International Kootenay Lake Board of Control

2015 Annual Report to the International Joint Commission

This Annual Report covers the operations of Corra Linn Dam by the Applicant to the IJC Order (FortisBC) and the associated effects on the water level of Kootenay Lake in 2015. FortisBC operates Corra Linn Dam on the Kootenay River approximately 22 kilometers upstream from its confluence with the Columbia River, and downstream from the West Arm of Kootenay Lake. FortisBC controls discharge through and around Corra Linn Dam in accordance with requirements of the Order of the International Joint Commission dated November 11, 1938. FortisBC co-operates with BC Hydro, which also manages a hydro-electric generating facility (the Kootenay Canal Project) which is hydraulically connected to the Corra Linn dam forebay on the Kootenay River through a constructed canal.

Photographs shows Kootenay River discharge through Corra Linn dam.

Kootenay Lake 2015 Summary

Throughout 2015, FortisBC operated Corra Linn Dam in a manner consistent with that prescribed by the 1938 Kootenay Lake Order.

The minimum instantaneous water level was observed at 16:01 PST on March 14, 2015 at elevation 530.390 metres[1] (1740.12 feet). The Lake elevation did not reach the low elevation goal of 1739.32 feet due to high lake inflow beyond the control of the Applicant, therefore, there was no violation of the IJC Order, despite the exceedance of the rule curve. The high inflow events in 2015 were the result of intense precipitation events which resulted in rainfall-driven runoff rather than snow melt. There was lower than normal snow accumulation in 2015 due to warmer than normal late winter temperatures.

The Board and the Applicant jointly determined the date of the commencement of the spring rise as April 2nd, 2015. The maximum instantaneous water level for the lake at Queens Bay was subsequently observed at 11:45 PST on Jun 9, 2015 at elevation 532.531 metres (1747.15 feet). Kootenay Lake discharged 21.4 cubic kilometres (17.4 million acre-feet) of water in 2015, with an average flow of 680 cubic metres per second (24,000 cubic feet per second).

Board Membership

In 2015, the IJC appointed Dr. Kyle Blasch as a new Board member to the US Section, replacing former Board member Michael Lewis. The USGS appointed Dr. Blasch as the new Director of the USGS Idaho Water Science Centre in 2015, following promotion and relocation of Michael Lewis from this Director position to a different USGS office. The Board members during 2015 were as follows:

For the United States:

Colonel John Buck, District Engineer, Seattle District,
United States Army, Corps of Engineers, Seattle, Washington;

Dr. Kyle Blasch, Director, Idaho Water Science Center,
United States Geological Survey, Boise, Idaho;

[1] All elevations are referred to G.S.C. 1928 datum.

For Canada:

Mr. Bruno Tassone, Manager, Water Survey

Environment Canada, Vancouver, British Columbia

Mr. Glen Davidson, Director, Water Management Branch,

BC Ministry of Natural Resource Operations, Victoria, British Columbia.

Board Secretariat:

Ms. Sara Marxen and Mr. Gwyn Graham provided secretariat support to the US and Canadian sections, respectively.

1938 Kootenay Lake Order Sections 2(4) 2(5) and 2(6)

2(4) …the Applicant shall be permitted to store water in the main body of Kootenay Lake to a maximum elevation of 1745.32, Geodetic Survey of Canada datum, 1928 adjustment (i.e. six feet above zero of the Nelson gauge), in accordance with the rule curve detailed in Sub-section (5).

(5) That after the high water of the spring and early summer flood and when the lake level at Nelson on its falling stage recedes to elevation 1743.32, Geodetic Survey of Canada datum, 1928 adjustment, the gates of the dam may be so operated as to retain it at said level until August 31st, and after said date, the level of the main body of the lake may be raised to elevation 1745.32, which shall be the maximum storage level until January 7, and thereafter it shall be lowered so that it shall not exceed elevation 1744 on February 1, elevation 1742.4 on March 1, and elevation 1739.32 (i.e. zero of the Nelson gauge) on or about April 1, except under extraordinary natural high inflow conditions, when sufficient gates shall be opened and remain open throughout such period of excess so as to lower the level of the main body of Kootenay Lake to the storage level at that time obtaining as above defined.

(6) ...throughout the period of flood flow in each and every year, (i.e. from the commencement of the spring rise in March or April until the level of the lake at Nelson returns to elevation 1743.32, Geodetic Survey of Canada, 1928 adjustment, on the falling stage), a sufficient number of gates and sluiceways of the dam shall be opened to provide, in conjunction with the flow through the turbines, for the lowering of the main body of Kootenay Lake ... by at least the amounts ... as follows:

Discharge from Kootenay Lake under original conditions (in second feet) [vs.] Amount of lowering to be affected on the main body of Kootenay Lake (in feet)

10,000 ..... 1.0
25,000 ..... 1.3
50,000 ..... 1.7
75,000 ..... 2.1
100,000 ..... 2.6
125,000 ..... 3.0
150,000 ..... 3.2
175,000 ..... 3.5
200,000 ..... 3.8
225,000 ..... 4.0

Lake Regulation

Figure 1 presents observed calendar-year 2015 water levels on Kootenay Lake and the elevations specified in the November 11, 1938 IJC Order. Water levels on Kootenay Lake showed a single distinct yet relatively subdued freshet peak in 2015, corresponding to increased inflows from snow-melt in this mountainous watershed. Water levels on Kootenay Lake rose early for a brief period in mid-February due to an intense rainfall event (unusual for this time of year) and then began an early sustained rise in mid-March due to additional large rainfall events and subsequent onset of higher-elevation snow-melt. During this period, upstream Libby Dam was essentially in a storage mode with inflow to Lake Koocanusa greater than the outflow, thus having a further moderating effect on the maximum lake level achieved during the 2015 freshet. Freshet ended relatively early in 2015 (early July) and Corra Linn dam operations maintained fairly stable water levels on Kootenay Lake through the end of August at which point water levels were allowed to decrease during the peak Kokanee (fish) spawning period, prior to raising water levels towards the storage maximum by mid-November.

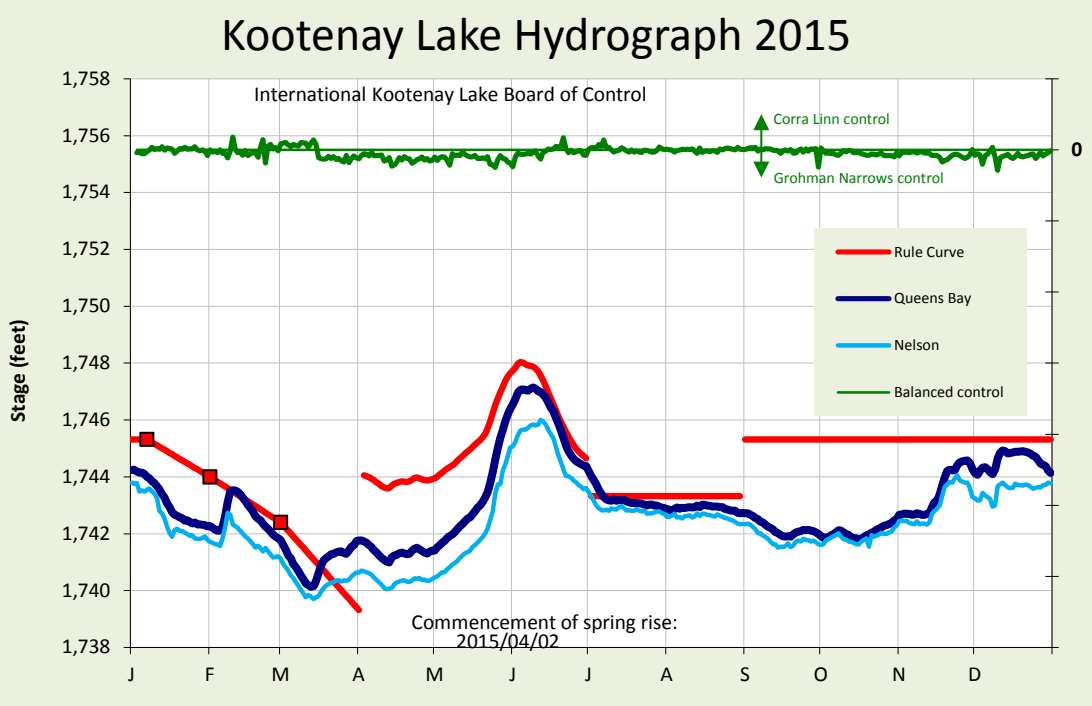

Figure 1

The maximum instantaneous water level of 532.531 metres (1747.15 feet) for the lake at Queens Bay was reached on June 9, 2015 at 11:45 PST. The minimum instantaneous water level was observed on March 14, 2015 at 16:01

PST, elevation 530.390 metres (1740.12 feet). Relative to the 85-year period of record (1931 to 2015, with two years missing; 1934 and 1947), this year's maximum water level ranked 72nd highest, and the minimum was the 80th lowest annual minimum. Over the period of record, water levels in the lake have ranged from a high of 537.04 metres (1761.95 feet) in 1961 to a low of 529.56 metres (1737.41 feet) in 1944.

Kootenay Lake discharged 21.4 cubic kilometres (17.4 million acre-feet) of water this year through Corra Linn Dam and the Kootenay Canal Plant, with an average flow of 680 m^3/s (24,000 cfs). Relative to the 78 years of available discharge data, the annual volume of flow out of the lake was 57th highest over this period of record. Total lake outflow has ranged from a high of 33.8 km^3 (27.4 million acre-feet) in 1954 to a low of 13.8 km^3 (11.2 million acre-feet) in 1944. The maximum daily mean outflow was 1,410 m^3/s (49,800 cfs) on June 3, 2015. The minimum daily mean outflow of 159 m^3/s (5,600 cfs) was observed from October 18 to 20, 2015 inclusively.

FortisBC has continued to supply the Board with complete records of the regulation of Kootenay Lake as affected by the operations of Corra Linn Dam and the Kootenay Canal Plant. FortisBC attempts to operate the lake within the optimal range of 1738.5 feet to 1749.5 feet, subject to the stipulations of the IJC Order and natural inflows.

The Board and the Applicant jointly determined the commencement of the spring rise to be 00:00 PST on April 2, 2015, the point at which the IJC rule curve switches from maximum lake elevation criteria to the lowering formula as stipulated in the IJC Order. The spring rise was declared using the Kootenay Lake 3-day consecutive rise rule in 2015, due to lack of clear freshet signal in unregulated streams.

Board Meetings

The Board held its annual and public meetings in Nelson, BC on October 6, 2015. The minutes were delivered to the Commission prior to the IJC's 2015 fall semi-annual meeting and are available on the IJC's IKLBC website. Board secretaries provided a presentation of hydrologic conditions in 2015, showing FortisBC to be in compliance with the requirements of the IJC Order despite two separate rule curve exceedances that resulted from high natural inflows due to large rainfall events.

Board Tour of Corra Linn Dam

In the morning of October 6, FortisBC operations staff led Board members on a tour of the Corra Linn Dam facility. Board members learned about the history of the dam as well as previous and planned refurbishments and upgrades to the original 1932 structure and equipment.

The Corra Linn project is a concrete dam on the Kootenay River (approximately 15 km (9 miles) downstream of Nelson, BC) initially built in 1932 to control upstream storage in Kootenay Lake for power generation benefits. The dam generates power through three 19,000 horsepower Francis turbine units (approximately 20 MW generating capacity each). The overall generating capacity is about 60 MW. The turbines are original units although with some refurbishment over the years. The flow control gantry and gate system on the dam is currently due for refurbishment and FortisBC is seeking approval through the BC Utilities Commission (BCUC). Refurbishment would include seismic upgrade work and corrosion protection. The flow control gates are operated from the FortisBC control center (Warfield, BC) but also have on-site back-up gate operation systems (natural gas and diesel powered generators as well as hand-crank backups) in case of problems with the electronic gate control.

Photograph: Mr. Jamie King (FortisBC - second from left) guides the tour of FortisBC's Corra Linn Dam for the International Kootenay Lake Board of Control (IKLBC) on October 6, 2015. . Participants include, from Left to Right.: Blair Weston (FortisBC), Jaimie King (FortisBC), Bruno Tassone (IKLBC Chair, Canada); Greg Johnston (FortisBC), David Fay (IJC Engineering Advisor, Canada), Mark Colosimo (IJC Engineering Advisor, USA), Gordon Walker (IJC Commissioner, Canada), Rich Moy (IJC Commissioner, USA), Col John Buck (IKLBC Board Chair, USA), Kyle Blasch (IKLBC Member, USA)

Board members viewed the power house, the flow control gates and gantry system. The tour also allowed a view of the Corra Linn forebay and canal intake for the BC Hydro Kootenay Canal Generating Station. FortisBC staff provided an overview of the Canal Plant agreement, initially established in 1974 (with subsequent renewals in 2005 and 2011) to allow BC Hydro to make the most efficient use of flow regulation from upstream Duncan and Libby dams and requiring Corra Linn dam to meet certain operational requirements in exchange for a power generation entitlement. BC Hydro's Kootenay Canal plant draws on the Corra Linn forebay to route flow through a canal to a dam and power plant which discharges back into the Kootenay River after bypassing 4 FortisBC power plants on the Kootenay River. The Canal Plant has a generation capacity of about 585 MW.

Annual Board Meeting

The Board received an update from BC Hydro on their Grohman Narrows channel improvement project (GNCIP) study. Historically, the narrows were excavated in 1890, 1931 and 1939. The 2012 high water event resulted in highest Kootenay Lake levels since 1974 and reinvigorated the plan to study potential further channel improvements. BC Hydro embarked on this study in 2011 since improving channel capacity through the Narrows could provide energy benefits from potential dredging. The studies have shown the following results:

- BC Hydro believes the excavation could be completed with just dredging and bedrock removal/blasting would likely not be needed. Channel velocities would be stabilized, or smoothed out, resulting in better conveyance.
- Three alternatives were modeled in Phase 1: low excavation, medium excavation, high excavation with associated 0.7 feet, 1.0 feet, 2.0 feet peak flood level reduction, respectively. Studies indicate that 2012 high water damages would have been reduced with the high excavation option. Peak discharge wouldn't be higher, but would likely occur earlier. Excavation costs ranging from $20 million for the "low excavation" to $60 million for the "high excavation" with an uncertainty in the cost of -5% to + 100%.
- Only the high excavation scenario resulted in increased hydropower generation. The Net Present Value (NPV, the total capital costs offset by power benefit amortized over 40 years) increased to plus $15 million for

the low excavation, no change for medium excavation and minus $50 million for the high excavation.

Photographs shows a natural channel constriction on the Kootenay River known as Grohman Narows, located upstream of the Corra Linn dam. Grohman Narrows acts as a natural constraint on outflow from Kootenay Lake and was excavated in the 1930's as part of the original Cora Linn Dam construction project to help lower the lake levels during freshet (high water events).

During public meetings on the project, BC Hydro noted that public perception was mixed. There was an appreciation of potential improvement to flood risk management on Kootenay Lake, but also concerns over possible low lake levels during key recreational periods of the year and some concerns over downstream channel erosion and sediment redistribution.

On December 21, 2015, BC Hydro announced formally to the IKLBC that they would not be proceeding with any further work on the Grohman Narrows Channel Improvement Project. The Board provided this information to the International Joint Commission.

In September, the Board received a letter from Ms. Nancy Knight (lakeshore resident) regarding issues with low lake levels over the last two years in late summer/early fall and outlined a number of concerns regarding lake access, navigation and water intakes. The Board reviewed the information and concerns outlined in the letter and directed the Board secretaries to draft a response letter, indicating that the order is intended to regulate the maximum

lake elevation, allowing the applicant to operate to lower elevations in consideration of a range of water management interests. A review of data suggests that the Lake was not significantly lower than previous years, but that the 2014 work on the Canal Plant intake and the 2015 Kokanee shoal spawning water management efforts had contributed to some lowering beyond what would normally be expected for that time of year. The Board provided comment from FortisBC that that these are not considered normal annual events and that the resulting water levels are not part of typical annual dam operations.

With regard to the lowering of late summer/early fall period water levels, FortisBC indicated that lake level management operations for Kokanee fish spawning occurs every four years and helps to prevent dewatering of Kokanee spawning beds during spring drawdown of the Lake, when the fish eggs are hatching. Kokanee spawning survivability in 2012 was about 75% during this operation as opposed to about 25% in previous years.

Annual Public Meeting

For the Board's public meeting (held on the evening of October 6th), an overview of the IJC Order and the related compliance requirements for operation of Corra Linn Dam were provided, as well as a summary of hydrologic conditions in 2015 affecting Kootenay Lake levels, including upstream operations at Duncan and Libby Dams (CRT operations). The Kootenay Lake hydrograph along with explanation of the Libby effect showed that Corra Linn Dam was in compliance with the IJC rule curve in 2015.

The public meeting was attended by approximately 17 people, including local residents, regional elected officials and hydro-sector stakeholders. Most of the questions related to the status of BC Hydro's Grohman Narrows project, the extent of dredging and/or blasting that it might entail and concerns over potential for increased manipulation of low Lake levels during late summer and early fall Lake recreation periods. Questions were also asked about the extent of snow and weather stations in the Kootenay River Basin and if more stations could contribute to improved reservoir forecasting. These questions and the Board responses are provided in greater detail in the minutes of the public meeting, located on the Board website.

FortisBC announced that their applications to the British Columbia Utilities Commission (BECU) for spillway refurbishment was approved. Estimated cost is $30 million for the following improvements:

- Condition assessment of the gates.
- Re-coating, structural modifications or replacement of the flow control gates.
- Improvement of gate isolation in the event of failure.
- Seismic upgrades to superstructure.
- Backup power feed to the gantries.
- Repair or restoration of concrete rollways, pier caps and splitter walls.
- Assessment of seismic withstand capacity of the dam structures (re. updated earthquake loads).

FortisBC undertakes preventative maintenance of its water level recorders twice each year. FortisBC continues to seek firm land access rights to the Queen's Bay water gauge from the current property owner, but in the meantime FortisBC has boat access to this station.

According to the 1938 Order, FortisBC must pay farmers on the Kootenai Flats in Idaho up to $3,000.00 (U.S) for additional pumping costs related to dyke seepage from higher water levels during storage periods. A number of years ago, FortisBC made a separate agreement with the Kootenai Valley Reclamation Association for an additional pumping cost payment based on actual receipts. FortisBC paid the Idaho farmers $26,345 (U.S) in April 2015 to cover 2014 pumping costs.