sediment Pond Decant (GH_CC1, 0200252), based on the information outlined in AMEC (2018) and summarized in Table B-5.

Table B-5: Surface Water – Groundwater Partitioning at Cataract Creek Sediment Pond Decant (GH_CC1, 0200252)

Category	Information
Location	• Cataract Creek Sediment Pond Decant (GH_CC1, 0200252)
Contributing Sub-catchments	• Cataract Creek; Phase 6 Pit at GHO (only up to 2009)
Setting	• Sediment pond downstream of the toe of a small heavily, disturbed tributary to the Fording River • Underlying surficial materials characterized as thin overburden with shallow depth to bedrock (near surface) • Consistent surface discharge year-round
Lines of Evidence	☒ Surface water level and flow monitoring data ☒ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☒ Field studies: pumping tests ☐ Field studies: flow accretion ☒ Field studies: groundwater monitoring data (levels, quality) ☐ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☒ Catchment water balance / water budget ☐ Analytical estimate of groundwater flow ☒ Numerical groundwater modelling
Groundwater Flow Estimates	• Estimated to be a negligible component of total flow
Groundwater Flow Value in 2020 RWQM	• 0% of total simulated catchment flow
Notes	• Beginning in 2019, flow from Cataract Creek has been diverted to Swift Creek at a location upstream of the monitoring location, as part of the Swift water management system for the FRO AWTF-S. The collection system is designed to collect all the flow from Cataract Creek.

AWTF-S: Active Water Treatment Facility- South; FRO = Fording River Operations.

3.5 Thompson Creek

Explicit representation of the partitioning of total flow into surface water and groundwater components was implemented at Thompson Creek at LRP Road (GH_TC1, E102714). It was informed by a catchment water balance, and comparisons between modelled total flows and monitored flows. The values used to define the division of total flow into surface and subsurface components at this location, along with a summary of the supporting lines of evidence, are summarized in Table B-6.

Table B-6: Surface Water – Groundwater Partitioning at Thompson Creek at LRP Road (GH_TC1, E102714)

Category	Information
Location	• Thompson Creek at LRP Road (GH_TC1, E102714)
Contributing Sub-catchments	• Thompson Creek Upper, Thompson Creek Lower, Phase 3 Pit (during dewatering)
Setting	• Alluvial fan with bedrock ridge influencing flow direction in the upper and mid-sections of the catchment • Underlying surficial materials in lower catchment may include Elk River valley-bottom alluvial sediments • Consistent surface discharge in most years
Lines of Evidence	☒ Surface water level and flow monitoring data ☒ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☐ Field studies: pumping tests ☐ Field studies: flow accretion ☐ Field studies: groundwater monitoring data (levels, quality) ☐ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☒ Catchment water balance / water budget ☐ Analytical estimate of groundwater flow ☐ Numerical groundwater modelling
Groundwater Flow Estimates	• Estimated to be >80% of total catchment yield at certain times of year • Expected to be much lower (i.e., negligible) at potential intake location placed in upper tributary
Groundwater Flow Value in 2020 RWQM	• 80% of total simulated catchment flow, up to a maximum of 5,000 m^3/d
Notes	• Estimates in the 2020 RWQM are based on a catchment water balance, and comparisons between modelled total flows and monitored flows.

3.6 Greenhills Creek

Explicit representation of the partitioning of total flow into surface water and groundwater components was implemented at the Greenhills Creek Sediment Pond Decant (GH_GH1, E102709). It was informed by the information outlined in SNC (2021b). The values used to define the division of total flow into surface and subsurface components at this location, along with a summary of the supporting lines of evidence, are summarized in Table B-7.

Table B-7: Surface Water – Groundwater Partitioning at Greenhills Creek Sediment Pond Decant (GH_GH1, E102709)

Category	Information
Location	• Greenhills Creek Sediment Pond Decant (GH_GH1, E102709)
Contributing Sub-catchments	• Greenhills Creek North, Greenhills Creek South
Setting	• Sediment pond decant in valley-fill alluvial sediments (Greenhills Creek alluvial fan) • Fording River valley-fill sediments are thick near the confluence of Greenhills Creek • Consistent surface water discharge
Lines of Evidence	☒ Surface water level and flow monitoring data ☒ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☐ Field studies: pumping tests ☒ Field studies: flow accretion ☒ Field studies: groundwater monitoring data (levels, quality) ☐ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☒ Catchment water balance / water budget ☒ Analytical estimate of groundwater flow ☐ Numerical groundwater modelling
Groundwater Flow Estimates	• Estimated to be between 500 to 6,000 m^3/d
Groundwater Flow Value in 2020 RWQM	• 30% of total simulated catchment flow, up to a maximum of 6,000 m^3/d
Notes	• Constituent concentrations in groundwater are typically lower than in surface water, which indicates load partitioning does not match flow partitioning (less mine-affected water in the subsurface than would otherwise be expected).

3.7 LCO Dry Creek

Explicit representation of the partitioning of total flow into surface water and groundwater components was implemented at three locations in the LCO Dry Creek catchment:

- upstream of East Tributary Creek (LC_DC3, E288273)
- mouth of East Tributary of Dry Creek (LC_DCEF, E288274)
- mouth of LCO Dry Creek (at bridge) (LC_DC1, E288270)

It was informed by the information outlined in Golder (2016). The values used to define the division of total flow into surface and subsurface components at each location, along with a summary of the supporting lines of evidence, are summarized in Tables B-8, B-9 and B-10.

Table B-1: Surface Water – Groundwater Partitioning at LCO Dry Creek upstream of East Tributary Creek (LC_DC3, E288273)

Category	Information
Location	• LCO Dry Creek upstream of East Tributary Creek (LC_DC3, E288273)
Contributing Sub-catchments	• Upper LCO Dry Creek
Setting	• Located in upper tributary in area underlain by colluvium and highly consolidated basal till • In an area of groundwater upwelling (vertically upward gradients) • Consistent discharge year-round
Lines of Evidence	☒ Surface water level and flow monitoring data ☒ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☒ Field studies: pumping test ☒ Field studies: flow accretion ☒ Field studies: groundwater monitoring data (level, quality) ☒ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☐ Catchment water balance / water budget ☒ Analytical estimate of groundwater flow ☒ Numerical groundwater modelling
Groundwater Flow Estimates	• Estimated at 1 to 10 m^3/d
Groundwater Flow Value in 2020 RWQM	• 0% of total simulated catchment flow
Notes	• The estimate is supported by flow and water quality monitoring to date.

Table B-2: Surface Water – Groundwater Partitioning Mouth of East Tributary of LCO Dry Creek (E288274)

Category	Information
Location	• Mouth of East Tributary of LCO Dry Creek (E288274)
Contributing Sub-catchments	• East Tributary of LCO Dry Creek
Setting	• Underlying alluvial sediments • Surface water discharge is not observed year-round (channel goes dry)
Lines of Evidence	☒ Surface water level and flow monitoring data ☒ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☐ Field studies: pumping test ☒ Field studies: flow accretion ☐ Field studies: groundwater monitoring data (level, quality) ☐ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☐ Catchment water balance / water budget ☐ Analytical estimate of groundwater flow ☐ Numerical groundwater modelling
Groundwater Flow Estimates	• Estimated to be majority of catchment runoff
Groundwater Flow Value in 2020 RWQM	• 80% of total simulated catchment flow, up to a maximum of 69,120 m^3/d
Notes	• Developed from field observations, most notably flow and load accretion studies.

Table B-3: Surface Water – Groundwater Partitioning at LCO Dry Creek near the Mouth (at bridge) (E288270)

Category	Information
Location	• LCO Dry Creek near the Mouth (at bridge) (E288270)
Contributing Sub-catchments	• Upper LCO Dry Creek, East Tributary of LCO Dry Creek, Lower LCO Dry Creek (to LC_DC4), Lower LCO Dry Creek (to LC_DC1)
Setting	• Sample site located in a losing reach in the tributary valley-bottom • In proximity to the Fording River valley-bottom alluvial sediments • Surface discharge year-round in most years
Lines of Evidence	☒ Surface water level and flow monitoring data ☒ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☐ Field studies: pumping test ☒ Field studies: flow accretion ☐ Field studies: groundwater monitoring data (level, quality) ☐ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☒ Catchment water balance / water budget ☐ Analytical estimate of groundwater flow ☐ Numerical groundwater modelling
Groundwater Flow Estimates	• Estimated at 35% of total flow
Groundwater Flow Value in 2020 RWQM	• 50% of total simulated catchment flow, up to a maximum of 8,000 m^3/d
Notes	• Flow and load accretion studies between LC_DCEF and LC_DC1 confirm the presence of a losing reach between LC_DC4 and LC_DC1.

3.8 West Line Creek

Explicit representation of the partitioning of total flow into surface water and groundwater components was implemented at West Line Creek (LC_WLC, E261958). It was informed by the information outlined in SNC (2021c). The values used to define the division of total flow into surface and subsurface components at this location, along with a summary of the supporting lines of evidence, are summarized in Table B-11.

Table B-4: Surface Water – Groundwater Partitioning at West Line Creek (LC_WLC, E261958)

Category	Information
Location	• West Line Creek (LC_WLC, E261958)
Contributing Sub-catchments	• West Line Creek
Setting	• Open channel located downstream of a waste rock spoil • Underlying material consists of heterogeneous alluvial aquifer composed of interbedded glaciofluvial and glaciolacustrine deposits and till • Consistent year-round discharge
Lines of Evidence	☒ Surface water level and flow monitoring data ☒ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☐ Field studies: pumping test ☐ Field studies: flow accretion ☒ Field studies: groundwater monitoring data (level, quality) ☒ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☒ Catchment water balance / water budget ☒ Analytical estimate of groundwater flow ☐ Numerical groundwater modelling
Groundwater Flow Estimates	• Best estimate is between 640 and 1,920 m^3/d
Groundwater Flow Value in 2020 RWQM	• 60% of total simulated catchment flow, up to a maximum of 10,000 m^3/d
Notes	• Constituent concentrations in groundwater are typically lower than in surface water, which indicates load partitioning does not match flow partitioning (less mine-affected water in the subsurface than would otherwise be expected). • Inclusion of groundwater – surface water partitioning helps to address discrepancy in previous calibrations of the RWQM • Upper limit used in RWQM informed by model calibration

3.9 EVO Dry Creek

Explicit representation of the partitioning of total flow into surface water and groundwater components was implemented at EVO Dry Creek Sediment Pond Decant (E298590). It was informed by the information outlined in Lorax (2019). The values used to define the division of total flow into surface and subsurface components at this location, along with a summary of the supporting lines of evidence, are summarized in Table B-12

Table B-5: Surface Water – Groundwater Partitioning at EVO Dry Creek Sediment Pond Decant (E298590)

Category	Information
Location	• EVO Dry Creek Sediment Pond Decant (E298590)
Contributing Sub-catchments	• EVO Dry Creek; Breaker Lake (some historical pumping)
Setting	• Sediment pond decant located downstream of a waste rock spoil in the headwaters of the catchment, and located just upstream of confluence with Upper Harmer Creek • Thin overburden materials and presence of bedrock outcrops upstream of the sediment pond. • Consistent surface discharge year-round
Lines of Evidence	☒ Surface water level and flow monitoring data ☒ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☐ Field studies: pumping test ☒ Field studies: flow accretion ☐ Field studies: groundwater monitoring data (level, quality) ☐ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☒ Catchment water balance / water budget ☐ Analytical estimate of groundwater flow ☐ Numerical groundwater modelling
Groundwater Flow Estimates	• Estimated to be in the order of 10% of total runoff
Groundwater Flow Value in 2020 RWQM	• When total flow < 20,000 m^3/d, 100% to bypass to a max of 2,000 m^3/d • When total flow > 20,000 m^3/d, then 10% to bypass to a max of 5,000 m^3/d
Notes	• Formulas used in 2020 RWQM acknowledge preference for water to go to ground and provide a gradual transition in groundwater flow as one moves from lower to higher flow conditions. • Developed from field observations, most notably flow and load accretion studies.

3.10 Harmer Creek

Explicit representation of the partitioning of total flow into surface water and groundwater components was implemented at EVO Dry Creek Sediment Pond Decant (E298590). It was informed by the information outlined in Lorax (2019). The values used to define the division of total flow into surface and subsurface components at this location, along with a summary of the supporting lines of evidence, are summarized in Table B-13.

Table B-6: Surface Water – Groundwater Partitioning at the EVO Harmer Creek Compliance Point – Harmer Spillway (E102682)

Category	Information
Location	• EVO Harmer Creek Compliance Point – Harmer Spillway (E102682)
Contributing Sub-catchments	• EVO Dry Creek, Harmer Creek above EVO Dry Creek, Harmer Creek below EVO Dry Creek
Setting	• Spillway of a dam, with some leakage of flow at hydrometric station • Valley-bottom sediments • Consistent surface discharge year-round
Lines of Evidence	☒ Surface water level and flow monitoring data ☒ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☐ Field studies: pumping test ☒ Field studies: flow accretion ☐ Field studies: groundwater monitoring data (level, quality) ☐ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☒ Catchment water balance / water budget ☐ Analytical estimate of groundwater flow ☐ Numerical groundwater modelling
Groundwater Flow Estimates	• Estimated to be in the order of 6% of total runoff
Groundwater Flow Value in 2020 RWQM	• 5% of total simulated catchment flow, up to a maximum of 5,000 m^3/d
Notes	• Developed from field observations, most notably flow and load accretion studies. • Same surface water – groundwater partitioning assumed at mouth of Grave Creek

3.11 Erickson Creek

3.11.1 Flow Monitoring Station

Explicit representation of the partitioning of total flow into surface water and groundwater components was implemented at the monitoring station located at the mouth of Erickson Creek (EV_EC1, 0200097). It was informed by the information outlined in Teck (2020). The values used to define the division of total flow into surface and subsurface components at this location, along with a summary of the supporting lines of evidence, are summarized in Table B-14. Water balance uncertainty in this catchment is acknowledged and will be addressed through the execution of the work plan that is being submitted to the Director on March 31, 2021, as required under the *Environmental Management Act* Permit 107517.

Table B-14: Surface Water – Groundwater Partitioning at Mouth of Erickson Creek (0200097)

Category	Information
Location	• Erickson Creek at Mouth (0200097)
Contributing Sub-catchments	• Upper Erickson Creek, Erickson Creek at Bridge, Adit Ridge Pit and Lower Erickson Creek
Setting	• Monitoring at spillway near the confluence with Michel Creek • Located upstream of Michel Creek valley-fill sediments. • Consistent surface discharge year-round
Lines of Evidence	☒ Surface water level and flow monitoring data ☒ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☐ Field studies: pumping tests ☒ Field studies: flow accretion ☐ Field studies: groundwater monitoring data (levels, quality) ☐ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☒ Catchment water balance / water budget ☐ Analytical estimate of groundwater flow ☐ Numerical groundwater modelling
Groundwater Flow Estimates	• Estimated to be in the order of 10 to 15% of total runoff
Groundwater Flow Value in 2020 RWQM	• 15% of total simulated catchment flow, up to a maximum of 34,600 m^3/d
Notes	• Groundwater modelling activities have so far been primarily focused on the upstream intake location. • Groundwater estimates at this location developed primarily from flow accretion studies.

3.11.2 Intake Location

Explicit representation of the partitioning of total flow into surface water and groundwater components was implemented at the monitoring station located at the Erickson Creek Intake (EV_ECBridge) to the EVO Saturated Rockfill Treatment Facility (SRF). It was informed by the information outlined in Teck (2020). The values used to define the division of total flow into surface and subsurface components at this location, along with a summary of the supporting lines of evidence, are summarized in Table B-15.

Table B-15: Surface Water – Groundwater Partitioning at the Erickson Creek Intake

Category	Information
Location	• Erickson Creek Intake (EV_ECBridge)
Contributing Sub-catchments	• Upper Erickson Creek, Erickson Creek at Bridge, Adit Ridge Pit
Setting	• Gaining reach located downstream of waste rock spoil • Surficial materials comprise a thin layer of sand overlaying low permeability till • Consistent surface discharge year-round
Lines of Evidence	☒ Surface water level and flow monitoring data ☒ Surface water quality monitoring data ☒ Conceptual groundwater model / 3D visualization ☒ Field studies: pumping tests ☒ Field studies: flow accretion ☒ Field studies: groundwater monitoring data (levels, quality) ☒ Field studies: geophysical surveys ☐ Field studies: sediment sampling from ponds ☒ Catchment water balance / water budget ☒ Analytical estimate of groundwater flow ☒ Numerical groundwater modelling
Groundwater Flow Estimates	• Negligible partitioning of mine-influenced flow into the subsurface
Groundwater Flow Value in 2020 RWQM	• Currently described using water availability assumptions, which are set as per the EVO SRF Application (Teck 2020)

SRF: saturated rockfill; EVO: Elkview Operations.

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Appendix C

Statistical Test Descriptions

2020 Elk Valley Regional Water Quality Model Update – Appendix C of Annex B

Statistical Test Descriptions

Rev1

May 2022

Teck

Contents

1 Nash-Sutcliffe Efficiency (E)

$$E = 1 - \frac{\sum_{i=1}^{n} (O_i - P_i)^2}{\sum_{i=1}^{n} (O_i - \bar{O})^2}$$

Nash and Sutcliffe [1970] Eq. 5.1

Where: O_i = measured data, P_i = simulated (predicted) data, $\bar{O}$ = mean of measured data.

The range of *E* lies between 1.0 (perfect fit) and minus infinity (-∞). An *E* = 0.0 indicates that the square of the differences between the model simulations and the observations is as large as the variability in the measured data. In other words, the measured mean is as good a predictor as the model. An *E* <0.0 indicates that the mean for the measured dataset is a better predictor than the model. An *E* >0.0 indicates that the model is a better predictor than the mean of the measured dataset.

The Nash-Sutcliffe efficiency statistic has been widely used to evaluate the performance of hydrologic models and represents an improvement over the coefficient of determination (Legates and McCabe 1999). The largest disadvantage of the Nash-Sutcliffe efficiency is that differences between observed and predicted values are calculated as squared values. Larger values in a time series therefore strongly influence *E*, while lower values have much less influence (Legates and McCabe 1999). In addition, the Nash-Sutcliffe Efficiency is not overly sensitive to systematic model over- or underprediction, especially during low flow periods (Krause et.al. 2005).

2 Index of Agreement (d)

$$d = 1 - \frac{\sum_{i=1}^{n} (O_i - P_i)^2}{\sum_{i=1}^{n} \left(\left|P_i - \bar{O}\right| + \left|O_i - \bar{O}\right|\right)^2}$$

Willmott [1981] Eq. 5.2

Where: O_i = measured data, P_i = simulated (predicted) data, $\bar{O}$ = mean of measured data.

The Index of Agreement ranges from 0 (no correlation) to 1 (perfect fit). Practical applications of *d* show that the technique has some disadvantages, namely:

- relatively high values (more than 0.65) of *d* may be obtained even for poor model fits, leaving only a narrow range for model calibration
- despite Willmot's intention, *d* is not sensitive to systematic model over- or under-prediction (Krause et.al. 2005)

3 Modified forms of E and d

$$E_j = 1 - \frac{\sum_{i=1}^{n} |O_i - P_i|^j}{\sum_{i=1}^{n} \left|O_i - \bar{O}\right|^j} \text{ with } j \in \mathrm{N}$$

Willmott et.al. [1985] Eq. 5.3

$$d_j = 1 - \frac{\sum_{i=1}^{n} |O_i - P_i|^j}{\sum_{i=1}^{n} \left(\left|P_i - \bar{O}\right| + \left|O_i - \bar{O}\right|\right)^j} \text{ with } j \in \mathrm{N}$$

Where: O_i = measured data, P_i = simulated (predicted) data, $\bar{O}$ = mean of measured data, $|X\text{-}Y|$ = absolute value.

The modified index of agreement (d_1) and modified coefficient of efficiency (E_1) are produced from the above equations where j=1. The advantage of these modified forms is that errors and differences are given their appropriate weighting and not inflated by their squared value (i.e., the overweighting of the flood peaks is reduced, resulting in a better overall evaluation). In practice, $d_2 > d_1$ for the range of most values, although this relationship does not hold for extremely low values of both statistics (Legates and McCabe 1999).

4 Root Mean Square Error (RMSE) and Mean Absolute Error (MAE)

$$\mathrm{RMSE} = \sqrt{N^{-1} \sum_{i=1}^{N} (O_i - P_i)^2}$$

Eq. 5.4

$$\mathrm{MAE} = N^{-1} \sum_{i=1}^{N} |O_i - P_i|$$

Where: O_i = measured data, P_i = modelled (predicted) data.

The root mean square error, RMSE, and mean absolute error, MAE, are well-accepted absolute error goodness-of-fit indicators that describe differences in measured and predicted values in the appropriate units (Legates and McCabe 1999).

5 Coefficient of Determination (R2)

$$r^2 = \left(\frac{\sum_{i=1}^{n} (O_i - \bar{O})(P_i - \bar{P})}{\sqrt{\sum_{i=1}^{n} (O_i - \bar{O})^2} \sqrt{\sum_{i=1}^{n} (P_i - \bar{P})^2}} \right)^2 \qquad \text{Eq. 5.5}$$

Where: O_i = measured data, P_i = simulated (predicted) data, $\bar{O}$ = mean of measured data, $\bar{P}$ = mean of simulated data.

The coefficient of determination describes the proportion of the total variance in the measured data that can be explained by the model. It ranges from 0 to 1, with higher values indicating better agreement.

The coefficient of determination technique is limited in that it only evaluates linear relationships between the variables and is insensitive to additive and proportional differences (Legates and McCabe 1999). Correlation-based measures are also more sensitive to outliers than to measurements near the mean (Legates and Davis 1997). The fact that only the dispersion is quantified is one major drawbacks of r^2 if it is considered alone (Krause et.al. 2005).

Appendix D

Model Performance Output Summary

2020 Elk Valley Regional Water Quality Model Update – Appendix D of Annex B

Model Performance Output Summary

Rev1

May 2022

Teck

Contents

Tables

1 Introduction - Model Performance Output Summaries

The following pages contain a series of sheets with model performance results, presented in the order listed in Table D-1.

Table D-1: List of Stations and Period of Record Shown in the Model Performance Output Summaries

ID	Category	Node ID	Node Description	Period Shown	
				From	To
1	Fording River and Mine Influenced	FR_HC1	Henretta Creek upstream of Fording River (E216778)	2004	2018
2		FR_CC1	Decant from Clode Sediment Pond (E102481)	2004	2018
3		FR_FRNTP	Fording River at North Tailings Pond	2004	2018
4		GH_SC1	Swift Creek Sediment Pond Decant (E221329)	2004	2018
5		GH_SC2	Swift Creek Sediment Pond Bypass (E105061)	2004	2018
6		FR_KC1	Kilmarnock Creek downstream of Rock Drain (0200252)	2004	2018
7		GH_CC1	Cataract Creek Sediment Pond Decant (0200384)	2004	2018
8		FR_FRCP1	FRO Compliance Point - Fording River, 525 m d/s of Cataract Creek (E300071)	2004	2018
9		FR_UFR1	Fording River upstream of Henretta Creek	2004	2018
10		FR_LMP1	Lake Mountain Sediment Pond Decant	2004	2018
11		FR_LP1	Liverpool Sediment Pond Decant	2004	2018
12		FR_FR1	Fording River downstream of Henretta Creek (0200251)	2004	2018
13		FR_FR2	Fording River upstream of Kilmarnock Creek (0200201)	2004	2018
14		FR_FR4	Fording River between Swift and Cataract creeks (0200311)	2004	2018

Table D-1: List of Stations and Period of Record Shown in the Model Performance Output Summaries

ID	Category	Node ID	Node Description	Period Shown	
				From	To
15		FR_FRABCH	Fording River above Chauncey Creek	2004	2018
16		GH_PC1	Porter Creek Sediment Pond Decant (0200385)	2004	2018
17		GH_TC1	Thompson Creek at LRP Road (E102714)	2004	2018
18		GH_TC2	Lower Thompson Creek Sediment Pond Decant (E207436)	2004	2018
19		GH_GH1	Greenhills Creek Sediment Pond Decant (E102709)	2004	2018
20		GH_FR1	GHO Fording River Compliance Point - Upper Fording River, 205 m d/s of Greenhills Creek (0200378)	2004	2018
21		GH_LC1	Leask Creek Sediment Pond Decant (E257796)	2004	2018
22		GH_LC2	Leask Creek u/s of Pond Inlet	2004	2018
23		GH_WC1	Wolfram Creek Sediment Pond Decant (E257795)	2004	2018
24		GH_WC2	Wolfram Creek u/s Pond Inflow	2004	2018
25		LC_LC5	Fording River downstream of Line Creek (0200028)	2004	2018
26		LC_LC4	Line Creek upstream of Process Plant (0200044) (near the mouth)	2004	2018
27		LC_LC1	Upper Line Creek upstream of MSA North Pit (E126142)	2004	2018
28		LC_WLC	West Line Creek (E261958)	2004	2018
29		LC_LC3	Line Creek downstream of West Line Creek (0200337)	2004	2018
30		LC_DC3	LCO Dry Creek upstream of East Tributary Creek (E288273)	2004	2018

Table D-1: List of Stations and Period of Record Shown in the Model Performance Output Summaries

ID	Category	Node ID	Node Description	Period Shown	
				From	To
31		LC_DCEF	East Tributary of LCO Dry Creek (E288274)	2004	2018
32		LC_DC1	LCO Dry Creek near the Mouth (at bridge) (E288270)	2004	2018
33		LC_DCDS	LCO Dry Creek d/s of Sedimentation Ponds (E295210)	2004	2018
34		LC_LCUSWLC	Line Creek u/s of West Line Creek (E293369)	2004	2018
35		LC_LCDSSLCC	LCO Compliance Point - Line Creek immediately downstream of South Line Creek confluence (E297110)	2004	2018
36		EV_GT1	Gate Creek Sediment Pond Decant (E206231)	2004	2018
37		EV_BC1	Bodie Creek Sediment Pond Decant (E102685)	2004	2018
38		EV_DC1	EVO Dry Creek Sediment Pond Decant (E298590)	2004	2018
39		EV_HC1	EVO Harmer Compliance Point – Harmer Spillway (E102682)	2004	2018
40		EV_GV1	Grave Creek at Bridge (near the mouth)	2004	2018
41		EV_EC1	Erickson Creek at Mouth (0200097)	2004	2018
42	Michel Creek (mainstem)	EV_MC2	EVO Michel Creek Compliance Point - Michel Creek at Hwy 3 Bridge (E300091)	2004	2018
43		EV_MC3	Michel Creek upstream of Erickson Creek (0200203)	2004	2018
44	Elk River (mainstem)	GH_ER1	Elk River u/s of Boivin Creek (u/s of Fording River) (E206661)	2004	2018
45		EV_ER4	Elk River u/s of Grave Creek (from Fording River to Michel Creek) (0200389)	2004	2018

Table D-1: List of Stations and Period of Record Shown in the Model Performance Output Summaries

ID	Category	Node ID	Node Description	Period Shown	
				From	To
46		EV_ER1	Elk River downstream of Michel Creek (0200393)	2004	2018
47		RG_ELKORE	Elk River at Elko Reservoir (E294312)	2004	2018
48		GH_ERC	GHO Elk River Compliance Point - Elk River, 220 m d/s of Thompson Creek (E300090)	2004	2018

The following details are included on the top left of each sheet:

- details of results being compared (i.e., the 2017 RWQM [total flows], the 2020 RWQM [surface flows], 2020 RWQM [total flows] and monitoring data [surface flows])
- station information (Station ID, description, drainage area, disturbed area within the watershed, partitioning of surface and groundwater flow components);
- notes on flow modelling method;
- comparisons between the measured and modelled watershed yield.

The following plots are included on each sheet:

- time series plot of weekly flows (up to 2018);
- flow duration curves (also known as exceedance curves);
- mean annual hydrograph for concurrent data to show an accurate comparison between data series;
- bar chart of mean seasonal flows for concurrent data, with the seasons defined as Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) and Freshet (mid-April through mid-July));
- annual hydrograph for 2019 (for check against preliminary 2019 observed data)

The following statistical information is included on the bottom right of each sheet:

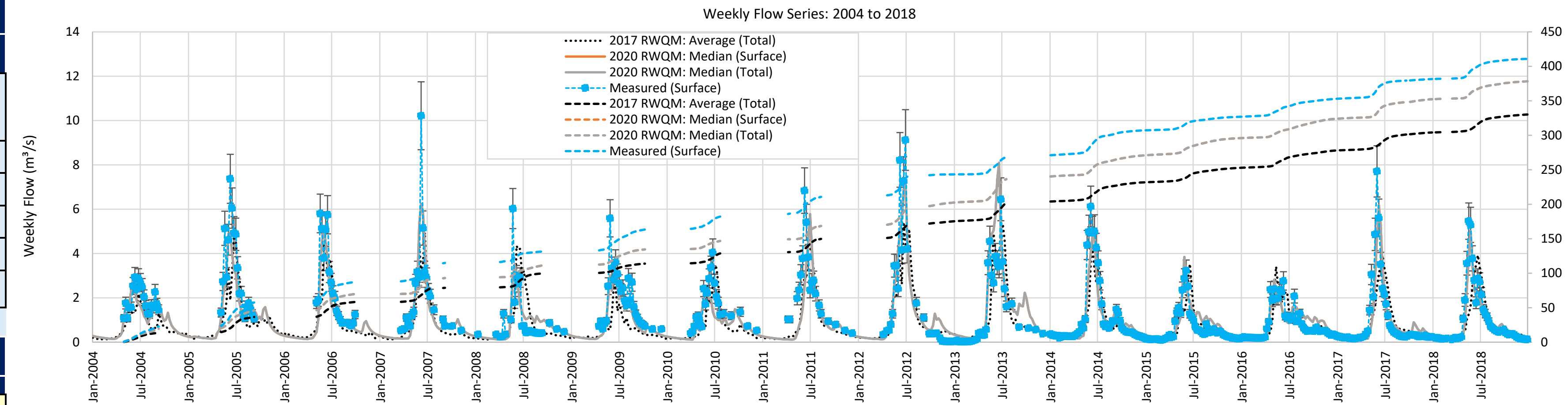
- Goodness-of-fit statistics for comparisons of monitored flows against modelled flows for the concurrent period of record for the 2017 RWQM, 2020 RWQM (surface flow), 2020 RWQM (total flow), including:
    - Nash Sutcliffe Efficiency
    - Modified Nash Sutcliffe Efficiency
    - Index of Agreement
    - Modified Index of Agreement
    - Mean Absolute Error (MAE);
    - Root Mean Square Error (RMSE)
    - Coefficient of Determination (R^2)
- Total weekly data points considered for the evaluation
- Approximate watershed yield for the 2017 RWQM, 2020 RWQM (surface flow), 2020 RWQM (total flow). This metric was calculated only when sufficient concurrent data were available for all weeks of the year.

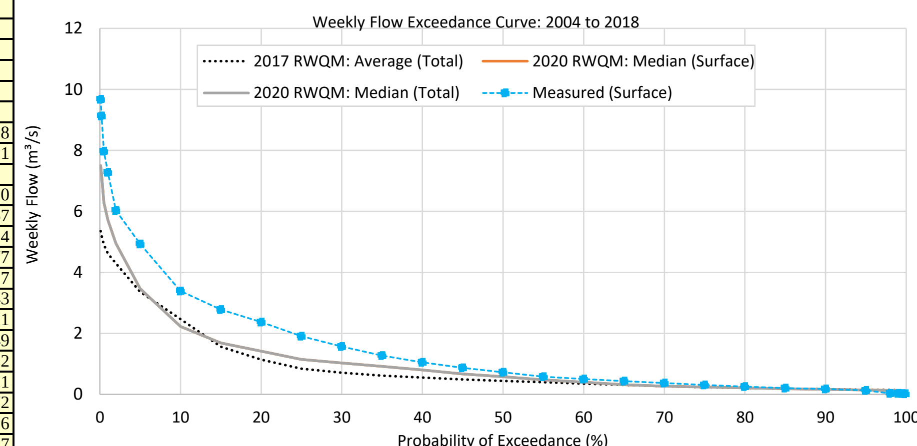
Explanatory notes are included on the bottom right of each sheet.

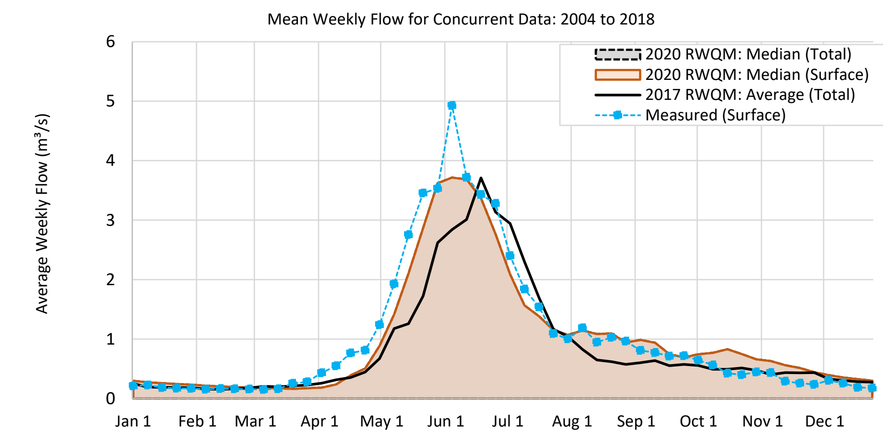
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

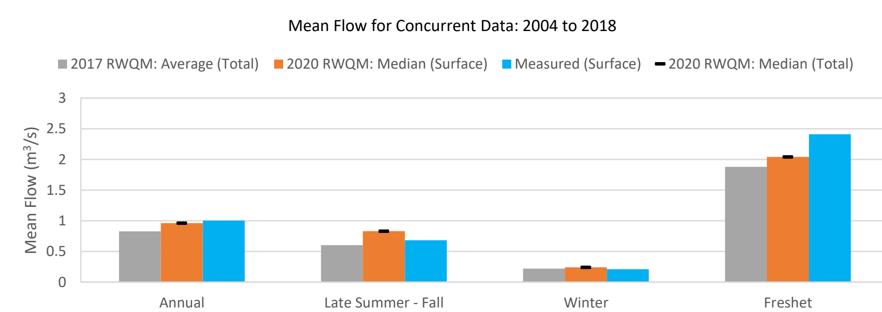
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchments of Henretta, McSlide, McDonald, McMillan and Moore creeks		**Surface-Groundwater Partitioning**	Not Implemented
Spinner ID	4	**Mean annual surface runoff (monitored)**		650
Selected Year	2019	**Mean annual total runoff (2020 RWQM)**		620
Comparison Start Year	2004	**Evaluation period (weeks)**		783
Comparison End Year	2018	**Weeks with monitoring data (%)**		63%
Station ID & Description	**FR_HC1**	**Henretta Creek upstream of Fording River (E216778)**		
Drainage Area (2018)	**4930 ha**	**Disturbed Area (2018)**		~ 9%

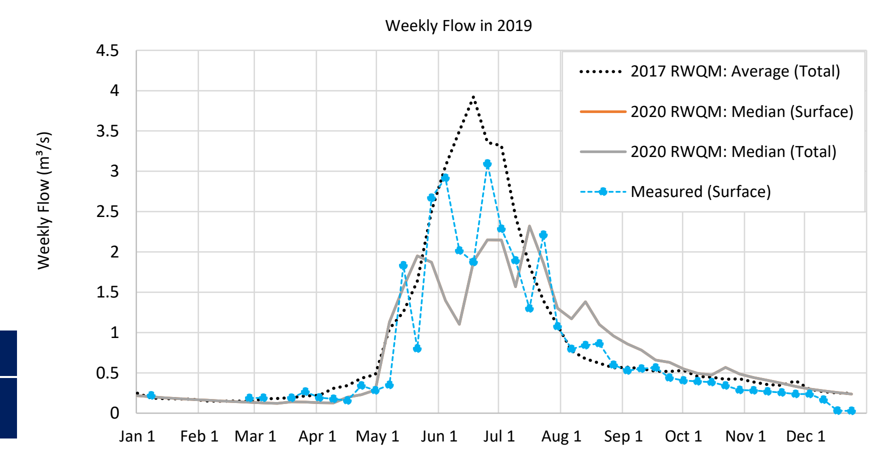
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.247	0.215	0.215	
2019-01-10	0.189	0.203	0.203	0.220
2019-01-17	0.180	0.191	0.191	
2019-01-24	0.178	0.180	0.180	
2019-01-31	0.173	0.170	0.170	
2019-02-07	0.150	0.160	0.160	
2019-02-14	0.149	0.151	0.151	
2019-02-21	0.151	0.143	0.143	
2019-02-28	0.146	0.135	0.135	0.188
2019-03-07	0.177	0.127	0.127	0.191
2019-03-14	0.183	0.122	0.122	
2019-03-21	0.194	0.142	0.142	0.190
2019-03-28	0.214	0.137	0.137	0.267
2019-04-04	0.221	0.131	0.131	0.194
2019-04-11	0.309	0.128	0.128	0.177
2019-04-18	0.341	0.198	0.198	0.157
2019-04-25	0.435	0.230	0.230	0.343
2019-05-02	0.478	0.287	0.287	0.281
2019-05-09	1.047	1.131	1.131	0.349
2019-05-16	1.256	1.564	1.564	1.832
2019-05-23	1.639	1.952	1.952	0.801
2019-05-30	2.506	1.873	1.873	2.672
2019-06-06	3.064	1.399	1.399	2.916
2019-06-13	3.499	1.102	1.102	2.017
2019-06-20	3.923	1.883	1.883	1.875
2019-06-27	3.357	2.151	2.151	3.095
2019-07-04	3.319	2.148	2.148	2.285
2019-07-11	2.440	1.569	1.569	1.892
2019-07-18	1.825	2.321	2.321	1.299
2019-07-25	1.395	1.860	1.860	2.213
2019-08-01	1.088	1.302	1.302	1.075
2019-08-08	0.774	1.169	1.169	0.797
2019-08-15	0.674	1.383	1.383	0.842
2019-08-22	0.619	1.100	1.100	0.863
2019-08-29	0.563	0.958	0.958	0.600
2019-09-05	0.570	0.857	0.857	0.529
2019-09-12	0.551	0.782	0.782	0.553
2019-09-19	0.520	0.660	0.660	0.565
2019-09-26	0.519	0.631	0.631	0.440
2019-10-03	0.530	0.549	0.549	0.405
2019-10-10	0.456	0.494	0.494	0.396
2019-10-17	0.447	0.473	0.473	0.385
2019-10-24	0.421	0.568	0.568	0.343
2019-10-31	0.426	0.487	0.487	0.287
2019-11-07	0.388	0.442	0.442	0.282
2019-11-14	0.354	0.409	0.409	0.269
2019-11-21	0.345	0.372	0.372	0.256
2019-11-28	0.402	0.332	0.332	0.237
2019-12-05	0.297	0.301	0.301	0.237
2019-12-12	0.266	0.276	0.276	0.167
2019-12-19	0.250	0.255	0.255	0.029
2019-12-26	0.246	0.238	0.238	0.028
Annual	0.85	0.73	0.73	0.80
Late Summer - Fall	0.58	0.78	0.78	0.60
Winter	0.20	0.18	0.18	0.17
Freshet	1.96	1.33	1.33	1.47











Statistics on concurrent data: 2004 to 2018	Poor	Good		
Parameter	**2017 RWQM: Average (Total)**	**2020 RWQM: Median (Surface)**	**2020 RWQM: Median (Total)**	**Measured (Surface)**
Nash-Sutcliffe efficiency (E)	0.50	0.73	0.73	
Modified Nash-Sutcliffe efficiency (E1)	0.47	0.58	0.58	
Index of agreement (d)	0.82	0.92	0.92	
Modified index of agreement (d1)	0.72	0.77	0.77	
MAE	0.61	0.49	0.49	
RMSE	1.11	0.81	0.81	
Coefficient of Determination (R^2)	0.53	0.74	0.74	
Number of data in statistics	497	497	497	
Total number of weekly data	783	783	783	497
Mean of all weekly data	1.098	1.259	1.259	1.367
Standard deviation of all weekly data	1.175	1.355	1.355	1.573
Approximated mean annual runoff (mm/yr)	540	620	620	650

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

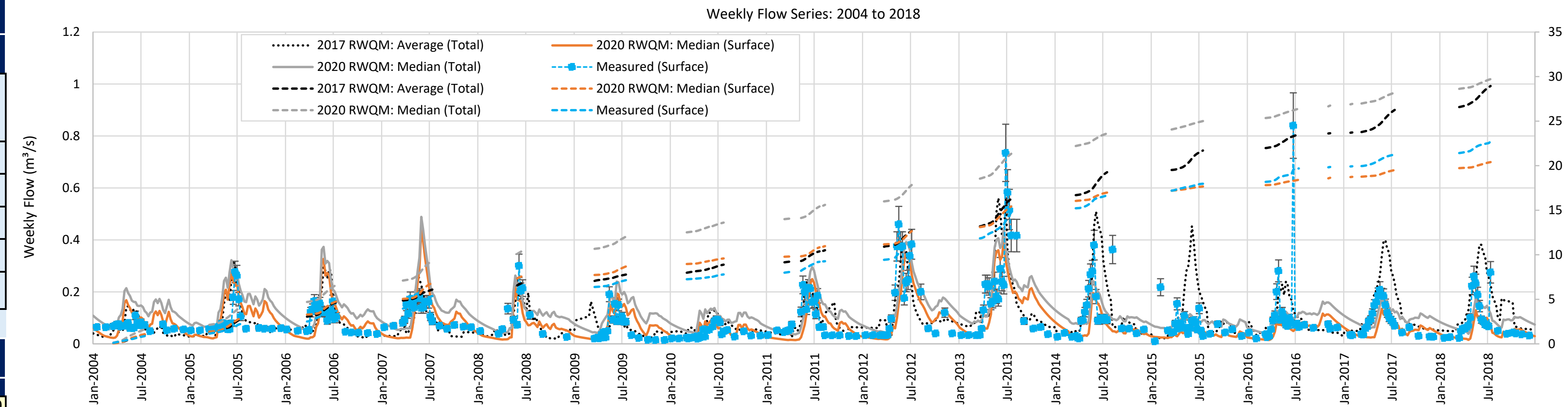
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

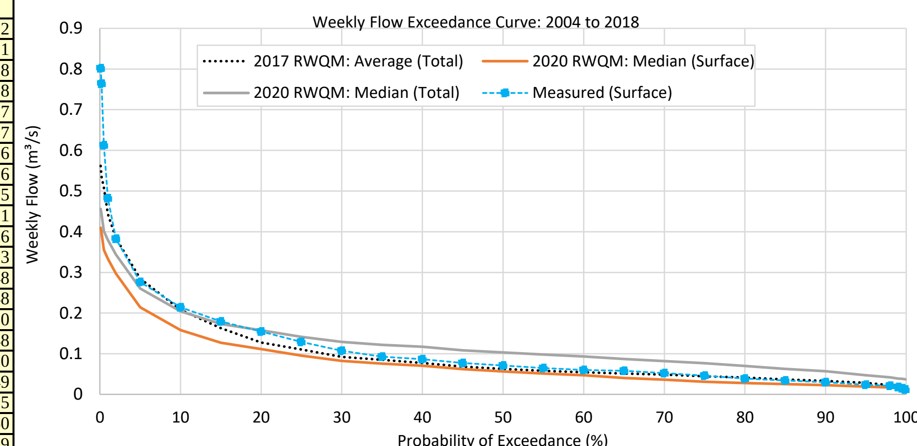
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

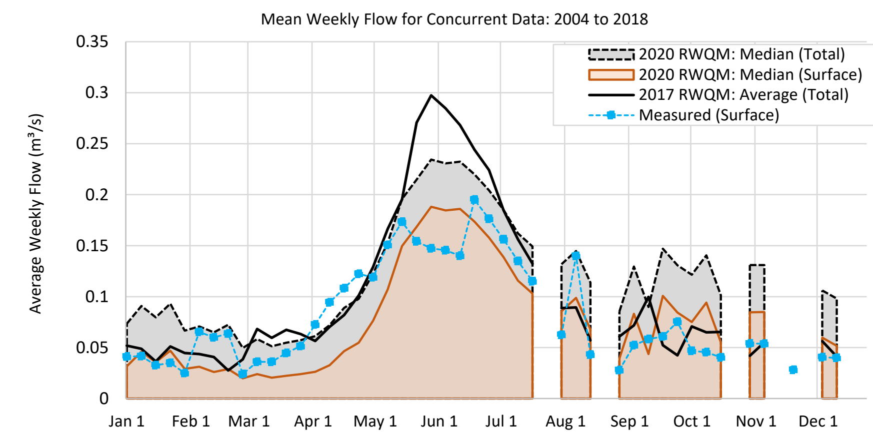
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

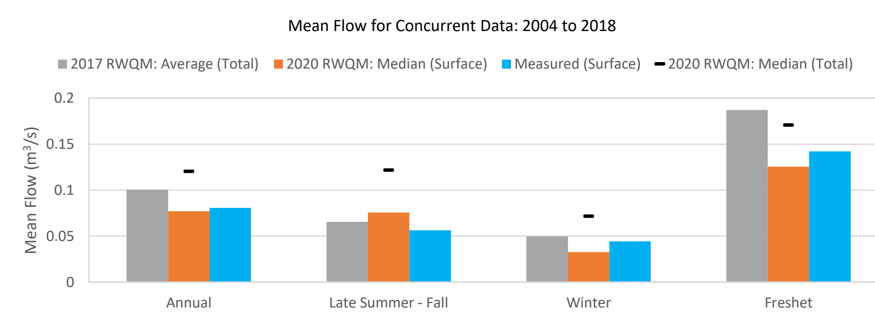
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module, Pit Module in sub-catchments of Clode Creek Upper, Clode Creek Lower, E6 to Clode, E6 West Pit, E4 Pit		Surface-Groundwater Partitioning	60%, maximum of 4,000 m3/d
Spinner ID	7	Mean annual surface runoff (monitored)		280
Selected Year	2019	Mean annual total runoff (2020 RWQM)		440
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		46%
Station ID & Description	FR_CC1	Clode Creek Sediment Pond Decant (E102481)		
Drainage Area (2018)	870 ha	Disturbed Area (2018)		~ 70%

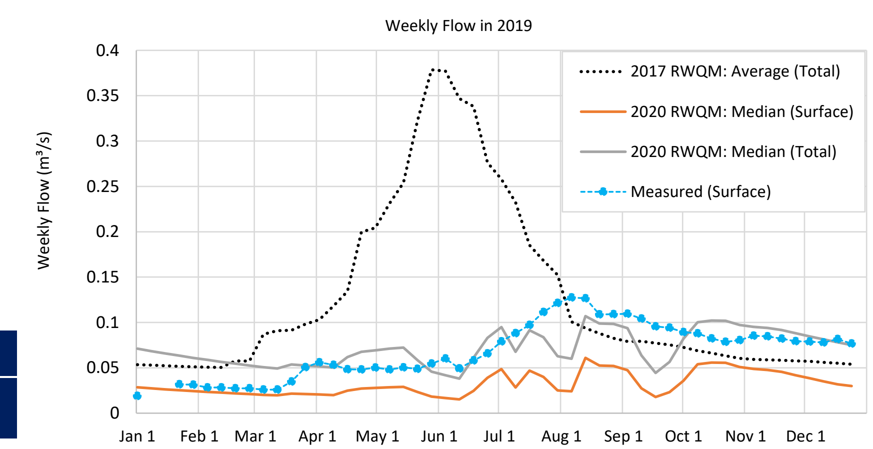
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.054	0.028	0.071	0.019
2019-01-10	0.053	0.027	0.068	
2019-01-17	0.052	0.026	0.066	
2019-01-24	0.052	0.025	0.063	0.032
2019-01-31	0.051	0.024	0.061	0.031
2019-02-07	0.051	0.024	0.059	0.028
2019-02-14	0.050	0.023	0.057	0.028
2019-02-21	0.058	0.022	0.055	0.027
2019-02-28	0.058	0.021	0.053	0.027
2019-03-07	0.087	0.020	0.051	0.026
2019-03-14	0.091	0.020	0.049	0.026
2019-03-21	0.091	0.021	0.054	0.035
2019-03-28	0.098	0.021	0.053	0.051
2019-04-04	0.103	0.021	0.052	0.056
2019-04-11	0.118	0.020	0.050	0.053
2019-04-18	0.134	0.025	0.062	0.048
2019-04-25	0.200	0.027	0.068	0.048
2019-05-02	0.204	0.028	0.069	0.050
2019-05-09	0.231	0.028	0.071	0.048
2019-05-16	0.254	0.029	0.072	0.050
2019-05-23	0.322	0.023	0.059	0.049
2019-05-30	0.379	0.018	0.046	0.055
2019-06-06	0.377	0.017	0.042	0.060
2019-06-13	0.347	0.015	0.038	0.049
2019-06-20	0.338	0.025	0.061	0.058
2019-06-27	0.276	0.039	0.083	0.066
2019-07-04	0.258	0.049	0.095	0.079
2019-07-11	0.232	0.028	0.068	0.088
2019-07-18	0.185	0.047	0.091	0.097
2019-07-25	0.168	0.040	0.084	0.112
2019-08-01	0.153	0.025	0.063	0.122
2019-08-08	0.101	0.024	0.060	0.128
2019-08-15	0.094	0.061	0.107	0.127
2019-08-22	0.088	0.053	0.099	0.109
2019-08-29	0.083	0.052	0.098	0.109
2019-09-05	0.079	0.048	0.094	0.110
2019-09-12	0.079	0.027	0.064	0.104
2019-09-19	0.077	0.018	0.044	0.096
2019-09-26	0.075	0.023	0.056	0.094
2019-10-03	0.073	0.036	0.082	0.089
2019-10-10	0.069	0.054	0.100	0.088
2019-10-17	0.066	0.056	0.102	0.082
2019-10-24	0.063	0.056	0.102	0.079
2019-10-31	0.060	0.051	0.097	0.080
2019-11-07	0.059	0.049	0.095	0.085
2019-11-14	0.059	0.048	0.094	0.085
2019-11-21	0.058	0.045	0.092	0.082
2019-11-28	0.058	0.042	0.088	0.079
2019-12-05	0.057	0.038	0.085	0.079
2019-12-12	0.056	0.035	0.081	0.078
2019-12-19	0.055	0.032	0.078	0.082
2019-12-26	0.054	0.030	0.075	0.077
Annual	0.13	0.03	0.07	0.07
Late Summer - Fall	0.08	0.04	0.09	0.10
Winter	0.07	0.03	0.06	0.04
Freshet	0.26	0.03	0.07	0.06











Statistics on concurrent data: 2004 to 2018	Poor	Poor but improved		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	-0.17	0.12	0.00	
Modified Nash-Sutcliffe efficiency (E1)	-0.02	0.12	-0.07	
Index of agreement (d)	0.68	0.68	0.66	
Modified index of agreement (d1)	0.54	0.56	0.44	
MAE	0.07	0.06	0.07	
RMSE	0.11	0.09	0.10	
Coefficient of Determination (R^2)	0.27	0.24	0.25	
Number of data in statistics	362	362	362	
Total number of weekly data	783	783	783	362
Mean of all weekly data	0.134	0.094	0.137	0.104
Standard deviation of all weekly data	0.111	0.083	0.086	0.100
Approximated mean annual runoff (mm/yr)	350	280	440	280

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

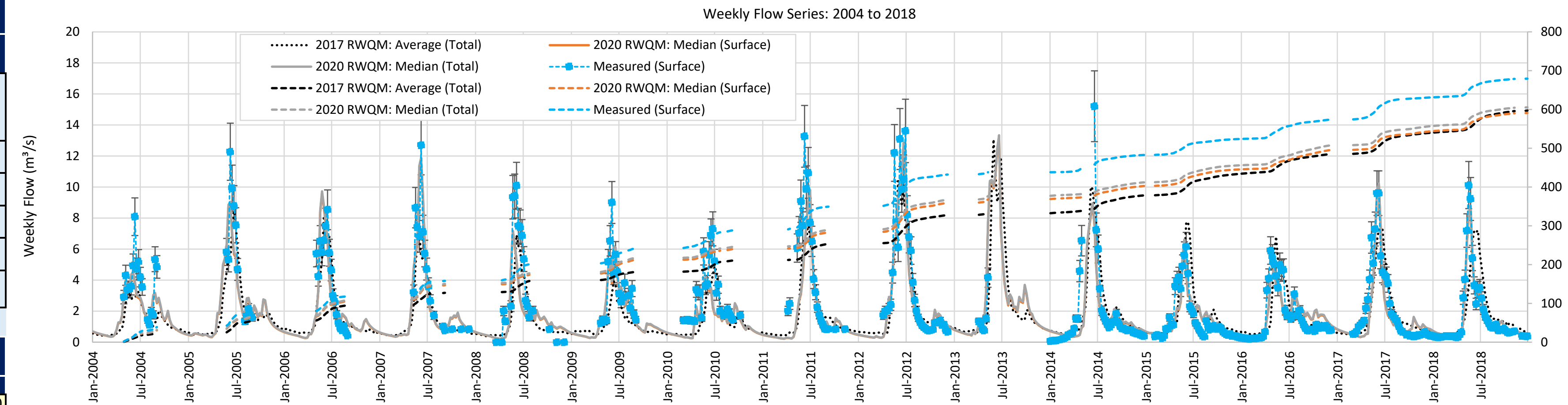
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

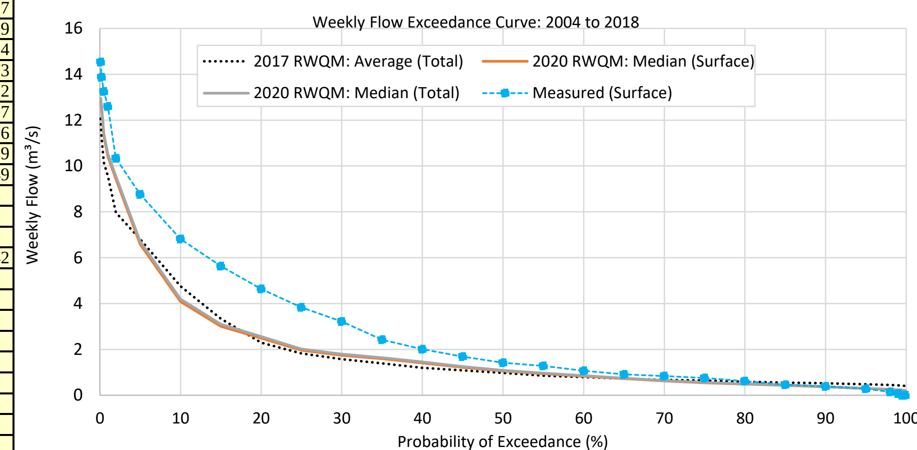
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

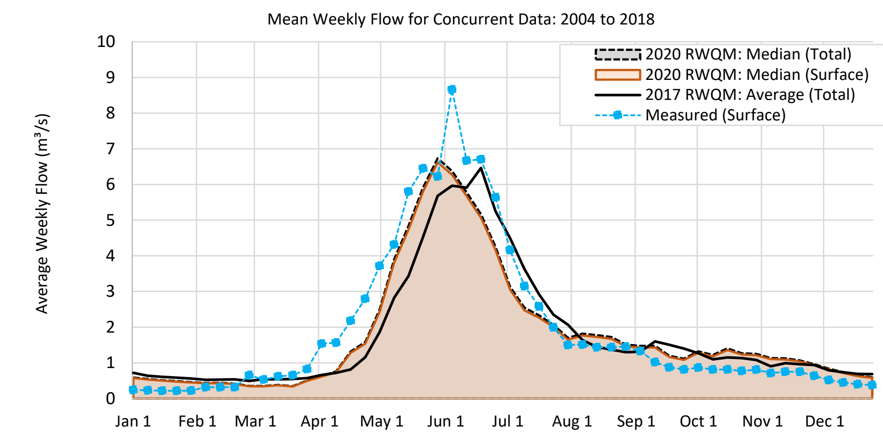
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

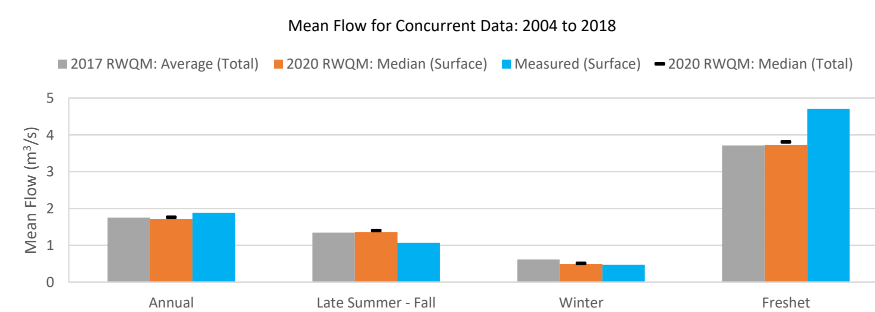
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	FR_FR1 + FR_PP1 + Turnbull Bridge Spoil + FR_CC1 + FR_LMP1 + FR_LP1 + FR_EC1 (Sum of modelled flows)		Surface-Groundwater Partitioning	3%, maximum of 10,000 m3/d
Spinner ID	15	Mean annual surface runoff (monitored)		480
Selected Year	2019	Mean annual total runoff (2020 RWQM)		450
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		54%
Station ID & Description	FR_FRNTP	Fording River at North Tailings Pond		
Drainage Area (2018)	12640 ha	Disturbed Area (2018)		~ 21%

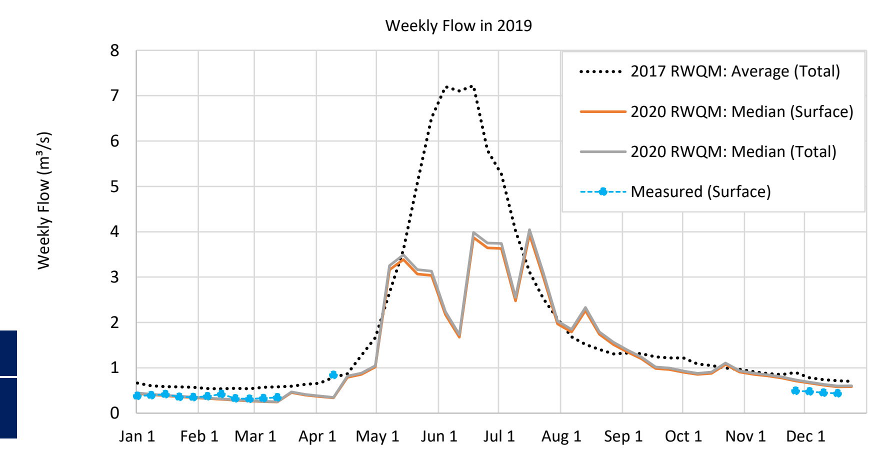
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m^3/s)	
2019-01-03	0.667	0.431	0.445	0.380
2019-01-10	0.602	0.407	0.420	0.396
2019-01-17	0.587	0.384	0.396	0.417
2019-01-24	0.580	0.362	0.373	0.359
2019-01-31	0.569	0.342	0.352	0.354
2019-02-07	0.542	0.323	0.333	0.373
2019-02-14	0.537	0.305	0.314	0.422
2019-02-21	0.548	0.288	0.297	0.327
2019-02-28	0.541	0.268	0.276	0.316
2019-03-07	0.571	0.253	0.260	0.329
2019-03-14	0.583	0.247	0.254	0.349
2019-03-21	0.593	0.454	0.468	
2019-03-28	0.638	0.400	0.413	
2019-04-04	0.661	0.367	0.379	
2019-04-11	0.791	0.336	0.347	0.842
2019-04-18	0.871	0.792	0.817	
2019-04-25	1.276	0.856	0.882	
2019-05-02	1.666	1.016	1.048	
2019-05-09	2.652	3.162	3.254	
2019-05-16	3.601	3.390	3.492	
2019-05-23	5.075	3.069	3.164	
2019-05-30	6.508	3.039	3.133	
2019-06-06	7.195	2.171	2.238	
2019-06-13	7.104	1.677	1.728	
2019-06-20	7.222	3.874	3.984	
2019-06-27	5.798	3.645	3.753	
2019-07-04	5.270	3.633	3.743	
2019-07-11	4.022	2.476	2.553	
2019-07-18	3.113	3.941	4.046	
2019-07-25	2.522	2.992	3.084	
2019-08-01	2.079	1.969	2.030	
2019-08-08	1.686	1.793	1.849	
2019-08-15	1.517	2.259	2.329	
2019-08-22	1.407	1.739	1.793	
2019-08-29	1.309	1.514	1.561	
2019-09-05	1.327	1.349	1.391	
2019-09-12	1.310	1.199	1.236	
2019-09-19	1.241	0.986	1.017	
2019-09-26	1.217	0.964	0.994	
2019-10-03	1.218	0.900	0.928	
2019-10-10	1.084	0.853	0.879	
2019-10-17	1.052	0.879	0.907	
2019-10-24	0.993	1.074	1.107	
2019-10-31	0.968	0.906	0.934	
2019-11-07	0.915	0.855	0.881	
2019-11-14	0.875	0.821	0.846	
2019-11-21	0.853	0.774	0.798	
2019-11-28	0.896	0.713	0.735	0.491
2019-12-05	0.782	0.664	0.684	0.478
2019-12-12	0.739	0.619	0.638	0.448
2019-12-19	0.714	0.580	0.598	0.436
2019-12-26	0.700	0.586	0.604	
Annual	1.88	1.32	1.37	0.42
Late Summer - Fall	1.29	1.29	1.33	0.49
Winter	0.62	0.40	0.42	0.38
Freshet	4.14	2.47	2.55	0.84











Statistics on concurrent data: 2004 to 2018	Acceptable	Good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.63	0.71	0.72	
Modified Nash-Sutcliffe efficiency (E1)	0.51	0.57	0.57	
Index of agreement (d)	0.87	0.91	0.91	
Modified index of agreement (d1)	0.73	0.77	0.77	
MAE	1.06	0.93	0.93	
RMSE	1.71	1.50	1.49	
Coefficient of Determination (R^2)	0.65	0.73	0.73	
Number of data in statistics	423	423	423	
Total number of weekly data	783	783	783	423
Mean of all weekly data	2.334	2.310	2.366	2.656
Standard deviation of all weekly data	2.136	2.302	2.333	2.816
Approximated mean annual runoff (mm/yr)	440	440	450	480

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

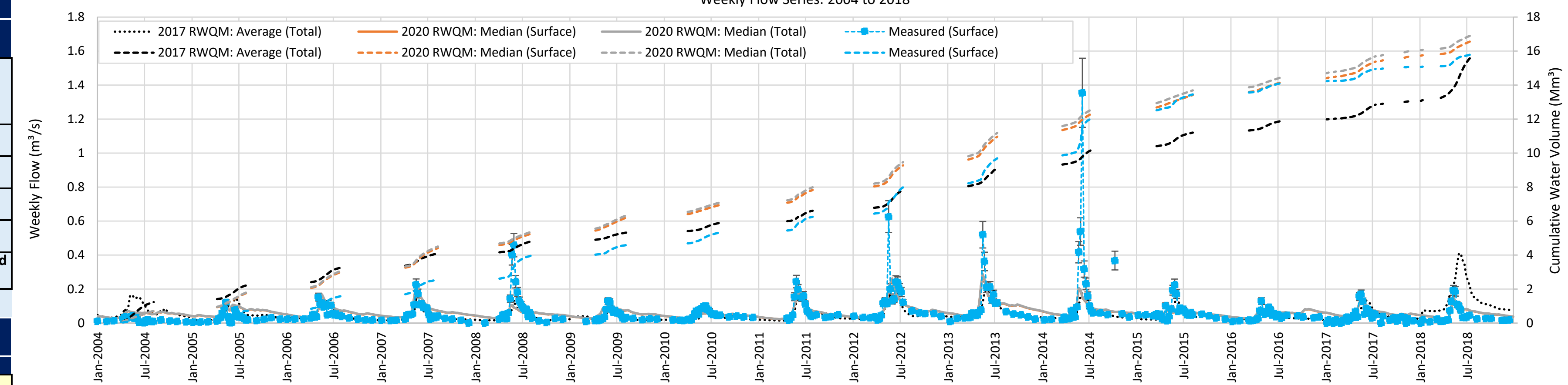
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

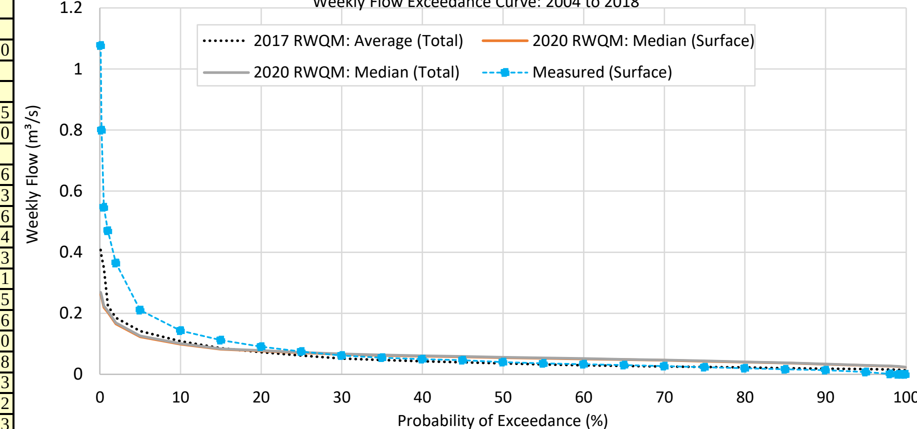
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module of sub-catchment Swift Spoil		Surface-Groundwater Partitioning	2%, maximum of 1,000 m3/d
Spinner ID	27	Mean annual surface runoff (monitored)		300
Selected Year	2019	Mean annual total runoff (2020 RWQM)		400
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		49%
Station ID & Description	GH_SC1_GH_SC2	Swift Creek Sediment Pond Decant (E221329) / Swift Creek Sediment Pond Bypass (E105061		
Drainage Area (2018)	510 ha	Disturbed Area (2018)		~ 75%

Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m^3/s)	
2019-01-03	0.074	0.036	0.037	
2019-01-10	0.073	0.035	0.035	0.000
2019-01-17	0.072	0.034	0.034	0.015
2019-01-24	0.071	0.032	0.033	
2019-01-31	0.071	0.031	0.032	
2019-02-07	0.070	0.030	0.031	0.000
2019-02-14	0.070	0.029	0.030	
2019-02-21	0.069	0.028	0.029	
2019-02-28	0.069	0.027	0.028	0.035
2019-03-07	0.069	0.027	0.027	0.010
2019-03-14	0.072	0.026	0.027	
2019-03-21	0.072	0.031	0.032	0.016
2019-03-28	0.077	0.031	0.032	0.013
2019-04-04	0.081	0.031	0.032	0.016
2019-04-11	0.101	0.031	0.032	0.014
2019-04-18	0.113	0.040	0.041	0.013
2019-04-25	0.168	0.045	0.046	0.011
2019-05-02	0.183	0.050	0.051	0.015
2019-05-09	0.215	0.051	0.052	0.016
2019-05-16	0.255	0.049	0.050	0.010
2019-05-23	0.338	0.047	0.048	0.018
2019-05-30	0.395	0.049	0.050	0.013
2019-06-06	0.398	0.047	0.048	0.012
2019-06-13	0.360	0.045	0.046	0.013
2019-06-20	0.343	0.059	0.060	0.007
2019-06-27	0.272	0.060	0.061	0.015
2019-07-04	0.243	0.063	0.065	0.004
2019-07-11	0.214	0.060	0.061	0.026
2019-07-18	0.172	0.068	0.069	0.022
2019-07-25	0.155	0.067	0.069	
2019-08-01	0.140	0.063	0.064	
2019-08-08	0.136	0.061	0.063	0.018
2019-08-15	0.127	0.124	0.126	
2019-08-22	0.119	0.121	0.123	
2019-08-29	0.112	0.117	0.119	
2019-09-05	0.109	0.114	0.116	
2019-09-12	0.109	0.111	0.113	
2019-09-19	0.106	0.107	0.109	0.034
2019-09-26	0.103	0.105	0.107	
2019-10-03	0.100	0.103	0.105	
2019-10-10	0.094	0.101	0.103	0.018
2019-10-17	0.091	0.104	0.106	
2019-10-24	0.087	0.102	0.104	
2019-10-31	0.083	0.098	0.100	
2019-11-07	0.081	0.097	0.099	0.023
2019-11-14	0.080	0.097	0.099	
2019-11-21	0.079	0.096	0.098	
2019-11-28	0.078	0.093	0.094	
2019-12-05	0.077	0.090	0.092	0.022
2019-12-12	0.076	0.087	0.089	0.043
2019-12-19	0.074	0.084	0.085	0.043
2019-12-26	0.073	0.079	0.081	
Annual	0.14	0.07	0.07	0.02
Late Summer - Fall	0.10	0.10	0.10	0.02
Winter	0.07	0.04	0.04	0.02
Freshet	0.25	0.05	0.05	0.01

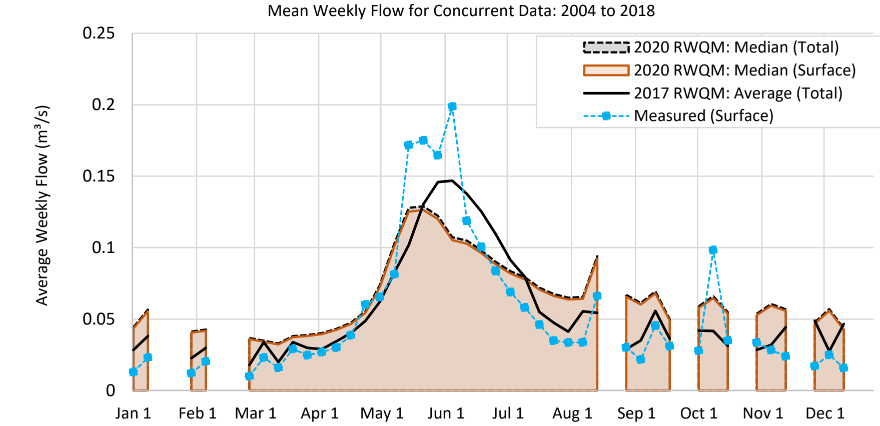
Weekly Flow Series: 2004 to 2018



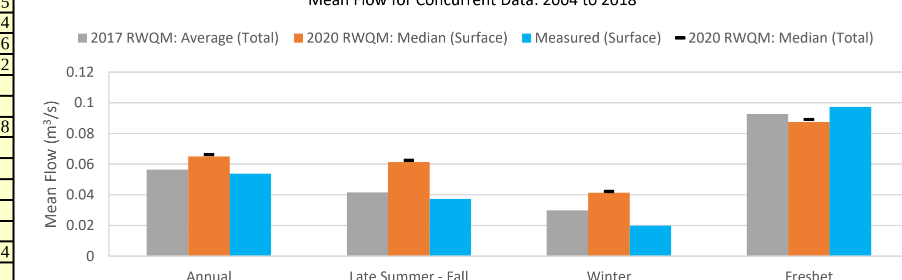
Weekly Flow Exceedance Curve: 2004 to 2018



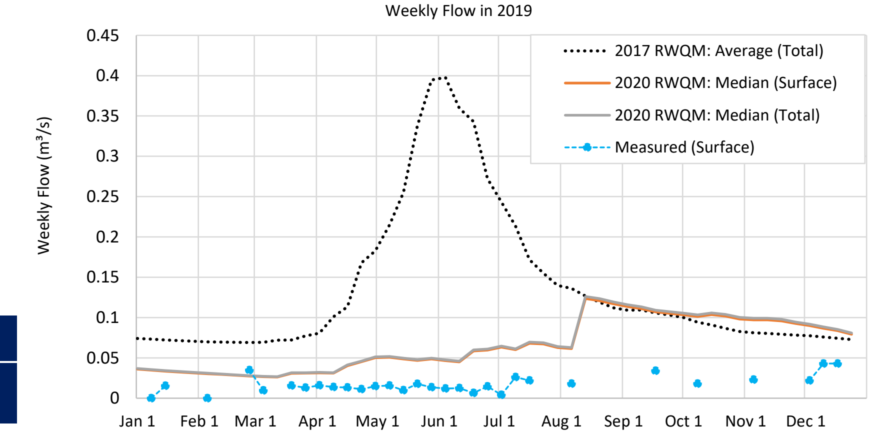
Mean Weekly Flow for Concurrent Data: 2004 to 2018



Mean Flow for Concurrent Data: 2004 to 2018



Weekly Flow in 2019



Statistics on concurrent data: 2004 to 2018	Poor	Poor but improved		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.10	0.32	0.32	
Modified Nash-Sutcliffe efficiency (E1)	0.21	0.28	0.27	
Index of agreement (d)	0.52	0.59	0.60	
Modified index of agreement (d1)	0.56	0.53	0.52	
MAE	0.04	0.04	0.04	
RMSE	0.10	0.08	0.08	
Coefficient of Determination (R^2)	0.14	0.36	0.36	
Number of data in statistics	382	382	382	
Total number of weekly data	783	783	783	382
Mean of all weekly data	0.069	0.072	0.074	0.069
Standard deviation of all weekly data	0.060	0.041	0.041	0.103
Approximated mean annual runoff (mm/yr)	330	390	400	300

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

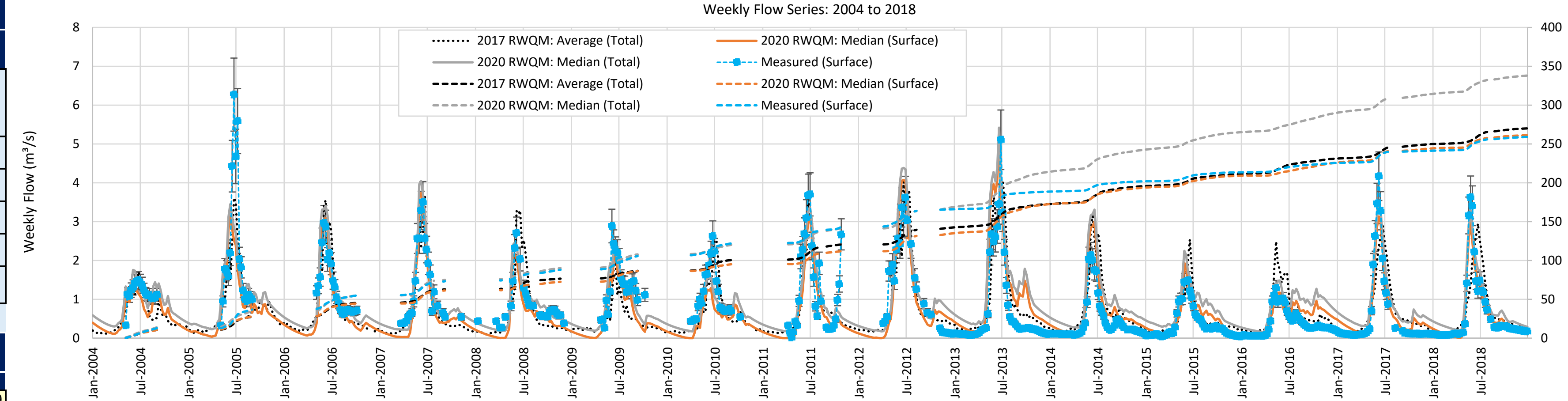
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

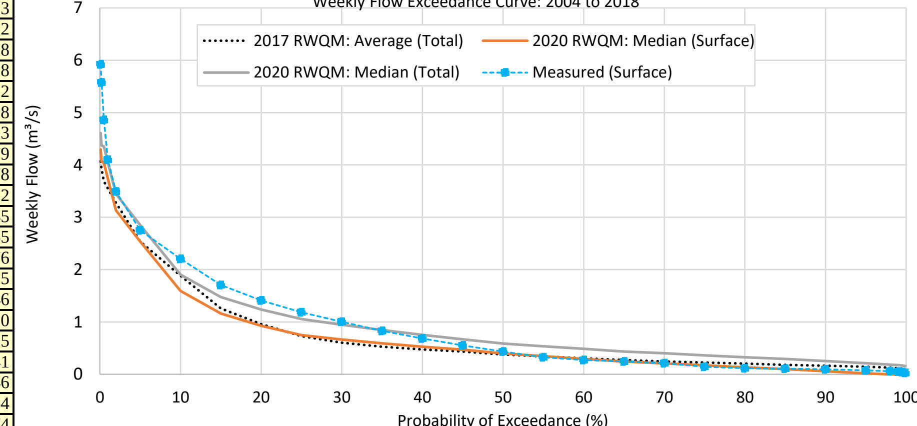
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module of sub-catchments Kilmarnock Upper, Kilmarnock Lower, Brownie Creek		Surface-Groundwater Partitioning	Flows < 60,000 m3/d: 100%, maximum of 16,500 m3/d Flows > 60,000 m3/d: 30%, maximum of 26,900 m3/d
Spinner ID	24	Mean annual surface runoff (monitored)		460
Selected Year	2019	Mean annual total runoff (2020 RWQM)		650
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		66%
Station ID & Description	FR_KC1	Kilmarnock Creek downstream of Rock Drain (200252)		
Drainage Area (2018)	4360 ha	Disturbed Area (2018)		~ 30%

Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m^3/s)	
2019-01-03	0.188	0.084	0.275	0.119
2019-01-10	0.141	0.070	0.261	0.118
2019-01-17	0.134	0.058	0.249	0.116
2019-01-24	0.132	0.046	0.237	0.113
2019-01-31	0.128	0.035	0.226	0.112
2019-02-07	0.106	0.024	0.215	0.108
2019-02-14	0.105	0.014	0.205	0.098
2019-02-21	0.107	0.005	0.196	0.092
2019-02-28	0.103	0.000	0.187	0.088
2019-03-07	0.133	0.000	0.178	0.083
2019-03-14	0.140	0.000	0.172	0.079
2019-03-21	0.148	0.009	0.199	0.078
2019-03-28	0.167	0.002	0.193	0.102
2019-04-04	0.176	0.000	0.187	0.145
2019-04-11	0.308	0.001	0.180	0.165
2019-04-18	0.342	0.068	0.259	0.176
2019-04-25	0.450	0.102	0.293	0.185
2019-05-02	0.471	0.179	0.370	0.246
2019-05-09	0.937	0.683	0.954	0.280
2019-05-16	1.070	0.783	1.093	0.655
2019-05-23	1.360	0.958	1.269	1.241
2019-05-30	1.997	1.144	1.456	1.246
2019-06-06	2.356	0.880	1.191	2.064
2019-06-13	2.646	0.691	0.986	1.574
2019-06-20	2.943	1.197	1.508	0.957
2019-06-27	2.524	1.292	1.604	0.907
2019-07-04	2.500	1.336	1.647	1.183
2019-07-11	1.860	1.005	1.316	0.974
2019-07-18	1.402	1.371	1.682	0.767
2019-07-25	1.095	1.200	1.511	0.761
2019-08-01	0.874	0.848	1.159	0.821
2019-08-08	0.645	0.743	1.051	0.656
2019-08-15	0.570	0.867	1.178	0.579
2019-08-22	0.526	0.690	0.984	0.546
2019-08-29	0.482	0.609	0.871	0.537
2019-09-05	0.489	0.549	0.785	0.470
2019-09-12	0.476	0.505	0.718	0.381
2019-09-19	0.453	0.427	0.618	0.360
2019-09-26	0.450	0.396	0.587	0.318
2019-10-03	0.455	0.330	0.521	0.257
2019-10-10	0.395	0.278	0.469	0.239
2019-10-17	0.386	0.277	0.468	0.239
2019-10-24	0.365	0.324	0.515	0.241
2019-10-31	0.366	0.274	0.465	0.248
2019-11-07	0.294	0.258	0.449	0.235
2019-11-14	0.271	0.245	0.436	0.226
2019-11-21	0.264	0.228	0.419	0.215
2019-11-28	0.303	0.206	0.397	0.204
2019-12-05	0.225	0.185	0.376	0.192
2019-12-12	0.202	0.165	0.356	0.180
2019-12-19	0.190	0.146	0.337	0.175
2019-12-26	0.186	0.129	0.320	0.169
Annual	0.67	0.42	0.65	0.43
Late Summer - Fall	0.48	0.49	0.72	0.40
Winter	0.15	0.05	0.24	0.12
Freshet	1.54	0.78	1.05	0.84

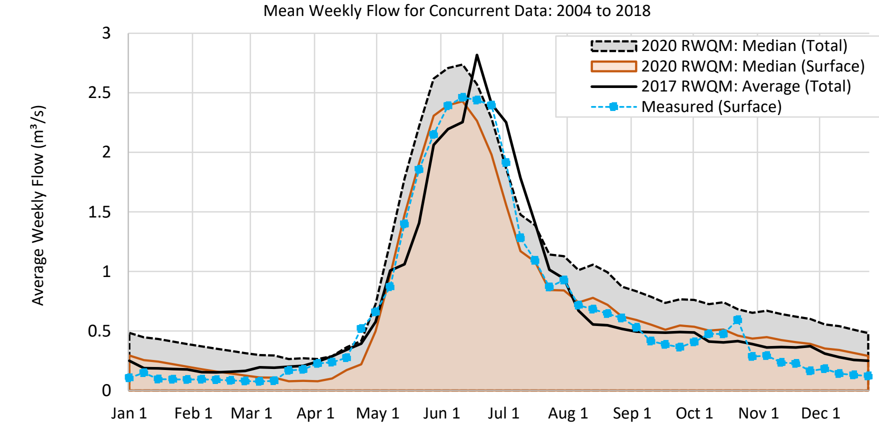
Weekly Flow Series: 2004 to 2018



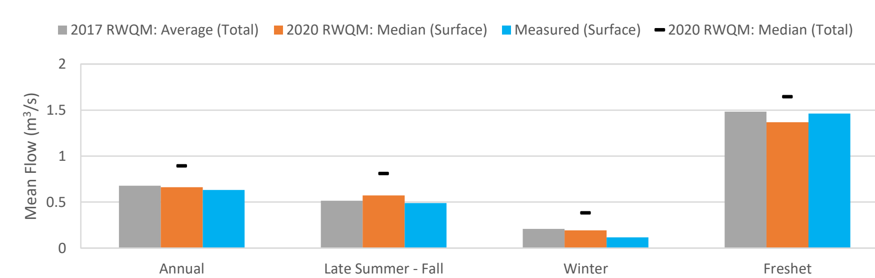
Weekly Flow Exceedance Curve: 2004 to 2018



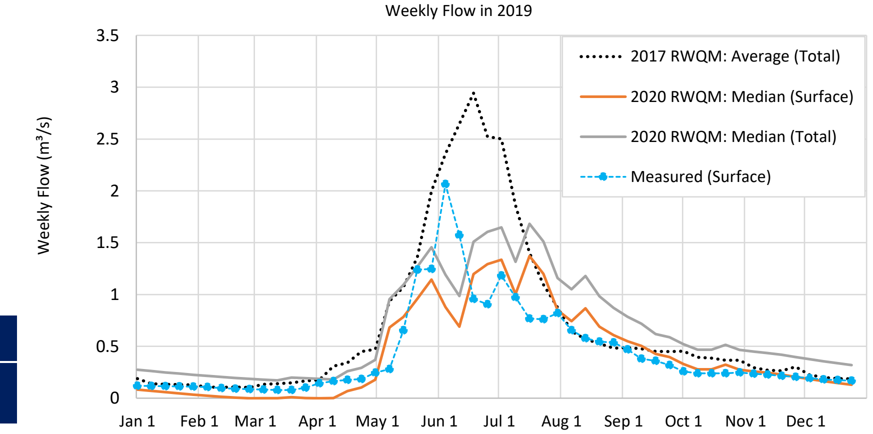
Mean Weekly Flow for Concurrent Data: 2004 to 2018



Mean Flow for Concurrent Data: 2004 to 2018



Weekly Flow in 2019



Statistics on concurrent data: 2004 to 2018	Good	Good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.67	0.70	0.63	
Modified Nash-Sutcliffe efficiency (E1)	0.49	0.52	0.40	
Index of agreement (d)	0.90	0.91	0.90	
Modified index of agreement (d1)	0.73	0.75	0.68	
MAE	0.37	0.34	0.42	
RMSE	0.54	0.52	0.58	
Coefficient of Determination (R^2)	0.68	0.71	0.71	
Number of data in statistics	516	516	516	
Total number of weekly data	783	783	783	516
Mean of all weekly data	0.865	0.837	1.083	0.830
Standard deviation of all weekly data	0.872	0.880	0.922	0.953
Approximated mean annual runoff (mm/yr)	500	490	650	460

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

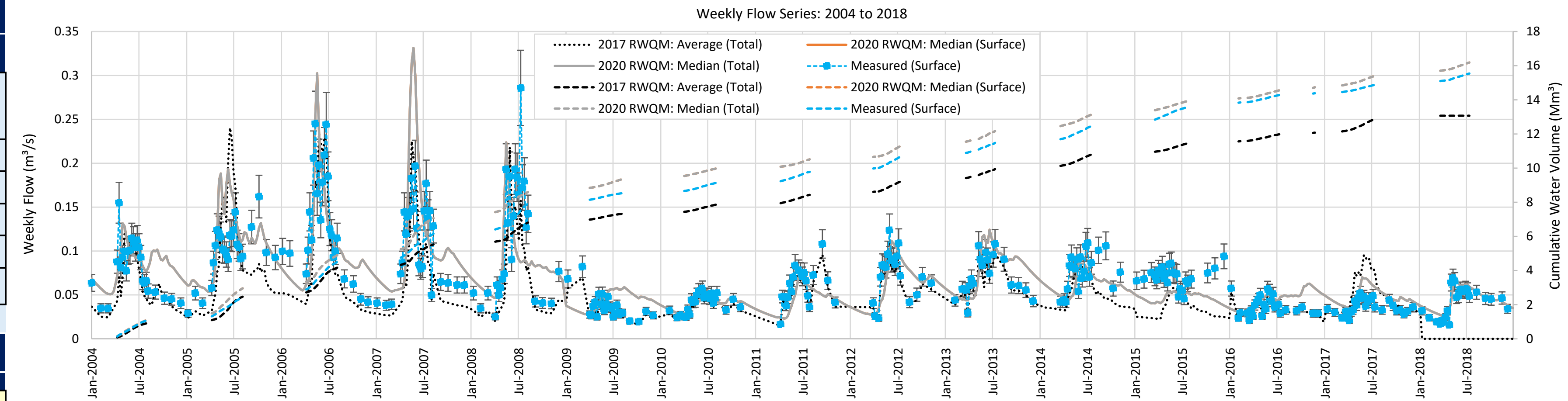
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

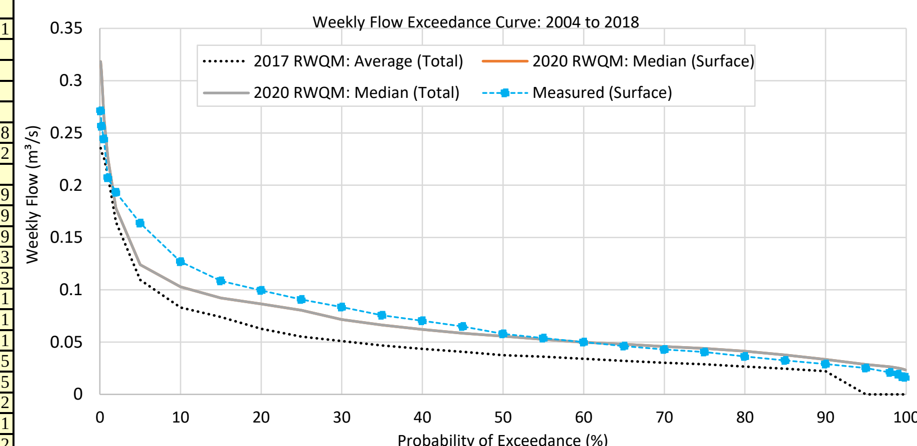
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

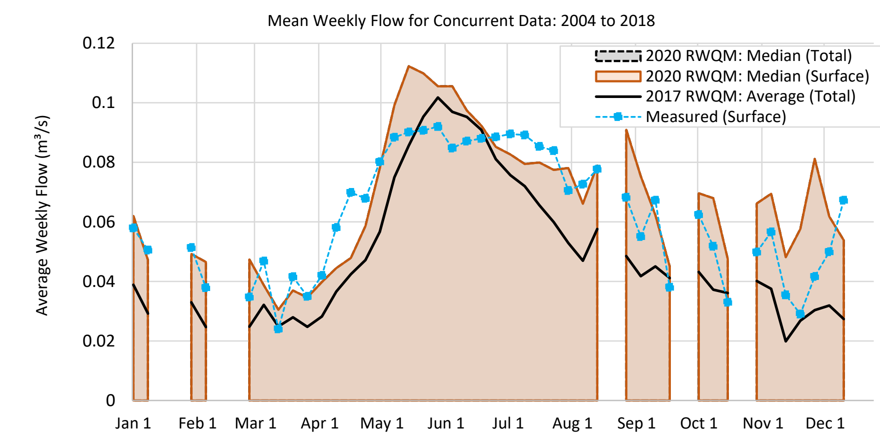
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

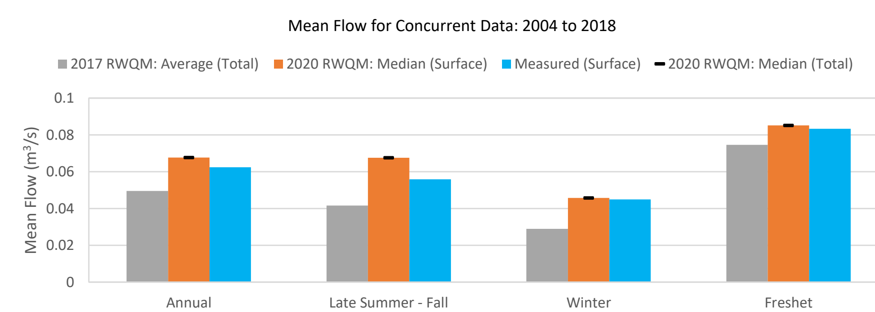
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module of sub-catchment Cataract Creek		Surface-Groundwater Partitioning	0%
Spinner ID	34	Mean annual surface runoff (monitored)		530
Selected Year	2019	Mean annual total runoff (2020 RWQM)		580
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		47%
Station ID & Description	GH_CC1	Cataract Creek Sediment Pond Decant (200384)		
Drainage Area (2018)	360 ha	Disturbed Area (2018)		~ 94%

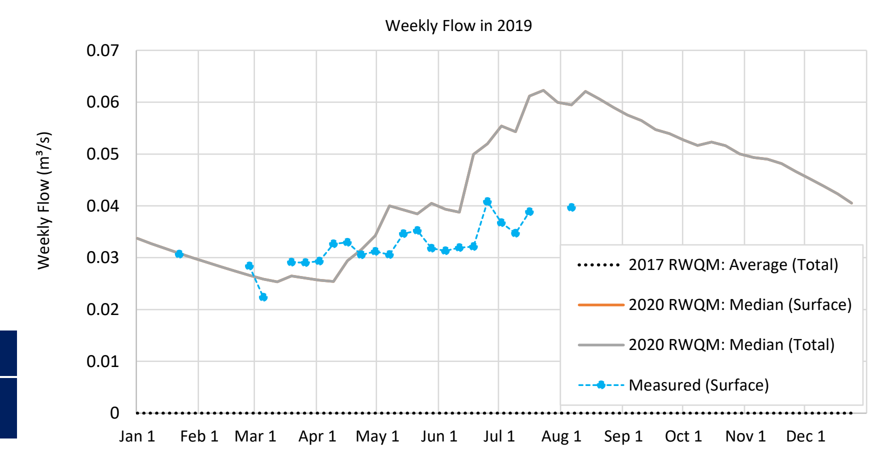
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.000	0.034	0.034	
2019-01-10	0.000	0.033	0.033	
2019-01-17	0.000	0.032	0.032	
2019-01-24	0.000	0.031	0.031	0.031
2019-01-31	0.000	0.030	0.030	
2019-02-07	0.000	0.029	0.029	
2019-02-14	0.000	0.028	0.028	
2019-02-21	0.000	0.027	0.027	
2019-02-28	0.000	0.027	0.027	0.028
2019-03-07	0.000	0.026	0.026	0.022
2019-03-14	0.000	0.025	0.025	
2019-03-21	0.000	0.026	0.026	0.029
2019-03-28	0.000	0.026	0.026	0.029
2019-04-04	0.000	0.026	0.026	0.029
2019-04-11	0.000	0.025	0.025	0.033
2019-04-18	0.000	0.029	0.029	0.033
2019-04-25	0.000	0.032	0.032	0.031
2019-05-02	0.000	0.034	0.034	0.031
2019-05-09	0.000	0.040	0.040	0.031
2019-05-16	0.000	0.039	0.039	0.035
2019-05-23	0.000	0.038	0.038	0.035
2019-05-30	0.000	0.040	0.040	0.032
2019-06-06	0.000	0.039	0.039	0.031
2019-06-13	0.000	0.039	0.039	0.032
2019-06-20	0.000	0.050	0.050	0.032
2019-06-27	0.000	0.052	0.052	0.041
2019-07-04	0.000	0.055	0.055	0.037
2019-07-11	0.000	0.054	0.054	0.035
2019-07-18	0.000	0.061	0.061	0.039
2019-07-25	0.000	0.062	0.062	
2019-08-01	0.000	0.060	0.060	
2019-08-08	0.000	0.059	0.059	0.040
2019-08-15	0.000	0.062	0.062	
2019-08-22	0.000	0.061	0.061	
2019-08-29	0.000	0.059	0.059	
2019-09-05	0.000	0.058	0.058	
2019-09-12	0.000	0.056	0.056	
2019-09-19	0.000	0.055	0.055	
2019-09-26	0.000	0.054	0.054	
2019-10-03	0.000	0.053	0.053	
2019-10-10	0.000	0.052	0.052	
2019-10-17	0.000	0.052	0.052	
2019-10-24	0.000	0.052	0.052	
2019-10-31	0.000	0.050	0.050	
2019-11-07	0.000	0.049	0.049	
2019-11-14	0.000	0.049	0.049	
2019-11-21	0.000	0.048	0.048	
2019-11-28	0.000	0.047	0.047	
2019-12-05	0.000	0.045	0.045	
2019-12-12	0.000	0.044	0.044	
2019-12-19	0.000	0.042	0.042	
2019-12-26	0.000	0.041	0.041	
Annual	-	0.04	0.04	0.03
Late Summer - Fall	-	0.05	0.05	0.04
Winter	-	0.03	0.03	0.03
Freshet	-	0.04	0.04	0.03











Statistics on concurrent data: 2004 to 2018	Poor	Poor		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.48	0.36	0.36	
Modified Nash-Sutcliffe efficiency (E1)	0.34	0.29	0.29	
Index of agreement (d)	0.87	0.84	0.84	
Modified index of agreement (d1)	0.69	0.65	0.65	
MAE	0.02	0.02	0.02	
RMSE	0.03	0.03	0.03	
Coefficient of Determination (R^2)	0.62	0.52	0.52	
Number of data in statistics	365	365	365	
Total number of weekly data	783	783	783	365
Mean of all weekly data	0.059	0.074	0.074	0.071
Standard deviation of all weekly data	0.046	0.048	0.048	0.044
Approximated mean annual runoff (mm/yr)	410	580	580	530

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

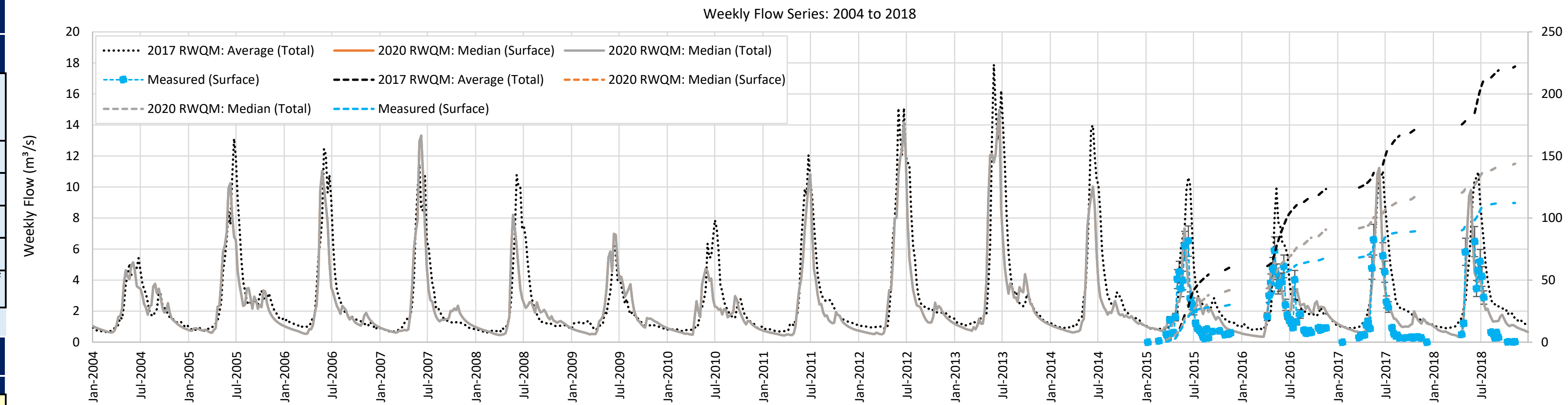
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

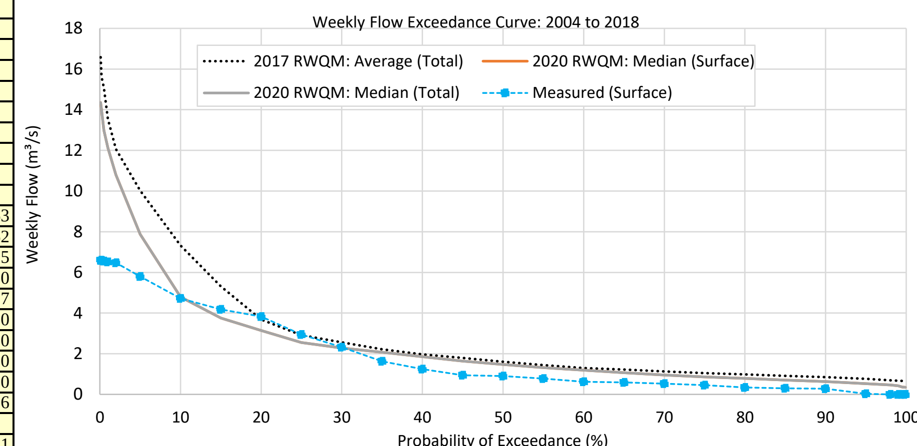
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

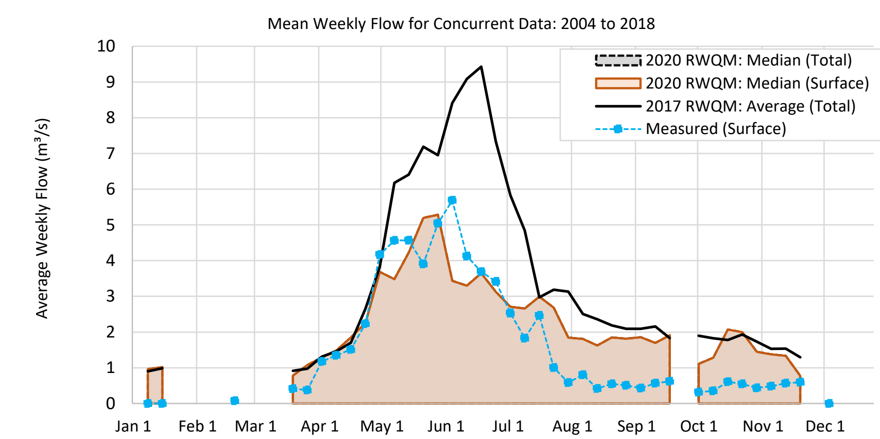
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

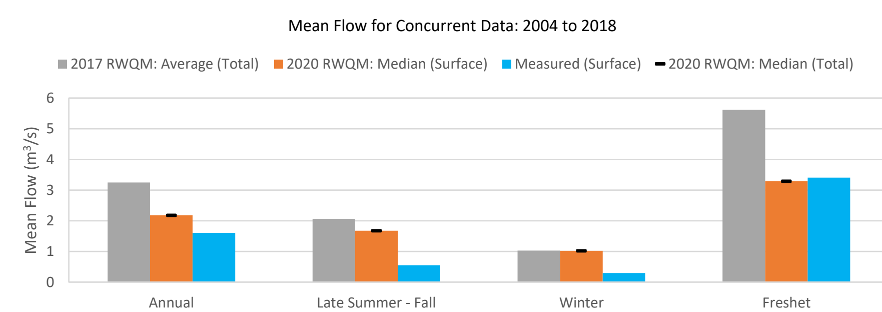
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	FR_FR4 + GH_CC1 + other unnamed areas (sum of modelled flows)		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	37	Mean annual surface runoff (monitored)		210
Selected Year	2019	Mean annual total runoff (2020 RWQM)		320
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		13%
Station ID & Description	FR_FRCP1	FRO Compliance Point- Fording River approximately 525 m downstream of Cataract Creek (E300071)		
Drainage Area (2018)	18790 ha	Disturbed Area (2018)		~ 28%

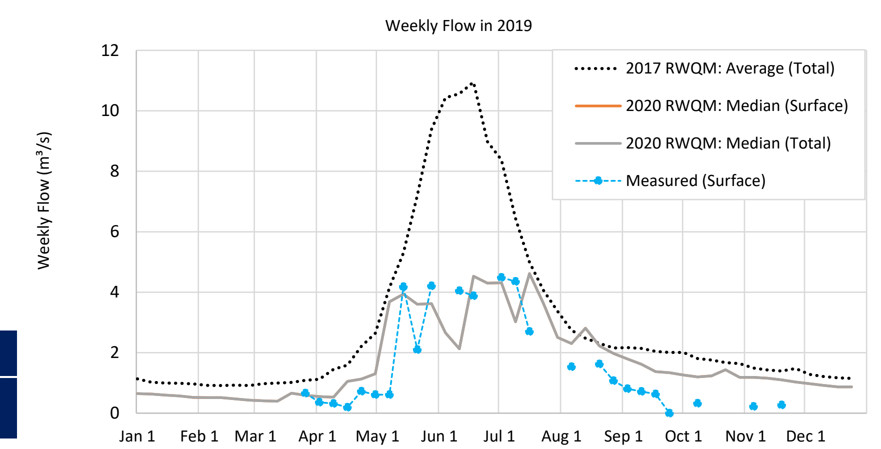
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	1.135	0.649	0.649	
2019-01-10	1.022	0.631	0.631	
2019-01-17	0.998	0.597	0.597	
2019-01-24	0.988	0.570	0.570	
2019-01-31	0.971	0.523	0.523	
2019-02-07	0.920	0.514	0.514	
2019-02-14	0.914	0.518	0.518	
2019-02-21	0.925	0.470	0.470	
2019-02-28	0.914	0.434	0.434	
2019-03-07	0.975	0.410	0.410	
2019-03-14	0.998	0.395	0.395	
2019-03-21	1.016	0.659	0.659	
2019-03-28	1.088	0.593	0.593	0.663
2019-04-04	1.126	0.553	0.553	0.362
2019-04-11	1.451	0.526	0.526	0.315
2019-04-18	1.590	1.055	1.055	0.190
2019-04-25	2.210	1.132	1.132	0.727
2019-05-02	2.643	1.307	1.307	0.610
2019-05-09	4.151	3.683	3.683	0.610
2019-05-16	5.299	3.934	3.934	4.180
2019-05-23	7.208	3.599	3.599	2.100
2019-05-30	9.383	3.624	3.624	4.206
2019-06-06	10.432	2.661	2.661	
2019-06-13	10.564	2.125	2.125	4.051
2019-06-20	10.950	4.531	4.531	3.878
2019-06-27	8.981	4.303	4.303	
2019-07-04	8.380	4.311	4.311	4.488
2019-07-11	6.439	3.020	3.020	4.355
2019-07-18	4.991	4.619	4.619	2.704
2019-07-25	4.062	3.632	3.632	
2019-08-01	3.369	2.507	2.507	
2019-08-08	2.741	2.306	2.306	1.537
2019-08-15	2.479	2.810	2.810	
2019-08-22	2.310	2.229	2.229	1.624
2019-08-29	2.154	1.974	1.974	1.073
2019-09-05	2.172	1.790	1.790	0.806
2019-09-12	2.142	1.617	1.617	0.716
2019-09-19	2.044	1.373	1.373	0.631
2019-09-26	2.012	1.341	1.341	0.000
2019-10-03	2.011	1.261	1.261	
2019-10-10	1.806	1.202	1.202	0.325
2019-10-17	1.759	1.234	1.234	
2019-10-24	1.672	1.437	1.437	
2019-10-31	1.639	1.188	1.188	
2019-11-07	1.492	1.183	1.183	0.224
2019-11-14	1.426	1.156	1.156	
2019-11-21	1.395	1.104	1.104	0.273
2019-11-28	1.476	1.032	1.032	
2019-12-05	1.281	0.973	0.973	
2019-12-12	1.213	0.919	0.919	
2019-12-19	1.173	0.871	0.871	
2019-12-26	1.153	0.868	0.868	
Annual	2.95	1.69	1.69	1.63
Late Summer - Fall	2.11	1.70	1.70	0.72
Winter	1.04	0.62	0.62	0.51
Freshet	6.31	2.96	2.96	2.49











Statistics on concurrent data: 2004 to 2018	Poor	Acceptable		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	-0.81	0.62	0.62	
Modified Nash-Sutcliffe efficiency (E1)	-0.28	0.38	0.38	
Index of agreement (d)	0.73	0.87	0.87	
Modified index of agreement (d1)	0.44	0.63	0.63	
MAE	2.00	0.96	0.96	
RMSE	2.50	1.15	1.15	
Coefficient of Determination (R^2)	0.61	0.71	0.71	
Number of data in statistics	103	103	103	
Total number of weekly data	783	783	783	103
Mean of all weekly data	3.566	2.308	2.308	1.800
Standard deviation of all weekly data	2.806	1.340	1.340	1.867
Approximated mean annual runoff (mm/yr)	450	320	320	210

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

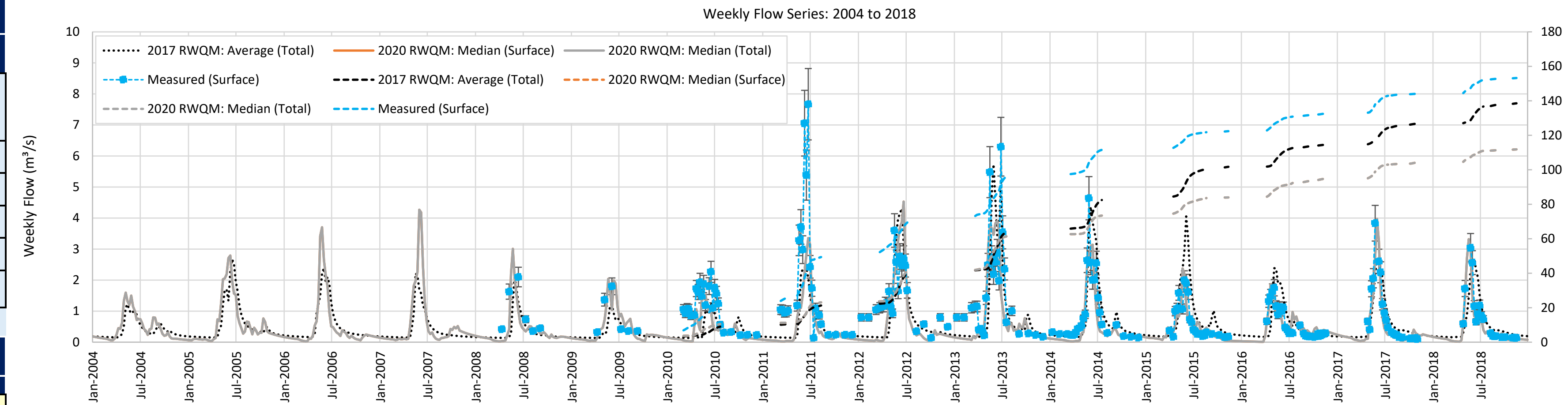
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

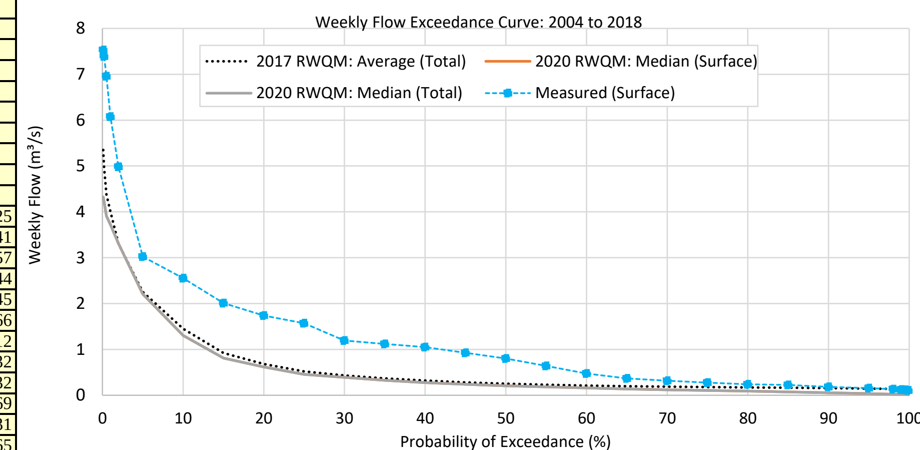
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

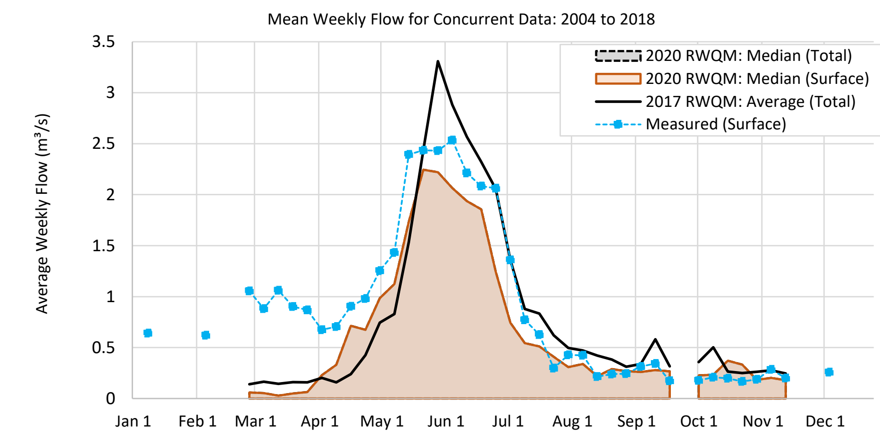
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

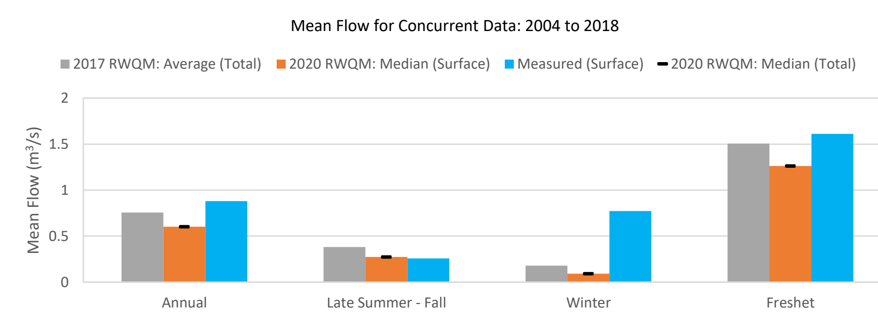
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchment of Upper Fording		**Surface-Groundwater Partitioning**	Not Implemented
Spinner ID	1	**Mean annual surface runoff (monitored)**		630
Selected Year	2019	**Mean annual total runoff (2020 RWQM)**		400
Comparison Start Year	2004	**Evaluation period (weeks)**		783
Comparison End Year	2018	**Weeks with monitoring data (%)**		29%
Station ID & Description	**FR_UFR1**	**Fording River upstream of Henretta Creek (E216777)**		
Drainage Area (2018)	**3910 ha**	**Disturbed Area (2018)**		~ 0%

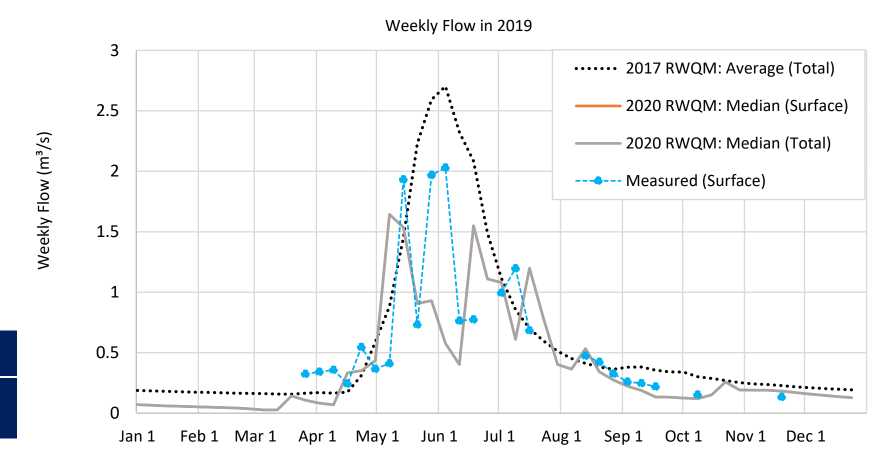
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m^3/s)	
2019-01-03	0.188	0.071	0.071	
2019-01-10	0.185	0.066	0.066	
2019-01-17	0.181	0.061	0.061	
2019-01-24	0.178	0.057	0.057	
2019-01-31	0.174	0.053	0.053	
2019-02-07	0.171	0.049	0.049	
2019-02-14	0.169	0.046	0.046	
2019-02-21	0.166	0.043	0.043	
2019-02-28	0.163	0.036	0.036	
2019-03-07	0.161	0.028	0.028	
2019-03-14	0.159	0.027	0.027	
2019-03-21	0.157	0.143	0.143	
2019-03-28	0.166	0.107	0.107	0.325
2019-04-04	0.170	0.083	0.083	0.341
2019-04-11	0.165	0.070	0.070	0.357
2019-04-18	0.175	0.333	0.333	0.244
2019-04-25	0.311	0.352	0.352	0.545
2019-05-02	0.588	0.434	0.434	0.366
2019-05-09	0.883	1.644	1.644	0.412
2019-05-16	1.452	1.537	1.537	1.932
2019-05-23	2.230	0.907	0.907	0.732
2019-05-30	2.593	0.930	0.930	1.969
2019-06-06	2.703	0.577	0.577	2.031
2019-06-13	2.323	0.402	0.402	0.765
2019-06-20	2.084	1.551	1.551	0.774
2019-06-27	1.488	1.111	1.111	
2019-07-04	1.115	1.080	1.080	0.995
2019-07-11	0.856	0.611	0.611	1.198
2019-07-18	0.700	1.199	1.199	0.684
2019-07-25	0.598	0.785	0.785	
2019-08-01	0.514	0.403	0.403	
2019-08-08	0.451	0.364	0.364	
2019-08-15	0.412	0.534	0.534	0.475
2019-08-22	0.382	0.342	0.342	0.424
2019-08-29	0.362	0.274	0.274	0.326
2019-09-05	0.381	0.223	0.223	0.260
2019-09-12	0.381	0.188	0.188	0.248
2019-09-19	0.356	0.133	0.133	0.219
2019-09-26	0.342	0.132	0.132	
2019-10-03	0.340	0.124	0.124	
2019-10-10	0.301	0.120	0.120	0.153
2019-10-17	0.288	0.151	0.151	
2019-10-24	0.269	0.259	0.259	
2019-10-31	0.253	0.192	0.192	
2019-11-07	0.243	0.189	0.189	
2019-11-14	0.238	0.189	0.189	
2019-11-21	0.228	0.183	0.183	0.133
2019-11-28	0.218	0.171	0.171	
2019-12-05	0.211	0.159	0.159	
2019-12-12	0.205	0.148	0.148	
2019-12-19	0.199	0.138	0.138	
2019-12-26	0.194	0.129	0.129	
Annual	0.57	0.37	0.37	0.66
Late Summer - Fall	0.35	0.26	0.26	0.28
Winter	0.18	0.08	0.08	0.33
Freshet	1.31	0.85	0.85	0.93











Statistics on concurrent data: 2004 to 2018	Poor	Poor but improved		
Parameter	**2017 RWQM: Average (Total)**	**2020 RWQM: Median (Surface)**	**2020 RWQM: Median (Total)**	**Measured (Surface)**
Nash-Sutcliffe efficiency (E)	0.31	0.45	0.45	
Modified Nash-Sutcliffe efficiency (E1)	0.20	0.34	0.34	
Index of agreement (d)	0.79	0.82	0.82	
Modified index of agreement (d1)	0.62	0.68	0.68	
MAE	0.66	0.54	0.54	
RMSE	0.99	0.88	0.88	
Coefficient of Determination (R^2)	0.42	0.53	0.53	
Number of data in statistics	228	228	228	
Total number of weekly data	783	783	783	228
Mean of all weekly data	1.005	0.811	0.811	1.111
Standard deviation of all weekly data	1.148	0.976	0.976	1.186
Approximated mean annual runoff (mm/yr)	510	400	400	630

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

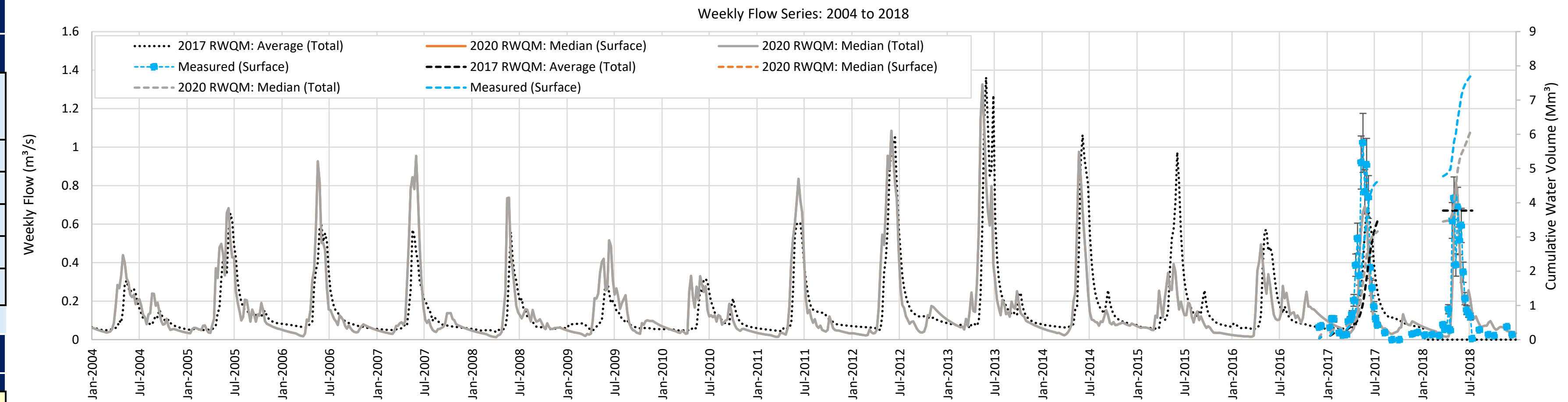
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

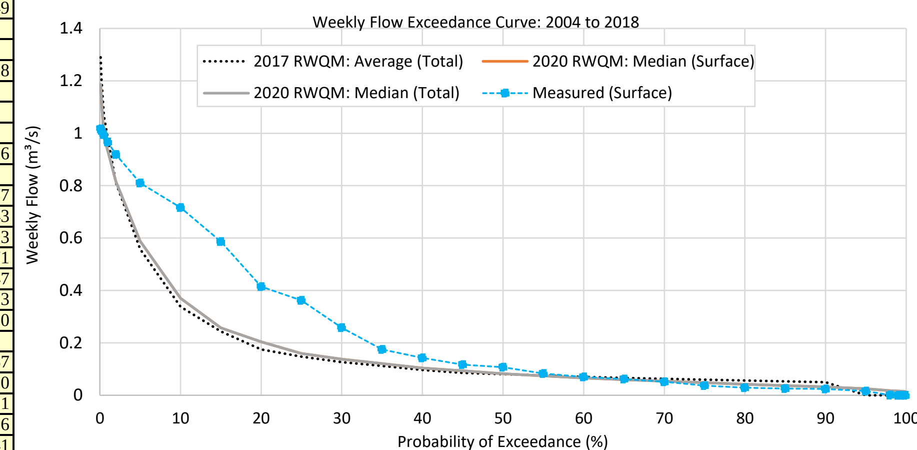
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

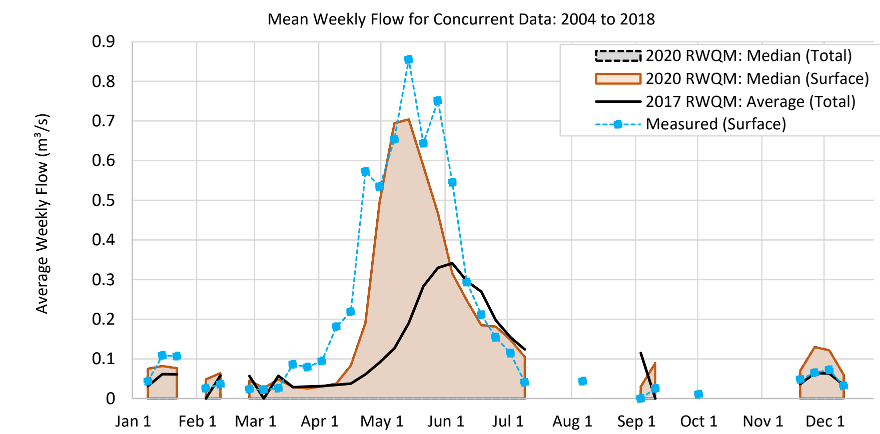
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

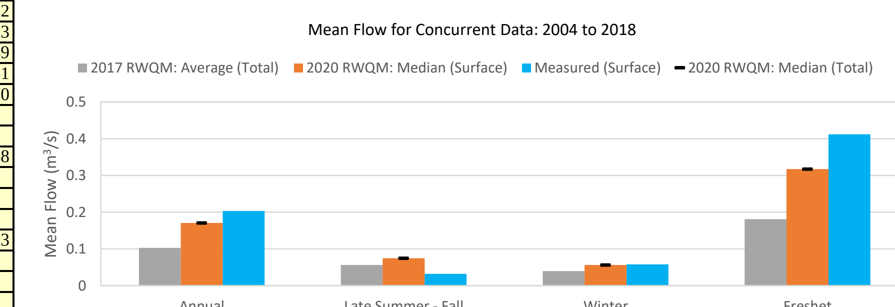
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchments of John Creek, Lake Pit, Lake Mountain Pit, Tower Diversion, Tower Diversion Extension		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	9	Mean annual surface runoff (monitored)		430
Selected Year	2019	Mean annual total runoff (2020 RWQM)		400
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		7%
Station ID & Description	FR_LMP1	Lake Mountain Pond (E306924)		
Drainage Area (2018)	1060 ha	Disturbed Area (2018)		~ 39%

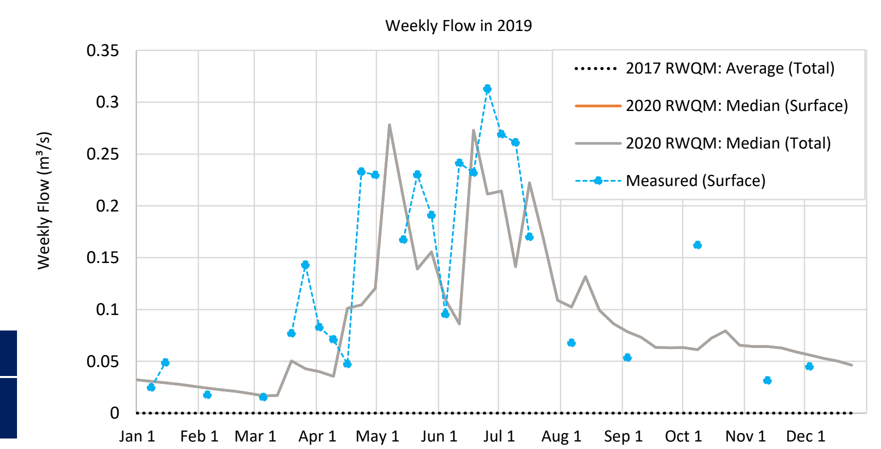
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.000	0.032	0.032	
2019-01-10	0.000	0.031	0.031	0.025
2019-01-17	0.000	0.029	0.029	0.049
2019-01-24	0.000	0.028	0.028	
2019-01-31	0.000	0.026	0.026	
2019-02-07	0.000	0.024	0.024	0.018
2019-02-14	0.000	0.022	0.022	
2019-02-21	0.000	0.021	0.021	
2019-02-28	0.000	0.019	0.019	
2019-03-07	0.000	0.017	0.017	0.016
2019-03-14	0.000	0.017	0.017	
2019-03-21	0.000	0.050	0.050	0.077
2019-03-28	0.000	0.043	0.043	0.143
2019-04-04	0.000	0.040	0.040	0.083
2019-04-11	0.000	0.036	0.036	0.071
2019-04-18	0.000	0.101	0.101	0.047
2019-04-25	0.000	0.105	0.105	0.233
2019-05-02	0.000	0.121	0.121	0.230
2019-05-09	0.000	0.278	0.278	
2019-05-16	0.000	0.207	0.207	0.167
2019-05-23	0.000	0.139	0.139	0.230
2019-05-30	0.000	0.156	0.156	0.191
2019-06-06	0.000	0.110	0.110	0.096
2019-06-13	0.000	0.086	0.086	0.241
2019-06-20	0.000	0.273	0.273	0.232
2019-06-27	0.000	0.211	0.211	0.313
2019-07-04	0.000	0.214	0.214	0.269
2019-07-11	0.000	0.141	0.141	0.261
2019-07-18	0.000	0.222	0.222	0.170
2019-07-25	0.000	0.168	0.168	
2019-08-01	0.000	0.109	0.109	
2019-08-08	0.000	0.102	0.102	0.068
2019-08-15	0.000	0.132	0.132	
2019-08-22	0.000	0.099	0.099	
2019-08-29	0.000	0.086	0.086	
2019-09-05	0.000	0.079	0.079	0.053
2019-09-12	0.000	0.073	0.073	
2019-09-19	0.000	0.063	0.063	
2019-09-26	0.000	0.063	0.063	
2019-10-03	0.000	0.063	0.063	
2019-10-10	0.000	0.061	0.061	0.162
2019-10-17	0.000	0.073	0.073	
2019-10-24	0.000	0.079	0.079	
2019-10-31	0.000	0.065	0.065	
2019-11-07	0.000	0.064	0.064	
2019-11-14	0.000	0.064	0.064	0.031
2019-11-21	0.000	0.063	0.063	
2019-11-28	0.000	0.059	0.059	
2019-12-05	0.000	0.056	0.056	0.045
2019-12-12	0.000	0.053	0.053	
2019-12-19	0.000	0.050	0.050	
2019-12-26	0.000	0.046	0.046	
Annual	-	0.09	0.09	0.14
Late Summer - Fall	-	0.08	0.08	0.08
Winter	-	0.03	0.03	0.06
Freshet	-	0.16	0.16	0.20











Statistics on concurrent data: 2004 to 2018	Poor	Good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.04	0.69	0.69	
Modified Nash-Sutcliffe efficiency (E1)	0.20	0.54	0.54	
Index of agreement (d)	0.67	0.90	0.90	
Modified index of agreement (d1)	0.58	0.75	0.75	
MAE	0.18	0.10	0.10	
RMSE	0.27	0.15	0.15	
Coefficient of Determination (R^2)	0.26	0.72	0.72	
Number of data in statistics	55	55	55	
Total number of weekly data	783	783	783	55
Mean of all weekly data	0.113	0.191	0.191	0.235
Standard deviation of all weekly data	0.184	0.215	0.215	0.278
Approximated mean annual runoff (mm/yr)	260	400	400	430

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

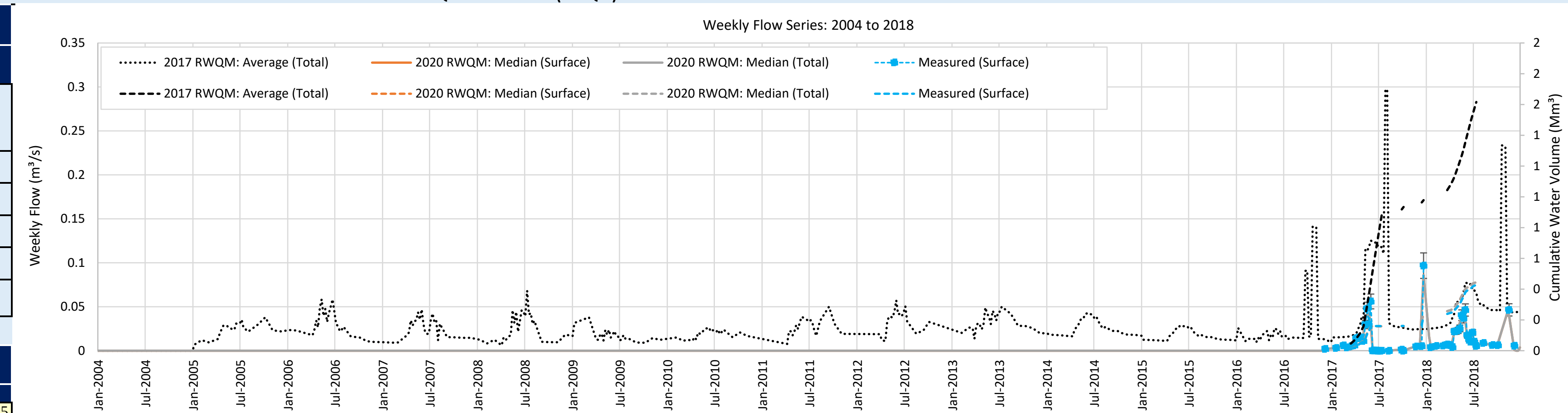
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

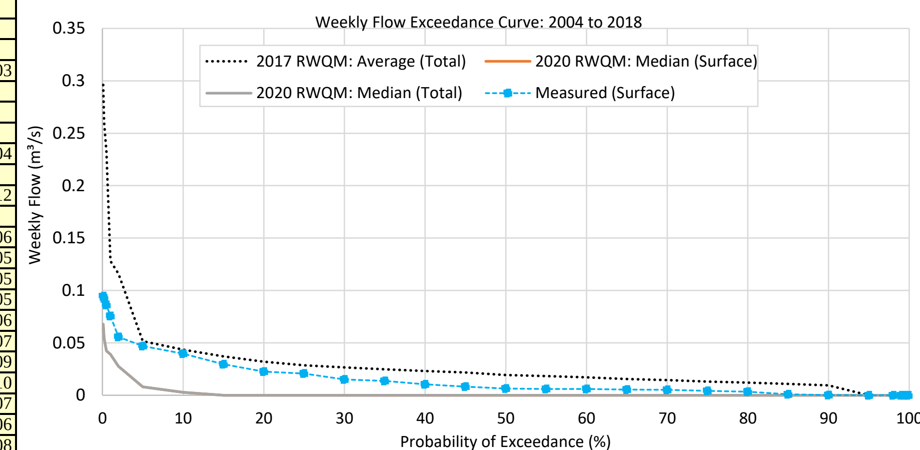
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

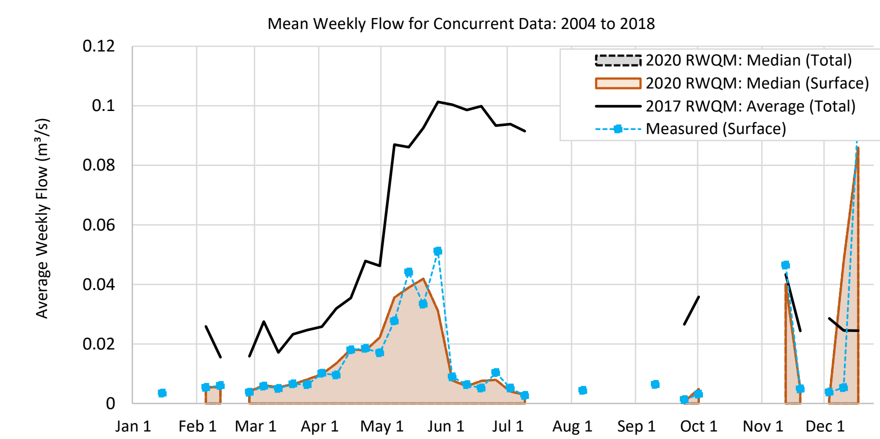
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

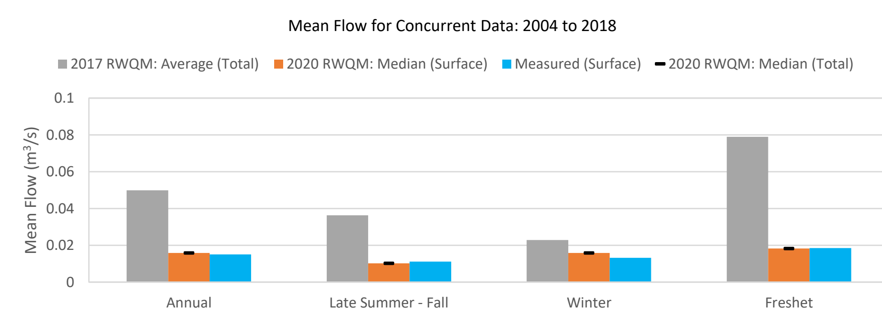
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Module, Pit Module in sub-catchments of Swift Pit, Fording LF2 Upper		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	14	Mean annual surface runoff (monitored)		70
Selected Year	2019	Mean annual total runoff (2020 RWQM)		80
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		7%
Station ID & Description	FR_LP1	Liverpool Sediment Pond Decant (E304835)		
Drainage Area (2018)	540 ha	Disturbed Area (2018)		~ 98%

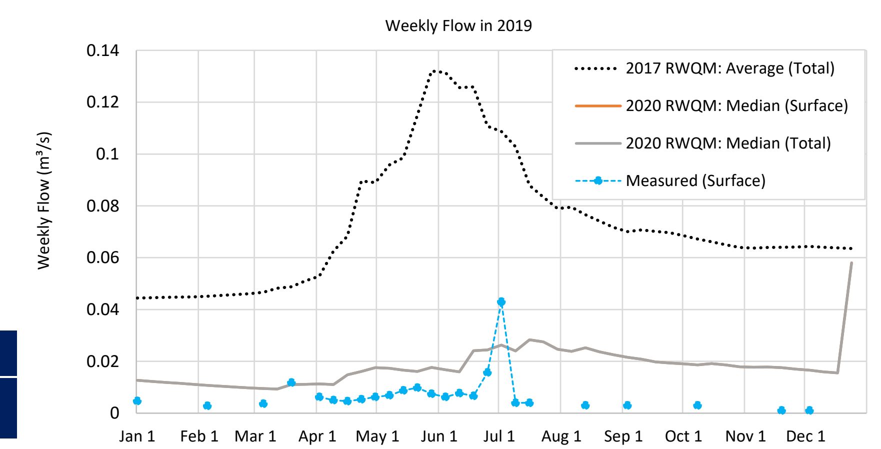
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.044	0.013	0.013	0.005
2019-01-10	0.045	0.012	0.012	
2019-01-17	0.045	0.012	0.012	
2019-01-24	0.045	0.012	0.012	
2019-01-31	0.045	0.011	0.011	
2019-02-07	0.045	0.011	0.011	0.003
2019-02-14	0.045	0.010	0.010	
2019-02-21	0.046	0.010	0.010	
2019-02-28	0.046	0.010	0.010	
2019-03-07	0.047	0.009	0.009	0.004
2019-03-14	0.048	0.009	0.009	
2019-03-21	0.049	0.011	0.011	0.012
2019-03-28	0.051	0.011	0.011	
2019-04-04	0.053	0.011	0.011	0.006
2019-04-11	0.063	0.011	0.011	0.005
2019-04-18	0.068	0.015	0.015	0.005
2019-04-25	0.090	0.016	0.016	0.005
2019-05-02	0.089	0.018	0.018	0.006
2019-05-09	0.096	0.017	0.017	0.007
2019-05-16	0.099	0.017	0.017	0.009
2019-05-23	0.115	0.016	0.016	0.010
2019-05-30	0.132	0.018	0.018	0.007
2019-06-06	0.131	0.017	0.017	0.006
2019-06-13	0.126	0.016	0.016	0.008
2019-06-20	0.126	0.024	0.024	0.007
2019-06-27	0.111	0.024	0.024	0.016
2019-07-04	0.109	0.026	0.026	0.043
2019-07-11	0.103	0.024	0.024	0.004
2019-07-18	0.088	0.028	0.028	0.004
2019-07-25	0.083	0.027	0.027	
2019-08-01	0.079	0.025	0.025	
2019-08-08	0.079	0.024	0.024	
2019-08-15	0.077	0.025	0.025	0.003
2019-08-22	0.074	0.024	0.024	
2019-08-29	0.072	0.023	0.023	
2019-09-05	0.070	0.022	0.022	0.003
2019-09-12	0.071	0.021	0.021	
2019-09-19	0.070	0.020	0.020	
2019-09-26	0.070	0.019	0.019	
2019-10-03	0.069	0.019	0.019	
2019-10-10	0.067	0.019	0.019	0.003
2019-10-17	0.066	0.019	0.019	
2019-10-24	0.065	0.019	0.019	
2019-10-31	0.064	0.018	0.018	
2019-11-07	0.064	0.018	0.018	
2019-11-14	0.064	0.018	0.018	
2019-11-21	0.064	0.018	0.018	0.001
2019-11-28	0.064	0.017	0.017	
2019-12-05	0.064	0.017	0.017	0.001
2019-12-12	0.064	0.016	0.016	
2019-12-19	0.064	0.015	0.015	
2019-12-26	0.064	0.058	0.058	
Annual	0.07	0.02	0.02	0.01
Late Summer - Fall	0.07	0.02	0.02	0.00
Winter	0.05	0.01	0.01	0.01
Freshet	0.10	0.02	0.02	0.01











Statistics on concurrent data: 2004 to 2018	Poor	Very good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	-8.27	0.80	0.80	
Modified Nash-Sutcliffe efficiency (E1)	-2.33	0.71	0.71	
Index of agreement (d)	0.32	0.94	0.94	
Modified index of agreement (d1)	0.19	0.85	0.85	
MAE	0.04	0.00	0.00	
RMSE	0.06	0.01	0.01	
Coefficient of Determination (R^2)	0.02	0.80	0.80	
Number of data in statistics	53	53	53	
Total number of weekly data	783	783	783	53
Mean of all weekly data	0.055	0.015	0.015	0.015
Standard deviation of all weekly data	0.036	0.017	0.017	0.018
Approximated mean annual runoff (mm/yr)	260	80	80	70

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

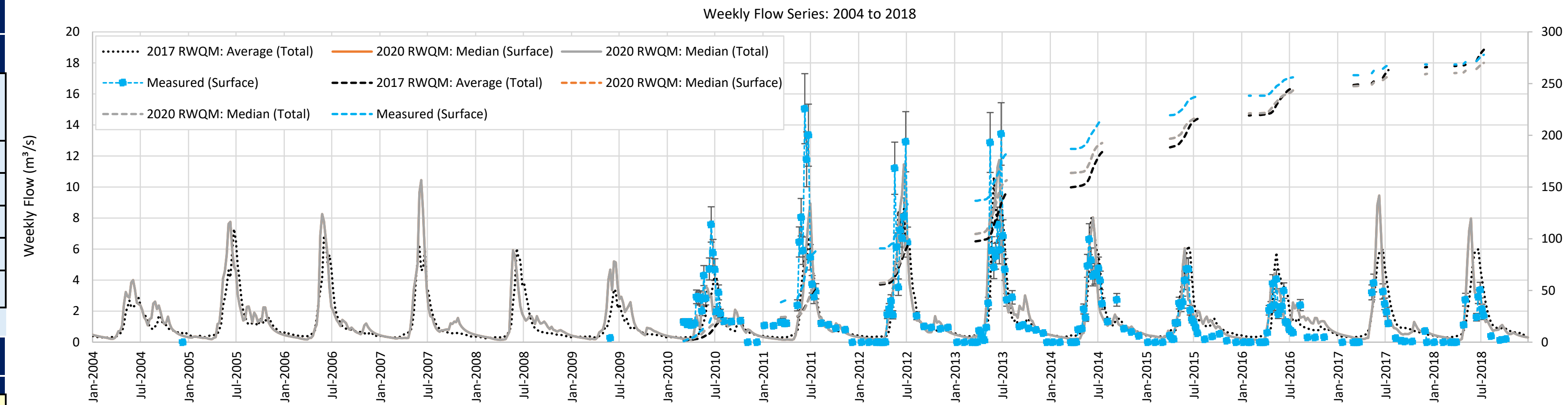
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

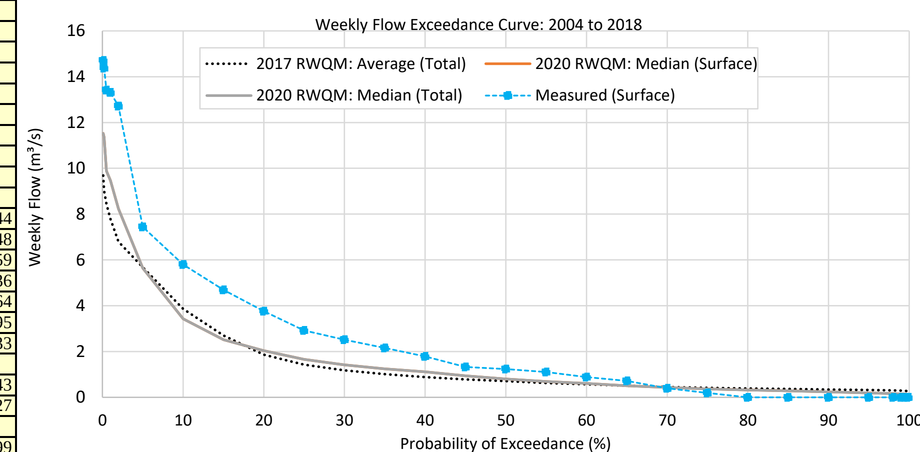
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

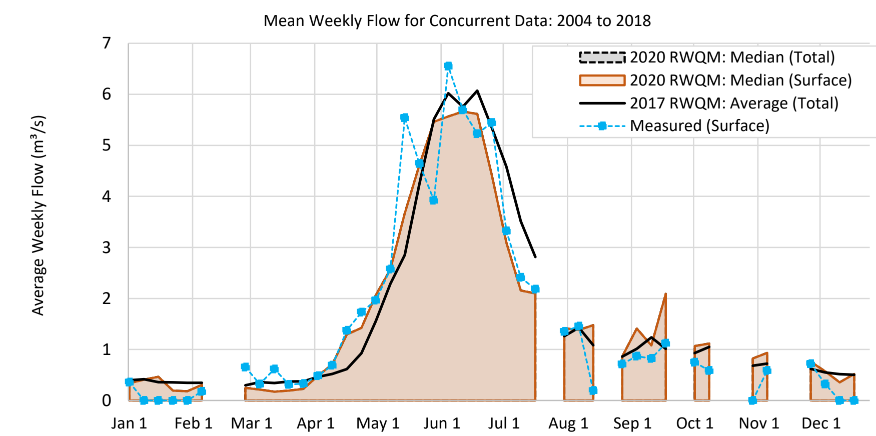
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

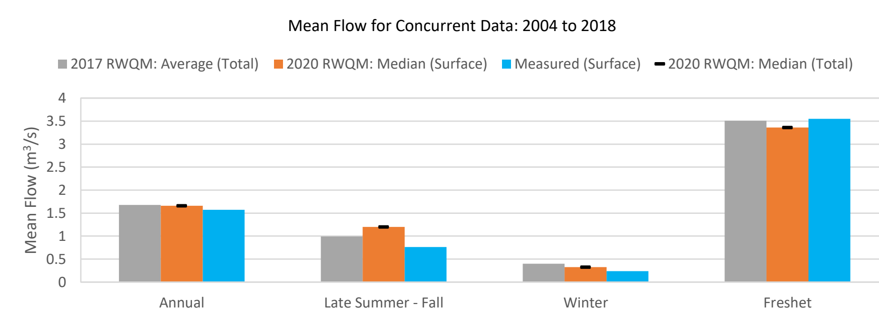
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	FR_HC1 + FR_UFR1 + Turn Creek (Sum of modelled flows)		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	5	Mean annual surface runoff (monitored)		500
Selected Year	2019	Mean annual total runoff (2020 RWQM)		540
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		27%
Station ID & Description	FR_FR1	Fording River downstream of Henretta Creek (0200251)		
Drainage Area (2018)	8900 ha	Disturbed Area (2018)		~ 5%

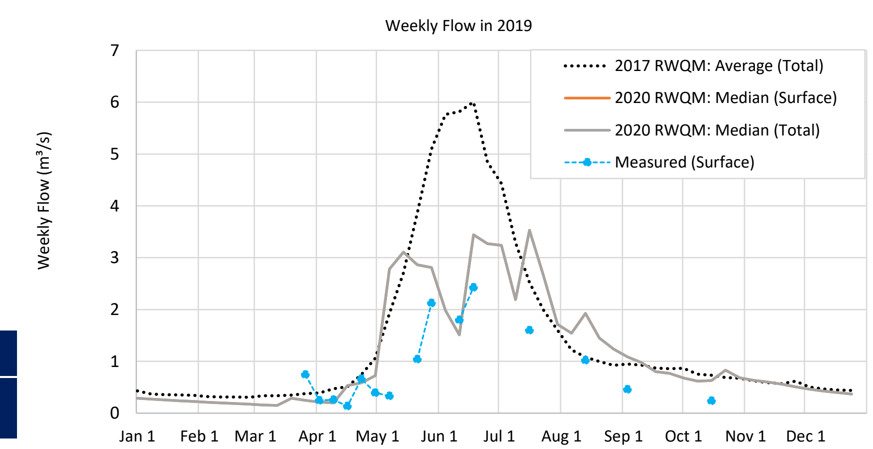
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m^3/s)	
2019-01-03	0.433	0.289	0.289	
2019-01-10	0.370	0.271	0.271	
2019-01-17	0.357	0.255	0.255	
2019-01-24	0.353	0.239	0.239	
2019-01-31	0.344	0.225	0.225	
2019-02-07	0.319	0.212	0.212	
2019-02-14	0.314	0.199	0.199	
2019-02-21	0.313	0.187	0.187	
2019-02-28	0.306	0.173	0.173	
2019-03-07	0.335	0.156	0.156	
2019-03-14	0.339	0.150	0.150	
2019-03-21	0.348	0.287	0.287	
2019-03-28	0.377	0.246	0.246	0.744
2019-04-04	0.388	0.216	0.216	0.248
2019-04-11	0.471	0.199	0.199	0.259
2019-04-18	0.513	0.533	0.533	0.136
2019-04-25	0.743	0.585	0.585	0.664
2019-05-02	1.063	0.724	0.724	0.395
2019-05-09	1.927	2.780	2.780	0.333
2019-05-16	2.705	3.106	3.106	
2019-05-23	3.866	2.865	2.865	1.043
2019-05-30	5.096	2.810	2.810	2.127
2019-06-06	5.764	1.982	1.982	
2019-06-13	5.819	1.510	1.510	1.799
2019-06-20	6.005	3.442	3.442	2.427
2019-06-27	4.842	3.270	3.270	
2019-07-04	4.431	3.238	3.238	
2019-07-11	3.292	2.189	2.189	
2019-07-18	2.522	3.530	3.530	1.600
2019-07-25	1.989	2.655	2.655	
2019-08-01	1.598	1.713	1.713	
2019-08-08	1.221	1.542	1.542	
2019-08-15	1.083	1.926	1.926	1.020
2019-08-22	0.998	1.449	1.449	
2019-08-29	0.922	1.239	1.239	
2019-09-05	0.948	1.088	1.088	0.457
2019-09-12	0.929	0.977	0.977	
2019-09-19	0.873	0.800	0.800	
2019-09-26	0.857	0.770	0.770	
2019-10-03	0.868	0.679	0.679	
2019-10-10	0.753	0.619	0.619	
2019-10-17	0.733	0.629	0.629	0.237
2019-10-24	0.687	0.832	0.832	
2019-10-31	0.675	0.685	0.685	
2019-11-07	0.627	0.636	0.636	
2019-11-14	0.589	0.602	0.602	
2019-11-21	0.570	0.560	0.560	
2019-11-28	0.617	0.507	0.507	
2019-12-05	0.505	0.464	0.464	
2019-12-12	0.467	0.428	0.428	
2019-12-19	0.446	0.397	0.397	
2019-12-26	0.437	0.370	0.370	
Annual	1.41	1.10	1.10	0.90
Late Summer - Fall	0.92	1.05	1.05	0.57
Winter	0.38	0.26	0.26	0.50
Freshet	3.27	2.18	2.18	1.08











Statistics on concurrent data: 2004 to 2018	Acceptable	Acceptable		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.53	0.57	0.57	
Modified Nash-Sutcliffe efficiency (E1)	0.40	0.44	0.44	
Index of agreement (d)	0.84	0.86	0.86	
Modified index of agreement (d1)	0.70	0.71	0.71	
MAE	1.20	1.12	1.12	
RMSE	1.93	1.84	1.84	
Coefficient of Determination (R^2)	0.54	0.58	0.58	
Number of data in statistics	208	208	208	
Total number of weekly data	783	783	783	208
Mean of all weekly data	2.262	2.159	2.159	2.213
Standard deviation of all weekly data	2.387	2.482	2.482	2.819
Approximated mean annual runoff (mm/yr)	550	540	540	500

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

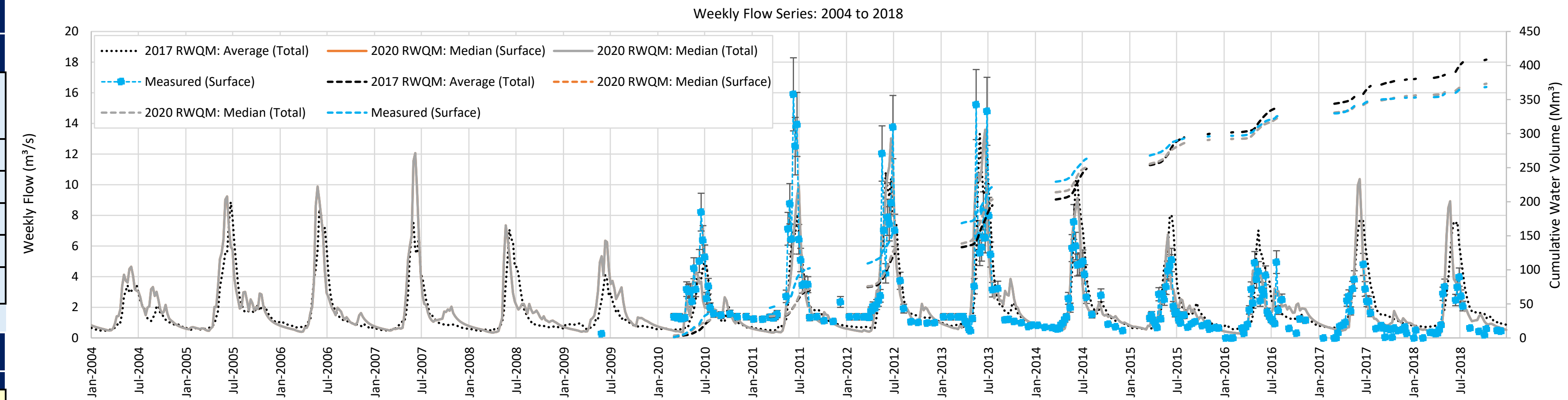
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

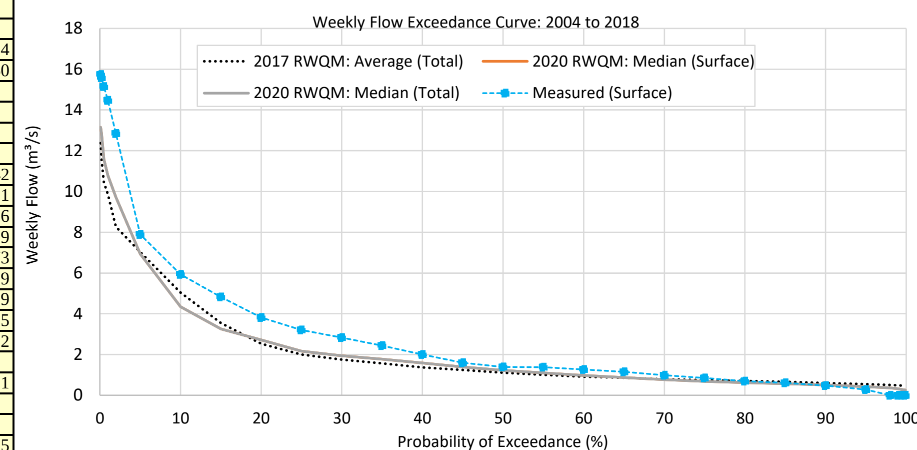
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

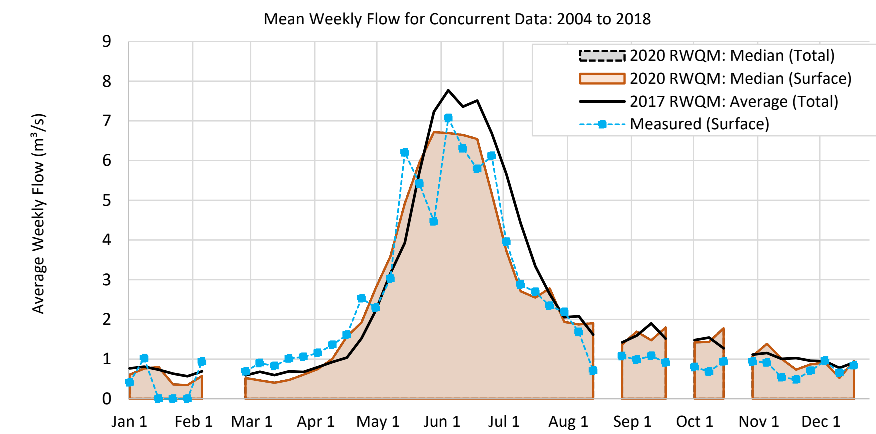
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

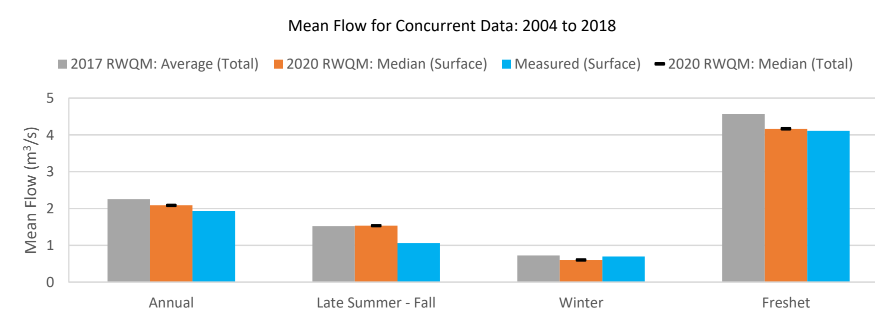
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	FR_FRNTP + Fording LF2 Lower + South Tailings Pond Seepage (sum of modelled flows)		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	16	Mean annual surface runoff (monitored)		430
Selected Year	2019	Mean annual total runoff (2020 RWQM)		470
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		30%
Station ID & Description	FR_FR2	Fording River upstream of Kilmarnock Creek (200201)		
Drainage Area (2018)	13110 ha	Disturbed Area (2018)		~ 23%

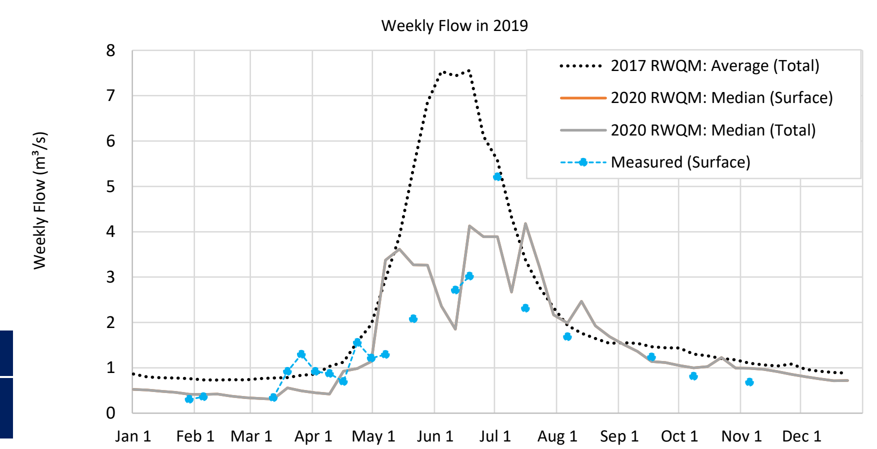
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.863	0.524	0.524	
2019-01-10	0.798	0.511	0.511	
2019-01-17	0.782	0.482	0.482	
2019-01-24	0.775	0.460	0.460	
2019-01-31	0.763	0.418	0.418	0.304
2019-02-07	0.735	0.412	0.412	0.360
2019-02-14	0.731	0.420	0.420	
2019-02-21	0.741	0.376	0.376	
2019-02-28	0.733	0.344	0.344	
2019-03-07	0.764	0.323	0.323	
2019-03-14	0.777	0.310	0.310	0.342
2019-03-21	0.787	0.556	0.556	0.921
2019-03-28	0.836	0.490	0.490	1.296
2019-04-04	0.861	0.449	0.449	0.919
2019-04-11	1.034	0.424	0.424	0.873
2019-04-18	1.126	0.924	0.924	0.699
2019-04-25	1.576	0.987	0.987	1.559
2019-05-02	1.958	1.141	1.141	1.215
2019-05-09	2.954	3.376	3.376	1.292
2019-05-16	3.897	3.616	3.616	
2019-05-23	5.394	3.273	3.273	2.081
2019-05-30	6.856	3.261	3.261	
2019-06-06	7.538	2.359	2.359	
2019-06-13	7.437	1.853	1.853	2.715
2019-06-20	7.556	4.129	4.129	3.019
2019-06-27	6.107	3.894	3.894	
2019-07-04	5.579	3.889	3.889	5.210
2019-07-11	4.321	2.670	2.670	
2019-07-18	3.381	4.181	4.181	2.315
2019-07-25	2.781	3.226	3.226	
2019-08-01	2.328	2.166	2.166	
2019-08-08	1.937	1.988	1.988	1.684
2019-08-15	1.761	2.466	2.466	
2019-08-22	1.645	1.926	1.926	
2019-08-29	1.541	1.690	1.690	
2019-09-05	1.555	1.519	1.519	
2019-09-12	1.538	1.362	1.362	
2019-09-19	1.467	1.141	1.141	1.239
2019-09-26	1.441	1.117	1.117	
2019-10-03	1.439	1.050	1.050	
2019-10-10	1.302	1.002	1.002	0.813
2019-10-17	1.267	1.030	1.030	
2019-10-24	1.206	1.229	1.229	
2019-10-31	1.178	0.993	0.993	
2019-11-07	1.104	0.991	0.991	0.681
2019-11-14	1.063	0.966	0.966	
2019-11-21	1.040	0.918	0.918	
2019-11-28	1.083	0.854	0.854	
2019-12-05	0.968	0.803	0.803	
2019-12-12	0.925	0.756	0.756	
2019-12-19	0.899	0.716	0.716	
2019-12-26	0.884	0.721	0.721	
Annual	2.12	1.47	1.47	1.48
Late Summer - Fall	1.51	1.45	1.45	1.10
Winter	0.81	0.50	0.50	0.69
Freshet	4.45	2.67	2.67	2.10











Statistics on concurrent data: 2004 to 2018	Poor	Acceptable		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.47	0.57	0.57	
Modified Nash-Sutcliffe efficiency (E1)	0.32	0.42	0.42	
Index of agreement (d)	0.85	0.88	0.88	
Modified index of agreement (d1)	0.68	0.71	0.71	
MAE	1.32	1.13	1.13	
RMSE	2.04	1.83	1.83	
Coefficient of Determination (R^2)	0.55	0.61	0.61	
Number of data in statistics	238	238	238	
Total number of weekly data	783	783	783	238
Mean of all weekly data	2.848	2.599	2.599	2.564
Standard deviation of all weekly data	2.798	2.740	2.740	2.811
Approximated mean annual runoff (mm/yr)	510	470	470	430

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

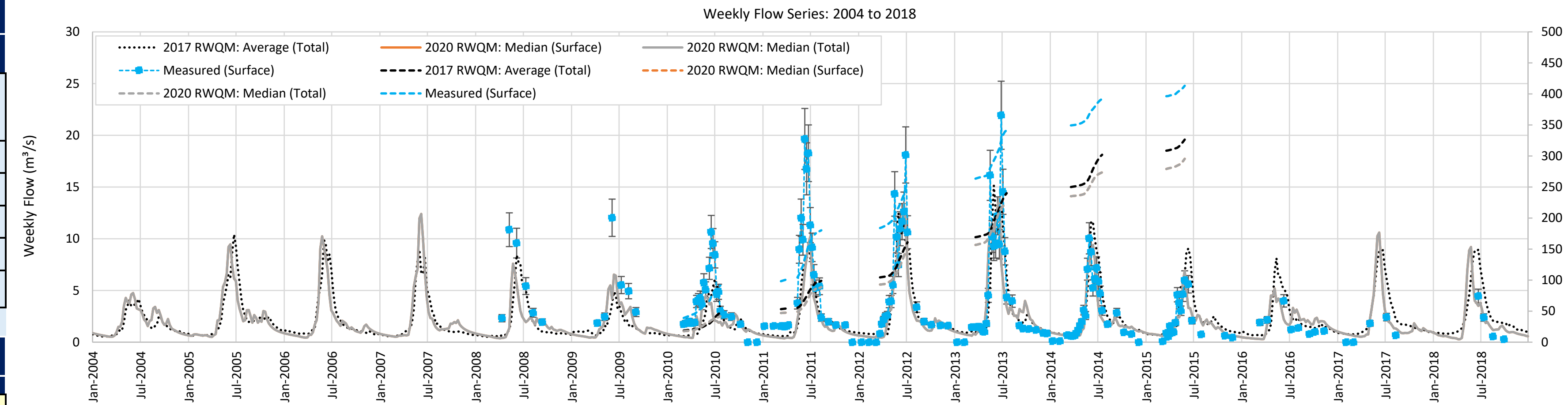
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

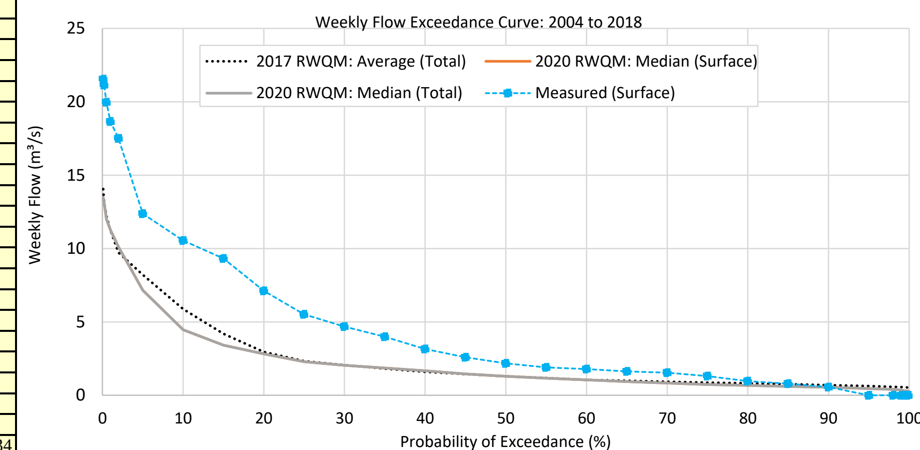
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

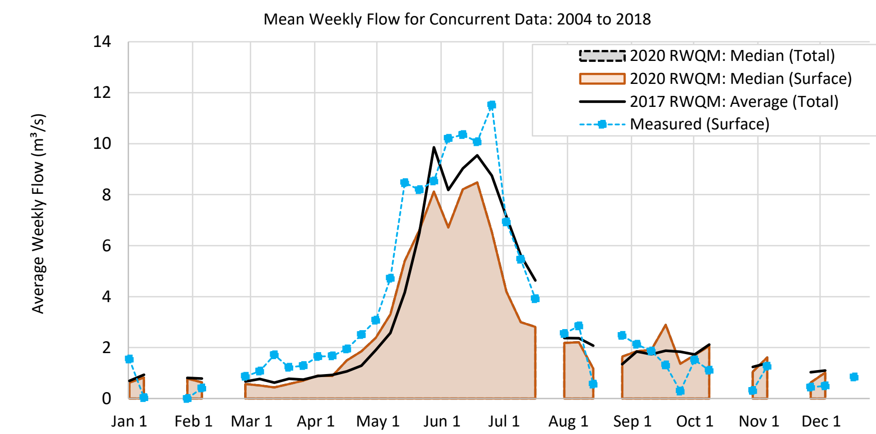
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

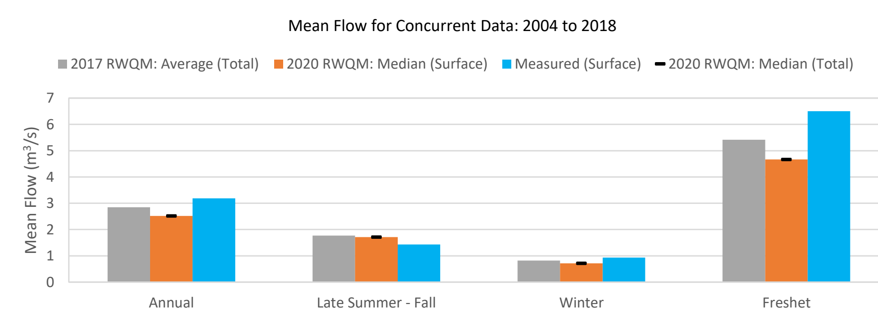
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	FR_FR2 + GH_SC1 + Swift Creek Upper Diversion + FR_SKP1 (sum of modelled flows)		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	32	Mean annual surface runoff (monitored)		470
Selected Year	2019	Mean annual total runoff (2020 RWQM)		390
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		22%
Station ID & Description	FR_FR4	Fording River downstream of Swift Creek, upstream of Cataract Creek (200311)		
Drainage Area (2018)	18240 ha	Disturbed Area (2018)		~ 26%

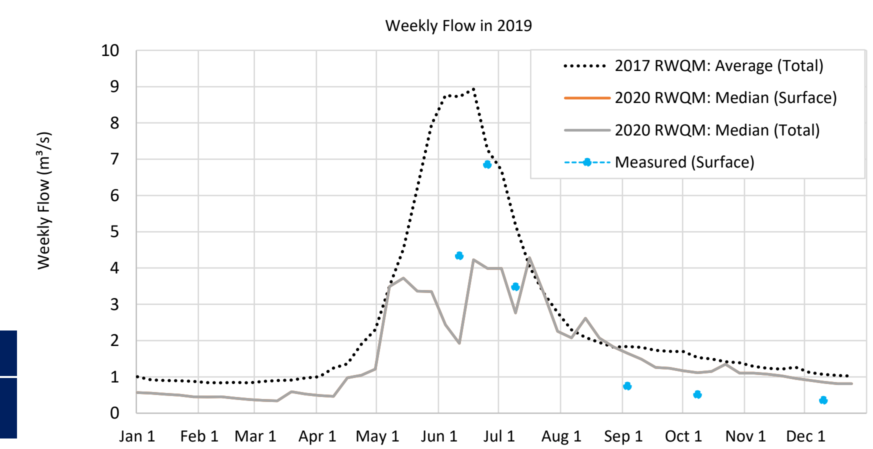
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	1.003	0.568	0.568	
2019-01-10	0.921	0.553	0.553	
2019-01-17	0.901	0.522	0.522	
2019-01-24	0.893	0.498	0.498	
2019-01-31	0.879	0.455	0.455	
2019-02-07	0.843	0.448	0.448	
2019-02-14	0.837	0.455	0.455	
2019-02-21	0.848	0.409	0.409	
2019-02-28	0.839	0.376	0.376	
2019-03-07	0.880	0.354	0.354	
2019-03-14	0.898	0.340	0.340	
2019-03-21	0.911	0.594	0.594	
2019-03-28	0.971	0.528	0.528	
2019-04-04	1.003	0.488	0.488	
2019-04-11	1.242	0.462	0.462	
2019-04-18	1.359	0.977	0.977	
2019-04-25	1.902	1.048	1.048	
2019-05-02	2.306	1.214	1.214	
2019-05-09	3.496	3.492	3.492	
2019-05-16	4.527	3.722	3.722	
2019-05-23	6.208	3.365	3.365	
2019-05-30	7.950	3.352	3.352	
2019-06-06	8.760	2.439	2.439	
2019-06-13	8.723	1.926	1.926	4.334
2019-06-20	8.929	4.230	4.230	
2019-06-27	7.263	3.992	3.992	6.847
2019-07-04	6.697	3.992	3.992	
2019-07-11	5.185	2.761	2.761	3.482
2019-07-18	4.043	4.287	4.287	
2019-07-25	3.319	3.327	3.327	
2019-08-01	2.774	2.255	2.255	
2019-08-08	2.299	2.074	2.074	
2019-08-15	2.087	2.617	2.617	
2019-08-22	1.948	2.070	2.070	
2019-08-29	1.822	1.828	1.828	
2019-09-05	1.835	1.651	1.651	0.746
2019-09-12	1.813	1.491	1.491	
2019-09-19	1.731	1.264	1.264	
2019-09-26	1.702	1.237	1.237	
2019-10-03	1.698	1.168	1.168	
2019-10-10	1.534	1.117	1.117	0.510
2019-10-17	1.493	1.149	1.149	
2019-10-24	1.420	1.346	1.346	
2019-10-31	1.389	1.105	1.105	
2019-11-07	1.288	1.102	1.102	
2019-11-14	1.238	1.078	1.078	
2019-11-21	1.212	1.028	1.028	
2019-11-28	1.267	0.960	0.960	
2019-12-05	1.124	0.905	0.905	
2019-12-12	1.071	0.854	0.854	0.354
2019-12-19	1.039	0.810	0.810	
2019-12-26	1.022	0.810	0.810	
Annual	2.49	1.56	1.56	2.71
Late Summer - Fall	1.78	1.57	1.57	0.63
Winter	0.94	0.55	0.55	0.35
Freshet	5.24	2.75	2.75	4.89











Statistics on concurrent data: 2004 to 2018	Acceptable	Acceptable		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.59	0.56	0.56	
Modified Nash-Sutcliffe efficiency (E1)	0.47	0.47	0.47	
Index of agreement (d)	0.86	0.84	0.84	
Modified index of agreement (d1)	0.72	0.71	0.71	
MAE	1.78	1.77	1.77	
RMSE	2.82	2.92	2.92	
Coefficient of Determination (R^2)	0.61	0.63	0.63	
Number of data in statistics	173	173	173	
Total number of weekly data	783	783	783	173
Mean of all weekly data	3.500	3.057	3.057	4.155
Standard deviation of all weekly data	3.480	3.136	3.136	4.403
Approximated mean annual runoff (mm/yr)	440	390	390	470

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

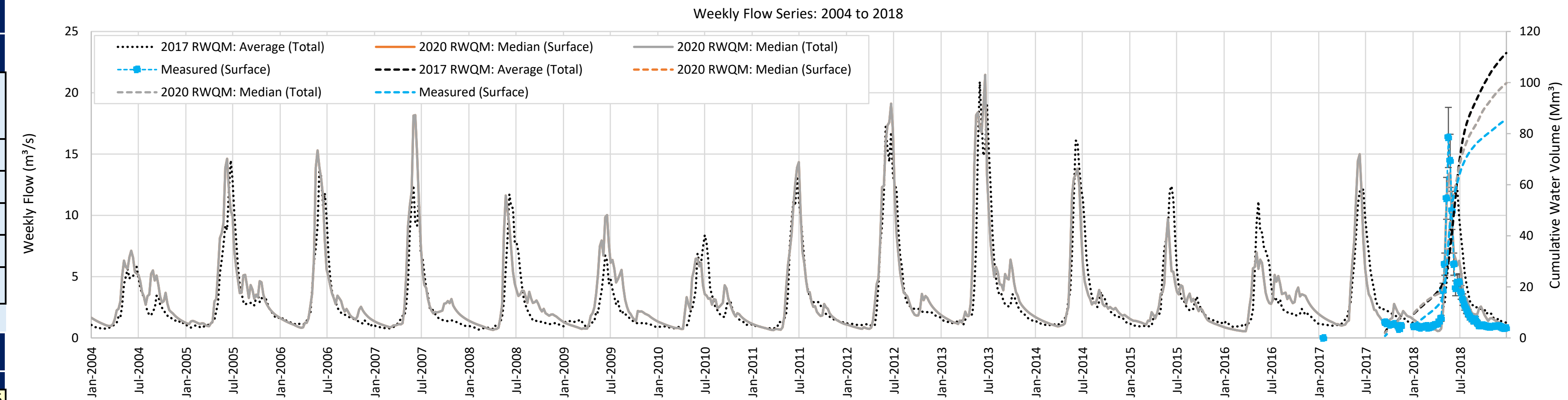
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

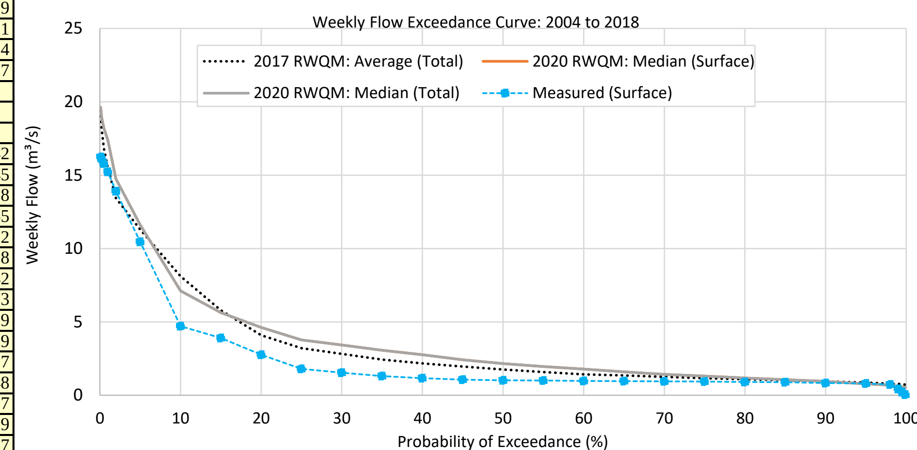
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

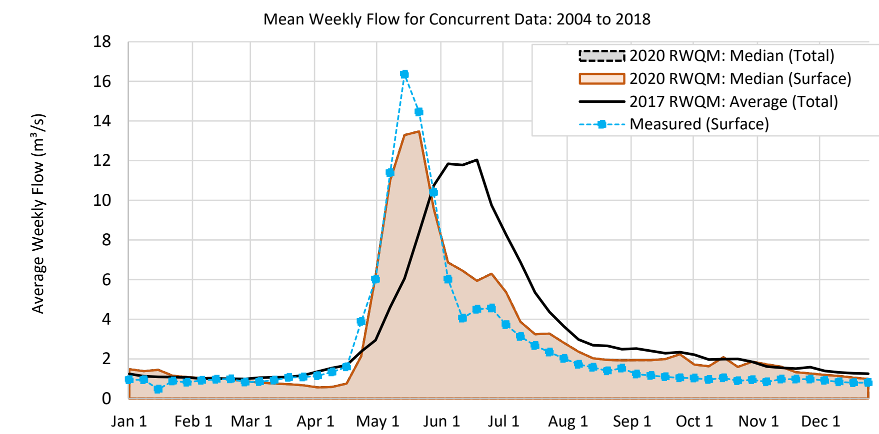
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

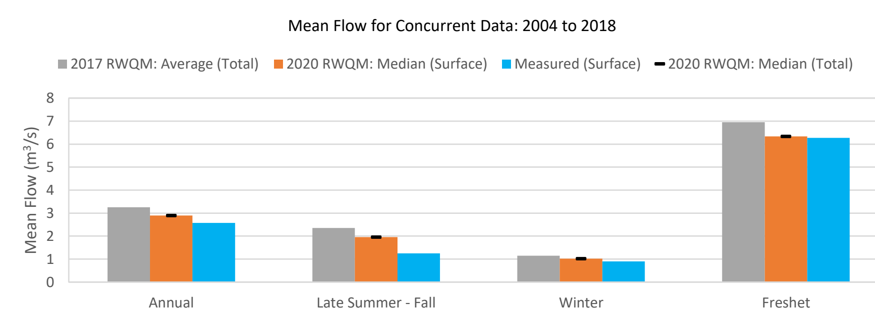
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	GH_PC2 + a portion of the Castle Mountain watershed and unnamed areas between GH_PC2 and FR_FRABCH (Sum of modelled flows)		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	46	Mean annual surface runoff (monitored)		380
Selected Year	2019	Mean annual total runoff (2020 RWQM)		430
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		8%
Station ID & Description	FR_FRABCH	Fording River above Chauncey Creek		
Drainage Area (2018)	21450 ha	Disturbed Area (2018)		~ 25%

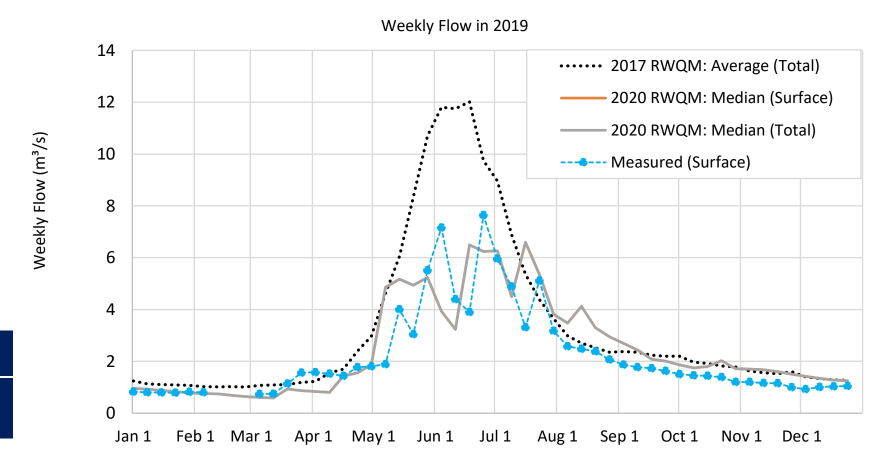
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m^3/s)	
2019-01-03	1.245	0.962	0.962	0.825
2019-01-10	1.129	0.927	0.927	0.808
2019-01-17	1.103	0.878	0.878	0.799
2019-01-24	1.091	0.836	0.836	0.791
2019-01-31	1.073	0.776	0.776	0.824
2019-02-07	1.021	0.754	0.754	0.807
2019-02-14	1.013	0.746	0.746	
2019-02-21	1.023	0.686	0.686	
2019-02-28	1.011	0.640	0.640	
2019-03-07	1.070	0.605	0.605	0.742
2019-03-14	1.093	0.589	0.589	0.745
2019-03-21	1.110	0.932	0.932	1.138
2019-03-28	1.187	0.870	0.870	1.565
2019-04-04	1.227	0.834	0.834	1.582
2019-04-11	1.553	0.804	0.804	1.518
2019-04-18	1.700	1.440	1.440	1.442
2019-04-25	2.394	1.555	1.555	1.773
2019-05-02	2.962	1.875	1.875	1.809
2019-05-09	4.618	4.858	4.858	1.889
2019-05-16	6.045	5.170	5.170	4.007
2019-05-23	8.341	4.937	4.937	3.048
2019-05-30	10.701	5.236	5.236	5.517
2019-06-06	11.803	3.931	3.931	7.159
2019-06-13	11.746	3.233	3.233	4.397
2019-06-20	12.015	6.494	6.494	3.903
2019-06-27	9.748	6.237	6.237	7.641
2019-07-04	8.963	6.264	6.264	5.950
2019-07-11	6.892	4.498	4.498	4.890
2019-07-18	5.362	6.593	6.593	3.316
2019-07-25	4.382	5.355	5.355	5.112
2019-08-01	3.646	3.816	3.816	3.179
2019-08-08	2.987	3.478	3.478	2.578
2019-08-15	2.705	4.122	4.122	2.479
2019-08-22	2.520	3.301	3.301	2.384
2019-08-29	2.353	2.945	2.945	2.067
2019-09-05	2.380	2.698	2.698	1.875
2019-09-12	2.350	2.441	2.441	1.777
2019-09-19	2.239	2.080	2.080	1.733
2019-09-26	2.200	2.009	2.009	1.625
2019-10-03	2.198	1.865	1.865	1.505
2019-10-10	1.973	1.753	1.753	1.454
2019-10-17	1.919	1.801	1.801	1.440
2019-10-24	1.822	2.027	2.027	1.387
2019-10-31	1.781	1.720	1.720	1.201
2019-11-07	1.628	1.704	1.704	1.202
2019-11-14	1.561	1.672	1.672	1.162
2019-11-21	1.524	1.603	1.603	1.152
2019-11-28	1.600	1.504	1.504	0.998
2019-12-05	1.402	1.424	1.424	0.928
2019-12-12	1.330	1.343	1.343	1.008
2019-12-19	1.288	1.275	1.275	1.030
2019-12-26	1.265	1.250	1.250	1.052
Annual	3.26	2.45	2.45	2.23
Late Summer - Fall	2.30	2.52	2.52	1.91
Winter	1.15	0.91	0.91	0.98
Freshet	6.99	4.21	4.21	3.88











Statistics on concurrent data: 2004 to 2018	Poor	Very good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.26	0.91	0.91	
Modified Nash-Sutcliffe efficiency (E1)	0.19	0.64	0.64	
Index of agreement (d)	0.76	0.98	0.98	
Modified index of agreement (d1)	0.57	0.81	0.81	
MAE	1.64	0.73	0.73	
RMSE	2.76	0.94	0.94	
Coefficient of Determination (R^2)	0.40	0.93	0.93	
Number of data in statistics	60	60	60	
Total number of weekly data	783	783	783	60
Mean of all weekly data	3.074	2.748	2.748	2.359
Standard deviation of all weekly data	2.989	2.925	2.925	3.231
Approximated mean annual runoff (mm/yr)	480	430	430	380

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

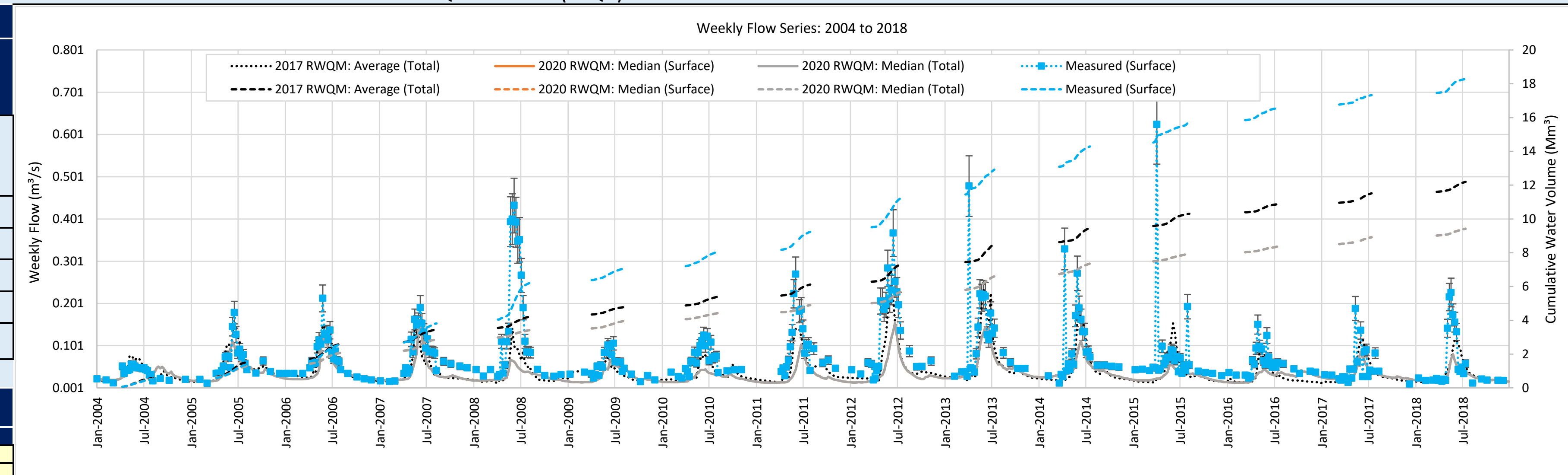
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

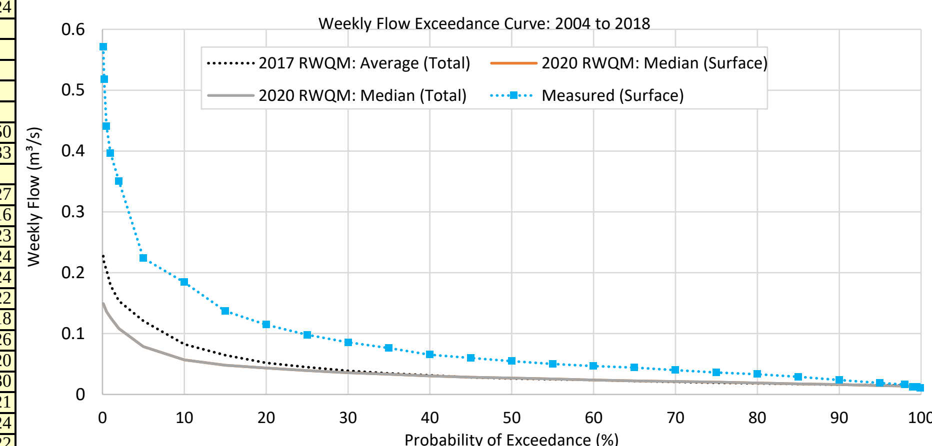
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

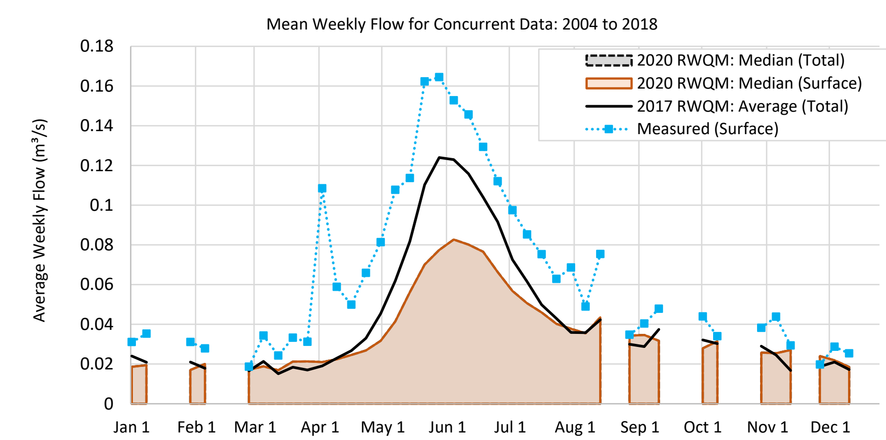
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - CALIBRATION DASHBOARD

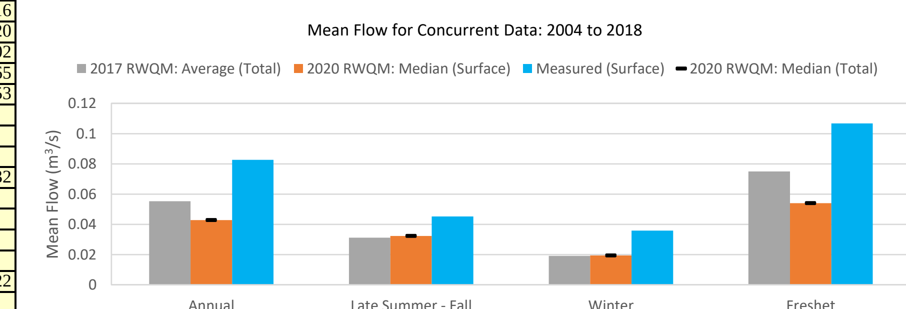
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Notes on Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchment Porter Creek		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	33	Mean annual runoff (monitored)		1010
Selected Year	2019	Mean annual runoff (2020 RWQM)		580
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		47%
Station ID & Description	GH_PC1	Porter Creek Sediment Pond Decant (200385)		
Drainage Area (2018)	180 ha	Disturbed Area (2018)		~ 52%

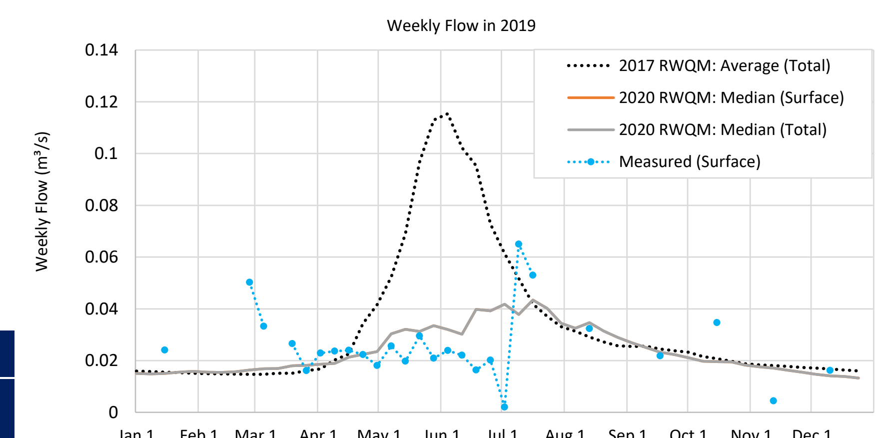
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.016	0.015	0.015	
2019-01-10	0.016	0.015	0.015	
2019-01-17	0.016	0.015	0.015	0.024
2019-01-24	0.015	0.016	0.016	
2019-01-31	0.015	0.016	0.016	
2019-02-07	0.015	0.016	0.016	
2019-02-14	0.015	0.015	0.015	
2019-02-21	0.015	0.016	0.016	
2019-02-28	0.015	0.016	0.016	0.050
2019-03-07	0.015	0.017	0.017	0.033
2019-03-14	0.015	0.017	0.017	
2019-03-21	0.015	0.018	0.018	0.027
2019-03-28	0.016	0.018	0.018	0.016
2019-04-04	0.017	0.019	0.019	0.023
2019-04-11	0.020	0.019	0.019	0.024
2019-04-18	0.023	0.021	0.021	0.024
2019-04-25	0.034	0.022	0.022	0.022
2019-05-02	0.042	0.023	0.023	0.018
2019-05-09	0.052	0.030	0.030	0.026
2019-05-16	0.069	0.032	0.032	0.020
2019-05-23	0.097	0.031	0.031	0.030
2019-05-30	0.113	0.034	0.034	0.021
2019-06-06	0.115	0.032	0.032	0.024
2019-06-13	0.102	0.030	0.030	0.022
2019-06-20	0.095	0.040	0.040	0.016
2019-06-27	0.073	0.039	0.039	0.020
2019-07-04	0.061	0.042	0.042	0.002
2019-07-11	0.052	0.038	0.038	0.065
2019-07-18	0.042	0.043	0.043	0.053
2019-07-25	0.037	0.040	0.040	
2019-08-01	0.033	0.034	0.034	
2019-08-08	0.031	0.033	0.033	
2019-08-15	0.029	0.035	0.035	0.032
2019-08-22	0.027	0.031	0.031	
2019-08-29	0.026	0.029	0.029	
2019-09-05	0.025	0.027	0.027	
2019-09-12	0.026	0.025	0.025	
2019-09-19	0.025	0.023	0.023	0.022
2019-09-26	0.024	0.022	0.022	
2019-10-03	0.023	0.021	0.021	
2019-10-10	0.022	0.020	0.020	
2019-10-17	0.021	0.020	0.020	0.035
2019-10-24	0.020	0.019	0.019	
2019-10-31	0.019	0.018	0.018	
2019-11-07	0.018	0.018	0.018	
2019-11-14	0.018	0.017	0.017	0.004
2019-11-21	0.018	0.016	0.016	
2019-11-28	0.017	0.015	0.015	
2019-12-05	0.017	0.015	0.015	
2019-12-12	0.017	0.014	0.014	0.016
2019-12-19	0.016	0.014	0.014	
2019-12-26	0.016	0.013	0.013	
Annual	0.03	0.02	0.02	0.03
Late Summer - Fall	0.02	0.02	0.02	0.02
Winter	0.02	0.02	0.02	0.03
Freshet	0.07	0.03	0.03	0.03











Statistics on concurrent data: 2004 to 2018	Poor	Poor		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.23	-0.01	-0.01	
Modified Nash-Sutcliffe efficiency (E1)	0.34	0.20	0.20	
Index of agreement (d)	0.66	0.53	0.53	
Modified index of agreement (d1)	0.65	0.57	0.57	
MAE	0.04	0.04	0.04	
RMSE	0.07	0.08	0.08	
Coefficient of Determination (R^2)	0.35	0.27	0.27	
Number of data in statistics	367	367	367	
Total number of weekly data	783	783	783	367
Mean of all weekly data	0.055	0.043	0.043	0.083
Standard deviation of all weekly data	0.044	0.028	0.028	0.079
Approximated mean annual runoff (mm/yr)	680	580	580	1010

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

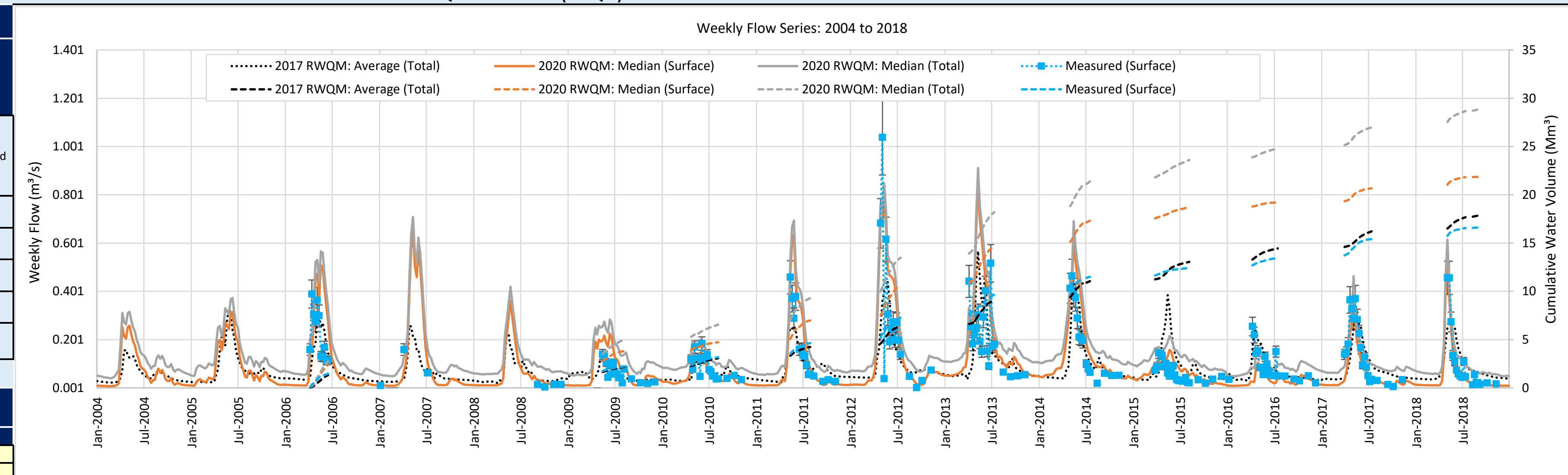
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

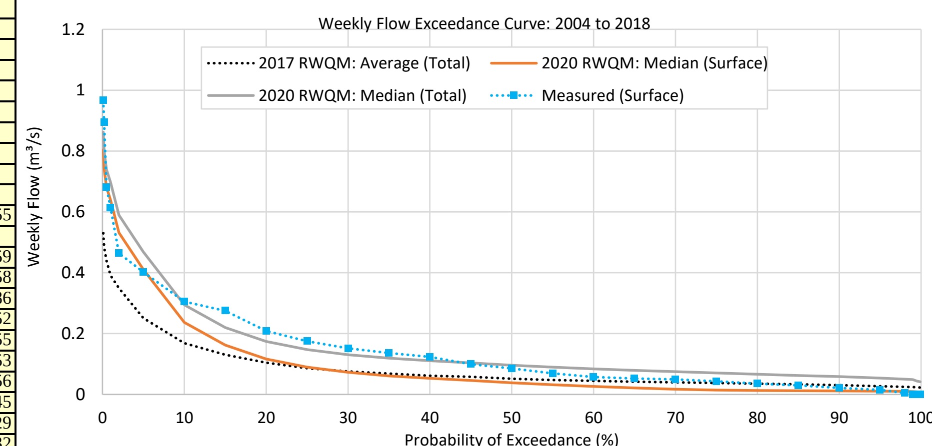
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

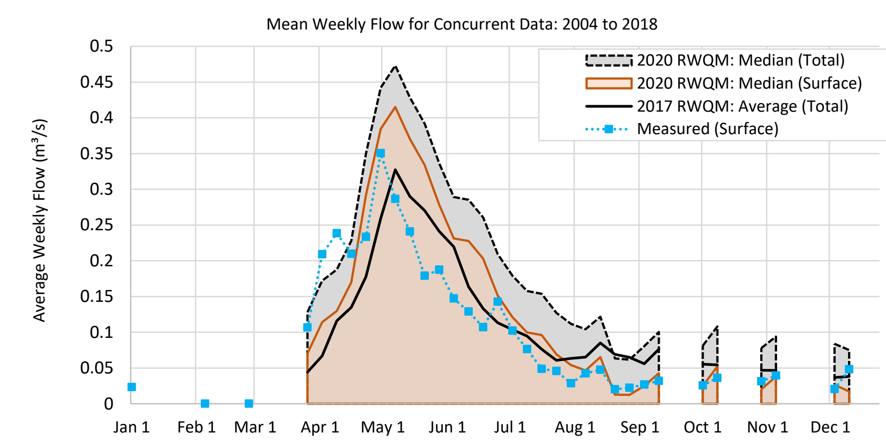
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - CALIBRATION DASHBOARD

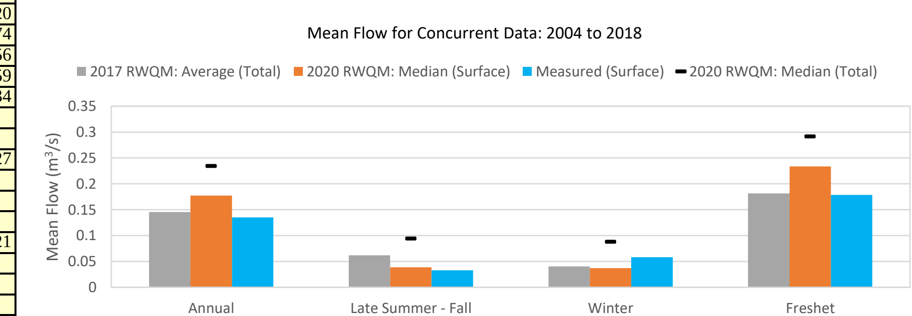
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Notes on Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchments Thompson Creek Upper & Lower, Phase 3 pit dewatering		Surface-Groundwater Partitioning	80%, maximum of 5,000 m3/d
Spinner ID	20	Mean annual runoff (monitored)		200
Selected Year	2019	Mean annual runoff (2020 RWQM)		370
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		26%
Station ID & Description	GH_TC1	Thompson Creek at LRP Road (E102714)		
Drainage Area (2018)	1210 ha	Disturbed Area (2018)		~ 23%

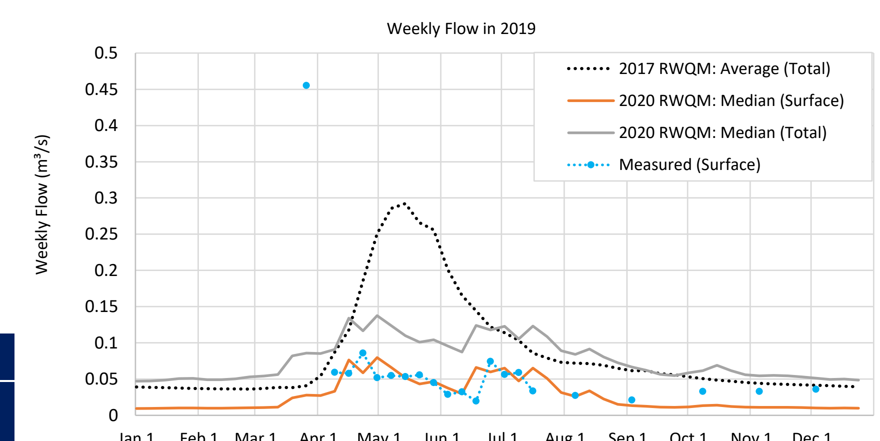
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.039	0.009	0.047	
2019-01-10	0.039	0.009	0.047	
2019-01-17	0.038	0.010	0.049	
2019-01-24	0.038	0.010	0.051	
2019-01-31	0.037	0.010	0.051	
2019-02-07	0.037	0.010	0.049	
2019-02-14	0.037	0.010	0.049	
2019-02-21	0.036	0.010	0.050	
2019-02-28	0.036	0.011	0.053	
2019-03-07	0.037	0.011	0.054	
2019-03-14	0.039	0.011	0.056	
2019-03-21	0.038	0.024	0.082	
2019-03-28	0.041	0.028	0.086	0.455
2019-04-04	0.054	0.027	0.085	
2019-04-11	0.087	0.033	0.091	0.059
2019-04-18	0.118	0.076	0.134	0.058
2019-04-25	0.186	0.059	0.117	0.086
2019-05-02	0.251	0.080	0.138	0.052
2019-05-09	0.286	0.066	0.124	0.055
2019-05-16	0.292	0.052	0.110	0.053
2019-05-23	0.266	0.043	0.101	0.056
2019-05-30	0.256	0.046	0.104	0.045
2019-06-06	0.201	0.038	0.096	0.029
2019-06-13	0.166	0.030	0.087	0.032
2019-06-20	0.144	0.066	0.124	0.020
2019-06-27	0.122	0.060	0.118	0.074
2019-07-04	0.114	0.065	0.123	0.056
2019-07-11	0.103	0.047	0.105	0.059
2019-07-18	0.086	0.065	0.123	0.034
2019-07-25	0.079	0.051	0.109	
2019-08-01	0.073	0.031	0.089	
2019-08-08	0.072	0.026	0.084	0.027
2019-08-15	0.071	0.034	0.092	
2019-08-22	0.069	0.023	0.081	
2019-08-29	0.065	0.015	0.073	
2019-09-05	0.062	0.013	0.067	0.021
2019-09-12	0.062	0.012	0.062	
2019-09-19	0.058	0.011	0.057	
2019-09-26	0.056	0.011	0.055	
2019-10-03	0.053	0.012	0.059	
2019-10-10	0.051	0.013	0.062	0.033
2019-10-17	0.049	0.014	0.069	
2019-10-24	0.047	0.012	0.062	
2019-10-31	0.045	0.011	0.056	
2019-11-07	0.044	0.011	0.055	0.033
2019-11-14	0.043	0.011	0.055	
2019-11-21	0.043	0.011	0.055	
2019-11-28	0.042	0.011	0.053	
2019-12-05	0.042	0.010	0.051	0.036
2019-12-12	0.041	0.010	0.050	
2019-12-19	0.040	0.010	0.050	
2019-12-26	0.039	0.010	0.049	
Annual	0.09	0.03	0.08	0.07
Late Summer - Fall	0.06	0.02	0.07	0.03
Winter	0.04	0.01	0.06	0.25
Freshet	0.18	0.06	0.11	0.05











Statistics on concurrent data: 2004 to 2018	Poor	Poor		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.36	0.08	-0.33	
Modified Nash-Sutcliffe efficiency (E1)	0.29	0.21	-0.12	
Index of agreement (d)	0.76	0.81	0.75	
Modified index of agreement (d1)	0.61	0.66	0.51	
MAE	0.07	0.08	0.11	
RMSE	0.11	0.14	0.16	
Coefficient of Determination (R^2)	0.39	0.53	0.53	
Number of data in statistics	204	204	204	
Total number of weekly data	783	783	783	204
Mean of all weekly data	0.145	0.177	0.235	0.135
Standard deviation of all weekly data	0.110	0.187	0.187	0.142
Approximated mean annual runoff (mm/yr)	230	230	370	200

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

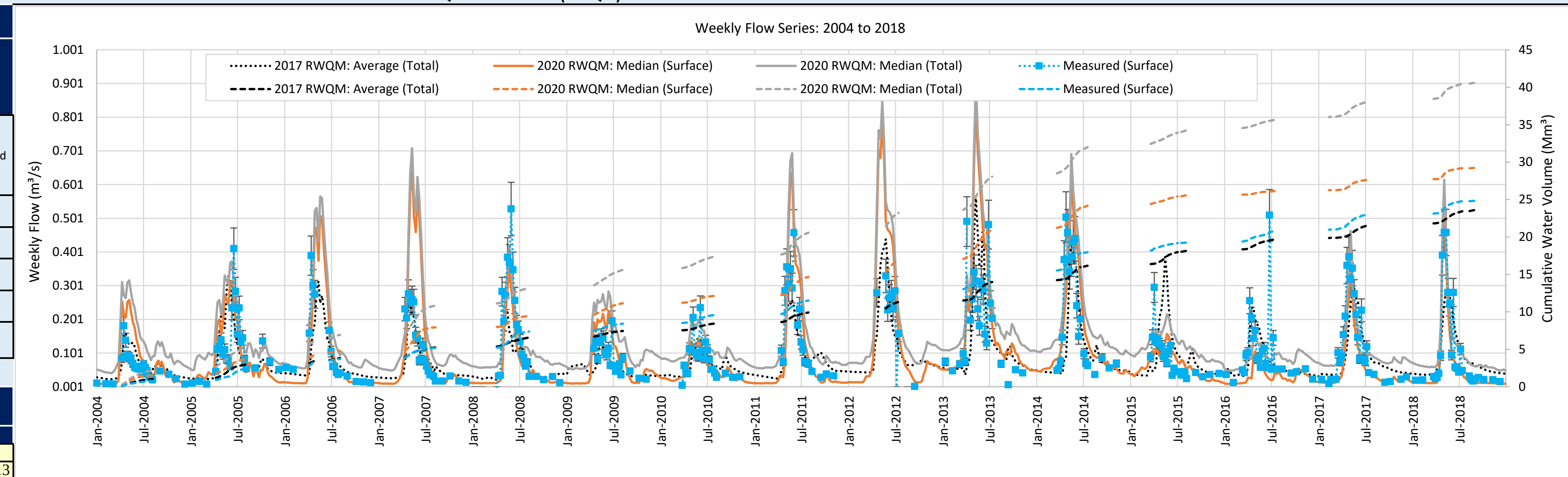
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

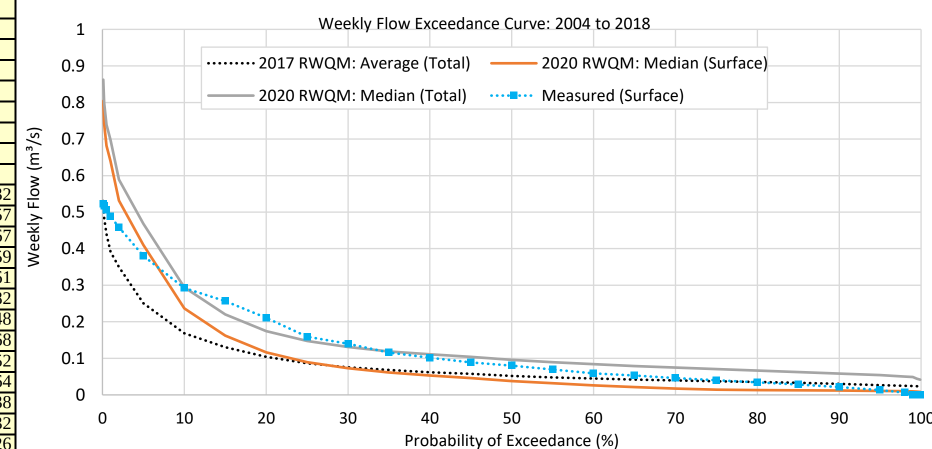
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

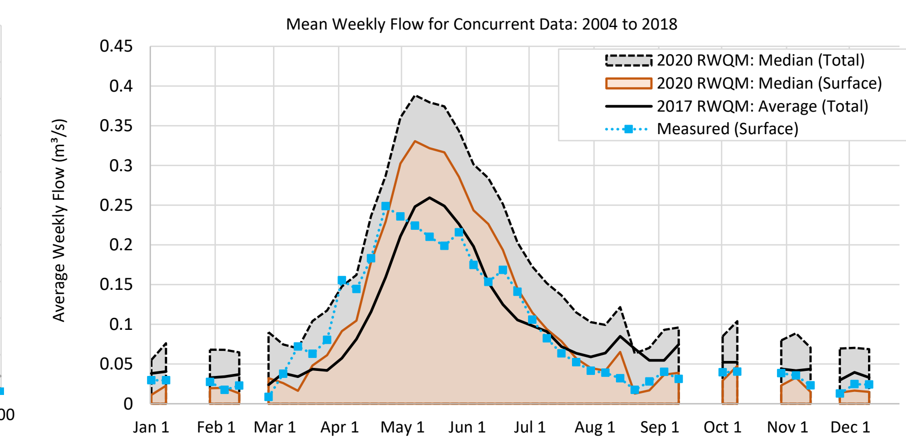
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - CALIBRATION DASHBOARD

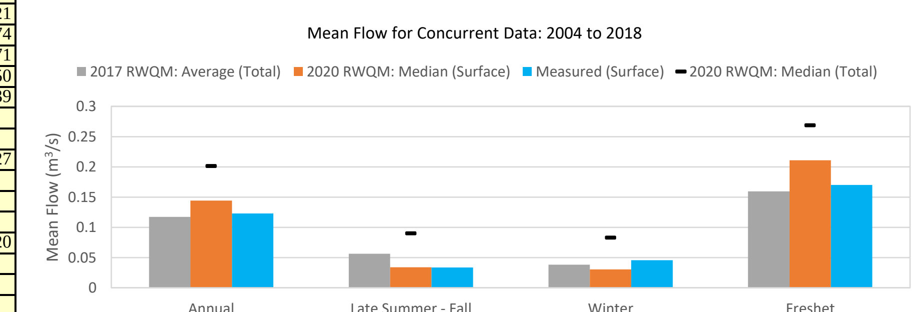
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Notes on Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchments Thompson Creek Upper & Lower, Phase 3 pit dewatering		**Surface-Groundwater Partitioning**	80%, maximum of 5,000 m3/d
Spinner ID	21	**Mean annual runoff (monitored)**		200
Selected Year	2019	**Mean annual runoff (2020 RWQM)**		360
Comparison Start Year	2004	**Evaluation period (weeks)**		783
Comparison End Year	2018	**Weeks with monitoring data (%)**		43%
Station ID & Description	**GH_TC2**	**Lower Thompson Creek Sediment Pond Decant (E207436)**		
Drainage Area (2018)	**1210 ha**	**Disturbed Area (2018)**		**~ 23%**

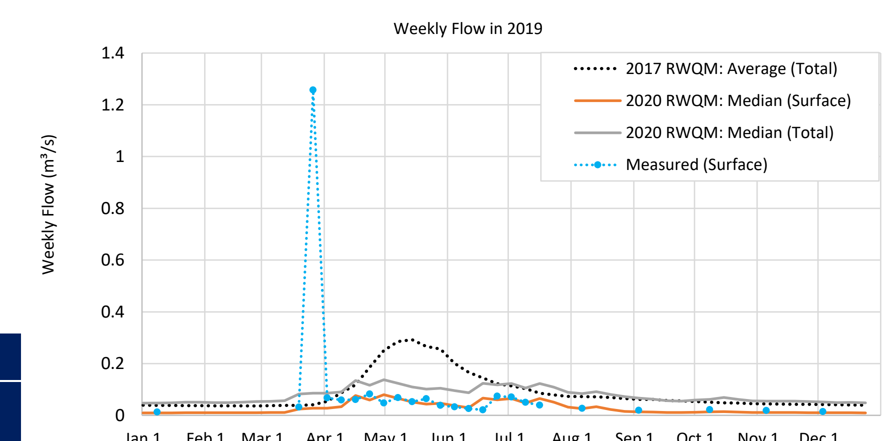
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.039	0.009	0.047	
2019-01-10	0.039	0.009	0.047	0.013
2019-01-17	0.038	0.010	0.049	
2019-01-24	0.038	0.010	0.051	
2019-01-31	0.037	0.010	0.051	
2019-02-07	0.037	0.010	0.049	
2019-02-14	0.037	0.010	0.049	
2019-02-21	0.036	0.010	0.050	
2019-02-28	0.036	0.011	0.053	
2019-03-07	0.037	0.011	0.054	
2019-03-14	0.039	0.011	0.056	
2019-03-21	0.038	0.024	0.082	0.032
2019-03-28	0.041	0.028	0.086	1.257
2019-04-04	0.054	0.027	0.085	0.067
2019-04-11	0.087	0.033	0.091	0.059
2019-04-18	0.118	0.076	0.134	0.061
2019-04-25	0.186	0.059	0.117	0.082
2019-05-02	0.251	0.080	0.138	0.048
2019-05-09	0.286	0.066	0.124	0.068
2019-05-16	0.292	0.052	0.110	0.052
2019-05-23	0.266	0.043	0.101	0.064
2019-05-30	0.256	0.046	0.104	0.038
2019-06-06	0.201	0.038	0.096	0.032
2019-06-13	0.166	0.030	0.087	0.026
2019-06-20	0.144	0.066	0.124	0.021
2019-06-27	0.122	0.060	0.118	0.074
2019-07-04	0.114	0.065	0.123	0.071
2019-07-11	0.103	0.047	0.105	0.050
2019-07-18	0.086	0.065	0.123	0.039
2019-07-25	0.079	0.051	0.109	
2019-08-01	0.073	0.031	0.089	
2019-08-08	0.072	0.026	0.084	0.027
2019-08-15	0.071	0.034	0.092	
2019-08-22	0.069	0.023	0.081	
2019-08-29	0.065	0.015	0.073	
2019-09-05	0.062	0.013	0.067	0.020
2019-09-12	0.062	0.012	0.062	
2019-09-19	0.058	0.011	0.057	
2019-09-26	0.056	0.011	0.055	
2019-10-03	0.053	0.012	0.059	
2019-10-10	0.051	0.013	0.062	0.022
2019-10-17	0.049	0.014	0.069	
2019-10-24	0.047	0.012	0.062	
2019-10-31	0.045	0.011	0.056	
2019-11-07	0.044	0.011	0.055	0.018
2019-11-14	0.043	0.011	0.055	
2019-11-21	0.043	0.011	0.055	
2019-11-28	0.042	0.011	0.053	
2019-12-05	0.042	0.010	0.051	0.015
2019-12-12	0.041	0.010	0.050	
2019-12-19	0.040	0.010	0.050	
2019-12-26	0.039	0.010	0.049	
Annual	0.09	0.03	0.08	0.09
Late Summer - Fall	0.06	0.02	0.07	0.02
Winter	0.04	0.01	0.06	0.28
Freshet	0.18	0.06	0.11	0.05











Statistics on concurrent data: 2004 to 2018	**Poor**	**Poor**		
Parameter	**2017 RWQM: Average (Total)**	**2020 RWQM: Median (Surface)**	**2020 RWQM: Median (Total)**	**Measured (Surface)**
Nash-Sutcliffe efficiency (E)	0.32	0.02	-0.41	
Modified Nash-Sutcliffe efficiency (E1)	0.33	0.22	-0.09	
Index of agreement (d)	0.76	0.80	0.74	
Modified index of agreement (d1)	0.63	0.65	0.51	
MAE	0.06	0.07	0.10	
RMSE	0.10	0.12	0.14	
Coefficient of Determination (R^2)	0.37	0.47	0.48	
Number of data in statistics	335	335	335	
Total number of weekly data	783	783	783	335
Mean of all weekly data	0.117	0.144	0.201	0.123
Standard deviation of all weekly data	0.094	0.156	0.157	0.116
Approximated mean annual runoff (mm/yr)	210	210	360	200

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

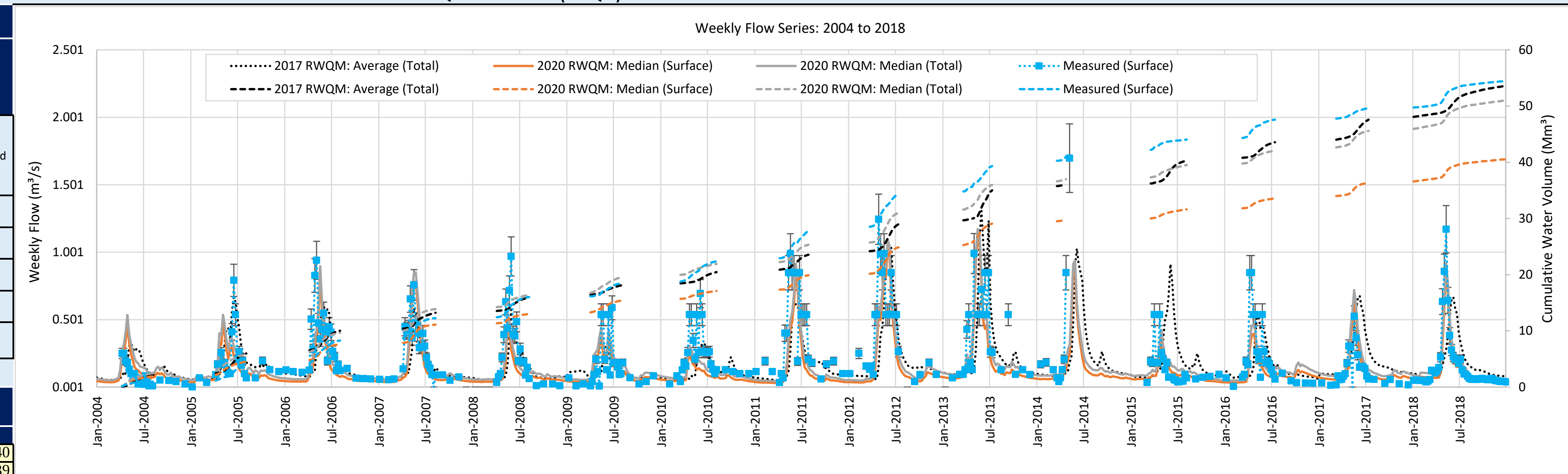
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

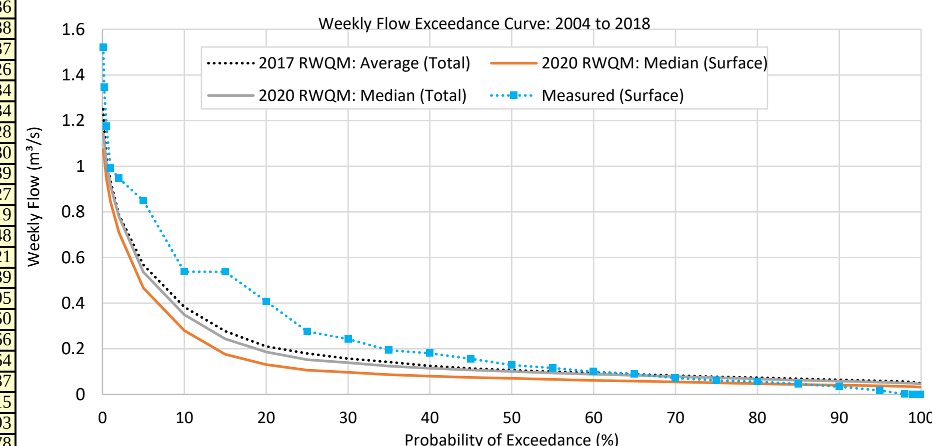
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

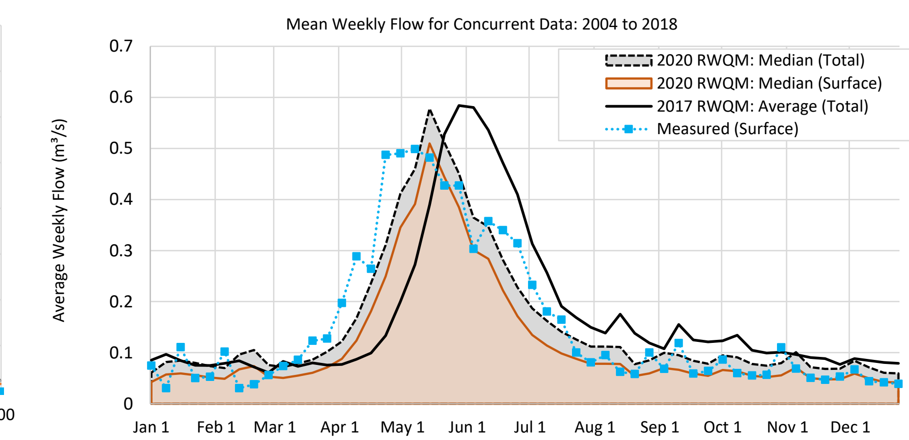
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - CALIBRATION DASHBOARD

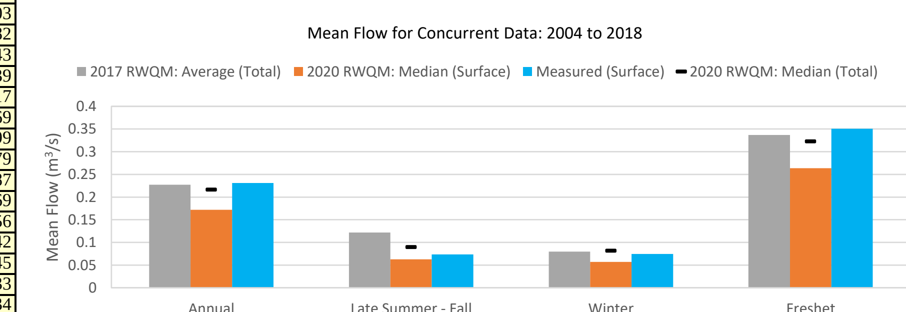
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Notes on Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchments Greenhills Creek North & South, process plant and tailings storage facilities		Surface-Groundwater Partitioning	30%, maximum of 6,000 m3/d
Spinner ID	28	Mean annual runoff (monitored)		320
Selected Year	2019	Mean annual runoff (2020 RWQM)		320
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		50%
Station ID & Description	GH_GH1	Greenhills Creek Sediment Pond Decant (E102709)		
Drainage Area (2018)	1520 ha	Disturbed Area (2018)		~ 25%

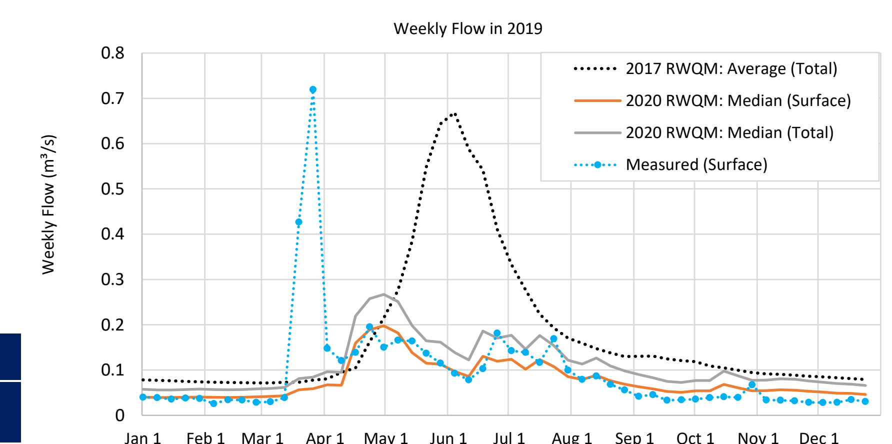
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.078	0.040	0.057	0.040
2019-01-10	0.077	0.039	0.056	0.039
2019-01-17	0.076	0.039	0.056	0.036
2019-01-24	0.075	0.040	0.057	0.038
2019-01-31	0.074	0.040	0.058	0.037
2019-02-07	0.073	0.040	0.057	0.026
2019-02-14	0.073	0.040	0.057	0.034
2019-02-21	0.072	0.040	0.057	0.034
2019-02-28	0.072	0.041	0.058	0.028
2019-03-07	0.072	0.042	0.060	0.030
2019-03-14	0.073	0.043	0.062	0.039
2019-03-21	0.073	0.057	0.081	0.427
2019-03-28	0.078	0.059	0.084	0.719
2019-04-04	0.081	0.068	0.096	0.148
2019-04-11	0.095	0.066	0.095	0.121
2019-04-18	0.105	0.160	0.219	0.139
2019-04-25	0.162	0.189	0.258	0.195
2019-05-02	0.215	0.198	0.267	0.150
2019-05-09	0.276	0.182	0.251	0.166
2019-05-16	0.385	0.139	0.198	0.164
2019-05-23	0.548	0.115	0.165	0.137
2019-05-30	0.644	0.113	0.161	0.115
2019-06-06	0.669	0.097	0.139	0.093
2019-06-13	0.588	0.086	0.122	0.078
2019-06-20	0.542	0.130	0.186	0.103
2019-06-27	0.411	0.119	0.171	0.182
2019-07-04	0.333	0.124	0.177	0.143
2019-07-11	0.277	0.102	0.146	0.139
2019-07-18	0.224	0.123	0.176	0.117
2019-07-25	0.193	0.108	0.154	0.169
2019-08-01	0.171	0.085	0.122	0.099
2019-08-08	0.159	0.079	0.113	0.079
2019-08-15	0.147	0.088	0.126	0.087
2019-08-22	0.138	0.076	0.109	0.069
2019-08-29	0.130	0.069	0.098	0.056
2019-09-05	0.131	0.063	0.090	0.042
2019-09-12	0.131	0.058	0.083	0.045
2019-09-19	0.125	0.053	0.075	0.033
2019-09-26	0.121	0.051	0.073	0.034
2019-10-03	0.119	0.054	0.077	0.035
2019-10-10	0.109	0.054	0.077	0.039
2019-10-17	0.105	0.069	0.098	0.041
2019-10-24	0.099	0.061	0.087	0.039
2019-10-31	0.094	0.054	0.077	0.067
2019-11-07	0.092	0.054	0.078	0.034
2019-11-14	0.091	0.056	0.080	0.033
2019-11-21	0.088	0.056	0.080	0.032
2019-11-28	0.086	0.053	0.076	0.028
2019-12-05	0.085	0.051	0.073	0.028
2019-12-12	0.083	0.049	0.070	0.029
2019-12-19	0.081	0.048	0.069	0.035
2019-12-26	0.079	0.046	0.066	0.030
Annual	0.18	0.08	0.11	0.09
Late Summer - Fall	0.12	0.07	0.09	0.06
Winter	0.08	0.05	0.07	0.10
Freshet	0.36	0.13	0.18	0.14











Statistics on concurrent data: 2004 to 2018	Poor	Poor but improved		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.01	0.35	0.41	
Modified Nash-Sutcliffe efficiency (E1)	0.15	0.34	0.36	
Index of agreement (d)	0.65	0.76	0.79	
Modified index of agreement (d1)	0.54	0.65	0.65	
MAE	0.16	0.12	0.12	
RMSE	0.25	0.20	0.19	
Coefficient of Determination (R^2)	0.19	0.41	0.44	
Number of data in statistics	390	390	390	
Total number of weekly data	783	783	783	390
Mean of all weekly data	0.227	0.172	0.216	0.231
Standard deviation of all weekly data	0.214	0.187	0.201	0.250
Approximated mean annual runoff (mm/yr)	350	250	320	320

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

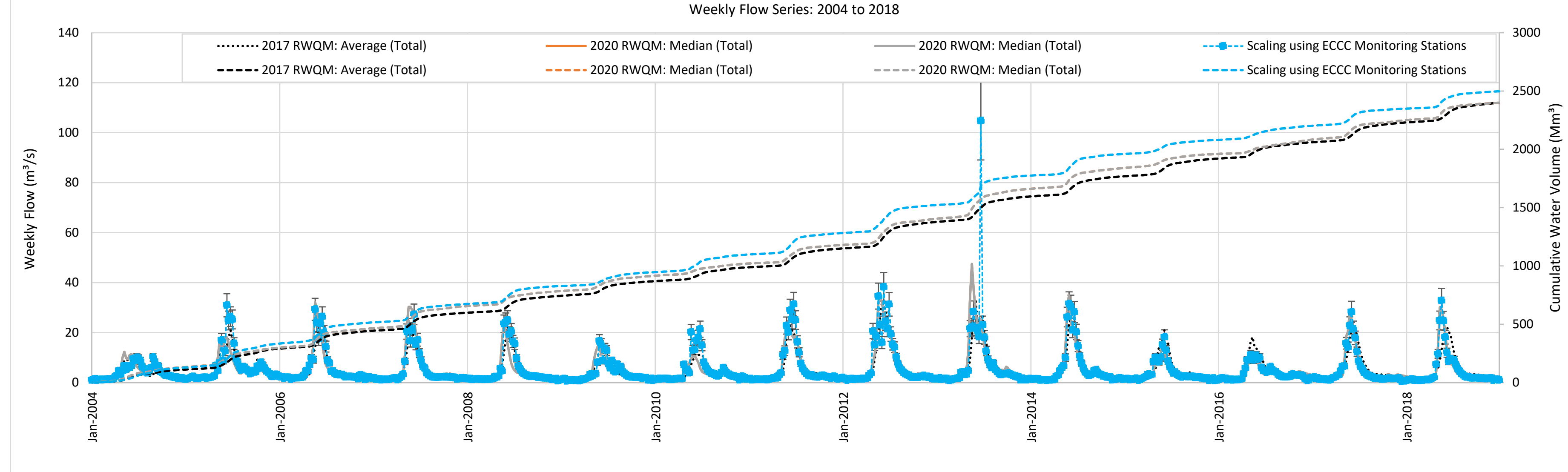
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

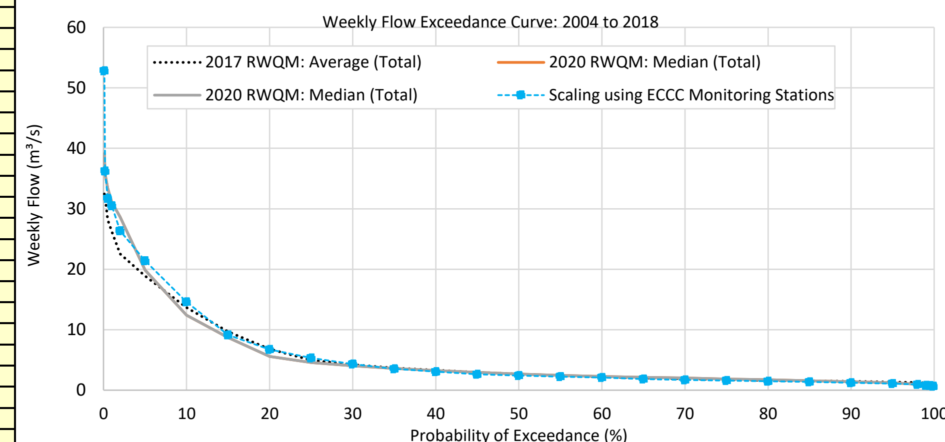
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

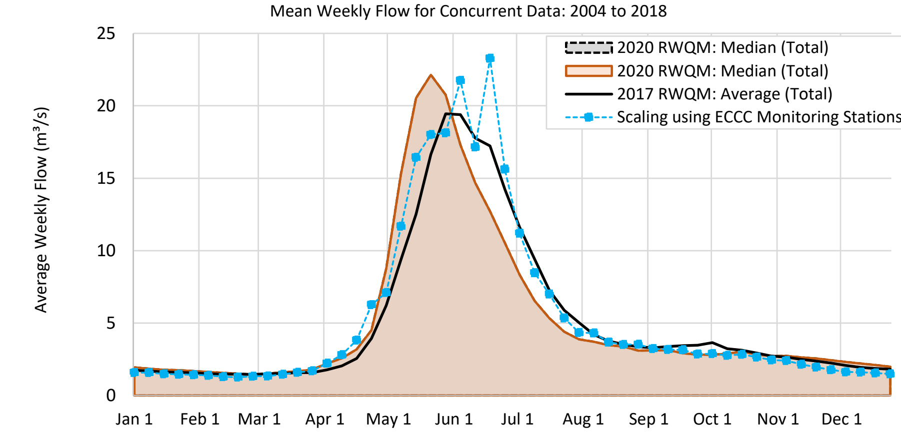
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - CALIBRATION DASHBOARD

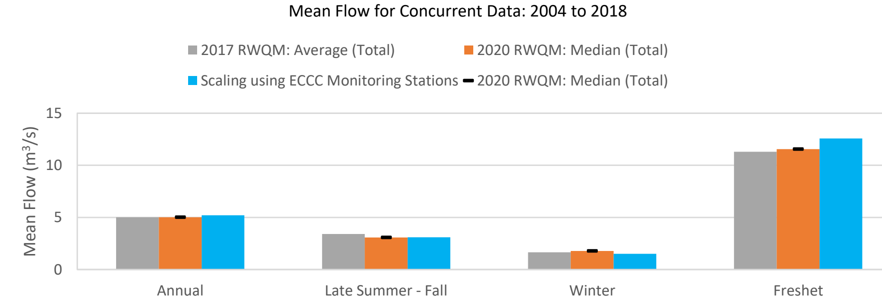
Scenario	2017RWQM_TF_MF	2020RWQM_TF_MF	2020RWQM_TF_MF	Scaling_Method
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Total)	2020 RWQM: Median (Total)	Scaling using ECCC Monitoring Stations
Notes on Flow Modelling Method	FR_FRABCH + Chauncey + Ewin + Todhunter + LCO Dry + Grace + GH_GH1 + unnamed areas between FR_FRABCH and GH_FR1 (Sum of modelled flows)	Surface-Groundwater Partitioning	Not implemented	
Spinner ID	17	Mean annual surface runoff (monitored)		410
Selected Year	2019	Mean annual total runoff (2020 RWQM)		390
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		100%
Station ID & Description	GH_FR1	Fording River downstream of Greenhills Creek (200378)		
Drainage Area (2018)	40750 ha	Disturbed Area (2018)		~ 15%

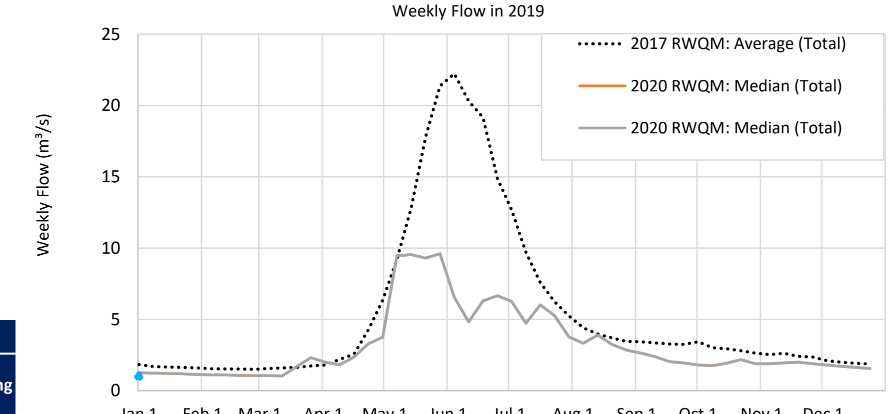
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Total)	2020 RWQM: Median (Total)	Scaling using ECCC Monitoring Stations
	Weekly Flow in 2019		(m³/s)	
2019-01-03	1.826	1.261	1.261	0.987
2019-01-10	1.693	1.225	1.225	
2019-01-17	1.653	1.195	1.195	
2019-01-24	1.628	1.179	1.179	
2019-01-31	1.597	1.130	1.130	
2019-02-07	1.538	1.105	1.105	
2019-02-14	1.517	1.103	1.103	
2019-02-21	1.516	1.064	1.064	
2019-02-28	1.494	1.052	1.052	
2019-03-07	1.547	1.043	1.043	
2019-03-14	1.598	1.033	1.033	
2019-03-21	1.622	1.684	1.684	
2019-03-28	1.738	2.311	2.311	
2019-04-04	1.791	1.986	1.986	
2019-04-11	2.190	1.816	1.816	
2019-04-18	2.563	2.363	2.363	
2019-04-25	4.261	3.291	3.291	
2019-05-02	6.347	3.741	3.741	
2019-05-09	9.196	9.456	9.456	
2019-05-16	12.825	9.538	9.538	
2019-05-23	17.787	9.287	9.287	
2019-05-30	21.366	9.603	9.603	
2019-06-06	22.228	6.549	6.549	
2019-06-13	20.308	4.832	4.832	
2019-06-20	19.152	6.296	6.296	
2019-06-27	14.891	6.651	6.651	
2019-07-04	12.700	6.264	6.264	
2019-07-11	9.704	4.717	4.717	
2019-07-18	7.584	6.017	6.017	
2019-07-25	6.233	5.253	5.253	
2019-08-01	5.232	3.762	3.762	
2019-08-08	4.398	3.314	3.314	
2019-08-15	3.977	3.893	3.893	
2019-08-22	3.696	3.249	3.249	
2019-08-29	3.455	2.847	2.847	
2019-09-05	3.424	2.629	2.629	
2019-09-12	3.345	2.386	2.386	
2019-09-19	3.270	2.039	2.039	
2019-09-26	3.247	1.947	1.947	
2019-10-03	3.420	1.798	1.798	
2019-10-10	3.011	1.748	1.748	
2019-10-17	2.931	1.909	1.909	
2019-10-24	2.801	2.169	2.169	
2019-10-31	2.635	1.885	1.885	
2019-11-07	2.521	1.892	1.892	
2019-11-14	2.617	1.943	1.943	
2019-11-21	2.397	1.991	1.991	
2019-11-28	2.365	1.889	1.889	
2019-12-05	2.102	1.792	1.792	
2019-12-12	1.989	1.703	1.703	
2019-12-19	1.917	1.629	1.629	
2019-12-26	1.869	1.551	1.551	
Annual	5.36	3.15	3.15	0.99
Late Summer - Fall	3.42	2.55	2.55	
Winter	1.70	1.39	1.39	0.99
Freshet	12.21	6.03	6.03	











Statistics on concurrent data: 2004 to 2018	Good	Good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Total)	2020 RWQM: Median (Total)	Scaling using ECCC Monitoring Stations
Nash-Sutcliffe efficiency (E)	0.70	0.69	0.69	
Modified Nash-Sutcliffe efficiency (E1)	0.66	0.65	0.65	
Index of agreement (d)	0.90	0.90	0.90	
Modified index of agreement (d1)	0.82	0.82	0.82	
MAE	1.53	1.58	1.58	
RMSE	4.01	4.08	4.08	
Coefficient of Determination (R²)	0.71	0.69	0.69	
Number of data in statistics	783	783	783	
Total number of weekly data	783	783	783	783
Mean of all weekly data	5.065	5.066	5.066	5.273
Standard deviation of all weekly data	5.678	6.306	6.306	7.339
Approximated mean annual runoff (mm/yr)	390	390	390	410

Notes

Performance statistics: For E, E1, d, d1, and R² a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

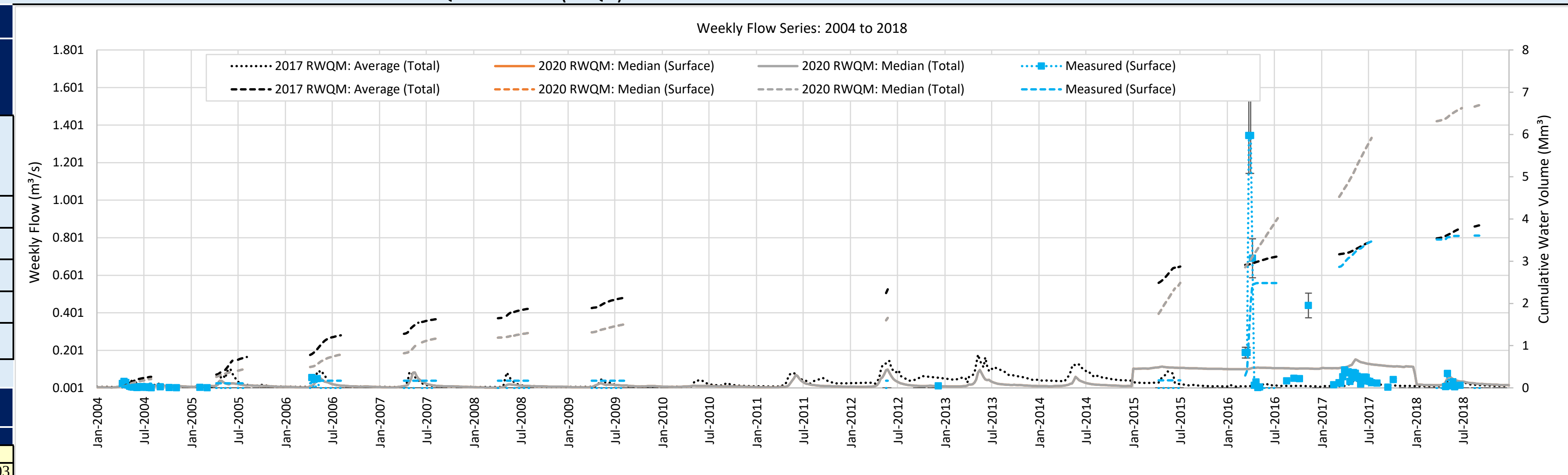
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

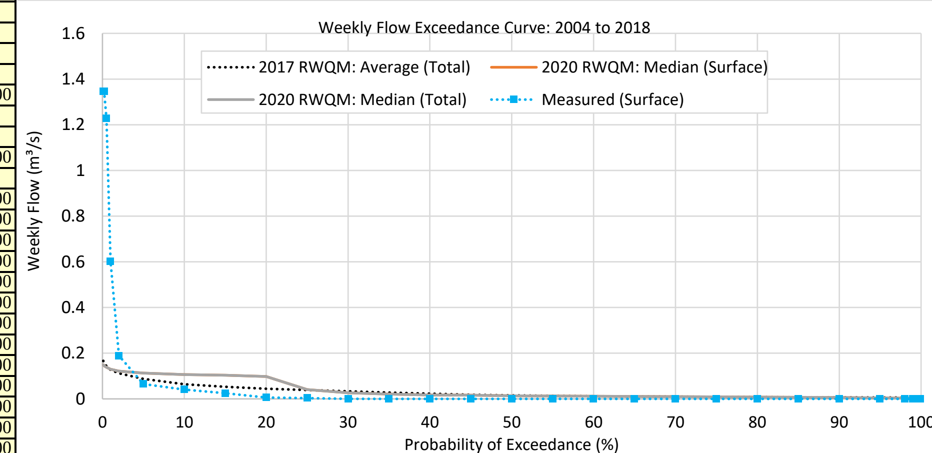
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

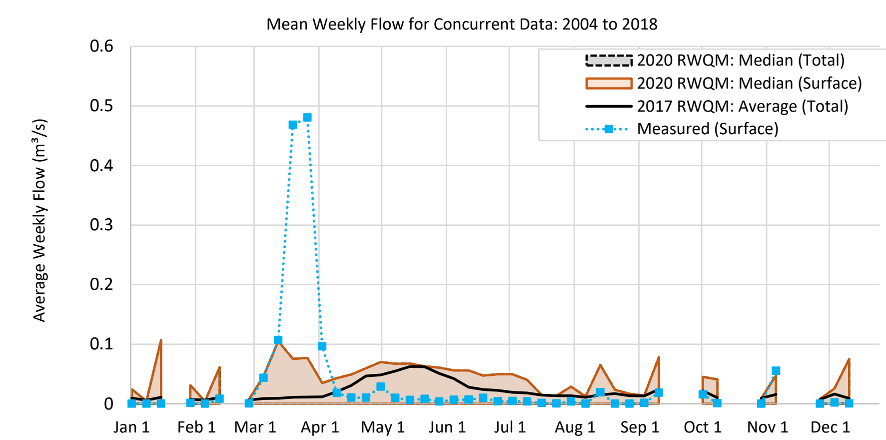
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - CALIBRATION DASHBOARD

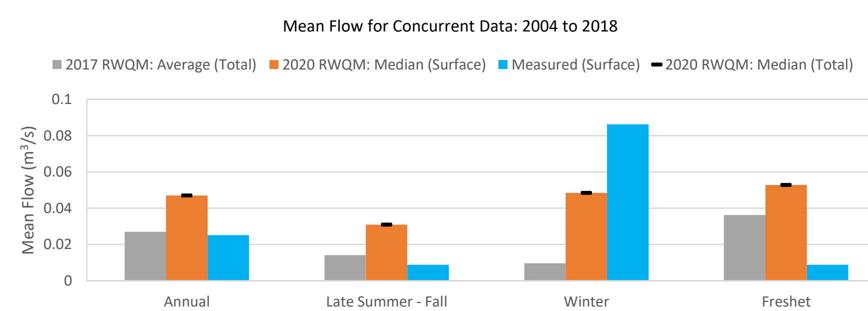
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Notes on Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchments Leask Creek Upper & Lower, Mickelson Creek from 2017, Phase 6 pit dewatering		**Surface-Groundwater Partitioning**	Not Implemented
Spinner ID	16	**Mean annual runoff (monitored)**		170
Selected Year	2019	**Mean annual runoff (2020 RWQM)**		250
Comparison Start Year	2004	**Evaluation period (weeks)**		783
Comparison End Year	2018	**Weeks with monitoring data (%)**		30%
Station ID & Description	GH_LC1	**Leask Creek Sediment Pond Decant (E257796)**		
Drainage Area (2018)	540 ha	**Disturbed Area (2018)**		~ 91%

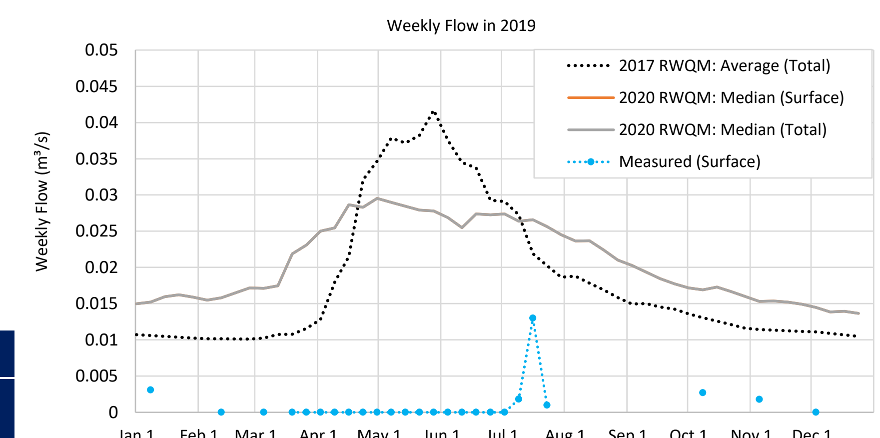
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m^3/s)	
2019-01-03	0.011	0.015	0.015	
2019-01-10	0.011	0.015	0.015	0.003
2019-01-17	0.010	0.016	0.016	
2019-01-24	0.010	0.016	0.016	
2019-01-31	0.010	0.016	0.016	
2019-02-07	0.010	0.015	0.015	
2019-02-14	0.010	0.016	0.016	0.000
2019-02-21	0.010	0.016	0.016	
2019-02-28	0.010	0.017	0.017	
2019-03-07	0.010	0.017	0.017	0.000
2019-03-14	0.011	0.017	0.017	
2019-03-21	0.011	0.022	0.022	0.000
2019-03-28	0.012	0.023	0.023	0.000
2019-04-04	0.013	0.025	0.025	0.000
2019-04-11	0.018	0.025	0.025	0.000
2019-04-18	0.022	0.029	0.029	0.000
2019-04-25	0.032	0.028	0.028	0.000
2019-05-02	0.035	0.030	0.030	0.000
2019-05-09	0.038	0.029	0.029	0.000
2019-05-16	0.037	0.028	0.028	0.000
2019-05-23	0.038	0.028	0.028	0.000
2019-05-30	0.042	0.028	0.028	0.000
2019-06-06	0.038	0.027	0.027	0.000
2019-06-13	0.034	0.025	0.025	0.000
2019-06-20	0.034	0.027	0.027	0.000
2019-06-27	0.029	0.027	0.027	0.000
2019-07-04	0.029	0.027	0.027	0.000
2019-07-11	0.027	0.026	0.026	0.002
2019-07-18	0.022	0.027	0.027	0.013
2019-07-25	0.020	0.026	0.026	0.001
2019-08-01	0.019	0.025	0.025	
2019-08-08	0.019	0.024	0.024	0.033
2019-08-15	0.018	0.024	0.024	
2019-08-22	0.017	0.022	0.022	
2019-08-29	0.016	0.021	0.021	
2019-09-05	0.015	0.020	0.020	0.047
2019-09-12	0.015	0.019	0.019	
2019-09-19	0.015	0.018	0.018	
2019-09-26	0.014	0.018	0.018	
2019-10-03	0.014	0.017	0.017	
2019-10-10	0.013	0.017	0.017	0.003
2019-10-17	0.013	0.017	0.017	
2019-10-24	0.012	0.017	0.017	
2019-10-31	0.012	0.016	0.016	
2019-11-07	0.011	0.015	0.015	0.002
2019-11-14	0.011	0.015	0.015	
2019-11-21	0.011	0.015	0.015	
2019-11-28	0.011	0.015	0.015	
2019-12-05	0.011	0.014	0.014	0.000
2019-12-12	0.011	0.014	0.014	
2019-12-19	0.011	0.014	0.014	
2019-12-26	0.010	0.014	0.014	
Annual	0.02	0.02	0.02	0.00
Late Summer - Fall	0.01	0.02	0.02	0.02
Winter	0.01	0.02	0.02	0.00
Freshet	0.03	0.03	0.03	0.00











Statistics on concurrent data: 2004 to 2018	Poor	Poor but improved		
Parameter	**2017 RWQM: Average (Total)**	**2020 RWQM: Median (Surface)**	**2020 RWQM: Median (Total)**	**Measured (Surface)**
Nash-Sutcliffe efficiency (E)	-0.06	0.02	0.02	
Modified Nash-Sutcliffe efficiency (E1)	-0.06	-0.29	-0.29	
Index of agreement (d)	0.04	0.29	0.29	
Modified index of agreement (d1)	0.25	0.30	0.30	
MAE	0.04	0.05	0.05	
RMSE	0.14	0.13	0.13	
Coefficient of Determination (R^2)	0.01	0.06	0.06	
Number of data in statistics	237	237	237	
Total number of weekly data	783	783	783	237
Mean of all weekly data	0.027	0.047	0.047	0.025
Standard deviation of all weekly data	0.024	0.044	0.044	0.135
Approximated mean annual runoff (mm/yr)	110	250	250	170

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

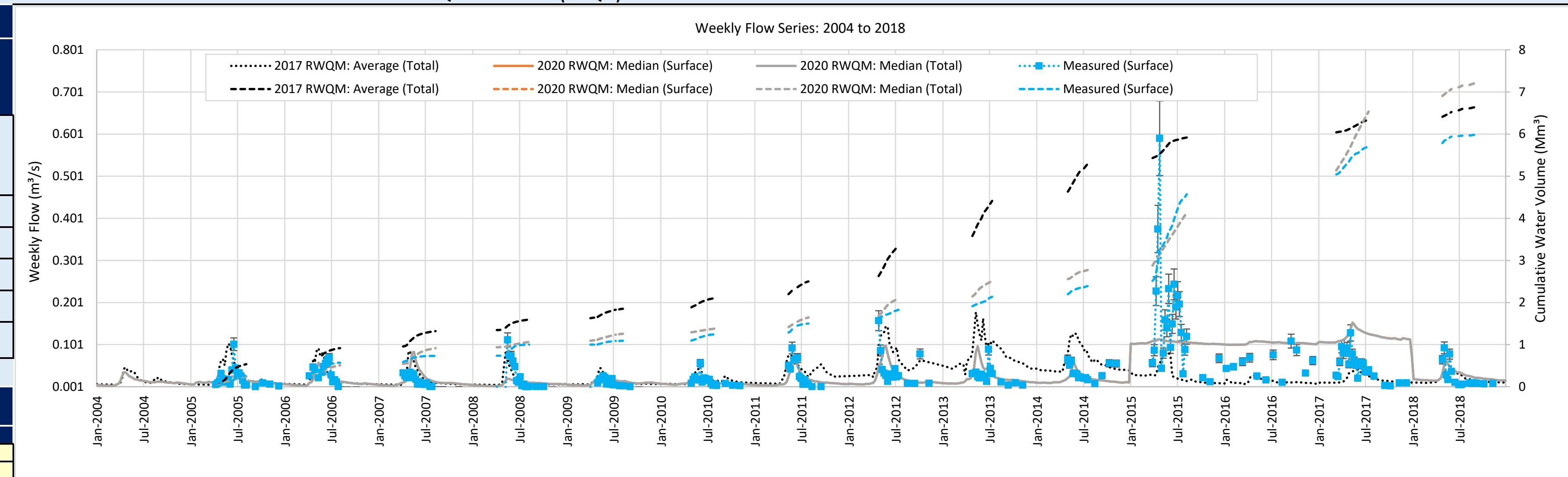
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

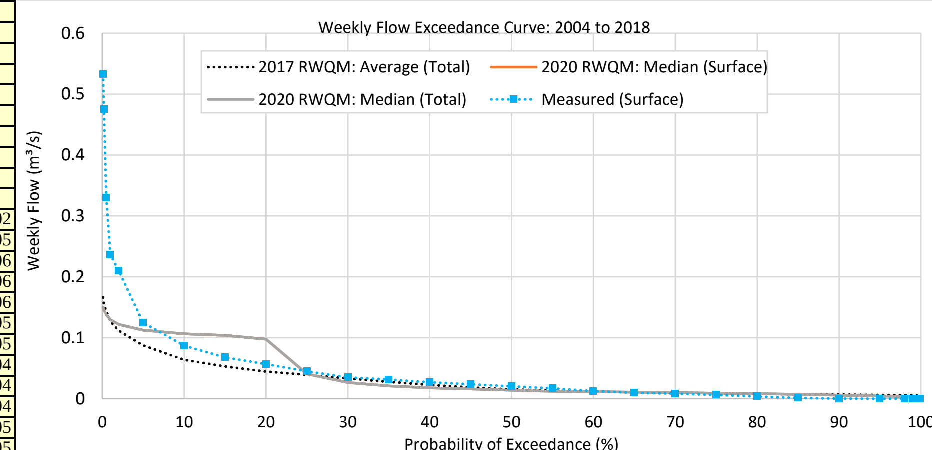
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

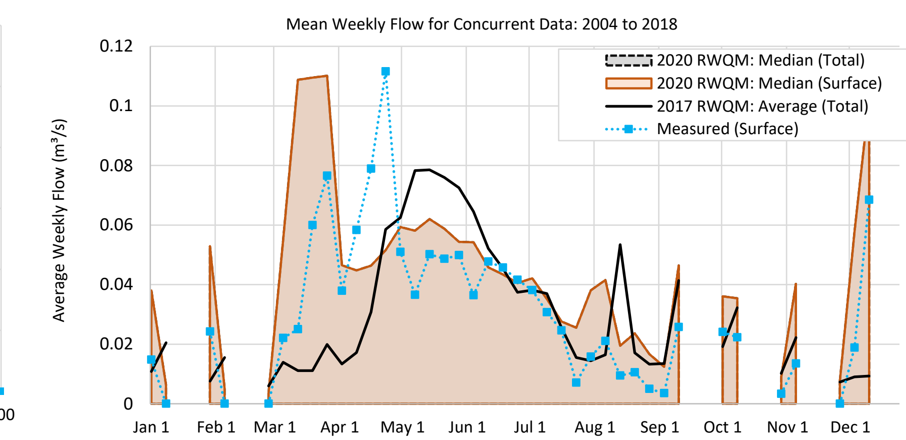
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - CALIBRATION DASHBOARD

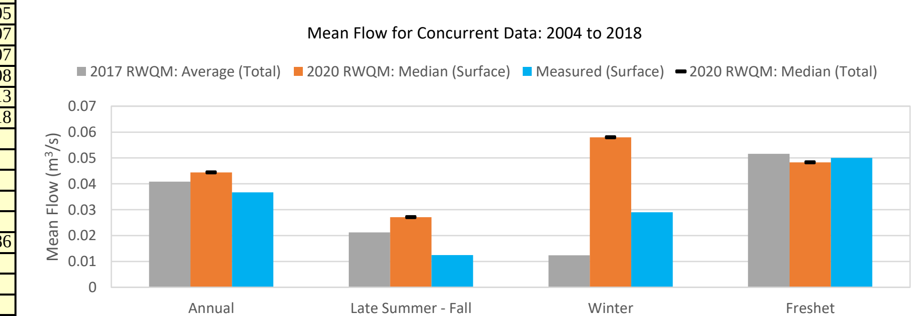
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Notes on Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchments Leask Creek Upper & Lower, Mickelson Creek from 2017, Phase 6 pit dewatering		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	17	Mean annual runoff (monitored)		160
Selected Year	2019	Mean annual runoff (2020 RWQM)		250
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		34%
Station ID & Description	GH_LC2	Leask Creek u/s of Pond Inlet		
Drainage Area (2018)	540 ha	Disturbed Area (2018)		~ 91%

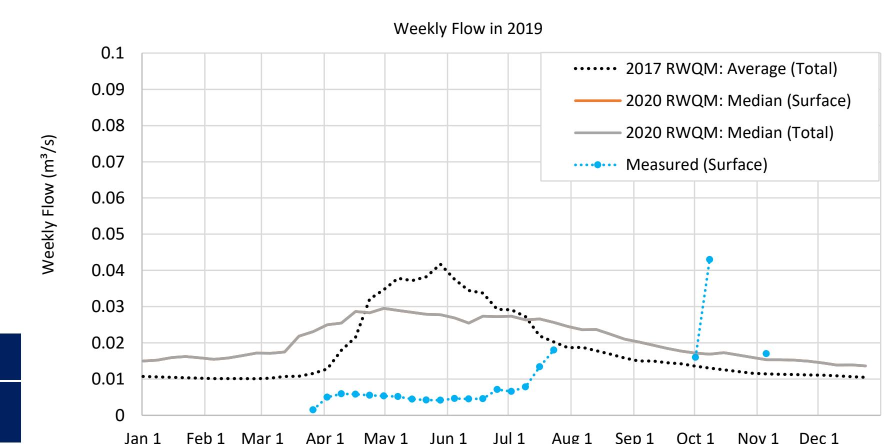
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m^3/s)	
2019-01-03	0.011	0.015	0.015	
2019-01-10	0.011	0.015	0.015	
2019-01-17	0.010	0.016	0.016	
2019-01-24	0.010	0.016	0.016	
2019-01-31	0.010	0.016	0.016	
2019-02-07	0.010	0.015	0.015	
2019-02-14	0.010	0.016	0.016	
2019-02-21	0.010	0.016	0.016	
2019-02-28	0.010	0.017	0.017	
2019-03-07	0.010	0.017	0.017	
2019-03-14	0.011	0.017	0.017	
2019-03-21	0.011	0.022	0.022	
2019-03-28	0.012	0.023	0.023	0.002
2019-04-04	0.013	0.025	0.025	0.005
2019-04-11	0.018	0.025	0.025	0.006
2019-04-18	0.022	0.029	0.029	0.006
2019-04-25	0.032	0.028	0.028	0.006
2019-05-02	0.035	0.030	0.030	0.005
2019-05-09	0.038	0.029	0.029	0.005
2019-05-16	0.037	0.028	0.028	0.004
2019-05-23	0.038	0.028	0.028	0.004
2019-05-30	0.042	0.028	0.028	0.004
2019-06-06	0.038	0.027	0.027	0.005
2019-06-13	0.034	0.025	0.025	0.005
2019-06-20	0.034	0.027	0.027	0.005
2019-06-27	0.029	0.027	0.027	0.007
2019-07-04	0.029	0.027	0.027	0.007
2019-07-11	0.027	0.026	0.026	0.008
2019-07-18	0.022	0.027	0.027	0.013
2019-07-25	0.020	0.026	0.026	0.018
2019-08-01	0.019	0.025	0.025	
2019-08-08	0.019	0.024	0.024	
2019-08-15	0.018	0.024	0.024	
2019-08-22	0.017	0.022	0.022	
2019-08-29	0.016	0.021	0.021	
2019-09-05	0.015	0.020	0.020	0.086
2019-09-12	0.015	0.019	0.019	
2019-09-19	0.015	0.018	0.018	
2019-09-26	0.014	0.018	0.018	
2019-10-03	0.014	0.017	0.017	0.016
2019-10-10	0.013	0.017	0.017	0.043
2019-10-17	0.013	0.017	0.017	
2019-10-24	0.012	0.017	0.017	
2019-10-31	0.012	0.016	0.016	
2019-11-07	0.011	0.015	0.015	0.017
2019-11-14	0.011	0.015	0.015	
2019-11-21	0.011	0.015	0.015	
2019-11-28	0.011	0.015	0.015	
2019-12-05	0.011	0.014	0.014	
2019-12-12	0.011	0.014	0.014	
2019-12-19	0.011	0.014	0.014	
2019-12-26	0.010	0.014	0.014	
Annual	0.02	0.02	0.02	0.01
Late Summer - Fall	0.01	0.02	0.02	0.04
Winter	0.01	0.02	0.02	0.00
Freshet	0.03	0.03	0.03	0.01











Statistics on concurrent data: 2004 to 2018	Poor	Poor but improved		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	-0.21	0.19	0.19	
Modified Nash-Sutcliffe efficiency (E1)	-0.11	0.11	0.11	
Index of agreement (d)	0.35	0.66	0.66	
Modified index of agreement (d1)	0.39	0.55	0.55	
MAE	0.04	0.03	0.03	
RMSE	0.06	0.05	0.05	
Coefficient of Determination (R^2)	0.02	0.25	0.25	
Number of data in statistics	270	270	270	
Total number of weekly data	783	783	783	270
Mean of all weekly data	0.041	0.044	0.044	0.037
Standard deviation of all weekly data	0.036	0.041	0.041	0.058
Approximated mean annual runoff (mm/yr)	160	250	250	160

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

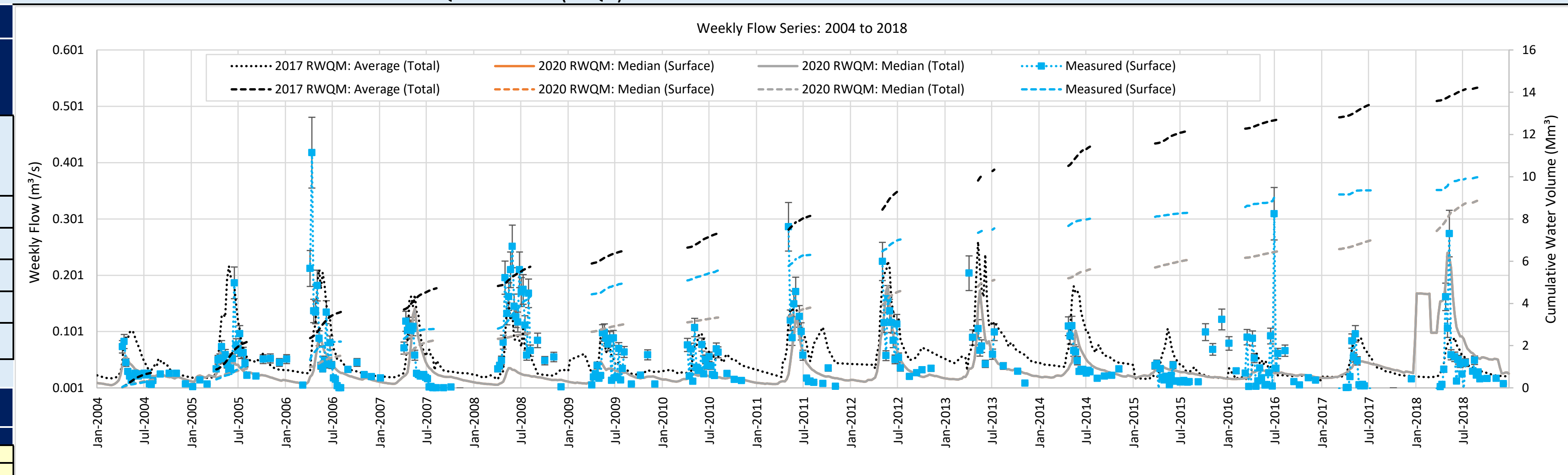
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

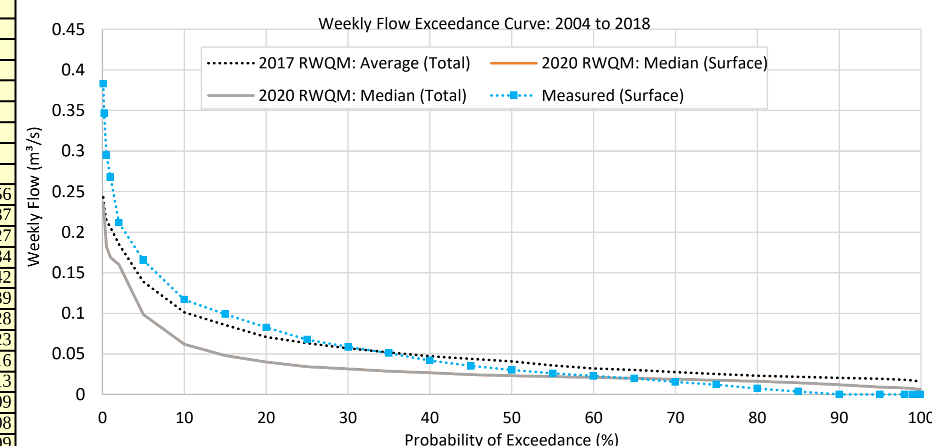
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

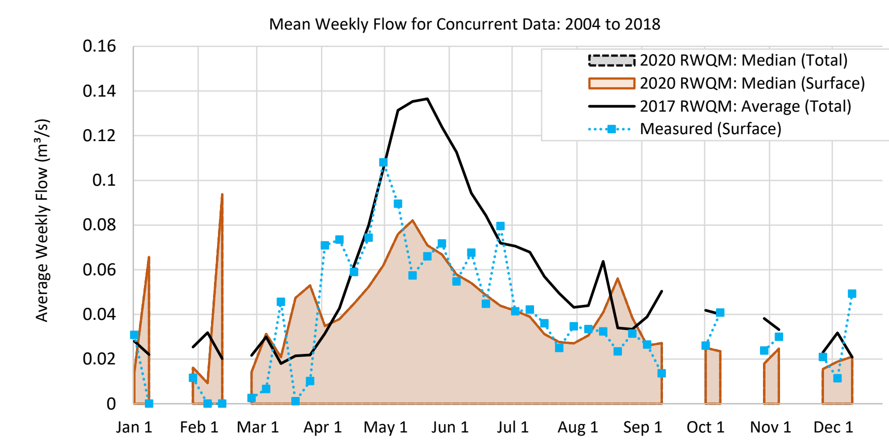
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - CALIBRATION DASHBOARD

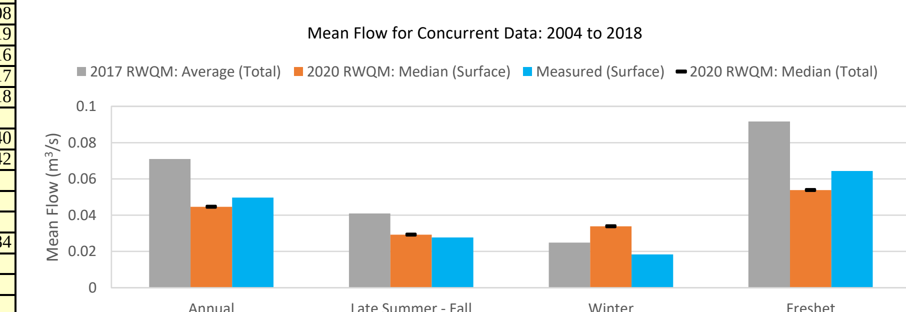
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Notes on Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module, Pit Module in sub-catchments Wolfram Creek North & South Upper & Lower, Phase 3, 4, 6 Pit dewatering		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	18	Mean annual runoff (monitored)		180
Selected Year	2019	Mean annual runoff (2020 RWQM)		190
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		43%
Station ID & Description	GH_WC1	Wolfram Creek Sediment Pond Decant (E257795)		
Drainage Area (2018)	620 ha	Disturbed Area (2018)		~ 85%

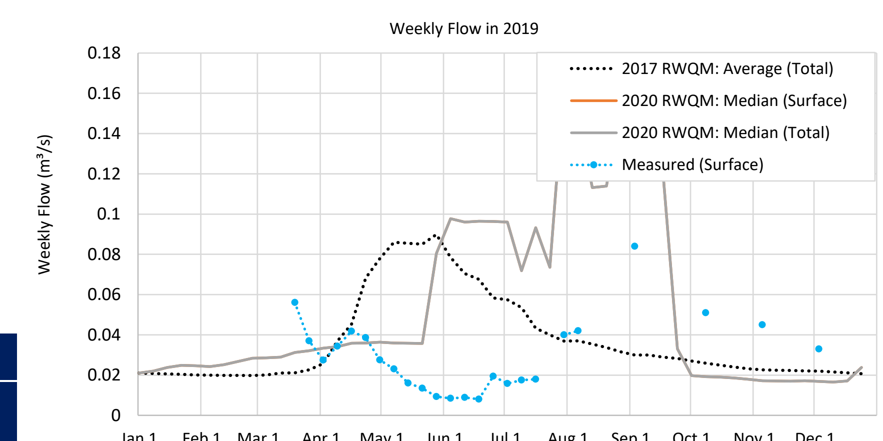
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.021	0.021	0.021	
2019-01-10	0.021	0.022	0.022	
2019-01-17	0.021	0.024	0.024	
2019-01-24	0.020	0.025	0.025	
2019-01-31	0.020	0.025	0.025	
2019-02-07	0.020	0.024	0.024	
2019-02-14	0.020	0.025	0.025	
2019-02-21	0.020	0.027	0.027	
2019-02-28	0.020	0.028	0.028	
2019-03-07	0.020	0.029	0.029	
2019-03-14	0.021	0.029	0.029	
2019-03-21	0.021	0.031	0.031	0.056
2019-03-28	0.023	0.032	0.032	0.037
2019-04-04	0.026	0.033	0.033	0.027
2019-04-11	0.037	0.034	0.034	0.034
2019-04-18	0.045	0.036	0.036	0.042
2019-04-25	0.068	0.036	0.036	0.039
2019-05-02	0.078	0.036	0.036	0.028
2019-05-09	0.086	0.036	0.036	0.023
2019-05-16	0.085	0.036	0.036	0.016
2019-05-23	0.085	0.036	0.036	0.013
2019-05-30	0.090	0.080	0.080	0.009
2019-06-06	0.078	0.098	0.098	0.008
2019-06-13	0.070	0.096	0.096	0.009
2019-06-20	0.068	0.096	0.096	0.008
2019-06-27	0.058	0.096	0.096	0.019
2019-07-04	0.057	0.096	0.096	0.016
2019-07-11	0.053	0.072	0.072	0.017
2019-07-18	0.043	0.093	0.093	0.018
2019-07-25	0.040	0.074	0.074	
2019-08-01	0.037	0.164	0.164	0.040
2019-08-08	0.037	0.149	0.149	0.042
2019-08-15	0.035	0.113	0.113	
2019-08-22	0.034	0.114	0.114	
2019-08-29	0.032	0.153	0.153	
2019-09-05	0.030	0.149	0.149	0.084
2019-09-12	0.030	0.130	0.130	
2019-09-19	0.029	0.120	0.120	
2019-09-26	0.028	0.033	0.033	
2019-10-03	0.027	0.020	0.020	
2019-10-10	0.026	0.019	0.019	0.051
2019-10-17	0.025	0.019	0.019	
2019-10-24	0.024	0.019	0.019	
2019-10-31	0.023	0.018	0.018	
2019-11-07	0.023	0.017	0.017	0.045
2019-11-14	0.022	0.017	0.017	
2019-11-21	0.022	0.017	0.017	
2019-11-28	0.022	0.017	0.017	
2019-12-05	0.022	0.017	0.017	0.033
2019-12-12	0.022	0.017	0.017	
2019-12-19	0.021	0.017	0.017	
2019-12-26	0.021	0.024	0.024	
Annual	0.04	0.05	0.05	0.03
Late Summer - Fall	0.03	0.07	0.07	0.05
Winter	0.02	0.02	0.02	0.04
Freshet	0.07	0.07	0.07	0.02











Statistics on concurrent data: 2004 to 2018	Poor	Poor but improved		
Parameter	**2017 RWQM: Average (Total)**	**2020 RWQM: Median (Surface)**	**2020 RWQM: Median (Total)**	**Measured (Surface)**
Nash-Sutcliffe efficiency (E)	-0.18	-0.16	-0.16	
Modified Nash-Sutcliffe efficiency (E1)	-0.10	0.03	0.03	
Index of agreement (d)	0.60	0.48	0.48	
Modified index of agreement (d1)	0.42	0.43	0.43	
MAE	0.04	0.04	0.04	
RMSE	0.06	0.06	0.06	
Coefficient of Determination (R^2)	0.17	0.05	0.05	
Number of data in statistics	333	333	333	
Total number of weekly data	783	783	783	333
Mean of all weekly data	0.071	0.045	0.045	0.050
Standard deviation of all weekly data	0.049	0.038	0.038	0.057
Approximated mean annual runoff (mm/yr)	250	190	190	180

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

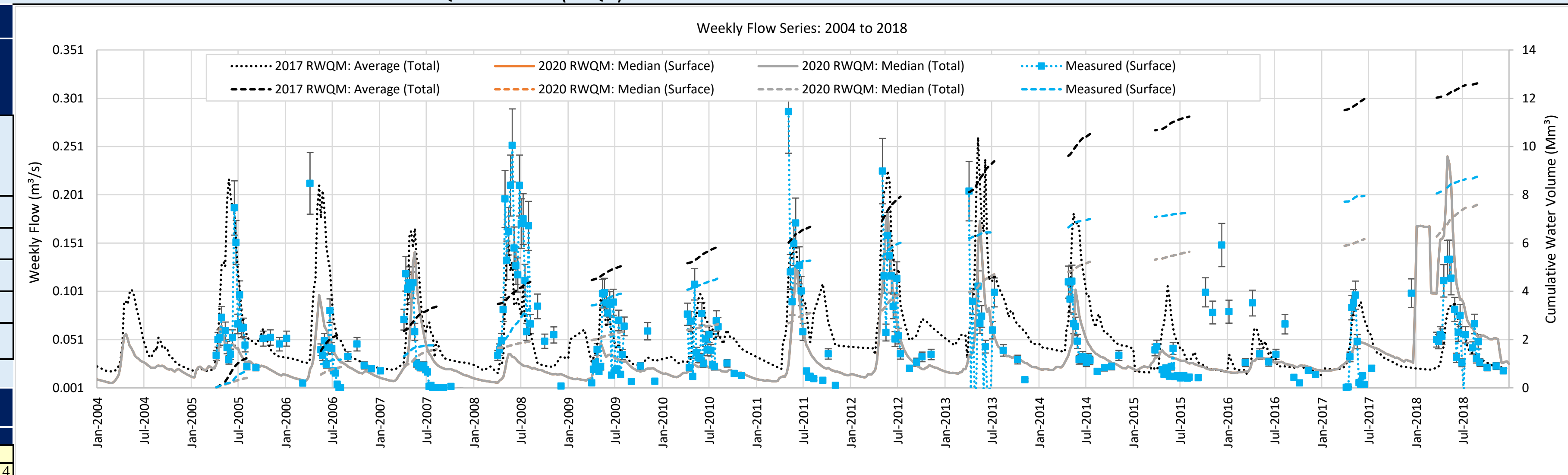
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

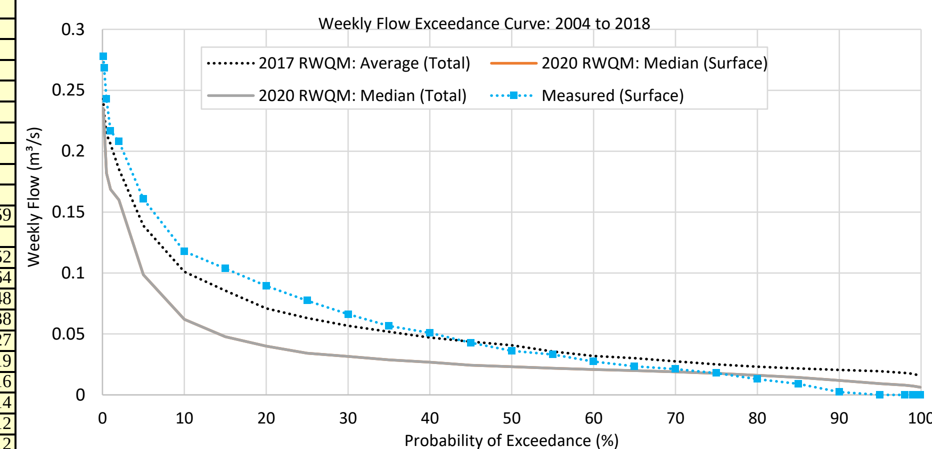
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

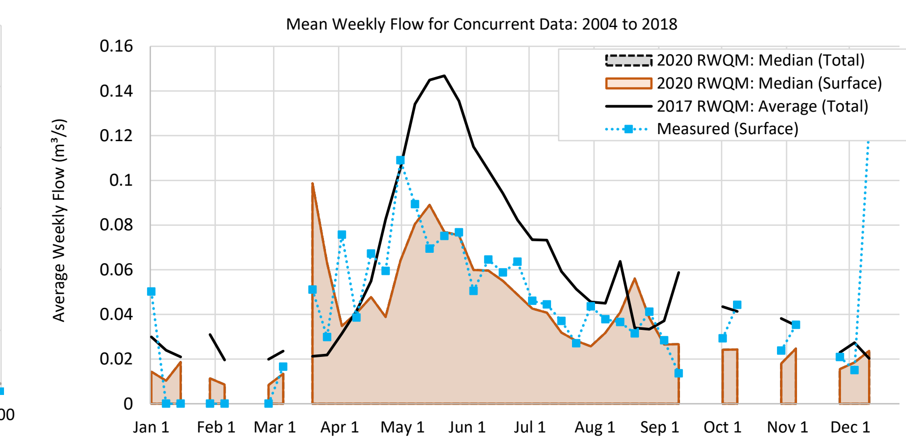
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - CALIBRATION DASHBOARD

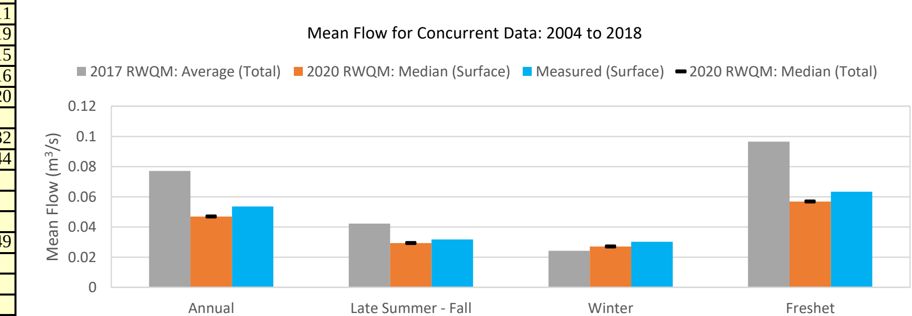
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Notes on Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module, Pit Module in sub-catchments Wolfram Creek North & South Upper & Lower, Phase 3, 4, 6 Pit dewatering		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	19	Mean annual runoff (monitored)		200
Selected Year	2019	Mean annual runoff (2020 RWQM)		180
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		35%
Station ID & Description	GH_WC2	Wolfram Creek u/s Pond inflow		
Drainage Area (2018)	620 ha	Disturbed Area (2018)		~ 85%

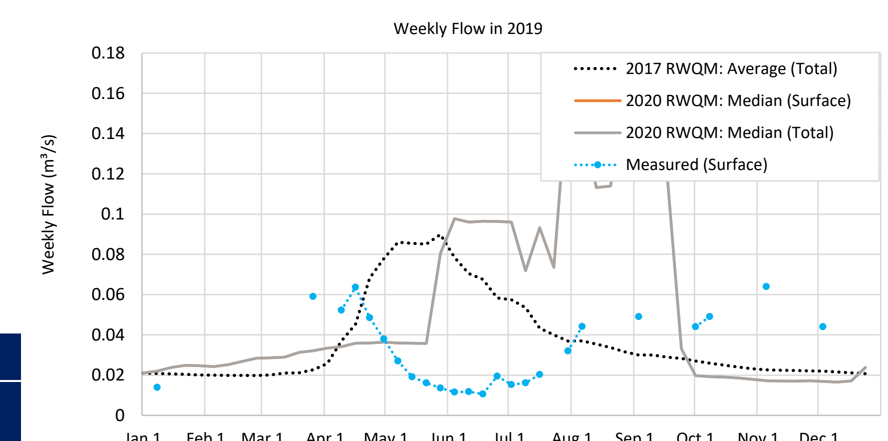
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.021	0.021	0.021	
2019-01-10	0.021	0.022	0.022	0.014
2019-01-17	0.021	0.024	0.024	
2019-01-24	0.020	0.025	0.025	
2019-01-31	0.020	0.025	0.025	
2019-02-07	0.020	0.024	0.024	
2019-02-14	0.020	0.025	0.025	
2019-02-21	0.020	0.027	0.027	
2019-02-28	0.020	0.028	0.028	
2019-03-07	0.020	0.029	0.029	
2019-03-14	0.021	0.029	0.029	
2019-03-21	0.021	0.031	0.031	
2019-03-28	0.023	0.032	0.032	0.059
2019-04-04	0.026	0.033	0.033	
2019-04-11	0.037	0.034	0.034	0.052
2019-04-18	0.045	0.036	0.036	0.064
2019-04-25	0.068	0.036	0.036	0.048
2019-05-02	0.078	0.036	0.036	0.038
2019-05-09	0.086	0.036	0.036	0.027
2019-05-16	0.085	0.036	0.036	0.019
2019-05-23	0.085	0.036	0.036	0.016
2019-05-30	0.090	0.080	0.080	0.014
2019-06-06	0.078	0.098	0.098	0.012
2019-06-13	0.070	0.096	0.096	0.012
2019-06-20	0.068	0.096	0.096	0.011
2019-06-27	0.058	0.096	0.096	0.019
2019-07-04	0.057	0.096	0.096	0.015
2019-07-11	0.053	0.072	0.072	0.016
2019-07-18	0.043	0.093	0.093	0.020
2019-07-25	0.040	0.074	0.074	
2019-08-01	0.037	0.164	0.164	0.032
2019-08-08	0.037	0.149	0.149	0.044
2019-08-15	0.035	0.113	0.113	
2019-08-22	0.034	0.114	0.114	
2019-08-29	0.032	0.153	0.153	
2019-09-05	0.030	0.149	0.149	0.049
2019-09-12	0.030	0.130	0.130	
2019-09-19	0.029	0.120	0.120	
2019-09-26	0.028	0.033	0.033	
2019-10-03	0.027	0.020	0.020	0.044
2019-10-10	0.026	0.019	0.019	0.049
2019-10-17	0.025	0.019	0.019	
2019-10-24	0.024	0.019	0.019	
2019-10-31	0.023	0.018	0.018	
2019-11-07	0.023	0.017	0.017	0.064
2019-11-14	0.022	0.017	0.017	
2019-11-21	0.022	0.017	0.017	
2019-11-28	0.022	0.017	0.017	
2019-12-05	0.022	0.017	0.017	0.044
2019-12-12	0.022	0.017	0.017	
2019-12-19	0.021	0.017	0.017	
2019-12-26	0.021	0.024	0.024	
Annual	0.04	0.05	0.05	0.03
Late Summer - Fall	0.03	0.07	0.07	0.05
Winter	0.02	0.02	0.02	0.04
Freshet	0.07	0.07	0.07	0.03











Statistics on concurrent data: 2004 to 2018	Poor	Poor but improved		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	-0.50	-0.21	-0.21	
Modified Nash-Sutcliffe efficiency (E1)	-0.21	0.00	0.00	
Index of agreement (d)	0.57	0.52	0.52	
Modified index of agreement (d1)	0.40	0.43	0.43	
MAE	0.05	0.04	0.04	
RMSE	0.06	0.06	0.06	
Coefficient of Determination (R^2)	0.12	0.06	0.06	
Number of data in statistics	272	272	272	
Total number of weekly data	783	783	783	272
Mean of all weekly data	0.077	0.047	0.047	0.054
Standard deviation of all weekly data	0.051	0.039	0.039	0.052
Approximated mean annual runoff (mm/yr)	260	180	180	200

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

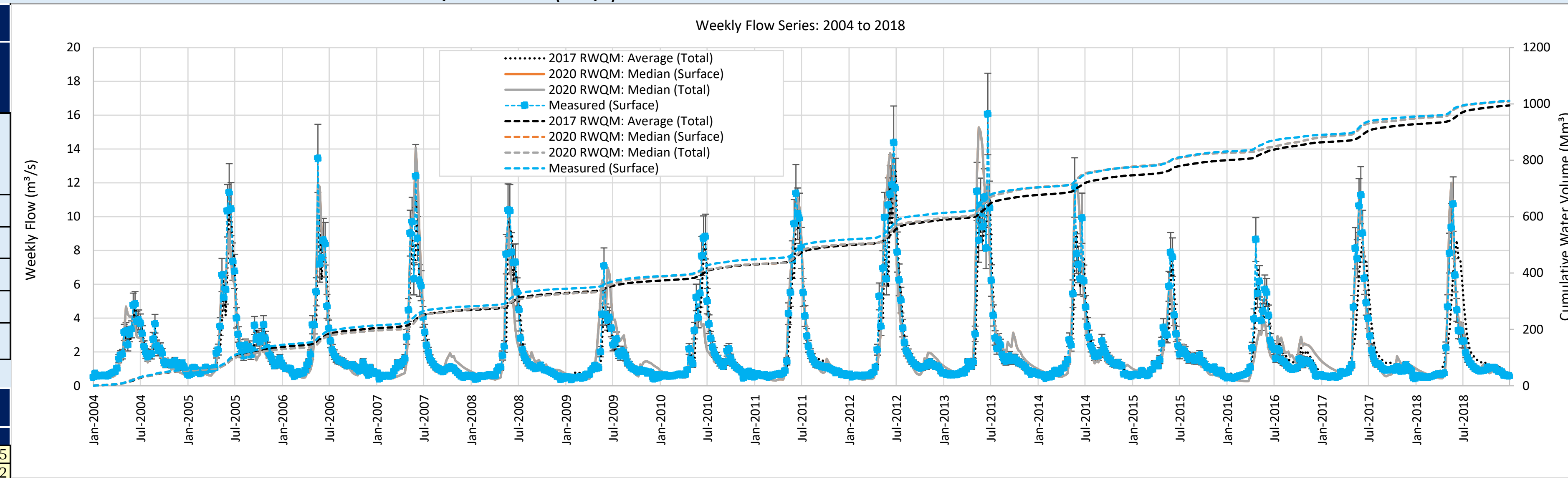
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

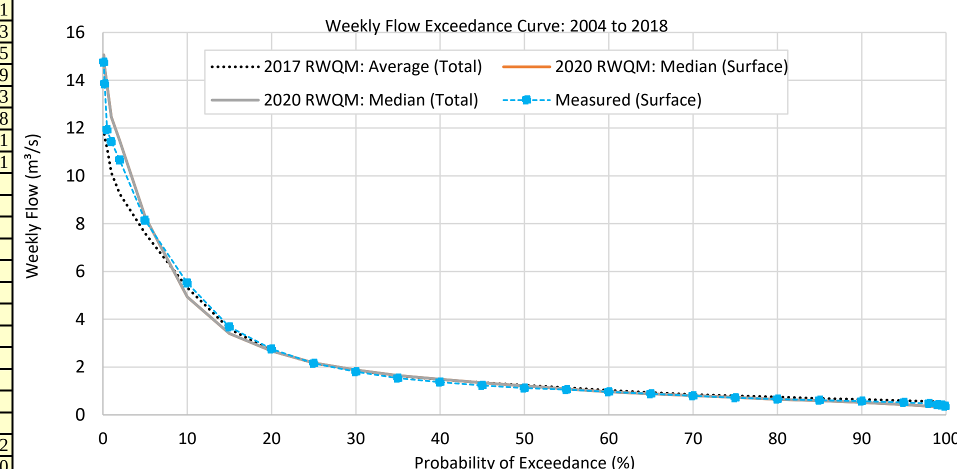
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

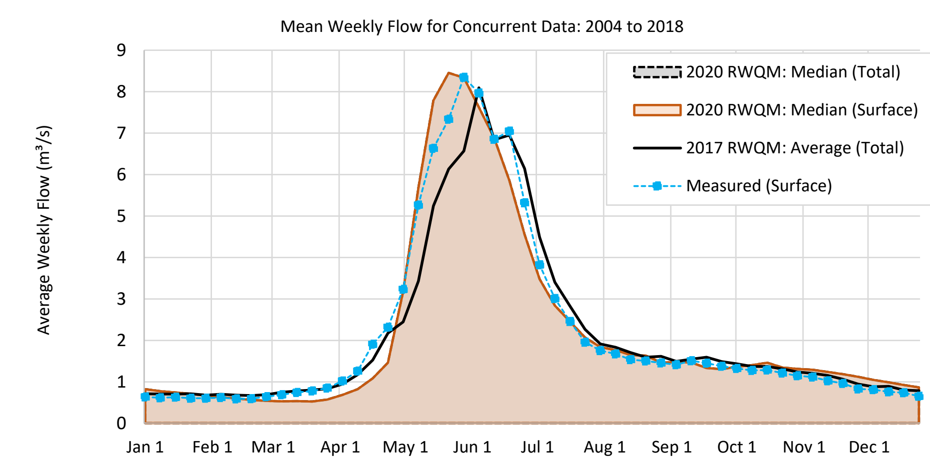
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

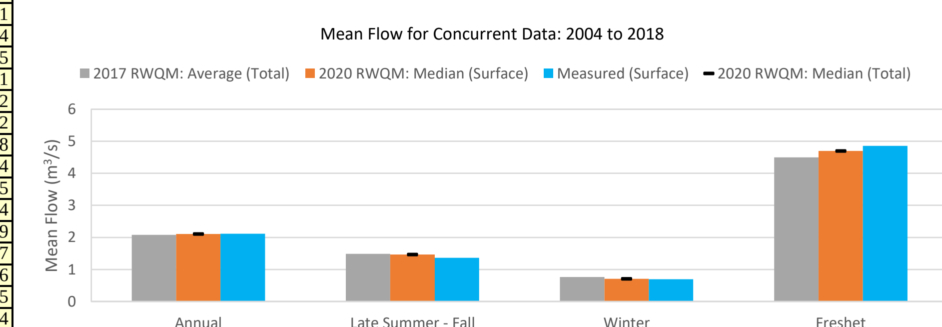
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	LC_LCDSSLC + undisturbed lower Line Creek sub-catchments modelled using Snowmelt Runoff Module (sum of modelled flows)		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	26	Mean annual surface runoff (monitored)		490
Selected Year	2019	Mean annual total runoff (2020 RWQM)		490
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		100%
Station ID & Description	LC_LC4	Line Creek upstream of Process Plant (0200044)		
Drainage Area (2018)	13790 ha	Disturbed Area (2018)		~ 14%

Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.716	0.511	0.511	0.605
2019-01-10	0.711	0.482	0.482	0.572
2019-01-17	0.690	0.454	0.454	0.551
2019-01-24	0.690	0.428	0.428	0.523
2019-01-31	0.682	0.403	0.403	0.505
2019-02-07	0.689	0.380	0.380	0.479
2019-02-14	0.669	0.359	0.359	0.473
2019-02-21	0.666	0.339	0.339	0.468
2019-02-28	0.677	0.320	0.320	0.441
2019-03-07	0.719	0.302	0.302	0.411
2019-03-14	0.787	0.300	0.300	
2019-03-21	0.805	0.487	0.487	
2019-03-28	0.859	0.500	0.500	
2019-04-04	0.926	0.522	0.522	
2019-04-11	1.125	0.515	0.515	
2019-04-18	1.318	0.853	0.853	
2019-04-25	2.157	0.972	0.972	
2019-05-02	2.592	1.705	1.705	
2019-05-09	3.352	4.280	4.280	
2019-05-16	5.043	4.050	4.050	
2019-05-23	6.728	3.045	3.045	
2019-05-30	7.803	3.083	3.083	
2019-06-06	8.718	2.317	2.317	8.432
2019-06-13	7.508	1.813	1.813	4.010
2019-06-20	7.426	4.207	4.207	3.521
2019-06-27	6.175	3.653	3.653	4.394
2019-07-04	4.725	3.674	3.674	3.395
2019-07-11	3.638	2.653	2.653	2.981
2019-07-18	2.801	3.641	3.641	2.052
2019-07-25	2.257	2.977	2.977	2.452
2019-08-01	1.964	2.042	2.042	1.718
2019-08-08	1.828	1.809	1.809	1.354
2019-08-15	1.666	2.156	2.156	1.255
2019-08-22	1.565	1.670	1.670	1.264
2019-08-29	1.496	1.425	1.425	1.149
2019-09-05	1.403	1.237	1.237	1.017
2019-09-12	1.405	1.094	1.094	1.046
2019-09-19	1.443	0.892	0.892	1.025
2019-09-26	1.345	0.849	0.849	0.994
2019-10-03	1.320	0.865	0.865	0.952
2019-10-10	1.244	0.854	0.854	0.959
2019-10-17	1.258	1.116	1.116	0.941
2019-10-24	1.225	1.166	1.166	0.888
2019-10-31	1.114	0.976	0.976	0.825
2019-11-07	1.084	0.966	0.966	0.772
2019-11-14	1.261	0.971	0.971	0.748
2019-11-21	1.039	0.945	0.945	0.705
2019-11-28	0.933	0.889	0.889	0.716
2019-12-05	0.884	0.844	0.844	0.687
2019-12-12	0.871	0.793	0.793	0.628
2019-12-19	0.794	0.750	0.750	0.597
2019-12-26	0.767	0.706	0.706	0.503
Annual	2.15	1.43	1.43	1.43
Late Summer - Fall	1.41	1.31	1.31	1.09
Winter	0.76	0.49	0.49	0.53
Freshet	4.74	2.70	2.70	4.11

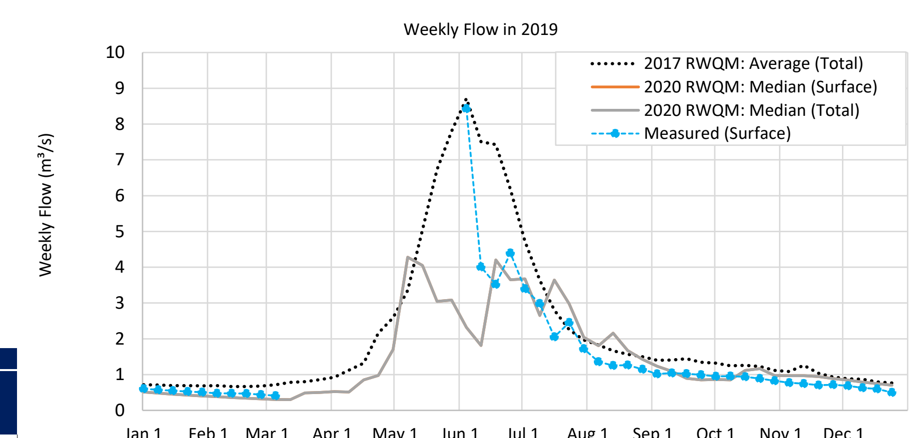








Statistics on concurrent data: 2004 to 2018	Very good	Very good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.88	0.84	0.84	
Modified Nash-Sutcliffe efficiency (E1)	0.76	0.67	0.67	
Index of agreement (d)	0.96	0.96	0.96	
Modified index of agreement (d1)	0.87	0.83	0.83	
MAE	0.41	0.56	0.56	
RMSE	0.88	1.00	1.00	
Coefficient of Determination (R^2)	0.88	0.85	0.85	
Number of data in statistics	783	783	783	
Total number of weekly data	783	783	783	783
Mean of all weekly data	2.100	2.131	2.131	2.135
Standard deviation of all weekly data	2.210	2.578	2.578	2.510
Approximated mean annual runoff (mm/yr)	480	490	490	490



Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

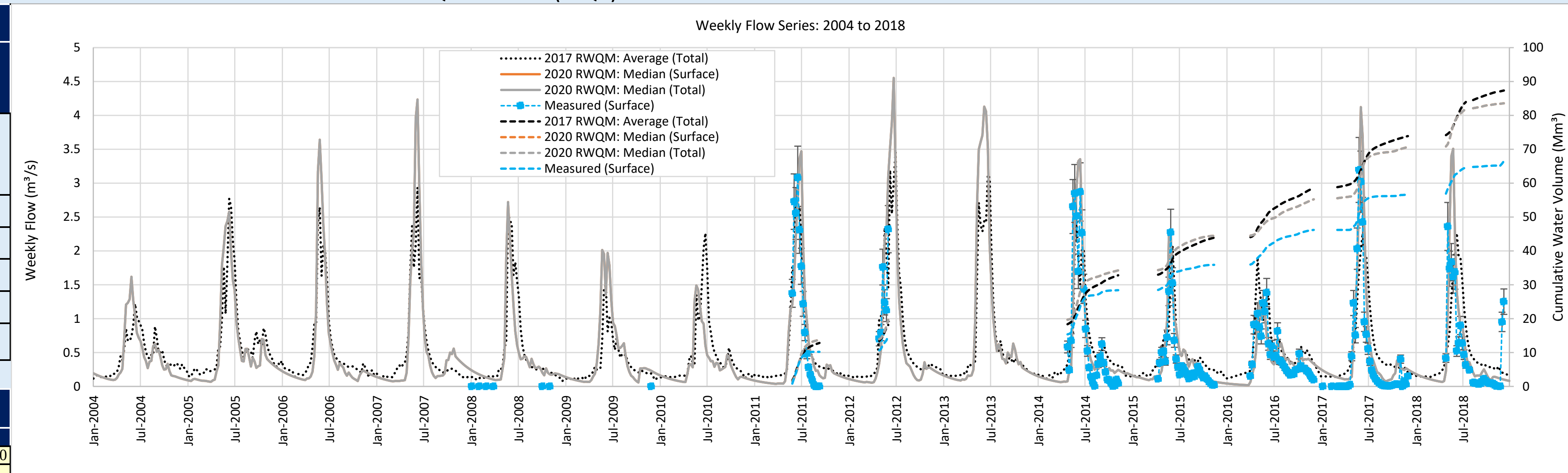
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

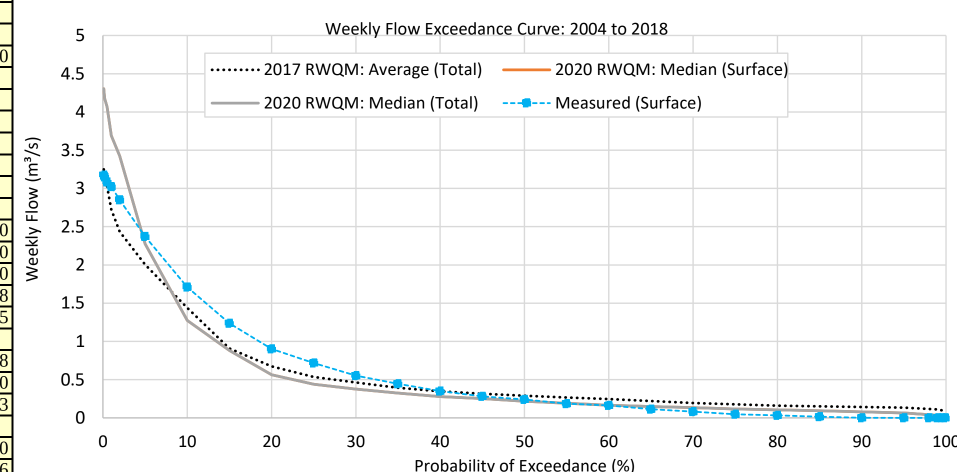
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

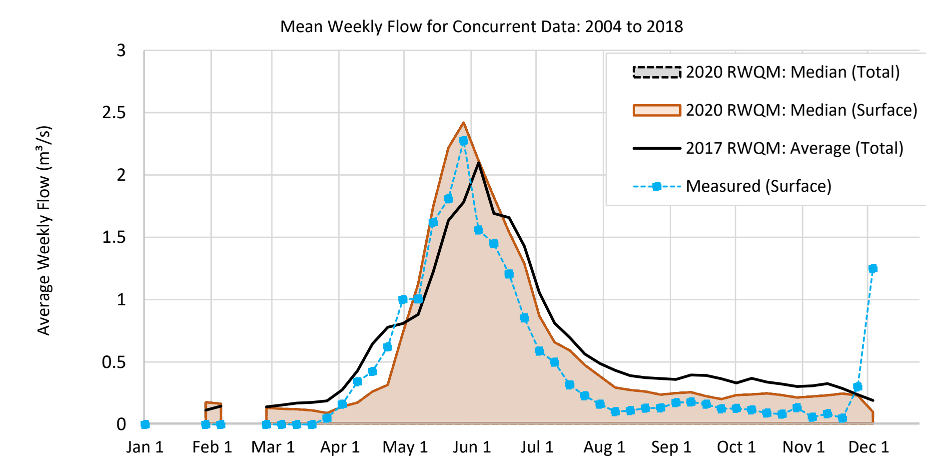
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

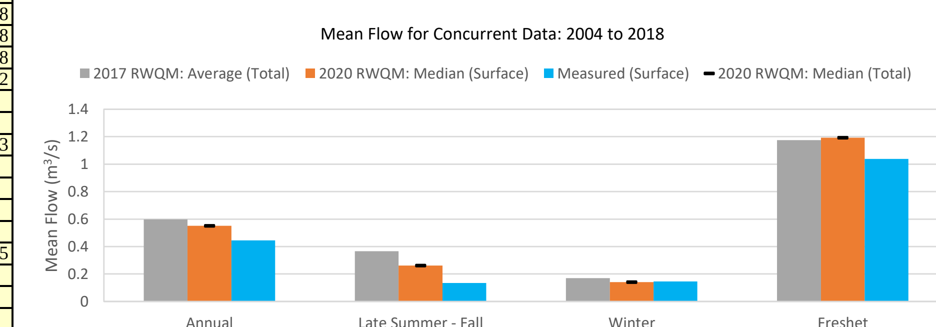
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Module of subcatchment Upper Line Creek 1		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	14	Mean annual surface runoff (monitored)		510
Selected Year	2019	Mean annual total runoff (2020 RWQM)		560
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		25%
Station ID & Description	LC_LC1	Line Creek upstream of MSA North Pit (E126142)		
Drainage Area (2018)	2790 ha	Disturbed Area (2018)		~ 0%

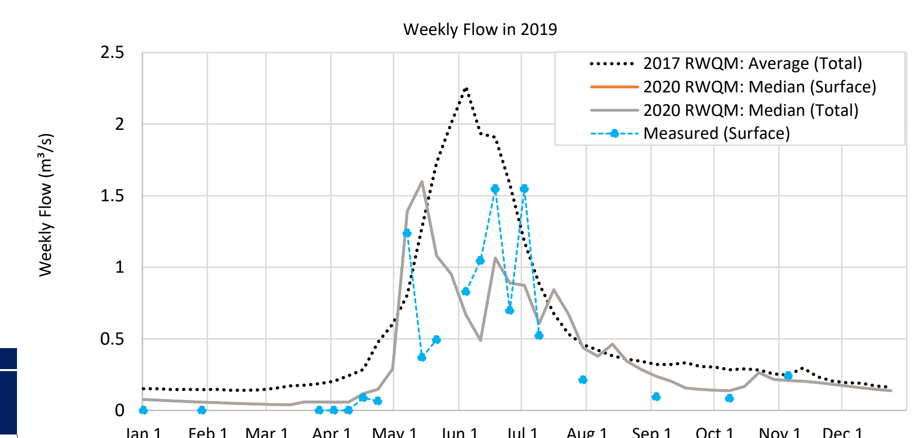
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m^3/s)	
2019-01-03	0.152	0.076	0.076	0.000
2019-01-10	0.151	0.071	0.071	
2019-01-17	0.146	0.066	0.066	
2019-01-24	0.146	0.062	0.062	
2019-01-31	0.144	0.057	0.057	0.000
2019-02-07	0.147	0.054	0.054	
2019-02-14	0.141	0.050	0.050	
2019-02-21	0.140	0.047	0.047	
2019-02-28	0.143	0.043	0.043	
2019-03-07	0.154	0.040	0.040	
2019-03-14	0.171	0.039	0.039	
2019-03-21	0.176	0.059	0.059	
2019-03-28	0.187	0.058	0.058	0.000
2019-04-04	0.203	0.057	0.057	0.000
2019-04-11	0.241	0.057	0.057	0.000
2019-04-18	0.286	0.117	0.117	0.088
2019-04-25	0.475	0.146	0.146	0.065
2019-05-02	0.602	0.290	0.290	
2019-05-09	0.806	1.391	1.391	1.238
2019-05-16	1.280	1.598	1.598	0.370
2019-05-23	1.731	1.081	1.081	0.493
2019-05-30	2.004	0.953	0.953	
2019-06-06	2.262	0.668	0.668	0.830
2019-06-13	1.933	0.488	0.488	1.046
2019-06-20	1.908	1.064	1.064	1.548
2019-06-27	1.580	0.889	0.889	0.698
2019-07-04	1.177	0.874	0.874	1.548
2019-07-11	0.883	0.607	0.607	0.522
2019-07-18	0.677	0.843	0.843	
2019-07-25	0.533	0.672	0.672	
2019-08-01	0.459	0.437	0.437	0.213
2019-08-08	0.421	0.378	0.378	
2019-08-15	0.381	0.463	0.463	
2019-08-22	0.357	0.343	0.343	
2019-08-29	0.343	0.283	0.283	
2019-09-05	0.321	0.238	0.238	0.095
2019-09-12	0.322	0.204	0.204	
2019-09-19	0.333	0.156	0.156	
2019-09-26	0.307	0.146	0.146	
2019-10-03	0.303	0.140	0.140	
2019-10-10	0.284	0.138	0.138	0.084
2019-10-17	0.290	0.167	0.167	
2019-10-24	0.283	0.264	0.264	
2019-10-31	0.255	0.215	0.215	
2019-11-07	0.247	0.208	0.208	0.243
2019-11-14	0.296	0.204	0.204	
2019-11-21	0.235	0.195	0.195	
2019-11-28	0.206	0.182	0.182	
2019-12-05	0.192	0.169	0.169	
2019-12-12	0.190	0.158	0.158	
2019-12-19	0.169	0.147	0.147	
2019-12-26	0.163	0.137	0.137	
Annual	0.52	0.34	0.34	0.45
Late Summer - Fall	0.33	0.26	0.26	0.16
Winter	0.16	0.08	0.08	-
Freshet	1.19	0.74	0.74	0.70











Statistics on concurrent data: 2004 to 2018	Acceptable	Acceptable		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.57	0.64	0.64	
Modified Nash-Sutcliffe efficiency (E1)	0.33	0.47	0.47	
Index of agreement (d)	0.86	0.92	0.92	
Modified index of agreement (d1)	0.63	0.74	0.74	
MAE	0.37	0.29	0.29	
RMSE	0.49	0.45	0.45	
Coefficient of Determination (R^2)	0.63	0.76	0.76	
Number of data in statistics	198	198	198	
Total number of weekly data	783	783	783	198
Mean of all weekly data	0.729	0.698	0.698	0.555
Standard deviation of all weekly data	0.620	0.863	0.863	0.751
Approximated mean annual runoff (mm/yr)	600	560	560	510

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

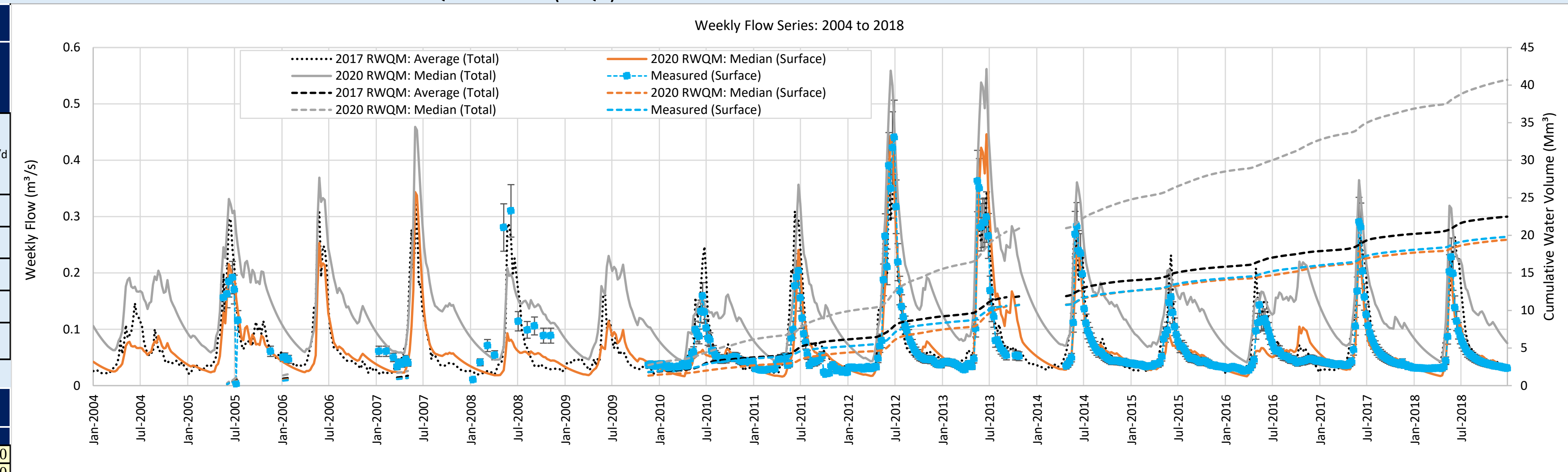
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

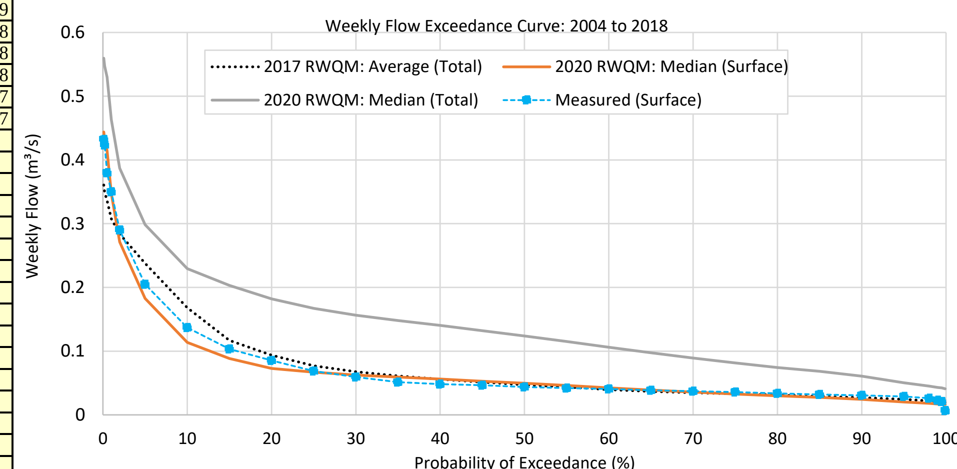
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

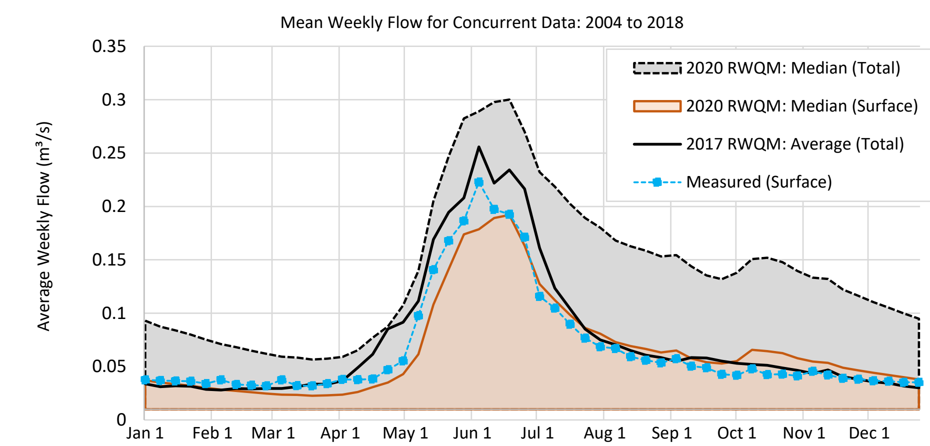
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

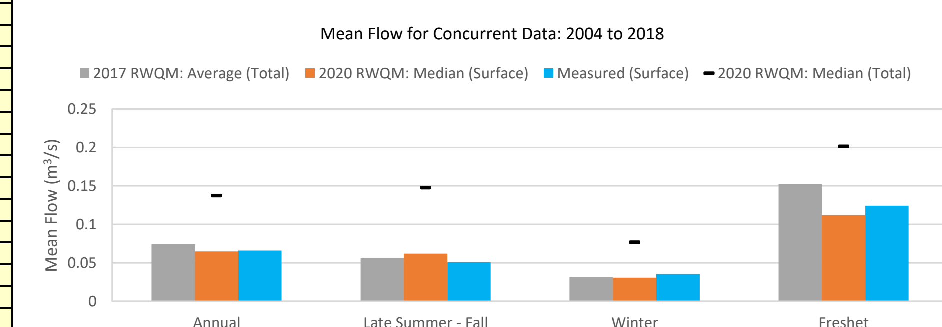
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Module of subcatchment West Line Creek		Surface-Groundwater Partitioning	60%, maximum of 10,000 m3/d
Spinner ID	22	Mean annual surface runoff (monitored)		210
Selected Year	2019	Mean annual total runoff (2020 RWQM)		440
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		61%
Station ID & Description	LC_WLC	West Line Creek (E261958)		
Drainage Area (2018)	1000 ha	Disturbed Area (2018)		~ 27%

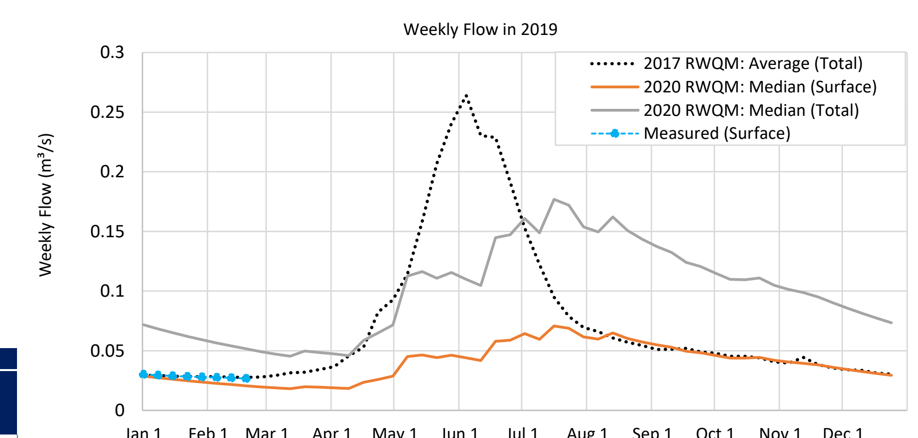
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.029	0.029	0.072	0.030
2019-01-10	0.029	0.027	0.068	0.030
2019-01-17	0.029	0.026	0.065	0.029
2019-01-24	0.029	0.025	0.062	0.028
2019-01-31	0.028	0.024	0.059	0.028
2019-02-07	0.028	0.023	0.056	0.028
2019-02-14	0.028	0.022	0.054	0.027
2019-02-21	0.028	0.021	0.052	0.027
2019-02-28	0.028	0.020	0.049	
2019-03-07	0.029	0.019	0.047	
2019-03-14	0.032	0.018	0.045	
2019-03-21	0.032	0.020	0.050	
2019-03-28	0.034	0.019	0.048	
2019-04-04	0.037	0.019	0.047	
2019-04-11	0.046	0.018	0.046	
2019-04-18	0.053	0.023	0.059	
2019-04-25	0.082	0.026	0.065	
2019-05-02	0.093	0.029	0.072	
2019-05-09	0.114	0.045	0.113	
2019-05-16	0.159	0.047	0.116	
2019-05-23	0.207	0.044	0.111	
2019-05-30	0.240	0.046	0.116	
2019-06-06	0.264	0.044	0.110	
2019-06-13	0.230	0.042	0.105	
2019-06-20	0.229	0.058	0.145	
2019-06-27	0.192	0.059	0.147	
2019-07-04	0.153	0.064	0.161	
2019-07-11	0.122	0.060	0.149	
2019-07-18	0.095	0.071	0.177	
2019-07-25	0.079	0.069	0.172	
2019-08-01	0.070	0.062	0.154	
2019-08-08	0.066	0.060	0.150	
2019-08-15	0.061	0.065	0.162	
2019-08-22	0.057	0.060	0.151	
2019-08-29	0.054	0.057	0.143	
2019-09-05	0.051	0.055	0.137	
2019-09-12	0.051	0.053	0.132	
2019-09-19	0.052	0.050	0.124	
2019-09-26	0.049	0.048	0.121	
2019-10-03	0.048	0.046	0.115	
2019-10-10	0.045	0.044	0.110	
2019-10-17	0.045	0.044	0.109	
2019-10-24	0.044	0.044	0.111	
2019-10-31	0.041	0.042	0.105	
2019-11-07	0.040	0.041	0.101	
2019-11-14	0.044	0.039	0.099	
2019-11-21	0.038	0.038	0.095	
2019-11-28	0.035	0.036	0.090	
2019-12-05	0.034	0.034	0.086	
2019-12-12	0.034	0.033	0.081	
2019-12-19	0.031	0.031	0.077	
2019-12-26	0.030	0.029	0.073	
Annual	0.07	0.04	0.10	0.03
Late Summer - Fall	0.05	0.05	0.13	
Winter	0.03	0.02	0.06	0.03
Freshet	0.15	0.05	0.11	











Statistics on concurrent data: 2004 to 2018	Good	Good		
Parameter	**2017 RWQM: Average (Total)**	**2020 RWQM: Median (Surface)**	**2020 RWQM: Median (Total)**	**Measured (Surface)**
Nash-Sutcliffe efficiency (E)	0.73	0.74	-0.80	
Modified Nash-Sutcliffe efficiency (E1)	0.53	0.55	-0.77	
Index of agreement (d)	0.94	0.93	0.75	
Modified index of agreement (d1)	0.78	0.77	0.38	
MAE	0.02	0.02	0.07	
RMSE	0.03	0.03	0.09	
Coefficient of Determination (R^2)	0.79	0.77	0.72	
Number of data in statistics	478	478	478	
Total number of weekly data	783	783	783	478
Mean of all weekly data	0.078	0.067	0.141	0.069
Standard deviation of all weekly data	0.071	0.067	0.090	0.065
Approximated mean annual runoff (mm/yr)	240	210	440	210

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

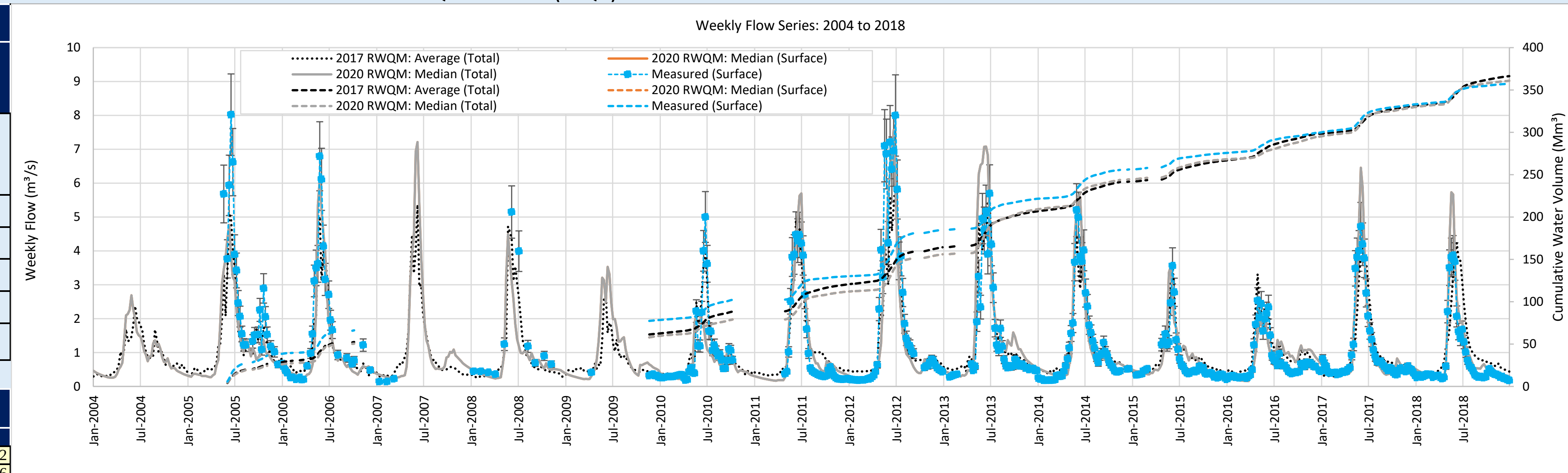
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

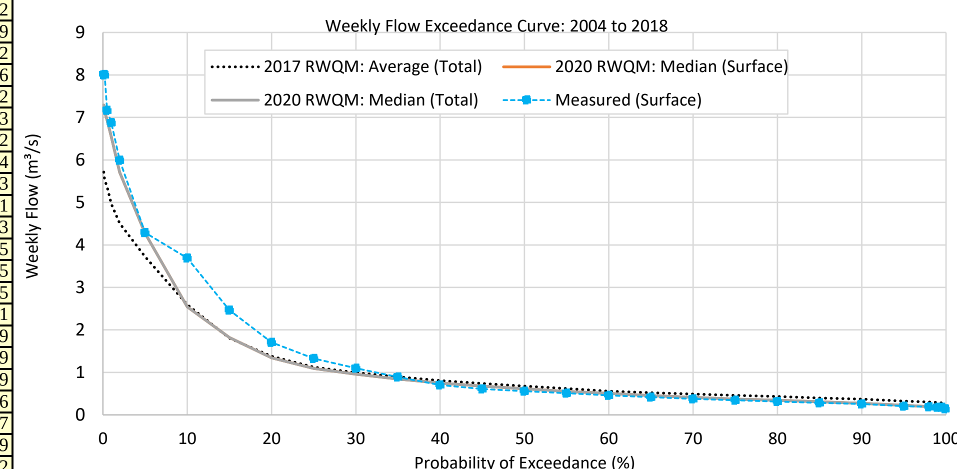
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

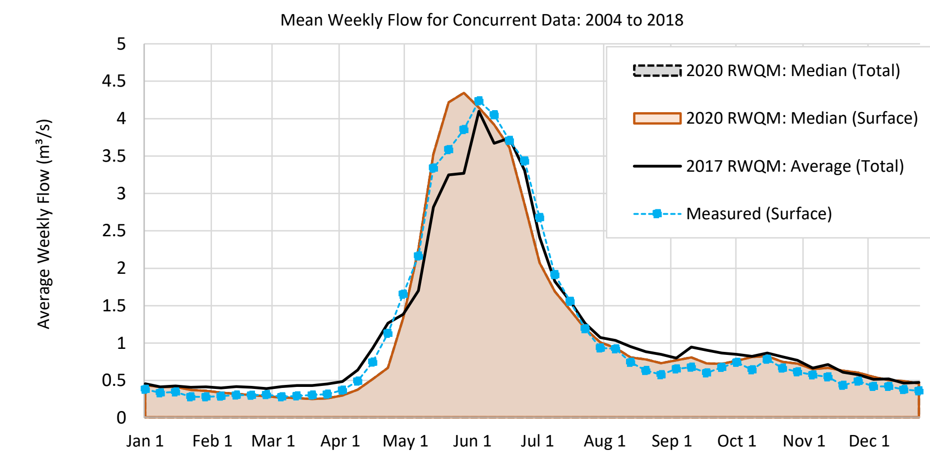
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

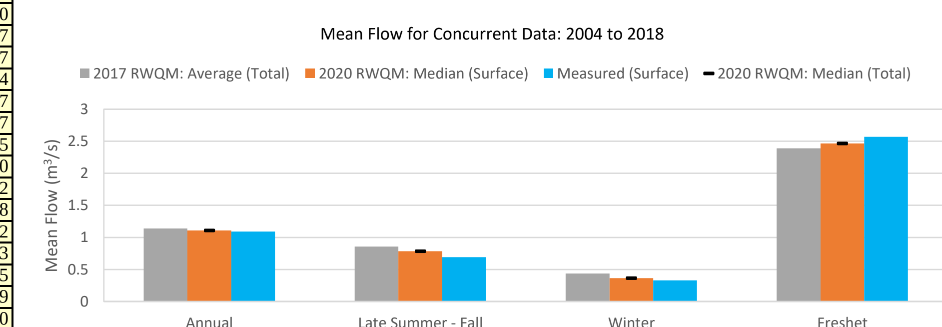
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	LC_LCUSWLC + LC_WLC (sum of modelled flows)		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	24	Mean annual surface runoff (monitored)		490
Selected Year	2019	Mean annual total runoff (2020 RWQM)		500
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		62%
Station ID & Description	LC_LC3	Line Creek downstream of West Line Creek (0200337)		
Drainage Area (2018)	7120 ha	Disturbed Area (2018)		~ 26%

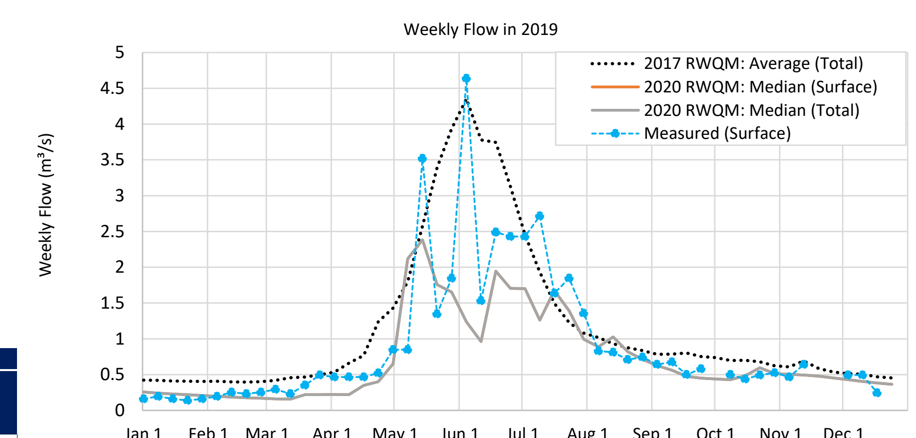
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m^3/s)	
2019-01-03	0.423	0.255	0.255	0.162
2019-01-10	0.420	0.242	0.242	0.196
2019-01-17	0.409	0.230	0.230	0.162
2019-01-24	0.408	0.218	0.218	0.139
2019-01-31	0.404	0.207	0.207	0.162
2019-02-07	0.406	0.197	0.197	0.196
2019-02-14	0.397	0.187	0.187	0.252
2019-02-21	0.396	0.178	0.178	0.233
2019-02-28	0.401	0.169	0.169	0.252
2019-03-07	0.421	0.160	0.160	0.294
2019-03-14	0.457	0.157	0.157	0.233
2019-03-21	0.466	0.218	0.218	0.351
2019-03-28	0.498	0.220	0.220	0.493
2019-04-04	0.534	0.223	0.223	0.465
2019-04-11	0.659	0.220	0.220	0.465
2019-04-18	0.767	0.348	0.348	0.465
2019-04-25	1.241	0.400	0.400	0.521
2019-05-02	1.430	0.652	0.652	0.849
2019-05-09	1.797	2.118	2.118	0.849
2019-05-16	2.575	2.383	2.383	3.519
2019-05-23	3.390	1.757	1.757	1.346
2019-05-30	3.936	1.651	1.651	1.847
2019-06-06	4.354	1.235	1.235	4.639
2019-06-13	3.779	0.963	0.963	1.532
2019-06-20	3.746	1.946	1.946	2.490
2019-06-27	3.128	1.706	1.706	2.427
2019-07-04	2.454	1.701	1.701	2.427
2019-07-11	1.934	1.262	1.262	2.714
2019-07-18	1.496	1.672	1.672	1.637
2019-07-25	1.228	1.391	1.391	1.847
2019-08-01	1.078	0.993	0.993	1.355
2019-08-08	1.017	0.888	0.888	0.830
2019-08-15	0.931	1.027	1.027	0.812
2019-08-22	0.875	0.820	0.820	0.708
2019-08-29	0.835	0.712	0.712	0.742
2019-09-05	0.784	0.627	0.627	0.643
2019-09-12	0.785	0.563	0.563	0.675
2019-09-19	0.800	0.474	0.474	0.499
2019-09-26	0.752	0.451	0.451	0.580
2019-10-03	0.736	0.438	0.438	
2019-10-10	0.696	0.429	0.429	0.498
2019-10-17	0.699	0.484	0.484	0.438
2019-10-24	0.679	0.596	0.596	0.493
2019-10-31	0.623	0.515	0.515	0.526
2019-11-07	0.608	0.502	0.502	0.465
2019-11-14	0.690	0.495	0.495	0.643
2019-11-21	0.586	0.479	0.479	
2019-11-28	0.536	0.453	0.453	
2019-12-05	0.513	0.429	0.429	0.493
2019-12-12	0.505	0.405	0.405	0.493
2019-12-19	0.467	0.384	0.384	0.245
2019-12-26	0.453	0.363	0.363	
Annual	1.15	0.71	0.71	0.92
Late Summer - Fall	0.79	0.65	0.65	0.73
Winter	0.44	0.25	0.25	0.28
Freshet	2.45	1.33	1.33	1.85











Statistics on concurrent data: 2004 to 2018	Very good	Very good		
Parameter	**2017 RWQM: Average (Total)**	**2020 RWQM: Median (Surface)**	**2020 RWQM: Median (Total)**	**Measured (Surface)**
Nash-Sutcliffe efficiency (E)	0.84	0.75	0.75	
Modified Nash-Sutcliffe efficiency (E1)	0.65	0.60	0.60	
Index of agreement (d)	0.95	0.93	0.93	
Modified index of agreement (d1)	0.81	0.79	0.79	
MAE	0.37	0.42	0.42	
RMSE	0.60	0.74	0.74	
Coefficient of Determination (R^2)	0.86	0.76	0.76	
Number of data in statistics	485	485	485	
Total number of weekly data	783	783	783	485
Mean of all weekly data	1.249	1.230	1.230	1.218
Standard deviation of all weekly data	1.177	1.440	1.440	1.483
Approximated mean annual runoff (mm/yr)	510	500	500	490

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

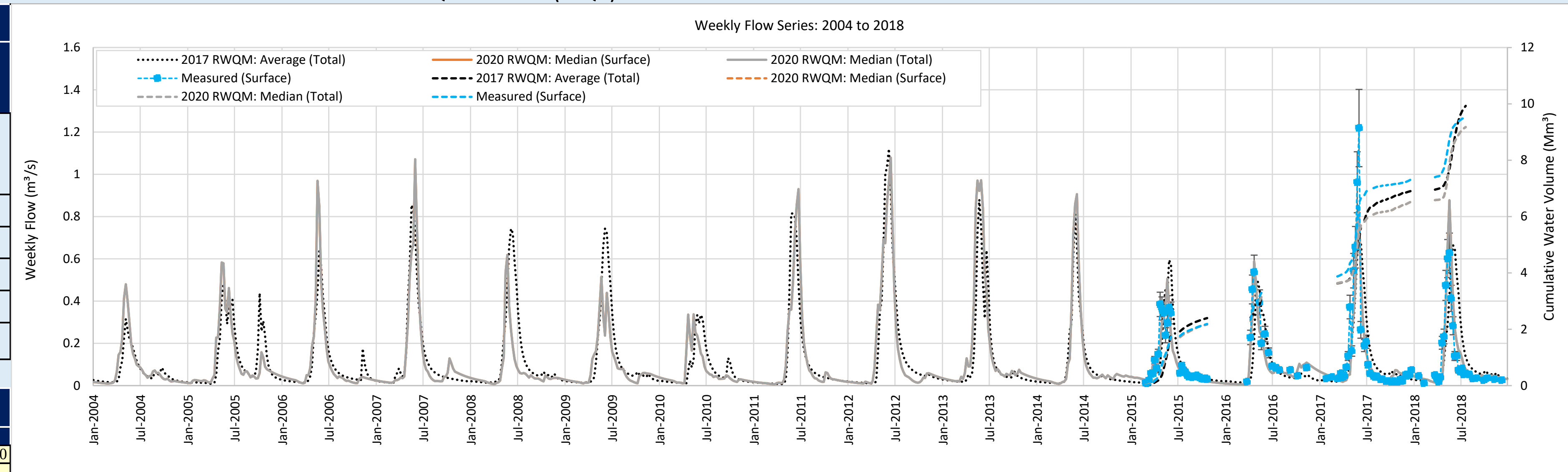
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

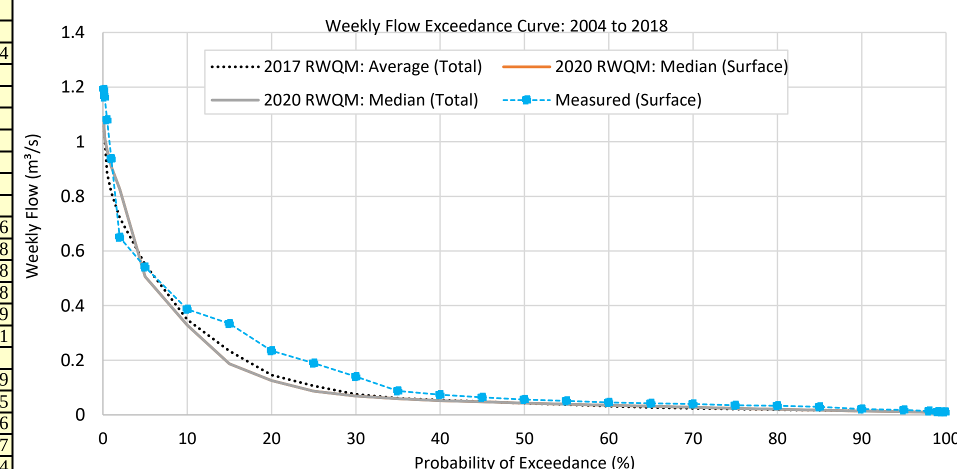
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

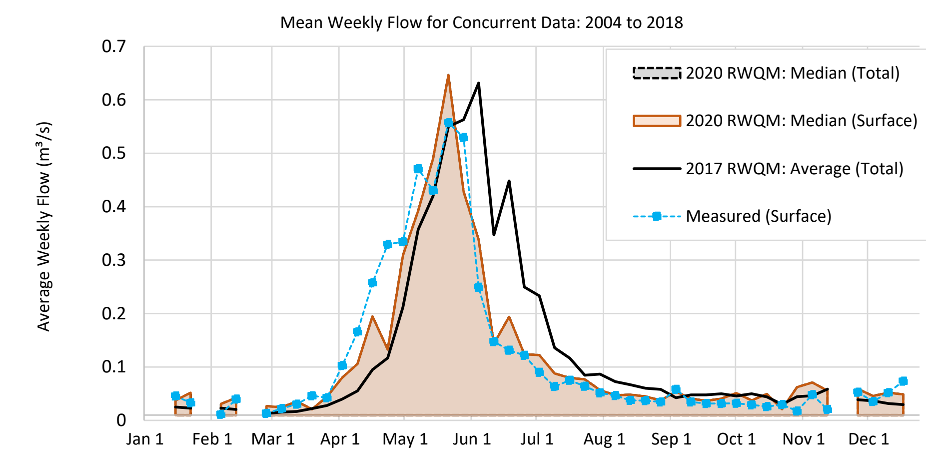
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

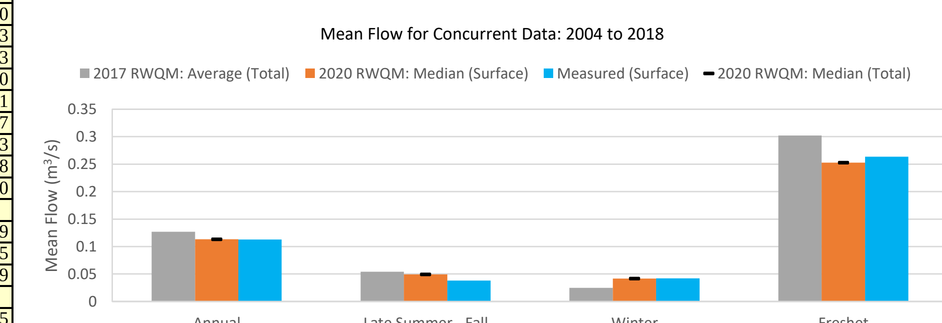
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Module of subcatchment Upper LCO Dry Creek, MTM 1-3 Pits		Surface-Groundwater Partitioning	0
Spinner ID	7	Mean annual surface runoff (monitored)		390
Selected Year	2019	Mean annual total runoff (2020 RWQM)		400
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		14%
Station ID & Description	LC_DC3	Dry Creek upstream of East Tributary Creek (E288273)		
Drainage Area (2018)	830 ha	Disturbed Area (2018)		~ 24%

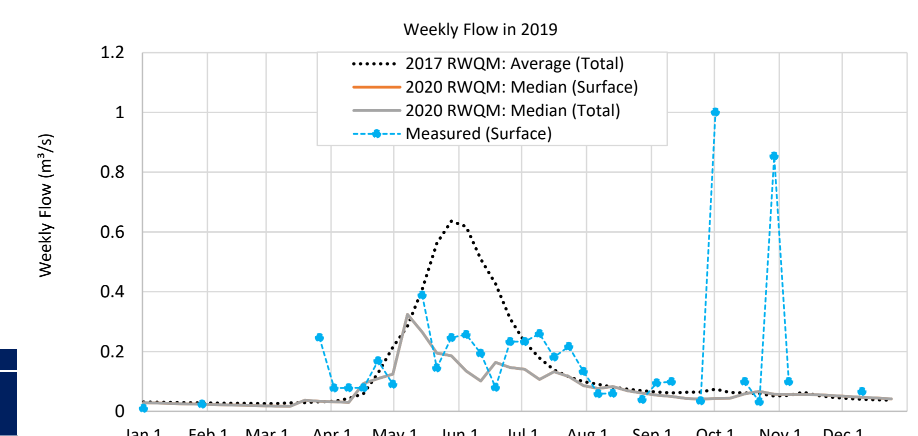
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.032	0.029	0.029	0.010
2019-01-10	0.030	0.028	0.028	
2019-01-17	0.030	0.026	0.026	
2019-01-24	0.029	0.025	0.025	
2019-01-31	0.028	0.024	0.024	0.024
2019-02-07	0.028	0.022	0.022	
2019-02-14	0.027	0.021	0.021	
2019-02-21	0.026	0.020	0.020	
2019-02-28	0.026	0.019	0.019	
2019-03-07	0.026	0.017	0.017	
2019-03-14	0.028	0.017	0.017	
2019-03-21	0.029	0.037	0.037	
2019-03-28	0.032	0.034	0.034	0.246
2019-04-04	0.034	0.032	0.032	0.078
2019-04-11	0.043	0.029	0.029	0.078
2019-04-18	0.059	0.093	0.093	0.078
2019-04-25	0.128	0.110	0.110	0.169
2019-05-02	0.215	0.124	0.124	0.091
2019-05-09	0.285	0.324	0.324	
2019-05-16	0.409	0.265	0.265	0.389
2019-05-23	0.563	0.194	0.194	0.145
2019-05-30	0.637	0.186	0.186	0.246
2019-06-06	0.618	0.135	0.135	0.257
2019-06-13	0.509	0.102	0.102	0.194
2019-06-20	0.427	0.164	0.164	0.080
2019-06-27	0.310	0.147	0.147	0.233
2019-07-04	0.232	0.141	0.141	0.233
2019-07-11	0.178	0.106	0.106	0.260
2019-07-18	0.138	0.133	0.133	0.181
2019-07-25	0.116	0.116	0.116	0.217
2019-08-01	0.099	0.086	0.086	0.133
2019-08-08	0.090	0.076	0.076	0.058
2019-08-15	0.081	0.083	0.083	0.060
2019-08-22	0.074	0.069	0.069	
2019-08-29	0.069	0.061	0.061	0.039
2019-09-05	0.064	0.054	0.054	0.095
2019-09-12	0.061	0.049	0.049	0.099
2019-09-19	0.064	0.043	0.043	
2019-09-26	0.065	0.041	0.041	0.035
2019-10-03	0.074	0.043	0.043	1.001
2019-10-10	0.063	0.044	0.044	
2019-10-17	0.061	0.059	0.059	0.099
2019-10-24	0.059	0.066	0.066	0.032
2019-10-31	0.051	0.057	0.057	0.854
2019-11-07	0.054	0.056	0.056	0.099
2019-11-14	0.063	0.056	0.056	
2019-11-21	0.053	0.055	0.055	
2019-11-28	0.047	0.052	0.052	
2019-12-05	0.043	0.049	0.049	
2019-12-12	0.040	0.047	0.047	0.066
2019-12-19	0.038	0.044	0.044	
2019-12-26	0.037	0.042	0.042	
Annual	0.13	0.08	0.08	0.18
Late Summer - Fall	0.07	0.06	0.06	0.22
Winter	0.03	0.03	0.03	0.08
Freshet	0.32	0.15	0.15	0.19











Statistics on concurrent data: 2004 to 2018	Poor	Very good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.41	0.80	0.80	
Modified Nash-Sutcliffe efficiency (E1)	0.32	0.62	0.62	
Index of agreement (d)	0.82	0.94	0.94	
Modified index of agreement (d1)	0.66	0.81	0.81	
MAE	0.09	0.05	0.05	
RMSE	0.15	0.09	0.09	
Coefficient of Determination (R^2)	0.47	0.80	0.80	
Number of data in statistics	109	109	109	
Total number of weekly data	783	783	783	109
Mean of all weekly data	0.155	0.142	0.142	0.147
Standard deviation of all weekly data	0.185	0.184	0.184	0.200
Approximated mean annual runoff (mm/yr)	440	400	400	390

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

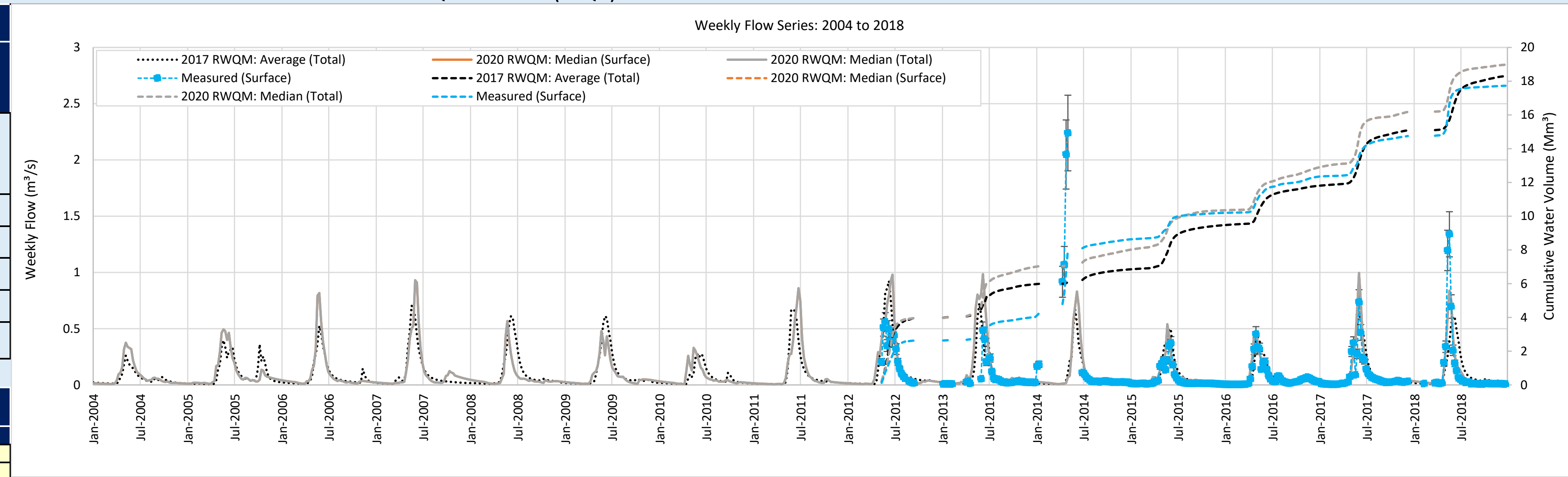
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

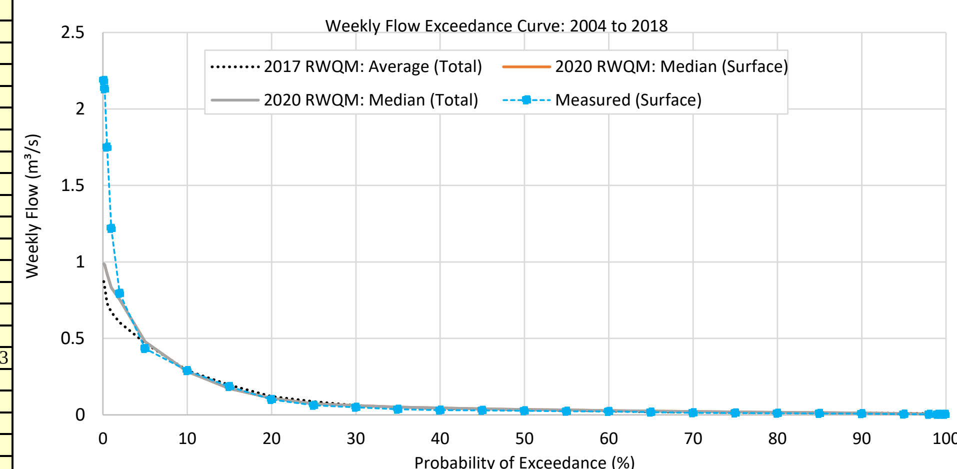
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

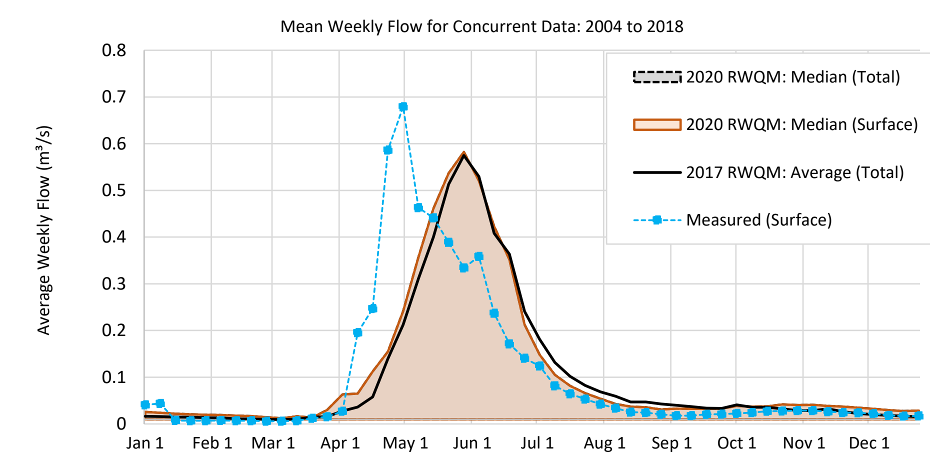
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

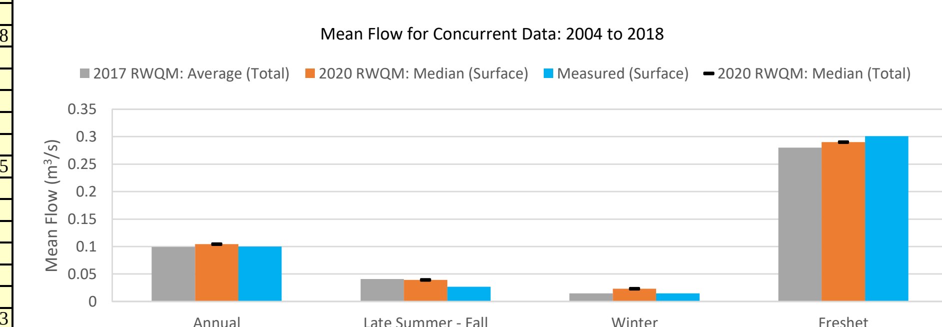
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Module of subcatchment East Tributary of LCO Dry Creek		**Surface-Groundwater Partitioning**	Not implemented
Spinner ID	8	**Mean annual surface runoff (monitored)**		460
Selected Year	2019	**Mean annual total runoff (2020 RWQM)**		480
Comparison Start Year	2004	**Evaluation period (weeks)**		783
Comparison End Year	2018	**Weeks with monitoring data (%)**		36%
Station ID & Description	LC_DCEF	**East Tributary of Dry Creek (E288274)**		
Drainage Area (2018)	700 ha	**Disturbed Area (2018)**		~ 0%

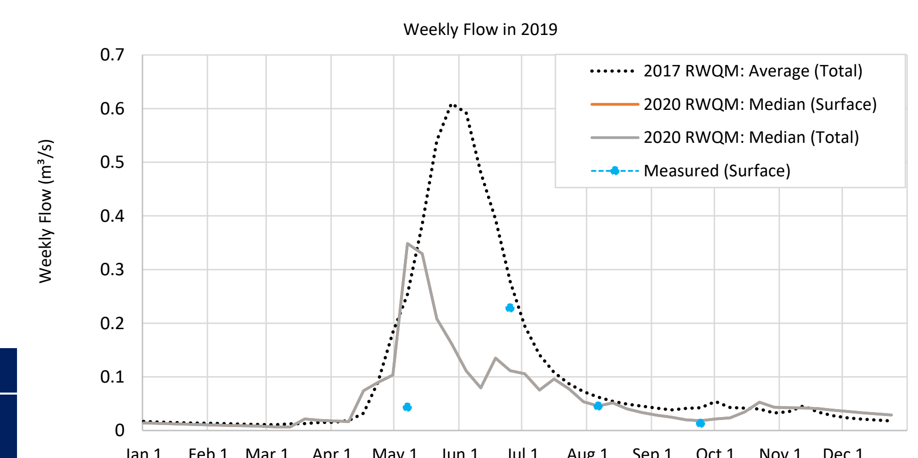
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m^3/s)	
2019-01-03	0.017	0.014	0.014	
2019-01-10	0.016	0.013	0.013	
2019-01-17	0.015	0.012	0.012	
2019-01-24	0.014	0.012	0.012	
2019-01-31	0.014	0.011	0.011	
2019-02-07	0.013	0.010	0.010	
2019-02-14	0.012	0.009	0.009	
2019-02-21	0.012	0.009	0.009	
2019-02-28	0.011	0.008	0.008	
2019-03-07	0.011	0.007	0.007	
2019-03-14	0.012	0.007	0.007	
2019-03-21	0.013	0.021	0.021	
2019-03-28	0.015	0.019	0.019	
2019-04-04	0.015	0.018	0.018	
2019-04-11	0.019	0.017	0.017	
2019-04-18	0.032	0.074	0.074	
2019-04-25	0.091	0.090	0.090	
2019-05-02	0.183	0.103	0.103	
2019-05-09	0.254	0.349	0.349	0.043
2019-05-16	0.385	0.329	0.329	
2019-05-23	0.540	0.208	0.208	
2019-05-30	0.609	0.163	0.163	
2019-06-06	0.592	0.111	0.111	
2019-06-13	0.481	0.079	0.079	
2019-06-20	0.394	0.135	0.135	
2019-06-27	0.278	0.112	0.112	0.228
2019-07-04	0.195	0.106	0.106	
2019-07-11	0.141	0.075	0.075	
2019-07-18	0.108	0.096	0.096	
2019-07-25	0.087	0.078	0.078	
2019-08-01	0.072	0.054	0.054	
2019-08-08	0.062	0.046	0.046	0.045
2019-08-15	0.054	0.052	0.052	
2019-08-22	0.049	0.040	0.040	
2019-08-29	0.045	0.034	0.034	
2019-09-05	0.042	0.029	0.029	
2019-09-12	0.038	0.025	0.025	
2019-09-19	0.041	0.020	0.020	
2019-09-26	0.042	0.018	0.018	0.013
2019-10-03	0.054	0.021	0.021	
2019-10-10	0.043	0.024	0.024	
2019-10-17	0.042	0.035	0.035	
2019-10-24	0.040	0.053	0.053	
2019-10-31	0.033	0.043	0.043	
2019-11-07	0.035	0.042	0.042	
2019-11-14	0.046	0.042	0.042	
2019-11-21	0.034	0.041	0.041	
2019-11-28	0.028	0.038	0.038	
2019-12-05	0.024	0.036	0.036	
2019-12-12	0.021	0.033	0.033	
2019-12-19	0.019	0.031	0.031	
2019-12-26	0.018	0.029	0.029	
Annual	0.11	0.06	0.06	0.08
Late Summer - Fall	0.05	0.04	0.04	0.03
Winter	0.02	0.02	0.02	
Freshet	0.29	0.14	0.14	0.14











Statistics on concurrent data: 2004 to 2018	Poor	Poor but improved		
Parameter	**2017 RWQM: Average (Total)**	**2020 RWQM: Median (Surface)**	**2020 RWQM: Median (Total)**	**Measured (Surface)**
Nash-Sutcliffe efficiency (E)	0.12	0.16	0.16	
Modified Nash-Sutcliffe efficiency (E1)	0.40	0.46	0.46	
Index of agreement (d)	0.58	0.66	0.66	
Modified index of agreement (d1)	0.68	0.72	0.72	
MAE	0.07	0.07	0.07	
RMSE	0.23	0.22	0.22	
Coefficient of Determination (R^2)	0.18	0.24	0.24	
Number of data in statistics	285	285	285	
Total number of weekly data	783	783	783	285
Mean of all weekly data	0.106	0.110	0.110	0.103
Standard deviation of all weekly data	0.164	0.189	0.189	0.245
Approximated mean annual runoff (mm/yr)	450	480	480	460

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

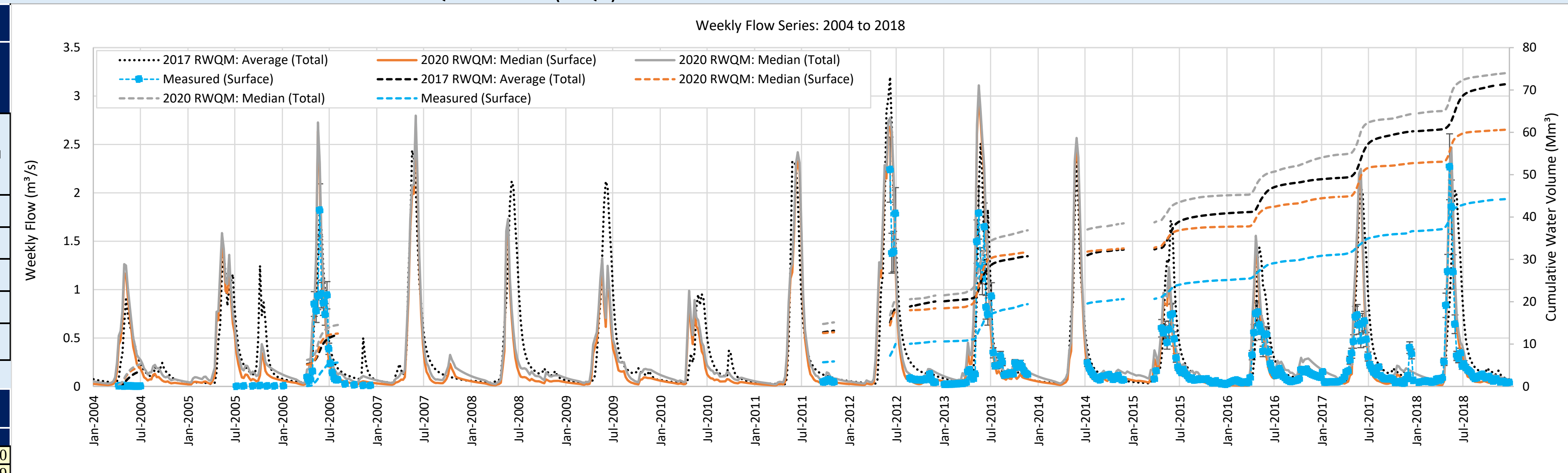
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

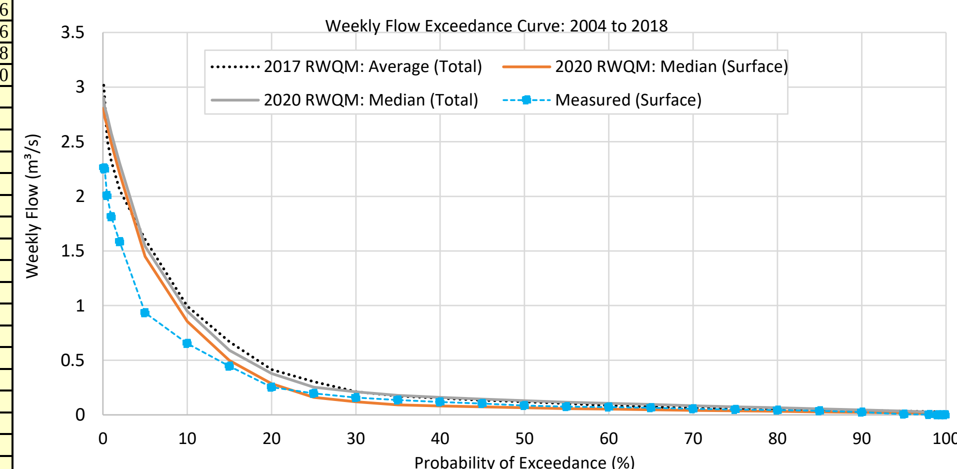
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

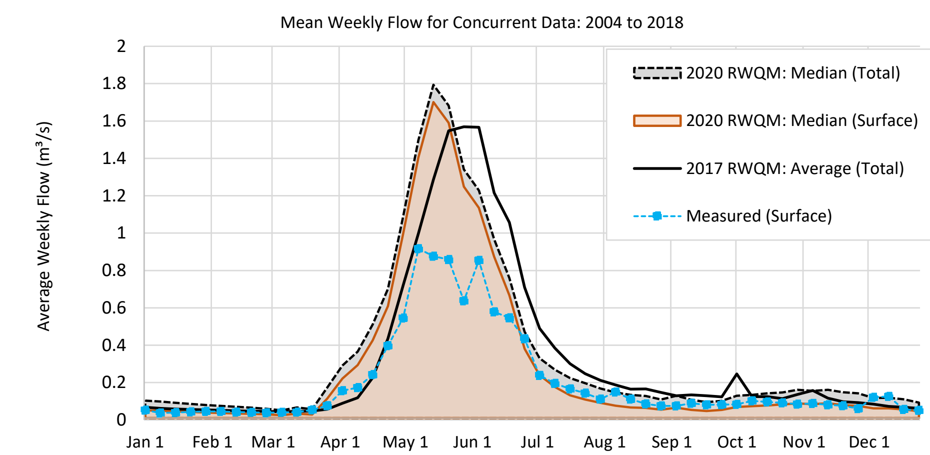
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

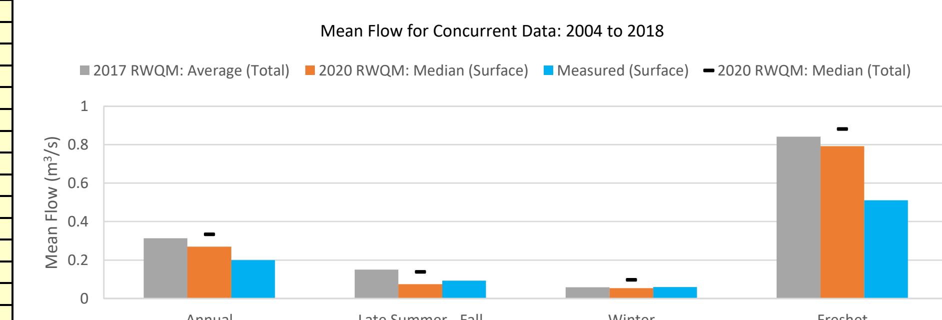
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Module of subcatchments East Tributary of LCO Dry Creek, Upper LCO Dry Creek, Lower LCO Dry Creek to DC4, Lower LCO Dry Creek to DC1		Surface-Groundwater Partitioning	50%, maximum of 8,000 m3/d
Spinner ID	12	Mean annual surface runoff (monitored)		250
Selected Year	2019	Mean annual total runoff (2020 RWQM)		420
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		41%
Station ID & Description	LC_DC1	Dry Creek near the Mouth (at bridge) (E288270)		
Drainage Area (2018)	2560 ha	Disturbed Area (2018)		~ 8%

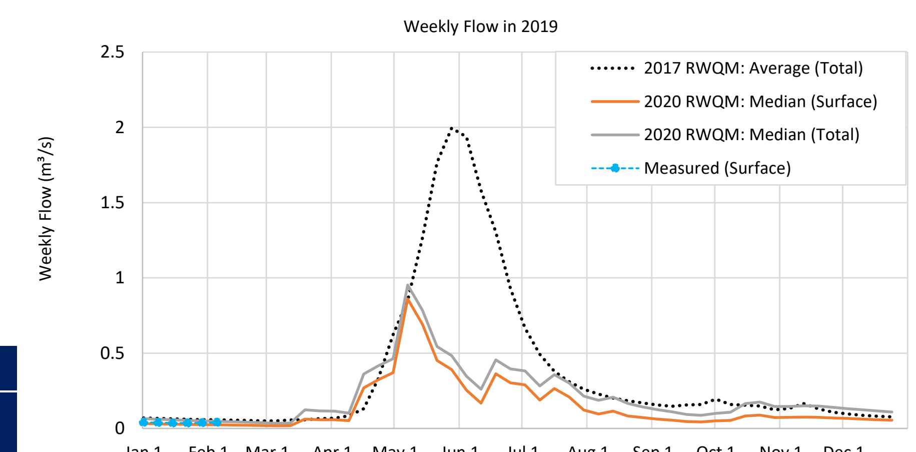
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.069	0.033	0.065	0.040
2019-01-10	0.066	0.031	0.061	0.039
2019-01-17	0.063	0.029	0.057	0.036
2019-01-24	0.061	0.027	0.054	0.036
2019-01-31	0.058	0.025	0.051	0.038
2019-02-07	0.057	0.024	0.048	0.040
2019-02-14	0.055	0.022	0.045	
2019-02-21	0.053	0.021	0.042	
2019-02-28	0.051	0.019	0.039	
2019-03-07	0.050	0.017	0.035	
2019-03-14	0.056	0.018	0.036	
2019-03-21	0.058	0.062	0.124	
2019-03-28	0.065	0.058	0.116	
2019-04-04	0.068	0.057	0.114	
2019-04-11	0.085	0.051	0.102	
2019-04-18	0.131	0.269	0.361	
2019-04-25	0.331	0.323	0.416	
2019-05-02	0.623	0.370	0.463	
2019-05-09	0.850	0.860	0.953	
2019-05-16	1.266	0.692	0.785	
2019-05-23	1.766	0.451	0.543	
2019-05-30	1.995	0.390	0.483	
2019-06-06	1.938	0.255	0.348	
2019-06-13	1.580	0.168	0.260	
2019-06-20	1.304	0.362	0.455	
2019-06-27	0.930	0.303	0.395	
2019-07-04	0.667	0.289	0.382	
2019-07-11	0.493	0.189	0.282	
2019-07-18	0.380	0.264	0.357	
2019-07-25	0.310	0.208	0.301	
2019-08-01	0.261	0.123	0.215	
2019-08-08	0.229	0.096	0.188	
2019-08-15	0.202	0.115	0.208	
2019-08-22	0.184	0.083	0.167	
2019-08-29	0.170	0.072	0.144	
2019-09-05	0.157	0.063	0.125	
2019-09-12	0.147	0.055	0.111	
2019-09-19	0.155	0.047	0.093	
2019-09-26	0.159	0.044	0.087	
2019-10-03	0.194	0.051	0.101	
2019-10-10	0.159	0.054	0.107	
2019-10-17	0.155	0.082	0.164	
2019-10-24	0.149	0.088	0.175	
2019-10-31	0.124	0.073	0.146	
2019-11-07	0.132	0.073	0.146	
2019-11-14	0.166	0.075	0.150	
2019-11-21	0.129	0.074	0.148	
2019-11-28	0.108	0.070	0.139	
2019-12-05	0.096	0.066	0.132	
2019-12-12	0.088	0.062	0.124	
2019-12-19	0.082	0.058	0.116	
2019-12-26	0.077	0.054	0.109	
Annual	0.36	0.14	0.21	0.04
Late Summer - Fall	0.17	0.08	0.15	
Winter	0.07	0.04	0.08	0.04
Freshet	0.96	0.35	0.44	











Statistics on concurrent data: 2004 to 2018	Poor	Poor but improved		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.03	0.25	0.08	
Modified Nash-Sutcliffe efficiency (E1)	0.16	0.36	0.23	
Index of agreement (d)	0.83	0.88	0.86	
Modified index of agreement (d1)	0.64	0.73	0.66	
MAE	0.19	0.15	0.18	
RMSE	0.36	0.32	0.35	
Coefficient of Determination (R^2)	0.61	0.75	0.75	
Number of data in statistics	322	322	322	
Total number of weekly data	783	783	783	322
Mean of all weekly data	0.367	0.312	0.380	0.227
Standard deviation of all weekly data	0.524	0.560	0.572	0.365
Approximated mean annual runoff (mm/yr)	390	340	420	250

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

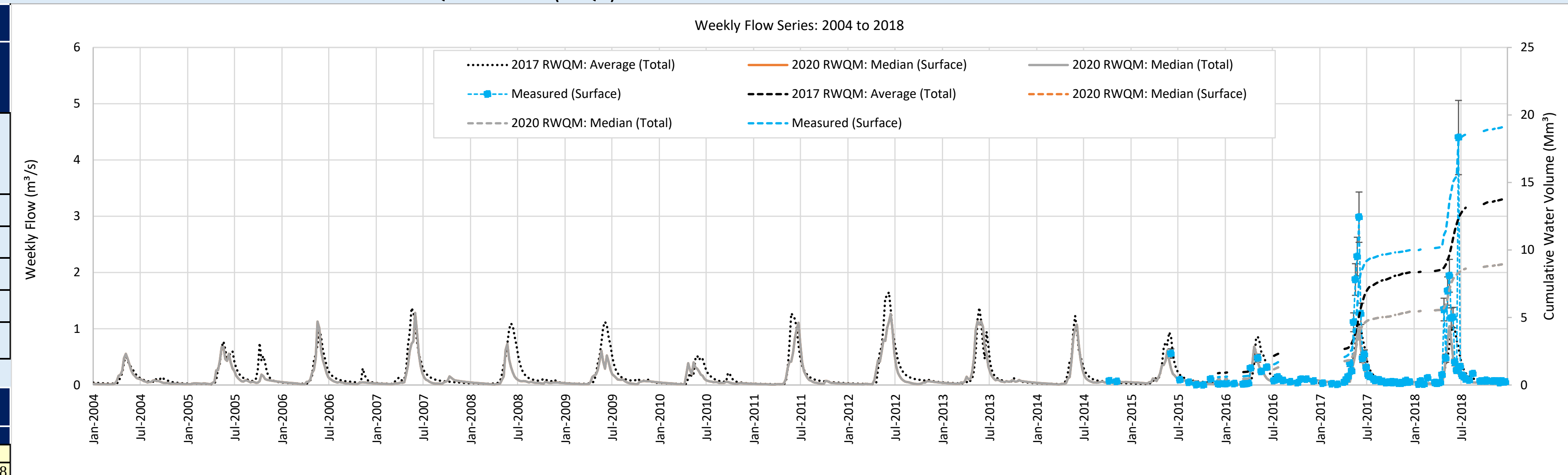
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

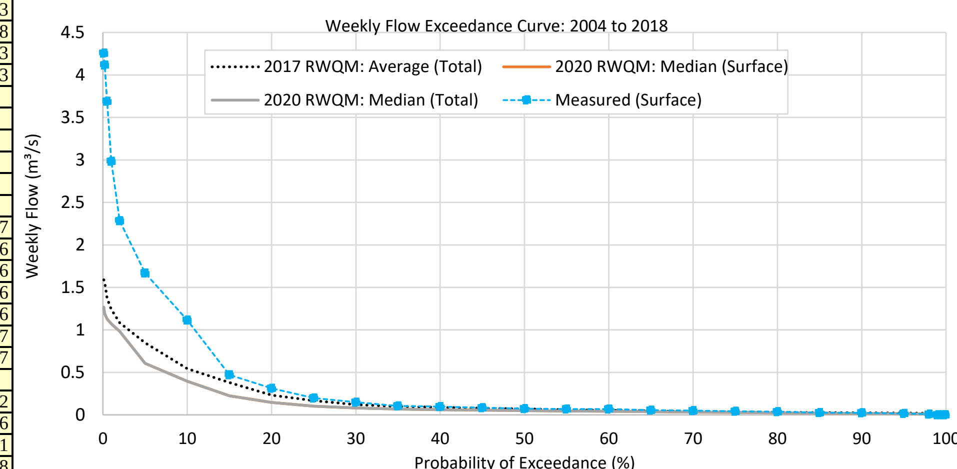
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

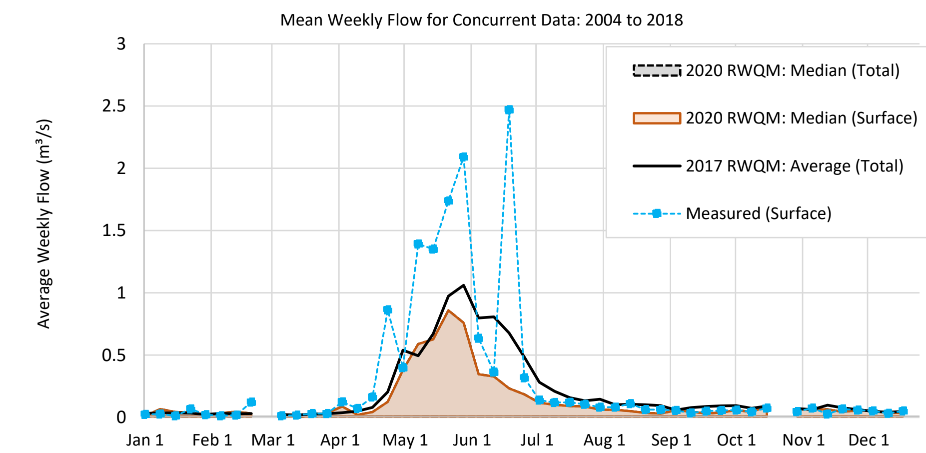
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

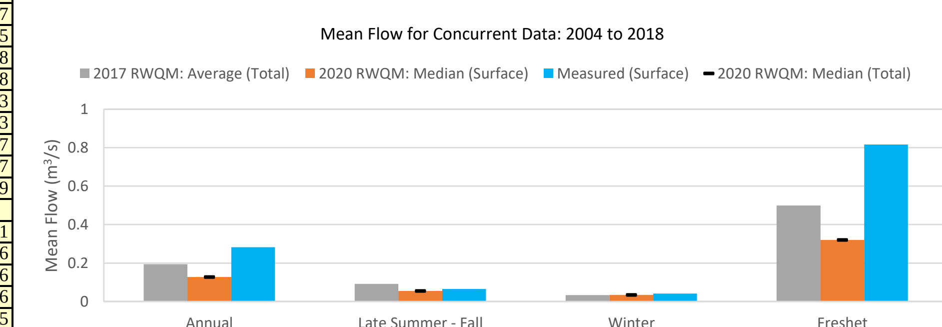
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Module of subcatchments East Tributary of LCO Dry Creek, Upper LCO Dry Creek		Surface-Groundwater Partitioning	80% of LC_DCEF in downstream reach, maximum of 69,100 m3/d
Spinner ID	9	Mean annual surface runoff (monitored)		560
Selected Year	2019	Mean annual total runoff (2020 RWQM)		260
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		13%
Station ID & Description	LC_DCDS	Dry Creek downstream of Sedimentation Ponds (E295210)		
Drainage Area (2018)	1530 ha	Disturbed Area (2018)		~ 13%

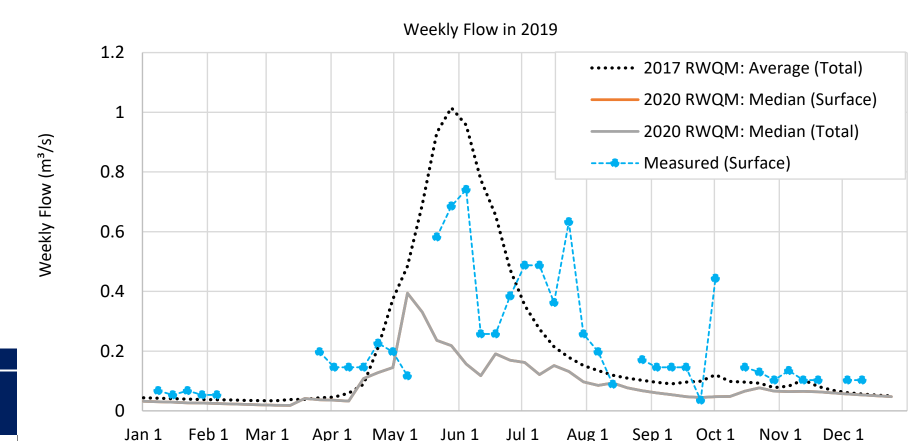
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m^3/s)	
2019-01-03	0.044	0.032	0.032	
2019-01-10	0.042	0.030	0.030	0.068
2019-01-17	0.041	0.029	0.029	0.053
2019-01-24	0.039	0.027	0.027	0.068
2019-01-31	0.038	0.026	0.026	0.053
2019-02-07	0.037	0.024	0.024	0.053
2019-02-14	0.036	0.023	0.023	
2019-02-21	0.035	0.022	0.022	
2019-02-28	0.034	0.020	0.020	
2019-03-07	0.034	0.018	0.018	
2019-03-14	0.038	0.018	0.018	
2019-03-21	0.039	0.041	0.041	
2019-03-28	0.044	0.037	0.037	0.197
2019-04-04	0.046	0.035	0.035	0.146
2019-04-11	0.059	0.033	0.033	0.146
2019-04-18	0.089	0.108	0.108	0.146
2019-04-25	0.213	0.128	0.128	0.226
2019-05-02	0.375	0.145	0.145	0.197
2019-05-09	0.485	0.394	0.394	0.117
2019-05-16	0.690	0.331	0.331	
2019-05-23	0.932	0.236	0.236	0.582
2019-05-30	1.015	0.218	0.218	0.686
2019-06-06	0.957	0.157	0.157	0.741
2019-06-13	0.774	0.117	0.117	0.258
2019-06-20	0.655	0.191	0.191	0.257
2019-06-27	0.474	0.169	0.169	0.385
2019-07-04	0.354	0.162	0.162	0.488
2019-07-11	0.274	0.121	0.121	0.488
2019-07-18	0.215	0.152	0.152	0.363
2019-07-25	0.179	0.132	0.132	0.633
2019-08-01	0.151	0.097	0.097	0.257
2019-08-08	0.135	0.085	0.085	0.197
2019-08-15	0.120	0.093	0.093	0.089
2019-08-22	0.110	0.077	0.077	
2019-08-29	0.102	0.067	0.067	0.171
2019-09-05	0.095	0.060	0.060	0.146
2019-09-12	0.091	0.054	0.054	0.146
2019-09-19	0.096	0.047	0.047	0.146
2019-09-26	0.099	0.045	0.045	0.035
2019-10-03	0.120	0.048	0.048	0.444
2019-10-10	0.098	0.048	0.048	
2019-10-17	0.096	0.066	0.066	0.146
2019-10-24	0.093	0.077	0.077	0.129
2019-10-31	0.078	0.066	0.066	0.103
2019-11-07	0.083	0.065	0.065	0.135
2019-11-14	0.104	0.065	0.065	0.103
2019-11-21	0.081	0.063	0.063	0.103
2019-11-28	0.069	0.060	0.060	
2019-12-05	0.061	0.057	0.057	0.103
2019-12-12	0.056	0.053	0.053	0.103
2019-12-19	0.053	0.051	0.051	
2019-12-26	0.050	0.048	0.048	
Annual	0.20	0.09	0.09	0.23
Late Summer - Fall	0.11	0.07	0.07	0.19
Winter	0.04	0.03	0.03	0.09
Freshet	0.50	0.18	0.18	0.36











Statistics on concurrent data: 2004 to 2018	Poor	Poor		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.39	0.32	0.32	
Modified Nash-Sutcliffe efficiency (E1)	0.49	0.52	0.52	
Index of agreement (d)	0.66	0.60	0.60	
Modified index of agreement (d1)	0.70	0.71	0.71	
MAE	0.19	0.18	0.18	
RMSE	0.52	0.54	0.54	
Coefficient of Determination (R^2)	0.46	0.55	0.55	
Number of data in statistics	101	101	101	
Total number of weekly data	783	783	783	101
Mean of all weekly data	0.225	0.147	0.147	0.313
Standard deviation of all weekly data	0.291	0.218	0.218	0.662
Approximated mean annual runoff (mm/yr)	390	260	260	560

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

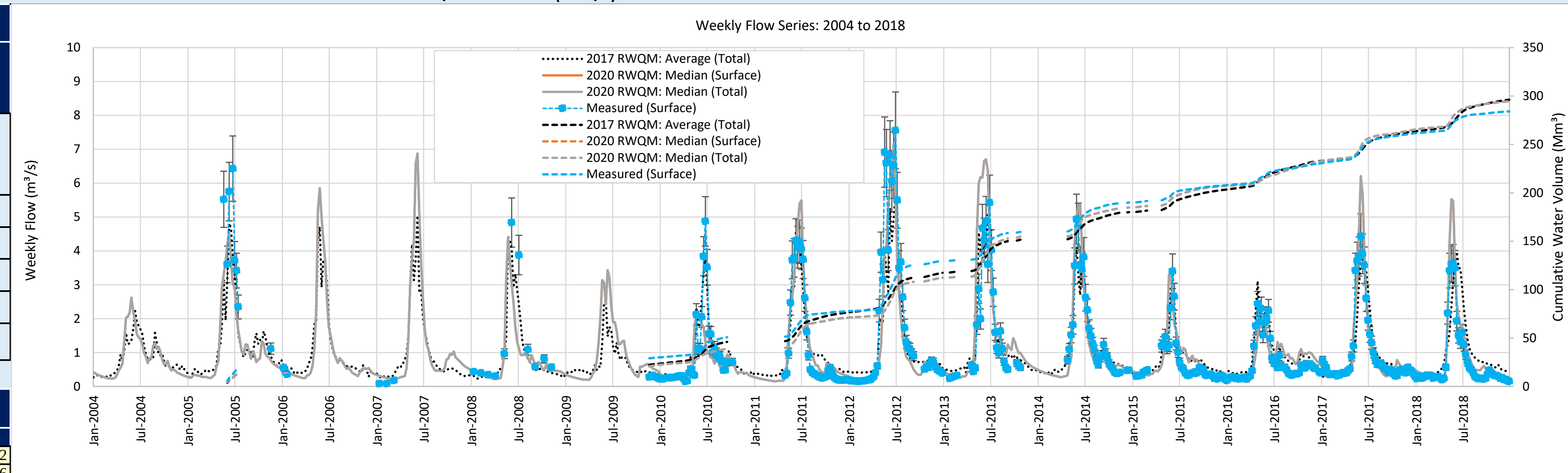
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

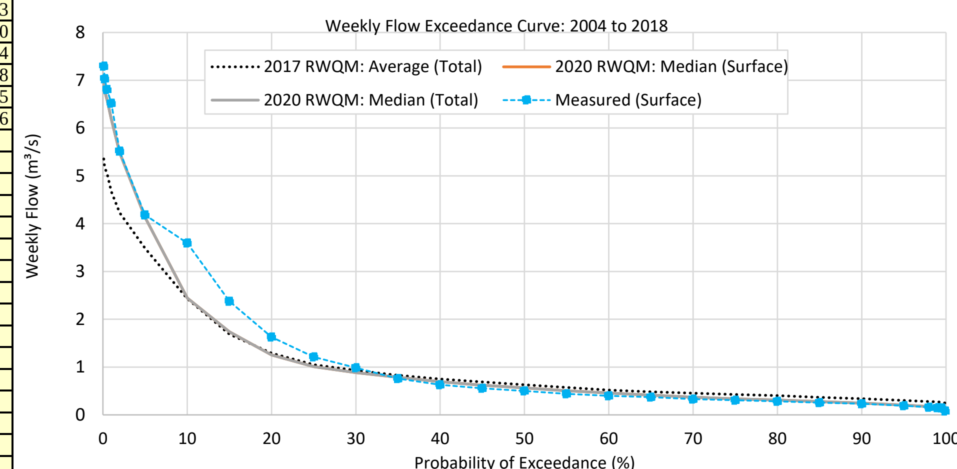
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

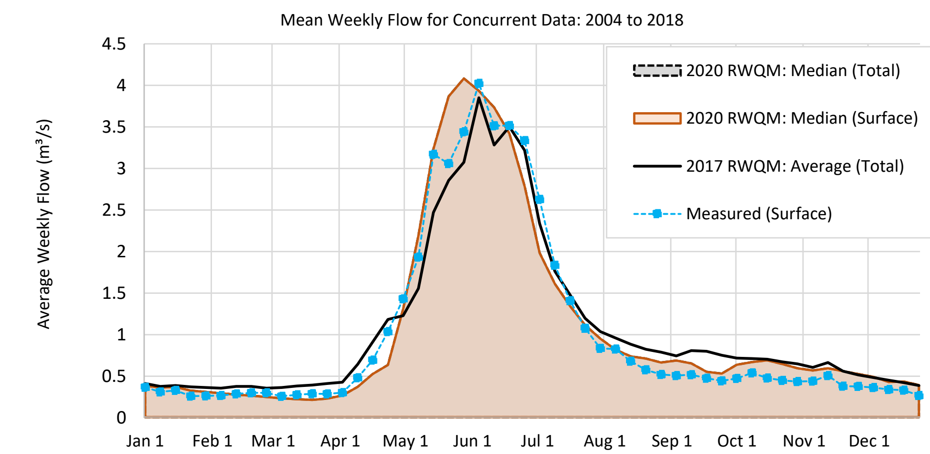
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

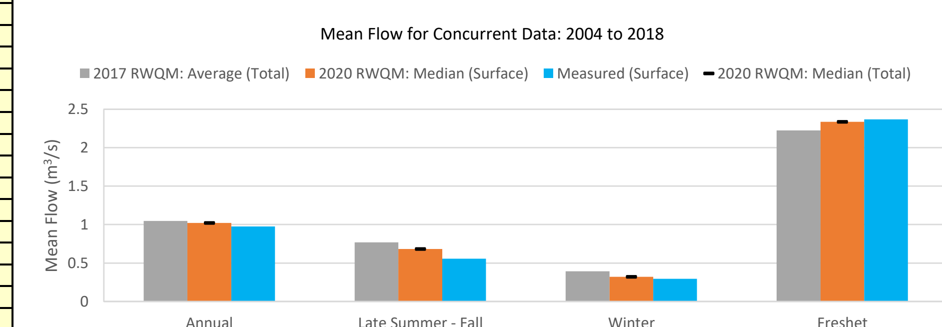
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Module of subcatchments Centre Line Creek, North Line Creek, HSR Pit, MSA West, Horseshoe Creek (1 & 2), Upper Line Creek (1 & 2), No Name Creek (Diversion, NLX Pit, Access Road Spoils)		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	21	Mean annual surface runoff (monitored)		510
Selected Year	2019	Mean annual total runoff (2020 RWQM)		530
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		53%
Station ID & Description	LC_LCUSWLC	Line Creek upstream of West Line Creek (E293369)		
Drainage Area (2018)	6110 ha	Disturbed Area (2018)		~ 26%

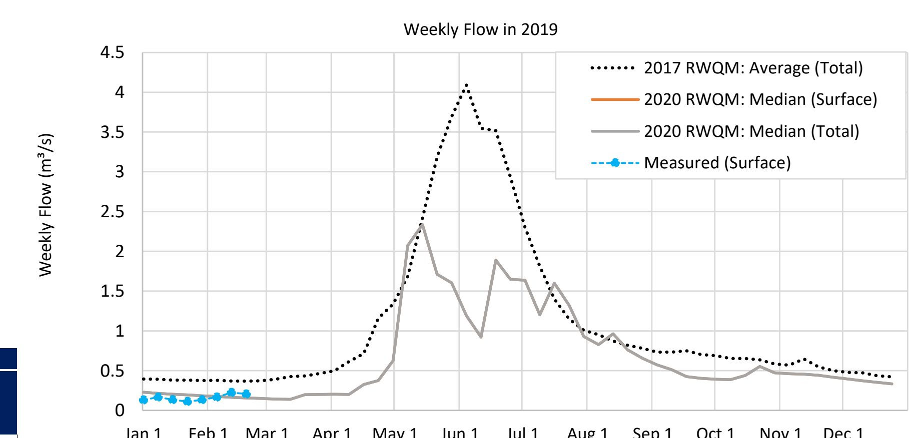
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.393	0.227	0.227	0.132
2019-01-10	0.390	0.215	0.215	0.166
2019-01-17	0.381	0.204	0.204	0.133
2019-01-24	0.380	0.193	0.193	0.110
2019-01-31	0.376	0.183	0.183	0.134
2019-02-07	0.378	0.174	0.174	0.168
2019-02-14	0.369	0.165	0.165	0.225
2019-02-21	0.368	0.157	0.157	0.206
2019-02-28	0.373	0.149	0.149	
2019-03-07	0.392	0.142	0.142	
2019-03-14	0.425	0.139	0.139	
2019-03-21	0.434	0.198	0.198	
2019-03-28	0.464	0.201	0.201	
2019-04-04	0.497	0.204	0.204	
2019-04-11	0.613	0.201	0.201	
2019-04-18	0.714	0.325	0.325	
2019-04-25	1.158	0.374	0.374	
2019-05-02	1.338	0.623	0.623	
2019-05-09	1.683	2.073	2.073	
2019-05-16	2.416	2.336	2.336	
2019-05-23	3.183	1.713	1.713	
2019-05-30	3.696	1.605	1.605	
2019-06-06	4.090	1.191	1.191	
2019-06-13	3.548	0.921	0.921	
2019-06-20	3.517	1.888	1.888	
2019-06-27	2.936	1.647	1.647	
2019-07-04	2.301	1.636	1.636	
2019-07-11	1.811	1.202	1.202	
2019-07-18	1.401	1.602	1.602	
2019-07-25	1.150	1.322	1.322	
2019-08-01	1.008	0.931	0.931	
2019-08-08	0.951	0.828	0.828	
2019-08-15	0.871	0.963	0.963	
2019-08-22	0.818	0.759	0.759	
2019-08-29	0.780	0.654	0.654	
2019-09-05	0.733	0.572	0.572	
2019-09-12	0.734	0.510	0.510	
2019-09-19	0.749	0.424	0.424	
2019-09-26	0.703	0.402	0.402	
2019-10-03	0.688	0.392	0.392	
2019-10-10	0.651	0.385	0.385	
2019-10-17	0.653	0.440	0.440	
2019-10-24	0.635	0.551	0.551	
2019-10-31	0.583	0.473	0.473	
2019-11-07	0.568	0.461	0.461	
2019-11-14	0.645	0.456	0.456	
2019-11-21	0.548	0.441	0.441	
2019-11-28	0.501	0.416	0.416	
2019-12-05	0.479	0.395	0.395	
2019-12-12	0.471	0.373	0.373	
2019-12-19	0.436	0.353	0.353	
2019-12-26	0.423	0.334	0.334	
Annual	1.07	0.67	0.67	0.16
Late Summer - Fall	0.74	0.60	0.60	
Winter	0.41	0.22	0.22	0.16
Freshet	2.29	1.29	1.29	











Statistics on concurrent data: 2004 to 2018	Very good	Good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.83	0.74	0.74	
Modified Nash-Sutcliffe efficiency (E1)	0.65	0.60	0.60	
Index of agreement (d)	0.95	0.93	0.93	
Modified index of agreement (d1)	0.80	0.79	0.79	
MAE	0.36	0.40	0.40	
RMSE	0.58	0.73	0.73	
Coefficient of Determination (R^2)	0.85	0.75	0.75	
Number of data in statistics	412	412	412	
Total number of weekly data	783	783	783	412
Mean of all weekly data	1.189	1.182	1.182	1.140
Standard deviation of all weekly data	1.123	1.411	1.411	1.419
Approximated mean annual runoff (mm/yr)	550	530	530	510

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

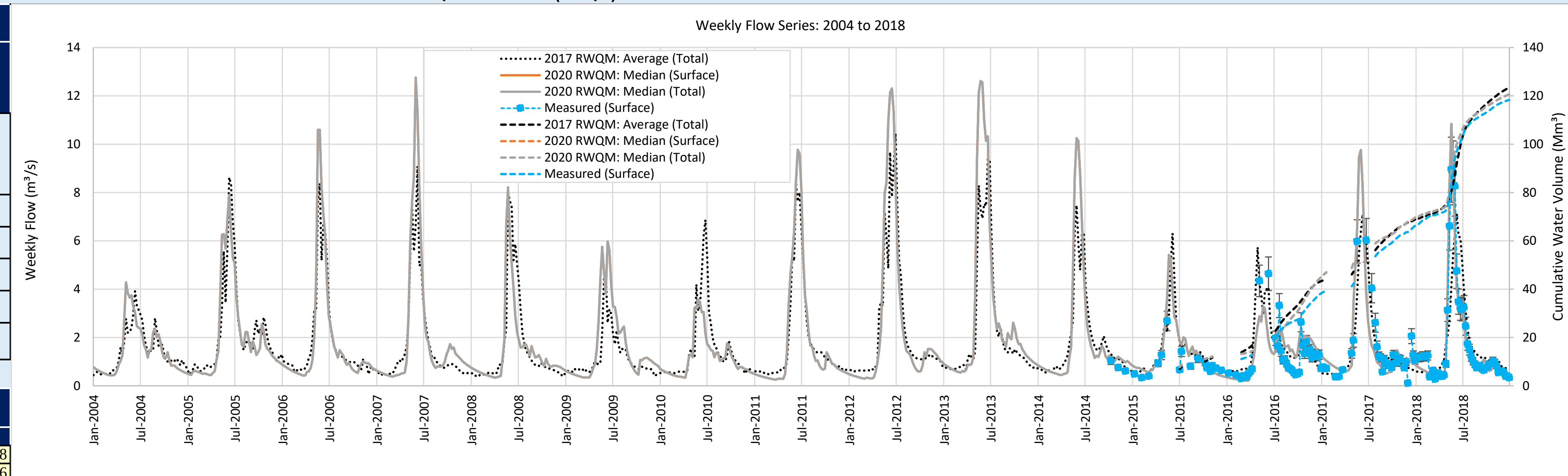
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

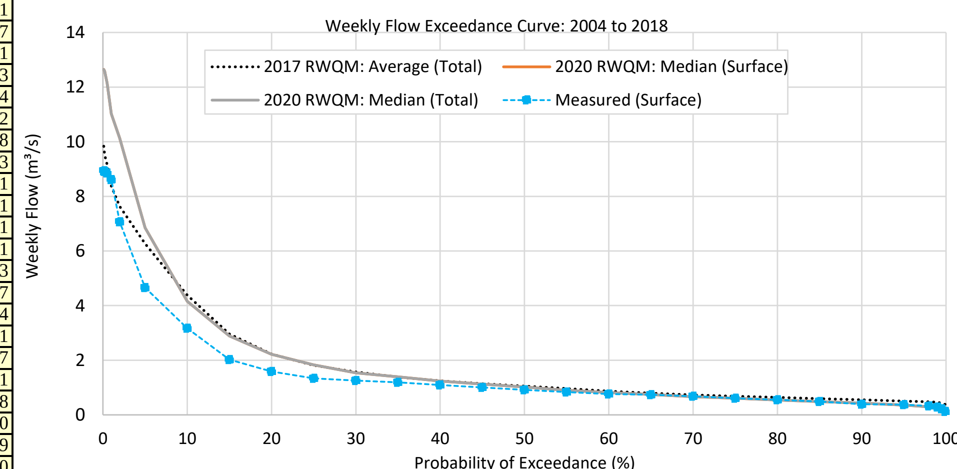
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

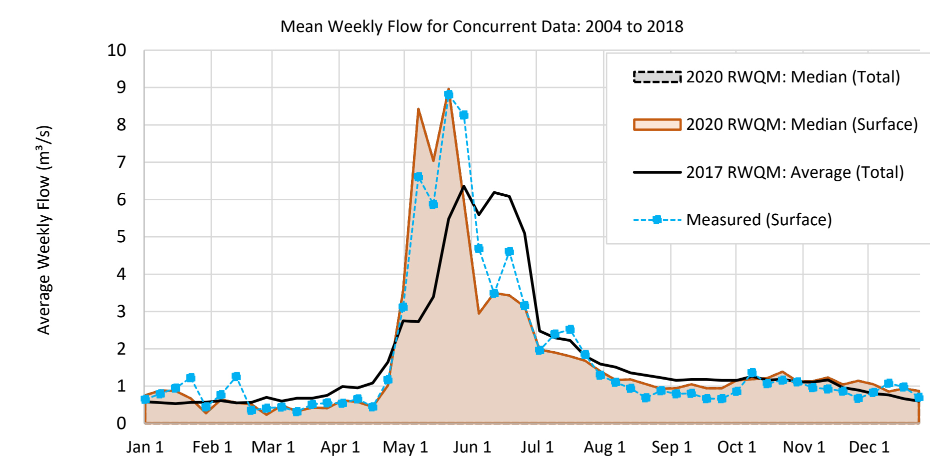
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

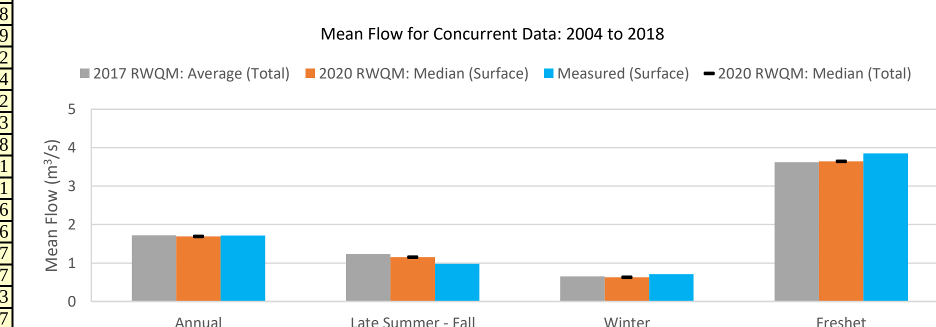
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	LC_LC3 + South Line Creek (LC_SLC) (sum of modelled flows)		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	25	Mean annual surface runoff (monitored)		480
Selected Year	2019	Mean annual total runoff (2020 RWQM)		480
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		17%
Station ID & Description	LC_LCDSSLCC	Line Creek downstream of South Line Creek confluence / LCO compliance point (E297110)		
Drainage Area (2018)	11180 ha	Disturbed Area (2018)		~ 17%

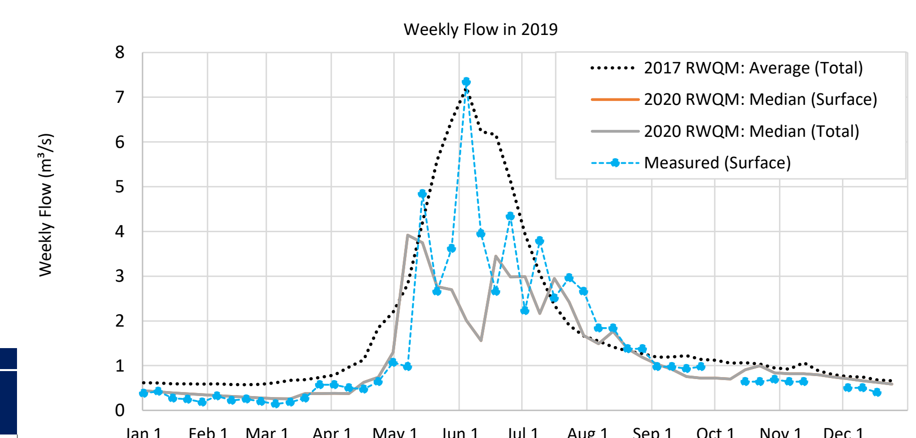
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	0.615	0.440	0.440	0.378
2019-01-10	0.611	0.415	0.415	0.426
2019-01-17	0.594	0.392	0.392	0.271
2019-01-24	0.593	0.370	0.370	0.247
2019-01-31	0.587	0.350	0.350	0.181
2019-02-07	0.592	0.330	0.330	0.323
2019-02-14	0.576	0.312	0.312	0.224
2019-02-21	0.574	0.295	0.295	0.252
2019-02-28	0.582	0.279	0.279	0.198
2019-03-07	0.617	0.264	0.264	0.143
2019-03-14	0.674	0.258	0.258	0.181
2019-03-21	0.689	0.375	0.375	0.271
2019-03-28	0.736	0.377	0.377	0.571
2019-04-04	0.792	0.381	0.381	0.571
2019-04-11	0.965	0.374	0.374	0.503
2019-04-18	1.129	0.627	0.627	0.477
2019-04-25	1.843	0.741	0.741	0.644
2019-05-02	2.194	1.299	1.299	1.071
2019-05-09	2.820	3.918	3.918	0.977
2019-05-16	4.198	3.750	3.750	4.841
2019-05-23	5.585	2.769	2.769	2.658
2019-05-30	6.479	2.698	2.698	3.620
2019-06-06	7.224	2.009	2.009	7.349
2019-06-13	6.231	1.561	1.561	3.950
2019-06-20	6.166	3.448	3.448	2.658
2019-06-27	5.131	2.985	2.985	4.339
2019-07-04	3.947	2.988	2.988	2.232
2019-07-11	3.054	2.167	2.167	3.794
2019-07-18	2.354	2.952	2.952	2.512
2019-07-25	1.905	2.419	2.419	2.963
2019-08-01	1.661	1.674	1.674	2.658
2019-08-08	1.551	1.490	1.490	1.841
2019-08-15	1.414	1.766	1.766	1.841
2019-08-22	1.329	1.379	1.379	1.376
2019-08-29	1.270	1.183	1.183	1.376
2019-09-05	1.191	1.032	1.032	0.977
2019-09-12	1.193	0.919	0.919	0.977
2019-09-19	1.223	0.757	0.757	0.933
2019-09-26	1.142	0.721	0.721	0.977
2019-10-03	1.120	0.720	0.720	
2019-10-10	1.057	0.701	0.701	
2019-10-17	1.067	0.906	0.906	0.644
2019-10-24	1.038	0.996	0.996	0.644
2019-10-31	0.946	0.838	0.838	0.689
2019-11-07	0.921	0.821	0.821	0.644
2019-11-14	1.065	0.818	0.818	0.644
2019-11-21	0.884	0.795	0.795	
2019-11-28	0.797	0.748	0.748	
2019-12-05	0.757	0.706	0.706	0.503
2019-12-12	0.745	0.664	0.664	0.503
2019-12-19	0.682	0.626	0.626	0.403
2019-12-26	0.659	0.589	0.589	
Annual	1.80	1.20	1.20	1.41
Late Summer - Fall	1.20	1.09	1.09	1.28
Winter	0.65	0.41	0.41	0.33
Freshet	3.95	2.29	2.29	2.78











Statistics on concurrent data: 2004 to 2018	Good	Very good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.68	0.81	0.81	
Modified Nash-Sutcliffe efficiency (E1)	0.46	0.53	0.53	
Index of agreement (d)	0.90	0.95	0.95	
Modified index of agreement (d1)	0.70	0.76	0.76	
MAE	0.52	0.46	0.46	
RMSE	0.89	0.69	0.69	
Coefficient of Determination (R^2)	0.69	0.82	0.82	
Number of data in statistics	137	137	137	
Total number of weekly data	783	783	783	137
Mean of all weekly data	1.490	1.456	1.456	1.428
Standard deviation of all weekly data	1.298	1.582	1.582	1.588
Approximated mean annual runoff (mm/yr)	490	480	480	480

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

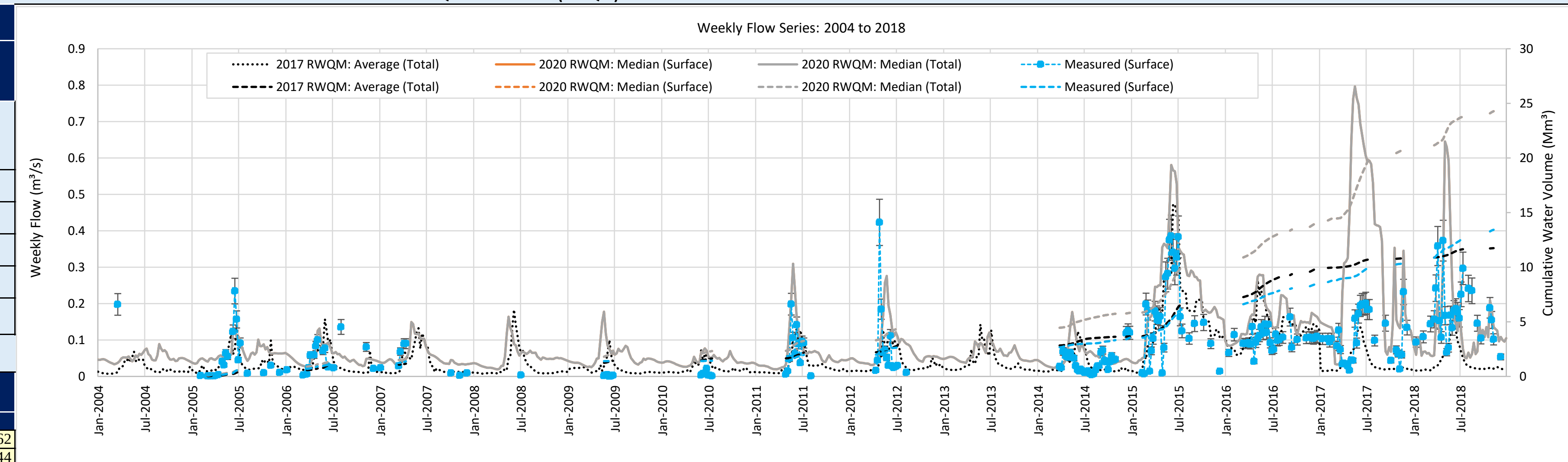
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

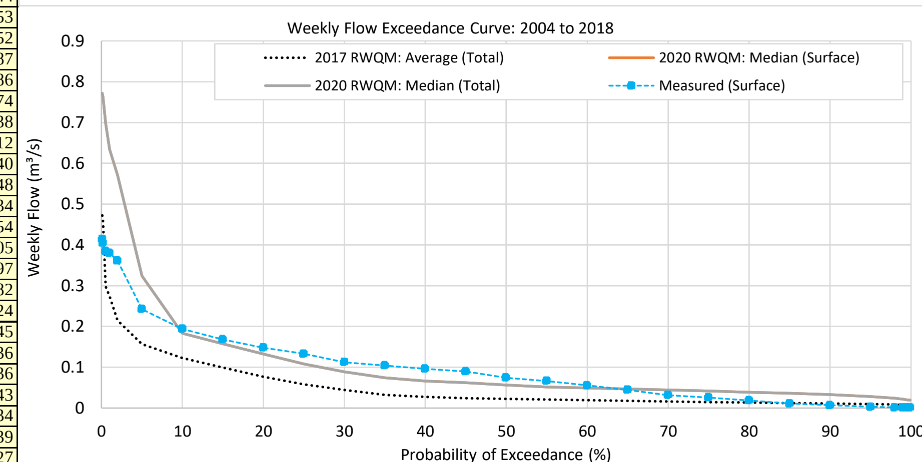
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

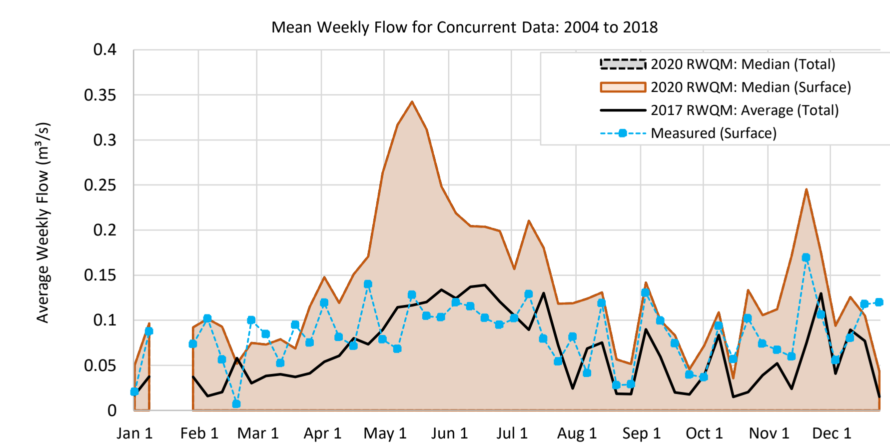
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

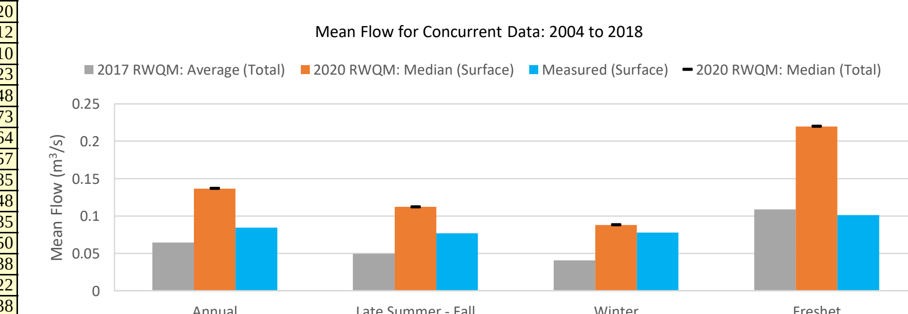
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchment of Gate Creek, dewatering of Natal Pit (diverted via Bodie Control Pond) and Natal Pit 2		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	26	Mean annual surface runoff (monitored)		610
Selected Year	2019	Mean annual total runoff (2020 RWQM)		990
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		31%
Station ID & Description	EV_GT1	Gate Creek Sediment Pond Decant (E206231)		
Drainage Area (2018)	430 ha	Disturbed Area (2018)		~ 63%

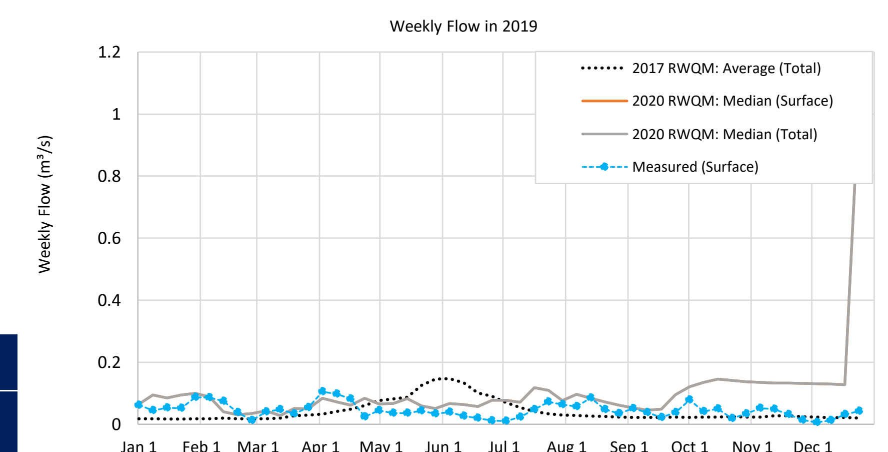
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
1/3/2019	0.018	0.065	0.065	0.062
1/10/2019	0.017	0.095	0.095	0.044
1/17/2019	0.017	0.085	0.085	0.053
1/24/2019	0.017	0.094	0.094	0.052
1/31/2019	0.018	0.100	0.100	0.087
2/7/2019	0.018	0.088	0.088	0.086
2/14/2019	0.020	0.040	0.040	0.074
2/21/2019	0.018	0.031	0.031	0.038
2/28/2019	0.018	0.035	0.035	0.012
3/7/2019	0.018	0.043	0.043	0.040
3/14/2019	0.019	0.028	0.028	0.048
3/21/2019	0.028	0.051	0.051	0.034
3/28/2019	0.029	0.049	0.049	0.054
4/4/2019	0.032	0.083	0.083	0.105
4/11/2019	0.041	0.072	0.072	0.097
4/18/2019	0.049	0.062	0.062	0.082
4/25/2019	0.060	0.084	0.084	0.024
5/2/2019	0.077	0.065	0.065	0.045
5/9/2019	0.081	0.067	0.067	0.036
5/16/2019	0.087	0.083	0.083	0.036
5/23/2019	0.125	0.059	0.059	0.043
5/30/2019	0.145	0.051	0.051	0.034
6/6/2019	0.147	0.067	0.067	0.039
6/13/2019	0.134	0.064	0.064	0.027
6/20/2019	0.101	0.057	0.057	0.020
6/27/2019	0.090	0.077	0.077	0.012
7/4/2019	0.070	0.077	0.077	0.010
7/11/2019	0.054	0.071	0.071	0.023
7/18/2019	0.041	0.117	0.117	0.048
7/25/2019	0.034	0.110	0.110	0.073
8/1/2019	0.029	0.076	0.076	0.064
8/8/2019	0.028	0.096	0.096	0.057
8/15/2019	0.026	0.084	0.084	0.085
8/22/2019	0.025	0.072	0.072	0.048
8/29/2019	0.023	0.062	0.062	0.035
9/5/2019	0.022	0.053	0.053	0.050
9/12/2019	0.022	0.045	0.045	0.038
9/19/2019	0.022	0.049	0.049	0.022
9/26/2019	0.023	0.096	0.096	0.038
10/3/2019	0.022	0.121	0.121	0.078
10/10/2019	0.024	0.135	0.135	0.042
10/17/2019	0.023	0.146	0.146	0.050
10/24/2019	0.026	0.141	0.141	0.019
10/31/2019	0.023	0.137	0.137	0.034
11/7/2019	0.023	0.135	0.135	0.052
11/14/2019	0.027	0.133	0.133	0.048
11/21/2019	0.028	0.133	0.133	0.031
11/28/2019	0.025	0.132	0.132	0.013
12/5/2019	0.024	0.131	0.131	0.006
12/12/2019	0.021	0.130	0.130	0.012
12/19/2019	0.022	0.128	0.128	0.032
12/26/2019	0.020	1.051	1.051	0.042
Annual	0.04	0.10	0.10	0.04
Late Summer - Fall	0.03	0.10	0.10	0.05
Winter	0.02	0.13	0.13	0.05
Freshet	0.09	0.07	0.07	0.04











Statistics on concurrent data: 2004 to 2018	Poor	Poor		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.05	-2.83	-2.83	
Modified Nash-Sutcliffe efficiency (E1)	0.09	-0.62	-0.62	
Index of agreement (d)	0.71	0.53	0.53	
Modified index of agreement (d1)	0.53	0.40	0.40	
MAE	0.06	0.10	0.10	
RMSE	0.08	0.16	0.16	
Coefficient of Determination (R^2)	0.25	0.20	0.20	
Number of data in statistics	241	241	241	
Total number of weekly data	783	783	783	241
Mean of all weekly data	0.081	0.167	0.167	0.092
Standard deviation of all weekly data	0.078	0.164	0.164	0.084
Approximated mean annual runoff (mm/yr)	460	990	990	610

Notes

Performance statistics: For E, E1, d, d1, and R² a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

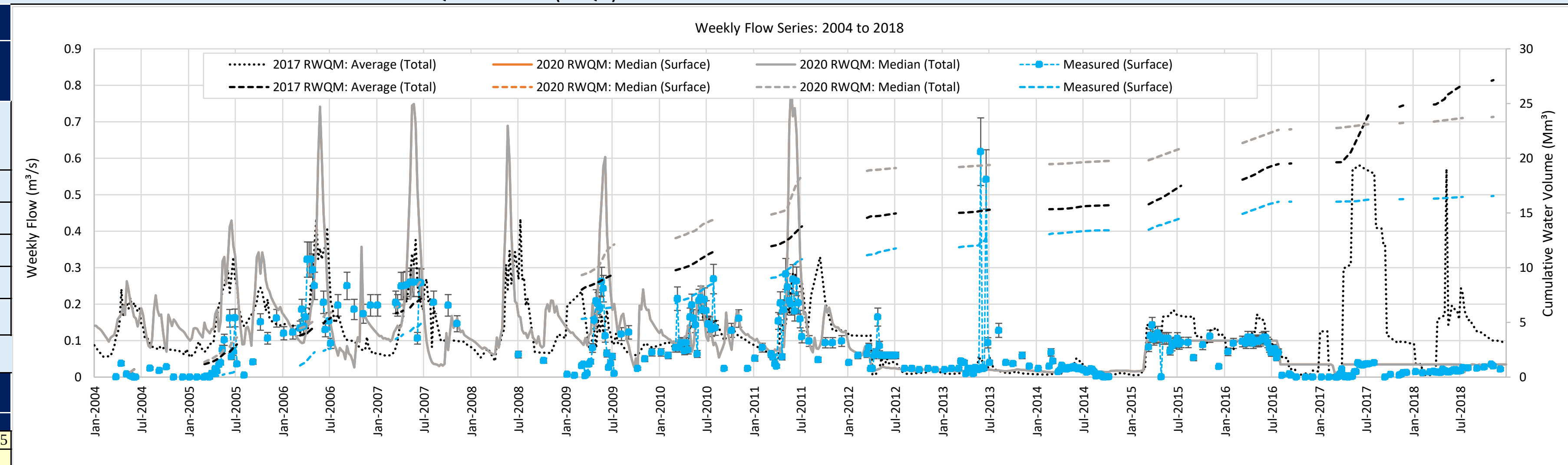
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

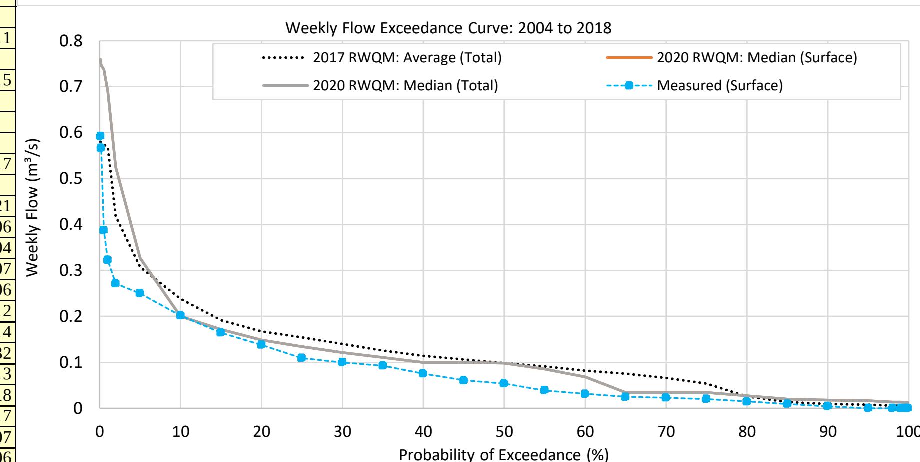
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

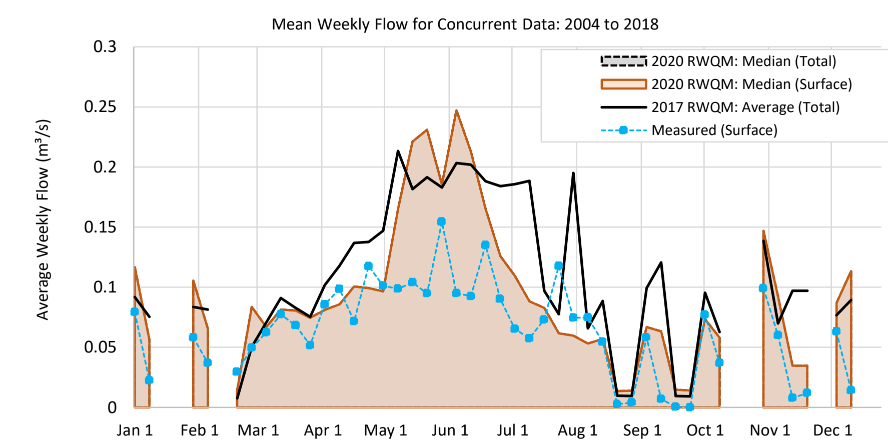
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

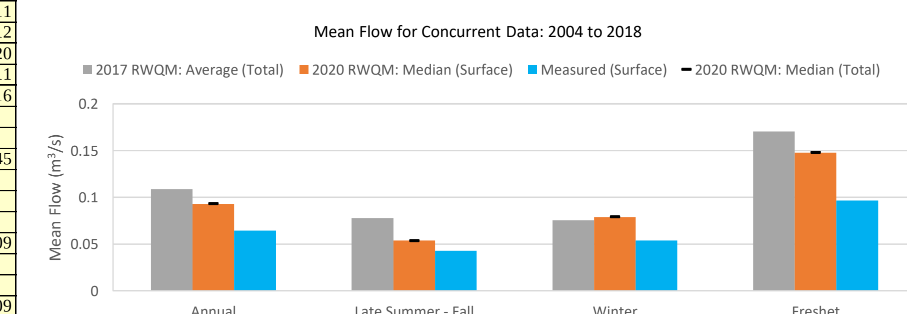
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchments of Bodie Creek and dewatering of Natal Pits (via Bodie Control Pond)		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	28	Mean annual surface runoff (monitored)		170
Selected Year	2019	Mean annual total runoff (2020 RWQM)		250
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		44%
Station ID & Description	EV_BC1	Bodie Creek Sediment Pond Decant (E102685)		
Drainage Area (2018)	1150 ha	Disturbed Area (2018)		~ 97%

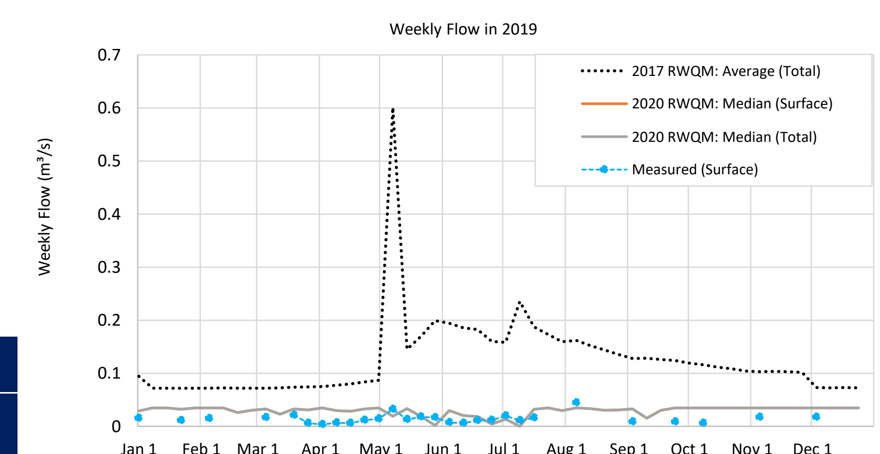
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m^3/s)	
1/3/2019	0.094	0.029	0.029	0.015
1/10/2019	0.072	0.035	0.035	
1/17/2019	0.072	0.035	0.035	
1/24/2019	0.072	0.032	0.032	0.011
1/31/2019	0.072	0.035	0.035	
2/7/2019	0.072	0.035	0.035	0.015
2/14/2019	0.072	0.035	0.035	
2/21/2019	0.072	0.026	0.026	
2/28/2019	0.072	0.030	0.030	
3/7/2019	0.072	0.033	0.033	0.017
3/14/2019	0.072	0.023	0.023	
3/21/2019	0.074	0.033	0.033	0.021
3/28/2019	0.074	0.031	0.031	0.006
4/4/2019	0.075	0.035	0.035	0.004
4/11/2019	0.078	0.030	0.030	0.007
4/18/2019	0.080	0.028	0.028	0.006
4/25/2019	0.084	0.033	0.033	0.012
5/2/2019	0.087	0.034	0.034	0.014
5/9/2019	0.601	0.019	0.019	0.032
5/16/2019	0.145	0.033	0.033	0.013
5/23/2019	0.170	0.018	0.018	0.018
5/30/2019	0.199	0.002	0.002	0.017
6/6/2019	0.194	0.030	0.030	0.007
6/13/2019	0.186	0.020	0.020	0.006
6/20/2019	0.182	0.018	0.018	0.011
6/27/2019	0.160	0.004	0.004	0.012
7/4/2019	0.158	0.013	0.013	0.020
7/11/2019	0.235	0.000	0.000	0.011
7/18/2019	0.188	0.032	0.032	0.016
7/25/2019	0.173	0.035	0.035	
8/1/2019	0.160	0.029	0.029	
8/8/2019	0.162	0.035	0.035	0.045
8/15/2019	0.152	0.034	0.034	
8/22/2019	0.144	0.030	0.030	
8/29/2019	0.135	0.031	0.031	
9/5/2019	0.128	0.033	0.033	0.009
9/12/2019	0.128	0.015	0.015	
9/19/2019	0.126	0.030	0.030	
9/26/2019	0.124	0.035	0.035	0.009
10/3/2019	0.119	0.035	0.035	
10/10/2019	0.116	0.035	0.035	0.006
10/17/2019	0.112	0.035	0.035	
10/24/2019	0.108	0.035	0.035	
10/31/2019	0.104	0.035	0.035	
11/7/2019	0.103	0.035	0.035	0.017
11/14/2019	0.103	0.035	0.035	
11/21/2019	0.103	0.035	0.035	
11/28/2019	0.102	0.035	0.035	
12/5/2019	0.073	0.035	0.035	0.017
12/12/2019	0.073	0.035	0.035	
12/19/2019	0.073	0.035	0.035	
12/26/2019	0.072	0.035	0.035	
Annual	0.12	0.03	0.03	0.01
Late Summer - Fall	0.13	0.03	0.03	0.02
Winter	0.07	0.03	0.03	0.01
Freshet	0.18	0.02	0.02	0.01











Statistics on concurrent data: 2004 to 2018	Poor	Poor but improved		
Parameter	**2017 RWQM: Average (Total)**	**2020 RWQM: Median (Surface)**	**2020 RWQM: Median (Total)**	**Measured (Surface)**
Nash-Sutcliffe efficiency (E)	-1.87	-1.17	-1.17	
Modified Nash-Sutcliffe efficiency (E1)	-0.34	-0.08	-0.08	
Index of agreement (d)	0.42	0.62	0.62	
Modified index of agreement (d1)	0.43	0.52	0.52	
MAE	0.09	0.07	0.07	
RMSE	0.14	0.13	0.13	
Coefficient of Determination (R^2)	0.02	0.23	0.23	
Number of data in statistics	342	342	342	
Total number of weekly data	783	783	783	342
Mean of all weekly data	0.132	0.115	0.115	0.080
Standard deviation of all weekly data	0.118	0.136	0.136	0.085
Approximated mean annual runoff (mm/yr)	290	250	250	170

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

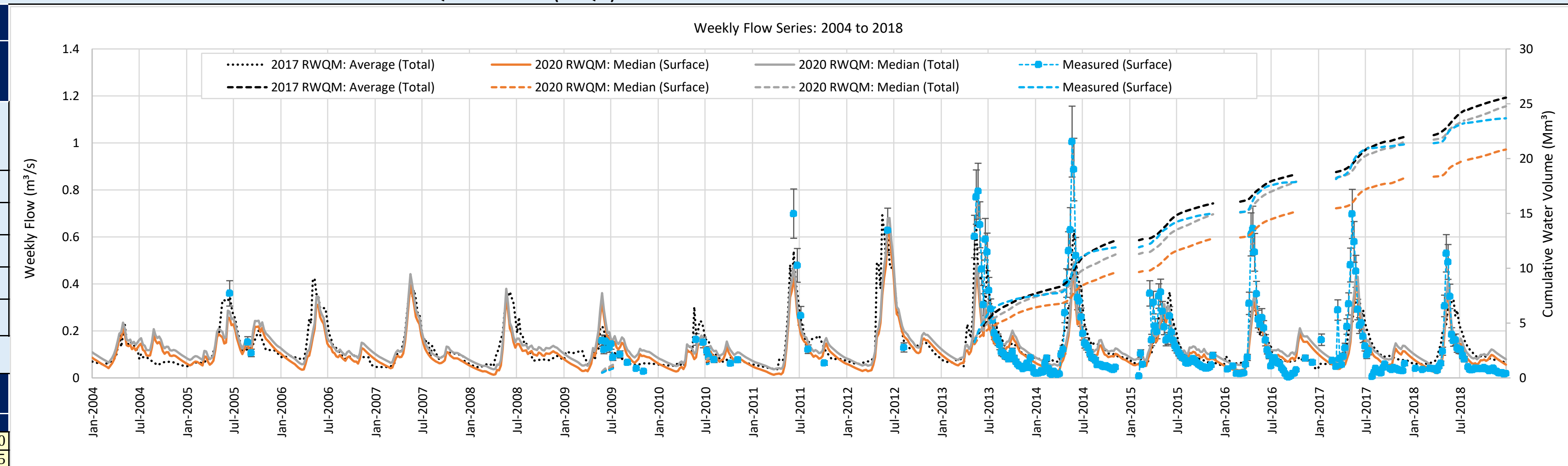
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

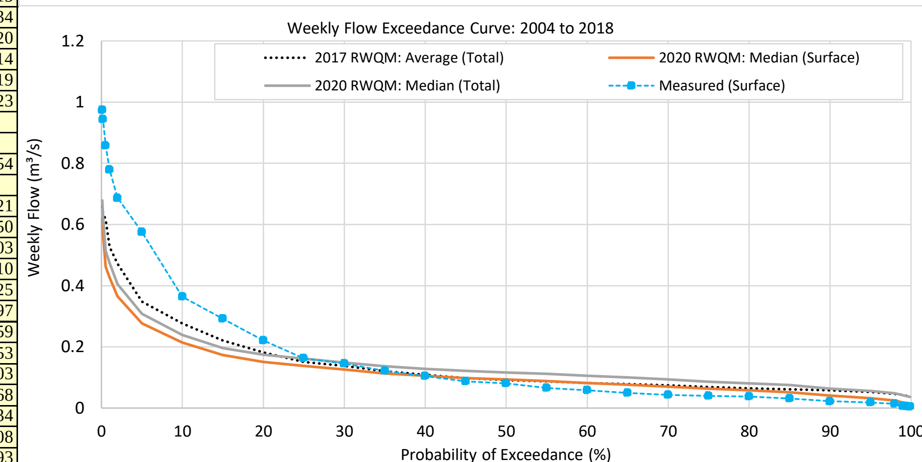
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

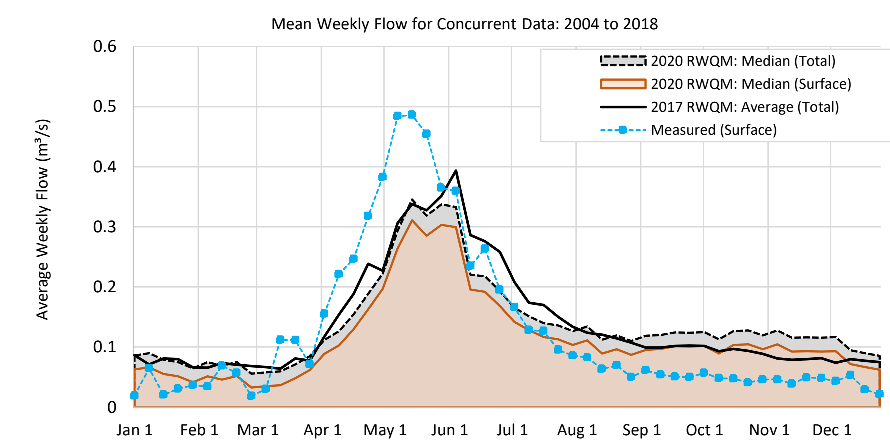
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

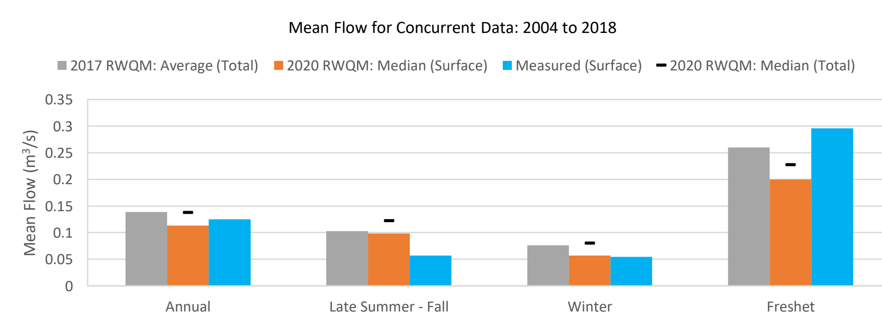
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchment of EVO Dry Creek		Surface-Groundwater Partitioning	Flows < 20,000 m3/d: 100%, maximum of 2,000 m3/d Flows > 20,000 m3/d: 10%, maximum of 5,000 m3/d
Spinner ID	4	Mean annual surface runoff (monitored)		460
Selected Year	2019	Mean annual total runoff (2020 RWQM)		510
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		34%
Station ID & Description	EV_DC1	Dry Creek Sediment Pond Decant (E298590)		
Drainage Area (2018)	860 ha	Disturbed Area (2018)		~ 55%

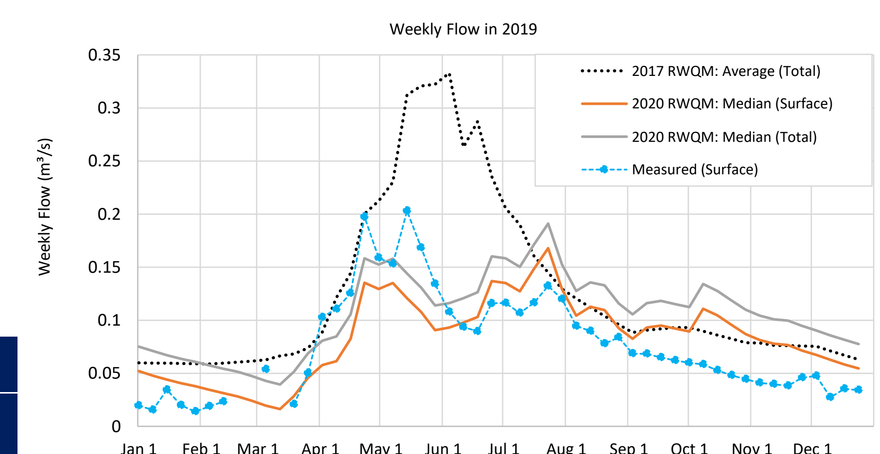
Date	2017 RWQM: Average (Total) Weekly Flow in 2019	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total) (m³/s)	Measured (Surface)
1/3/2019	0.060	0.052	0.075	0.020
1/10/2019	0.060	0.048	0.071	0.015
1/17/2019	0.059	0.044	0.067	0.034
1/24/2019	0.059	0.040	0.064	0.020
1/31/2019	0.059	0.038	0.061	0.014
2/7/2019	0.059	0.034	0.058	0.019
2/14/2019	0.060	0.031	0.054	0.023
2/21/2019	0.060	0.028	0.051	
2/28/2019	0.061	0.024	0.047	
3/7/2019	0.063	0.020	0.043	0.054
3/14/2019	0.066	0.016	0.039	
3/21/2019	0.068	0.028	0.052	0.021
3/28/2019	0.074	0.046	0.069	0.050
4/4/2019	0.089	0.058	0.081	0.103
4/11/2019	0.121	0.061	0.085	0.110
4/18/2019	0.144	0.082	0.106	0.125
4/25/2019	0.200	0.135	0.158	0.197
5/2/2019	0.212	0.129	0.152	0.159
5/9/2019	0.230	0.135	0.158	0.153
5/16/2019	0.312	0.121	0.144	0.203
5/23/2019	0.321	0.108	0.131	0.168
5/30/2019	0.322	0.091	0.114	0.134
6/6/2019	0.333	0.093	0.116	0.108
6/13/2019	0.263	0.098	0.121	0.093
6/20/2019	0.287	0.103	0.126	0.090
6/27/2019	0.235	0.137	0.160	0.116
7/4/2019	0.205	0.135	0.158	0.116
7/11/2019	0.190	0.127	0.150	0.107
7/18/2019	0.160	0.148	0.171	0.117
7/25/2019	0.145	0.168	0.191	0.132
8/1/2019	0.129	0.129	0.152	0.120
8/8/2019	0.120	0.104	0.127	0.095
8/15/2019	0.112	0.113	0.136	0.090
8/22/2019	0.104	0.110	0.133	0.078
8/29/2019	0.096	0.092	0.116	0.084
9/5/2019	0.088	0.082	0.106	0.068
9/12/2019	0.091	0.093	0.116	0.068
9/19/2019	0.092	0.095	0.118	0.065
9/26/2019	0.093	0.092	0.115	0.062
10/3/2019	0.093	0.089	0.112	0.060
10/10/2019	0.090	0.111	0.134	0.058
10/17/2019	0.086	0.104	0.128	0.053
10/24/2019	0.082	0.095	0.119	0.048
10/31/2019	0.079	0.087	0.110	0.044
11/7/2019	0.079	0.081	0.104	0.041
11/14/2019	0.076	0.078	0.101	0.040
11/21/2019	0.076	0.077	0.100	0.038
11/28/2019	0.076	0.071	0.095	0.046
12/5/2019	0.075	0.067	0.090	0.048
12/12/2019	0.071	0.063	0.086	0.027
12/19/2019	0.067	0.058	0.082	0.035
12/26/2019	0.063	0.054	0.078	0.034
Annual	0.13	0.08	0.11	0.08
Late Summer - Fall	0.10	0.10	0.12	0.07
Winter	0.07	0.04	0.06	0.03
Freshet	0.24	0.11	0.14	0.13











Statistics on concurrent data: 2004 to 2018	Good	Acceptable		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.69	0.59	0.62	
Modified Nash-Sutcliffe efficiency (E1)	0.45	0.46	0.39	
Index of agreement (d)	0.88	0.81	0.83	
Modified index of agreement (d1)	0.67	0.66	0.60	
MAE	0.07	0.07	0.08	
RMSE	0.10	0.11	0.11	
Coefficient of Determination (R^2)	0.73	0.71	0.72	
Number of data in statistics	263	263	263	
Total number of weekly data	783	783	783	263
Mean of all weekly data	0.161	0.131	0.156	0.149
Standard deviation of all weekly data	0.115	0.090	0.094	0.177
Approximated mean annual runoff (mm/yr)	510	420	510	460

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

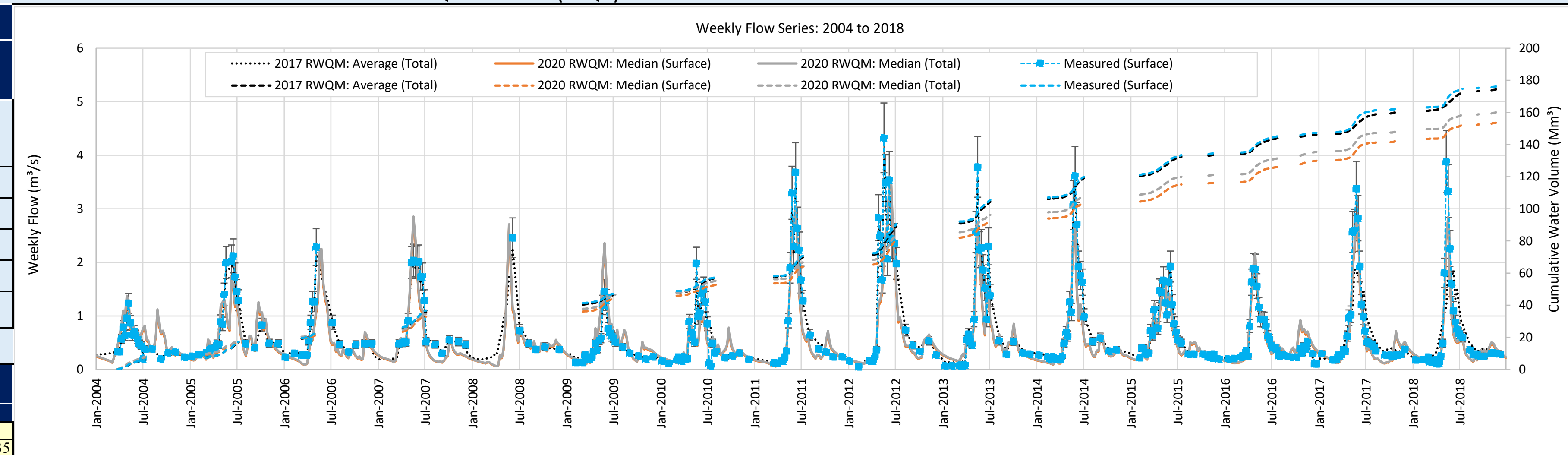
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

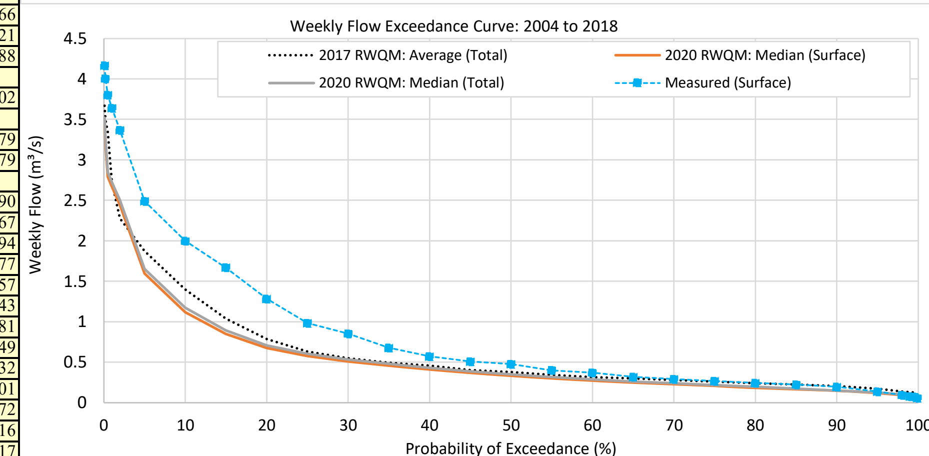
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

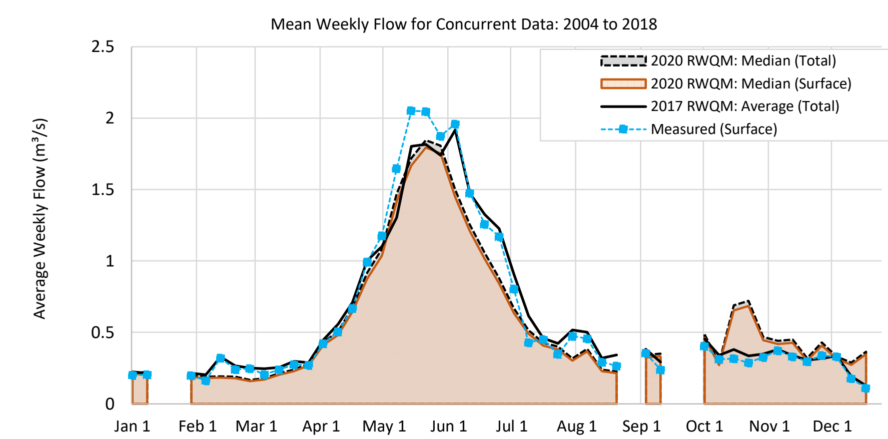
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

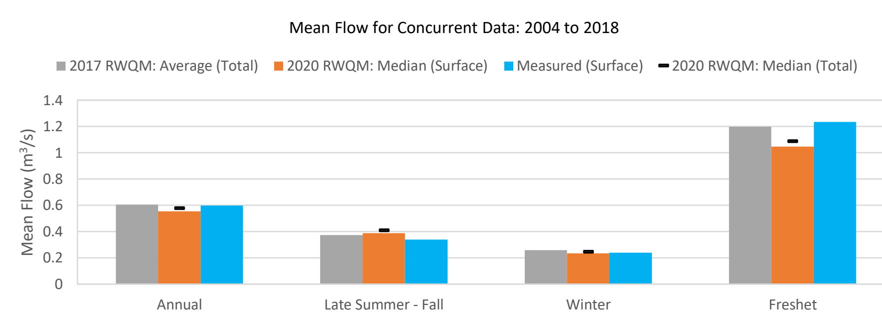
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchments of Harmer above EVO Dry Creek, Upper and Lower Harmer Creek		Surface-Groundwater Partitioning	5%, maximum of 5,000 m3/d
Spinner ID	5	Mean annual surface runoff (monitored)		460
Selected Year	2019	Mean annual total runoff (2020 RWQM)		450
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		47%
Station ID & Description	EV_HC1	Harmer Creek Dam Spillway (E102682)		
Drainage Area (2018)	3830 ha	Disturbed Area (2018)		~ 13%

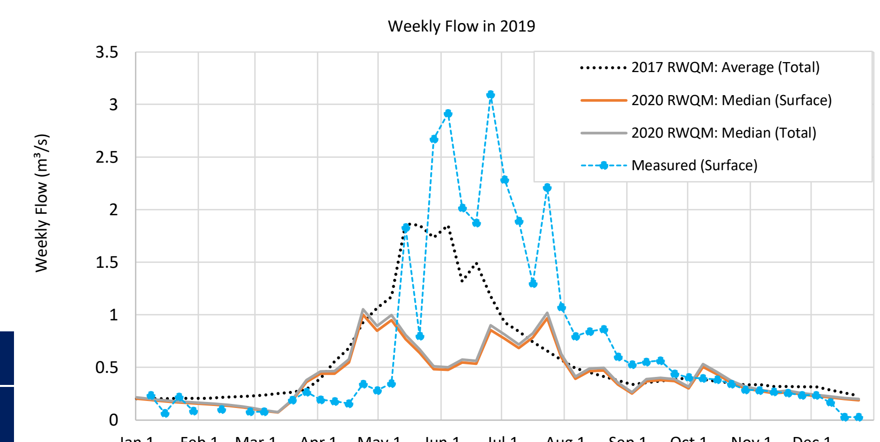
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
1/3/2019	0.203	0.204	0.215	
1/10/2019	0.204	0.190	0.200	0.235
1/17/2019	0.204	0.177	0.187	0.066
1/24/2019	0.205	0.166	0.175	0.221
1/31/2019	0.206	0.160	0.168	0.088
2/7/2019	0.207	0.149	0.157	
2/14/2019	0.214	0.140	0.147	0.102
2/21/2019	0.221	0.131	0.138	
2/28/2019	0.228	0.113	0.119	0.079
3/7/2019	0.235	0.088	0.093	0.079
3/14/2019	0.252	0.073	0.076	
3/21/2019	0.265	0.184	0.194	0.190
3/28/2019	0.291	0.362	0.381	0.267
4/4/2019	0.395	0.439	0.463	0.194
4/11/2019	0.557	0.442	0.465	0.177
4/18/2019	0.684	0.548	0.577	0.157
4/25/2019	0.926	1.002	1.055	0.343
5/2/2019	1.064	0.848	0.893	0.281
5/9/2019	1.172	0.949	0.999	0.349
5/16/2019	1.868	0.770	0.810	1.832
5/23/2019	1.851	0.638	0.672	0.801
5/30/2019	1.734	0.484	0.509	2.672
6/6/2019	1.849	0.477	0.502	2.916
6/13/2019	1.316	0.546	0.575	2.017
6/20/2019	1.495	0.535	0.563	1.875
6/27/2019	1.177	0.855	0.900	3.095
7/4/2019	0.928	0.771	0.812	2.285
7/11/2019	0.842	0.683	0.719	1.892
7/18/2019	0.742	0.785	0.826	1.299
7/25/2019	0.657	0.968	1.019	2.213
8/1/2019	0.571	0.595	0.626	1.075
8/8/2019	0.493	0.391	0.412	0.797
8/15/2019	0.453	0.464	0.488	0.842
8/22/2019	0.414	0.471	0.495	0.863
8/29/2019	0.375	0.338	0.356	0.600
9/5/2019	0.337	0.251	0.264	0.529
9/12/2019	0.354	0.368	0.387	0.553
9/19/2019	0.370	0.380	0.399	0.565
9/26/2019	0.386	0.370	0.390	0.440
10/3/2019	0.401	0.301	0.317	0.405
10/10/2019	0.385	0.504	0.530	0.396
10/17/2019	0.368	0.433	0.456	0.385
10/24/2019	0.351	0.356	0.375	0.343
10/31/2019	0.335	0.302	0.318	0.287
11/7/2019	0.336	0.275	0.289	0.282
11/14/2019	0.318	0.254	0.268	0.269
11/21/2019	0.317	0.264	0.278	0.256
11/28/2019	0.316	0.243	0.256	0.237
12/5/2019	0.315	0.228	0.240	0.237
12/12/2019	0.287	0.214	0.225	0.167
12/19/2019	0.258	0.199	0.210	0.029
12/26/2019	0.230	0.189	0.199	0.028
Annual	0.58	0.41	0.43	0.74
Late Summer - Fall	0.40	0.40	0.42	0.60
Winter	0.25	0.19	0.20	0.14
Freshet	1.21	0.69	0.73	1.47











Statistics on concurrent data: 2004 to 2018	Very good	Very good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.91	0.78	0.80	
Modified Nash-Sutcliffe efficiency (E1)	0.85	0.61	0.61	
Index of agreement (d)	0.97	0.93	0.94	
Modified index of agreement (d1)	0.92	0.79	0.79	
MAE	0.09	0.24	0.23	
RMSE	0.24	0.38	0.36	
Coefficient of Determination (R^2)	0.92	0.81	0.81	
Number of data in statistics	366	366	366	
Total number of weekly data	783	783	783	366
Mean of all weekly data	0.790	0.696	0.725	0.798
Standard deviation of all weekly data	0.708	0.656	0.672	0.809
Approximated mean annual runoff (mm/yr)	470	430	450	460

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

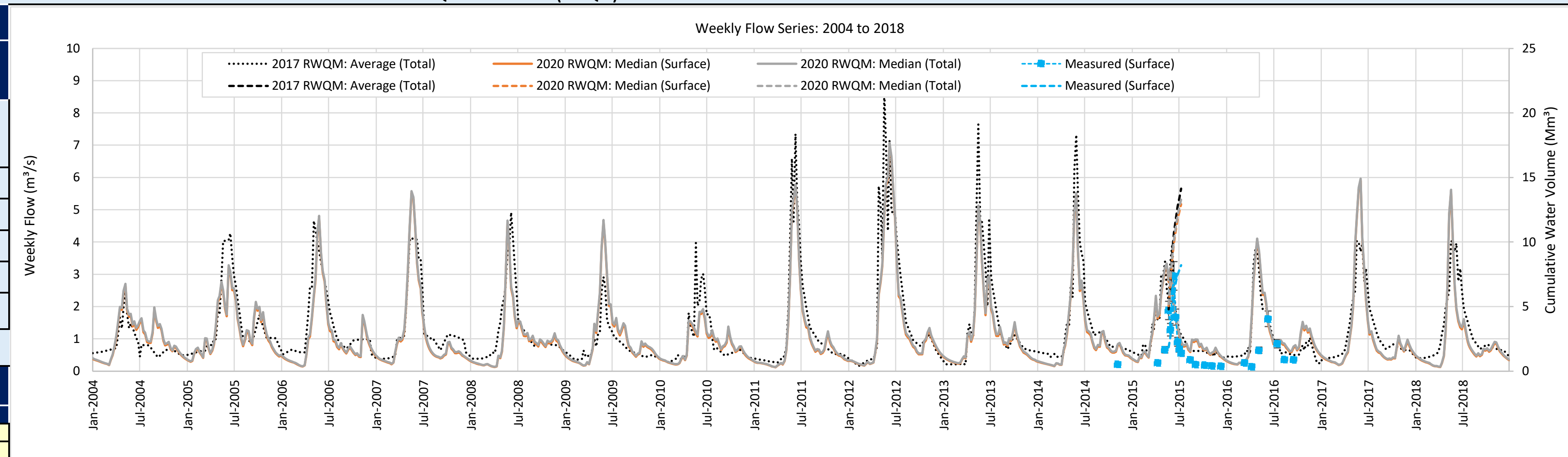
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

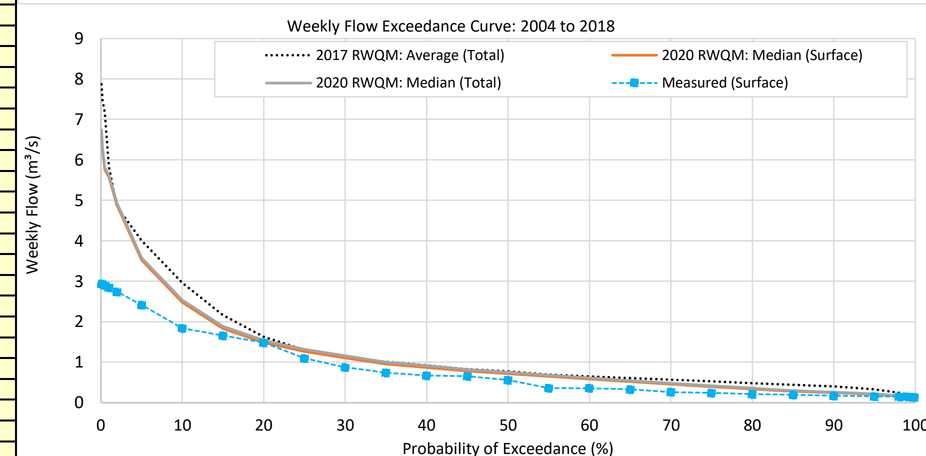
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

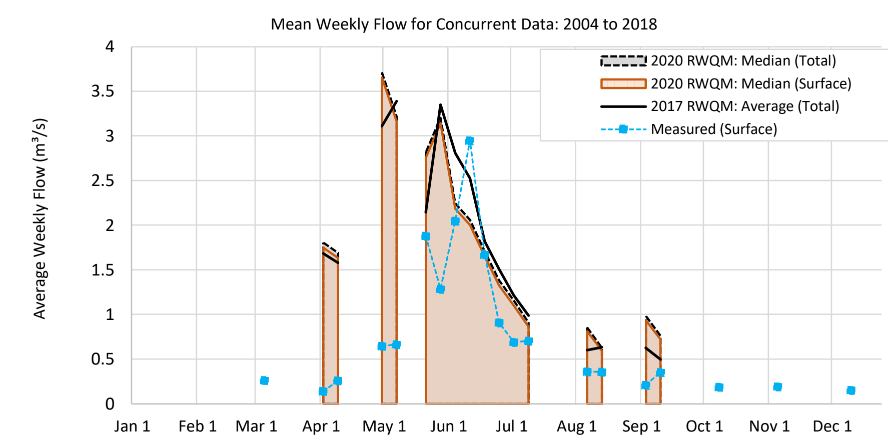
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

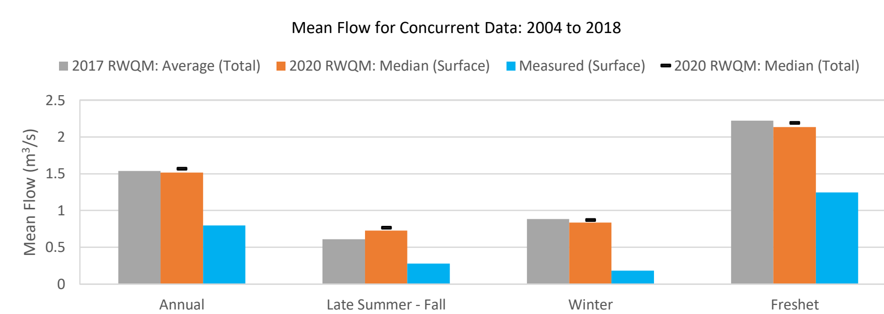
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchments of Dry Creek, Upper and Lower Harmer Creek, Grave above Harmer Creek, Lower Grave Creek		**Surface-Groundwater Partitioning**	5%, maximum of 5,000 m3/d
Spinner ID	6	**Mean annual surface runoff (monitored)**		N/A
Selected Year	2019	**Mean annual total runoff (2020 RWQM)**		N/A
Comparison Start Year	2004	**Evaluation period (weeks)**		783
Comparison End Year	2018	**Weeks with monitoring data (%)**		3%
Station ID & Description	**EV_GV1**	**Grave Creek at Bridge**		
Drainage Area (2018)	**8060 ha**	**Disturbed Area (2018)**		**~ 6%**

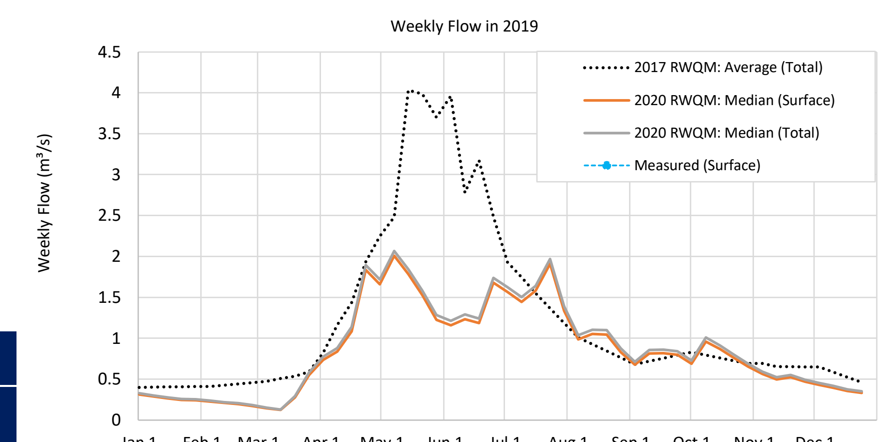
Date	2017 RWQM: Average (Total) Weekly Flow in 2019	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total) (m^3/s)	Measured (Surface)
1/3/2019	0.399	0.312	0.329	
1/10/2019	0.402	0.286	0.301	
1/17/2019	0.404	0.264	0.278	
1/24/2019	0.406	0.245	0.258	
1/31/2019	0.408	0.240	0.252	
2/7/2019	0.411	0.224	0.236	
2/14/2019	0.426	0.209	0.220	
2/21/2019	0.442	0.195	0.205	
2/28/2019	0.457	0.172	0.181	
3/7/2019	0.473	0.144	0.151	
3/14/2019	0.509	0.124	0.131	
3/21/2019	0.536	0.276	0.291	
3/28/2019	0.591	0.552	0.582	
4/4/2019	0.819	0.736	0.775	
4/11/2019	1.160	0.837	0.881	
4/18/2019	1.434	1.085	1.137	
4/25/2019	1.933	1.835	1.892	
5/2/2019	2.247	1.660	1.718	
5/9/2019	2.480	2.009	2.067	
5/16/2019	4.035	1.785	1.842	
5/23/2019	3.982	1.524	1.582	
5/30/2019	3.698	1.225	1.283	
6/6/2019	3.959	1.156	1.211	
6/13/2019	2.779	1.233	1.291	
6/20/2019	3.173	1.184	1.239	
6/27/2019	2.485	1.678	1.735	
7/4/2019	1.929	1.566	1.624	
7/11/2019	1.746	1.443	1.501	
7/18/2019	1.549	1.580	1.638	
7/25/2019	1.366	1.908	1.966	
8/1/2019	1.183	1.332	1.390	
8/8/2019	1.008	0.984	1.036	
8/15/2019	0.925	1.050	1.103	
8/22/2019	0.843	1.045	1.100	
8/29/2019	0.761	0.830	0.874	
9/5/2019	0.680	0.675	0.710	
9/12/2019	0.718	0.814	0.856	
9/19/2019	0.755	0.816	0.859	
9/26/2019	0.792	0.797	0.839	
10/3/2019	0.828	0.689	0.725	
10/10/2019	0.793	0.958	1.008	
10/17/2019	0.759	0.867	0.912	
10/24/2019	0.724	0.759	0.799	
10/31/2019	0.690	0.651	0.686	
11/7/2019	0.693	0.561	0.591	
11/14/2019	0.654	0.495	0.521	
11/21/2019	0.651	0.524	0.552	
11/28/2019	0.649	0.468	0.493	
12/5/2019	0.647	0.430	0.453	
12/12/2019	0.585	0.395	0.416	
12/19/2019	0.522	0.356	0.375	
12/26/2019	0.460	0.332	0.350	
Annual	1.21	0.84	0.87	
Late Summer - Fall	0.81	0.85	0.90	
Winter	0.49	0.31	0.32	
Freshet	2.57	1.45	1.51	











Statistics on concurrent data: 2004 to 2018	Poor	Poor		
Parameter	**2017 RWQM: Average (Total)**	**2020 RWQM: Median (Surface)**	**2020 RWQM: Median (Total)**	**Measured (Surface)**
Nash-Sutcliffe efficiency (E)	-0.90	-0.96	-1.08	
Modified Nash-Sutcliffe efficiency (E1)	-0.21	-0.24	-0.29	
Index of agreement (d)	0.68	0.63	0.62	
Modified index of agreement (d1)	0.50	0.47	0.45	
MAE	0.75	0.76	0.80	
RMSE	1.07	1.09	1.12	
Coefficient of Determination (R^2)	0.43	0.29	0.29	
Number of data in statistics	23	23	23	
Total number of weekly data	783	783	783	23
Mean of all weekly data	1.530	1.481	1.529	0.820
Standard deviation of all weekly data	1.072	0.998	1.008	0.794
Approximated mean annual runoff (mm/yr)	N/A	N/A	N/A	N/A

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

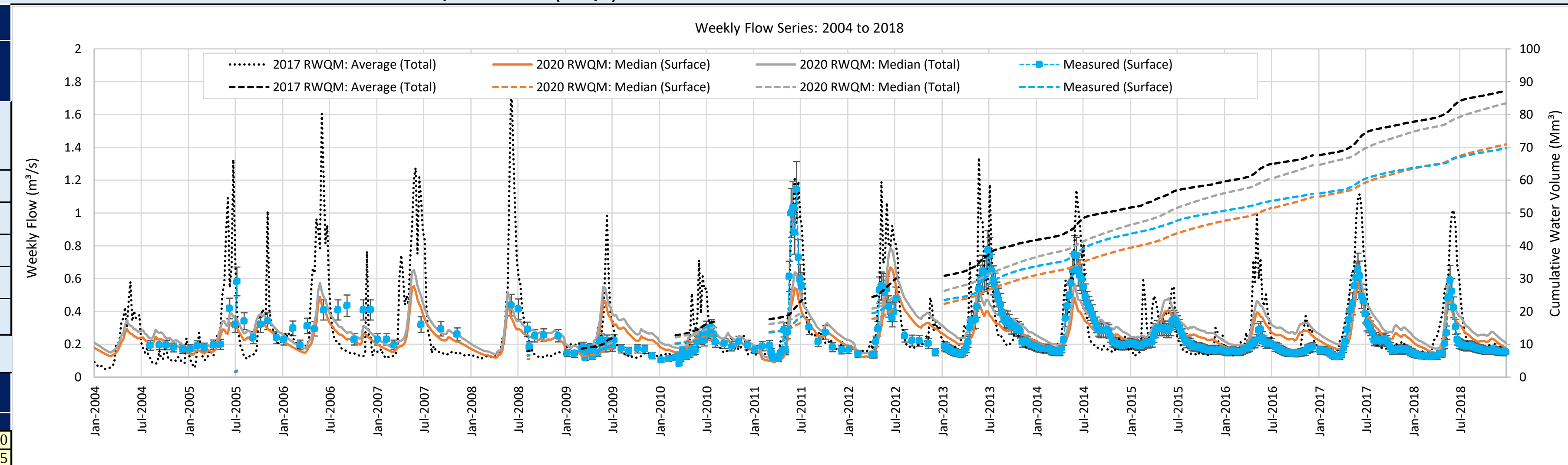
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

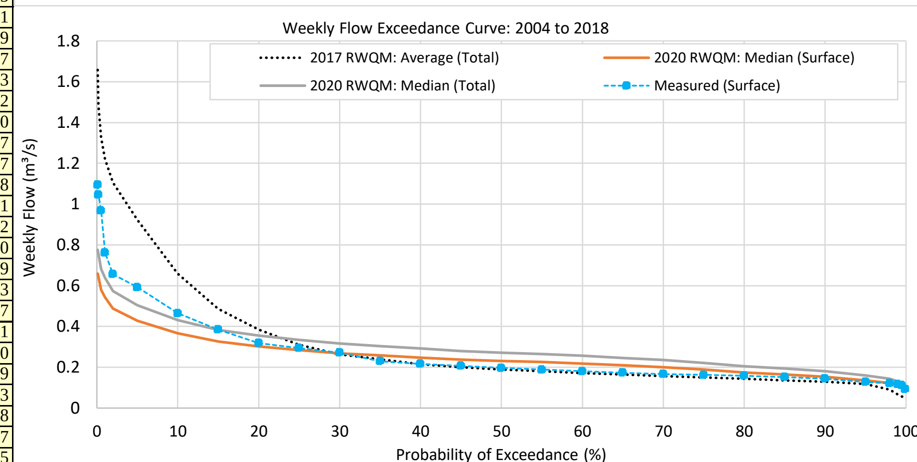
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

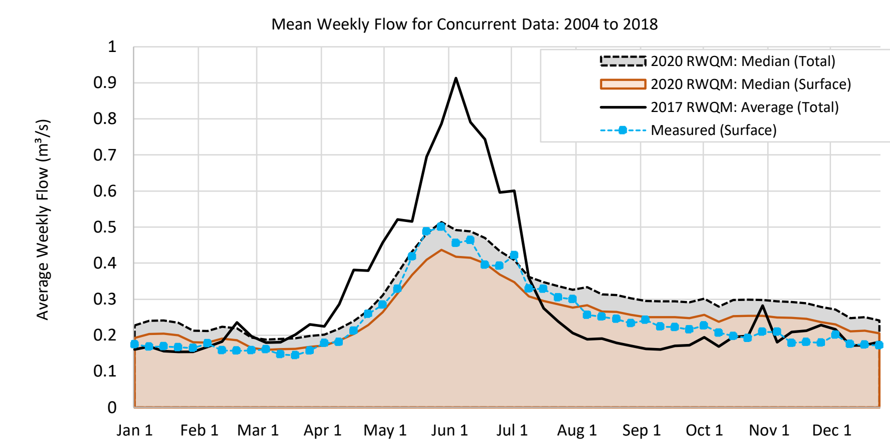
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

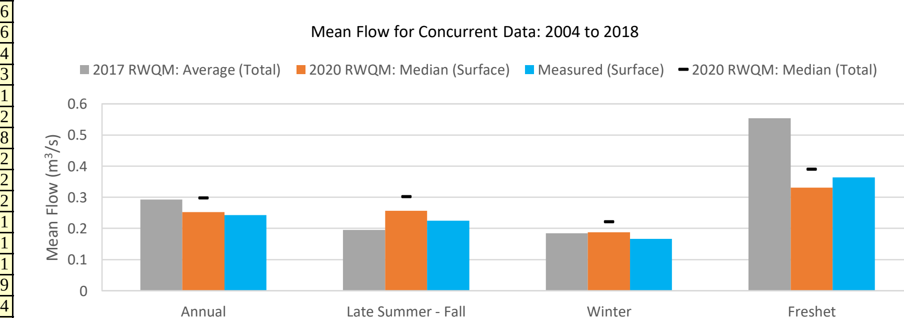
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Snowmelt Runoff Module, Waste Rock Hydrology Module in sub-catchments of Erickson Creek (Lower, Bridge and Upper), Adit Ridge Pit plus West Fork Tailings Facility flows		Surface-Groundwater Partitioning	10%, maximum of 34,560 m3/d
Spinner ID	17	Mean annual surface runoff (monitored)		240
Selected Year	2019	Mean annual total runoff (2020 RWQM)		300
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		58%
Station ID & Description	EV_EC1	Erickson Creek at Mouth (0200097)		
Drainage Area (2018)	3190 ha	Disturbed Area (2018)		~ 30%

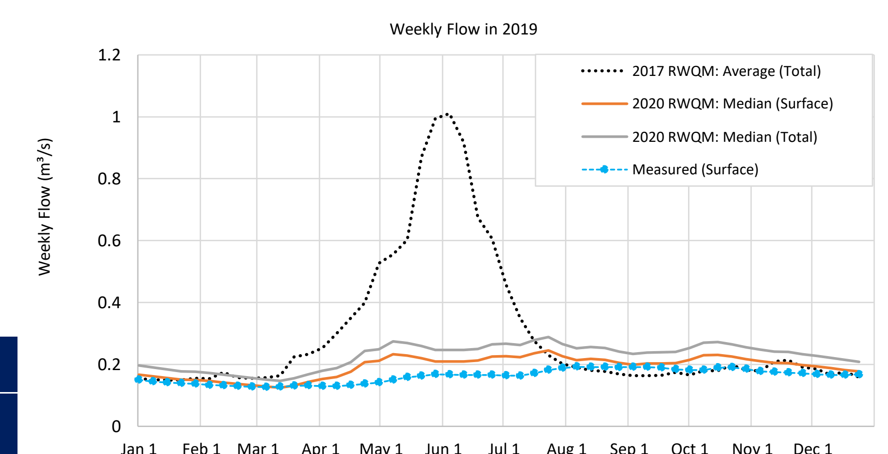
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
1/3/2019	0.154	0.167	0.197	0.150
1/10/2019	0.151	0.161	0.190	0.145
1/17/2019	0.149	0.156	0.184	0.141
1/24/2019	0.150	0.151	0.178	0.139
1/31/2019	0.156	0.150	0.177	0.137
2/7/2019	0.154	0.146	0.172	0.133
2/14/2019	0.174	0.142	0.167	0.132
2/21/2019	0.157	0.137	0.162	0.130
2/28/2019	0.156	0.132	0.156	0.127
3/7/2019	0.157	0.128	0.151	0.127
3/14/2019	0.164	0.125	0.147	0.128
3/21/2019	0.224	0.132	0.155	0.131
3/28/2019	0.233	0.143	0.168	0.132
4/4/2019	0.253	0.153	0.180	0.130
4/11/2019	0.300	0.160	0.188	0.129
4/18/2019	0.350	0.177	0.208	0.133
4/25/2019	0.399	0.207	0.244	0.137
5/2/2019	0.526	0.211	0.249	0.141
5/9/2019	0.555	0.233	0.275	0.150
5/16/2019	0.602	0.228	0.269	0.159
5/23/2019	0.869	0.220	0.259	0.163
5/30/2019	0.995	0.210	0.247	0.168
6/6/2019	1.011	0.210	0.247	0.167
6/13/2019	0.918	0.209	0.246	0.165
6/20/2019	0.675	0.212	0.250	0.166
6/27/2019	0.607	0.226	0.265	0.166
7/4/2019	0.458	0.227	0.267	0.164
7/11/2019	0.350	0.223	0.263	0.163
7/18/2019	0.275	0.237	0.278	0.171
7/25/2019	0.229	0.245	0.289	0.182
8/1/2019	0.202	0.226	0.266	0.188
8/8/2019	0.190	0.214	0.252	0.192
8/15/2019	0.181	0.218	0.256	0.192
8/22/2019	0.177	0.215	0.253	0.192
8/29/2019	0.169	0.205	0.241	0.191
9/5/2019	0.163	0.199	0.234	0.191
9/12/2019	0.164	0.203	0.238	0.191
9/19/2019	0.165	0.203	0.239	0.189
9/26/2019	0.174	0.205	0.241	0.184
10/3/2019	0.166	0.215	0.253	0.182
10/10/2019	0.179	0.230	0.270	0.182
10/17/2019	0.180	0.231	0.272	0.189
10/24/2019	0.198	0.225	0.265	0.190
10/31/2019	0.182	0.217	0.256	0.185
11/7/2019	0.179	0.210	0.247	0.178
11/14/2019	0.209	0.205	0.242	0.175
11/21/2019	0.214	0.205	0.241	0.174
11/28/2019	0.192	0.198	0.233	0.171
12/5/2019	0.185	0.193	0.227	0.168
12/12/2019	0.166	0.188	0.221	0.166
12/19/2019	0.177	0.182	0.214	0.166
12/26/2019	0.158	0.177	0.209	0.167
Annual	0.30	0.19	0.23	0.16
Late Summer - Fall	0.19	0.21	0.25	0.19
Winter	0.17	0.15	0.18	0.14
Freshet	0.59	0.21	0.25	0.16











Statistics on concurrent data: 2004 to 2018	Poor	Acceptable		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	-0.65	0.51	0.41	
Modified Nash-Sutcliffe efficiency (E1)	-0.07	0.33	0.15	
Index of agreement (d)	0.76	0.79	0.79	
Modified index of agreement (d1)	0.58	0.59	0.52	
MAE	0.12	0.07	0.09	
RMSE	0.19	0.11	0.12	
Coefficient of Determination (R^2)	0.53	0.52	0.52	
Number of data in statistics	452	452	452	
Total number of weekly data	783	783	783	452
Mean of all weekly data	0.319	0.259	0.305	0.255
Standard deviation of all weekly data	0.261	0.094	0.110	0.151
Approximated mean annual runoff (mm/yr)	290	250	300	240

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

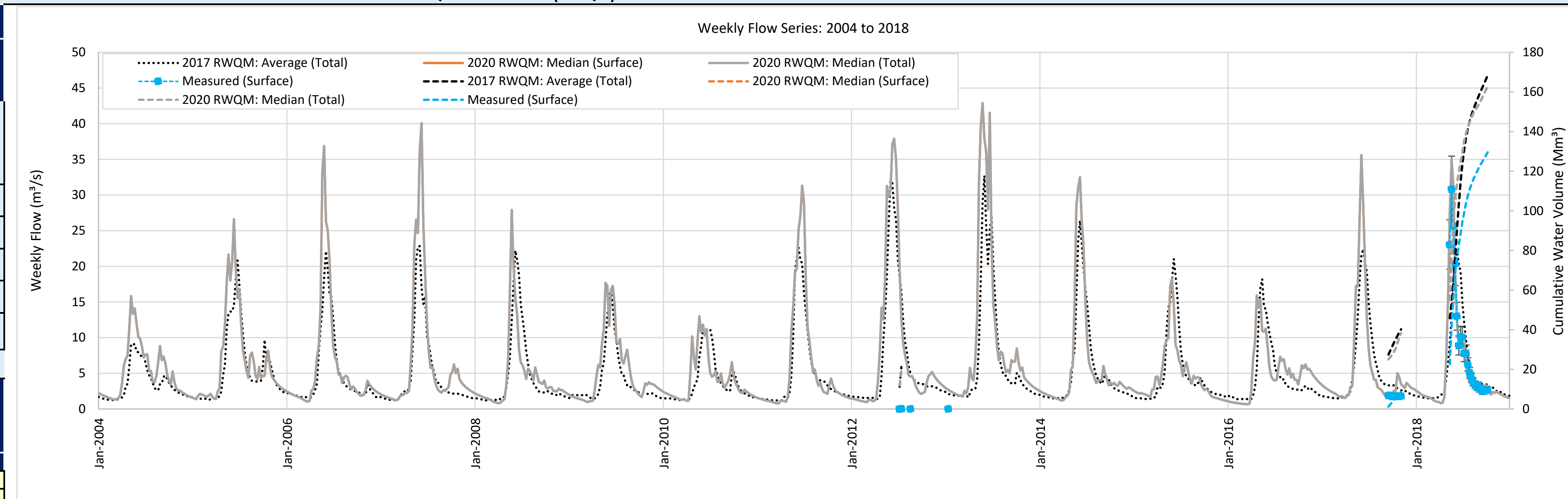
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

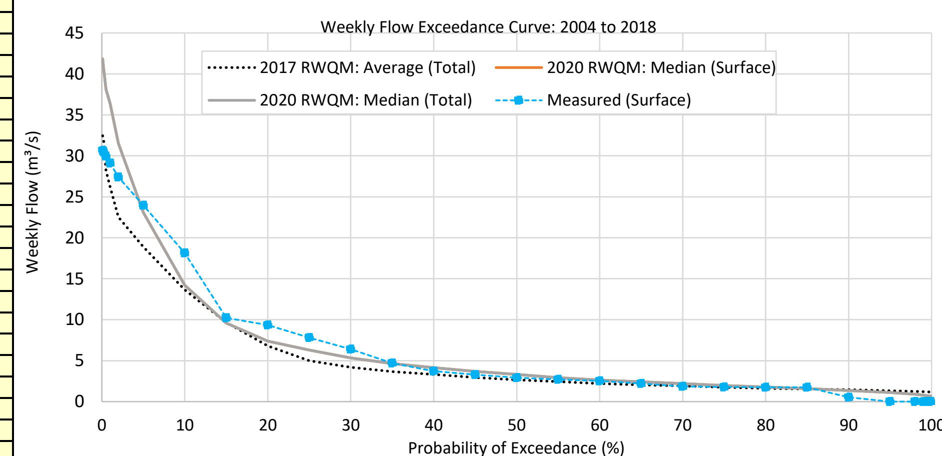
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

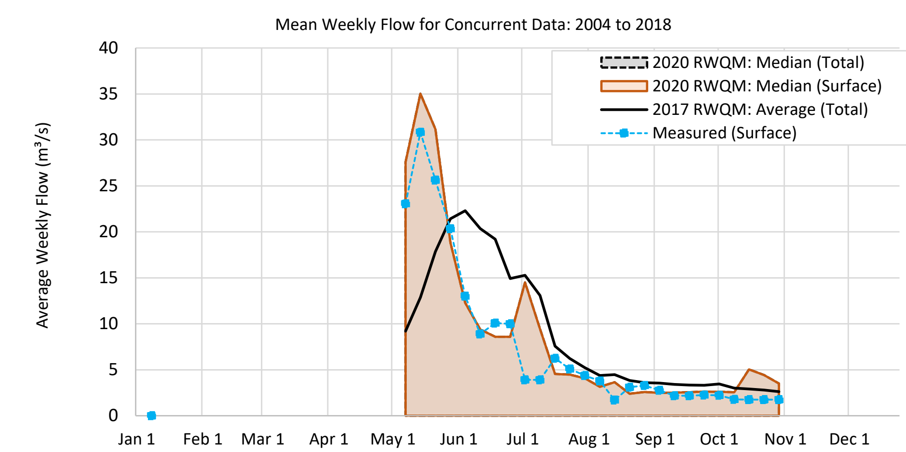
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

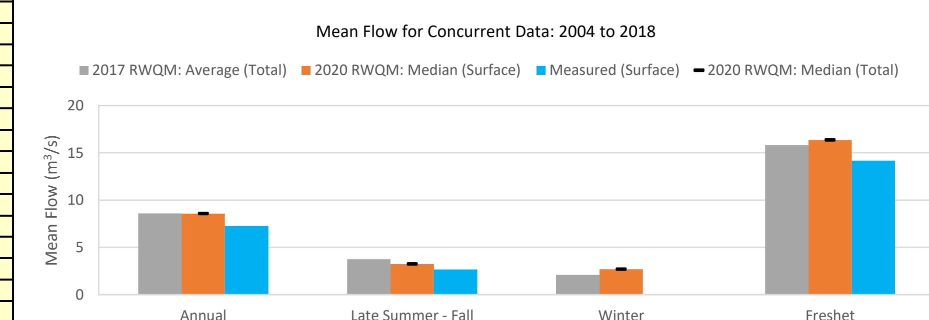
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitor
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Notes on Flow Modelling Method	FR_FRABCH + Chauncey + Ewin + Todhunter + LCO Dry + Grace + GH_GH1 + unnamed areas between FR_FRABCH and GH_FR1 (Sum of modelled flows)		Surface-Groundwater Partitioning	Not implemented
Spinner ID	17	Mean annual surface runoff (monitored)		N/A
Selected Year	2019	Mean annual total runoff (2020 RWQM)		N/A
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		4%
Station ID & Description	GH_FR1	Fording River downstream of Greenhills Creek (200378)		
Drainage Area (2018)	40750 ha	Disturbed Area (2018)		~ 15%

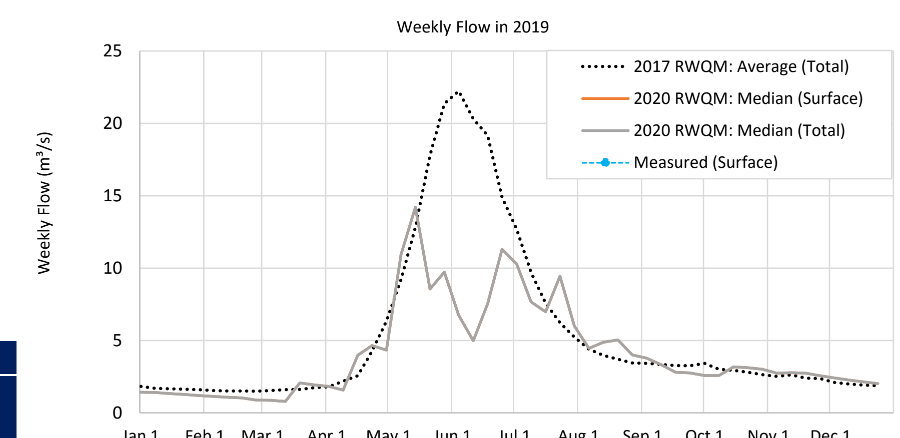
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	1.826	1.420	1.420	
2019-01-10	1.693	1.411	1.411	
2019-01-17	1.653	1.334	1.334	
2019-01-24	1.628	1.269	1.269	
2019-01-31	1.597	1.192	1.192	
2019-02-07	1.538	1.135	1.135	
2019-02-14	1.517	1.078	1.078	
2019-02-21	1.516	1.026	1.026	
2019-02-28	1.494	0.876	0.876	
2019-03-07	1.547	0.867	0.867	
2019-03-14	1.598	0.788	0.788	
2019-03-21	1.622	2.061	2.061	
2019-03-28	1.738	1.933	1.933	
2019-04-04	1.791	1.832	1.832	
2019-04-11	2.190	1.572	1.572	
2019-04-18	2.563	3.973	3.973	
2019-04-25	4.261	4.656	4.656	
2019-05-02	6.347	4.333	4.333	
2019-05-09	9.196	10.943	10.943	
2019-05-16	12.825	14.205	14.205	
2019-05-23	17.787	8.556	8.556	
2019-05-30	21.366	9.732	9.732	
2019-06-06	22.228	6.733	6.733	
2019-06-13	20.308	4.978	4.978	
2019-06-20	19.152	7.549	7.549	
2019-06-27	14.891	11.296	11.296	
2019-07-04	12.700	10.290	10.290	
2019-07-11	9.704	7.671	7.671	
2019-07-18	7.584	6.974	6.974	
2019-07-25	6.233	9.432	9.432	
2019-08-01	5.232	5.995	5.995	
2019-08-08	4.398	4.457	4.457	
2019-08-15	3.977	4.881	4.881	
2019-08-22	3.696	5.036	5.036	
2019-08-29	3.455	3.998	3.998	
2019-09-05	3.424	3.782	3.782	
2019-09-12	3.345	3.331	3.331	
2019-09-19	3.270	2.808	2.808	
2019-09-26	3.247	2.763	2.763	
2019-10-03	3.420	2.572	2.572	
2019-10-10	3.011	2.581	2.581	
2019-10-17	2.931	3.171	3.171	
2019-10-24	2.801	3.111	3.111	
2019-10-31	2.635	3.013	3.013	
2019-11-07	2.521	2.735	2.735	
2019-11-14	2.617	2.775	2.775	
2019-11-21	2.397	2.742	2.742	
2019-11-28	2.365	2.564	2.564	
2019-12-05	2.102	2.411	2.411	
2019-12-12	1.989	2.265	2.265	
2019-12-19	1.917	2.137	2.137	
2019-12-26	1.869	2.020	2.020	
Annual	5.36	4.08	4.08	
Late Summer - Fall	3.42	3.78	3.78	
Winter	1.70	1.50	1.50	
Freshet	12.21	7.56	7.56	











Statistics on concurrent data: 2004 to 2018	Poor. See notes	Good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.19	0.65	0.65	
Modified Nash-Sutcliffe efficiency (E1)	0.24	0.58	0.58	
Index of agreement (d)	0.74	0.92	0.92	
Modified index of agreement (d1)	0.61	0.79	0.79	
MAE	4.22	2.33	2.33	
RMSE	6.84	4.48	4.48	
Coefficient of Determination (R^2)	0.33	0.76	0.76	
Number of data in statistics	34	34	34	
Total number of weekly data	783	783	783	34
Mean of all weekly data	8.189	7.912	7.912	6.300
Standard deviation of all weekly data	6.635	8.673	8.673	7.718
Approximated mean annual runoff (mm/yr)	N/A	N/A	N/A	N/A

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

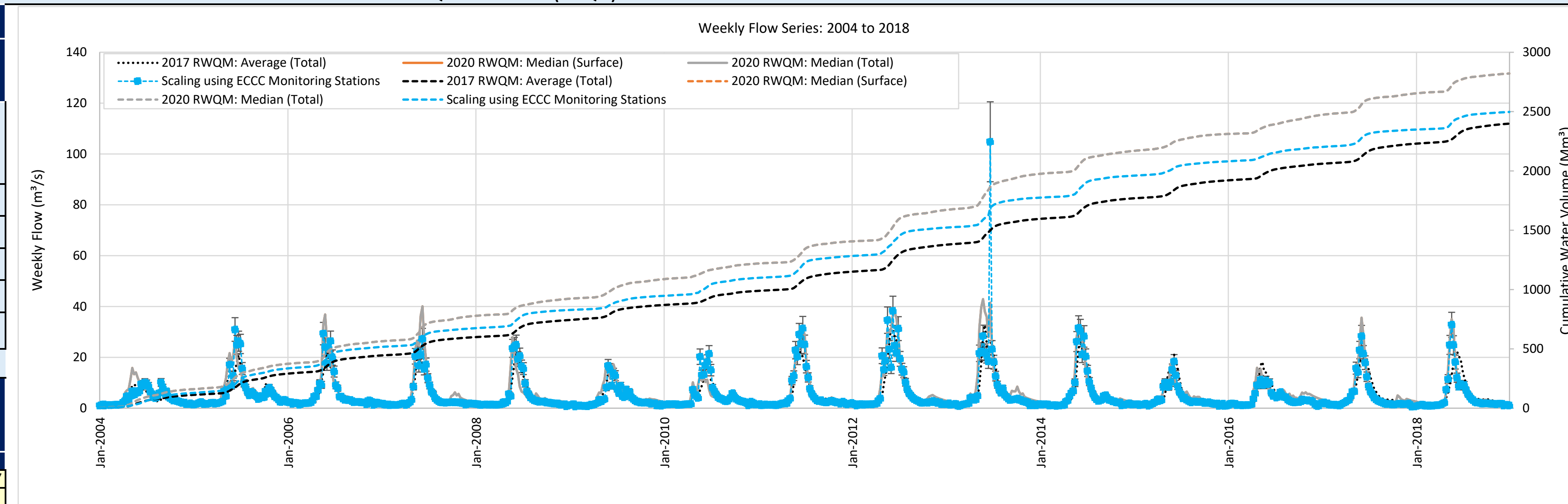
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

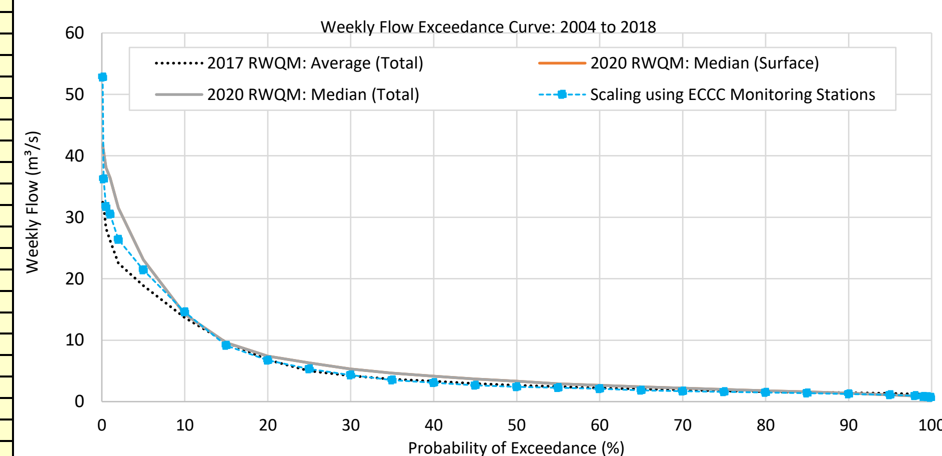
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

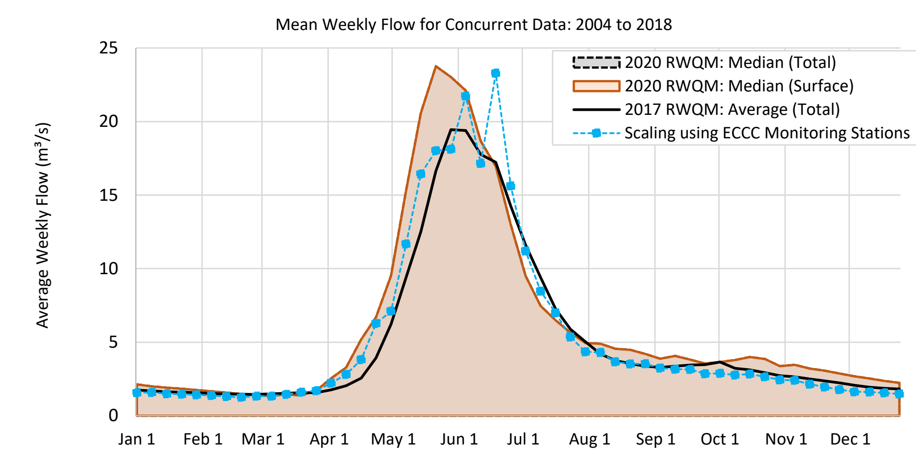
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

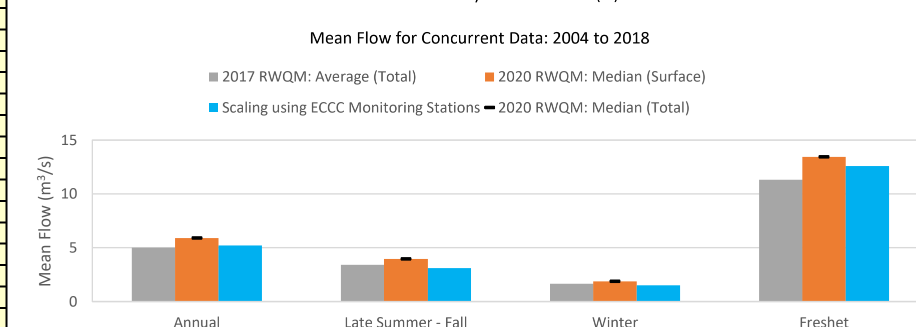
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Scaling_Method
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Scaling using ECCC Monitoring Stations
Notes on Flow Modelling Method	FR_FRABCH + Chauncey + Ewin + Todhunter + LCO Dry + Grace + GH_GH1 + unnamed areas between FR_FRABCH and GH_FR1 (Sum of modelled flows)		Surface-Groundwater Partitioning	Not implemented
Spinner ID	17	Mean annual surface runoff (monitored)		410
Selected Year	2019	Mean annual total runoff (2020 RWQM)		460
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		100%
Station ID & Description	GH_FR1	Fording River downstream of Greenhills Creek (200378)		
Drainage Area (2018)	40750 ha	Disturbed Area (2018)		~ 15%

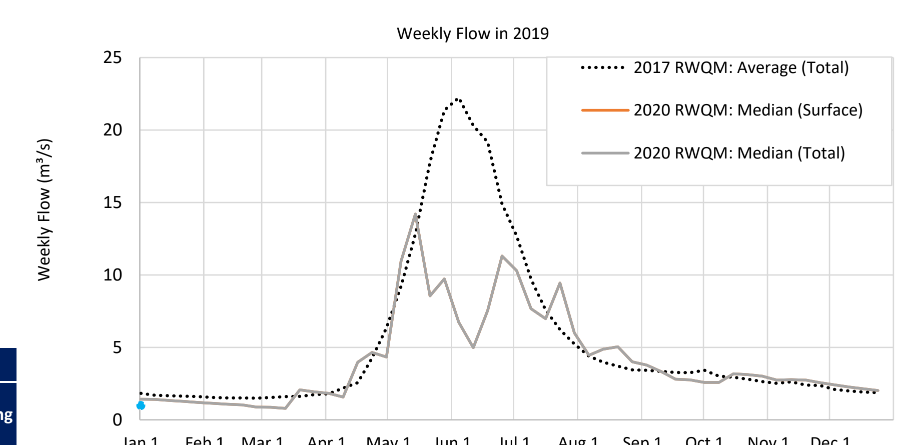
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Scaling using ECCC Monitoring Stations
	Weekly Flow in 2019		(m³/s)	
2019-01-03	1.826	1.420	1.420	0.987
2019-01-10	1.693	1.411	1.411	
2019-01-17	1.653	1.334	1.334	
2019-01-24	1.628	1.269	1.269	
2019-01-31	1.597	1.192	1.192	
2019-02-07	1.538	1.135	1.135	
2019-02-14	1.517	1.078	1.078	
2019-02-21	1.516	1.026	1.026	
2019-02-28	1.494	0.876	0.876	
2019-03-07	1.547	0.867	0.867	
2019-03-14	1.598	0.788	0.788	
2019-03-21	1.622	2.061	2.061	
2019-03-28	1.738	1.933	1.933	
2019-04-04	1.791	1.832	1.832	
2019-04-11	2.190	1.572	1.572	
2019-04-18	2.563	3.973	3.973	
2019-04-25	4.261	4.656	4.656	
2019-05-02	6.347	4.333	4.333	
2019-05-09	9.196	10.943	10.943	
2019-05-16	12.825	14.205	14.205	
2019-05-23	17.787	8.556	8.556	
2019-05-30	21.366	9.732	9.732	
2019-06-06	22.228	6.733	6.733	
2019-06-13	20.308	4.978	4.978	
2019-06-20	19.152	7.549	7.549	
2019-06-27	14.891	11.296	11.296	
2019-07-04	12.700	10.290	10.290	
2019-07-11	9.704	7.671	7.671	
2019-07-18	7.584	6.974	6.974	
2019-07-25	6.233	9.432	9.432	
2019-08-01	5.232	5.995	5.995	
2019-08-08	4.398	4.457	4.457	
2019-08-15	3.977	4.881	4.881	
2019-08-22	3.696	5.036	5.036	
2019-08-29	3.455	3.998	3.998	
2019-09-05	3.424	3.782	3.782	
2019-09-12	3.345	3.331	3.331	
2019-09-19	3.270	2.808	2.808	
2019-09-26	3.247	2.763	2.763	
2019-10-03	3.420	2.572	2.572	
2019-10-10	3.011	2.581	2.581	
2019-10-17	2.931	3.171	3.171	
2019-10-24	2.801	3.111	3.111	
2019-10-31	2.635	3.013	3.013	
2019-11-07	2.521	2.735	2.735	
2019-11-14	2.617	2.775	2.775	
2019-11-21	2.397	2.742	2.742	
2019-11-28	2.365	2.564	2.564	
2019-12-05	2.102	2.411	2.411	
2019-12-12	1.989	2.265	2.265	
2019-12-19	1.917	2.137	2.137	
2019-12-26	1.869	2.020	2.020	
Annual	5.36	4.08	4.08	0.99
Late Summer - Fall	3.42	3.78	3.78	
Winter	1.70	1.50	1.50	0.99
Freshet	12.21	7.56	7.56	











Statistics on concurrent data: 2004 to 2018	Good	Good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Scaling using ECCC Monitoring Stations
Nash-Sutcliffe efficiency (E)	0.70	0.74	0.74	
Modified Nash-Sutcliffe efficiency (E1)	0.66	0.62	0.62	
Index of agreement (d)	0.90	0.93	0.93	
Modified index of agreement (d1)	0.82	0.81	0.81	
MAE	1.53	1.73	1.73	
RMSE	4.01	3.74	3.74	
Coefficient of Determination (R^2)	0.71	0.76	0.76	
Number of data in statistics	783	783	783	
Total number of weekly data	783	783	783	783
Mean of all weekly data	5.065	5.957	5.957	5.273
Standard deviation of all weekly data	5.678	7.251	7.251	7.339
Approximated mean annual runoff (mm/yr)	390	460	460	410

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

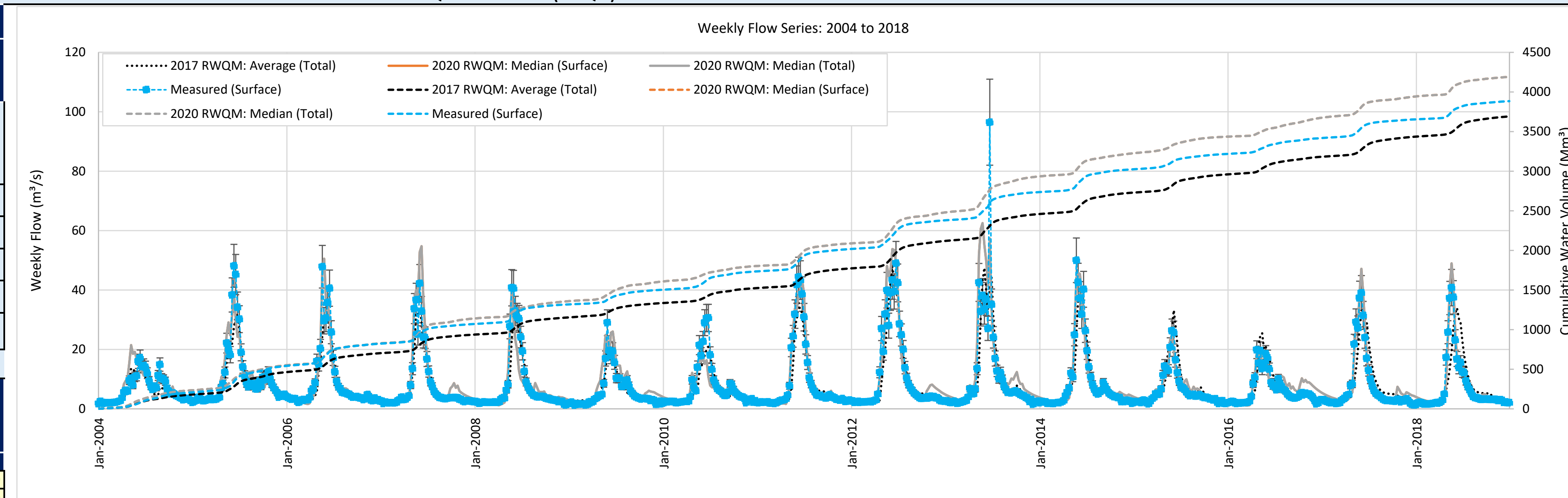
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

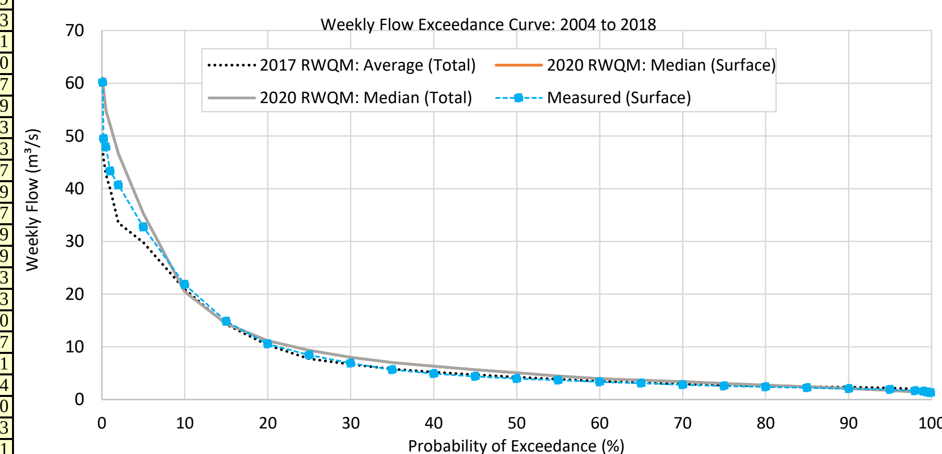
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

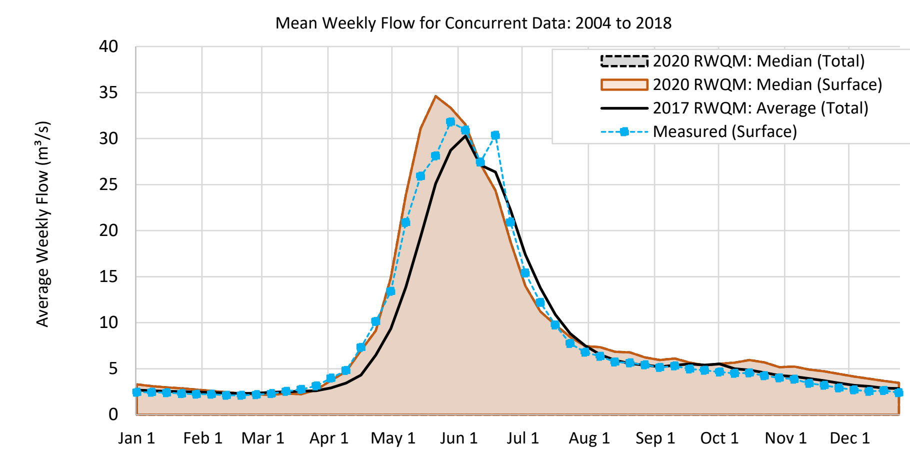
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

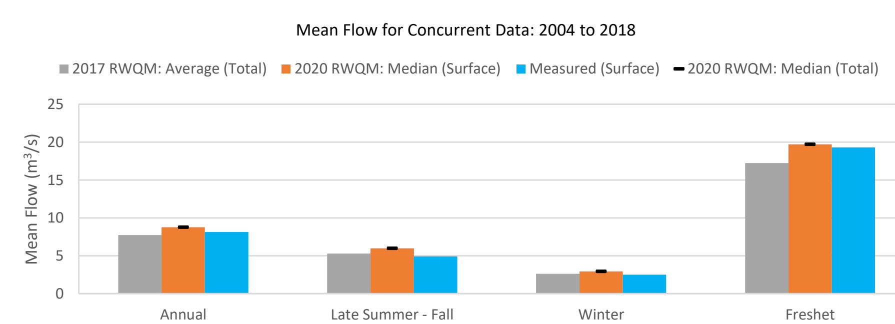
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitor
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Notes on Flow Modelling Method	GH_FR1 + LC_LC4 + unnamed areas between GH_FR1 and LC_LC5 (Sum of modelled flows)		**Surface-Groundwater Partitioning**	Not implemented
Spinner ID	18	**Mean annual surface runoff (monitored)**		420
Selected Year	2019	**Mean annual total runoff (2020 RWQM)**		450
Comparison Start Year	2004	**Evaluation period (weeks)**		783
Comparison End Year	2018	**Weeks with monitoring data (%)**		100%
Station ID & Description	**LC_LC5**	**Fording River downstream of Line Creek (0200028)**		
Drainage Area (2018)	**61760 ha**	**Disturbed Area (2018)**		~ 13%

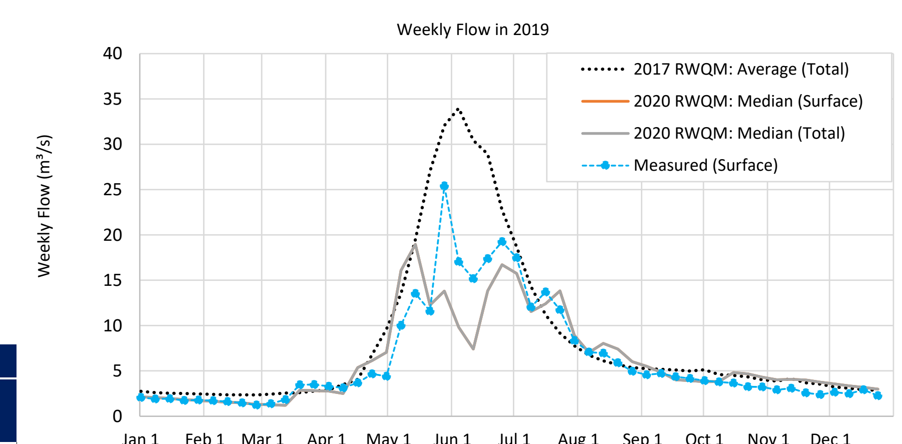
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m^3/s)	
2019-01-03	2.753	2.121	2.121	2.070
2019-01-10	2.611	2.070	2.070	1.920
2019-01-17	2.546	1.953	1.953	1.939
2019-01-24	2.517	1.850	1.850	1.753
2019-01-31	2.475	1.739	1.739	1.791
2019-02-07	2.420	1.650	1.650	1.720
2019-02-14	2.376	1.562	1.562	1.617
2019-02-21	2.369	1.482	1.482	1.479
2019-02-28	2.355	1.304	1.304	1.243
2019-03-07	2.448	1.271	1.271	1.393
2019-03-14	2.566	1.206	1.206	1.847
2019-03-21	2.606	2.882	2.882	3.469
2019-03-28	2.786	2.820	2.820	3.487
2019-04-04	2.911	2.779	2.779	3.309
2019-04-11	3.505	2.509	2.509	3.149
2019-04-18	4.084	5.363	5.363	3.693
2019-04-25	6.778	6.147	6.147	4.663
2019-05-02	9.605	7.044	7.044	4.420
2019-05-09	13.544	16.080	16.080	10.037
2019-05-16	19.503	18.960	18.960	13.551
2019-05-23	27.015	12.261	12.261	11.584
2019-05-30	32.075	13.801	13.801	25.400
2019-06-06	33.984	9.817	9.817	17.043
2019-06-13	30.427	7.408	7.408	15.171
2019-06-20	28.929	13.834	13.834	17.386
2019-06-27	22.754	16.712	16.712	19.257
2019-07-04	18.689	15.759	15.759	17.486
2019-07-11	14.312	11.540	11.540	12.043
2019-07-18	11.175	12.423	12.423	13.703
2019-07-25	9.164	13.823	13.823	11.743
2019-08-01	7.775	8.921	8.921	8.356
2019-08-08	6.735	7.041	7.041	7.081
2019-08-15	6.108	8.027	8.027	6.953
2019-08-22	5.692	7.421	7.421	5.903
2019-08-29	5.360	6.011	6.011	4.970
2019-09-05	5.255	5.509	5.509	4.580
2019-09-12	5.180	4.846	4.846	4.716
2019-09-19	5.115	4.016	4.016	4.356
2019-09-26	4.977	3.923	3.923	4.159
2019-10-03	5.124	3.805	3.805	3.931
2019-10-10	4.595	3.845	3.845	3.779
2019-10-17	4.516	4.808	4.808	3.664
2019-10-24	4.332	4.684	4.684	3.256
2019-10-31	4.036	4.317	4.317	3.221
2019-11-07	3.880	4.024	4.024	2.927
2019-11-14	4.151	4.078	4.078	3.089
2019-11-21	3.695	4.014	4.014	2.586
2019-11-28	3.545	3.766	3.766	2.383
2019-12-05	3.224	3.569	3.569	2.649
2019-12-12	3.091	3.349	3.349	2.487
2019-12-19	2.935	3.176	3.176	2.909
2019-12-26	2.854	3.000	3.000	2.272
Annual	8.14	6.08	6.08	6.15
Late Summer - Fall	5.22	5.63	5.63	4.82
Winter	2.66	2.21	2.21	2.19
Freshet	18.43	11.31	11.31	12.57











Statistics on concurrent data: 2004 to 2018	Very good	Very good		
Parameter	**2017 RWQM: Average (Total)**	**2020 RWQM: Median (Surface)**	**2020 RWQM: Median (Total)**	**Measured (Surface)**
Nash-Sutcliffe efficiency (E)	0.80	0.84	0.84	
Modified Nash-Sutcliffe efficiency (E1)	0.70	0.69	0.69	
Index of agreement (d)	0.94	0.96	0.96	
Modified index of agreement (d1)	0.84	0.84	0.84	
MAE	2.07	2.14	2.14	
RMSE	4.49	4.02	4.02	
Coefficient of Determination (R^2)	0.81	0.86	0.86	
Number of data in statistics	783	783	783	
Total number of weekly data	783	783	783	783
Mean of all weekly data	7.795	8.849	8.849	8.202
Standard deviation of all weekly data	8.589	10.473	10.473	10.151
Approximated mean annual runoff (mm/yr)	400	450	450	420

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

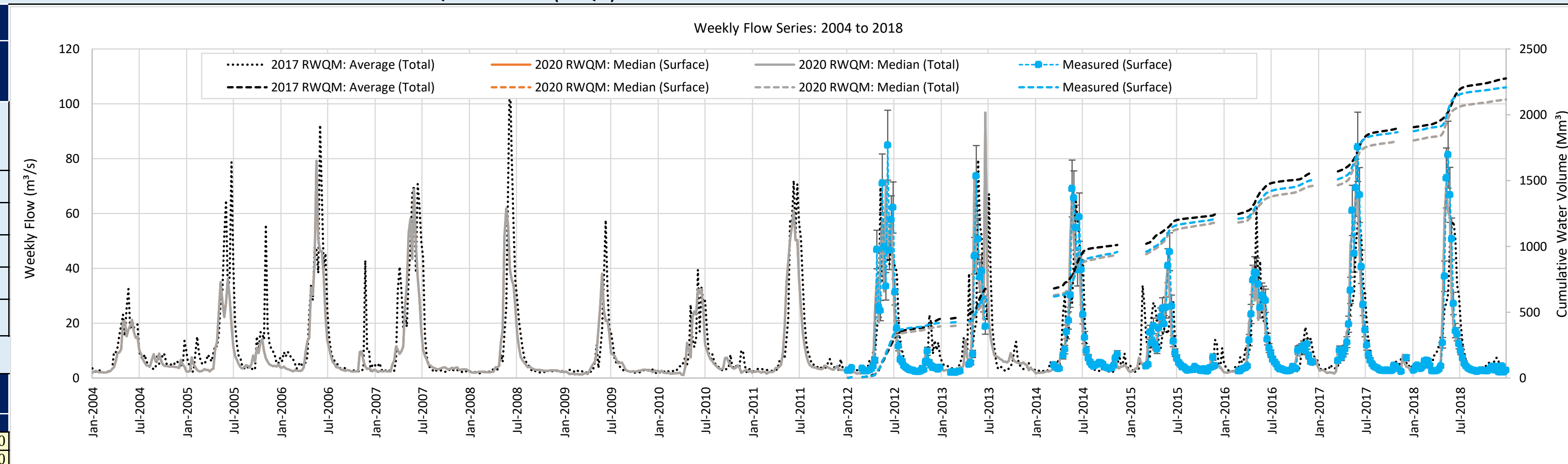
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

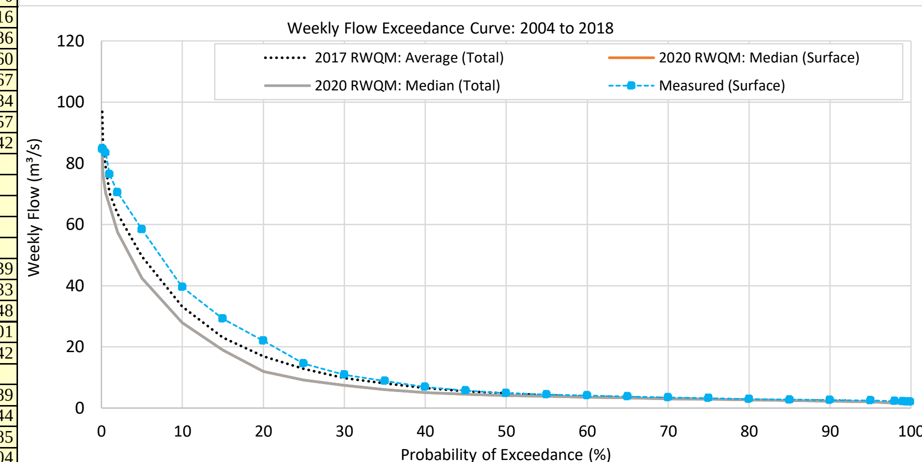
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

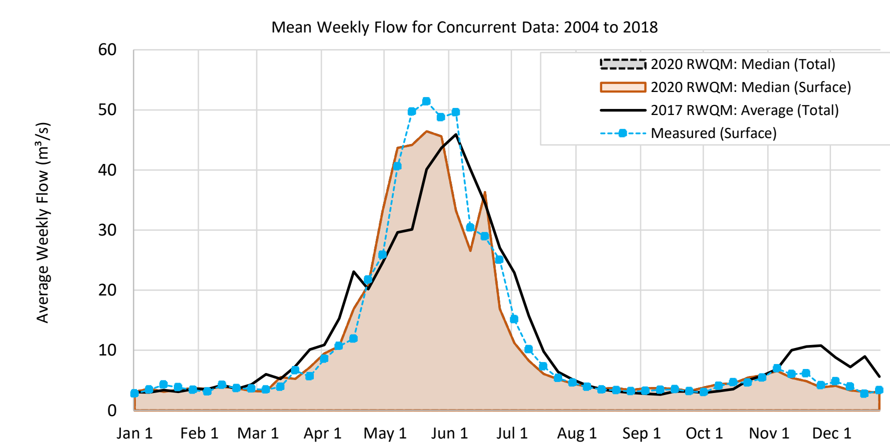
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

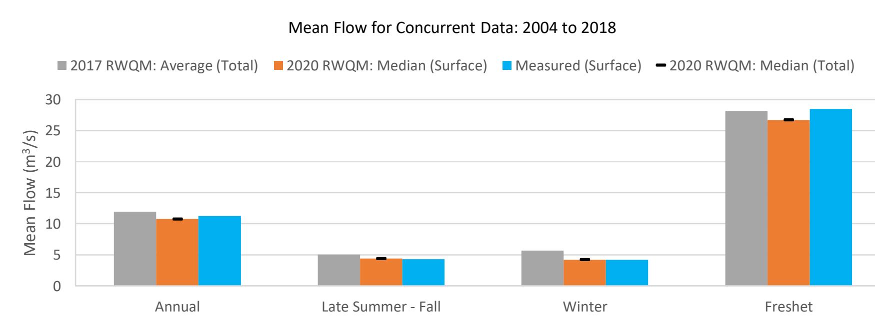
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	EV_MC3 + EV_EC1 + South Pit + Milligan + Thresher + EV_GT1 + EV_BC1 + other unnamed tributaries between EV_MC3 and EV_MC2 (sum of modelled flows)		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	30	Mean annual surface runoff (monitored)		560
Selected Year	2019	Mean annual total runoff (2020 RWQM)		530
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		34%
Station ID & Description	EV_MC2	Michel Creek downstream of Hwy 3 Bridge (E300091)		
Drainage Area (2018)	63700 ha	Disturbed Area (2018)		~ 5%

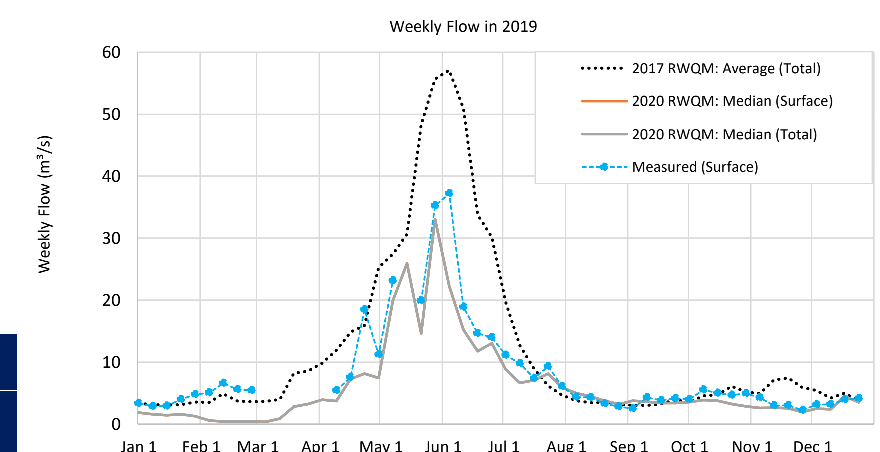
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
1/3/2019	3.362	1.832	1.832	3.360
1/10/2019	3.135	1.593	1.593	2.870
1/17/2019	3.062	1.433	1.433	2.916
1/24/2019	3.153	1.580	1.580	3.986
1/31/2019	3.570	1.285	1.285	4.760
2/7/2019	3.514	0.551	0.551	5.067
2/14/2019	4.901	0.438	0.438	6.584
2/21/2019	3.708	0.420	0.420	5.557
2/28/2019	3.610	0.388	0.388	5.442
3/7/2019	3.661	0.359	0.359	
3/14/2019	3.997	0.895	0.895	
3/21/2019	8.176	2.820	2.820	
3/28/2019	8.557	3.212	3.212	
4/4/2019	9.814	3.941	3.941	
4/11/2019	11.937	3.727	3.727	5.439
4/18/2019	14.851	7.257	7.257	7.533
4/25/2019	15.927	8.153	8.153	18.448
5/2/2019	25.265	7.455	7.455	11.201
5/9/2019	27.406	19.892	19.892	23.142
5/16/2019	30.636	25.891	25.891	
5/23/2019	48.345	14.606	14.606	19.889
5/30/2019	55.667	33.073	33.073	35.244
6/6/2019	57.096	22.250	22.250	37.185
6/13/2019	50.953	15.239	15.239	18.904
6/20/2019	33.798	11.728	11.728	14.646
6/27/2019	30.197	13.007	13.007	13.991
7/4/2019	19.703	8.815	8.815	11.112
7/11/2019	12.662	6.653	6.653	9.762
7/18/2019	8.946	7.080	7.080	7.378
7/25/2019	6.160	8.141	8.141	9.317
8/1/2019	4.696	5.872	5.872	6.077
8/8/2019	3.762	5.014	5.014	4.376
8/15/2019	3.467	4.436	4.436	4.275
8/22/2019	3.477	3.793	3.793	3.293
8/29/2019	3.192	3.184	3.184	2.821
9/5/2019	3.018	3.753	3.753	2.511
9/12/2019	3.029	3.619	3.619	4.288
9/19/2019	3.208	3.415	3.415	3.812
9/26/2019	3.927	3.378	3.378	4.121
10/3/2019	3.515	3.577	3.577	3.962
10/10/2019	4.554	3.850	3.850	5.516
10/17/2019	4.728	3.766	3.766	4.983
10/24/2019	6.098	3.235	3.235	4.658
10/31/2019	5.137	2.880	2.880	4.958
11/7/2019	4.962	2.604	2.604	4.244
11/14/2019	7.109	2.671	2.671	2.966
11/21/2019	7.441	2.521	2.521	3.013
11/28/2019	5.917	1.935	1.935	2.246
12/5/2019	5.443	2.492	2.492	3.150
12/12/2019	4.175	2.392	2.392	3.185
12/19/2019	4.977	4.510	4.510	3.904
12/26/2019	3.702	3.526	3.526	4.126
Annual	11.83	5.96	5.96	8.05
Late Summer - Fall	4.60	3.77	3.77	4.29
Winter	4.70	1.87	1.87	4.22
Freshet	29.56	13.66	13.66	16.71











Statistics on concurrent data: 2004 to 2018	Acceptable	Very good		
Parameter	**2017 RWQM: Average (Total)**	**2020 RWQM: Median (Surface)**	**2020 RWQM: Median (Total)**	**Measured (Surface)**
Nash-Sutcliffe efficiency (E)	0.60	0.77	0.77	
Modified Nash-Sutcliffe efficiency (E1)	0.51	0.72	0.72	
Index of agreement (d)	0.87	0.94	0.94	
Modified index of agreement (d1)	0.75	0.86	0.86	
MAE	6.32	3.60	3.60	
RMSE	11.38	8.58	8.58	
Coefficient of Determination (R^2)	0.61	0.78	0.78	
Number of data in statistics	267	267	267	
Total number of weekly data	783	783	783	267
Mean of all weekly data	14.095	13.101	13.101	13.674
Standard deviation of all weekly data	15.705	16.814	16.814	18.026
Approximated mean annual runoff (mm/yr)	590	530	530	560

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

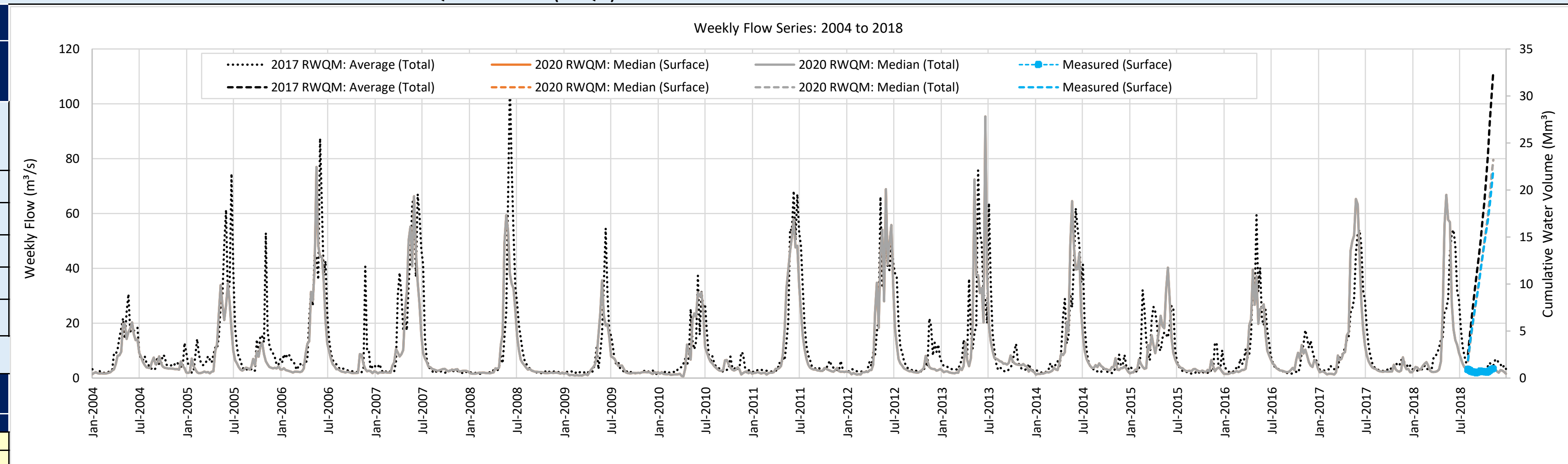
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

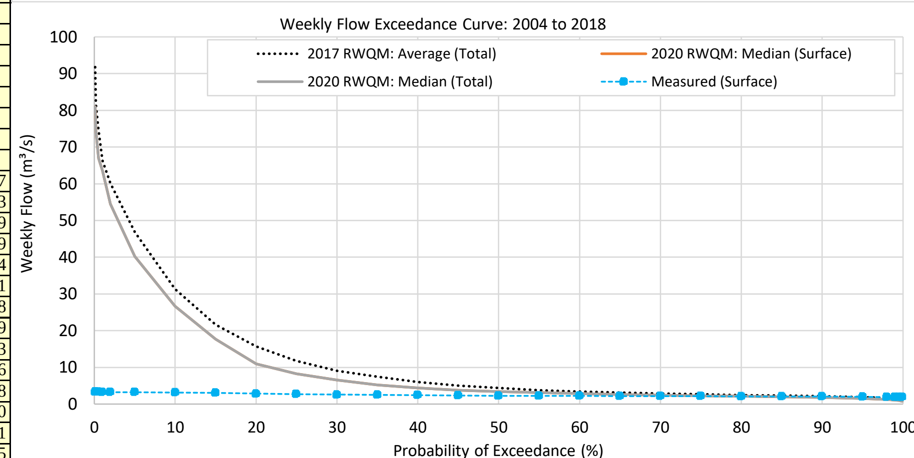
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

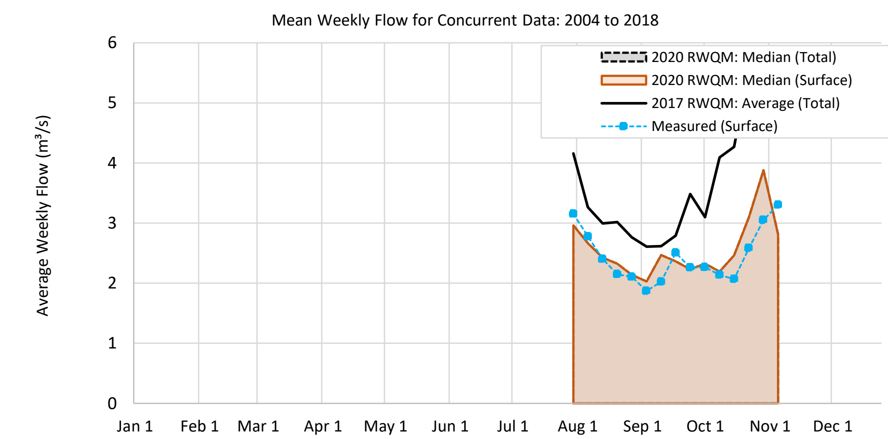
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

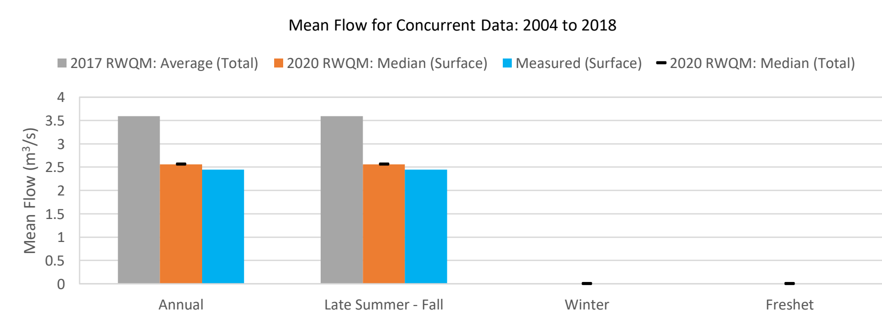
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitored_SF
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Flow Modelling Method	Scaling equation using flows estimated at EV_MC2 using a ranked regression relationship based on ECCC data at Elk River at Fernie and Elk River at Natal	Surface-Groundwater Partitioning		~130,000 m3/d
Spinner ID	15	Mean annual surface runoff (monitored)		N/A
Selected Year	2019	Mean annual total runoff (2020 RWQM)		N/A
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		2%
Station ID & Description	EV_MC3	Michel Creek upstream of Erickson Creek (0200203)		
Drainage Area (2018)	55770 ha	Disturbed Area (2018)		~ 2%

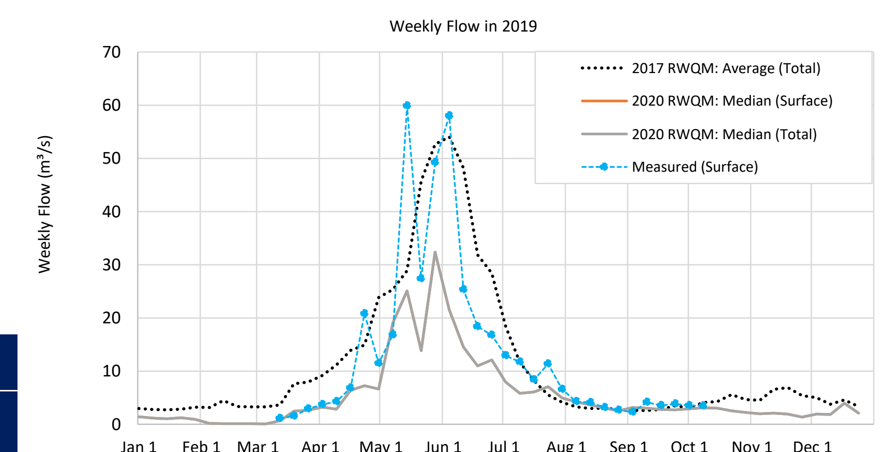
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
1/3/2019	2.992	1.443	1.443	
1/10/2019	2.797	1.184	1.184	
1/17/2019	2.728	1.049	1.049	
1/24/2019	2.816	1.201	1.201	
1/31/2019	3.214	0.891	0.891	
2/7/2019	3.161	0.176	0.176	
2/14/2019	4.485	0.123	0.123	
2/21/2019	3.346	0.134	0.134	
2/28/2019	3.253	0.106	0.106	
3/7/2019	3.301	0.075	0.075	
3/14/2019	3.618	0.644	0.644	1.107
3/21/2019	7.604	2.463	2.463	1.523
3/28/2019	7.962	2.683	2.683	2.919
4/4/2019	9.157	3.197	3.197	3.709
4/11/2019	11.156	2.862	2.862	4.254
4/18/2019	13.922	6.399	6.399	6.791
4/25/2019	14.895	7.255	7.255	20.818
5/2/2019	23.813	6.641	6.641	11.499
5/9/2019	25.357	19.065	19.065	16.793
5/16/2019	28.882	25.050	25.050	59.886
5/23/2019	45.739	13.828	13.828	27.358
5/30/2019	52.666	32.380	32.380	49.230
6/6/2019	54.041	21.525	21.525	58.001
6/13/2019	48.195	14.498	14.498	25.315
6/20/2019	31.822	11.000	11.000	18.382
6/27/2019	28.432	12.123	12.123	16.765
7/4/2019	18.417	7.925	7.925	12.890
7/11/2019	11.633	5.800	5.800	11.733
7/18/2019	8.166	6.100	6.100	8.385
7/25/2019	5.531	7.048	7.048	11.375
8/1/2019	4.156	4.981	4.981	6.594
8/8/2019	3.261	4.216	4.216	4.290
8/15/2019	2.996	3.647	3.647	4.106
8/22/2019	3.019	3.028	3.028	3.148
8/29/2019	2.762	2.506	2.506	2.671
9/5/2019	2.608	3.142	3.142	2.270
9/12/2019	2.618	3.005	3.005	4.150
9/19/2019	2.792	2.786	2.786	3.552
9/26/2019	3.481	2.698	2.698	3.849
10/3/2019	3.097	2.885	2.885	3.539
10/10/2019	4.095	3.087	3.087	3.487
10/17/2019	4.267	3.003	3.003	
10/24/2019	5.581	2.511	2.511	
10/31/2019	4.671	2.207	2.207	
11/7/2019	4.506	1.980	1.980	
11/14/2019	6.555	2.083	2.083	
11/21/2019	6.872	1.923	1.923	
11/28/2019	5.419	1.357	1.357	
12/5/2019	4.994	1.930	1.930	
12/12/2019	3.786	1.843	1.843	
12/19/2019	4.553	3.990	3.990	
12/26/2019	3.337	2.094	2.094	
Annual	11.01	5.30	5.30	13.24
Late Summer - Fall	4.12	3.06	3.06	4.42
Winter	4.28	1.40	1.40	2.31
Freshet	27.81	12.83	12.83	23.21











Statistics on concurrent data: 2004 to 2018	Poor	Poor but improved		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	-9.02	0.39	0.39	
Modified Nash-Sutcliffe efficiency (E1)	-2.18	0.33	0.33	
Index of agreement (d)	0.42	0.84	0.84	
Modified index of agreement (d1)	0.24	0.64	0.64	
MAE	1.15	0.24	0.24	
RMSE	1.36	0.34	0.34	
Coefficient of Determination (R^2)	0.31	0.56	0.56	
Number of data in statistics	15	15	15	
Total number of weekly data	783	783	783	15
Mean of all weekly data	3.594	2.558	2.558	2.444
Standard deviation of all weekly data	0.897	0.475	0.475	0.444
Approximated mean annual runoff (mm/yr)	N/A	N/A	N/A	N/A

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

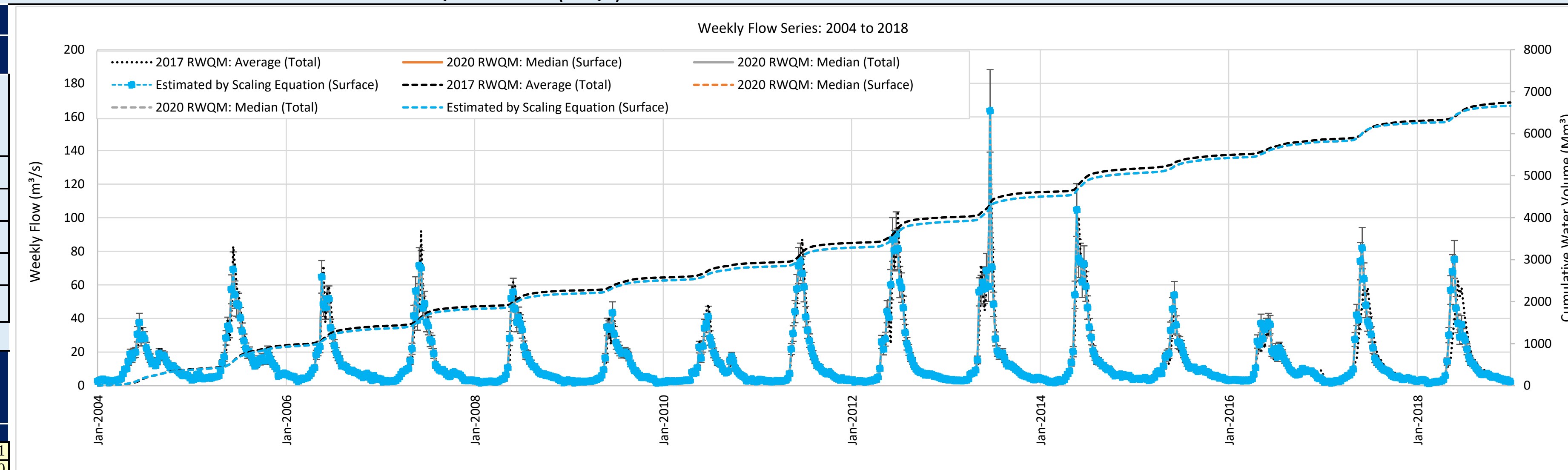
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

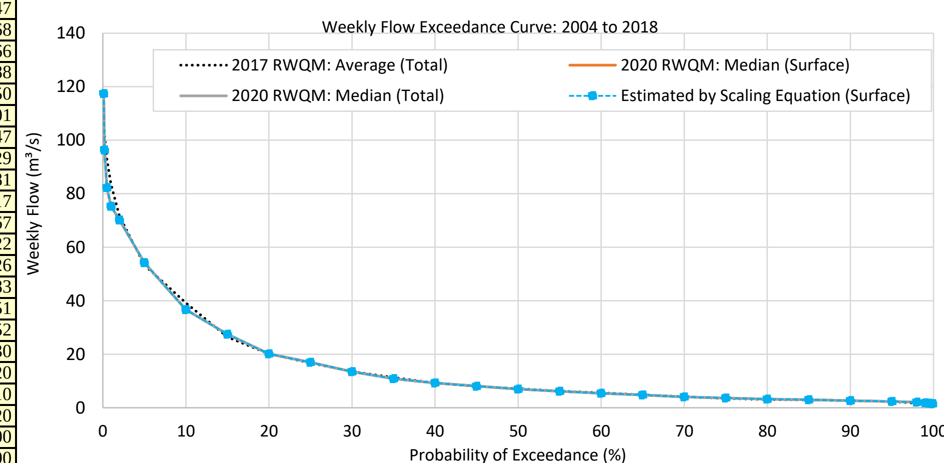
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

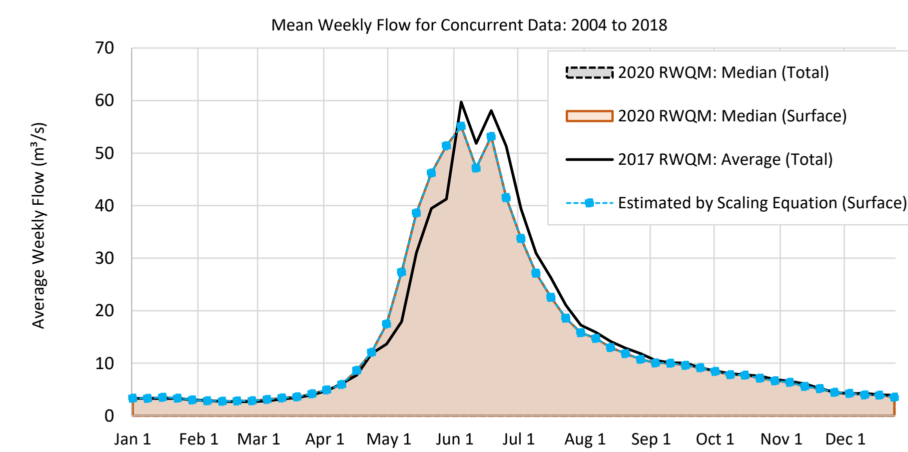
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

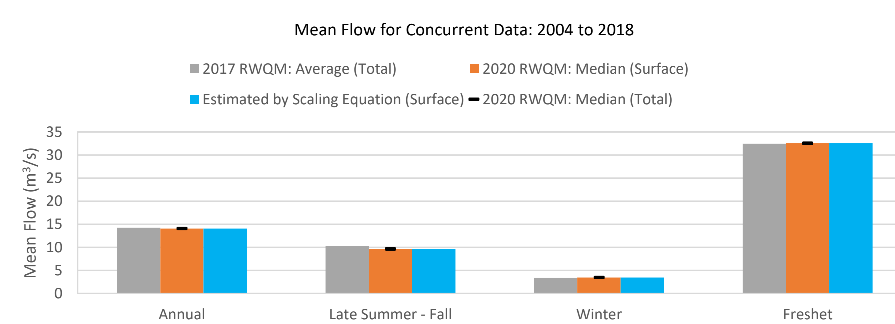
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Scaling_Method
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Estimated by Scaling Equation (Surface)
Notes on Flow Modelling Method	Scaling of flows from Environment Canada hydrometric station at Elk River near Natal and Fording River at the Mouth		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	2	Mean annual surface runoff (monitored)		460
Selected Year	2019	Mean annual total runoff (2020 RWQM)		460
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		100%
Station ID & Description	GH_ER1	Elk River upstream of Boivin Creek (E206661)		
Drainage Area (2018)	97700 ha	Disturbed Area (2018)		~ 1%

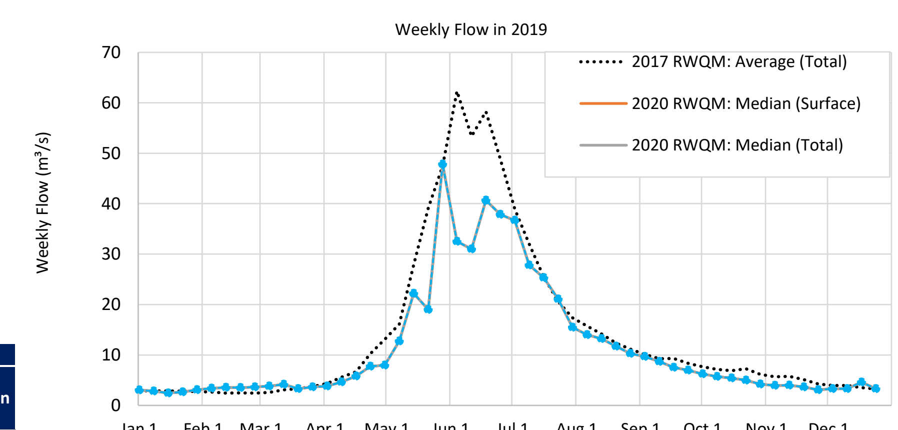
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Estimated by Scaling Equation (Surface)
	Weekly Flow in 2019		(m^3/s)	
2019-01-03	2.926	3.031	3.031	3.031
2019-01-10	2.885	2.820	2.820	2.820
2019-01-17	2.852	2.447	2.447	2.447
2019-01-24	2.805	2.668	2.668	2.668
2019-01-31	2.737	3.066	3.066	3.066
2019-02-07	2.633	3.388	3.388	3.388
2019-02-14	2.454	3.550	3.550	3.550
2019-02-21	2.464	3.501	3.501	3.501
2019-02-28	2.433	3.647	3.647	3.647
2019-03-07	2.554	3.829	3.829	3.829
2019-03-14	3.074	4.181	4.181	4.181
2019-03-21	3.288	3.317	3.317	3.317
2019-03-28	3.745	3.667	3.667	3.667
2019-04-04	4.319	3.822	3.822	3.822
2019-04-11	5.602	4.626	4.626	4.626
2019-04-18	6.672	5.783	5.783	5.783
2019-04-25	10.262	7.751	7.751	7.751
2019-05-02	13.107	7.952	7.952	7.952
2019-05-09	16.102	12.733	12.733	12.730
2019-05-16	27.845	22.222	22.222	22.220
2019-05-23	39.131	19.013	19.013	19.010
2019-05-30	47.452	47.824	47.824	47.820
2019-06-06	62.317	32.501	32.501	32.500
2019-06-13	53.343	30.992	30.992	30.990
2019-06-20	58.295	40.683	40.683	40.680
2019-06-27	48.855	37.863	37.863	37.860
2019-07-04	38.885	36.676	36.676	36.680
2019-07-11	31.986	27.790	27.790	27.790
2019-07-18	25.419	25.292	25.292	25.290
2019-07-25	20.589	21.085	21.085	21.090
2019-08-01	17.360	15.464	15.464	15.460
2019-08-08	15.714	14.005	14.005	14.000
2019-08-15	14.184	13.205	13.205	13.210
2019-08-22	12.351	11.705	11.705	11.710
2019-08-29	11.155	10.274	10.274	10.270
2019-09-05	10.103	9.707	9.707	9.707
2019-09-12	9.258	8.676	8.676	8.676
2019-09-19	9.305	7.544	7.544	7.544
2019-09-26	8.328	6.949	6.949	6.949
2019-10-03	7.661	6.230	6.230	6.230
2019-10-10	7.154	5.708	5.708	5.708
2019-10-17	6.878	5.399	5.399	5.399
2019-10-24	7.271	4.986	4.986	4.986
2019-10-31	6.136	4.186	4.186	4.186
2019-11-07	5.693	3.929	3.929	3.929
2019-11-14	5.760	3.974	3.974	3.974
2019-11-21	5.097	3.641	3.641	3.641
2019-11-28	4.245	3.073	3.073	3.073
2019-12-05	3.950	3.296	3.296	3.296
2019-12-12	3.930	3.311	3.311	3.311
2019-12-19	3.501	4.583	4.583	4.583
2019-12-26	3.251	3.290	3.290	3.290
Annual	13.95	11.17	11.17	11.17
Late Summer - Fall	9.70	8.41	8.41	8.41
Winter	3.10	3.41	3.41	3.41
Freshet	32.35	23.98	23.98	23.98











Statistics on concurrent data: 2004 to 2018	Very good	Very good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Estimated by Scaling Equation (Surface)
Nash-Sutcliffe efficiency (E)	0.89	1.00	1.00	
Modified Nash-Sutcliffe efficiency (E1)	0.78	1.00	1.00	
Index of agreement (d)	0.97	1.00	1.00	
Modified index of agreement (d1)	0.89	1.00	1.00	
MAE	2.62	0.00	0.00	
RMSE	5.85	0.00	0.00	
Coefficient of Determination (R^2)	0.89	1.00	1.00	
Number of data in statistics	783	783	783	
Total number of weekly data	783	783	783	783
Mean of all weekly data	14.239	14.075	14.075	14.075
Standard deviation of all weekly data	17.854	17.393	17.393	17.393
Approximated mean annual runoff (mm/yr)	460	460	460	460

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

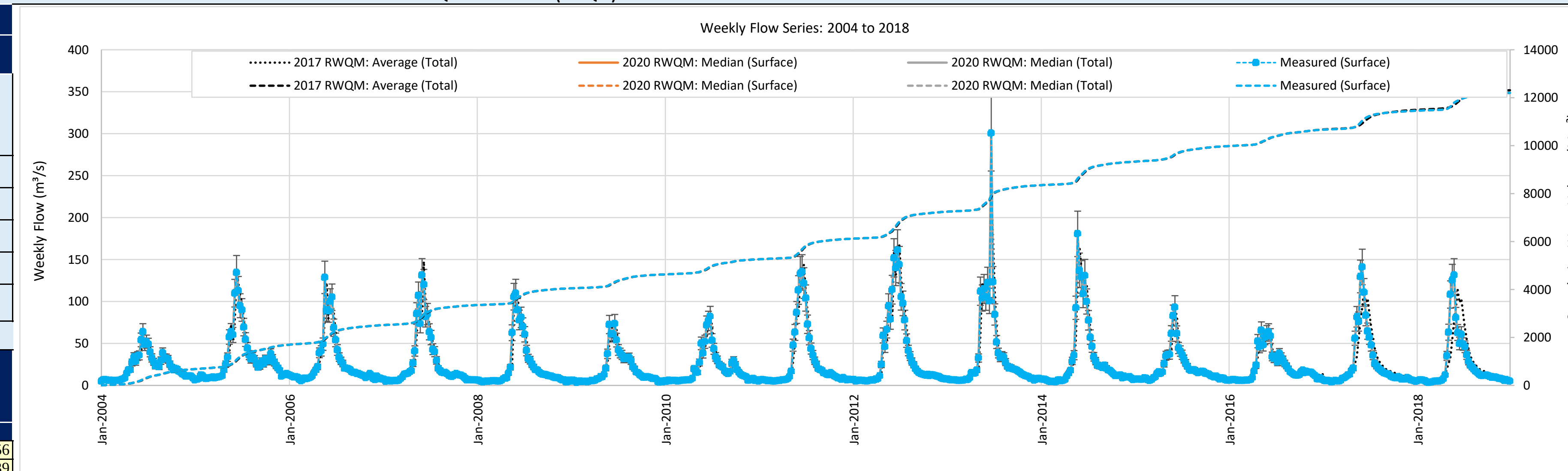
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

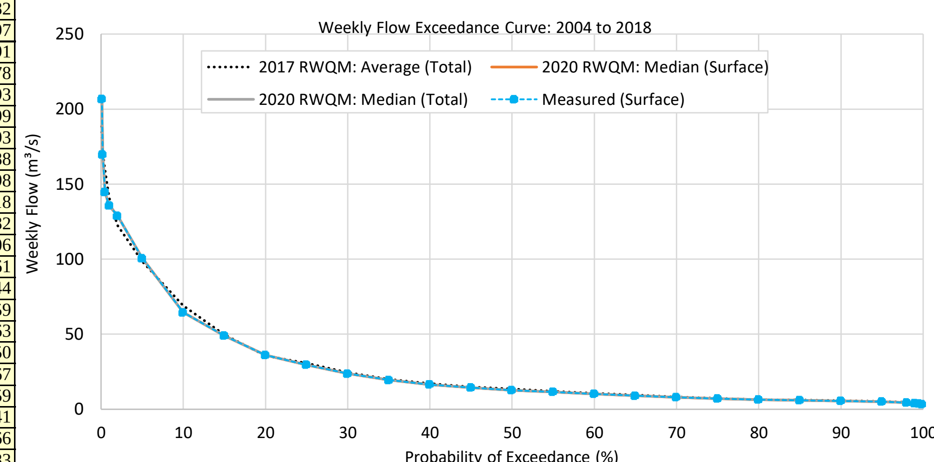
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

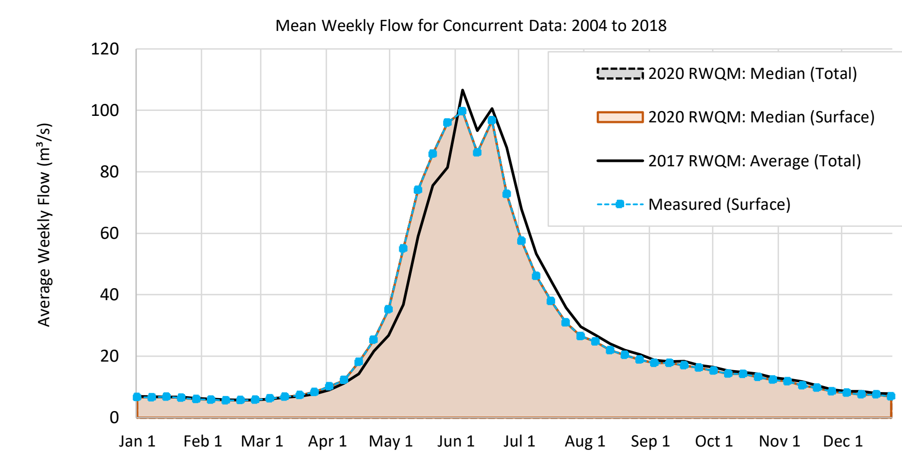
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

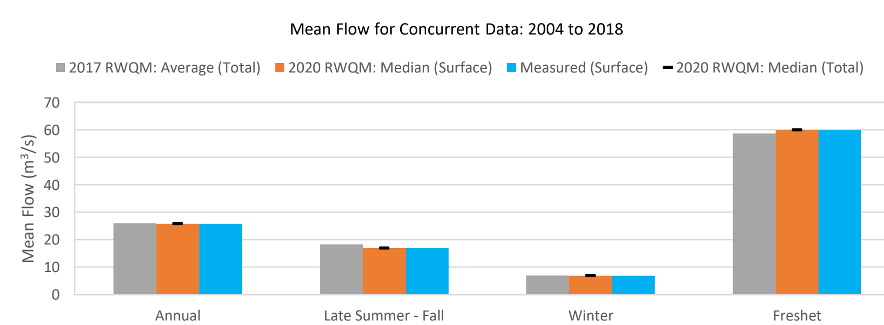
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitor
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Notes on Flow Modelling Method	Environment Canada hydrometric station at Elk River near Natal		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	3	Mean annual surface runoff (monitored)		440
Selected Year	2019	Mean annual total runoff (2020 RWQM)		440
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		100%
Station ID & Description	EV_ER4	Elk River upstream of Grave Creek (0200027)		
Drainage Area (2018)	184000 ha	Disturbed Area (2018)		~ 5%

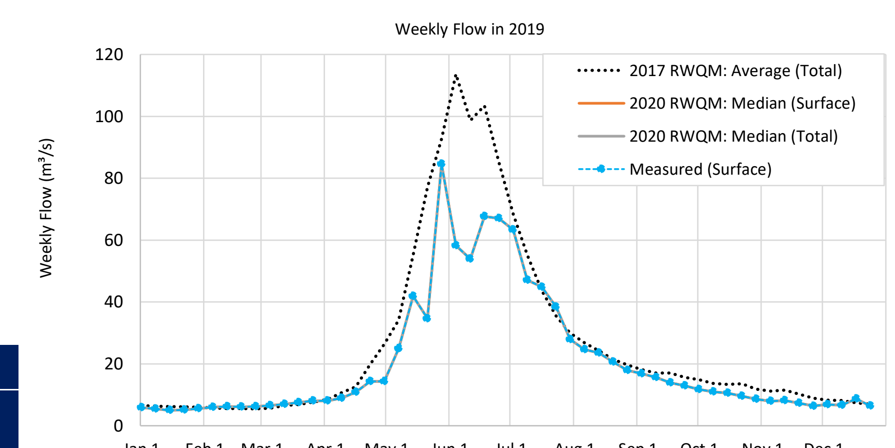
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
1/3/2019	6.493	5.856	5.856	5.856
1/10/2019	6.299	5.439	5.439	5.439
1/17/2019	6.192	4.982	4.982	4.982
1/24/2019	6.103	5.097	5.097	5.097
1/31/2019	5.974	5.591	5.591	5.591
2/7/2019	5.786	5.978	5.978	5.978
2/14/2019	5.513	6.193	6.193	6.193
2/21/2019	5.519	6.099	6.099	6.099
2/28/2019	5.465	6.193	6.193	6.193
3/7/2019	5.713	6.488	6.488	6.488
3/14/2019	6.496	6.998	6.998	6.998
3/21/2019	6.809	7.518	7.518	7.518
3/28/2019	7.574	8.082	8.082	8.082
4/4/2019	8.433	8.106	8.106	8.106
4/11/2019	10.667	8.961	8.961	8.961
4/18/2019	12.614	10.844	10.844	10.844
4/25/2019	19.897	14.359	14.359	14.359
5/2/2019	26.361	14.363	14.363	14.363
5/9/2019	34.129	24.950	24.950	24.950
5/16/2019	55.101	41.867	41.867	41.867
5/23/2019	77.040	34.659	34.659	34.659
5/30/2019	92.737	84.541	84.541	84.541
6/6/2019	113.650	58.266	58.266	58.266
6/13/2019	98.620	53.883	53.883	53.883
6/20/2019	103.453	67.631	67.631	67.631
6/27/2019	85.211	67.012	67.012	67.012
7/4/2019	68.400	63.303	63.303	63.303
7/11/2019	55.203	47.031	47.031	47.031
7/18/2019	43.671	44.848	44.848	44.848
7/25/2019	35.485	38.451	38.451	38.451
8/1/2019	29.969	27.888	27.888	27.888
8/8/2019	26.824	24.686	24.686	24.686
8/15/2019	24.241	23.546	23.546	23.546
8/22/2019	21.481	20.678	20.678	20.678
8/29/2019	19.621	17.941	17.941	17.941
9/5/2019	18.171	16.784	16.784	16.784
9/12/2019	17.015	15.632	15.632	15.632
9/19/2019	17.011	13.896	13.896	13.896
9/26/2019	15.624	12.937	12.937	12.937
10/3/2019	14.917	11.763	11.763	11.763
10/10/2019	13.741	11.016	11.016	11.016
10/17/2019	13.309	10.502	10.502	10.502
10/24/2019	13.627	9.607	9.607	9.607
10/31/2019	11.880	8.551	8.551	8.551
11/7/2019	11.159	7.930	7.930	7.930
11/14/2019	11.514	8.154	8.154	8.154
11/21/2019	10.212	7.279	7.279	7.279
11/28/2019	8.972	6.374	6.374	6.374
12/5/2019	8.274	6.853	6.853	6.853
12/12/2019	8.115	6.695	6.695	6.695
12/19/2019	7.410	8.674	8.674	8.674
12/26/2019	7.011	6.346	6.346	6.404
Annual	25.98	20.14	20.14	20.14
Late Summer - Fall	17.62	15.45	15.45	15.45
Winter	6.62	6.51	6.51	6.51
Freshet	59.78	42.43	42.43	42.43











Statistics on concurrent data: 2004 to 2018	Very good	Very good	Very good	
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	0.90	1.00	1.00	
Modified Nash-Sutcliffe efficiency (E1)	0.80	1.00	1.00	
Index of agreement (d)	0.97	1.00	1.00	
Modified index of agreement (d1)	0.90	1.00	1.00	
MAE	4.38	0.00	0.00	
RMSE	10.02	0.00	0.00	
Coefficient of Determination (R^2)	0.90	1.00	1.00	
Number of data in statistics	783	783	783	
Total number of weekly data	783	783	783	783
Mean of all weekly data	25.998	25.764	25.764	25.764
Standard deviation of all weekly data	30.891	31.568	31.568	31.568
Approximated mean annual runoff (mm/yr)	450	440	440	440

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

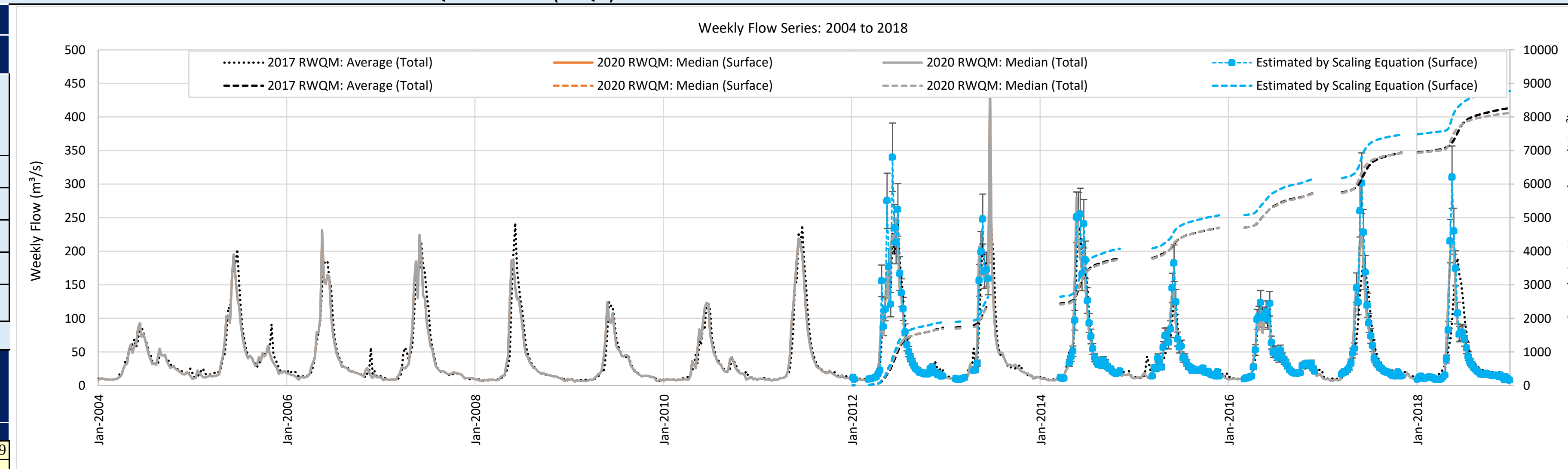
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

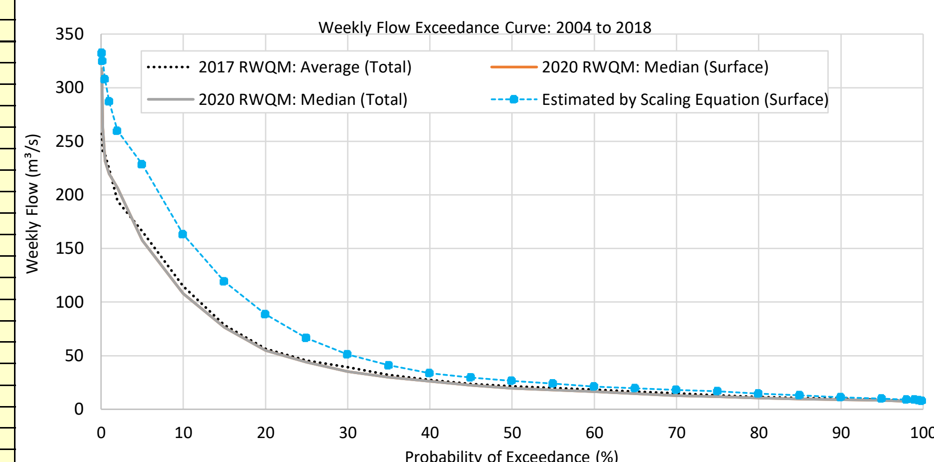
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

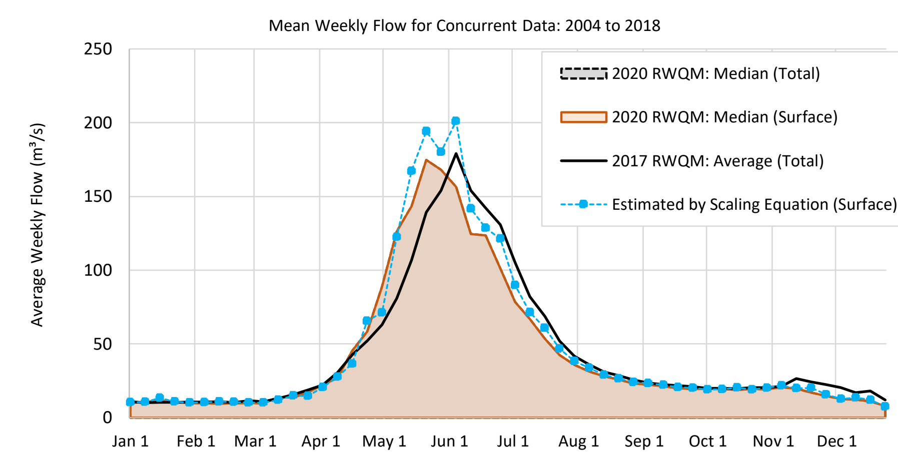
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

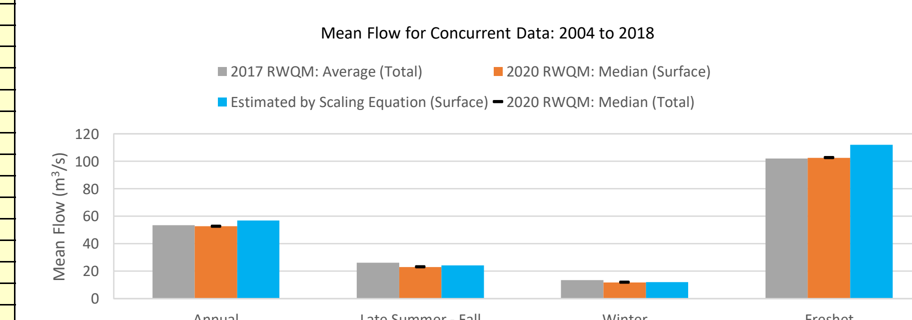
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Scaling_Method
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Estimated by Scaling Equation (Surface)
Notes on Flow Modelling Method	Sum of modeled flows at Michel Creek (EV_MC1) and at EV_ER2, estimated by scaling flows from Environment Canada hydrometric station at EV_ER4		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	6	Mean annual surface runoff (monitored)		510
Selected Year	2019	Mean annual total runoff (2020 RWQM)		470
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		33%
Station ID & Description	EV_ER1	Elk River downstream of Michel Creek (0200393)		
Drainage Area (2018)	281300 ha	Disturbed Area (2018)		~ 5%

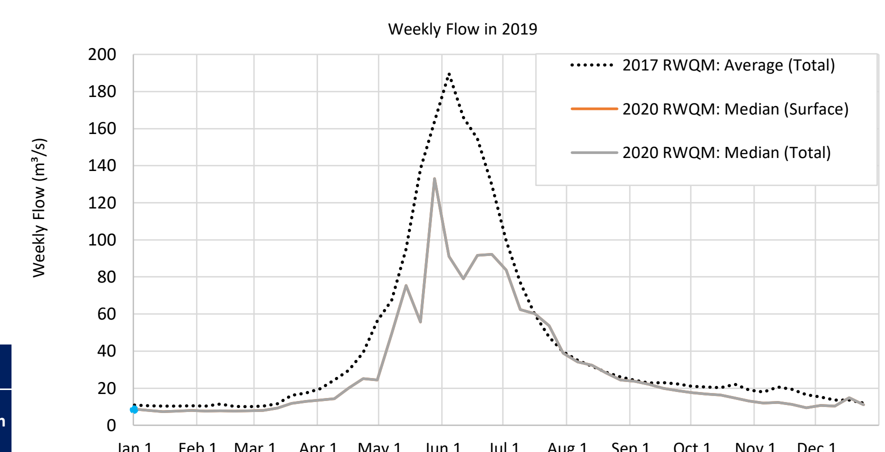
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Estimated by Scaling Equation (Surface)
	Weekly Flow in 2019		(m^3/s)	
1/3/2019	10.981	8.794	8.794	8.179
1/10/2019	10.527	8.061	8.061	
1/17/2019	10.328	7.359	7.359	
1/24/2019	10.316	7.640	7.640	
1/31/2019	10.585	7.930	7.930	
2/7/2019	10.309	7.653	7.653	
2/14/2019	11.386	7.792	7.792	
2/21/2019	10.193	7.660	7.660	
2/28/2019	10.032	7.737	7.737	
3/7/2019	10.373	8.052	8.052	
3/14/2019	11.622	9.188	9.188	
3/21/2019	16.187	11.739	11.739	
3/28/2019	17.462	12.816	12.816	
4/4/2019	19.726	13.584	13.584	
4/11/2019	24.469	14.383	14.383	
4/18/2019	29.670	20.138	20.138	
4/25/2019	39.245	25.189	25.189	
5/2/2019	56.148	24.490	24.490	
5/9/2019	67.339	49.433	49.433	
5/16/2019	94.988	75.422	75.422	
5/23/2019	138.324	55.623	55.623	
5/30/2019	163.961	133.024	133.024	
6/6/2019	189.728	91.159	91.159	
6/13/2019	166.063	78.973	78.973	
6/20/2019	154.447	91.706	91.706	
6/27/2019	129.592	92.266	92.266	
7/4/2019	99.485	83.690	83.690	
7/11/2019	77.047	62.302	62.302	
7/18/2019	59.882	60.154	60.154	
7/25/2019	47.552	53.666	53.666	
8/1/2019	39.657	38.910	38.910	
8/8/2019	35.060	34.261	34.261	
8/15/2019	31.755	32.335	32.335	
8/22/2019	28.551	28.304	28.304	
8/29/2019	26.098	24.456	24.456	
9/5/2019	24.234	23.654	23.654	
9/12/2019	22.900	22.160	22.160	
9/19/2019	23.074	19.903	19.903	
9/26/2019	22.182	18.733	18.733	
10/3/2019	20.944	17.542	17.542	
10/10/2019	20.619	16.935	16.935	
10/17/2019	20.290	16.242	16.242	
10/24/2019	22.036	14.651	14.651	
10/31/2019	19.036	13.045	13.045	
11/7/2019	18.021	12.032	12.032	
11/14/2019	20.591	12.360	12.360	
11/21/2019	19.409	11.176	11.176	
11/28/2019	16.435	9.524	9.524	
12/5/2019	15.147	10.657	10.657	
12/12/2019	13.687	10.369	10.369	
12/19/2019	13.673	14.823	14.823	
12/26/2019	11.925	11.088	11.088	
Annual	42.18	29.82	29.82	8.18
Late Summer - Fall	25.18	22.10	22.10	
Winter	12.47	9.61	9.61	8.18
Freshet	99.36	63.86	63.86	











Statistics on concurrent data: 2004 to 2018	Very good	Very good	Very good	
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Estimated by Scaling Equation (Surface)
Nash-Sutcliffe efficiency (E)	0.81	0.91	0.91	
Modified Nash-Sutcliffe efficiency (E1)	0.73	0.80	0.80	
Index of agreement (d)	0.94	0.97	0.97	
Modified index of agreement (d1)	0.86	0.90	0.90	
MAE	13.04	9.66	9.66	
RMSE	29.49	20.68	20.68	
Coefficient of Determination (R^2)	0.82	0.92	0.92	
Number of data in statistics	255	255	255	
Total number of weekly data	783	783	783	255
Mean of all weekly data	53.582	52.625	52.625	56.857
Standard deviation of all weekly data	54.661	57.848	57.848	67.436
Approximated mean annual runoff (mm/yr)	490	470	470	510

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

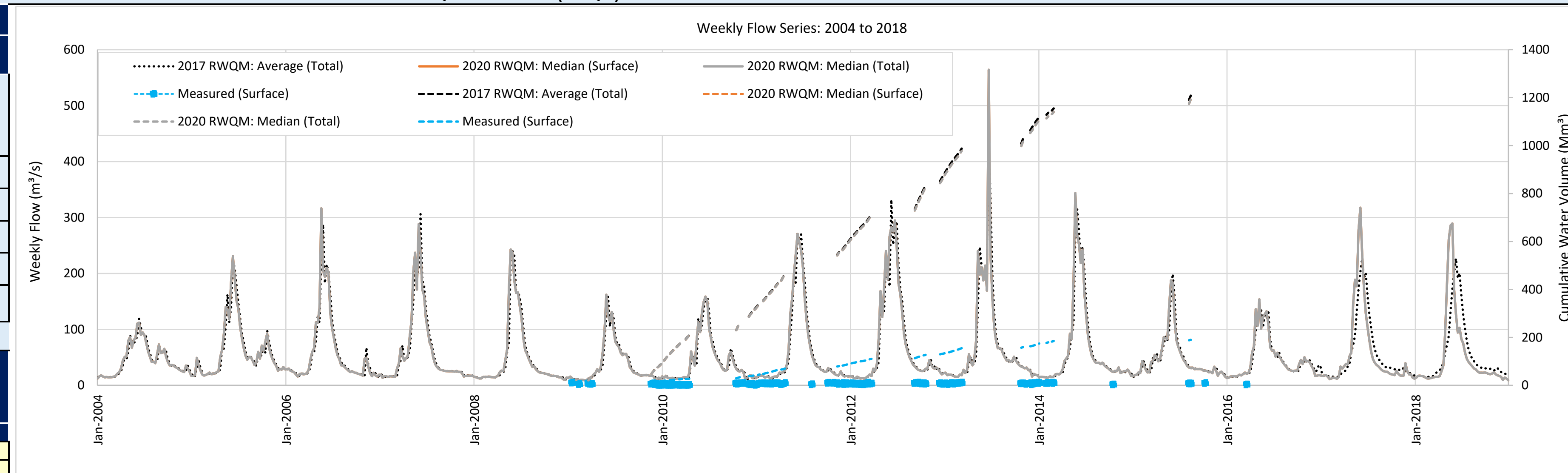
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

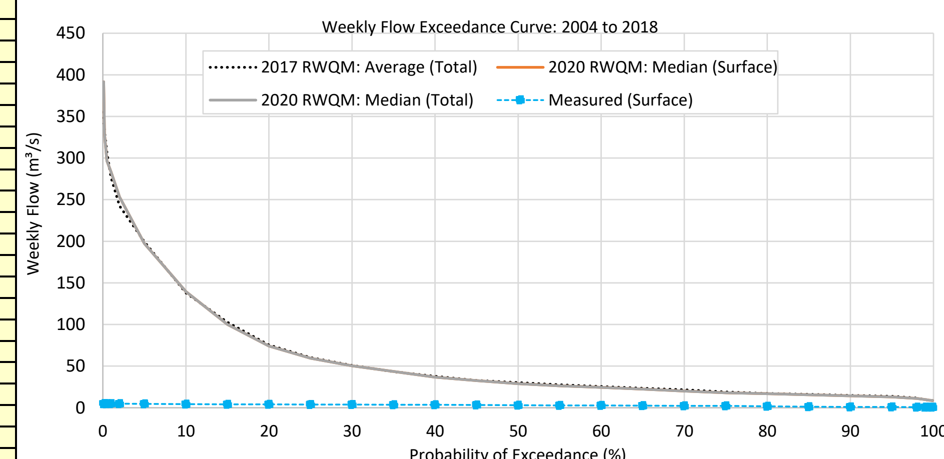
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

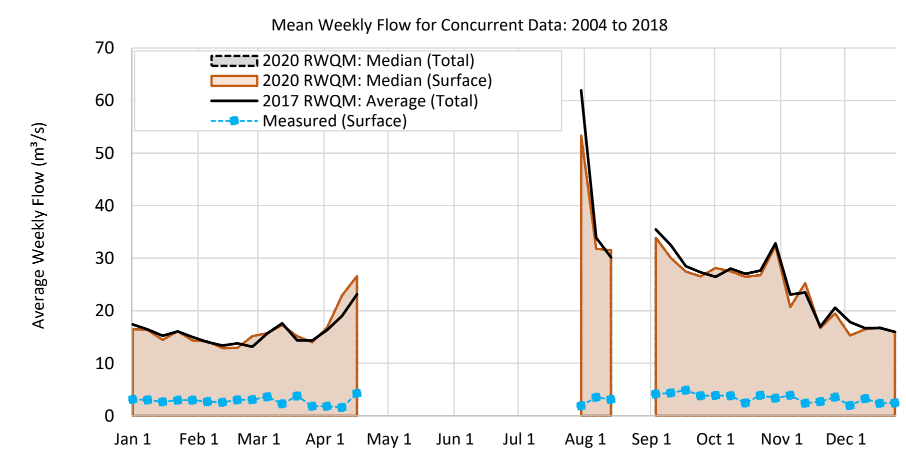
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

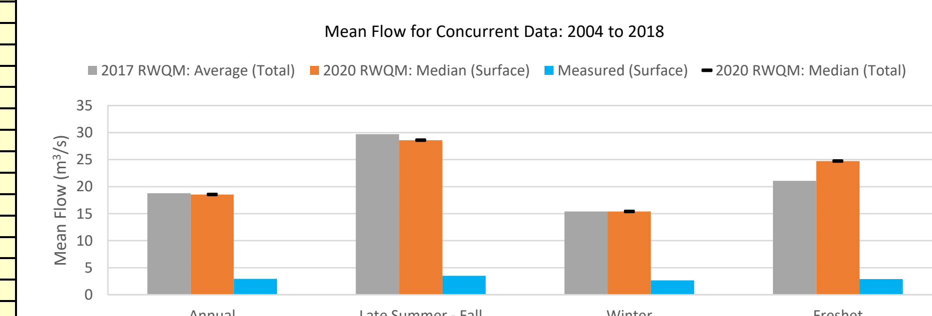
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Monitor
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Notes on Flow Modelling Method	Scaling of flows from Environment Canada hydrometric station at Elk River at Fernie		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	8	Mean annual surface runoff (monitored)		N/A
Selected Year	2019	Mean annual total runoff (2020 RWQM)		N/A
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		14%
Station ID & Description	RG_ELKORES	Elk River at Elko Reservoir (E294312)		
Drainage Area (2018)	355000 ha	Disturbed Area (2018)		~ 4%

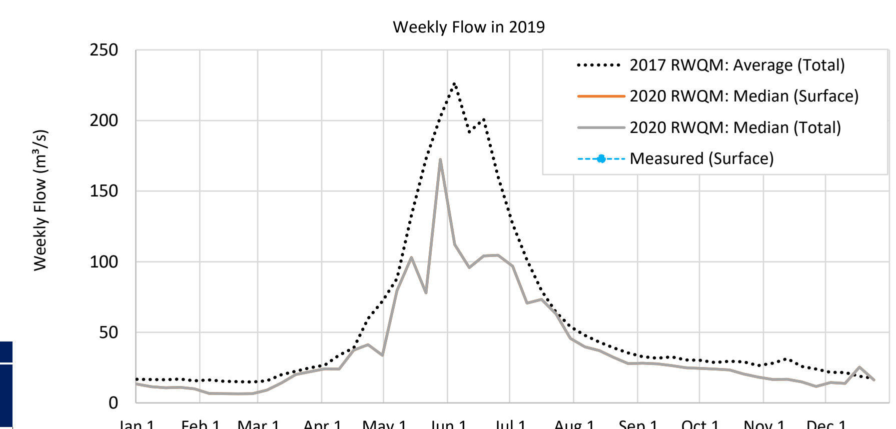
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	16.684	13.405	13.405	
2019-01-10	16.627	11.483	11.483	
2019-01-17	16.436	10.687	10.687	
2019-01-24	16.843	11.076	11.076	
2019-01-31	15.658	9.982	9.982	
2019-02-07	16.274	6.721	6.721	
2019-02-14	15.395	6.583	6.583	
2019-02-21	15.085	6.443	6.443	
2019-02-28	14.817	6.609	6.609	
2019-03-07	15.686	8.956	8.956	
2019-03-14	20.030	14.103	14.103	
2019-03-21	22.381	20.097	20.097	
2019-03-28	24.882	22.100	22.100	
2019-04-04	26.728	24.070	24.070	
2019-04-11	33.843	23.924	23.924	
2019-04-18	38.871	37.327	37.327	
2019-04-25	59.791	41.203	41.203	
2019-05-02	71.997	33.646	33.646	
2019-05-09	88.003	79.637	79.637	
2019-05-16	132.780	103.056	103.056	
2019-05-23	172.905	77.895	77.895	
2019-05-30	202.613	172.466	172.466	
2019-06-06	226.819	112.062	112.062	
2019-06-13	191.901	95.727	95.727	
2019-06-20	200.848	104.163	104.163	
2019-06-27	160.164	104.571	104.571	
2019-07-04	126.739	96.802	96.802	
2019-07-11	101.200	70.647	70.647	
2019-07-18	79.490	73.204	73.204	
2019-07-25	64.376	63.140	63.140	
2019-08-01	54.051	45.649	45.649	
2019-08-08	47.851	39.705	39.705	
2019-08-15	43.140	37.115	37.115	
2019-08-22	38.841	32.164	32.164	
2019-08-29	35.315	27.800	27.800	
2019-09-05	32.708	28.060	28.060	
2019-09-12	31.597	27.653	27.653	
2019-09-19	32.632	26.497	26.497	
2019-09-26	30.505	24.885	24.885	
2019-10-03	30.140	24.461	24.461	
2019-10-10	28.643	24.021	24.021	
2019-10-17	29.574	23.337	23.337	
2019-10-24	29.108	20.422	20.422	
2019-10-31	26.456	18.256	18.256	
2019-11-07	28.126	16.530	16.530	
2019-11-14	31.345	16.693	16.693	
2019-11-21	25.818	14.836	14.836	
2019-11-28	23.919	11.692	11.692	
2019-12-05	21.687	14.429	14.429	
2019-12-12	21.467	13.810	13.810	
2019-12-19	18.894	25.406	25.406	
2019-12-26	17.399	16.269	16.269	
Annual	55.48	38.30	38.30	
Late Summer - Fall	34.96	27.52	27.52	
Winter	18.50	13.46	13.46	
Freshet	125.86	81.76	81.76	











Statistics on concurrent data: 2004 to 2018	Poor	Poor but Improved		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Measured (Surface)
Nash-Sutcliffe efficiency (E)	-212.62	-201.15	-201.15	
Modified Nash-Sutcliffe efficiency (E1)	-14.78	-14.54	-14.54	
Index of agreement (d)	0.10	0.11	0.11	
Modified index of agreement (d1)	0.06	0.06	0.06	
MAE	15.84	15.60	15.60	
RMSE	17.41	16.93	16.93	
Coefficient of Determination (R^2)	0.07	0.08	0.08	
Number of data in statistics	109	109	109	
Total number of weekly data	783	783	783	109
Mean of all weekly data	18.773	18.531	18.531	2.932
Standard deviation of all weekly data	7.484	6.860	6.860	1.197
Approximated mean annual runoff (mm/yr)	N/A	N/A	N/A	N/A

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

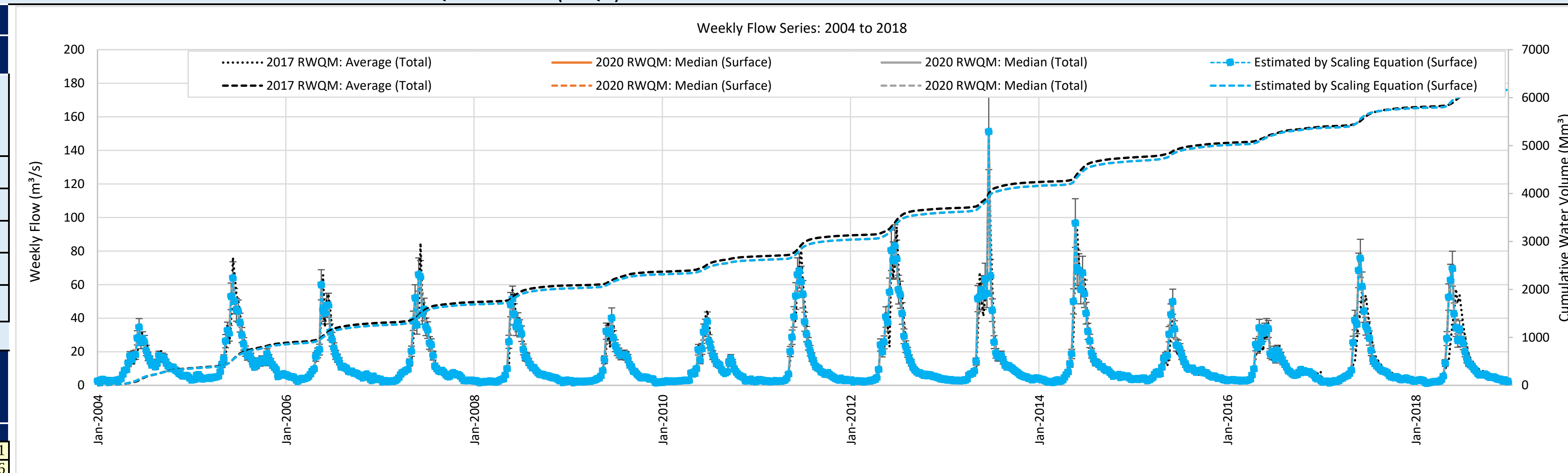
n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

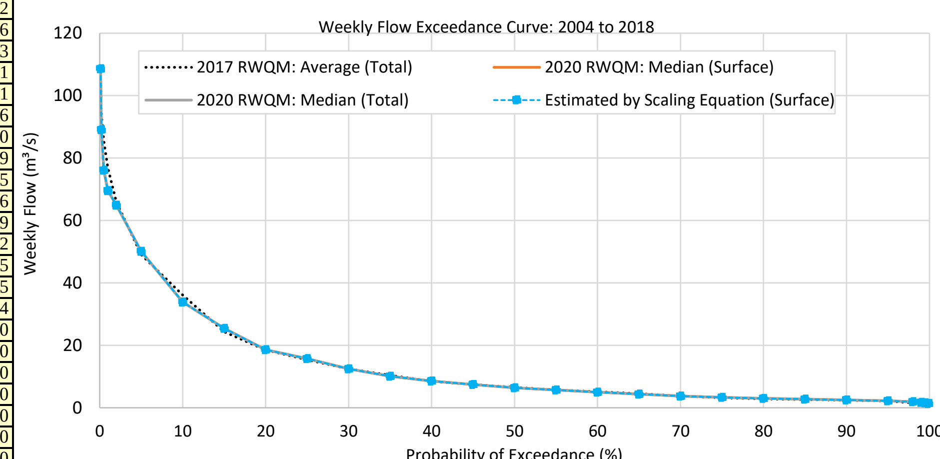
Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)

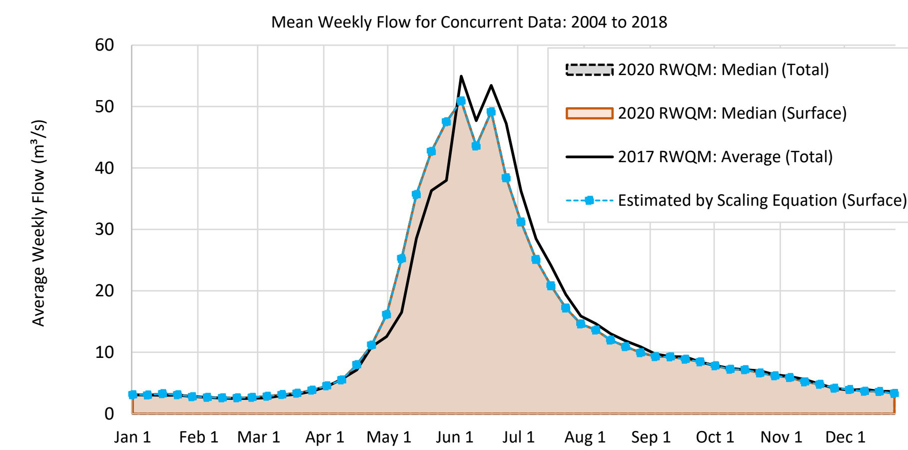
FLOW COMPONENT OF THE TECK ELK VALLEY REGIONAL WATER QUALITY MODEL (RWQM) - MODELLED PERFORMANCE

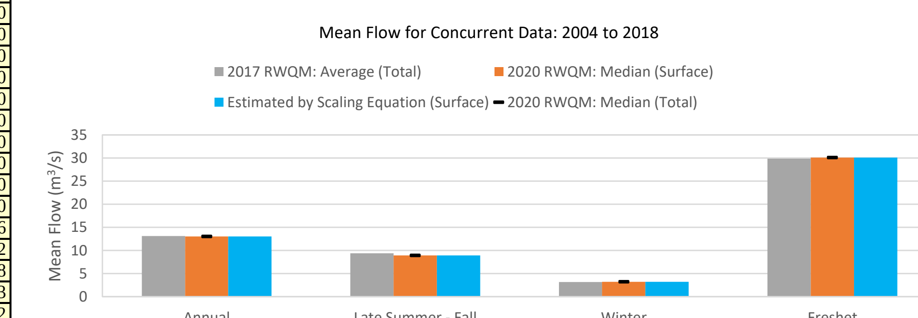
Scenario	2017RWQM_TF_MF	2020RWQM_SF_MF	2020RWQM_TF_MF	Scaling_Method
Case Description	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Estimated by Scaling Equation (Surface)
Notes on Flow Modelling Method	Scaling of flows from Environment Canada hydrometric station at Elk River near Natal and Fording River at the Mouth		Surface-Groundwater Partitioning	Not Implemented
Spinner ID	1	Mean annual surface runoff (monitored)		460
Selected Year	2019	Mean annual total runoff (2020 RWQM)		460
Comparison Start Year	2004	Evaluation period (weeks)		783
Comparison End Year	2018	Weeks with monitoring data (%)		100%
Station ID & Description	GH_ERC	Elk River 220 m downstream of Thompson Creek / GHO Elk River Compliance Point (E300090)		
Drainage Area (2018)	90300 ha	Disturbed Area (2018)		~ 1%

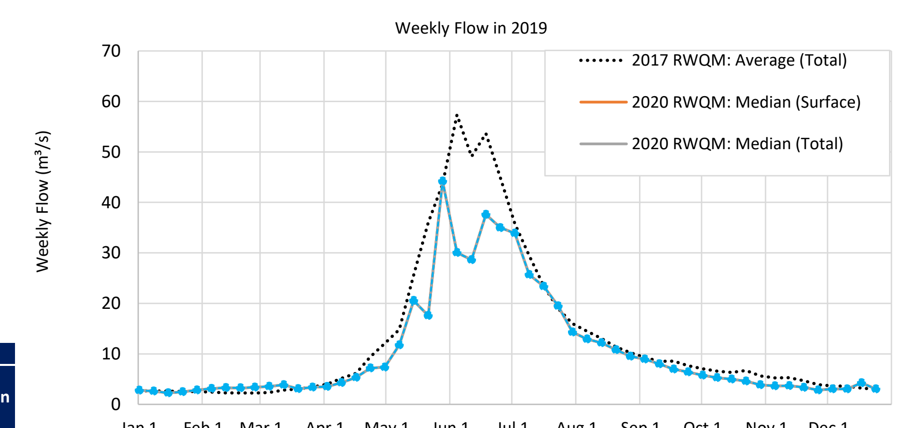
Date	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Estimated by Scaling Equation (Surface)
	Weekly Flow in 2019		(m³/s)	
2019-01-03	2.692	2.801	2.801	2.801
2019-01-10	2.655	2.606	2.606	2.606
2019-01-17	2.624	2.262	2.262	2.262
2019-01-24	2.581	2.466	2.466	2.466
2019-01-31	2.518	2.833	2.833	2.833
2019-02-07	2.423	3.131	3.131	3.131
2019-02-14	2.258	3.281	3.281	3.281
2019-02-21	2.267	3.236	3.236	3.236
2019-02-28	2.238	3.370	3.370	3.370
2019-03-07	2.350	3.539	3.539	3.539
2019-03-14	2.828	3.865	3.865	3.865
2019-03-21	3.025	3.066	3.066	3.066
2019-03-28	3.446	3.389	3.389	3.389
2019-04-04	3.974	3.532	3.532	3.532
2019-04-11	5.155	4.275	4.275	4.275
2019-04-18	6.140	5.345	5.345	5.345
2019-04-25	9.443	7.164	7.164	7.164
2019-05-02	12.061	7.350	7.350	7.350
2019-05-09	14.816	11.769	11.769	11.770
2019-05-16	25.622	20.539	20.539	20.540
2019-05-23	36.007	17.573	17.573	17.570
2019-05-30	43.664	44.202	44.202	44.200
2019-06-06	57.341	30.040	30.040	30.040
2019-06-13	49.084	28.645	28.645	28.640
2019-06-20	53.641	37.601	37.601	37.600
2019-06-27	44.955	34.995	34.995	34.990
2019-07-04	35.780	33.898	33.898	33.900
2019-07-11	29.432	25.685	25.685	25.690
2019-07-18	23.390	23.376	23.376	23.380
2019-07-25	18.945	19.488	19.488	19.490
2019-08-01	15.974	14.293	14.293	14.290
2019-08-08	14.459	12.944	12.944	12.940
2019-08-15	13.051	12.205	12.205	12.200
2019-08-22	11.365	10.819	10.819	10.820
2019-08-29	10.265	9.496	9.496	9.496
2019-09-05	9.296	8.972	8.972	8.972
2019-09-12	8.519	8.018	8.018	8.018
2019-09-19	8.562	6.973	6.973	6.973
2019-09-26	7.663	6.422	6.422	6.422
2019-10-03	7.049	5.758	5.758	5.758
2019-10-10	6.583	5.276	5.276	5.276
2019-10-17	6.329	4.990	4.990	4.990
2019-10-24	6.691	4.609	4.609	4.609
2019-10-31	5.646	3.869	3.869	3.869
2019-11-07	5.239	3.632	3.632	3.632
2019-11-14	5.300	3.673	3.673	3.673
2019-11-21	4.691	3.365	3.365	3.365
2019-11-28	3.906	2.840	2.840	2.840
2019-12-05	3.635	3.047	3.047	3.047
2019-12-12	3.616	3.060	3.060	3.060
2019-12-19	3.221	4.236	4.236	4.236
2019-12-26	2.992	3.041	3.041	3.041
Annual	12.83	10.32	10.32	10.32
Late Summer - Fall	8.92	7.77	7.77	7.77
Winter	2.85	3.15	3.15	3.15
Freshet	29.77	22.16	22.16	22.16











Statistics on concurrent data: 2004 to 2018	Very good	Very good		
Parameter	2017 RWQM: Average (Total)	2020 RWQM: Median (Surface)	2020 RWQM: Median (Total)	Estimated by Scaling Equation (Surface)
Nash-Sutcliffe efficiency (E)	0.89	1.00	1.00	
Modified Nash-Sutcliffe efficiency (E1)	0.78	1.00	1.00	
Index of agreement (d)	0.97	1.00	1.00	
Modified index of agreement (d1)	0.89	1.00	1.00	
MAE	2.40	0.00	0.00	
RMSE	5.39	0.00	0.00	
Coefficient of Determination (R^2)	0.89	1.00	1.00	
Number of data in statistics	783	783	783	
Total number of weekly data	783	783	783	783
Mean of all weekly data	13.102	13.009	13.009	13.009
Standard deviation of all weekly data	16.429	16.075	16.075	16.076
Approximated mean annual runoff (mm/yr)	460	460	460	460

Notes

Performance statistics: For E, E1, d, d1, and R^2 a statistic of 1 indicates best fit with monitored data. For E and E1, values less than 0 indicate that the model is no better than using the mean of all the data. For MAE and RMSE, a lower number generally indicates a better fit with monitored data.

Notes on seasonal periods: Annual (January through December); late Summer - Fall (late-July through November); Winter (December through early April) Freshet (mid-April through mid-July)

n/a = Not available or unable to calculate a value (e.g., mean annual runoff is not calculated if certain weeks or months are missing data)

Flows for the 2017 RWQM represent projected average flows from January 1, 2017 (i.e., historical predictions end in December 2016)