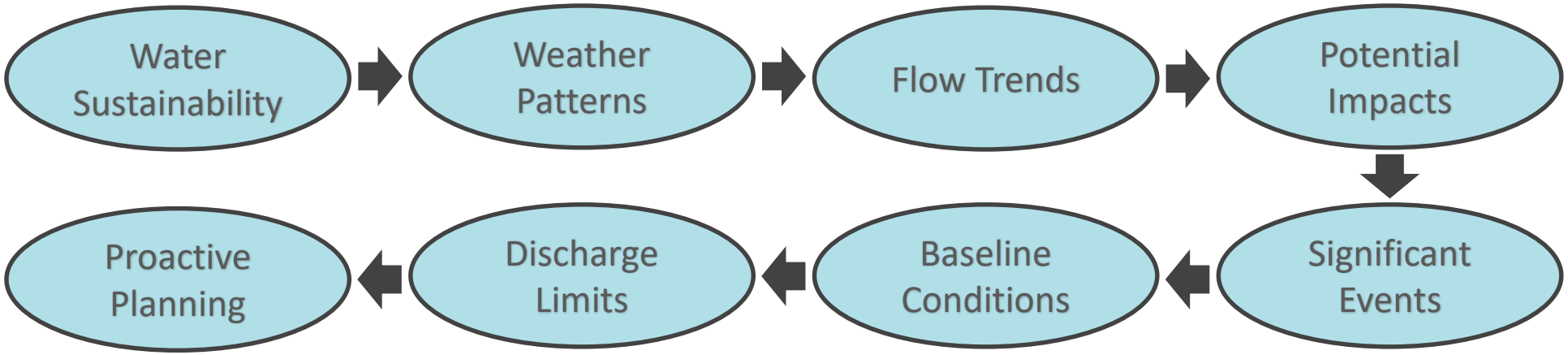
Discharging of Industrial and Municipal Effluent in a Changing Climate

Robert Best, M.Sc., P.Biol., R.P.Bio

global **environmental** and **advisory** solutions

SLR

The Journey


Water Sustainability
Weather Patterns
Flow Trends
Potential Impacts
Significant Events
Baseline Conditions
Discharge Limits
Proactive Planning

Water Sustainability

Water Sustainability

Communities

- Uses
  - Drinking water
  - General household use
  - Recreation
- Discharges
  - Sanitary sewage
  - Stormwater management

Businesses

- Uses
  - Drinking water
  - Irrigation and agriculture
  - Manufacturing
  - Mining (including O&G processes)
  - Hydroelectric generation
  - Thermal regulation
- Discharges
  - Sanitary sewage
  - Stormwater management
  - Treated effluent
  - Thermally impacted flow through water

Environment

- Uses
  - Natural flow regime for rivers, creeks, lakes, and wetlands
  - Specific outcomes for plants and animals (i.e., feed, breed, and growth)
- Discharges
  - Freshet pulses of sediment and flow
  - Release of naturally occurring substances

The Goal: Sustainable use of our water resources for the benefit of communities, businesses, and the environment.

Weather Patterns

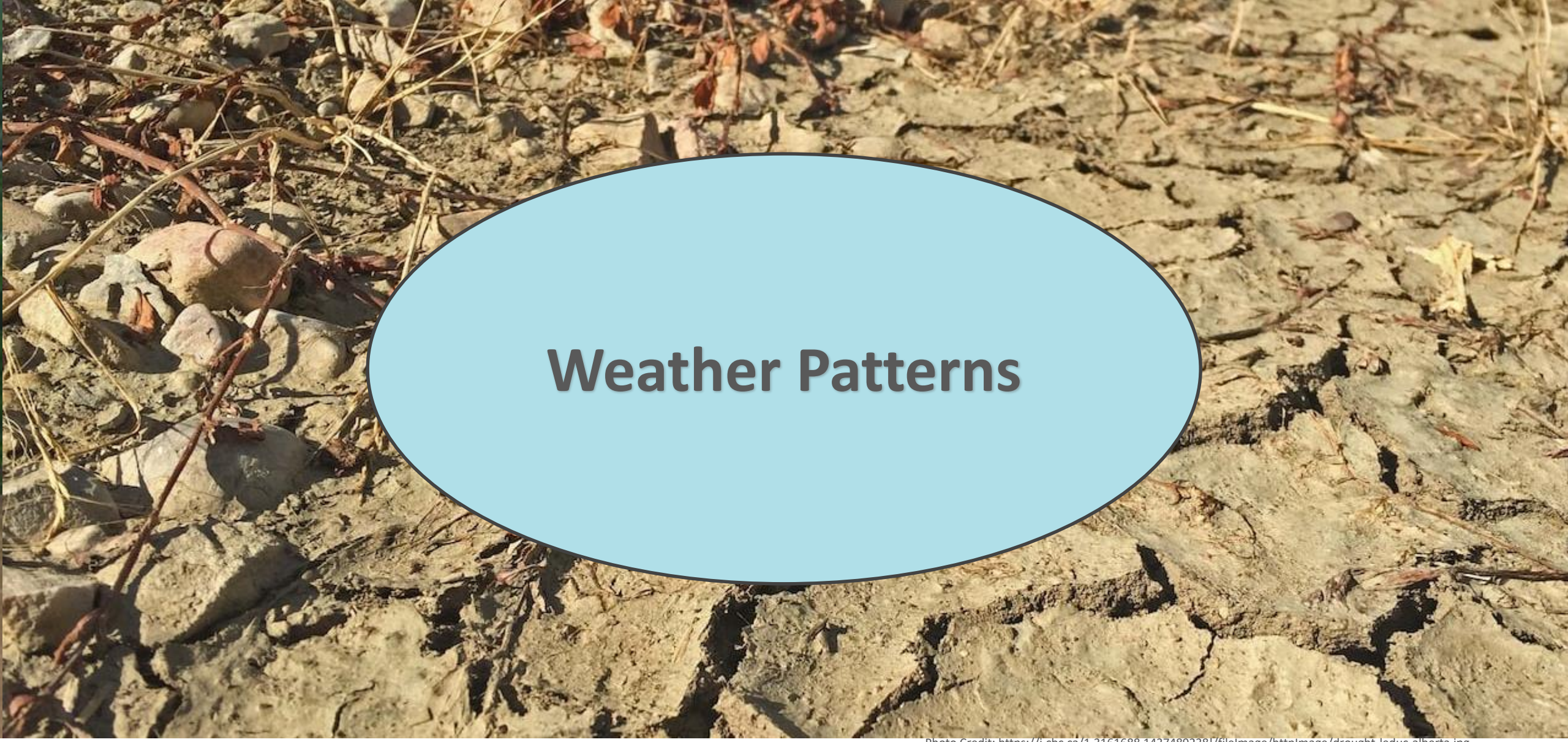
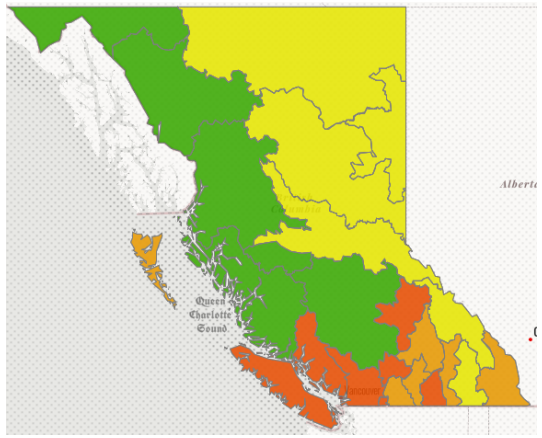


Photo Credit: https://i.cbc.ca/1.3161688.1437489238!/fileImage/httpImage/drought-leduc-alberta.jpg

Changing Weather Patterns

- Extreme drought mid-summer across southern interior, coastal regions, and Vancouver Island



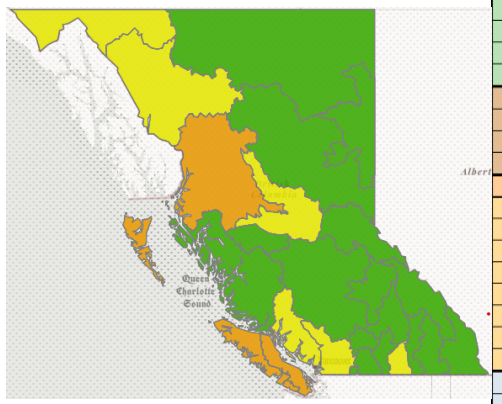
2015 DROUGHT LEVELS AT A GLANCE

Drought Levels:	1	Normal		2	Dry		3	Very Dry		4	Extremely Dry			
Basins	15-May	28-May	25-Jun	03-Jul	09-Jul	15-Jul	21-Jul	23-Jul	05-Aug	06-Aug	20-Aug	03-Sep	17-Sep	01-Oct
Northwest	2	1	1	1	1	1	1	1	1	1	1	1	1	1
Stikine	2	1	1	1	1	1	1	1	1	1	1	1	1	1
Northeast	1	1	1	1	2	2	2	2	2	2	1	1	1	1
Peace	1	1	1	1	2	2	2	2	2	2	2	1	1	1
East Peace	1	2	1	1	2	2	2	2	2	2	2	1	1	1
Skeena-Nass	1	1	1	1	1	1	1	2	2	2	2	1	1	1
Nechako	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Upper Fraser	1	1	1	1	1	1	1	2	2	2	2	2	1	1
Upper Columbia	1	1	1	1	1	1	1	2	2	2	2	2	1	1
Lower Columbia	1	1	2	2	2	2	2	2	2	3	3	3	2	2
West Kootenay	1	1	2	2	2	2	2	2	2	3	3	3	2	2
East Kootenay	2	1	2	2	2	2	2	2	2	3	3	3	1	1
Middle Fraser	2	1	1	1	1	1	1	2	2	3	3	3	2	1
North Thompson	1	1	1	1	2	2	2	2	3	3	4	4	2	1
South Thompson	1	1	2	2	3	3	3	4	4	4	4	4	3	2
Okanagan-Kettle	2	2	2	2	3	3	3	3	4	4	4	4	3	3
Kettle (separated July 23)								4	4	4	4	4	3	3
Nicola	2	2	2	2	3	3	4	4	4	4	4	4	3	2
Similkameen	2	2	2	2	3	3	3	4	4	4	4	4	3	2
Skagit	1	1	1	1	3	3	3	4	4	4	4	3	2	1
Lower Fraser	2	2	3	3	3	4	4	4	4	4	4	3	2	1
South Coast	2	2	3	3	3	4	4	4	4	4	4	3	2	1
Vancouver Island	2	3	3	4	4	4	4	4	4	4	4	3	2	1
Haida Gwaii	1	3	3	3	3	3	3	3	3	3	2	1	1	1
Central Coast	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Prepared By: Water Management Branch, Ministry of Forests, Lands and Natural Resource Operations
Last Update: October 2, 2015

Changing Weather Patterns

- Mild summer long drought across south coast and Vancouver Island



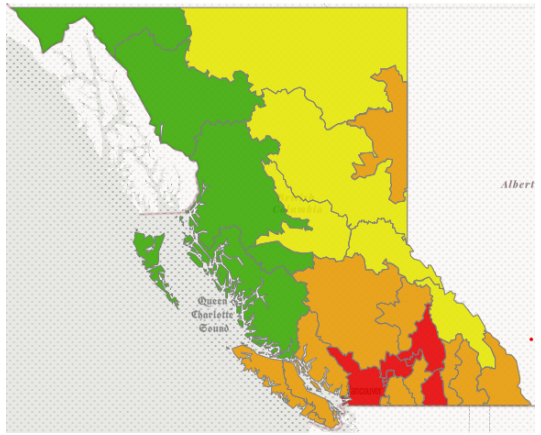
2016 DROUGHT LEVELS AT A GLANCE

Drought Levels:	1	Normal		2	Dry		3	Very Dry		4	Extremely Dry										
BASINS	27-Apr	19-May	27-May	02-Jun	16-Jun	28-Jun	30-Jun	14-Jul	28-Jul	03-Aug	11-Aug	18-Aug	25-Aug	30-Aug	01-Sep	02-Sep	08-Sep	13-Sep	22-Sep	23-Sep	05-Oct
Northeast	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
East Peace	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Peace	1	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Northwest	2	2	2	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1
Stikine	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1
Skeena-Nass	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	2	1	1	1	1	1
Nechako	1	1	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
Upper Fraser West	1	1	2	2	2	2	2	1	1	1	1	1	1	2	2	2	1	1	1	1	1
Upper Fraser East	1	1	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Upper Columbia	1	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
Lower Columbia	1	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
East Kootenay	1	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
West Kootenay	1	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
Middle Fraser	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
North Thompson	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
South Thompson	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Nicola	1	2	2	2	2	2	2	2	1	1	1	1	2	2	2	2	2	2	1	1	1
- Coldwater River Basin	1	2	2	2	2	2	2	2	1	1	1	3	3	3	3	3	3	3	1	1	1
- Salmon River Basin	1	2	2	2	2	2	2	2	1	1	1	2	2	2	2	2	1	1	1	1	1
Similkameen	1	2	2	2	2	2	2	1	1	1	1	1	2	2	2	2	2	2	2	1	1
Okanagan	1	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Kettle	1	2	2	2	2	2	2	1	1	1	1	1	2	2	2	2	2	2	2	1	1
Skagit	2	2	2	2	2	2	2	1	1	1	1	1	2	2	2	2	2	2	1	1	1
Lower Fraser	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
South Coast	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
Central Coast	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
West Vancouver Island	1	2	3	3	3	3	3	2	2	2	2	2	3	3	2	2	2	2	1	1	1
East Vancouver Island	1	2	3	3	3	4	4	3	3	3	3	3	3	3	3	3	3	3	2	2	1
Haida Gwaii	1	2	2	2	2	2	3	2	2	3	3	3	3	3	3	3	2	1	1	1	1

Prepared By: Water Management Branch, Ministry of Forests, Lands and Natural Resource Operations
Last Update: October 5, 2016

Changing Weather Patterns

- Extreme late-summer drought across southern interior, towards south coast region



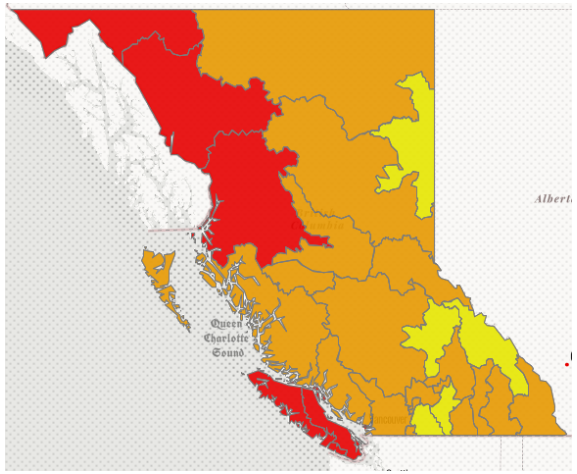
2017 DROUGHT LEVELS AT A GLANCE

Drought Levels:	1	Normal		2	Dry		3	Very Dry		4	Extremely Dry							
BASINS	31-May	01-Jun	22-Jun	06-Jul	20-Jul	03-Aug	10-Aug	14-Aug	17-Aug	23-Aug	28-Aug	31-Aug	08-Sep	14-Sep	28-Sep	12-Oct	18-Oct	26-Oct
Northeast	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
East Peace	1	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	2
Peace	1	1	1	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2
Northwest	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Stikine	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Skeena-Nass	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	1
Nechako	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Upper Fraser West	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Upper Fraser East	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Upper Columbia	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2
Lower Columbia	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	2
East Kootenay	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	2
West Kootenay	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	2
Middle Fraser	1	1	1	2	2	3	3	3	3	3	3	3	3	3	3	3	3	2
North Thompson	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	2
South Thompson	1	1	1	1	1	2	2	2	2	2	3	3	4	4	4	4	4	3
Nicola	1	1	1	1	2	2	3	3	3	3	3	4	4	4	4	4	4	2
- Coldwater River Basin	1	1	1	2	2	2	3	3	3	4	4	4	4	4	4	4	4	2
- Salmon River Basin	1	1	1	1	2	2	2	2	2	3	3	4	4	4	4	4	4	3
Similkameen	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	3	3	2
Okanagan	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3	2
Kettle	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	4	2
Skagit	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3	4	1	1
Lower Fraser	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	4	1	1
South Coast	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	4	1	1
Central Coast	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
West Vancouver Island	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	1	1
East Vancouver Island	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	2	1
Haida Gwaii	1	1	1	1	2	2	2	2	2	2	2	1	1	1	1	1	1	1

Prepared By: Water Management Branch - Ministry of Forests, Lands, Natural Resource Operations and Rural Development
Last Update: October 26, 2017

Changing Weather Patterns

- Intensive drought mid-late summer across the majority of British Columbia



2018 DROUGHT LEVELS AT A GLANCE

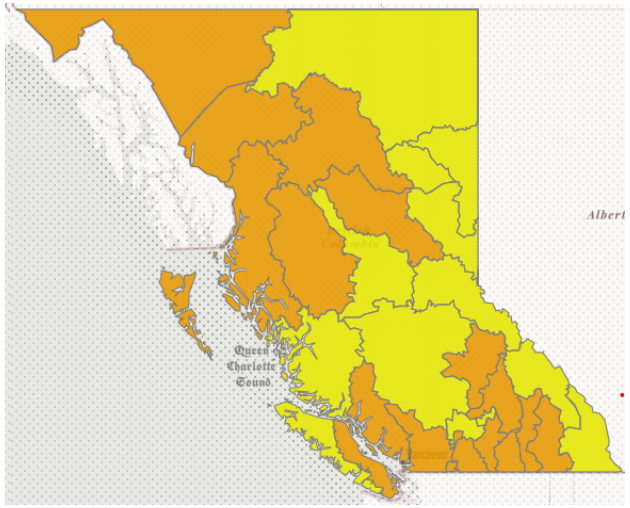
Drought Levels:	1	Normal	2	Dry	3	Very Dry	4	Extremely Dry		

BASINS	14-Jun	28-Jun	12-Jul	26-Jul	09-Aug	14-Aug	17-Aug	21-Aug	23-Aug	06-Sep	20-Sep	04-Oct	18-Oct	01-Nov	08-Nov
Northeast	2	1	1	2	3	3	3	3	4	3	2	2	2	1	1
East Peace	2	1	1	1	1	1	1	1	2	2	1	1	1	1	1
Peace	2	1	2	2	2	2	3	3	3	3	2	3	3	3	3
Northwest	2	2	2	3	3	3	3	3	4	3	3	3	3	2	1
Stikine	2	2	2	3	3	3	3	3	4	4	4	4	4	4	2
Skeena-Nass	2	2	2	3	3	3	3	3	4	4	4	4	4	4	3
Nechako	1	1	1	1	2	2	2	2	3	3	2	3	3	3	3
Upper Fraser West	1	1	1	1	2	2	3	3	3	3	3	3	3	3	2
Upper Fraser East	2	1	1	1	2	2	3	3	3	3	2	3	3	3	1
Upper Columbia	2	1	1	2	2	2	2	2	2	2	2	1	1	1	1
Lower Columbia	2	1	1	2	2	2	2	2	3	3	2	1	1	1	1
West Kootenay	2	1	2	2	2	2	2	2	3	3	2	1	1	1	1
East Kootenay	2	1	2	2	2	2	2	2	3	3	3	2	2	2	1
Middle Fraser	2	1	1	2	2	2	2	2	3	3	3	3	3	2	1
North Thompson	1	1	1	2	2	2	2	2	2	2	1	1	1	1	1
South Thompson	1	1	1	2	2	2	2	2	3	3	2	1	1	1	1
- Salmon River Basin	2	2	1	2	2	2	2	2	3	3	2	1	1	1	1
Nicola	2	1	1	2	2	2	2	3	3	3	2	1	1	1	1
- Coldwater River Basin	2	2	2	2	2	2	2	3	3	3	2	1	1	1	1
Similkameen	2	1	1	2	2	2	2	2	2	2	2	1	1	1	1
Okanagan	1	1	1	1	2	2	2	2	2	2	2	1	1	1	1
Kettle	1	1	1	2	2	2	3	3	3	3	2	1	1	1	1
Skagit	2	1	1	2	2	2	2	2	3	3	2	1	1	1	1
Lower Fraser	2	2	2	3	3	3	3	3	3	3	2	1	1	1	1
South Coast	2	2	2	3	3	3	3	3	3	3	2	1	1	1	1
Central Coast	2	1	1	3	3	3	3	3	3	3	3	3	3	2	1
West Vancouver Island	1	1	1	3	3	3	3	3	4	4	2	1	1	1	1
East Vancouver Island	2	2	2	3	3	4	4	4	4	4	2	1	1	1	1
Haida Gwaii	1	1	2	3	3	3	3	3	3	3	2	2	2	1	1

Prepared By: Water Management Branch - Ministry of Forests, Lands, Natural Resource Operations and Rural Development

Changing Weather Patterns

- Summer long drought across much of British Columbia

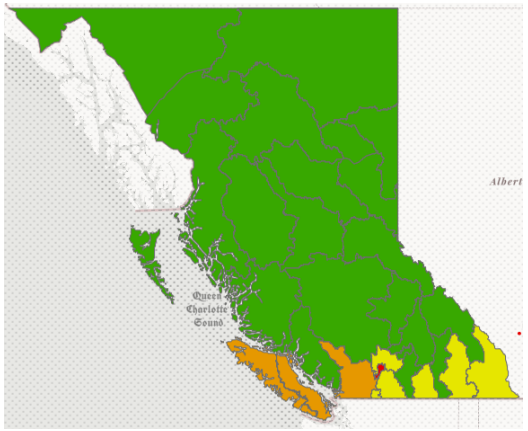


2019 DROUGHT LEVELS AT A GLANCE

Drought Levels:	1	Normal	2	Dry	3	Very Dry	4	Extremely Dry					
BASINS	30-May	13-Jun	27-Jun	04-Jul	11-Jul	17-Jul	25-Jul	01-Aug	08-Aug	15-Aug	22-Aug	06-Sep	19-Sep	03-Oct	28-Oct
Fort Nelson	3	4	3	3	2	1	1	1	1	1	1	1	1	1	1
East Peace	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1
North Peace	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1
South Peace	2	2	3	3	2	1	1	1	1	1	1	1	1	1	1
Northwest	2	2	2	2	3	3	3	3	3	3	3	2	2	2	2
Stikine	2	3	3	3	3	3	3	3	3	3	3	2	1	1	1
Skeena-Nass	2	3	3	3	3	2	2	2	3	3	2	2	1	1	1
Bulkley-Lakes	2	3	3	3	3	2	2	2	3	3	3	3	1	2	1
Finlay	2	3	3	3	3	3	2	2	1	1	1	1	1	1	1
Parsnip	2	3	3	3	3	3	2	2	2	2	1	1	1	1	1
Upper Fraser West	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Upper Fraser East	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1
Upper Columbia	1	2	2	2	2	2	1	1	1	1	1	1	1	1	1
Lower Columbia	1	3	3	3	3	3	2	2	2	2	1	1	1	1	1
West Kootenay	1	3	3	3	3	3	2	2	2	2	2	2	1	1	1
East Kootenay	2	3	3	3	2	2	1	1	1	1	1	1	1	1	1
Middle Fraser	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1
North Thompson	2	3	3	3	3	1	1	1	1	1	1	1	1	1	1
South Thompson	2	3	3	3	3	2	1	1	1	1	1	1	1	1	1
-Salmon River	2	3	3	3	2	2	1	1	1	1	1	2	1	1	1
Nicola	2	3	3	3	2	2	2	2	2	2	2	2	1	1	1
-Coldwater River	2	3	3	3	3	3	3	4	4	4	4	4	2	1	1
Similkameen	2	3	3	3	3	3	2	2	2	3	3	3	1	1	1
Okanagan	2	3	3	3	3	2	2	2	2	2	2	2	1	1	1
Kettle	2	3	3	3	3	2	2	2	2	1	2	2	1	1	1
Skagit	2	3	3	3	3	3	3	3	3	3	3	3	1	1	1
Lower Fraser	2	3	3	3	3	3	3	3	3	3	3	3	1	1	1
South Coast	2	3	3	3	3	3	3	3	3	3	3	3	1	1	1
Central Coast	2	2	2	2	2	2	2	2	1	1	2	2	1	1	1
West Vancouver Island	3	3	3	3	2	2	1	1	1	1	1	1	1	1	1
East Vancouver Island	3	3	3	3	3	3	2	2	2	2	2	3	1	1	1
Haida Gwaii	2	2	2	3	3	3	2	2	2	2	1	1	1	1	1

Changing Weather Patterns

- Extreme late-summer drought within the Coldwater River Basin in British Columbia



2020 DROUGHT LEVELS AT A GLANCE

Drought Levels:	1	Normal	2	Dry	3	Very Dry	4	Extremely Dry			
BASINS	24-Jun	13-Jul	22-Jul	05-Aug	19-Aug	02-Sep	10-Sep	16-Sep	23-Sep	28-Sep	30-Sep	14-Oct
Fort Nelson	1	1	1	1	1	1	1	1	1	1	1	1
East Peace	1	1	1	1	1	1	1	1	1	1	1	1
North Peace	1	1	1	1	1	1	1	1	1	1	1	1
South Peace	1	1	1	1	1	1	1	1	1	1	1	1
Northwest	1	1	1	1	1	1	1	1	1	1	1	1
Stikine	1	1	1	1	1	1	1	1	1	1	1	1
Skeena-Nass	1	1	1	1	1	1	1	1	1	1	1	1
Bulkley-Lakes	1	1	1	1	1	1	1	1	1	1	1	1
Finlay	1	1	1	1	1	1	1	1	1	1	1	1
Parsnip	1	1	1	1	1	1	1	1	1	1	1	1
Upper Fraser West	1	1	1	1	1	1	1	1	1	1	1	1
Upper Fraser East	1	1	1	1	1	1	1	1	1	1	1	1
Upper Columbia	1	1	1	1	1	1	1	1	1	1	1	1
Lower Columbia	1	1	1	1	1	1	1	1	1	1	1	1
West Kootenay	1	1	1	1	1	1	2	2	2	1	1	1
East Kootenay	1	1	1	1	2	2	2	2	2	2	2	1
Kettle	1	1	1	1	2	2	2	2	2	2	2	2
Middle Fraser	1	1	1	1	1	1	1	1	1	1	1	1
North Thompson	1	1	1	1	1	1	1	1	1	1	1	1
South Thompson	1	1	1	1	1	1	1	1	1	1	1	1
-Salmon River	1	1	1	1	1	1	1	1	1	1	1	1
Nicola	1	1	1	1	1	1	1	2	2	1	1	1
-Coldwater River	1	1	1	1	3	3	4	4	4	4	4	1
Okanagan	1	1	1	1	1	1	1	1	1	1	1	1
Similkameen	1	1	1	1	2	2	2	2	2	1	1	1
Skagit	1	1	1	1	1	1	1	2	2	1	1	1
Lower Fraser	1	1	1	1	1	2	2	3	3	1	1	1
South Coast	1	1	1	1	1	1	1	1	1	1	1	1
Central Coast	1	1	1	1	1	1	1	1	1	1	1	1
West Vancouver Island	1	1	1	2	2	2	2	3	3	2	1	1
East Vancouver Island	1	1	2	2	2	2	3	3	3	2	2	1
Haida Gwaii	1	1	1	1	1	1	1	1	1	1	1	1

Prepared By: Water Management Branch - Ministry of Forests, Lands, Natural Resource Operations and Rural Development

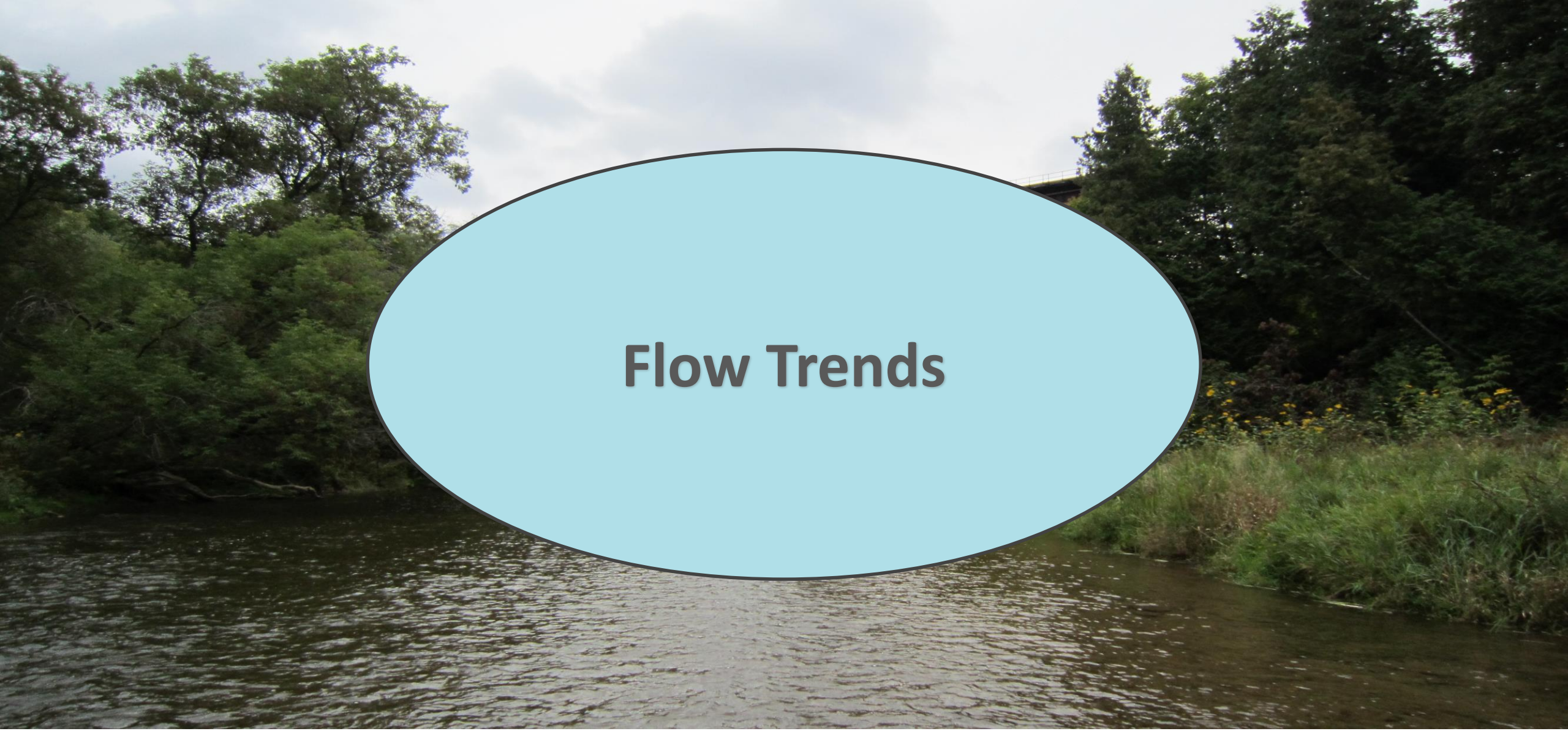
Changing Weather Patterns

- Extreme summer long drought across central, southern, and coastal regions of British Columbia

2021 DROUGHT LEVELS AT A GLANCE

Drought Levels:	0		1		2		3		4		5									
BASINS	26-May	09-Jun	23-Jun	07-Jul	14-Jul	21-Jul	28-Jul	04-Aug	11-Aug	18-Aug	20-Aug	25-Aug	01-Sep	08-Sep	15-Sep	17-Sep	22-Sep	29-Sep	06-Oct	20-Oct	28-Oct	01-Nov
Fort Nelson	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
East Peace	0	0	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
North Peace	0	0	0	0	2	2	2	2	2	2	2	0	0	0	0	0	1	1	0	0	0	0
South Peace	0	0	1	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
Northwest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stikine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Skeena-Nass	0	0	0	0	0	1	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0
Bulkley-Lakes	0	0	0	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
Finlay	0	0	0	0	0	2	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0
Parsnip	0	0	0	0	0	1	1	1	1	1	1	1	1	2	1	1	1	0	0	0	0	0
Upper Fraser West	0	0	0	2	2	2	1	1	1	1	1	1	1	2	2	2	1	1	1	0	0	0
Upper Fraser East	0	0	0	1	2	2	2	2	2	1	1	1	2	2	1	1	0	0	0	0	0	0
Upper Columbia	0	0	0	0	1	1	2	2	2	1	1	1	2	2	2	2	1	0	0	0	0	0
Lower Columbia	1	1	1	2	3	4	4	4	4	4	4	4	4	4	4	4	4	3	2	2	1	1
West Kootenay	1	1	1	2	3	4	4	4	4	4	4	4	4	4	4	4	4	3	2	2	1	1
East Kootenay	1	1	1	1	2	2	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2
Kettle	1	2	2	3	4	4	4	5	5	5	5	5	5	5	5	5	5	4	3	3	2	2
Middle Fraser	1	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	0	0	0	0
North Thompson	0	0	0	1	3	3	4	4	4	4	4	4	4	4	4	4	3	3	3	0	0	0
South Thompson	1	1	1	2	3	3	4	4	4	4	4	4	4	4	4	4	4	4	3	1	1	1
-Salmon River	1	2	2	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	5	3	3	3
Nicola	1	1	2	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	3	1	1	2
-Coldwater River	1	1	1	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	3	1	1	1
Okanagan	1	1	1	3	3	3	3	3	4	4	4	4	4	4	4	4	3	3	3	2	2	2
Similkameen	0	0	1	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1
Skagit	1	1	1	1	2	3	3	3	3	3	3	3	3	3	3	3	2	1	0	0	0	0
Lower Fraser	1	1	1	1	2	3	4	4	4	4	4	4	4	4	3	3	2	1	0	0	0	0
South Coast	1	1	1	1	3	3	4	4	4	4	4	4	4	4	3	3	2	1	0	0	0	0
Central Coast	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	2	0	0	0	0	0	0
West Vancouver Island	1	1	1	3	3	3	4	4	4	4	5	5	5	5	5	4	2	0	0	0	0	0
East Vancouver Island	2	2	2	4	4	4	4	4	4	4	5	5	5	5	5	4	2	1	0	0	0	0
Haida Gwaii	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Prepared By: Water Management Branch - Ministry of Forests, Lands, Natural Resource Operations and Rural Development


Flow Trends

River Flows

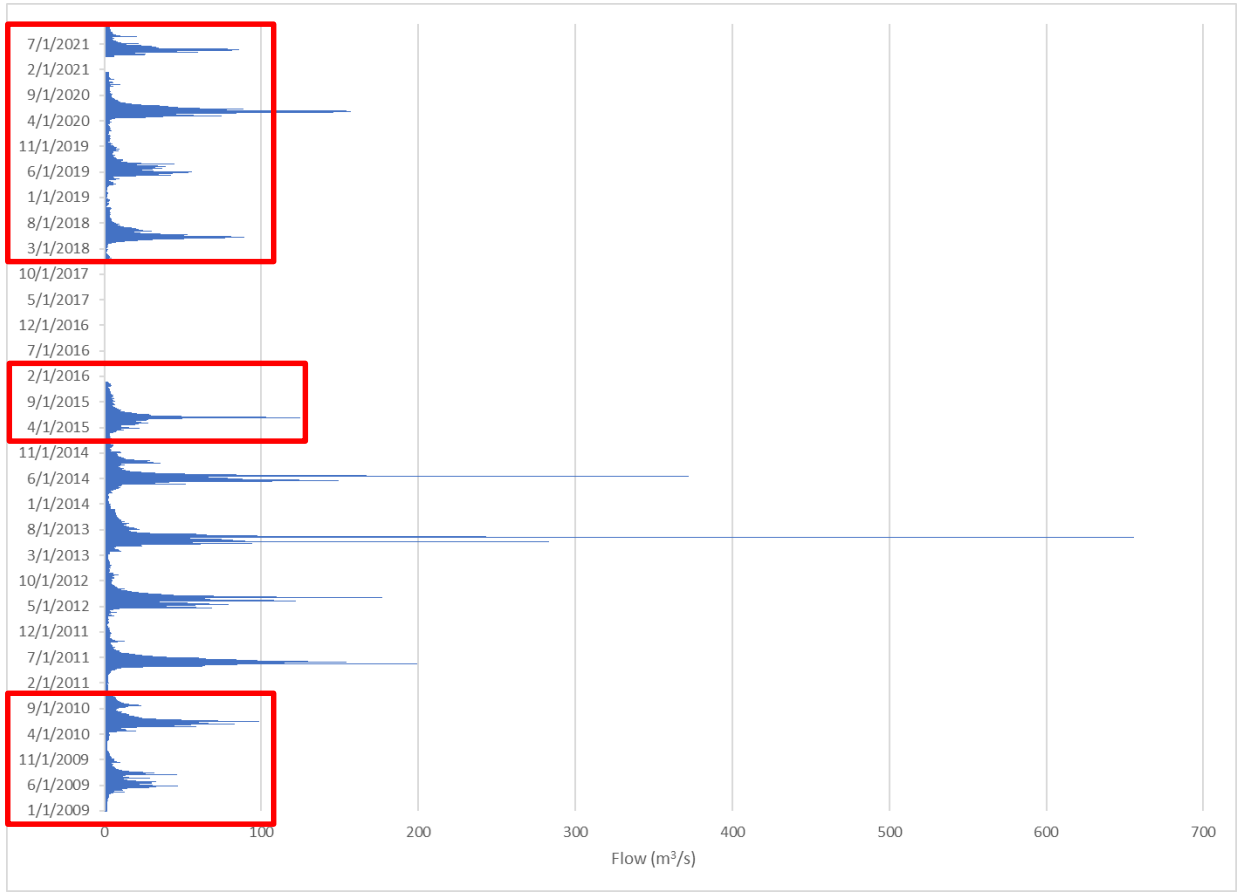
- Coldwater River at Merritt, BC (Water Survey of Canada [WSC] Station 08LG010)
  - From 1961 to 1995 the Critical Environmental Flow Threshold (CEFT) of 0.84 m^3/s[1] was not met approximately 11.3% of the time
    - Lowest value recorded flow = 0.112 m^3/s
  - From 2005 to 2020 the CEFT was not met approximately 15.1% of the time
    - Lowest value recorded flow = 0.084 m^3/s
  - **33.7% increase in CEFT not being met.**
  - **25% decrease in lowest recorded flow**
  - Drought conditions may stress juvenile fish and impact survival rates and impact spawning activities of resident and migratory fish species

Photo Credit: https://www.merrittherald.com/coldwater-river-watershed-in-extreme-drought-condition/

[1] https://www.fraserbasin.bc.ca/_Library/TR_Nicola/Coldwater_GW_SW_Interactions_Mar_23_2020.pdf

River Flows

- Oldman River at Range Road No. 13A
  - WSC Station 05AA035
  - Upstream of Oldman Reservoir
- Drought impacted flows
  - 2009-2010, 2015, 2018-2019, 2021
- Closed basin since 2006 = no new licences
- Angling restrictions during July/August




Potential Impacts

Potential Direct and Indirect Impacts

- Potential implications for communities
  - 156 current licences (surface and groundwater) in the Coldwater River Basin, 3 in application phase
  - Licences date back to 1889 for the local Indigenous community, 1897 for domestic use, 1896 for irrigation
  - Through regulatory instruments (*Water Sustainability Act*) water rights can be restricted, other than for essential household needs (250 L/day/dwelling)
  - Angling suspensions
- Potential implications for industrial users
  - Section 10 Use Approvals under the *Water Sustainability Act* were suspended for all oil and gas operators in the Coldwater River Basin in 2021
  - Water rights can be suspended where significant water shortages are designated
  - Production can be reduced or suspended entirely, which could result in job losses
  - Discharges of effluent may be required to be reduced as the anticipated dilution factor is no longer applicable
  - Exceedance of provincial or federal water quality guidelines or objectives

Potential Direct and Indirect Impacts

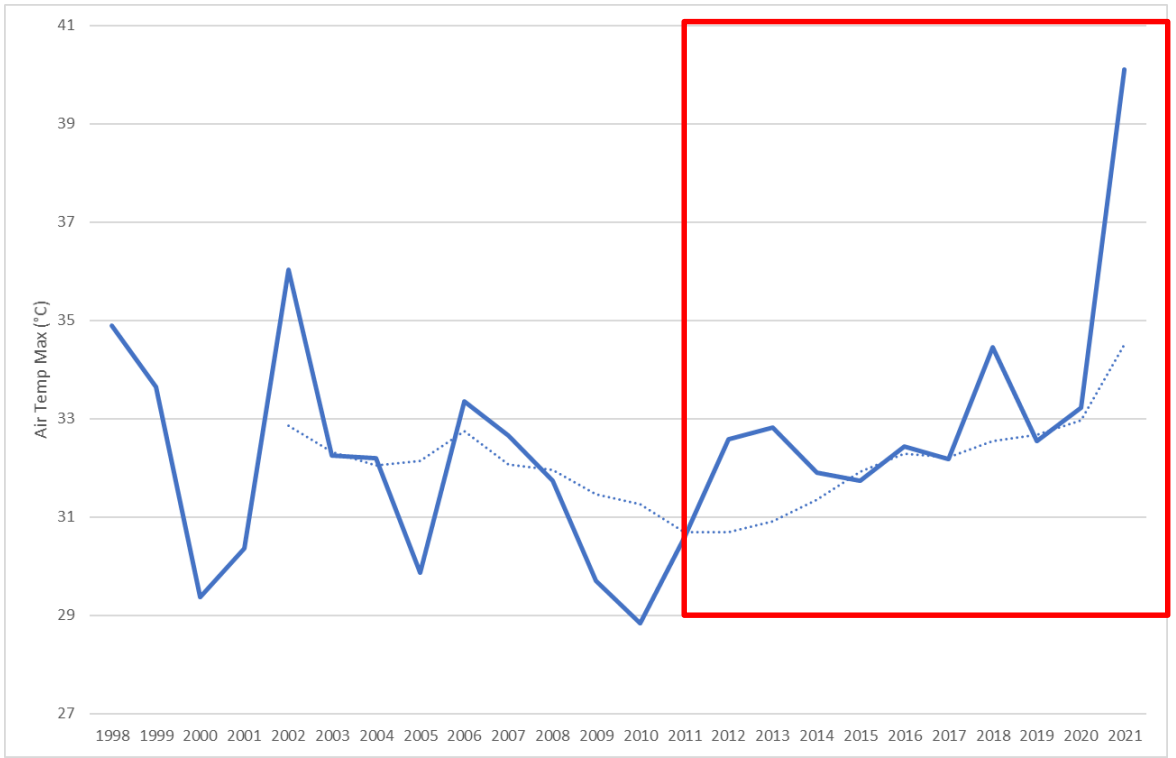
- Potential implications for the environment
  - Disruption of the natural flow regime for rivers, creeks, lakes, and wetlands
    - Smaller flow pulses may reduce the ability to clear out flood deposited material, limiting access to fish habitat
  - Potential long-term impacts to aquatic habitats and wildlife as optimal habitats disappear
  - Plants and animals may transition to survival mechanisms (where possible) and habitat avoidance, if alternative and connected habitats exist
  - Hotter and drier landscapes can provide optimal conditions for extreme weather events to occur
  - The capacity of an aquatic receiving environment to mix, and adequately dilute effluent within a specified zone can be reduced
    - Potentially toxic conditions for wildlife


Significant Events

Climate Trends - Alberta

- From 1951 to 2017[1]
  - Mean Annual Temperature Increases
    - Calgary 2.9°C
    - Edmonton 1.9°C
    - Grande Prairie 1.9°C
    - Fort McMurray 2.8°C
    - Cold Lake 2.2°C
  - Annual Precipitation Decreases
    - Calgary 8%
    - Edmonton 16%
    - Grande Prairie 17%
    - Fort McMurray 26%
    - Cold Lake 15%

- Fort McMurray Air Temperature Max
  - From 1998 to 2021[2]
  - Since 2011, consistently exceed the 5-year moving average



[1] Alberta Climate Records
[2] Alberta Climate Information Service

Significant Weather Events

- Fort McMurray wildfire in 2016
  - Drought conditions in the preceding years
  - High resin content in trees
  - Relative humidity in April 2016 was the lowest since before 1960
  - Financial cost of close to $10 billion
  - Burned approximately 579,767 hectares of land

Photo Credit: https://i0.wp.com/www.abexinsurance.com/wp-content/uploads/2016/07/forest-fire.jpg

Significant Weather Events

- 2021 wildfires in Lytton and surrounding regions
  - The largest 6 wildfires of note (BC) in 2021 engulfed much of the southern British Columbia interior throughout the summer and early fall
  - Sparks Lake, Lytton Creek, White Rock Lake, 5 km West of Flat Lake, Tremont Creek, McKay Creek (plus others)
    - All within 100 km of Kamloops, BC
  - Burned approximately 445,367 hectares of land
  - Financial cost still uncertain, but estimated at over $1 billion

Photo Credit: https://globalnews.ca/news/7996127/lytton-wildfire-damage/

Photo Credit: https://www.thestar.com/news/canada/2021/07/08/ash-rubble-and-yet-hope-lytton-residents-tour-their-fire-ravaged-bc-town-for-the-first-time.html

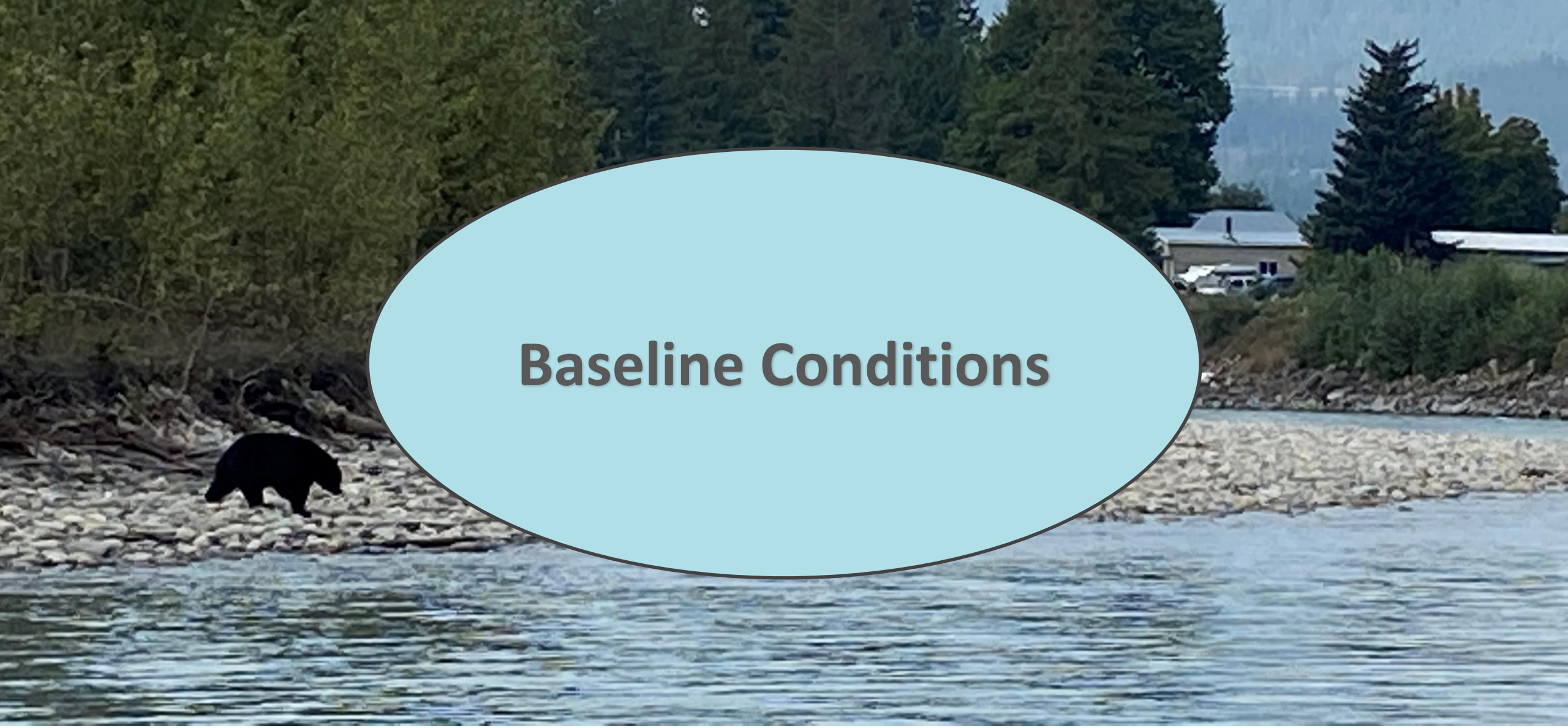
Significant Weather Events

- 2021 atmospheric river (AR) in the BC southern interior and along coastal regions
  - Major cause of catastrophic flooding and landslides
  - Financial cost estimated at over $13 billion
  - Becoming more frequent
  - Rating scale developed in 2019, similar to hurricanes
    - AR 1 to 5
      - 1 being weak and mostly beneficial
      - 4 and 5 are dangerous and potentially deadly to humans
  - In 2021, two AR's landed in BC and each was rated as a 4 or 5
  - Climate change is projected to cause AR's to:
    - Increase up to 25% in width (larger scale of impacts)
    - Increase up to 25% in length (duration of event extended)
    - Increase up to 50% in intensity (increased magnitude of impacts)

Satellite image ©2021 Maxar Technologies

Satellite image ©2021 Maxar Technologies

Photo Credit: https://globalnews.ca/news/8383490/bc-historic-flood-photo-from-space/



Baseline Conditions

Changing of Baseline Environmental Conditions

- Aquatic receiving environments are undergoing human induced and natural changes to baseline conditions
  - Water temperature
  - Dissolved oxygen
  - Salinity
  - Sedimentation and erosion
  - Nutrient levels
  - Changes to natural flow regime
    - Freshet is often occurring sooner and is more intense
    - Seasonal shift to freshet is also increasing length of low flow periods in some rivers
  - Water scarcity reduces potential dilution for dischargers
    - Potential increases to chronic toxicity for non-PBT substances

Discharge Limits

Changing Discharge Limits

- Water quality guidelines and objectives are constantly undergoing review and updates, based on new information
  - New research, demonstrated impacts, sensitive species or habitats, other external factors
- Discharge (e.g., backflush, dewatering, effluent, stormwater) permits or approval conditions may change as well
  - *Water Sustainability Act* (BC)
  - *Environmental Management Act* (BC)
  - *Water Act* (AB)
  - *Environmental Protection and Enhancement Act* (AB)
  - Pulp and Paper Effluent Regulations (federal)
  - Municipal Wastewater Regulations (federal)
  - CCME Strategy[1]
  - Local government by-laws

[1] Canada-wide Strategy for the Management of Municipal Wastewater Effluent

Changing Discharge Limits

- Water users may be able to negotiate these changes with the regulators, however, water users need to consider these scenarios to be sufficiently prepared
- There are proactive approaches that water users such as municipal and industrial operators should consider, to help facilitate the futureproofing of their approach

How can you encourage your business to become more resilient to climate change induced shifts in environmental baseline conditions?


Proactive Planning

Proactive Planning

- Aquatic receiving environment monitoring programs
  - Consider more-robust programs that can provide an early warning system for your operations
  - Coordinate provincial, federal, and local government monitoring requirements to reduce cost and improve data quality
  - Approach the regulator to have the conversation around effluent discharge limits
    - i.e., proactive vs reactive management of your waste products
  - Request second opinions on current level of monitoring activities
    - If there is a history of no demonstrated impacts to the receiving environment, you may be able to scale back some of your current programs and focus those investments on updating your processes (technology) or procedures (operational efficiency)
- Reduce reliance on discharging to surface water bodies for industrial processes
  - Increase use of alternative sources
  - Investment in water recycling technologies
- Operational planning for discharging outside of sensitive time windows
  - Review the changing flow regime of the receiving environment to realign your discharge period (if intermittent)

Questions / Comments?

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