



Study Area and Hydrometric Gauges

The Theodosia River watershed is located on the northern Sunshine Coast about 30 km north of Powel River, BC (see Figure 1). The river has a total watershed area of approximately 133 km² and flows into the eastern end of Theodosia Inlet in Desolation Sound. A diversion weir operated by Brookfield Renewable Power is located approximately 12 km upstream from the mouth of the river. The weir is used to divert water from the Theodosia River into Olsen Lake to provide additional water to the hydro-electric facility on Powel Lake, downstream from Olsen Lake. The maximum diversion rate specified in the water licence is 56.6 m³/s while the minimum release rate into the lower Theodosia River is 1.0 m³/s when ordered by the comptroller of water rights.

A series of hydrometric stations have been installed on the river by WSC to monitor river flows. There are three gauges at the diversion which when combined can be used to estimate flows upstream of the weir, downstream of the weir and the diverted flow to Olsen Lake (08GC005, 08GC006 and 08GC007). A fourth gauge is located approximately 8 km downstream of the diversion weir at a location upstream of the confluence of the Theodosia River and Scotty Creek (08HC008). All four gauges have been operating continuously since 2003 with a few missing data periods. The locations of the gauges are shown in Figure 1. A schematic of the three gauges near the diversion weir is shown in Figure 2.

Assessment of Summer Flows Downstream of the Weir

In order to assess the change to streamflows as a result of the diverted flow, river flows at the mouth of the Theodosia River were estimated for two cases:

1. Natural flows without the diversion; and
2. Regulated flows with the diversion.

The following section describes how the flows were calculated.

Estimation of diverted flows and natural river discharges at Theodosia River

The daily average flows diverted to Olsen Lake from Theodosia River were estimated by subtracting the Theodosia River By-pass flows (08GC006) from the Theodosia River diversion flows upstream the bypass (08GC005). In general, this results in a positive diversion flow to Olsen Lake. However, on certain low-flow days, subtracting the by-pass flows from the diversion flows upstream the bypass results in negative numbers meaning the flows in the by-pass are greater than the flows in the diversion channel upstream of the bypass. The number of days where this occurs ranges from 7 days in 2006 to 67 days in 2007. This is why the 2007 data was removed from the dataset. The WSC staff that operates the gauge have noted this anomaly as well, but have not yet determine the cause. The flow control weir at the Theodosia River By-pass (08GC006) is wide which results in large changes in flow for small changes in WL, especially at low flows. Any errors in water level readings at low flow could result in recorded flows being higher than actually measured resulting in recorded by-pass flows being higher than those recorded at the diversion. However, further review and investigation of the data and the field conditions would be required to confirm the actual source of the error. For this assessment, we ignored those days where negative diversion flows calculated and did not include these data in the analysis.

Natural daily average flows at the mouth of the Theodosia River were estimated by:

1. Calculating the natural flows at Theodosia River above Scotty Creek by adding the diverted flow to Olsen Lake to the recorded Theodosia River flows above Scotty Creek; and
2. Scaling the natural flows at Theodosia River above Scotty Creek to the mouth of Theodosia River using the ratio of the watershed areas.



Regulated daily average flows at the mouth of the Theodosia River were estimated by subtracting the daily diverted flows from the natural Theodosia River at the mouth flows calculated above.

Summer Flow Assessment Results

The estimated natural and regulated daily flows for Theodosia River at the mouth were used to develop monthly flow duration curves for July to October. The curves show the probability of exceedance of a given flow in the river. Flow duration curves for the natural and regulated conditions for July to October are compared in Figures 3 and 4. A summary of the results is also shown in Table 1.

The results indicate that at very low flows (typically less than 3.0 m³/s at the mouth), the diversion flows are minimal. However, as flows increase the difference between the estimated natural flows and the regulated flows with the diversion become greater. The median difference between natural and regulated flows ranges from 41% in October, which is estimated to have a median natural flow of 10.3 m³/s at the mouth, to 4% in August, which is estimated to have a median natural flow of 1.36 m³/s at the mouth.

The increasing diversion flow with increasing flow in the Theodosia River is understandable as the diversion is configured as an open channel while the by-pass flow is controlled by a culvert at the inlet. As flow and water level increase in the Theodosia River, the flow in the diversion channel increases while the flow in the by-pass channel is restricted to the capacity of the culvert. The comparisons of monthly hydrographs for 2004 to 2009 shown in Figure 5 and 9 clearly show the change in diversion flow with stream flow in the Theodosia River.

The results provided can be used to assess habitat suitability downstream of the diversion for the period of record. As only five years of data were available for this assessment from 2004 to 2009 excluding 2007, the results should not be used for estimation of longer term average conditions. A longer period of record would be recommended for assessing long term conditions.

Closing

If you have any questions or concerns regarding this assessment, please contact the undersigned.

KERR WOOD LEIDAL ASSOCIATES LTD.

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Revision History

Revision #	Date	Status	Revision	Author
0	April 12, 2011		Draft for Review	CS
1	December 13, 2011		Final Technical Memorandum	CS

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TABLE 1 - Theodosia River at Mouth - Estimated Summer Flow Distribution

Month	Natural without Diversion			Regulated with Diversion			Percent Change		
	25% Exceedance	50% Exceedance	75% Exceedance	25% Exceedance	50% Exceedance	75% Exceedance	25% Exceedance	50% Exceedance	75% Exceedance
July	6.85	4.16	2.61	4.65	3.43	2.27	-32%	-17%	-13%
August	2.86	1.36	1.00	2.80	1.31	0.97	-2%	-4%	-3%
September	6.64	2.41	1.55	3.95	2.22	1.42	-40%	-8%	-8%
October	20.13	10.27	4.46	10.24	6.07	3.44	-49%	-41%	-23%



Legend

- Watershed Boundary
- Watercourse
- Existing Hydrometric Station
- Reach

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 Scale in Metres 1:80,000

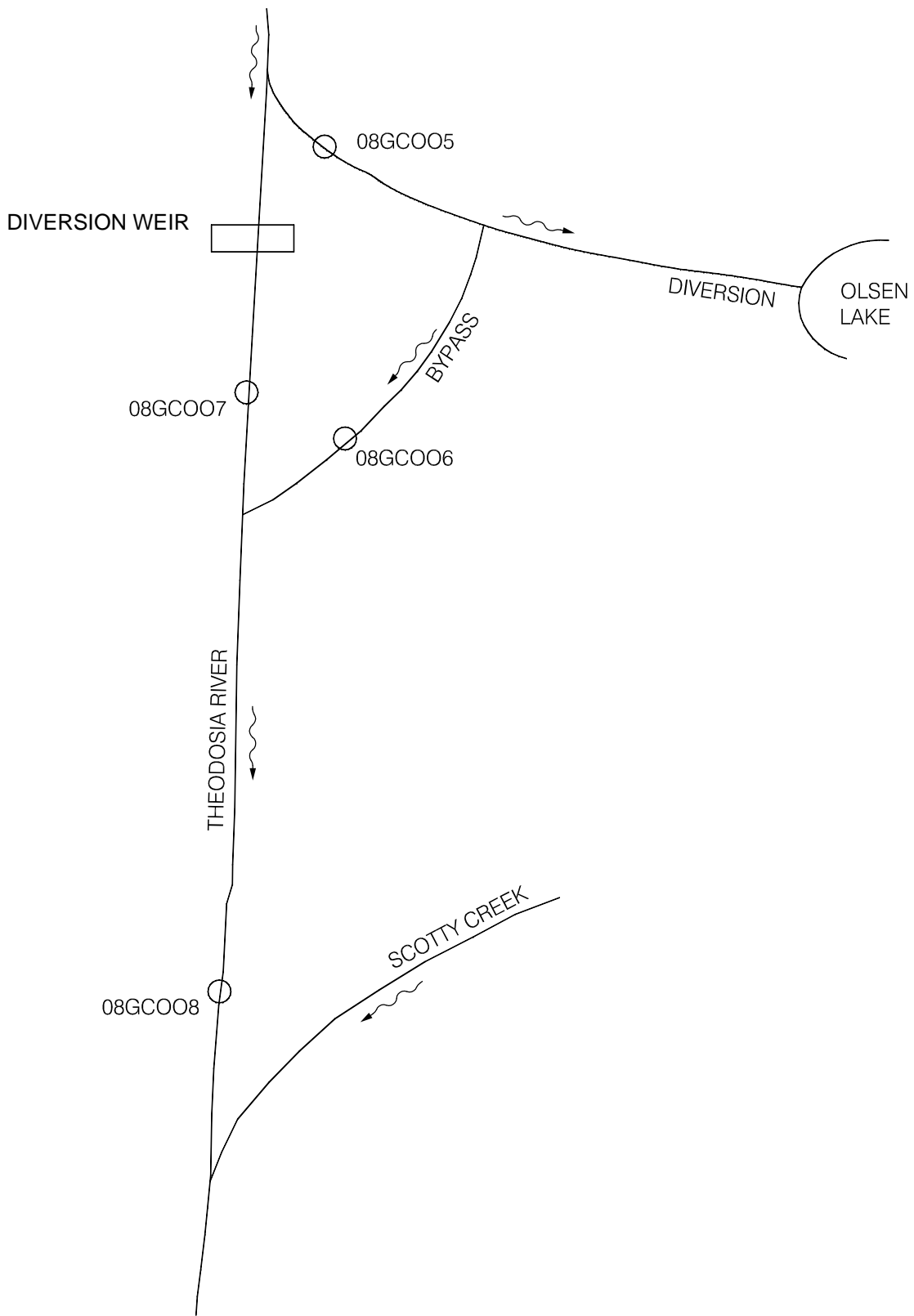
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Theodosia River Watershed

Figure 1

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THEODOSIA RIVER HYDROMETRIC GAUGE SCHEMATIC

FIGURE 2

