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Similkameen Watershed Plan: Technical Studies Update

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Outline

- Background & History
- Similkameen Watershed - Key water issues
  - Why a watershed plan?
- Watershed Studies 2014
  - Water Quality – “Status & Trends”
  - Water Availability Assessment
  - Groundwater-Surface Water Interaction
- Next Steps & Questions

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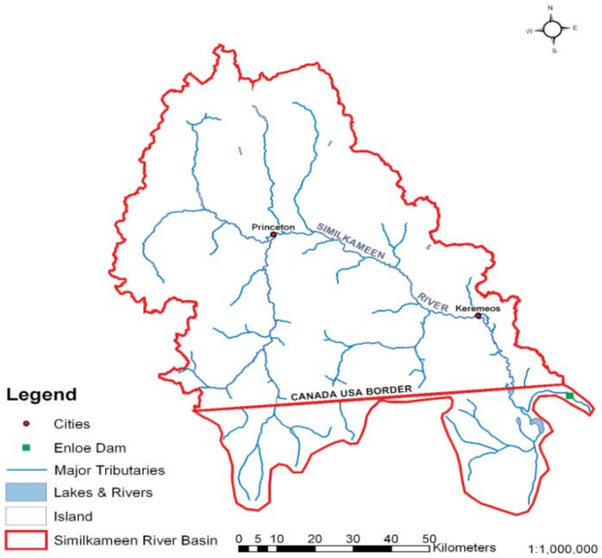
Background & History

- Similkameen Watershed Plan

Background & History

- The Similkameen is a special river:
  - Hydrology – “Interior with Coastal elements”
    - Located in the rain shadow of the Coast and Cascade Mountains
  - An international river
  - No major storage structures
  - Only small lakes/reservoirs



Background & History

- The Similkameen watershed is traditional territory of Okanagan Nation

- Governments:
  - Village of Keremeos
  - Town of Princeton
  - Regional District of Okanagan-Similkameen
  - Lower Similkameen Indian Band
  - Upper Similkameen Indian Band
- 6 major irrigation and improvement districts plus other smaller water purveyors
  - Both **surface water and groundwater** sources used

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Why a watershed plan?

- Started with Similkameen Valley Planning Society's Strategy for a Sustainable Similkameen (2010)
- **Strategic Means #7:**
  - Significantly improve water management including ability to adapt to climate change
- Scoping Study completed 2011
- Gas Tax funding enabled it to begin
- *Water Sustainability Act* coming 2016

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Similkameen Watershed Plan

- Goal of the watershed plan:
  - Guidance to help make more informed and integrated decisions
  - A **non-regulatory** plan – to be integrated into other local plans, bylaws, policies & Best Management Plans
- Phased approach to the development of the plan
  - Phase 1 – Background information review (2013)
  - Phase 2 – Technical assessments (2014-2015)

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Similkameen Watershed Plan

- Technical and Stakeholder Advisory Committee guidance
- Terms of Reference struck in October 2012
- Part 1 – "State of the Watershed" (2014)
- Part 2 – Technical Studies to fill gaps (2015)

SIMILKAMEEN RIVER WATERSHED
Backgrounder #6 Climate Change and Hydrological Implications

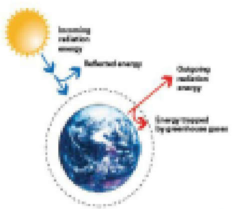
Background – Climate Change

The Greenhouse Effect
When the sun's radiation enters the Earth's atmosphere, some of the energy is reflected back into space, while the rest passes through the atmosphere and is absorbed by the Earth's surface. The Earth radiates some of this energy back into space, while a portion of the energy is absorbed by certain molecules (i.e. greenhouse gases) in the atmosphere. Greenhouse gases include carbon dioxide (CO_2), water vapour, methane (CH_4), nitrous oxide (N_2O), and ozone (O_3).

The absorbed energy creates an insulating layer over the Earth's surface, similar to a greenhouse. As more greenhouse gases are emitted into the atmosphere, they absorb and re-emit more heat, warming the planet.

Climate change refers to the alteration of long-term weather patterns such as temperature and precipitation, and the increased variability in weather events. Measures of climate change include changes in air temperature, changes in the amount and distribution of rain, snow, and ice, and increases to extreme weather events such as heat waves, heavy rainfalls and related flooding, droughts, and forest fires.

Earth's climate can be affected by natural factors such as volcanic activity, solar output, and the Earth's orbit around the sun. Human activities also influence climate through the burning of fossil fuels, which leads to increases in carbon dioxide levels in the atmosphere. Carbon dioxide and other greenhouse gases have been identified as one of the main causes of human-induced climate change.


The Greenhouse Effect (adapted from www.livesmartbc.ca)

To address climate change, the United Nations established the Intergovernmental Panel on Climate Change. This international body is made up of thousands of scientists that provide the world with clear scientific information on climate change and potential environmental and socio-economic impacts. Most of our knowledge of global change comes from General Circulation Models (also known as GCMs). These are numerical models that represent the physical processes in the atmosphere, ocean, ice and land surfaces and are able to simulate the response of the global or regional climate system to increases in greenhouse gas concentrations.

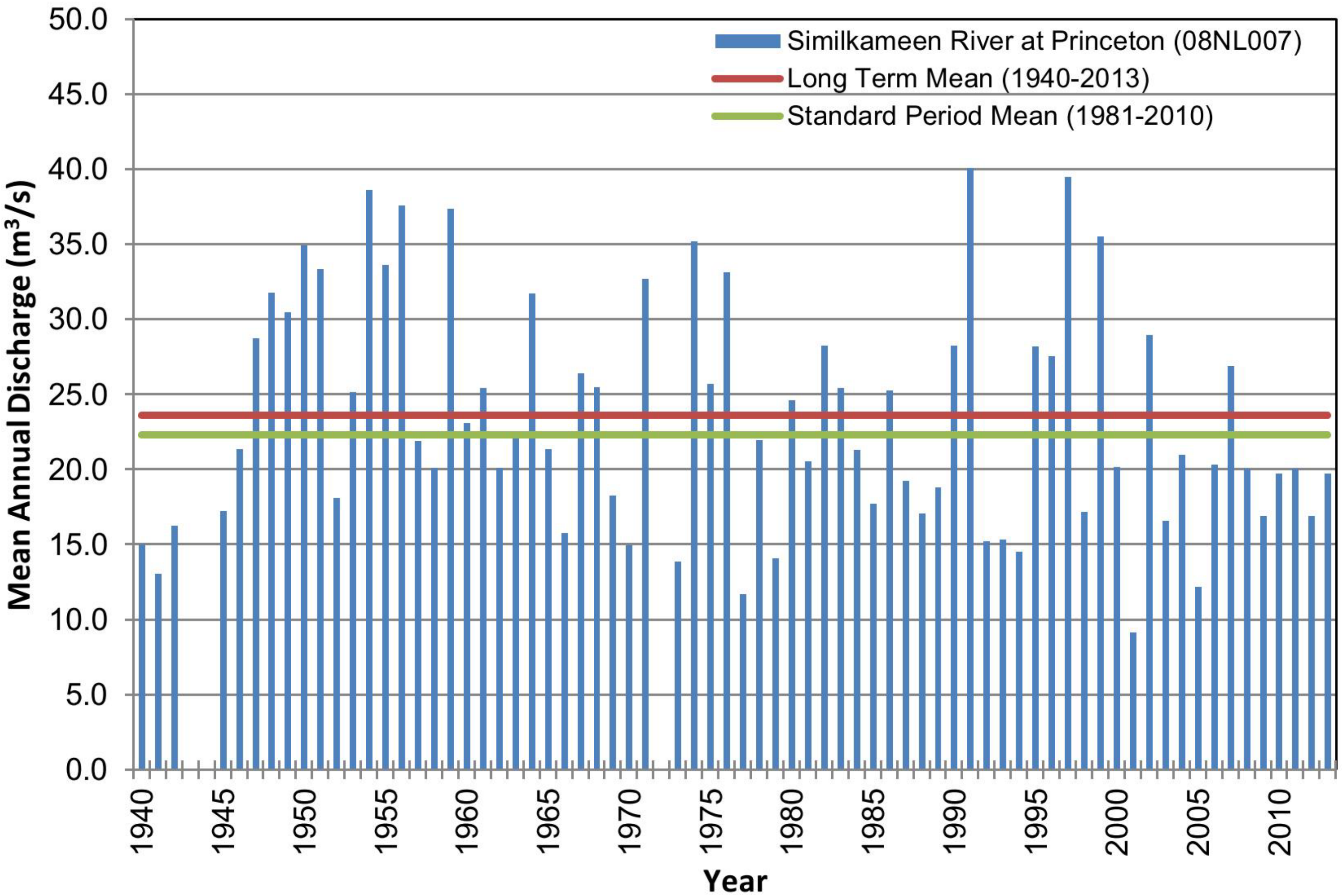
General Climate of the Similkameen River Watershed

The Similkameen River watershed is located in the rain shadow of the Coast and Cascade Mountains. The climate across the watershed varies, but it is generally characterized by warm summers and cool winters, with a relatively even distribution of precipitation throughout the year. The western section of the watershed is generally cooler and moister, while the southeastern section is warmer and drier. The coldest months are December and January and the warmest months are generally July and August. The highest temperature recorded in the watershed is 41.7 °C and the coldest temperature recorded is -42.8°C (recorded by Environment Canada at Princeton).

Key Issues & Questions

- **Water demand** during low flows, and **potential for conflict** (near future and medium term)
- **Climate change** effects and drought frequency
- **Environmental Flow Needs** (EFN - fish, traditional uses, & ecosystem services)
- **Surface water quality** and effects (mining, land development, agriculture, etc…)
- **Groundwater quality** trends (e.g. nitrate)
- **Groundwater – surface water interaction**

Flows Variable and may be Changing



Similkameen River at Princeton (WSC 08NL007)

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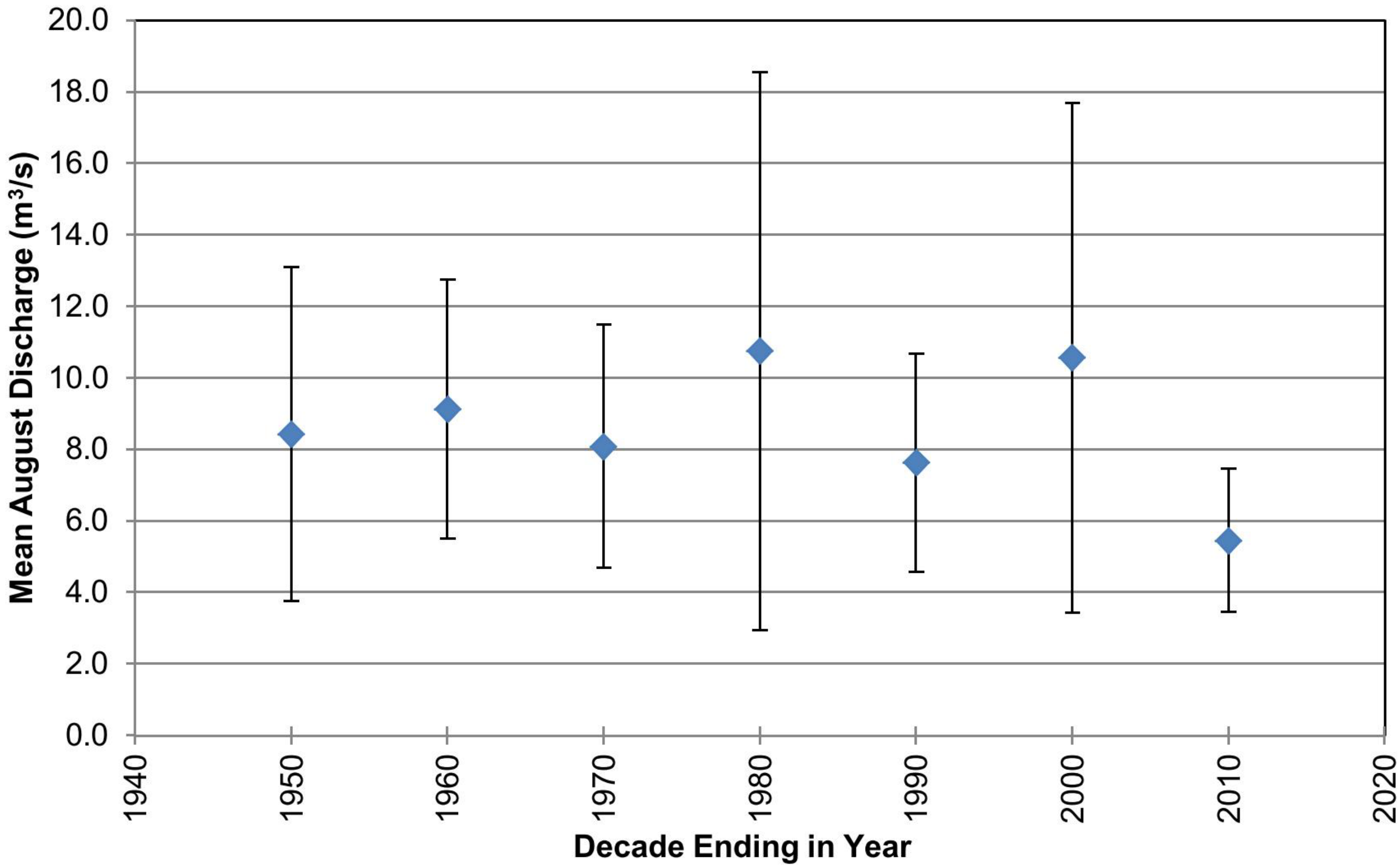
Is there a trend towards lower flows?



Similkameen River at Princeton (WSC 08NL007)
Mean August Decade Discharge ±1 Standard Deviation

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Similkameen Watershed Plan

- Phase 2 of the plan (June 2015):
  - Technical studies to fill high priority gaps identified during Phase 1
  - 3 high-priority technical studies
    - Water Quality Status and Trends Analysis
    - Water Availability Assessment
    - “Desktop” Groundwater –Surface Water Interaction Assessment

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Water Quality Status & Trends

- Similkameen Watershed Plan

Water Quality Task Objectives

- Obtain an up-to-date understanding of **surface water quality** in the Similkameen watershed, including:
  - How water quality compares to guidelines;
  - How water quality varies in the watershed; and
  - Whether or not water quality is changing over time

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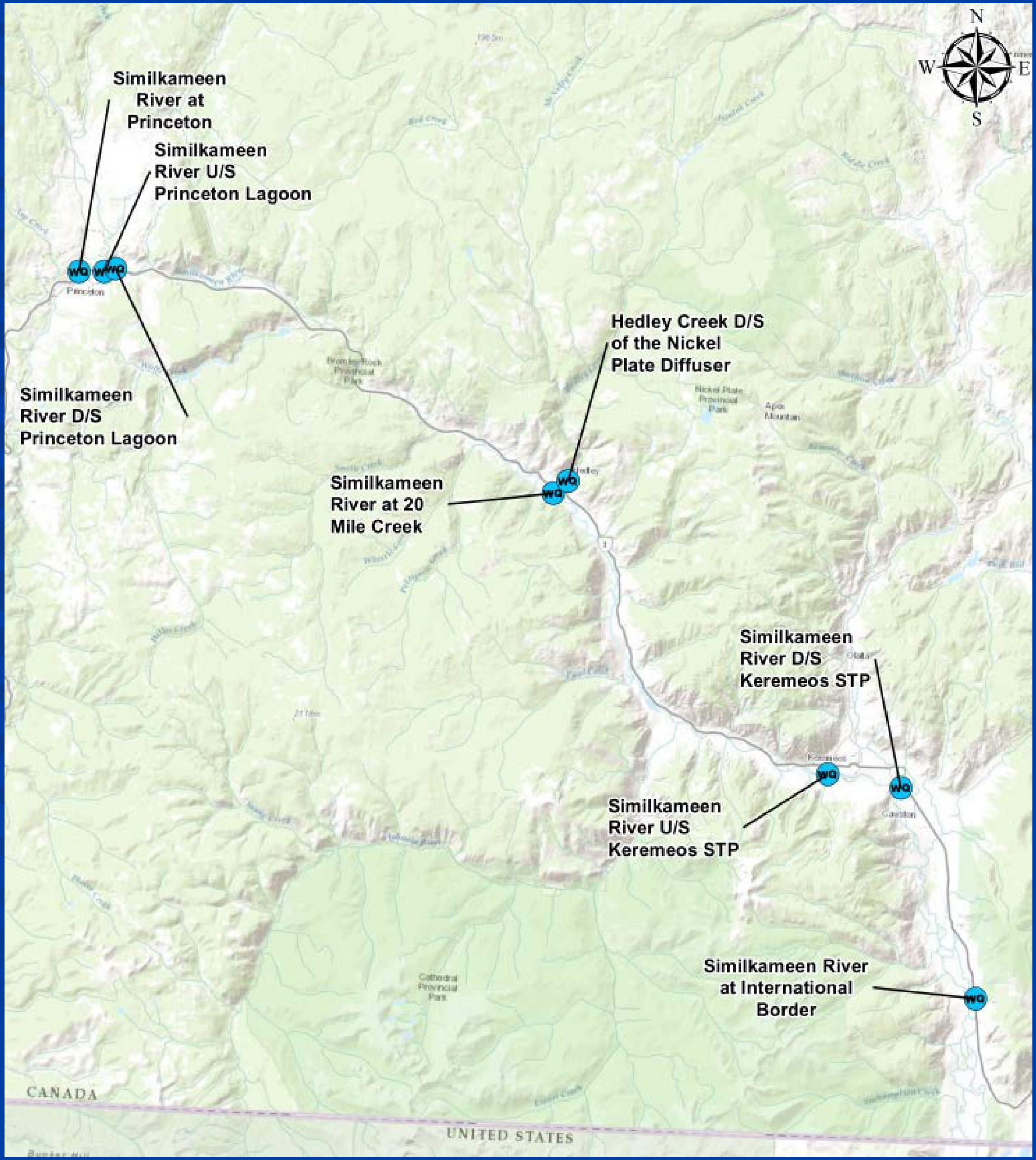
Water quality monitoring sites included in study



Water Quality Status

- Water quality of the Similkameen River is generally good.
- Water quality was similar between all sites.
- Notable exception: higher average concentration of total metals at the International Border site compared with Princeton.

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Water Quality Status

- Concentrations occasionally exceed B.C. Water Quality Guidelines and/or Similkameen Water Quality Objectives for:
  - Temperature
  - Colour
  - Turbidity
  - Dissolved oxygen
  - Fecal coliforms
  - Aluminum
  - Chromium
  - Copper
  - Iron
  - Manganese

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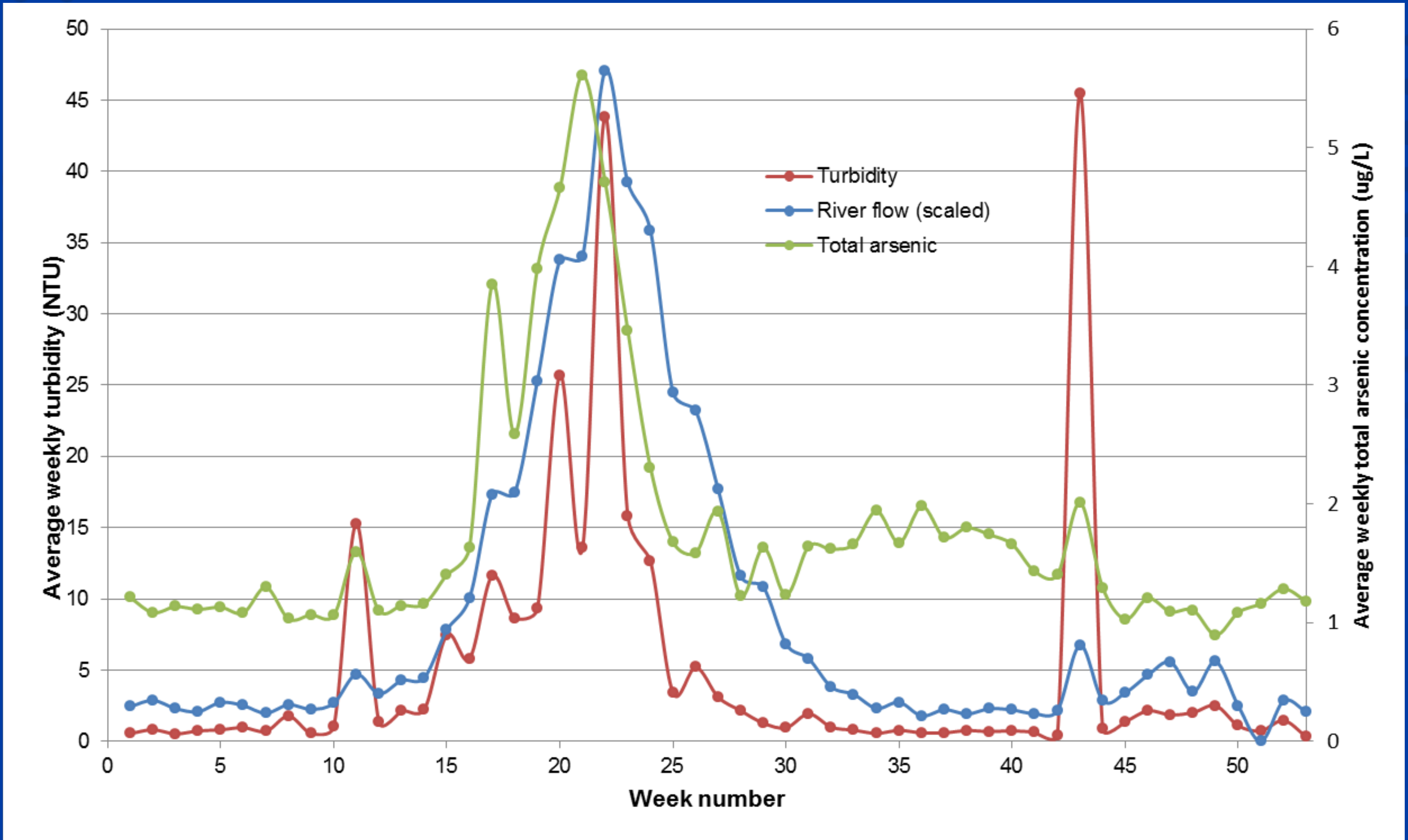

Turbidity
River flow (scaled)
Total arsenic
Average weekly turbidity (NTU)
Average weekly total arsenic concentration (ug/L)
Week number
0
5
10
15
20
25
30
35
40
45
50
0
1
2
3
4
5
6
0
5
10
15
20
25
30
35
40
45
50

Changes in Water Quality Over Time

- Increasing trends:
  - Total nitrogen, total dissolved nitrogen, and turbidity (both sites)
  - Total arsenic (Princeton only)
  - pH (International Border only)
- However,
  1. Magnitude of trend is slight
  2. Water meets the guidelines most of the time

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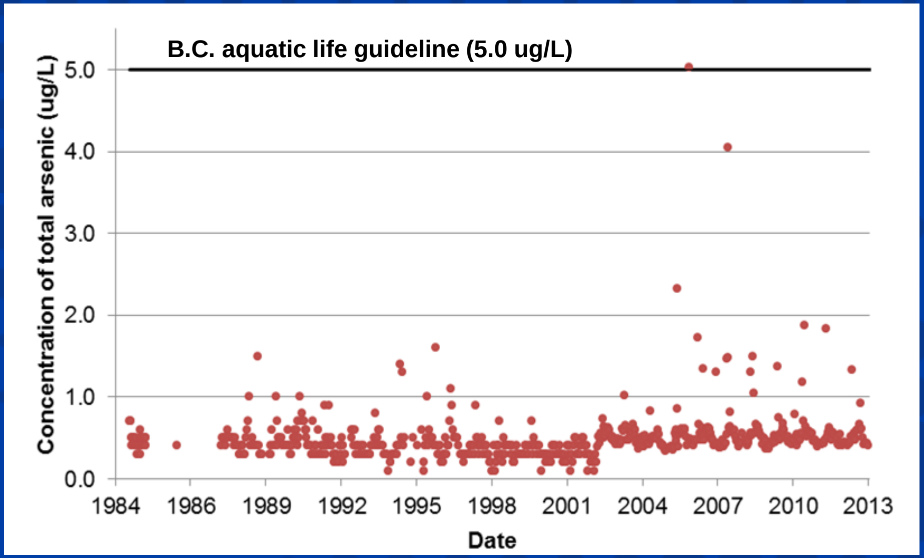
Changes in Water Quality Over Time

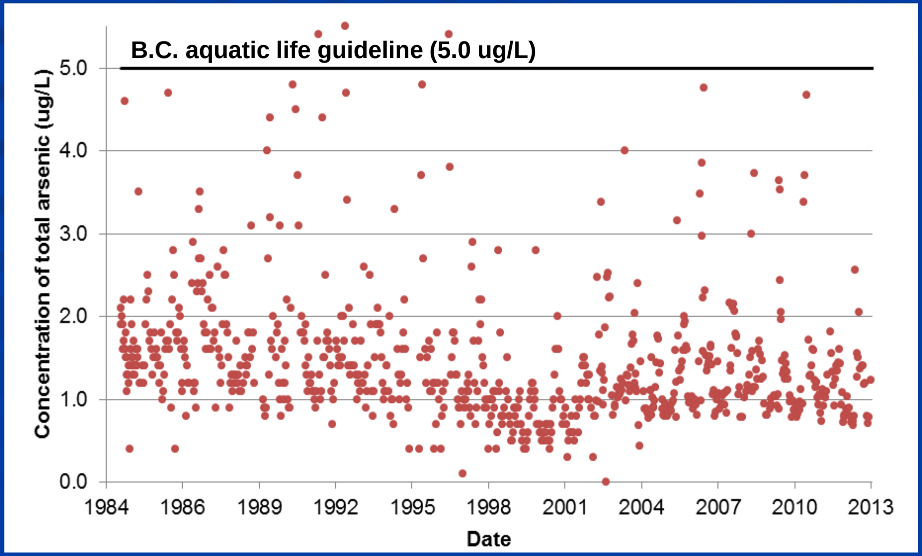
- Decreasing trends:
  - Aluminum, copper, iron, & zinc (both sites)
  - Arsenic (International Border only)
  - Hardness (International Border only)
- River flow & water temperature
  - Temperature has either stayed the same or decreased.
  - Similkameen River flow at Princeton decreased slightly since 1945
  - No trend in 1981-2013 data or in critical low flow months of August and September.

Magnitude of trends is slight:



↑ Arsenic (total) at Princeton water quality monitoring site

↓ Arsenic (total) at International Border water quality monitoring site



Other Water Quality Findings

"Upstream - Downstream"

- River WQ tested upstream & downstream of Princeton & Keremeos WWTPs
- No difference detected for most parameters
- Slight increase in nitrate at Keremeos
- But, not tested since 2000

Nickel Plate Mine

- Hedley Creek downstream of the mine generally good.
- Exceedances included cyanide and aluminum
- Cyanide used in mill at mine
  - 95th percentile - 0.23 µg/L
  - Drinking water guideline & objective – 0.20 µg/L

Water Availability Assessment

- Similkameen Watershed Plan

Water Supply Task Objectives

- Develop estimates of natural (or naturalized) flow at selected points-of-interest (POI)
- Compare Ministry of Agriculture's Agriculture Water Demand Model results to supplier records
- Assess future demand scenarios
  - Climate change
  - Changes in agriculture land use area
  - Changes in crop types

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Why Do We "Naturalize" Flows?

- Terminology
  - **Net Flows** – streamflows that include water extractions and storage effects occurring upstream
  - **Naturalized Flows** – estimates of natural flows adjusting net flows for the effects of water withdrawals and storage
- Naturalize to determine:
  - Effect of withdrawals under average, high & low flow periods
  - Characterize natural temporal patterns of flow – especially how low flows compare to licensed volumes
- Naturalized flow is the starting point for determining Environmental Flow Needs (EFN) for aquatic life

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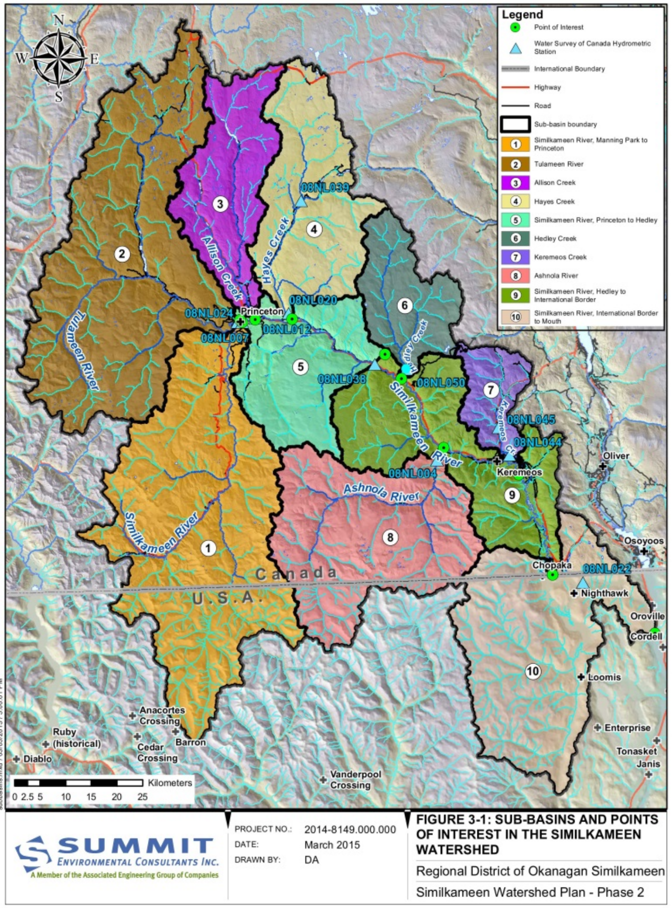
Surface Water Quantity

- 10 POIs (based on selected sub-basins)
  - Similkameen River at Princeton
  - Tulameen River at Princeton
  - Allison Creek at the Mouth
  - Hayes Creek at the Mouth
  - Similkameen River near Hedley
  - Hedley Creek at the Mouth
  - Keremeos Creek at the Mouth
  - Similkameen River at International Border
  - Similkameen River at the Mouth
- Adopted a standardized period of record (1981-2010)
  - Current water use statistics, current climate "normal" period



Water Use – Surface & Groundwater

- Total of 831 current licences (at 690 points of diversion) are issued on streams, springs, and lakes (in Canada)
  - Issued for:
    - Waterworks
    - Irrigation
    - Domestic
    - Stockwatering
    - Enterprise
    - Mining
    - Snow making
    - Processing
    - Storage
    - Conservation

- Actual water use information from purveyors – surface & groundwater use
- Compare to Agricultural Water Demand Model

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Water Purveyor Use

- The majority of purveyors are using groundwater as their main supply source
  - Missezula and Osprey Lake Waterworks Districts and Apex Mountain Resort use surface water source
  - Similkameen Improvement District manages Nickel Plate Lake to release water during August – October to supplement Hedley Creek flows for downstream users
  - LSIB and USIB mainly using groundwater
- Largest water use is generally in the summer months to meet irrigation demand requirements.
- Available water use records from purveyors range from 1991-2010 with either monthly or annual information

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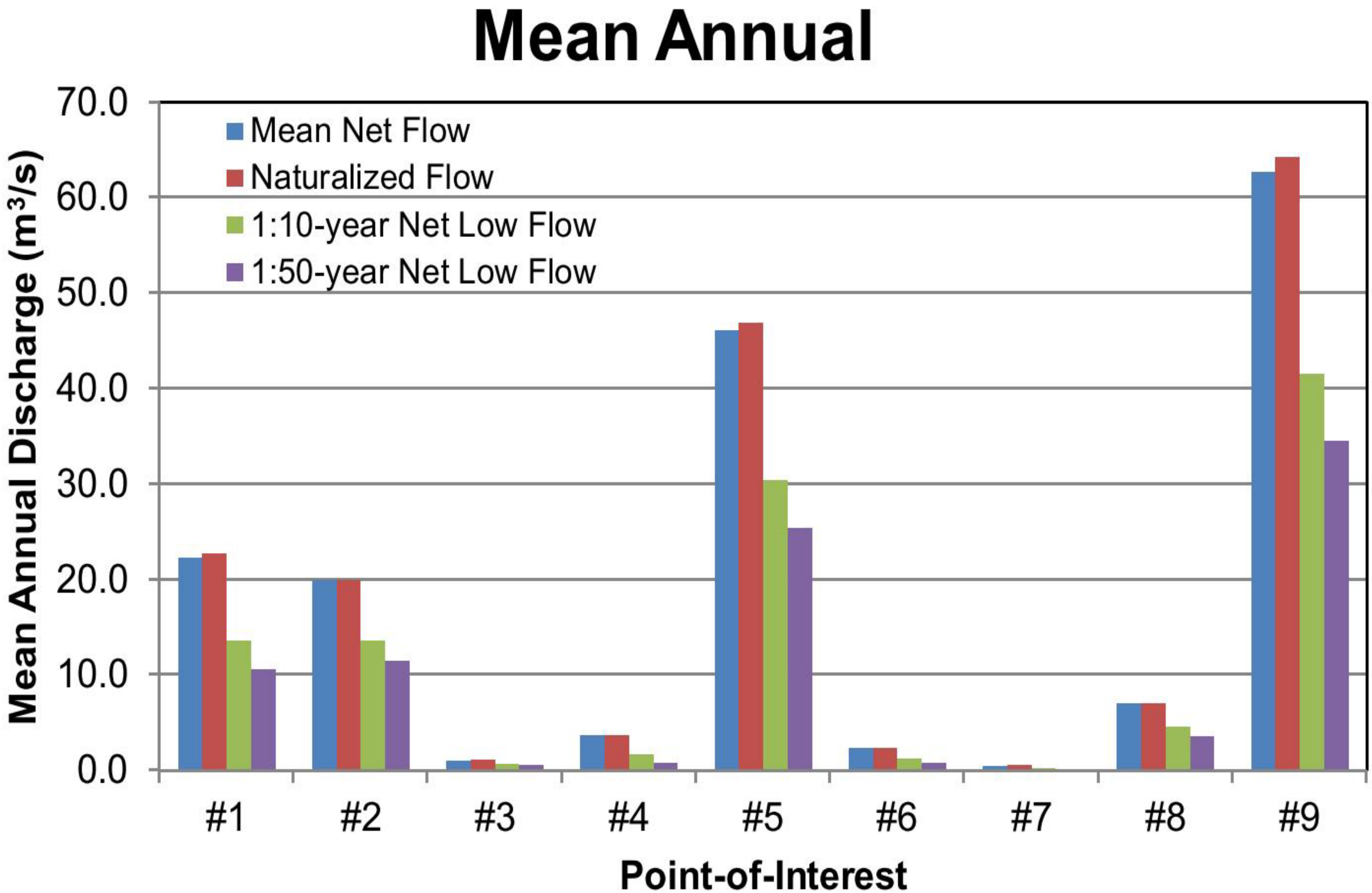
Net, Naturalized, and Low Flows



Results - Water Supply Assessment

- Total water use in most sub-basins is small in comparison to naturalized flow
  - Exception is Keremeos Creek – high surface water and groundwater use that may be influencing streamflows
- Flows in dry years drop off significantly from average years
  - Water use is higher, but most low flow years are explained by natural processes
  - Indicates that the Similkameen River is sensitive to climatic variation, like most semi-arid region rivers

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Water Availability Risk - Current

Risk – Inability of surface water to meet human requirements under median conditions

- High Risk – Keremeos Creek, Allison Creek
- Moderate Risk – Lowest part of Similkameen near U.S. border
- Low Risk – all other sub-basins

Agriculture Water Demand Model

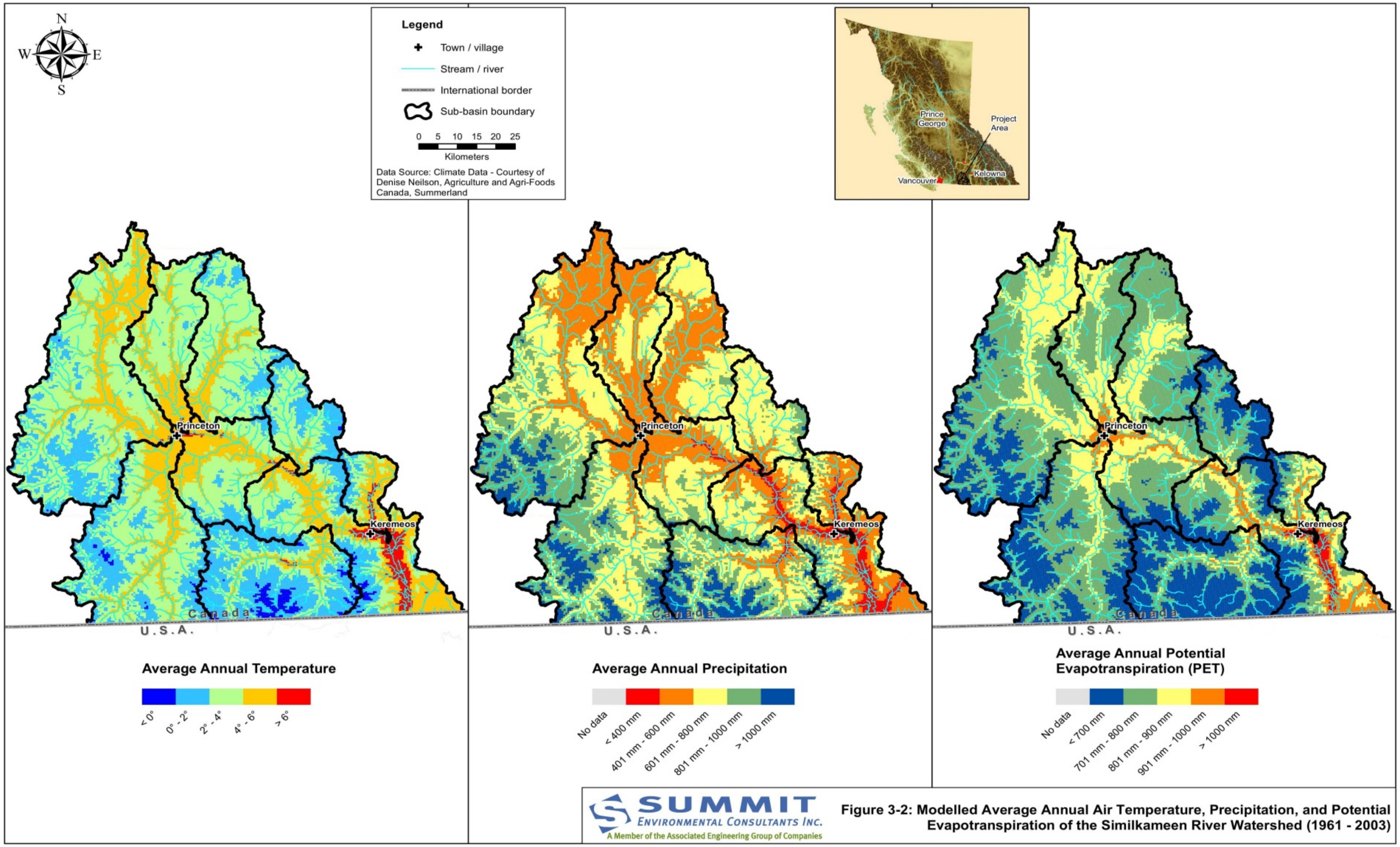

Figure 3-2: Modelled Average Annual Air Temperature, Precipitation, and Potential Evapotranspiration of the Similkameen River Watershed (1961 - 2003)

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Future Water Demand Scenarios

- Future water demands were predicted for 2011-2070 using the AWDM
  - 3 future scenarios considered using three different climate models (wet, dry, and average)
    - Scenario 1 – No land use change, consider climate change only
    - Scenario 2 – Irrigate all available lands and potential agricultural lands
    - Scenario 3 – No change in agricultural area but Increase grape crop land base by 6% (over 3 years)
- Comparison of scenario results to 1981-2010 water demands

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Results - Future Water Demand 2070

- **More demand** for water and a **more variable supply**
- Scenario A (climate change) – annual agriculture demand increase 16-28% overall; 12-20% in Keremeos Creek
- Scenario B (more agriculture) – 16% increase over Scenario A; 5% increase in Keremeos Creek
- Scenario C – (more grapes) reduced water demand compared to A and B

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Groundwater – Surface Water Interaction

- Similkameen Watershed Plan

GW-SW Task Objectives

- Is groundwater pumping reducing flow in the Similkameen River?
  - Examine positions of wells and hydrometric stations, to find opportunities to compare upstream and downstream changes in discharge.
  - Assess changes in groundwater levels over time using observation well data.
- Summarize groundwater quality data
- A “desktop” study

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Groundwater – Surface Water Interaction

- Only limited previous work, and only at Keremeos
- Valley bottom aquifers are **hydraulically connected** to the streams
- Streams may either:
  - gain water from groundwater (“gaining stream”);
  - lose water to groundwater (“losing stream”)

Identifying Key Locations

- Identified key locations using number of registered wells that met screening criteria:
  - ≤6-inch diameter and located within100 m from a stream
  - >6-inch diameter and located within 300 m from a stream
- About half of all wells meet criteria – these wells potentially affect streamflow

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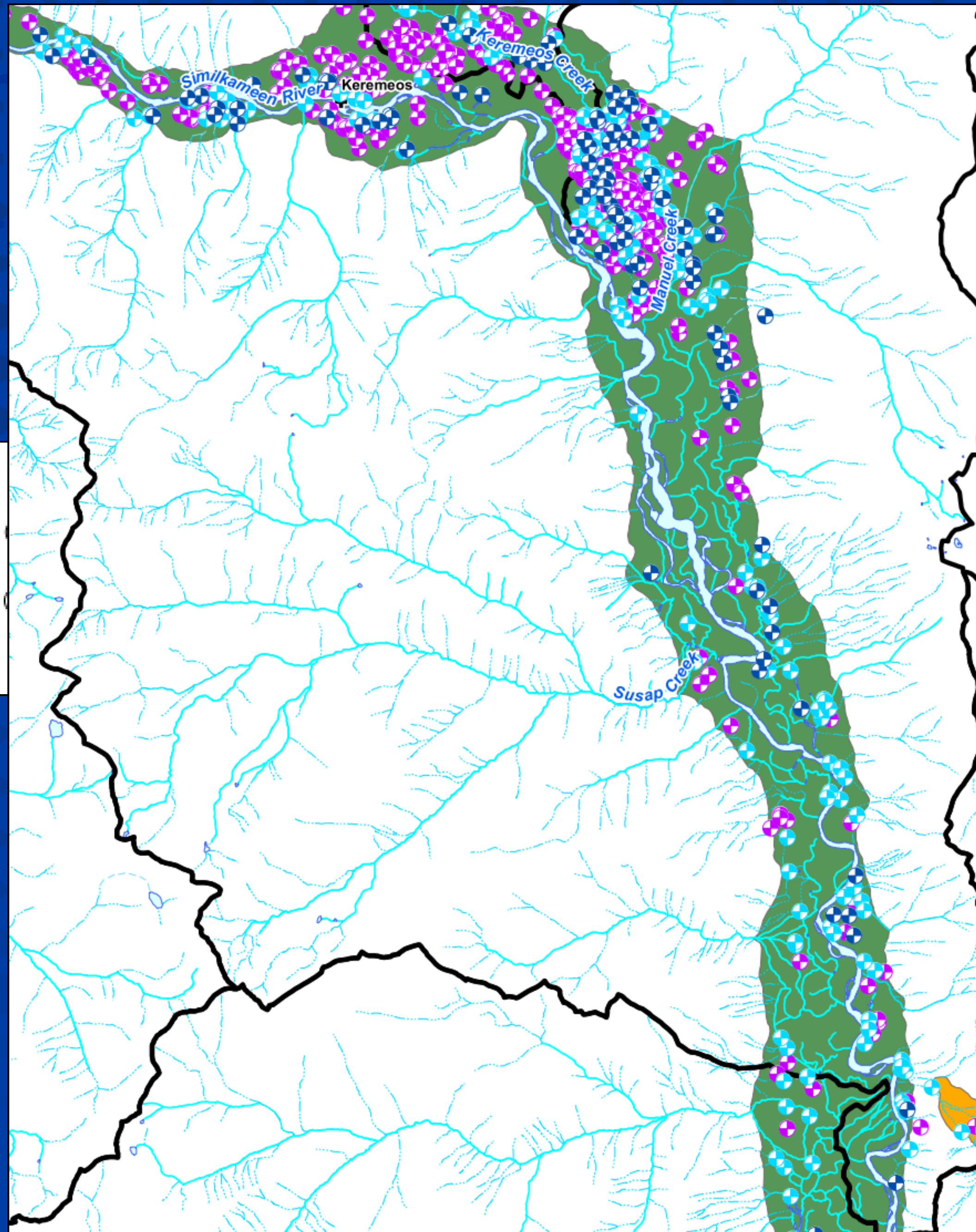

Legend

- Ground water wells > 6 inch (… of a stream)
- Ground water wells ≤ 6 inch (… of a stream)
- Ground water wells other

Groundwater – Surface Water Interaction

- Limited hydrometric information at key locations
- Keremeos Creek
  - Decrease in flow between upstream and downstream hydrometric stations (1971-1977)
  - Zero flow recorded at downstream station (Sept 1973)
  - MOE investigated zero flow (2001)
- Identified as a target location for further studies
  - Naturally a “losing stream” or from groundwater pumping?

Change in Groundwater Levels Over Time

- Trend analysis: Are groundwater levels decreasing over time?

Observation Well No.	Period	Trend analysis results
75 (Keremeos)	1963 - 2014	**Downward**
	2000 - 2014	**Upward**
203 (Cawston)	1977 - 2012	**Downward**
	2000 - 2012	None
220 (Princeton)	1977 - 2000	**Downward**

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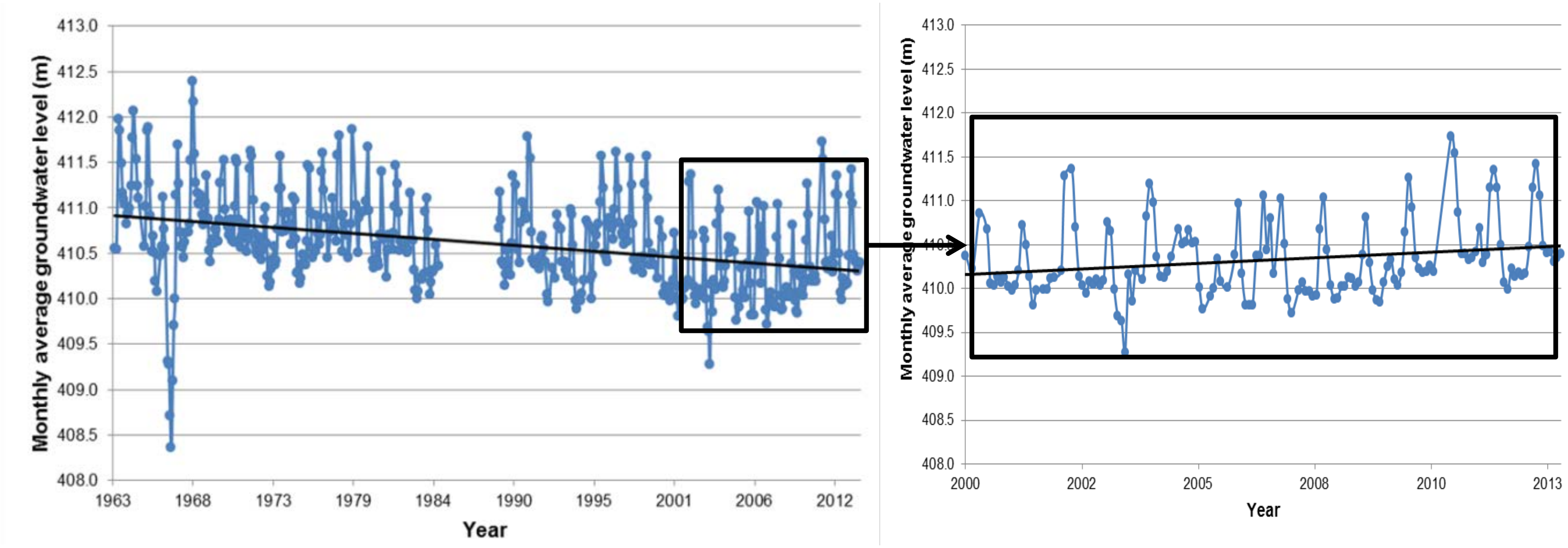
Keremeos – Some good news?

- Trend analysis: Changes in recent years

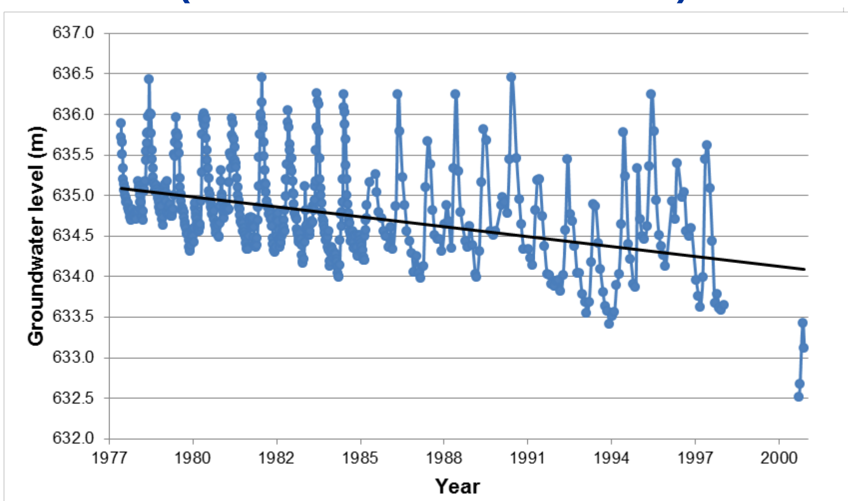


Keremeos Observation Well No. 75

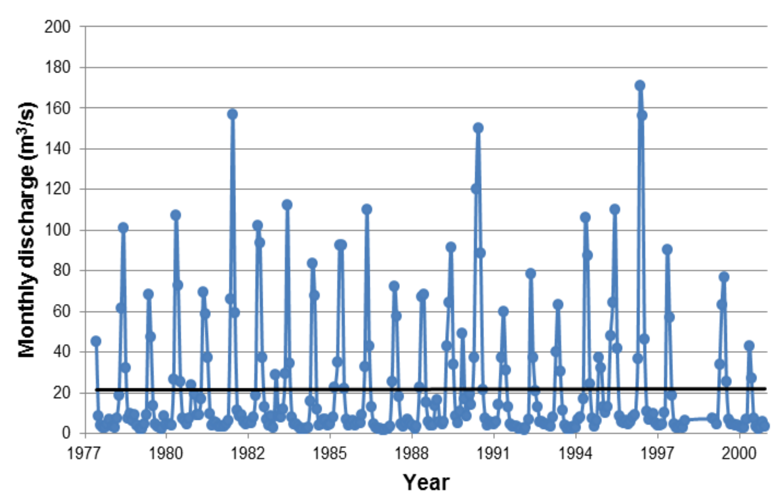
Princeton 1977-2001

- Cause of decreasing trend:
  - Likely due to groundwater use (pumping)
  - Climate: would expect to see similar pattern in river discharge

Groundwater levels 1977 – 2001 (Princeton Observation Well)



River discharge 1977 – 2001 (Similkameen River at Princeton)



Groundwater - Surface Water Key Findings

- Groundwater use is relatively small compared to streamflows, except in Keremeos Creek
  - <10% average, <20% in 1:50-year low flow
- Keremeos Creek recharges underlying aquifer – rate of GW pumping similar to stream recharge
- Although small, could influence fish habitat in some locations (EFN study recommended)
- Water conservation appears to help sustain flows
- But, we have limited data away from Keremeos

Take Away Messages

Water Quality

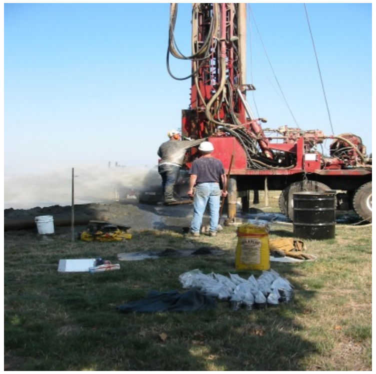
- Water quality of the Similkameen River is generally good, but river is sensitive to change
- Fortunate to have on-going monitoring – keep it going!
- Some significant trends noted, but amount of change is slight
- Historic effects of mining may be diminishing
- Some indication of above-background nitrogen

Water Availability and Use

- The majority of purveyors are using groundwater as their main supply source
- High risk that current demand not met by supply in Keremeos & Allison Creeks; Moderate in lowest part of Similkameen near border; Low elsewhere
- Future – more demand; more year-to-year variability in supply
- Demand projected to increase 16-28% due to climate change; mostly from agriculture
- Increase in supply-demand gap mid-July to October

Groundwater – Surface Water Interaction

- Aquifer is connected to the river – “one source”
- About half wells in valley may be influencing streams
- Largest wells have replaced licensed surface withdrawals – net effect not yet studied
- GW use still relatively small part of streamflow, but estimates are rough
- MFLNRO issuing contract to develop water balance for aquifer in 2016



Next Steps

- Move towards a plan document with community input
- Additional groundwater studies needed
- Incorporate LSIB and USIB water use & demand
- Environmental Flow Needs study
- Assess other future demand scenarios

Thank you. Questions?