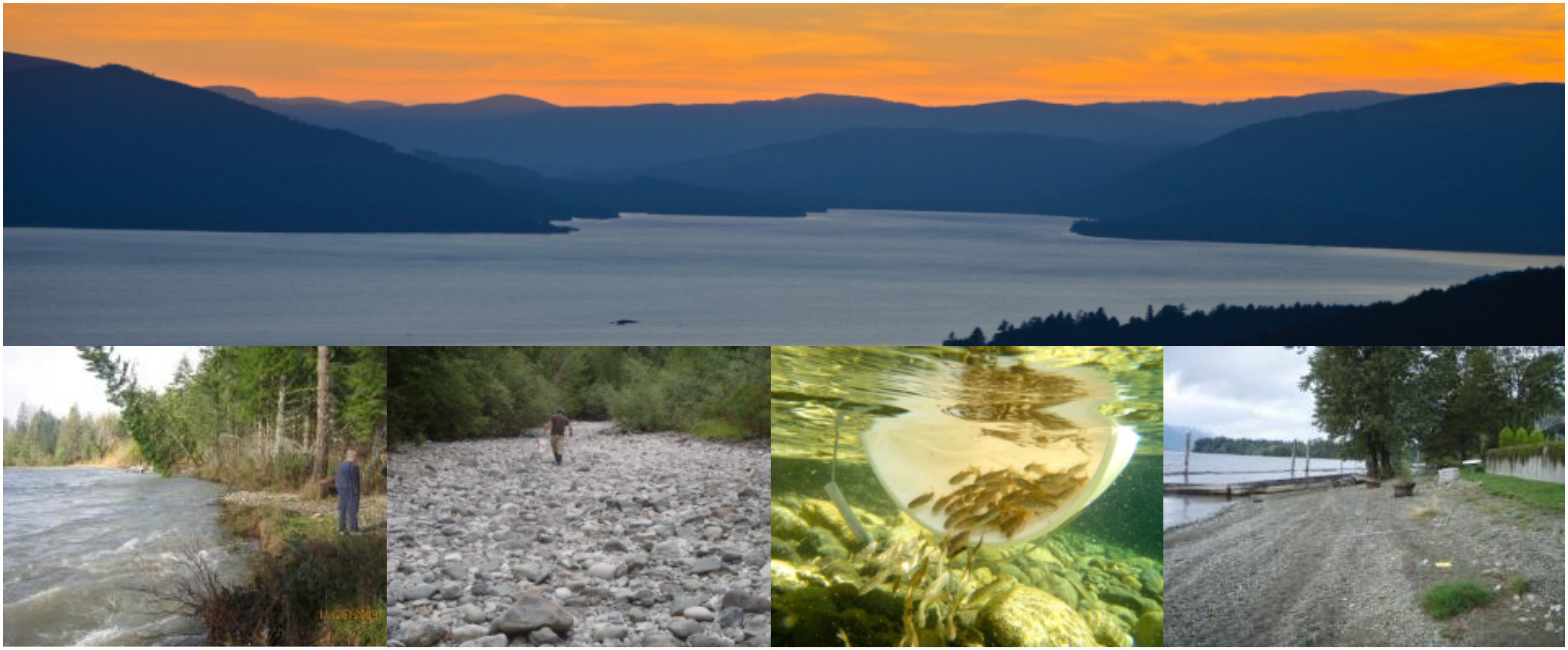


Cowichan Water Use Plan
Public Advisory Committee Meeting #1
Cowichan Water Management

November 22nd, 2017

A community planning initiative in partnership with:

CVRD

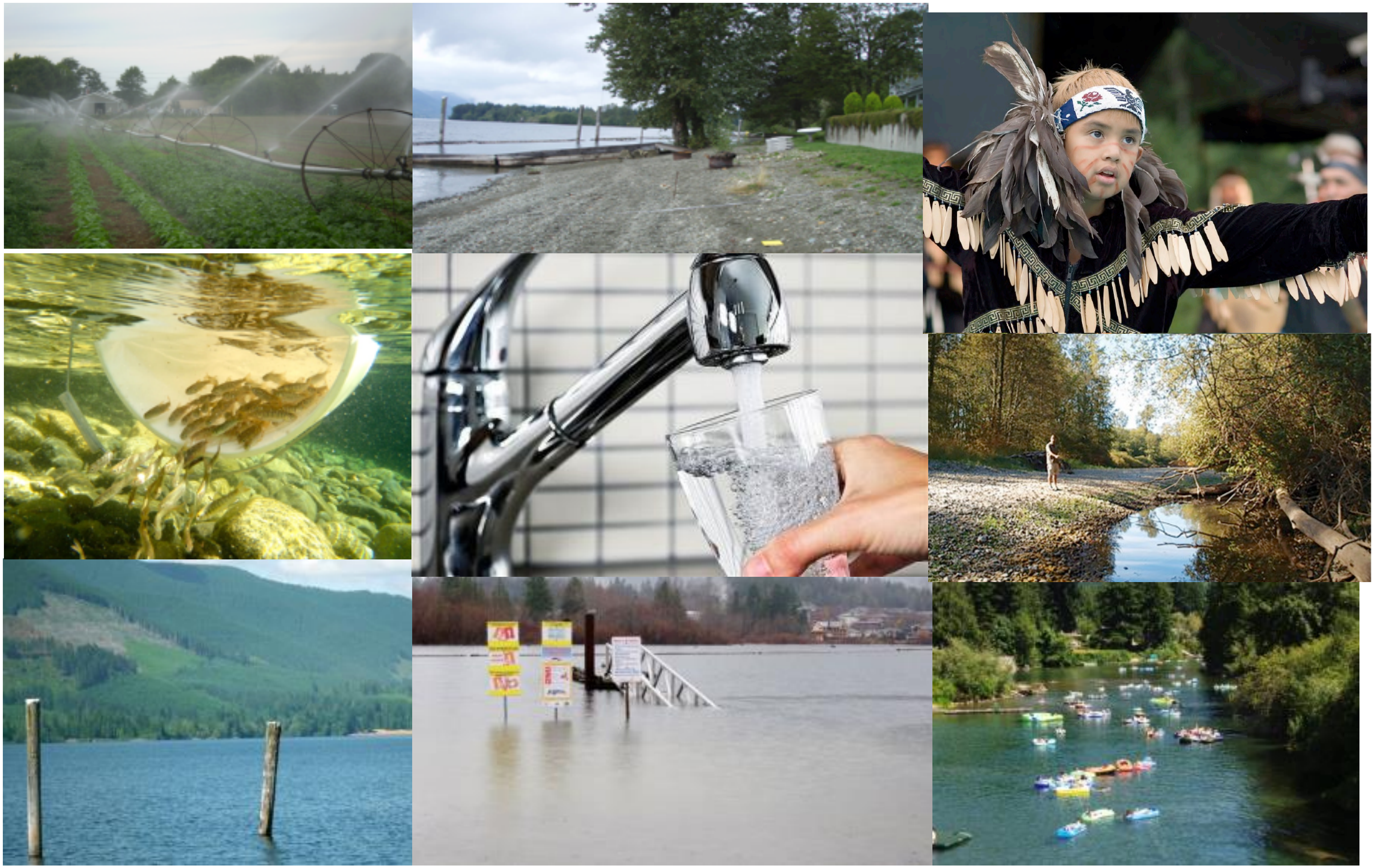
Cowichan Watershed Board

Catalyst

compass

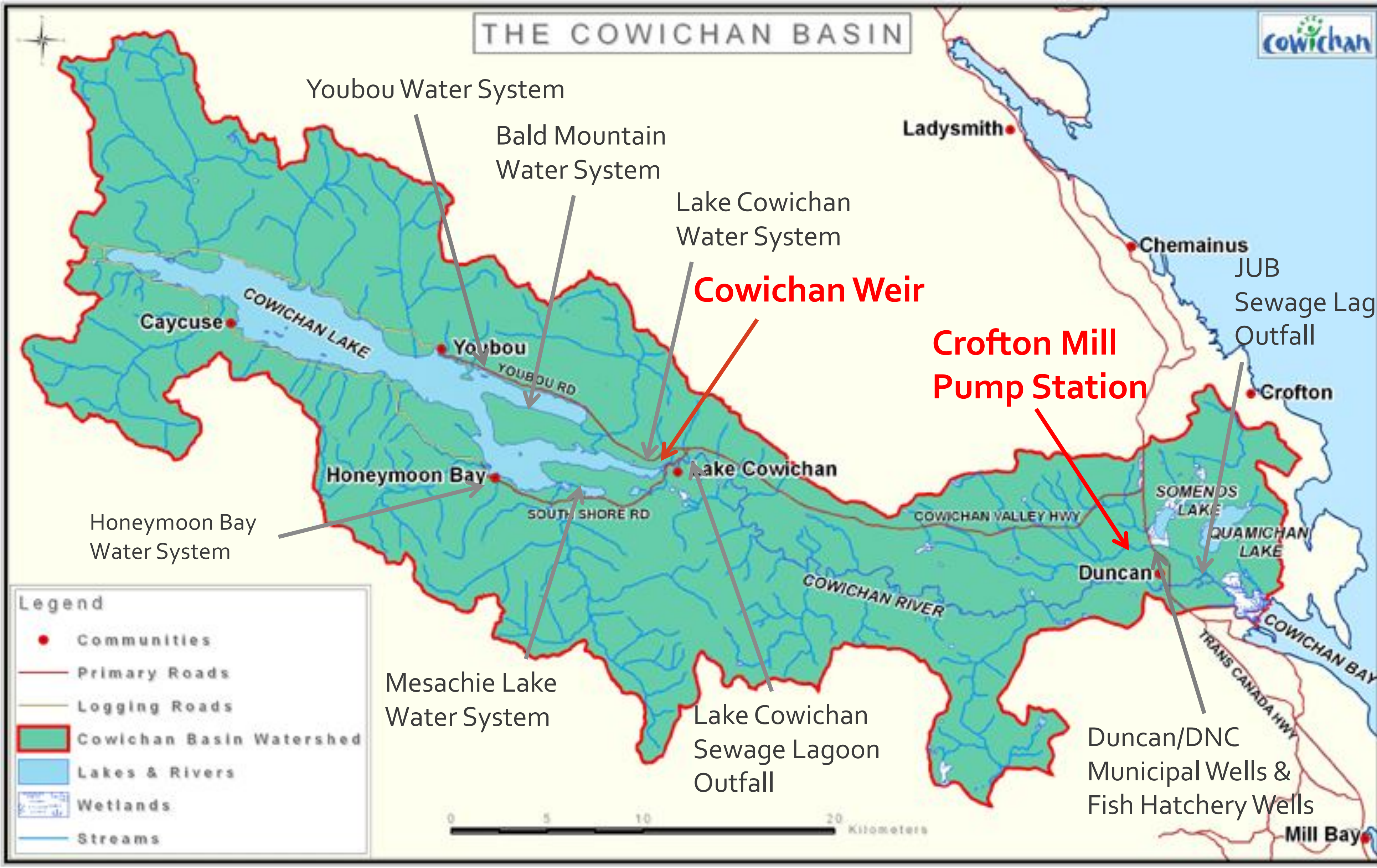
kwl

Cowichan Water Management



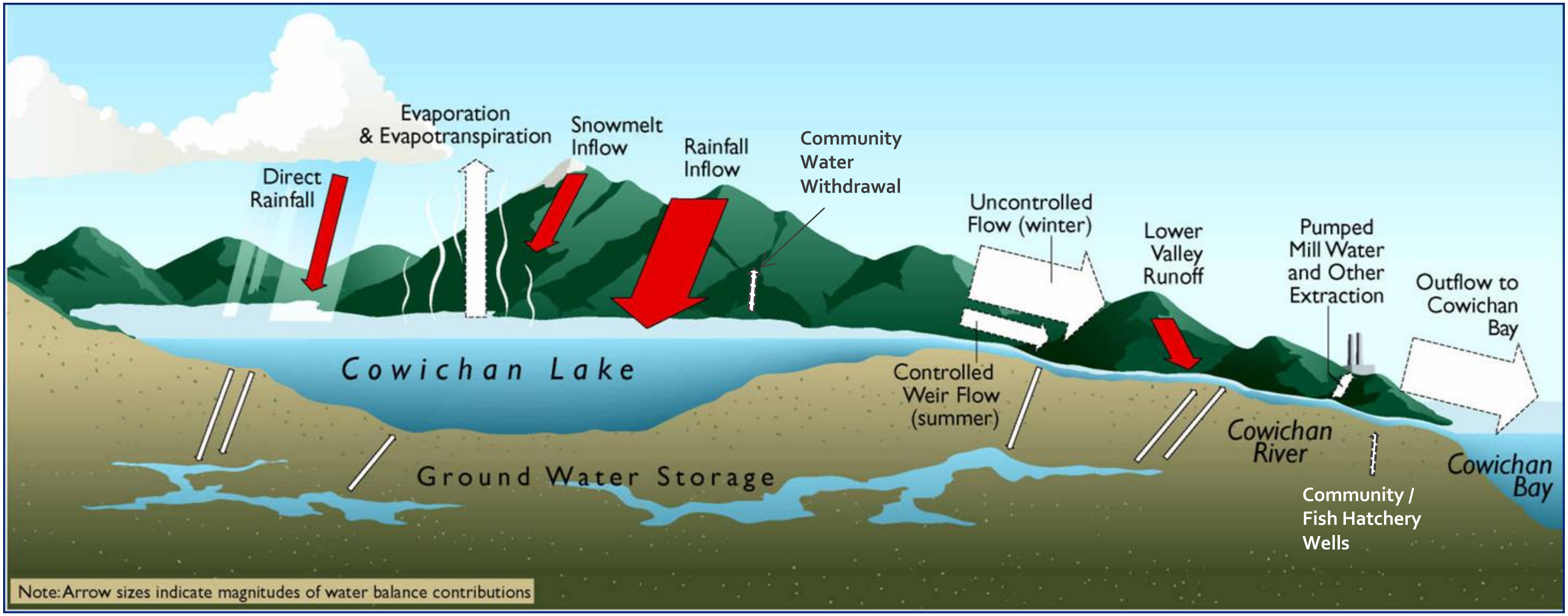
Cowichan Water Management

- Hydrology and climate change
- Water management system (weir)
- Modeling water use alternatives (methods and assumptions)
- Scope of the alternatives

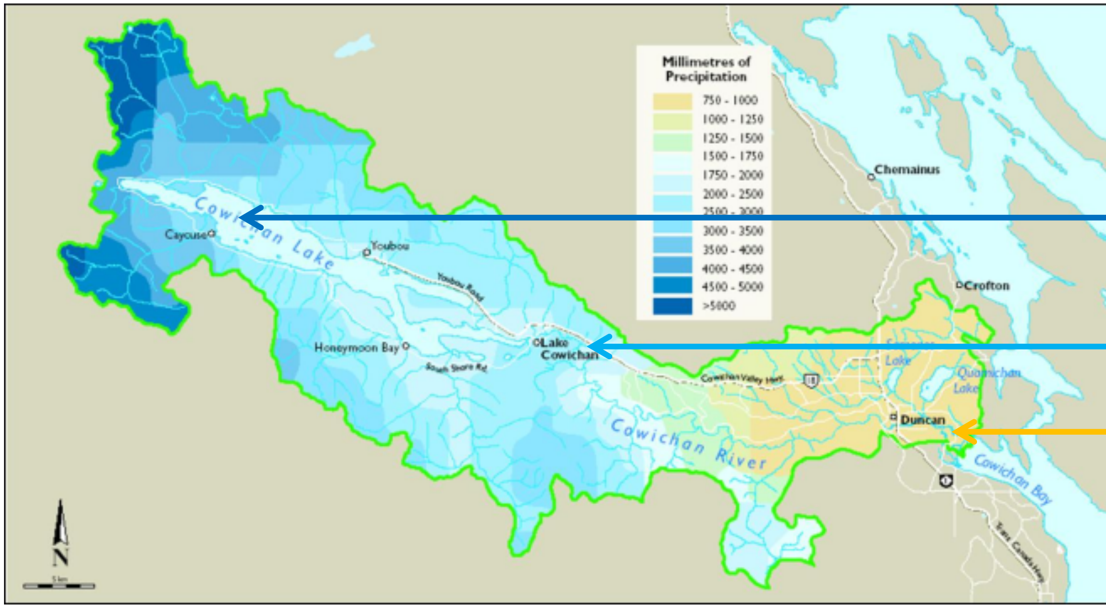


THE COWICHAN BASIN
cowichan
Youbou Water System
Bald Mountain Water System
Lake Cowichan Water System
Cowichan Weir
Crofton Mill Pump Station
JUB Sewage Lagoon Outfall
Ladysmith
Chemainus
Crofton
Caycuse
COWICHAN LAKE
Youbou
YOUBOU RD
Honeymoon Bay
Lake Cowichan
SOUTH SHORE RD
COWICHAN VALLEY HWY
SOMENOS LAKE
QUAMICHAN LAKE
Duncan
COWICHAN RIVER
COWICHAN BAY
TRANS CANADA HWY
Mill Bay
Honeymoon Bay Water System
Mesachie Lake Water System
Lake Cowichan Sewage Lagoon Outfall
Duncan/DNC Municipal Wells & Fish Hatchery Wells
Legend
Communities
Primary Roads
Logging Roads
Cowichan Basin Watershed
Lakes & Rivers
Wetlands
Streams
0 5 10 20 Kilometers

Cowichan Water Balance



Variation in Rainfall



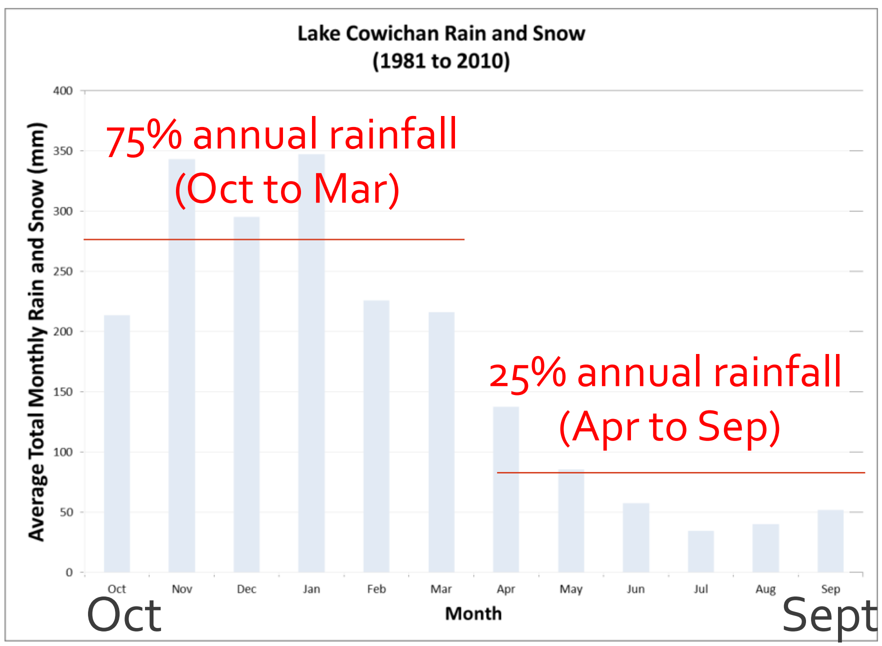
Total Annual Rainfall

Western Portion of Watershed - > 2,500 mm

Lake Cowichan – 2,050 mm

Duncan - 1,150 mm

We live in a rainforest…we have plenty of water….why are there water issues?



Variation in Flow and Demand

Winter | **Summer**

River Flow

River Flow (> 100 m^3/s)

River Flow (4 to 7 m^3/s)

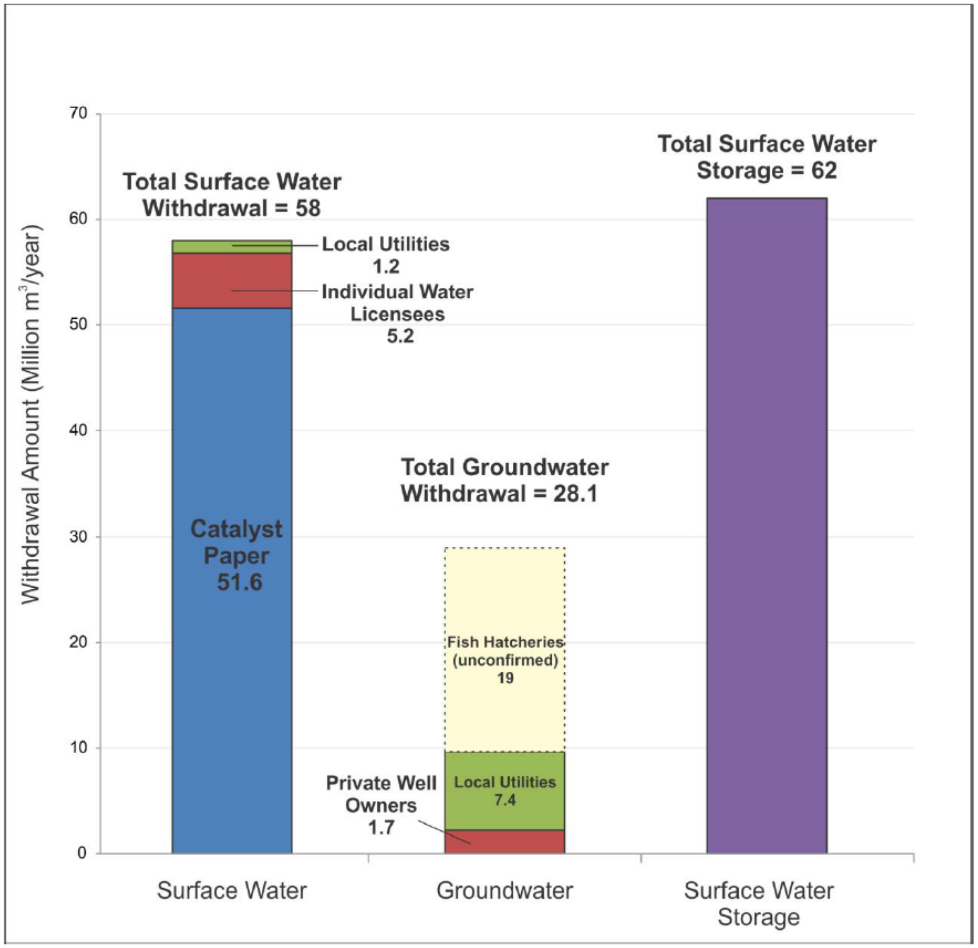
Water Demand

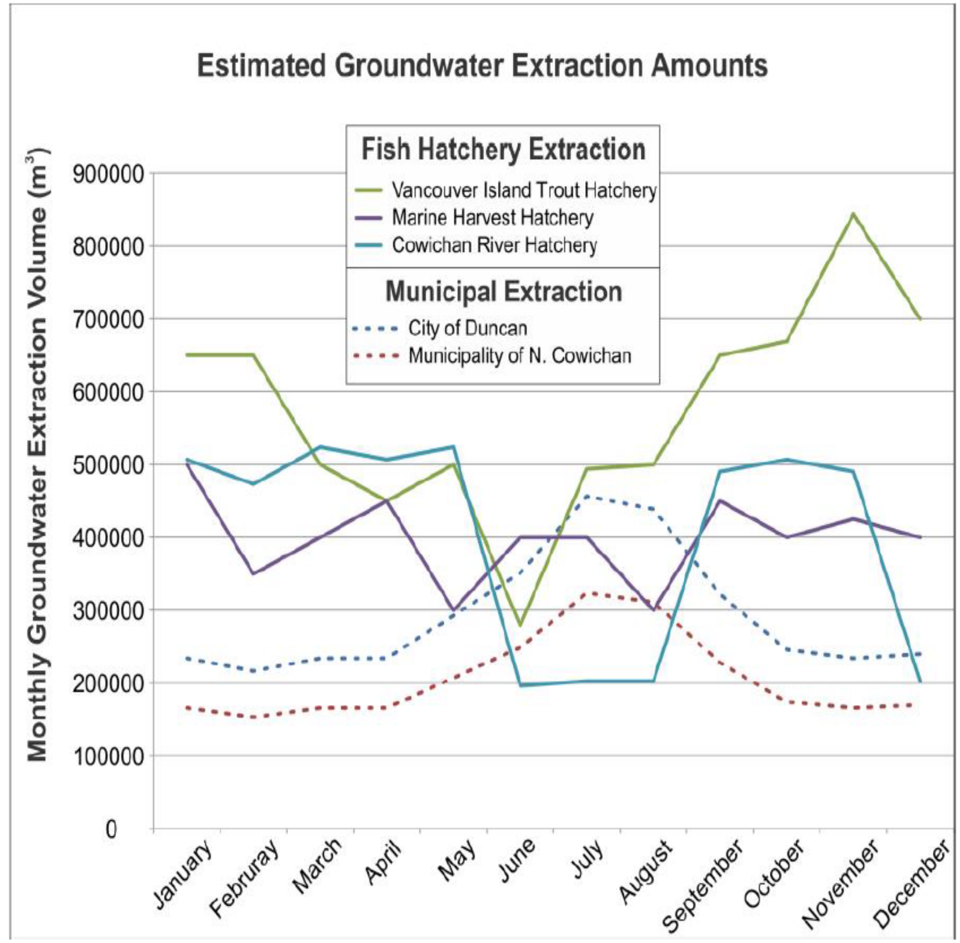
Community Demand

Irrigation + Community Demand

Fish Hatchery Wells

Water Use in the Cowichan





Source: Foster and Allen, 2015

<u>Crofton Mill</u>

~ 1.5 m^3/s constant

Water Licence 2.8 m^3/s

<u>Duncan/DNC well pumping rate</u>

Min. Winter = ~ 0.15 m^3/s

Max. Summer = ~ 0.30 m^3/s

<u>Fish Hatchery Pumping Rate</u>

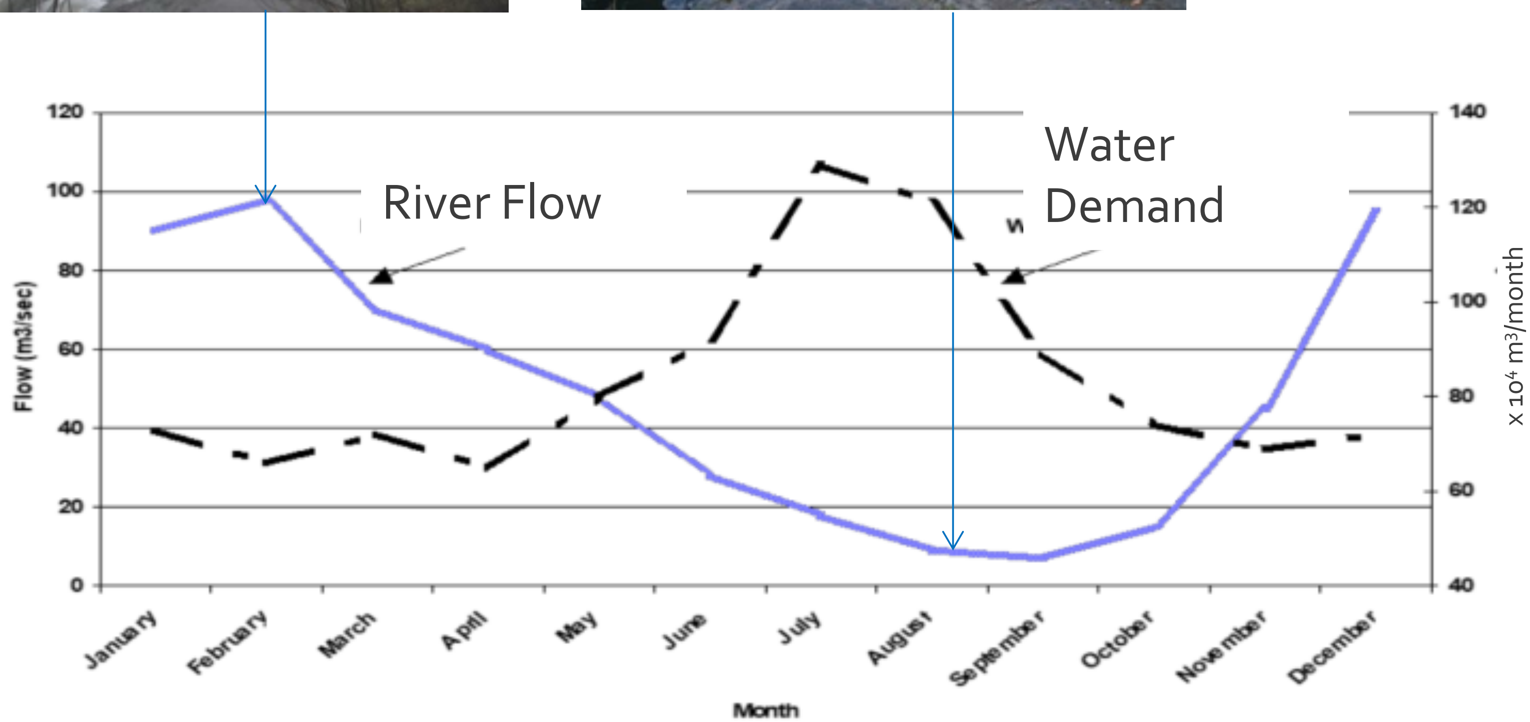
Max. Winter = ~ 0.68 m^3/s

Min. Summer = ~ 0.3 3m^3/s

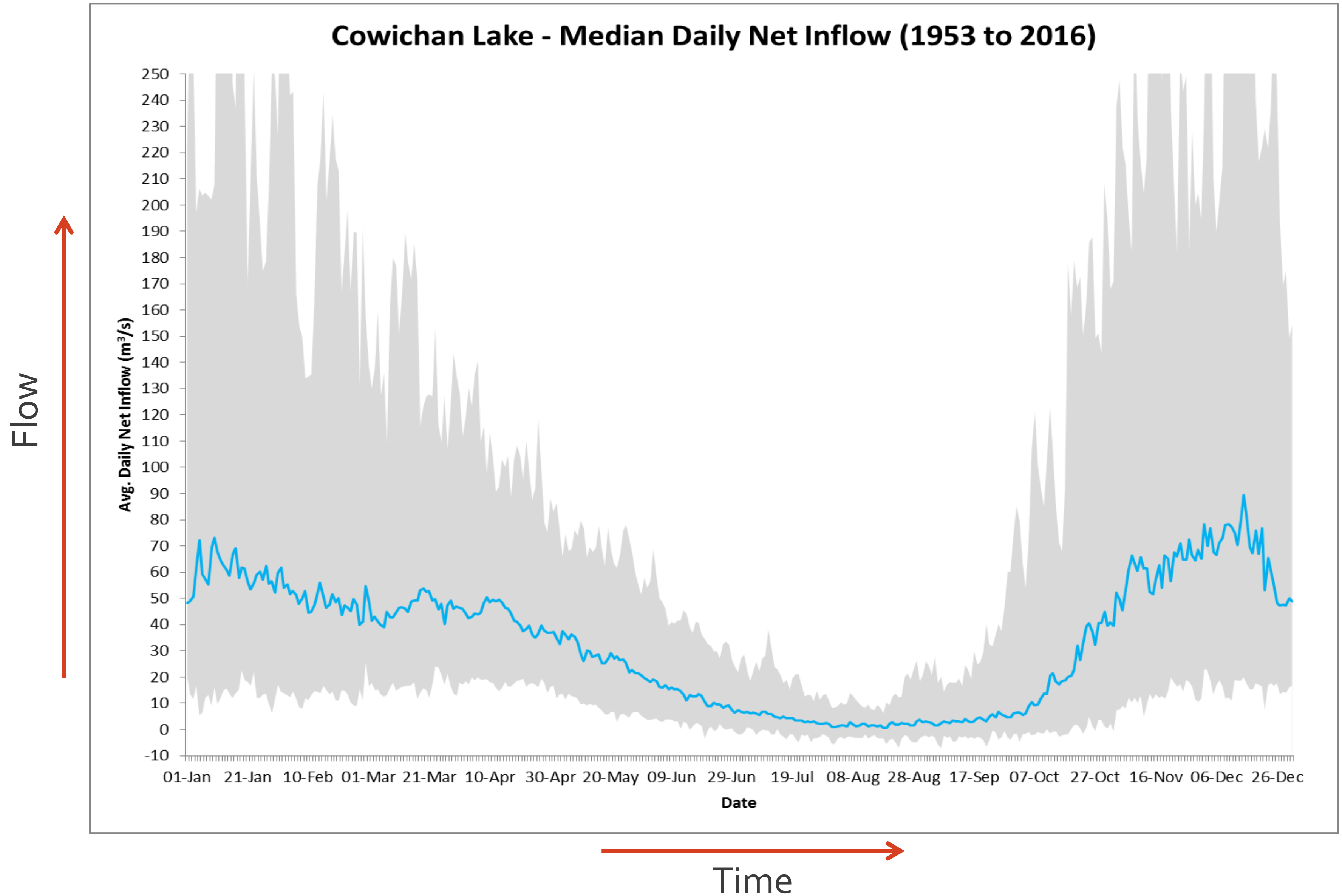
Variation in Flow and Demand

Winter - River Flow (> 100 m3/s)

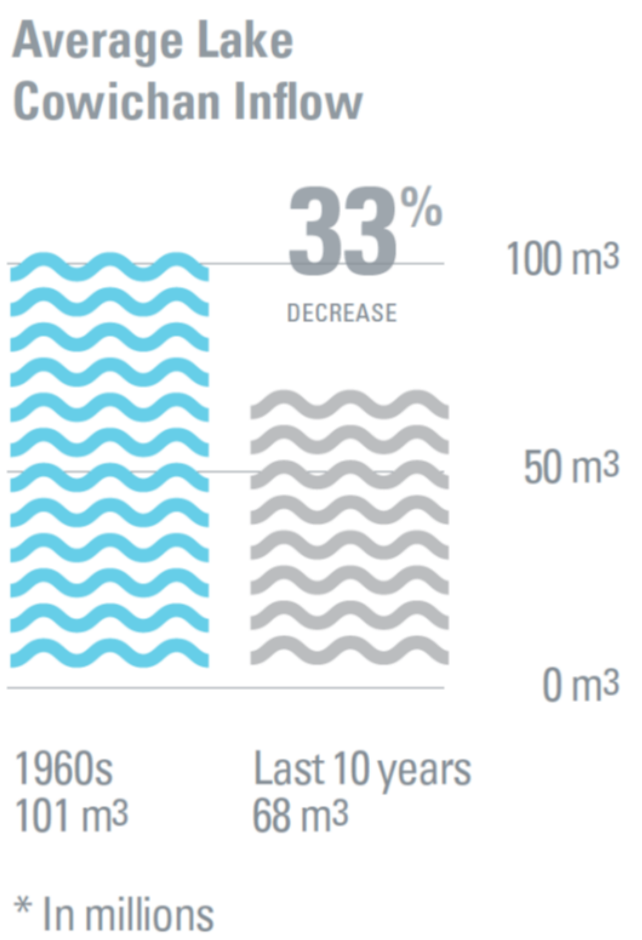
Summer - River Flow (4 to 7 m3/s)

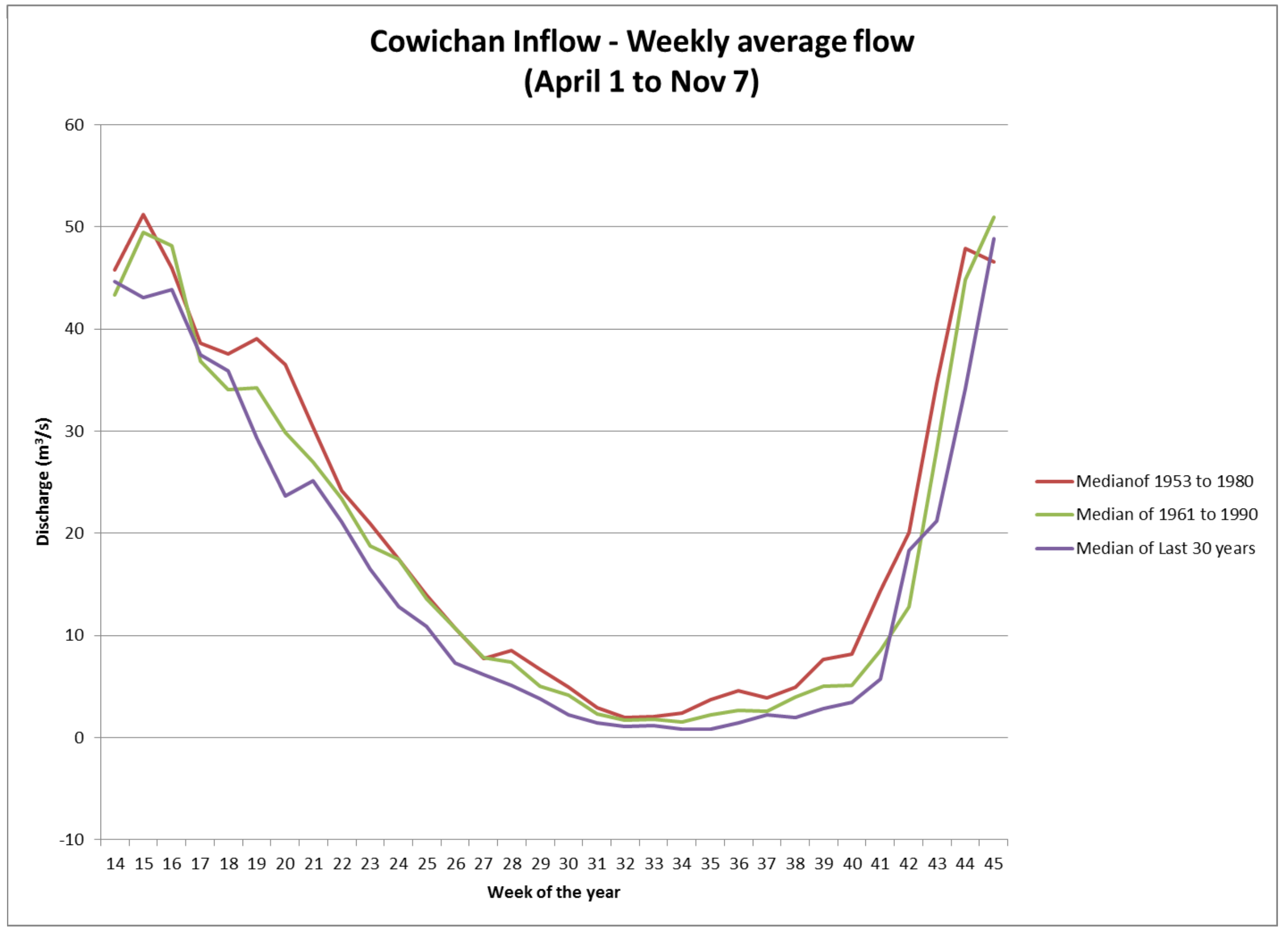


Inflow to Cowichan Lake (Record from 1953 to 2017)



Changing Inflow to Cowichan Lake



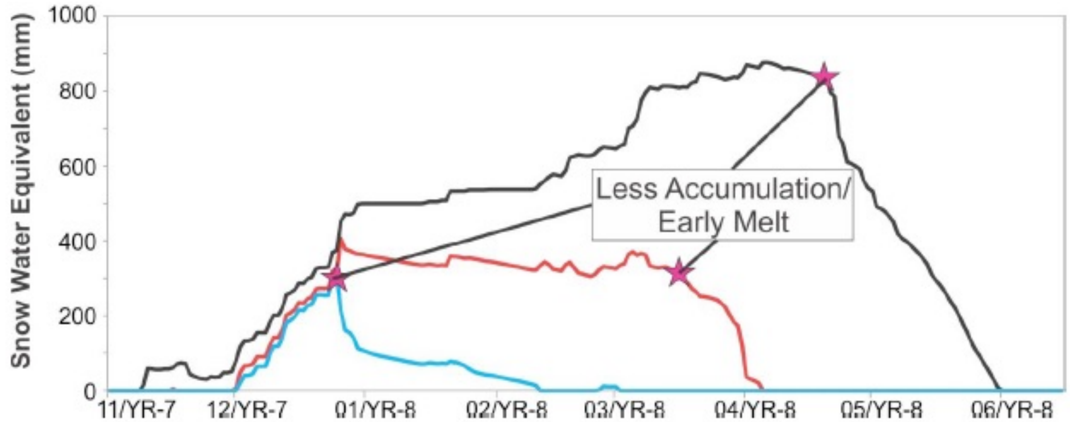


Climate Change in Cowichan

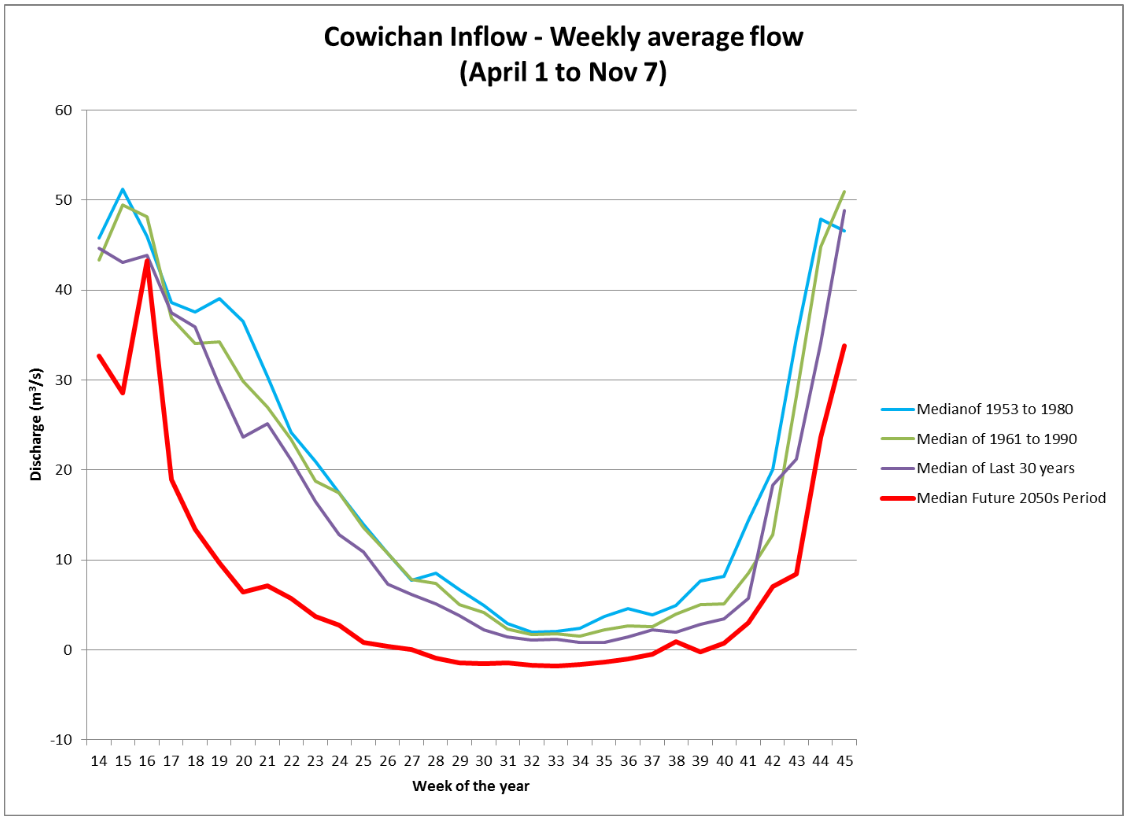
	Change by 2050	Change by 2080	Impact
Less summer rainfall	- 30 mm ↓	- 40 mm ↓	Less summer inflow to lake/river
Longer Dry Spells	From 22 days now to 26 days by 2050	From 22 days now to 32 days by 2080s	Longer period where storage required
Higher summer temp	+ 3.2 °C ↑	+ 5.2 °C ↑	Increase evaporation and increase irrigation demand
Higher winter temp	+ 2.4 °C ↑	+ 4.4 °C ↑	Less snow = less spring runoff
April 1 Snowpack	- 50% ↓	- 85% ↓	Less snow = less spring runoff

Source: Pacific Climate Impacts Consortium, 2017

Climate Change in Cowichan

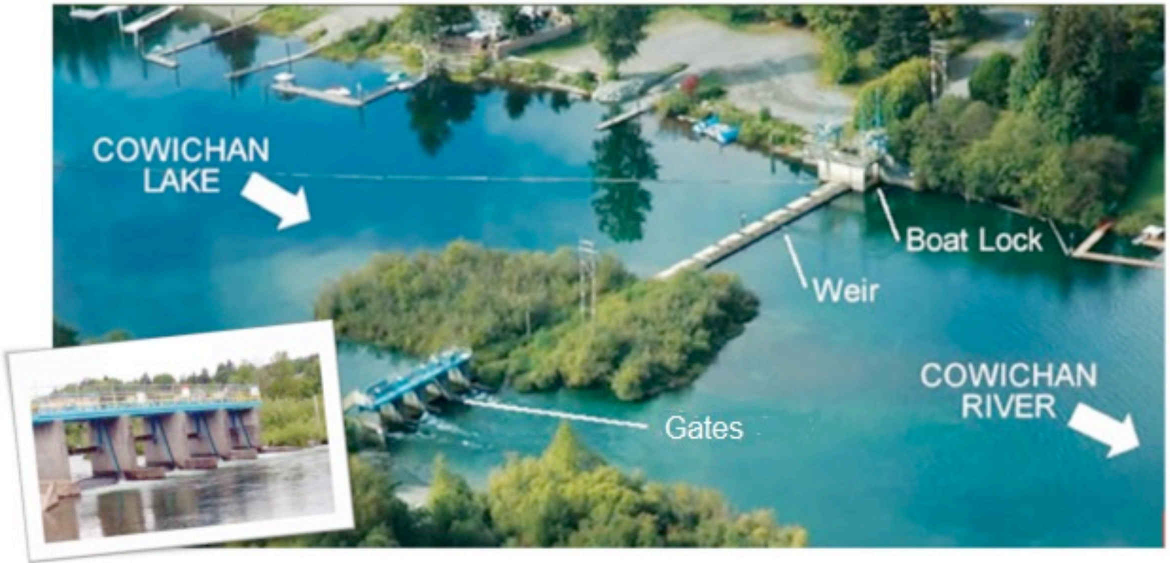


Source: Foster and Allen, 2015



Cowichan Weir

Constructed in 1957 – Operated by Catalyst Paper



Stores 59.5 million m^3 of water in Cowichan Lake
(equivalent to 97 cm depth of water over lake surface)
(about 97 days of supply at minimum flow)

Original design

Design Intent	Water Licence Flow
Maintain min. flow in Cowichan River below weir	250 cfs (about 7 m^3/s)
Provide water for Crofton Mill	100 cfs (about 2.8 m^3/s)
Maintain min. flow below the Crofton Mill Pump Station	100 cfs (about 2.8 m^3/s)

Cowichan Weir

Operation during the Year

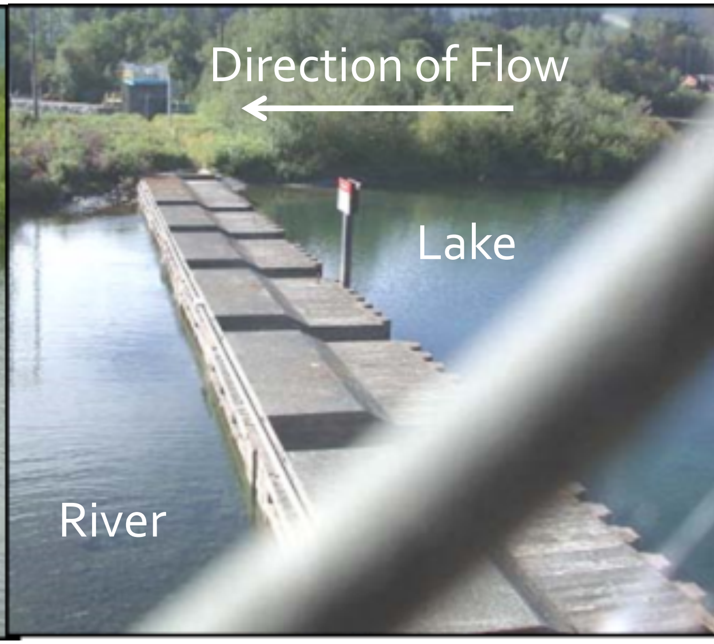
Weir/Gates Controlling Flow/Lake Level

Late Spring/Early Summer
(April to July)

Gates are fully raised and
Boat lock is closed

Try to maintain Lake level
Near top of weir to
Store water for summer
(but depends on inflow)

Late Summer/Early Fall
(August to October)

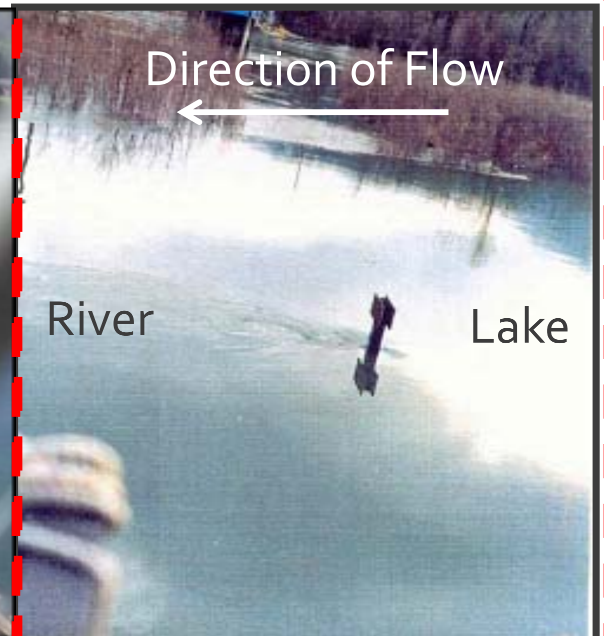


Gates are operated to
Maintain required minimum
Flow

Water levels drop in lake as
Water stored in spring is used to
maintain summer flows.

**Weir/Gates
Not Controlling Flow/
Lake Level**

Winter



Gates are fully lowered and
Boat lock opened

Lake levels rise above
the weir
- increased lake inflow
- flow constriction in
river channel downstream

Cowichan Weir

Hydraulics of the weir

River Flow – Channel Capacity

Wide channel
Downstream of weir

Narrow channel
at Greendale Trestle

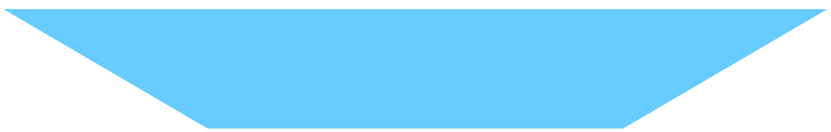
Cowichan Weir

Hydraulics of the weir

River Flow – Channel Capacity

Two rivers same flow and river slope

Cross sectional area of flow stays constant



Wide channel

Shallow water depth

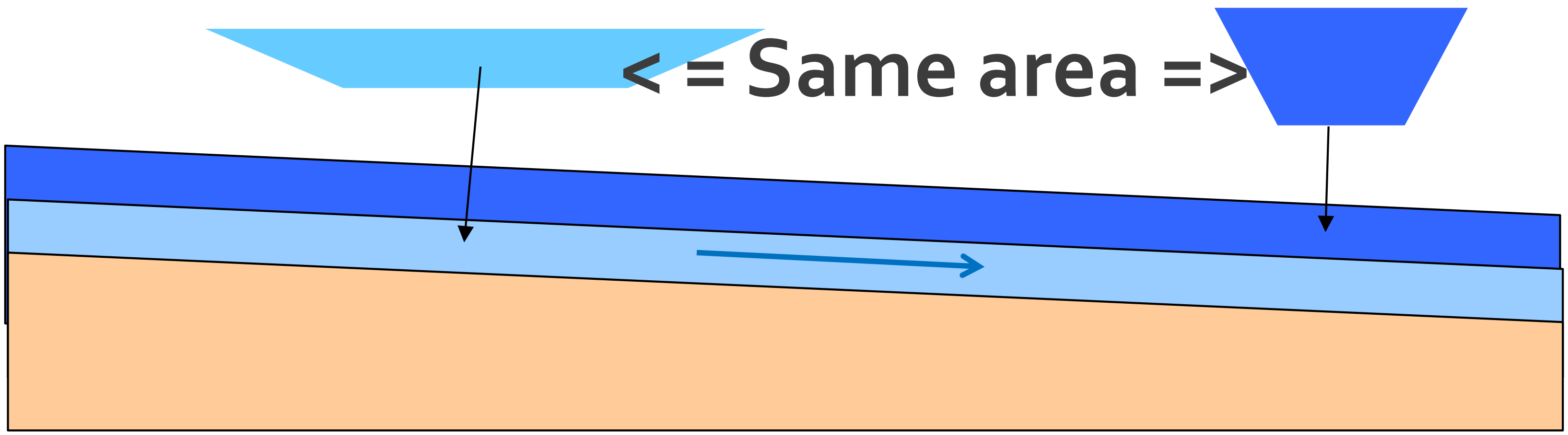
Narrow channel

Deep water depth

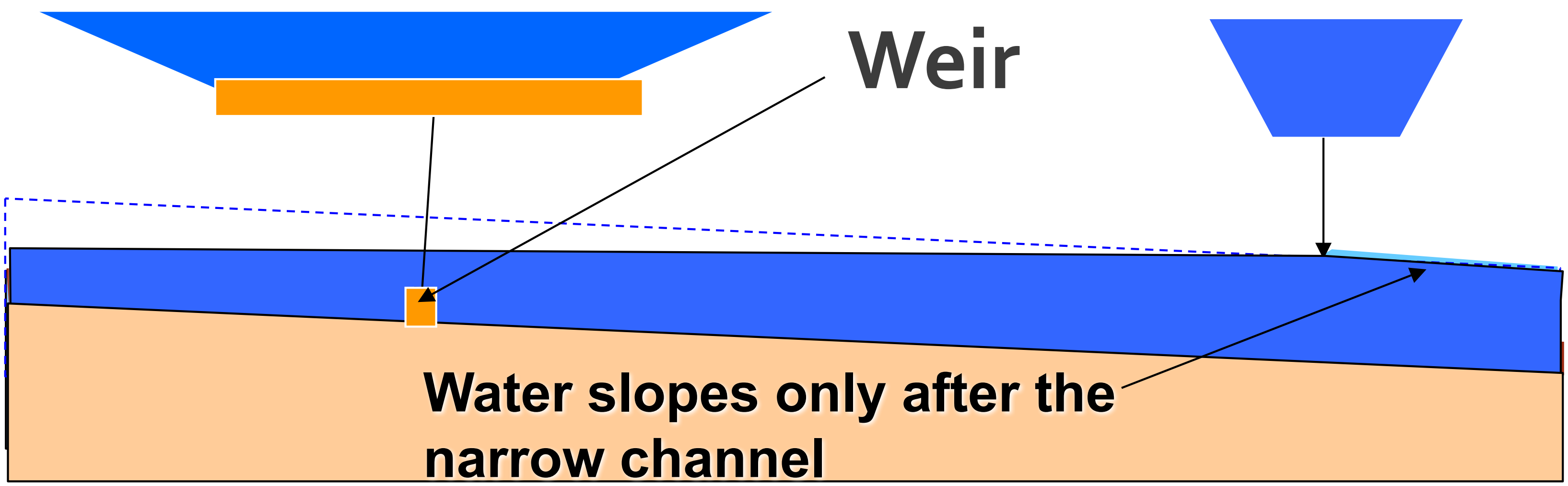
Cowichan Weir

Hydraulics of the weir

River Cross Sections = Cut perpendicular to the river

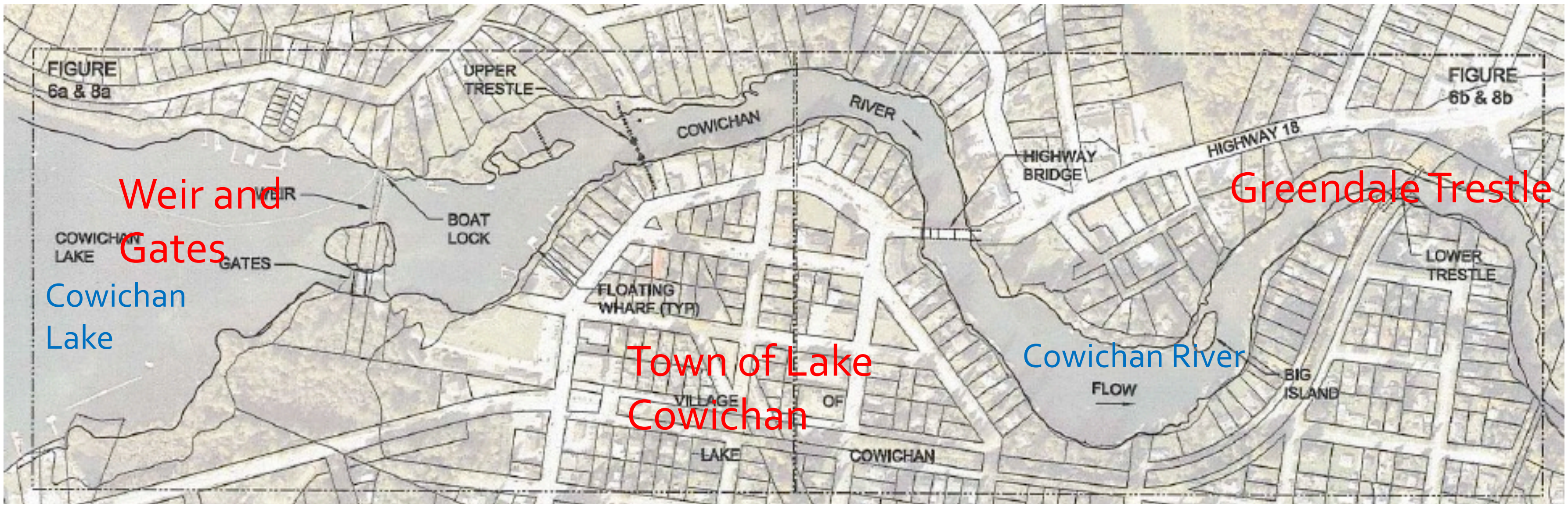


River Profile = Cut along the direction of river flow



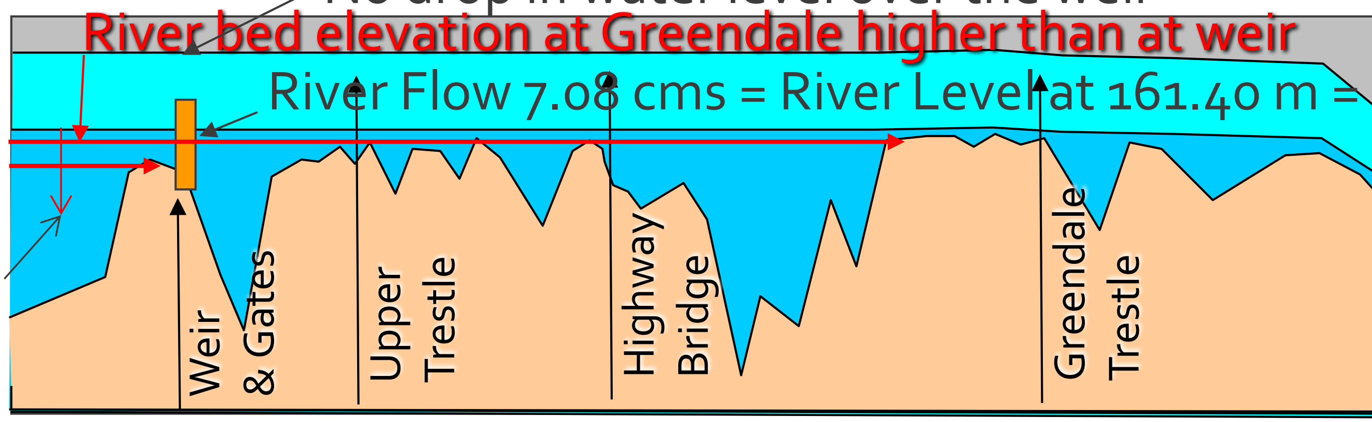
Cowichan Weir

Hydraulics of the weir



Plan of Outlet of Cowichan Lake/Start of Cowichan River

No drop in water level over the weir



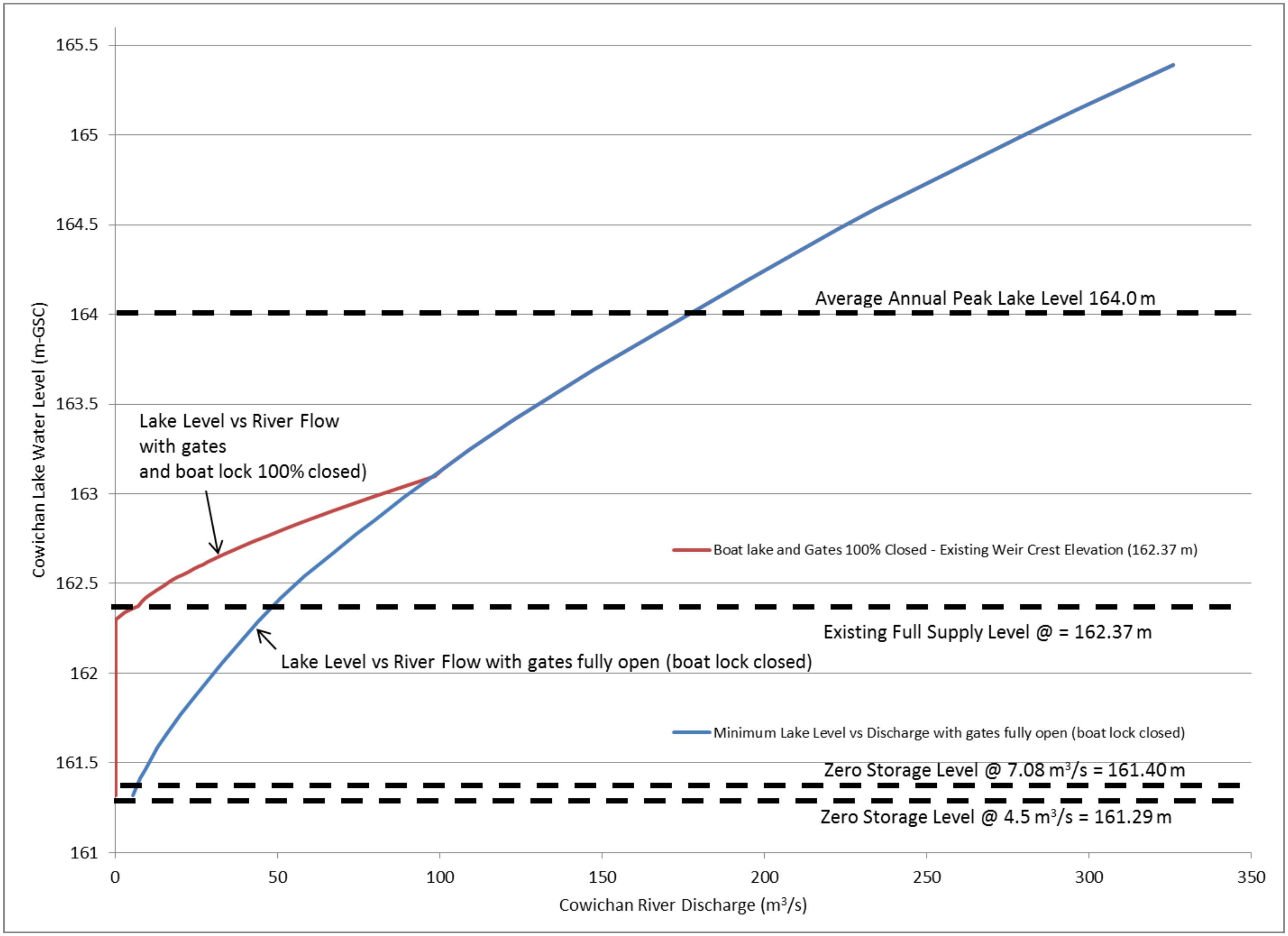
Below ZSL = Pumping

River Profile – Exaggerated Vertical Scale

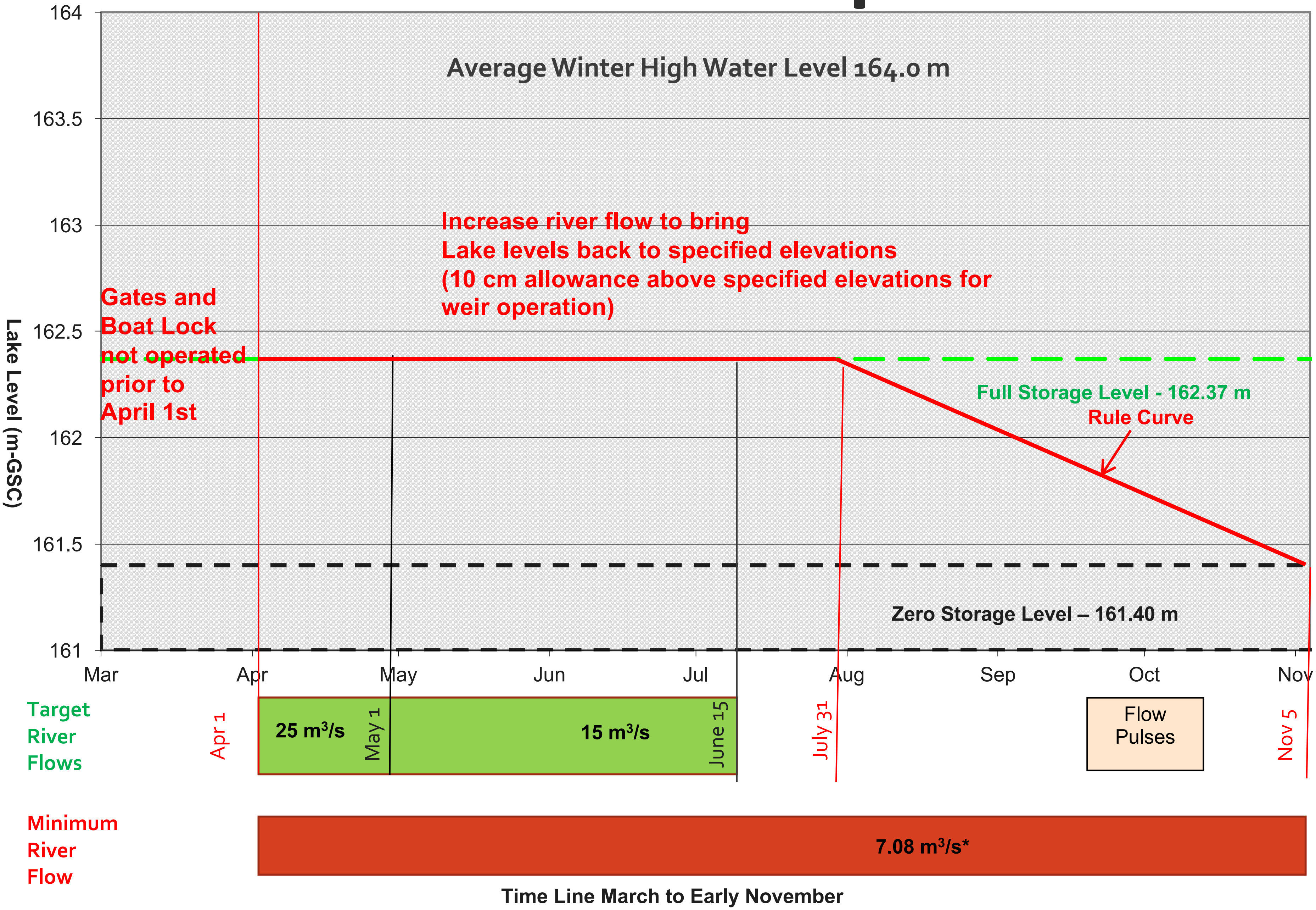
Cowichan Weir

Hydraulics of the weir

Cowichan Lake vs Cowichan River Flow Rating Curve

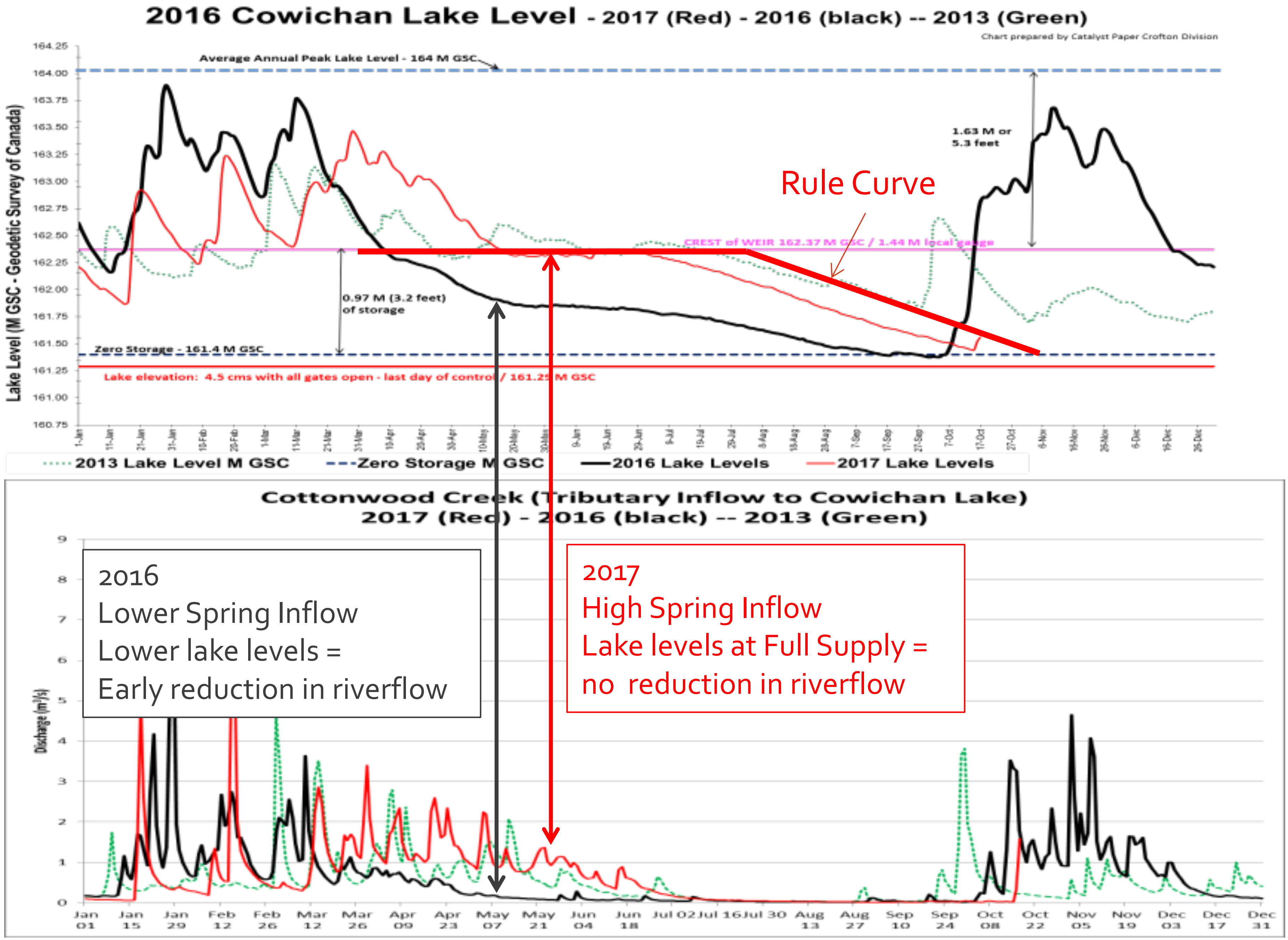


Cowichan Weir – Operation

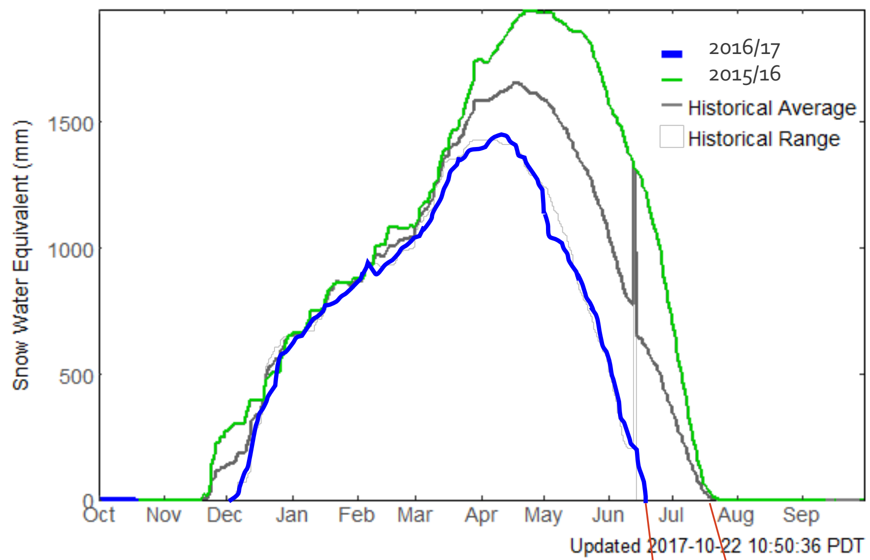


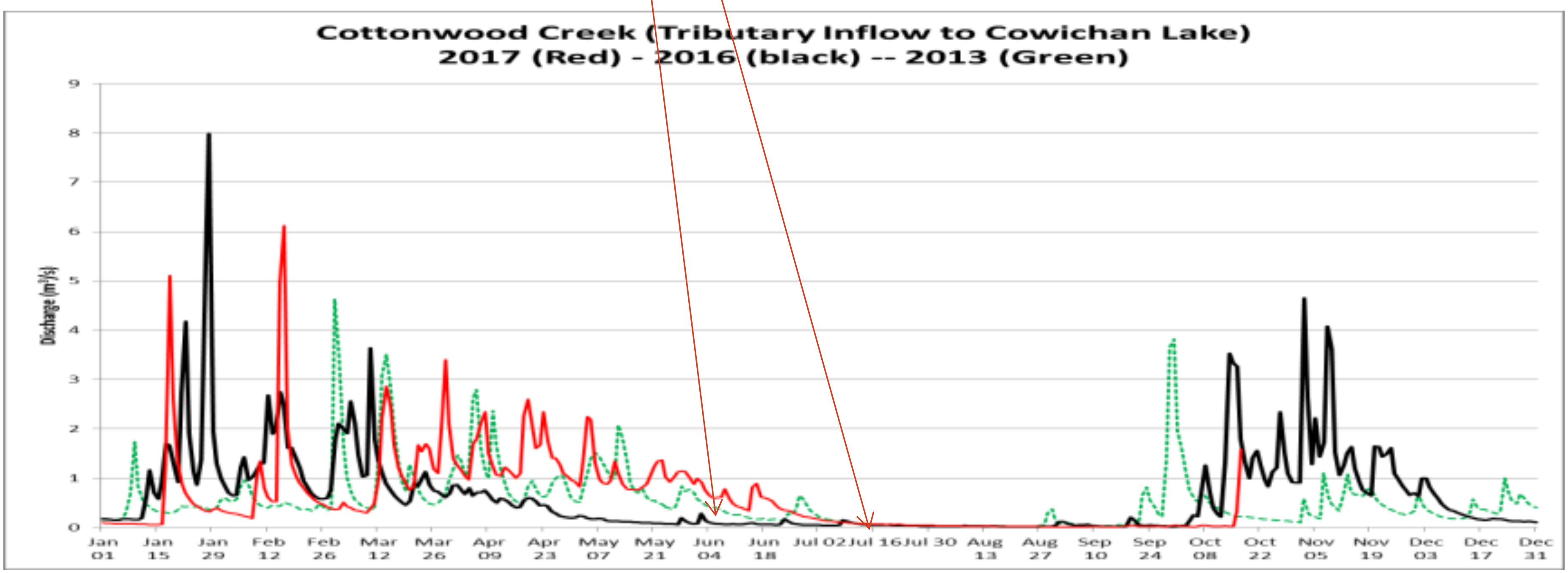
* - 7.08 m^3/s equal to 250 cfs minimum flow required by water licence

Historical Water Levels and Flows



Historical Water Levels and Flows



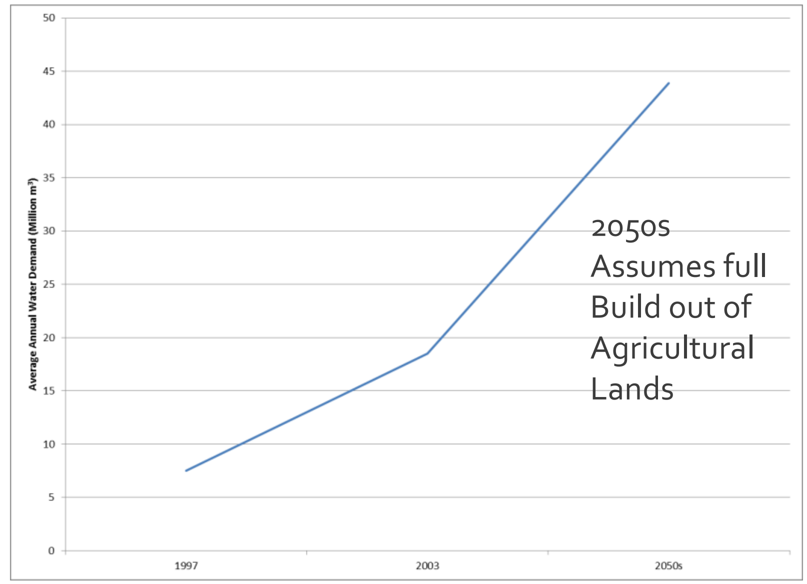


Cowichan Weir

Water availability and needs have changed since the 1950s

- Increase community water demand
- Sewer Treatment Plant Effluent Dilutions Minimum Flows
- Better understanding of ecological water needs
- Climate Change
- Land use

CVRD Agricultural Water Demand



Source: T.. Van der Gulik, Neilsen, D. and Fretwell, R (2013)

Cowichan Water Management

Modeling Water Use Alternatives

- Input

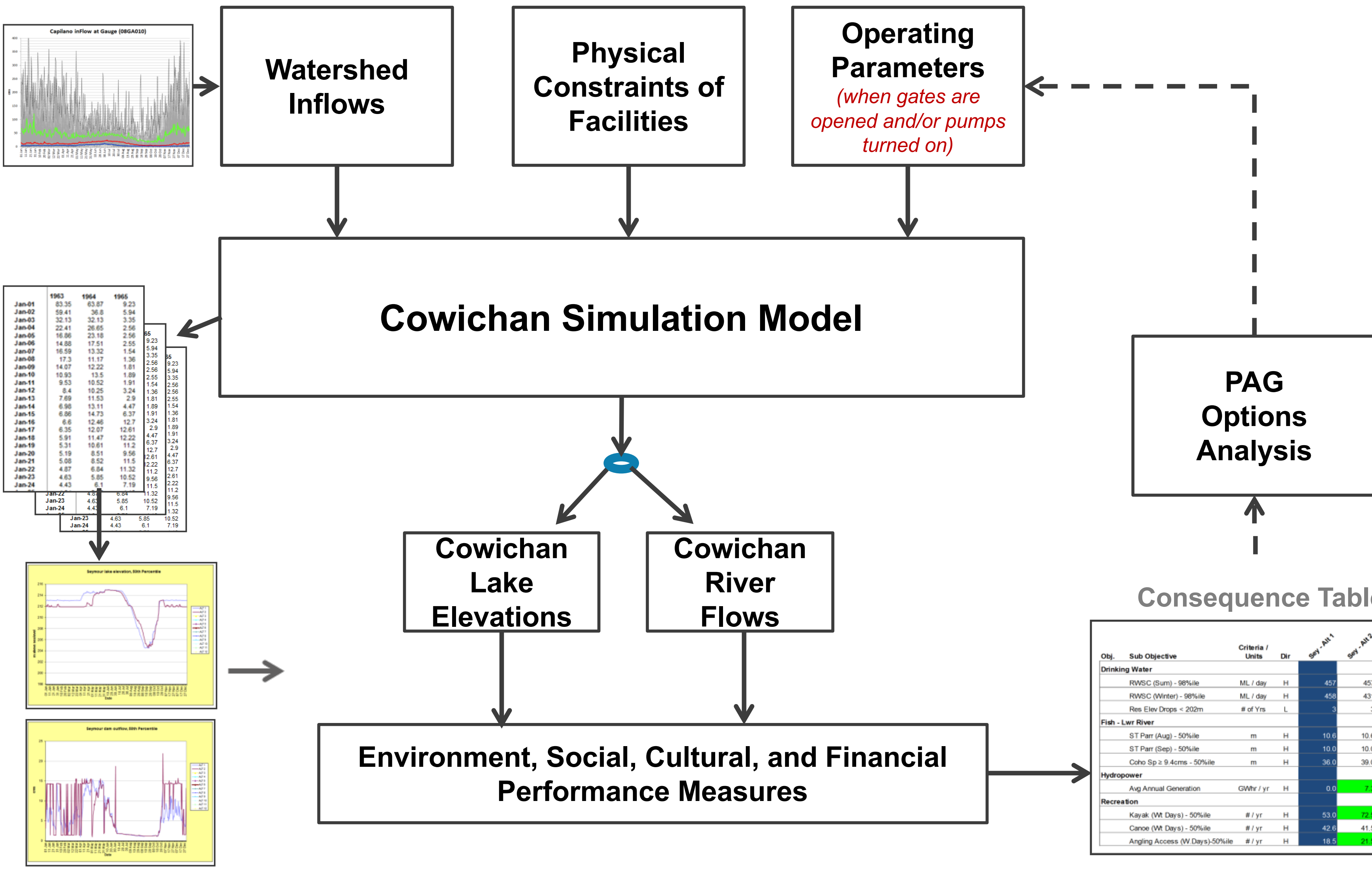
  Historical Inflow Records (1953 to 2016) and
  Future Climate (2050s)

- Runs daily time step
- Simulates weir operation alternatives

  - Changes in outflow schedule
  - Changes to weir crest elevation
  - Pumping

- Output is daily Cowichan Lake Level and Cowichan River Discharge

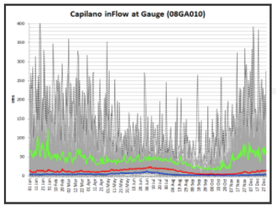
Modeling Framework



Consequence Table

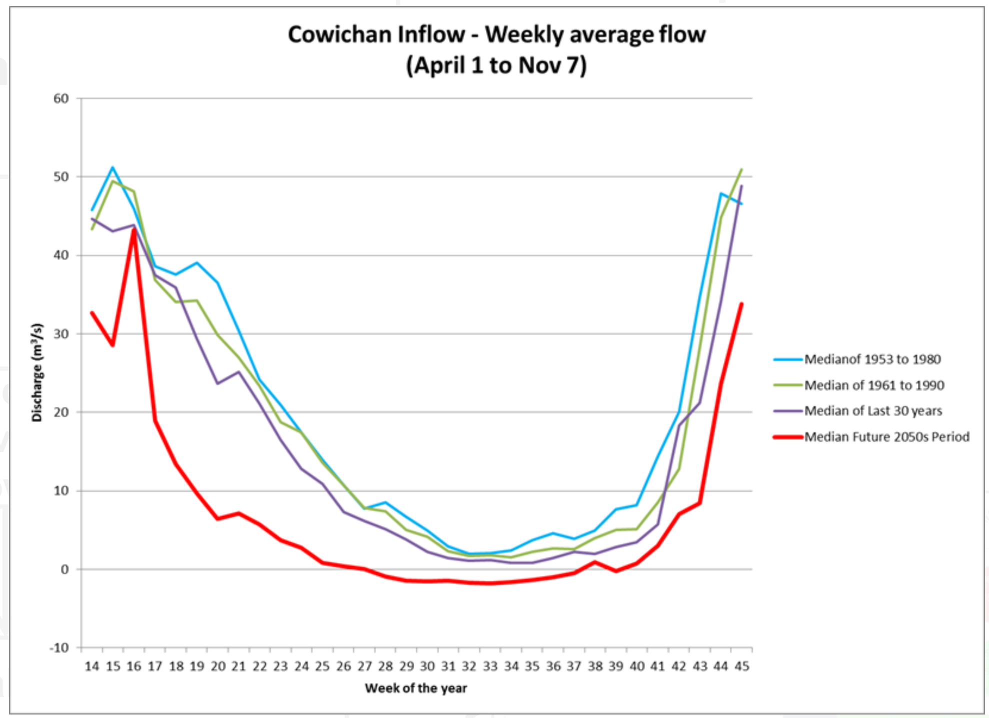
Obj.	Sub Objective	Criteria / Units	Dir	Sey - Alt 1	Sey - Alt 2	Sey - Alt 4b	Sey - Alt 6
Drinking Water							
	RWSC (Sum) - 98%ile	ML / day	H	457	457	455	365
	RWSC (Winter) - 98%ile	ML / day	H	458	431	431	154
	Res Elev Drops < 202m	# of Yrs	L	3	3	3	15
Fish - Lwr River							
	ST Parr (Aug) - 50%ile	m	H	10.6	10.6	12.3	15.6
	ST Parr (Sep) - 50%ile	m	H	10.0	10.0	12.5	15.6
	Coho Sp ≥ 9.4cms - 50%ile	m	H	36.0	39.0	39.5	51.0
Hydropower							
	Avg Annual Generation	GWhr / yr	H	0.0	7.3	7.1	3.7
Recreation							
	Kayak (Wt Days) - 50%ile	# / yr	H	53.0	72.5	68.5	61.0
	Canoe (Wt Days) - 50%ile	# / yr	H	42.6	41.5	41.7	46.0
	Angling Access (W.Days)-50%ile	# / yr	H	18.5	21.5	21.4	28.9

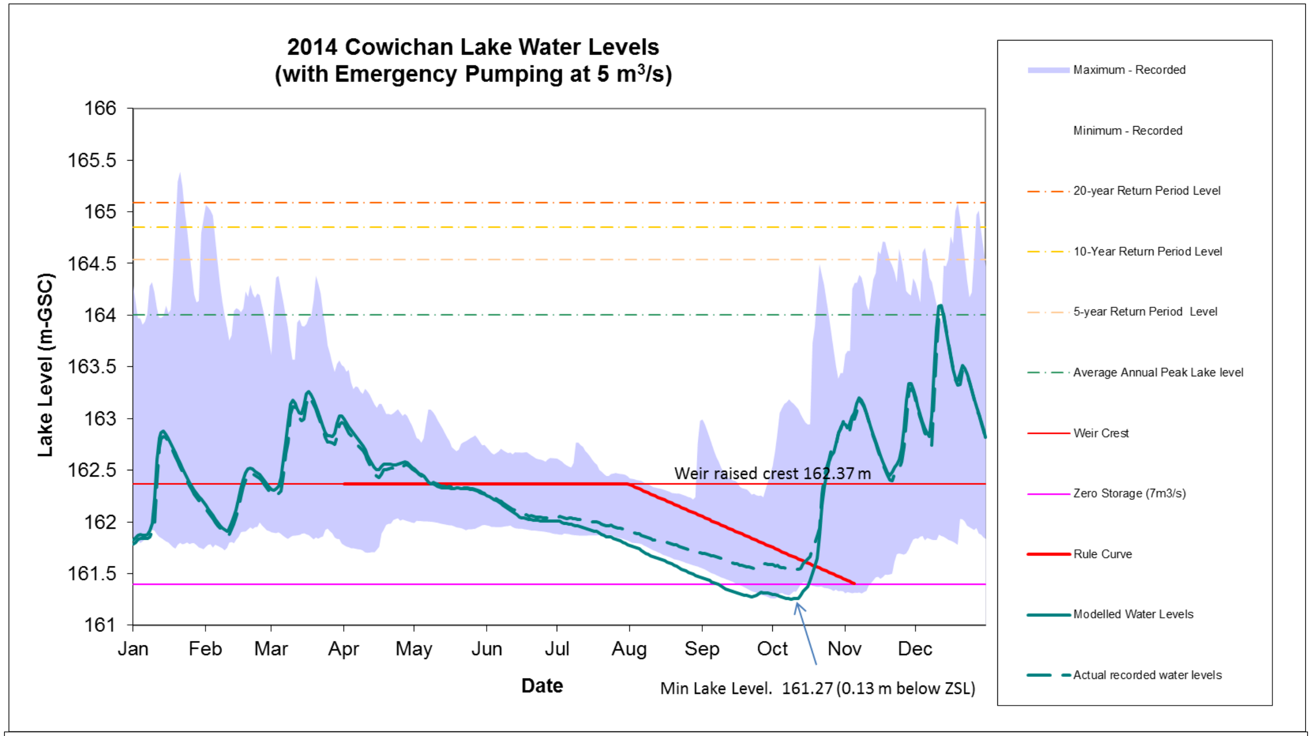
Modeling Parameters

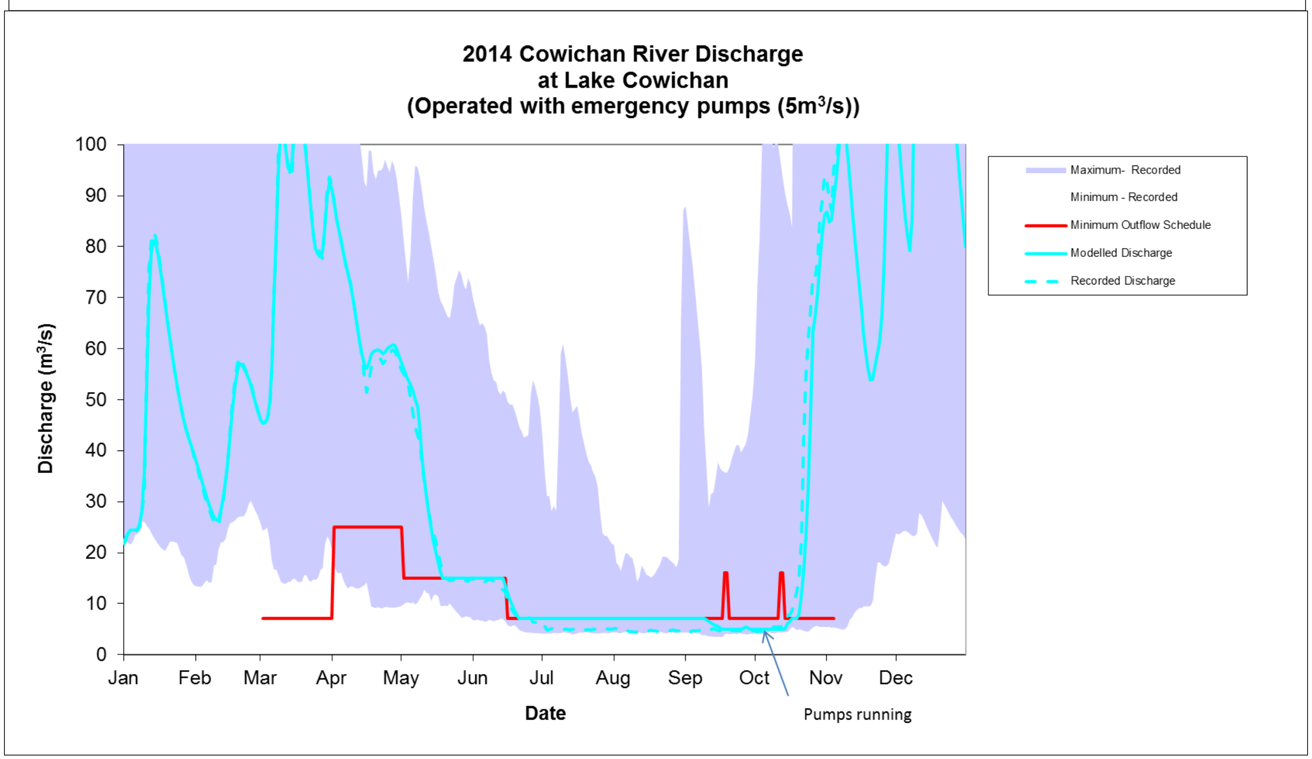


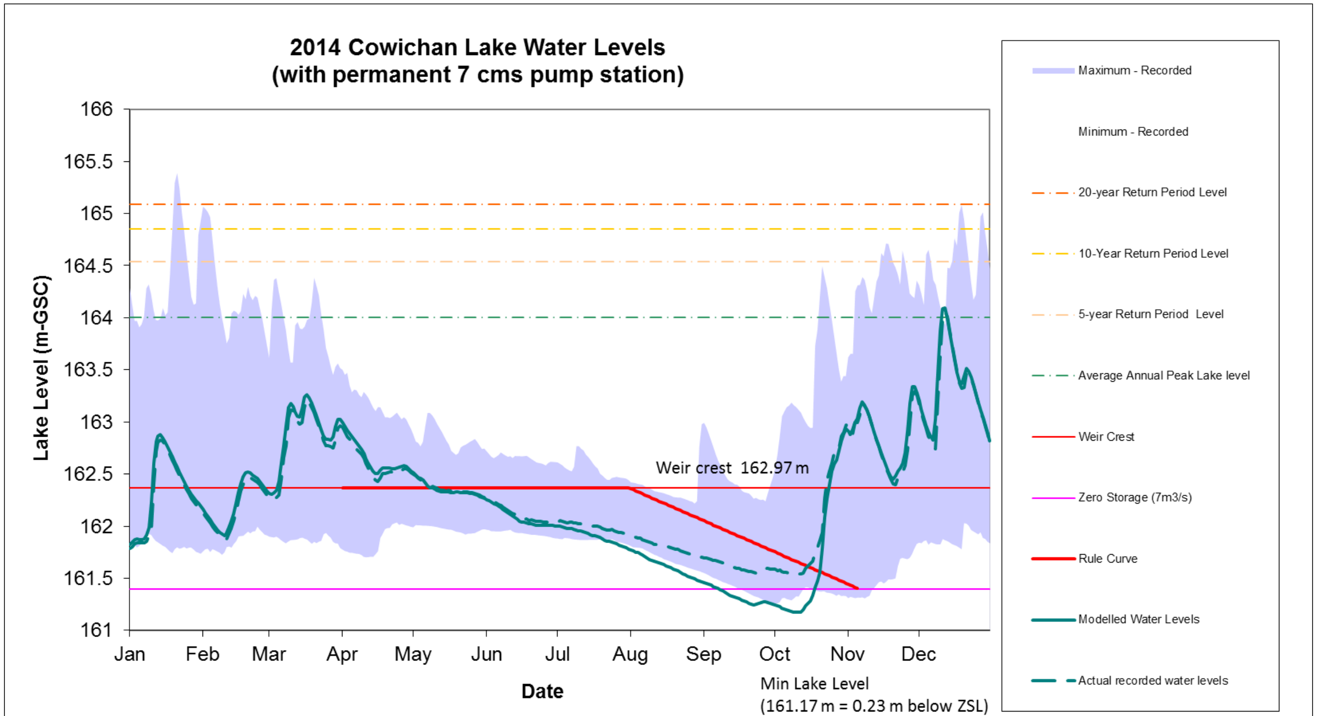
Need to decide on what hydrological dataset to use for the modeling?

- Historical inflow dataset (1953 to 2016)
- Simulated future dataset, based on climate change projections (2050s)
- Other?

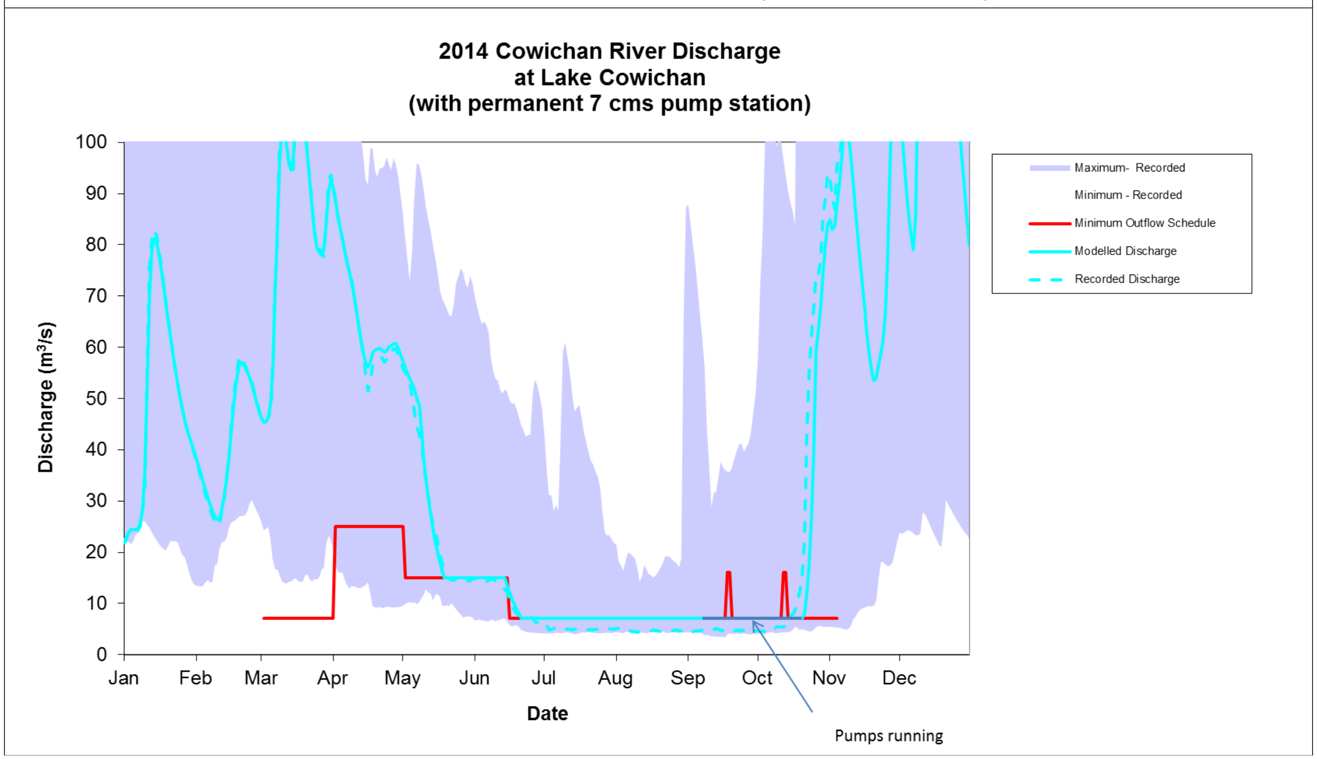



2014 Cowichan Lake Water Levels
(with Emergency Pumping at 5 m³/s)
Lake Level (m-GSC)
166
165.5
165
164.5
164
163.5
163
162.5
162
161.5
161
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Weir raised crest 162.37 m
Min Lake Level. 161.27 (0.13 m below ZSL)
Maximum - Recorded
Minimum - Recorded
20-year Return Period Level
10-Year Return Period Level
5-year Return Period Level
Average Annual Peak Lake level
Weir Crest
Zero Storage (7m3/s)
Rule Curve
Modelled Water Levels
Actual recorded water levels

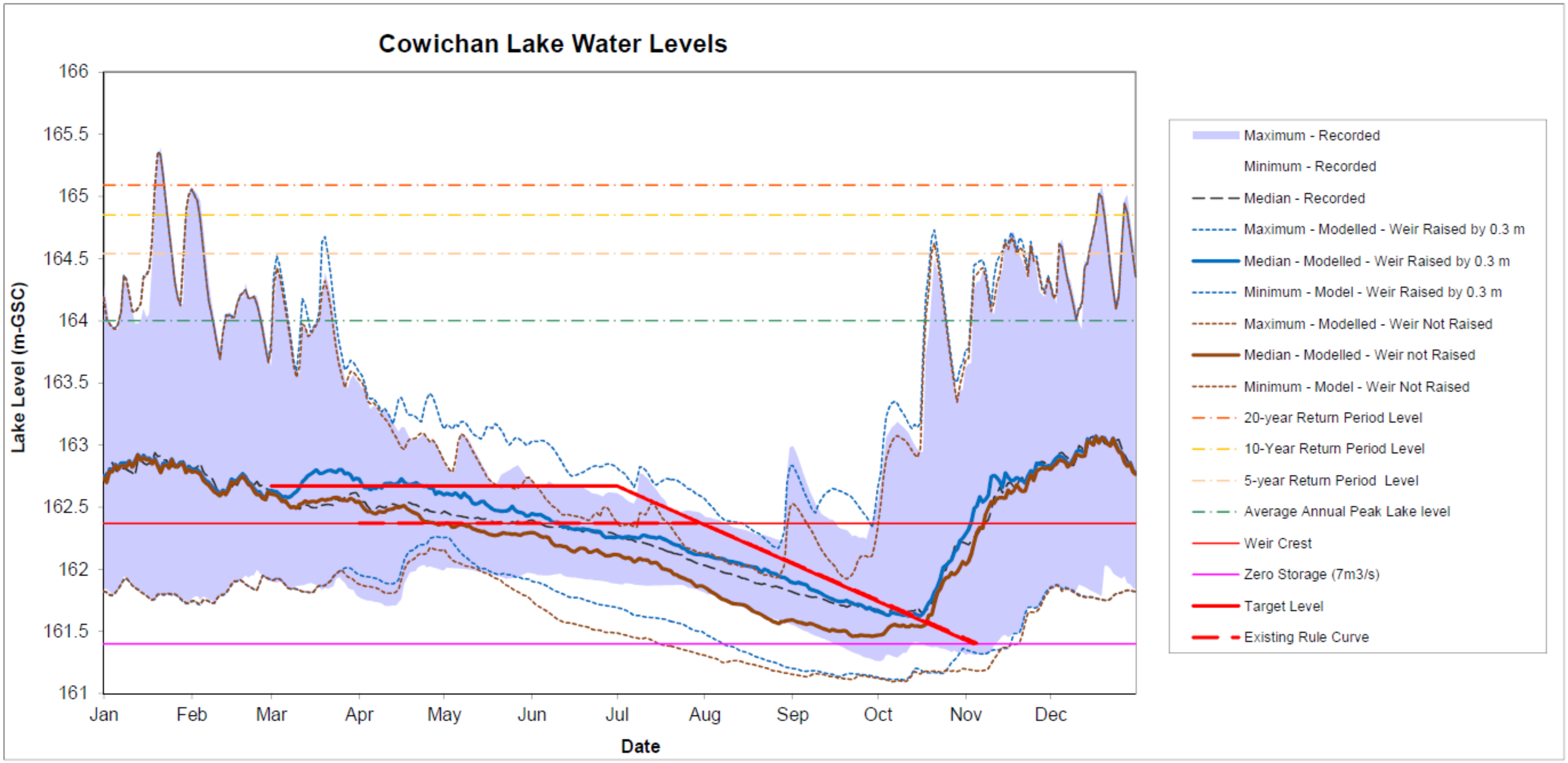

2014 Cowichan River Discharge
at Lake Cowichan
(Operated with emergency pumps (5m³/s))
Discharge (m³/s)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Pumps running
Maximum- Recorded
Minimum - Recorded
Minimum Outflow Schedule
Modelled Discharge
Recorded Discharge

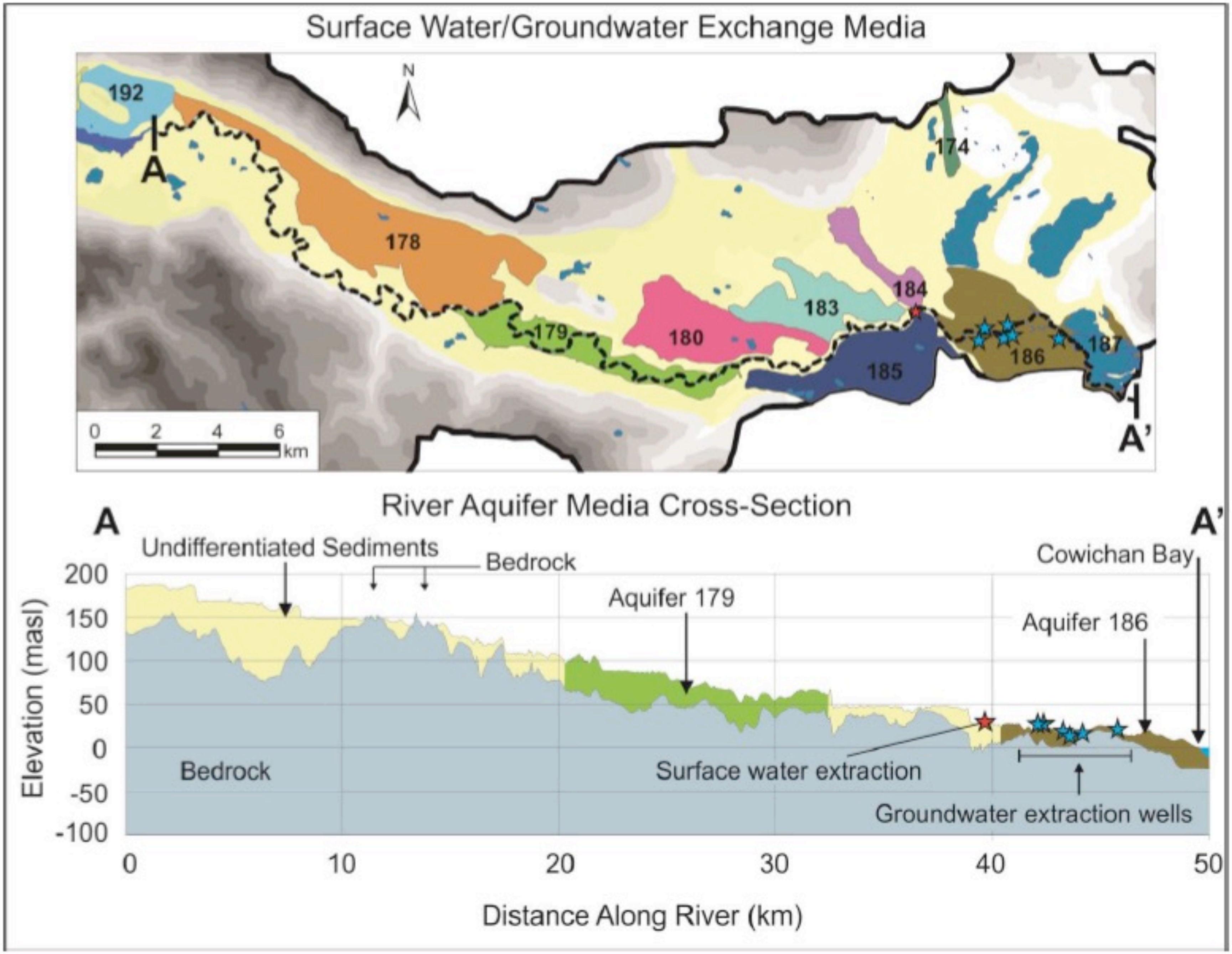


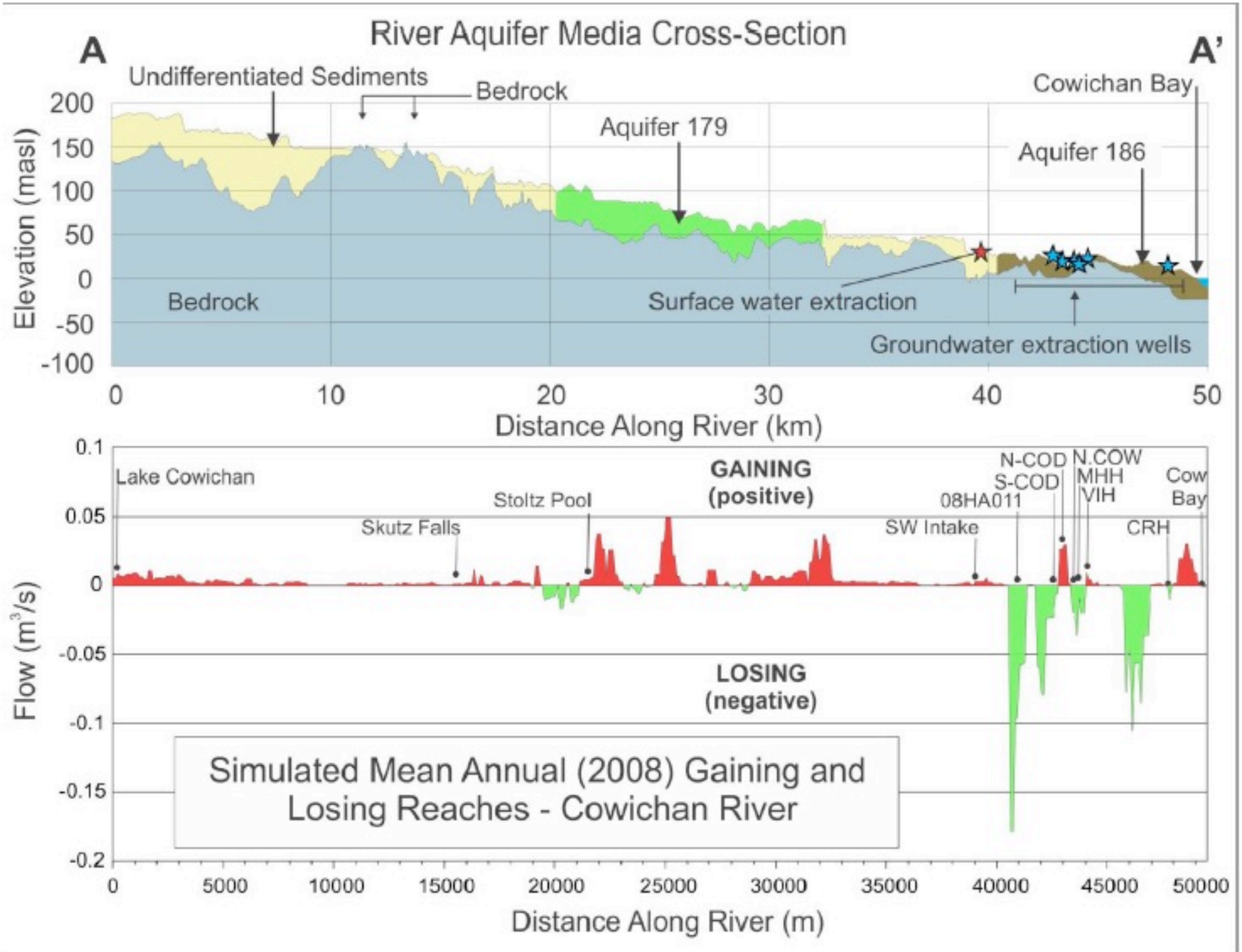
2014 Cowichan Lake Water Levels
(with permanent 7 cms pump station)
Lake Level (m-GSC)
166
165.5
165
164.5
164
163.5
163
162.5
162
161.5
161
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Weir crest 162.97 m
Min Lake Level
(161.17 m = 0.23 m below ZSL)
Maximum - Recorded
Minimum - Recorded
20-year Return Period Level
10-Year Return Period Level
5-year Return Period Level
Average Annual Peak Lake level
Weir Crest
Zero Storage (7m3/s)
Rule Curve
Modelled Water Levels
Actual recorded water levels



2014 Cowichan River Discharge
at Lake Cowichan
(with permanent 7 cms pump station)
Discharge (m³/s)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Pumps running
Maximum- Recorded
Minimum - Recorded
Minimum Outflow Schedule
Modelled Discharge
Recorded Discharge

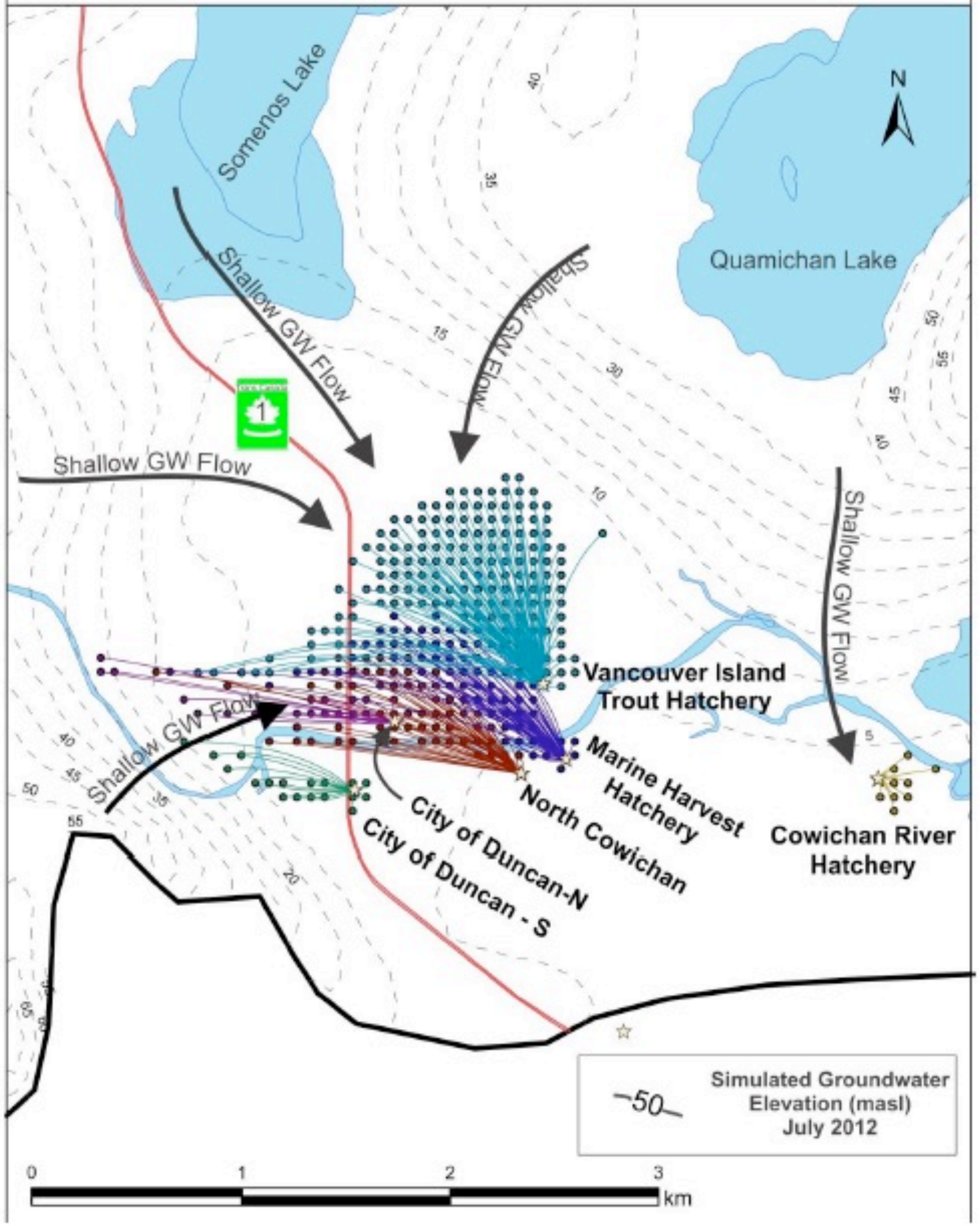

Cowichan Lake Water Levels
Lake Level (m-GSC)
166
165.5
165
164.5
164
163.5
163
162.5
162
161.5
161
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Maximum - Recorded
Minimum - Recorded
Median - Recorded
Maximum - Modelled - Weir Raised by 0.3 m
Median - Modelled - Weir Raised by 0.3 m
Minimum - Model - Weir Raised by 0.3 m
Maximum - Modelled - Weir Not Raised
Median - Modelled - Weir not Raised
Minimum - Model - Weir Not Raised
20-year Return Period Level
10-Year Return Period Level
5-year Return Period Level
Average Annual Peak Lake level
Weir Crest
Zero Storage (7m3/s)
Target Level
Existing Rule Curve

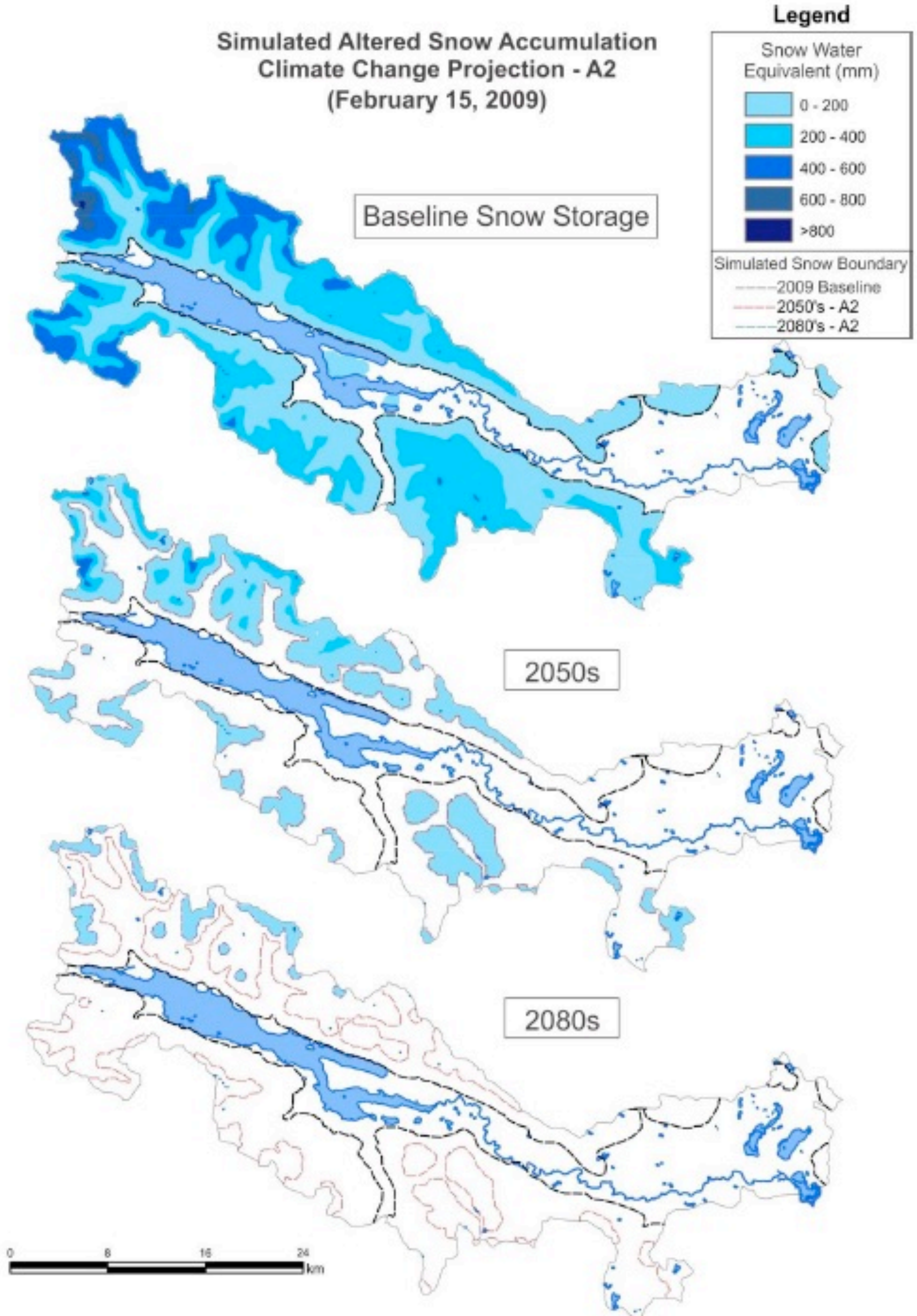

Surface Water/Groundwater Exchange Media
N
192
A
178
174
184
183
179
180
185
186
187
A'
0 2 4 6 km
River Aquifer Media Cross-Section
A
A'
Undifferentiated Sediments
Bedrock
Cowichan Bay
Aquifer 179
Aquifer 186
Elevation (masl)
200
150
100
50
0
-50
-100
Bedrock
Surface water extraction
Groundwater extraction wells
0
10
20
30
40
50
Distance Along River (km)



River Aquifer Media Cross-Section
A
A'
Undifferentiated Sediments
Bedrock
Aquifer 179
Cowichan Bay
Aquifer 186
Elevation (masl)
200
150
100
50
0
-50
-100
Bedrock
Surface water extraction
Groundwater extraction wells
0
10
20
30
40
50
Distance Along River (km)
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
Flow (m³/s)
Lake Cowichan
Skutz Falls
Stoltz Pool
GAINING
(positive)
LOSING
(negative)
SW Intake
08HA011
N-COD
S-COD
N.COW
MHH
VIH
CRH
Cow
Bay
Simulated Mean Annual (2008) Gaining and
Losing Reaches - Cowichan River
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000
Distance Along River (m)

June - October 2012 - GW Capture Zones Pathlines




Simulated Altered Snow Accumulation
Climate Change Projection - A2
(February 15, 2009)
Legend
Snow Water Equivalent (mm)
0 - 200
200 - 400
400 - 600
600 - 800
>800
Simulated Snow Boundary
2009 Baseline
2050's - A2
2080's - A2
Baseline Snow Storage
2050s
2080s
0
8
16
24
km