DECEMBER 2022
PERFORMANCE MEASURE RESEARCH INFORMATION SHEET
LOWER COLUMBIA RIVER: FLOODING

SUMMARY

Goal: Minimize damage to private property and community infrastructure, and injury to people.

Recommended Performance Measures

Measured at the Birchbank Water Survey Canada gauge

Objective / Location	Performance Measure	Units	Description
Flooding/ Lower Columbia River	Low lying area flooding	Median number of days per year when daily average flow ≥ 151,500 to <214,000 cfs (4,290 to <6,059.8 cms). Less is better.	Frequency that Castlegar recreation sites begin to be flooded
	Infrastructure damage	Total number of days when average flow ≥ 214,000 cfs. Less is better	Frequency that Castlegar sewer infrastructure, recreation infrastructure and Genelle access and septic systems are damaged

Further consideration of the best statistics (e.g. median, mean and what years to include) is ongoing and may result in some revision to these measures.

Sub-measures of the number of days, number of years and flow levels above the thresholds will inform detailed scenario evaluation.

INTRODUCTION

Castlegar and Trail experienced significant flood events before the Columbia River Treaty (CRT) dams were constructed (e.g. in 1948 and 1961). However, since construction of the Columbia River CRT hydroelectric facilities in the mid-late 1960s, the likelihood of flood events has been substantially reduced from historic levels. Since project construction, there have been three inflow years comparable to 1948 without any significant downstream impacts on Castlegar or Trail. See Figure 1.

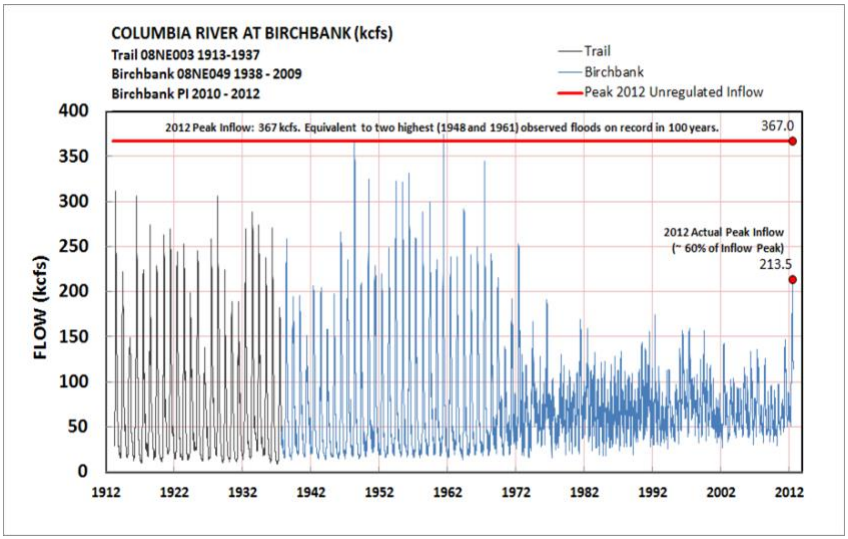


Figure 1. Historical flow on the Lower Columbia River at the Birchbank Water Survey of Canada gauge.

During a high flow event in June-July 2012, a peak flow of 215,000 cfs (6,088.1 cms) was measured at the Birchbank gauge located below the confluence with the Kootenay River, between Castlegar and Trail. This was the highest recorded river flow during the 40-year period (since 1973) with all upstream reservoirs operational. The actual peak flow event in 2012 is consistent with the results of a theoretical flood-frequency study done by BC Hydro in the early 1980s, in which the 30-year regulated peak flow for this site was estimated at 225,000 cfs (6,371.3 cms).

PAST PERFORMANCE MEASURE DEVELOPMENT

- **2005 Columbia Water Use Plan Consultative Committee Report**

  This report included the following performance measure for flood control at Genelle to protect the trailer park (Table 4.2). The report also notes that 'The City of Trail representative emphasized that damage to the city's infrastructure starts when river flows reach 165 kcfs' (section 4.4.1.2).

Table 1: Flood Control PM from the Columbia WUP Consultative Committee Report

Location	Performance Measure	Units	Description
Lower Columbia River	Frequency of Flood Flows	# of potential flood days per year at Genelle (>165,000 cfs/ 4672 cms)	This performance measure tracks the expected frequency with which flows exceed the flow rate that will cause property damage at Genelle.

- **2010 Non-Treaty Storage Agreement Consultations Infosheet #27**

  For this process, the performance measure from the 2004 Water Use Plan Consultative Committee Report was used and two additional thresholds were also developed to consider the potential for flooding of infrastructure in the City of Trail at flow levels above 72,000 cfs

(2,038.8 cms) and 177,499 cfs (5,026.2 cms). Specifically, concern was expressed that Lower Columbia flows at Trail could affect servicing of the sewage trunk line and impede use of the Indian Eddy ramp for emergency rescue. The expanded performance measures were based on the table below that summarizes critical thresholds for Columbia River flows at Trail with the source identified as G. De Rosa, City Councillor Trail (pers. correspondence). The resulting performance measures are shown at the top of this Info sheet.

Critical Flow Thresholds for Trail Infrastructure

	Critical Elev. (ft/ m)	Critical Flows (cfs/ cms)
Sewage treatment site	1325 / 403.9	50,000 / 1,425.8
Base of river wall	1327 / 404.5	58,636 / 1,660.4
Sewer service road at Old Bridge Road	**1330 / 405.4**	**72,000 / 2,038.8**
River access/egress at Indian Eddy for emergency rescue	**1344 / 409.7**	**177,499 / 5,026.2**
Loss of beach at Gyro Park	1345 / 410	182,000 / 5,153.7
Downtown basement flooding begins	1349 / 411.2	223,000 / 6,314.7

- **2013 CRT Review Technical Studies Infosheet #27**

In the Info Sheet for the Lower Columbia Flooding performance measure (Infosheet # 27) used in this process, it is noted that:

- Under normal operations, Arrow Reservoir discharge, including spill from the Hugh Keenleyside Dam and generation at Arrow Lakes Generating Station, is not expected to exceed 100,000 cfs (2,831.7 cms) or cause river flows at Birchbank (Kootenay River plus total Arrow discharge) to exceed 180,000 cfs (5,097 cms).

- Onset of minor flooding is known to occur along the lower Columbia River at discharges exceeding 180,000 cfs (5,097 cms) (which is included in the CRT Assured Operating Plan[1]).

- The 2003 Columbia River Treaty Flood Control Operating Plan (2003) sets onset of significant flooding impacts at 225,000 cfs (6,371.3 cms) and major damages at greater than 280,000 cfs (7,928.7 cms)

- In association with the 2012 high flow events, the following incremental issues were observed in the downstream floodplain at flows greater than 180,000 cfs (5,097 cms):

1. > 180,000 cfs (5,097 cms):
    - Access restrictions to Zuckerberg Island causeway (Castlegar), Millennium Park (Castlegar) and Trail (Gyro Park)
    - Increasing issues with Trail sewage processing (Aging Infrastructure, not original design capability)
2. > 185,000 cfs (5,238.6 cms): Whispering Pines (Genelle) access to ancillary road restricted

3. > 190,000 cfs (5,380.2 cms): Erosion issues at the Robinson sewage lagoon (Castlegar), river front backyards flooded (Twin Rivers: Castlegar)
4. > 195,000 cfs (5,521.8 cms): Access to Zuckerberg Island (Castlegar) cut off
5. > 215,000 cfs (6,088.1 cms) Incremental risk to Trail river retaining walls when dewatering from 215,000 kcfs to 165,000 cfs (4,672.3 cms)

The Infosheet also noted that during the Columbia River WUP, a flow threshold of 165,000 cfs (4,672.3 cms) at Genelle was used as an initial benchmark for the onset of high flow impacts in the lower Columbia River. This was based on observations taken during a relatively high flow event in 1992. At that time, the Whispering Pines septic field was impacted at 165,000 cfs (4,672.3 cms), whereas remediation work has been undertaken since then and this impact was not observed in 2012.

The performance measures used to evaluate scenarios in this process were the same as those used in the Non-Treaty Storage Agreement consultation in 2010 (Table 3).

Performance measures used in the Non-Treaty Storage Agreement (NTSA) Consultations (2010) and the Columbia River Treaty Review Technical Studies (2013) (measured at the Birchbank gauge)

Table 3: Performance measures used in the Non-Treaty Storage Agreement Consultations (2010) and the Columbia River Treaty Review Technical Studies (2013) (measured at the Birchbank gauge)

Objective/ Location	Performance Measure	Units	Description
Flood Control/ Lower Columbia River	Frequency of Flood Flows	# of day per year flows exceed 165,000 cfs (4,672.3 cms)	Frequency with which flows potentially flood property in Genelle
	Infrastructure	# of day per year flows exceed 72,000 cfs (2,038.8 cms)	Frequency with which flows potentially flood the Trail sewer service road
		# of day per year flows exceed 177,499 cfs (5,026.2 cms)	Frequency with which river flows limit use of the Indian Eddy ramp

NEW INFORMATION

The Team contacted the four local governments with jurisdiction in the Lower Columbia (RDCK, RDKB, City of Castlegar, City of Trail) to verify flooding impacts during the 2012 flood event and in recent years. The City of Trail has not yet been able to verify the critical thresholds provided during the NTSA process. As well, the local governments' list of flooded sites and flow levels when the flooding initiated in 2012 differs from the list above and from the CRT Review Technical Studies Infosheet (see Table 1). In addition, the team received photos from the City of Castlegar and a CBRAC member illustrating the onset of flooding of low lying areas in Millenium Park. The team has used the verified information from the local governments (see Table 4) to propose performance measures.

Table 4: Summary of new flooding information

Flood levels	Locations	Information sources

(Birchbank gauge)		
151,500 cfs	Low lying areas in Millenium Park in Castlegar	City of Castlegar, CBRAC member
162,450 cfs	Access restricted across Zuckerberg Island causeway	City of Castlegar
207,000 cfs	Access cut off to Zuckerberg Island	City of Castlegar
212,950 cfs	Millenium Park bridge at risk	City of Castlegar
	Kootenay River RV Park lower level sites	RDCK
214,000 cfs	Robson boat ramp at maximum pile height	CBRAC member
214,360 cfs	Robinson sewage lagoon erosion and settling	City of Castlegar
	Glenmerry sewer lift station overflow damage	RDKB and City of Trail
	Whispering Pines, Genelle road access limited and private septic tanks impacted	RDKB

The research team is aware that BC Hydro has identified the following Flood Risk Management Performance measures based on average flows at the Birchbank gauge:

- onset of minor flooding = flows equal to or greater than 180,000 cfs (5,097 cms) (from CRT Annual Operating Plan);
- regional flooding = equal to or greater than 225,000 cfs (6,371.3 cms) for regional flooding (from the CRT Flood Risk Management Plan); and
- major floods = equal to or greater than 280,000 (7,928.7 cms) (from the CRT Flood Risk Management Plan).

PM RECOMMENDATIONS

Based on the information the team has collected from local governments, the following performance measures are recommended (measured at the Birchbank gauge):

Table 5: Recommended PMs for Lower Columbia River Flooding

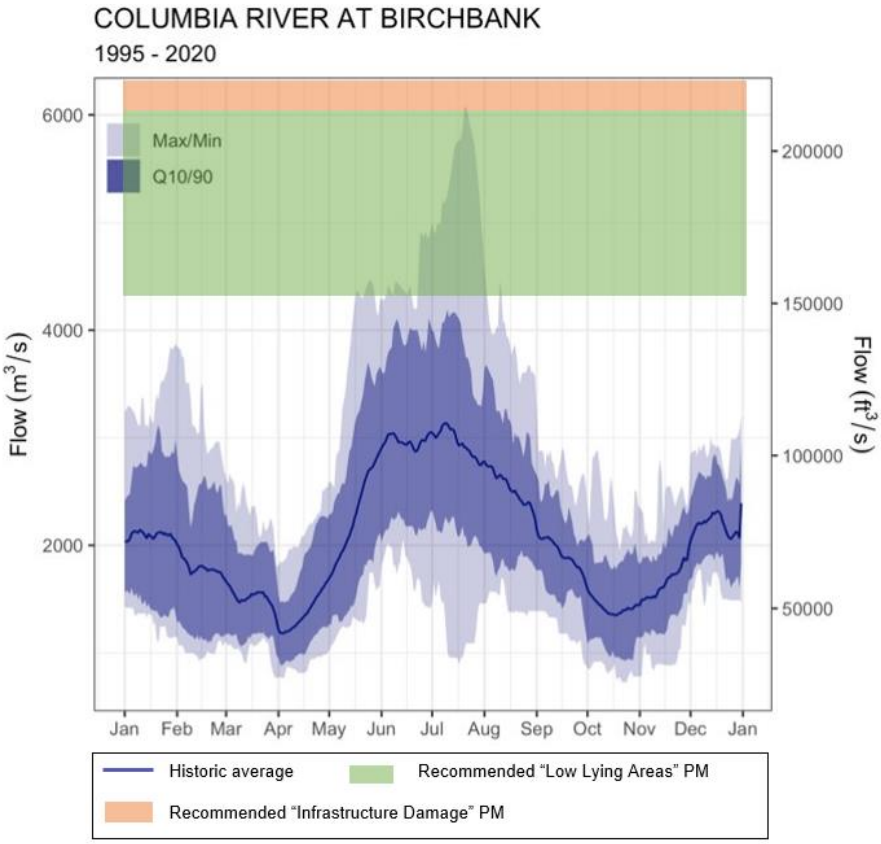
Objective / Location	Performance Measure	Units	Description
Flooding/ Lower Columbia River	Initial flooding	Median number of days per year when daily average flow ≥ 151,500 to <214,000 cfs (4,290 to <6,059.8 cms). Less is better.	Frequency that Castlegar recreation sites begin to be flooded
	Infrastructure damage	Total number of days that daily flow ≥ 214,000 cfs (≥ 6,059.8 cms). Less is better.	Frequency that Castlegar sewer infrastructure, recreation infrastructure and Genelle access and septic systems are damaged

Further consideration of the best statistics (e.g. median, mean and what years to include) is ongoing and may result in some revision to these measures.

The team also recommends that sub-measures of the number of days and number of years that flooding is estimated to occur, by one foot elevation increments, be prepared to inform detailed scenario evaluation.

The team recommends that the four local governments work together to complete a flood inundation mapping project for the developed river segments in the Lower Columbia to document flood risks from Columbia River flows. Staff of three of the four local governments have indicated a strong interest in this project.

The team also recommends that during future high-water events, the four local governments document properties and infrastructure where flood risk concerns occur and what structures, activities and operations are at risk, ideally with photographs.



CALCULATIONS

For each alternative:

1. Assemble the simulated results for flows at the Birchbank gauge.
2. Count the number of days per year that exceed the flow thresholds and number of years this occurs in the years that are included in each PM.
3. Summarize all statistics.

KEY ASSUMPTIONS AND UNCERTAINTIES

- Each scenario is simulated using the same set of system constraints, input assumptions (e.g., load forecasts) and historic basin inflows.