TRANSCANADA HYDRO NORTHEAST INC.

ILP Study 5
Operations Modeling Study

Study Report

In support of Federal Energy Regulatory Commission Relicensing of:

Wilder Hydroelectric Project (FERC Project No. 1892-026)
Bellows Falls Hydroelectric Project (FERC Project No. 1855-045)
Vernon Hydroelectric Project (FERC Project No. 1904-073)

Prepared for

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EXECUTIVE SUMMARY

The goal of this study was to develop an operations model of the mainstem of the Connecticut River in support of Federal Energy Regulatory Commission (FERC) relicensing efforts by TransCanada Hydro Northeast Inc. (TransCanada) for the Wilder Hydroelectric Project (FERC Project No. 1892), Bellows Falls Hydroelectric Project (FERC No. 1855) and the Vernon Hydroelectric Project (FERC No. 1904). The study area includes the three project impoundments and associated downstream riverine sections.

The model provides information on the effect of flows and water levels resulting from hydrology and operational scenarios, on environmental resources and at locations of interest ("nodes" or "econodes") identified in other ILP studies. The results of operations model on its own and in conjunction with Study 4 - Hydraulic Modeling Study (GEI, 2016) inform resource consultants regarding the effects of project operations on aquatic, terrestrial, and geologic resources. Steps to develop the operations model included:

- Revision of the operations model originally developed in 1992, to update generating unit characteristic and license conditions.
- Extension of the hydrologic record to include 2001 to 2011.
- Addition of shorter river reaches and their routing parameters, as determined in Study 5, which used the hydraulic model in the impoundment and riverine segments of the Wilder, Bellows Falls, and Vernon projects.
- Addition of numerous econodes that defined areas of interest as identified by other resource studies.
- Definition of econode rating curves as follows:
  - Elevation rating curves defined in Study 4 – Hydraulic Modeling Study (GEI, 2016); and
  - Habitat Suitability Index (HSI) rating curves defined in Study 9 – Instream Flow Study (Normandeau, 2016).
- Addition of functionalities to process hourly model results in order to provide time series of water levels, flows, and associated assessment indices to other studies.

Data from the operations model was used by numerous other ILP studies to evaluate potential project effects and/or to assess alternatives to mitigate project effects, as applicable.

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List of Abbreviations

CRWC	Connecticut River Watershed Council
FERC	Federal Energy Regulatory Commission
FirstLight	FirstLight Power Resources
FWS	U.S. Department of Interior, Fish and Wildlife Service
HSI	Habitat Suitability Index
ILP	Integrated Licensing Process
NAVD 88	North American Vertical Datum of 1988
NGS	National Geodetic Survey
NGVD 29	National Geodetic Vertical Datum of 1929
NHDES	New Hampshire Department of Environmental Services
NHFGD	New Hampshire Fish and Game Department
RSP	Revised Study Plan
SPD	Study Plan Determination
TNC	The Nature Conservancy
TransCanada	TransCanada Hydro Northeast Inc.
TU	Trout Unlimited
VANR	Vermont Agency of Natural Resources
WSE	water surface elevation

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1.0 INTRODUCTION

This report presents the results of the Operations Modeling Study (ILP Study 5) conducted in support of Federal Energy Regulatory Commission (FERC) relicensing efforts by TransCanada Hydro Northeast Inc. (TransCanada) for the Wilder Hydroelectric Project (FERC Project No. 1892), Bellows Falls Hydroelectric Project (FERC No. 1855) and the Vernon Hydroelectric Project (FERC No. 1904). TransCanada has initiated the Integrated Licensing Process (ILP) for these projects in order to extend the term of their operating licenses beyond the current expiration date of April 30, 2019 for each project.

In their study requests, FERC, US Fish and Wildlife Service (FWS), New Hampshire Department of Environmental Services (NHDES), New Hampshire Fish and Game Department (NHFGD), Vermont Agency of Natural Resources (VANR), Connecticut River Watershed Council (CRWC), The Nature Conservancy (TNC), and Trout Unlimited (TU) indicated an interest in understanding the effect of operations at the Wilder, Bellows Falls, and Vernon Projects on environmental resources.

Study requests also identified an interest in understanding how operations at the three TransCanada projects affect operations of the Northfield Mountain Pumped Storage Project (FERC No. 2485) and Turners Falls Project (FERC No. 1889). That was beyond the scope of TransCanada's hydraulic and operations models and it is the responsibility of FirstLight to develop that determination. TransCanada did, however, provide FirstLight with output from its models in the form of discharge at Vernon dam. This output served as the upstream inflow in the model FirstLight develops to assess the effect on its operation. FirstLight also provided TransCanada physical and operations data on the Turners Falls headpond, power canal, generators, and spillway, as well as Northfield Mountain storage, and pump/generator units. This two-model approach (TransCanada-FirstLight) meets the agency and stakeholder requests but preserve the separation of operations decisions, which is a necessity and requirement within the power market in which both TransCanada and FirstLight operate the businesses.

The Revised Study Plan (RSP) for this study was modified by FERC in its September 13, 2013 Study Plan Determination (SPD) with the following specific change (as clarified in FERC's October 22, 2013, letter in response to TransCanada's September 24, 2013, request for clarification on the determinations for several studies).

> "The study plan report (rather than the study plan) must demonstrate the appropriateness of TransCanada's 5-year representative hydrologic subset, show how the selected years are representative of the longer hydrologic record, and document why carry-over storage does not need to be considered in the model."

The adequacy of the selected 5-year hydrologic subset to represent the 30-year available hydrologic record is presented in Section 4.1 and the need not to consider carry over storage in the study project headponds is discussed in Section 4.3.

2.0 STUDY GOALS AND OBJECTIVES

The goal of this study was to develop an operations model to provide information on the effect of flows and water levels, resulting from hydrology and operational scenarios, on environmental resources.

The objective of this study was to develop a time-series database of hourly water levels and flows for various selected operational scenarios, to enable resources studies to assess the effects of project operations on aquatic, terrestrial, and geologic resources at locations of interest. The values were made available at many locations on the river system, including the three projects and identified areas of interest ("econodes").

3.0 STUDY AREA

The operations model was developed to simulate operations of the Wilder, Bellows Falls, and Vernon Projects. Dams at these three projects create three impoundments, which are represented as "headponds" in the operations model. The model also includes the upstream Dodge Falls Hydroelectric Project (FERC No. 8011) and the Fifteen Mile Falls Project (FERC No. 2077). Three upstream storage impoundments—Lake Francis, First Connecticut Lake, and Second Connecticut Lake—are also included in the operations model.

Turners Falls dam, owned and operated by FirstLight, was included in the study area (Figure 3.1) to account for potential effects of the Turners Falls Project and Northfield Mountain Pumped Storage Project on the riverine section associated with TransCanada's Vernon Project.

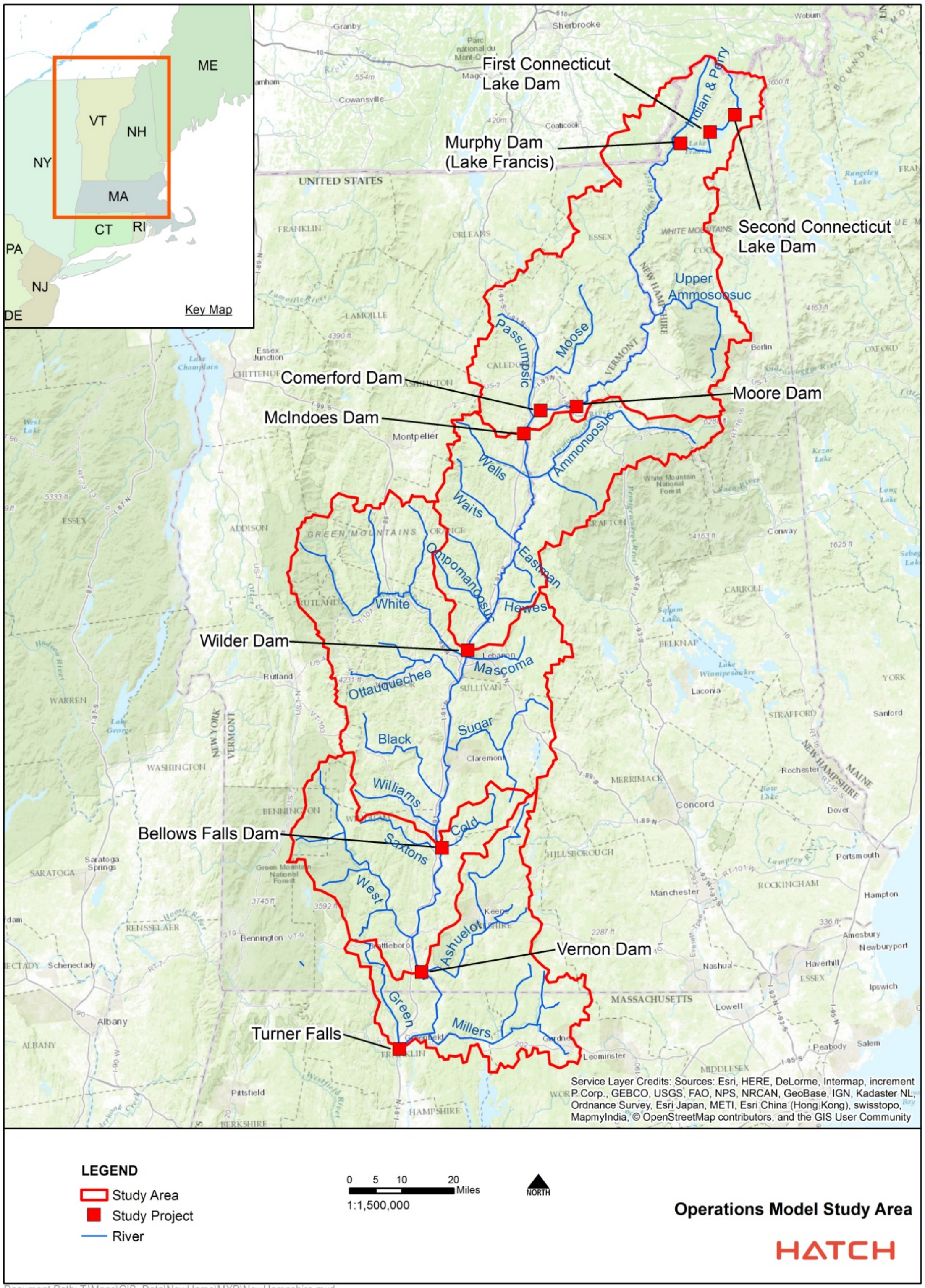


Figure 3.1. Operations model study area.

4.0 METHODS

The Vista DSS™ software system developed by Hatch Ltd was used in this study. Vista DSS™ is a proprietary system that provides a framework to model detailed operations of water resources and hydroelectric operations. It comprises nine integrated modules, under a Windows operating system, and uses robust database technologies and a sophisticated Windows user interface. Vista DSS™ is a network flow model that uses optimization methods to determine a realistic and representative operation of generating/pumping units, water control structures, and associated effects in river reaches and reservoirs. It is used primarily to first reliably meet license conditions (including minimum flows and impoundment limits), and then, at a lower priority, to maximize value from energy production. A cornerstone of the model is the continuous determination of optimum operational actions on an iterative basis, responding to changing conditions such as hydrologic inflows and energy pricing.

The model consists of a series of nodes (point locations) and arcs (flow paths) to define specific system features, such as hydrology (inflows from tributaries and upstream watersheds), river junctions, impoundments, tailwaters, spillways, and power generating units.

For study purposes, TransCanada and FirstLight projects are modeled separately. Figure 4.1 shows the model schematic for TransCanada projects. The projects are operated, on a continuous hourly basis, to pass flows and maintain water levels in the impoundments in accordance with constraints established in the current licenses and in response to daily hydrologic conditions and energy prices. Model objectives were to first to meet defined constraints and then to maximize the value of energy generation with the flexibility that remains.

The focus of the study is the Wilder, Bellows Falls, and Vernon projects and their effects. To facilitate reporting of effects of these projects, the long reaches in the impounded and riverine segments of the three projects are divided to shorter reaches with one hour water travel time between each reach. Figure 4.2 shows the model configuration for the shorter reaches bounded by specific hydraulic model (Study 4) nodal cross sections.

Figure 4.3 shows the model schematic for FirstLight projects. Simulated Vernon discharge from the separate TransCanada facilities model serves as upstream inflow to Turners Falls impoundment in addition to tributary inflows from the Ashuelot River and Millers River. The Turners Falls project and the Northfield Mountain Pumped Storage project are operated to pass flows and maintain water levels and combined storage in accordance to with current license.

The operational constraints that define the current license conditions for both TransCanada and FirstLight projects are listed in Appendix A (filed separately in Excel format).

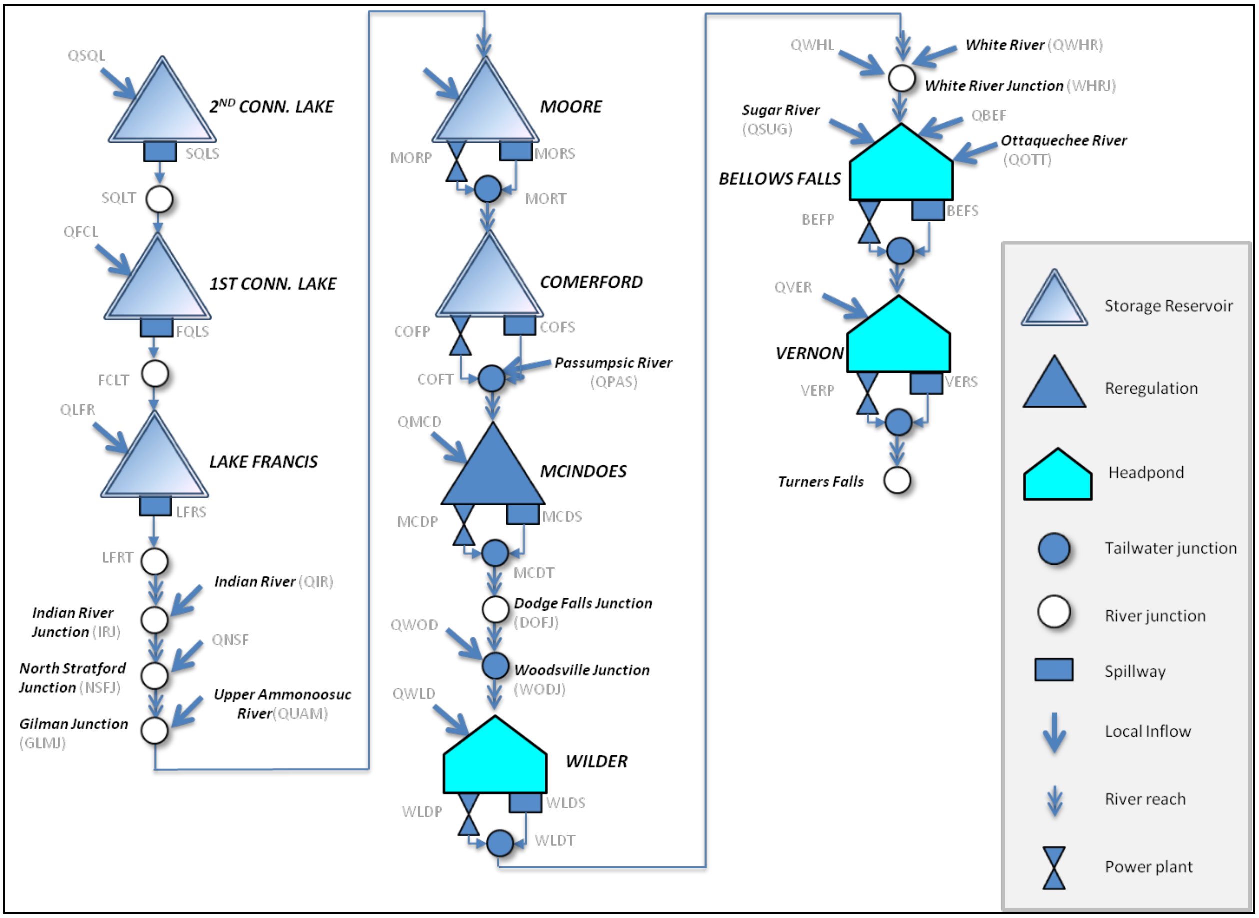


Figure 4.1. Vista schematic for the modeled TransCanada projects.

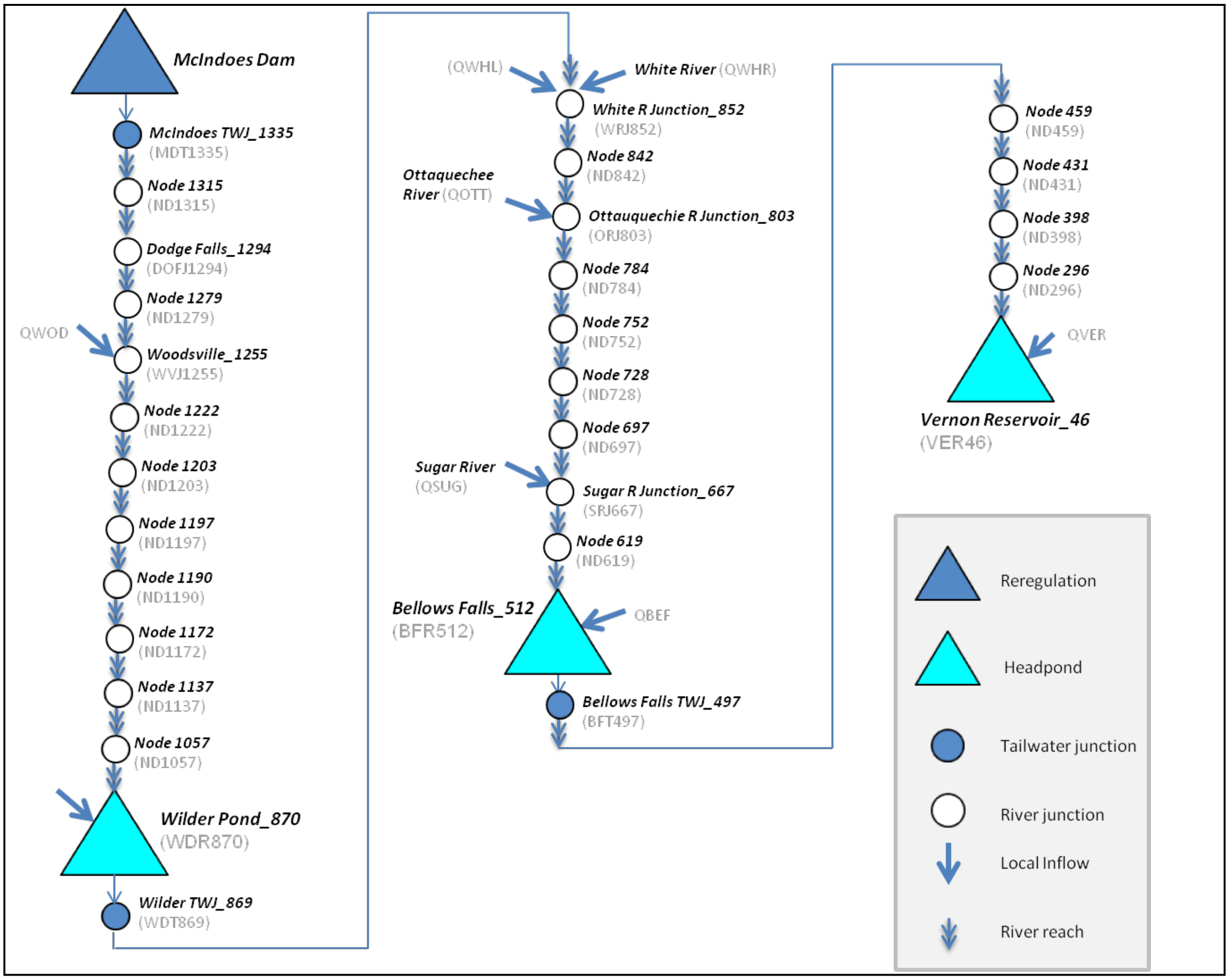


Figure 4.2 Vista configuration for shorter reaches in the lower Connecticut River.

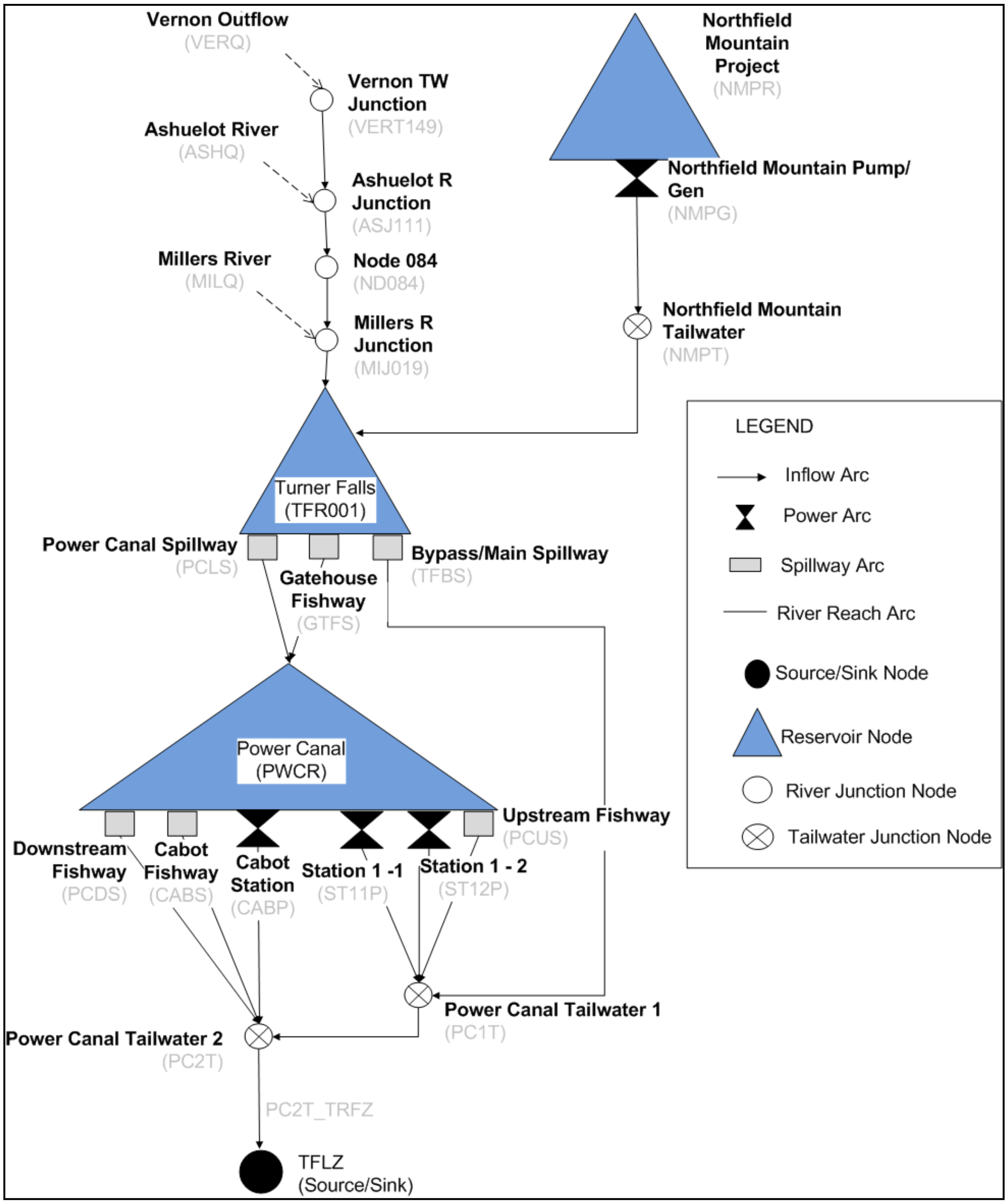


Figure 4.3 Vista schematic for the modeled FirstLight projects.

4.1 Model Development

Specific steps to develop the operations model included:

- Revise the operations model, originally developed in 1992, in the following areas:
  - Update the generating unit performance characteristics.
  - Update the operational constraints (license conditions).
  - Update the model hydrology dataset through 2011, thus having 30 years of hydrology available for the study. Each year of hourly analysis yields 8,760 data points for each result variable of interest.
- Select a representative 5-year subset of the available 30 years of inflow for use in the current study. The selection was based on ranking annual and spring total inflow volumes at the Vernon project and the system annual energy production from the lowest value (rank 1) to the highest (rank 30).

  The selected years were 1992, 1994, 1989, 2007, and 1990, corresponding to the following ranks:
  - 5, 9, 14, 20, and 25 ranking (out of 30) of the annual total inflow volume at the Vernon project. Dividing by the sample size of 30, the associated percentiles are 17 percent, 30 percent, 47 percent, 67 percent, and 83 percent (dry to wet progression);
  - 6, 16, 12, 21, and 22 ranking of the annual spring (March - June) inflow volume at the Vernon Project; and
  - 3, 8, 15, 22, and 28 ranking of the system annual energy production.

  It was not necessary to use all available hydrology for the study because the information on operational impacts could be provided by a properly selected representative subset of the hydrology. Figure 4.4 shows time series plots of the daily total inflow at Vernon for the selected years. The duration curves of the daily total inflow at Vernon for the selected subset of years are compared with the 30 years of available record, as follows:
  - for spring inflows in Figure 4.5
  - for the complete year in Figure 4.6.

  It can be seen from Figures 4.4, 4.5, and 4.6 that the selected hydrologic years have significant variability and represent quite well the observed range of flow conditions both annually and seasonally.

The subset also represents a wide range of annual energy production (ranking 3 to 28 out of 30) and thus reflects the actual TransCanada regulation effects in the river regime.

- Update the model with econodes that define areas of interest as identified in other resource studies.
  - Define econode elevation relationships with flows and downstream node elevations using the hydraulic model results developed from Study 4.
  - Define new river reaches, associated with the updated econodes, and the routing parameters.
  - Update econode Habitat Suitability Index (HSI) rating curves (function of flow and/or elevation) defined in Study 9 – Instream Flow Study. Define hourly market energy prices, which guide hourly energy production. The hourly day-ahead price schedule for 2010 was selected for the model because it was deemed to be representative of the seasonal and within-week fluctuating nature of historical market prices. However, hourly fluctuations in a particular year typically reflect market conditions at that time that may not be present at the same time in another year. Therefore, to be more representative of TransCanada operations, the 2010 hourly prices were filtered by deriving the average hourly week day and weekend prices for each month for use in the model. The filtering was done by averaging each week day-hour value (and each weekend-hour value) with all values available in the month. For example, the January week day (Monday to Friday) 10 a.m. price is taken as the average of the 23 values that occur in that month. Similarly, the January weekend (Saturday and Sunday) 10 a.m. price is taken as the average of the eight values that occur in that month. Thus, there was an hourly pattern over the week, which was then applied throughout the month. This pattern is representative of the hourly pattern over the week but with much-reduced noise.
- Run the operations model for a range of baseline operating conditions using the five representative hydrology years.
- Provide time-series database of hourly water levels and flows and associated assessment indices to enable other studies to assess the effects of operations on environmental resources at locations of interest. The time-series database enables assessments regarding the variability, rate of change, and frequency of fluctuation within the impoundments and riverine reaches, based on criteria and areas of interest identified by other studies.

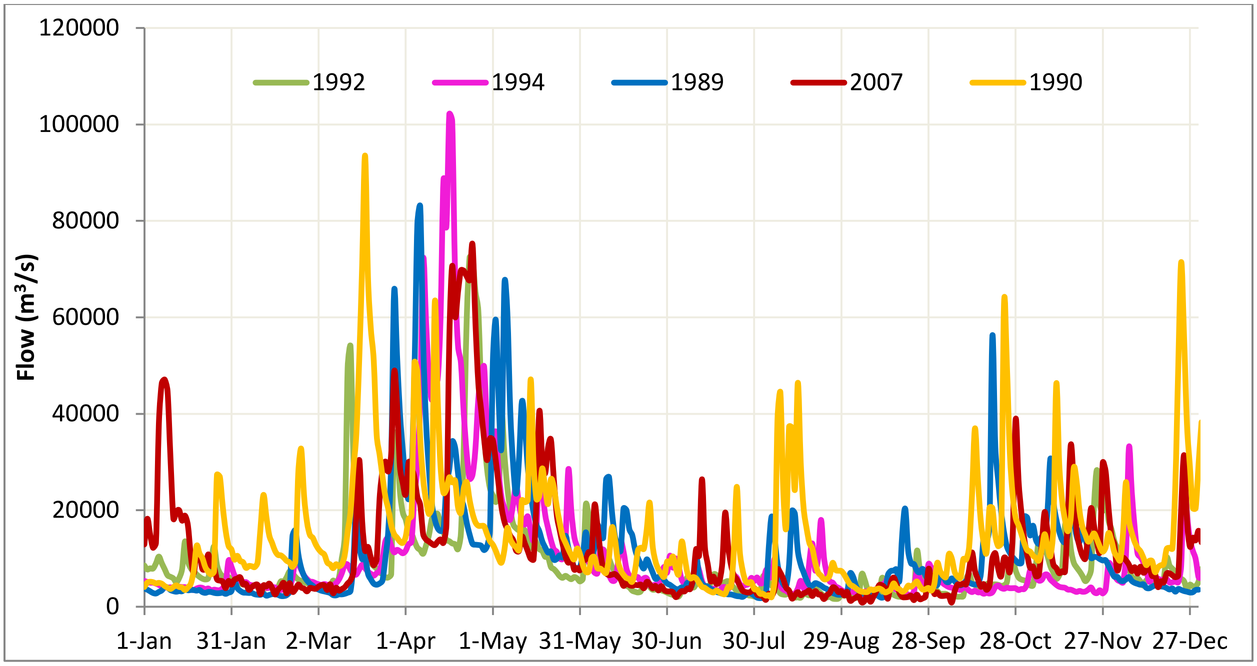


Figure 4.4. Vernon total daily inflow for the five selected years.

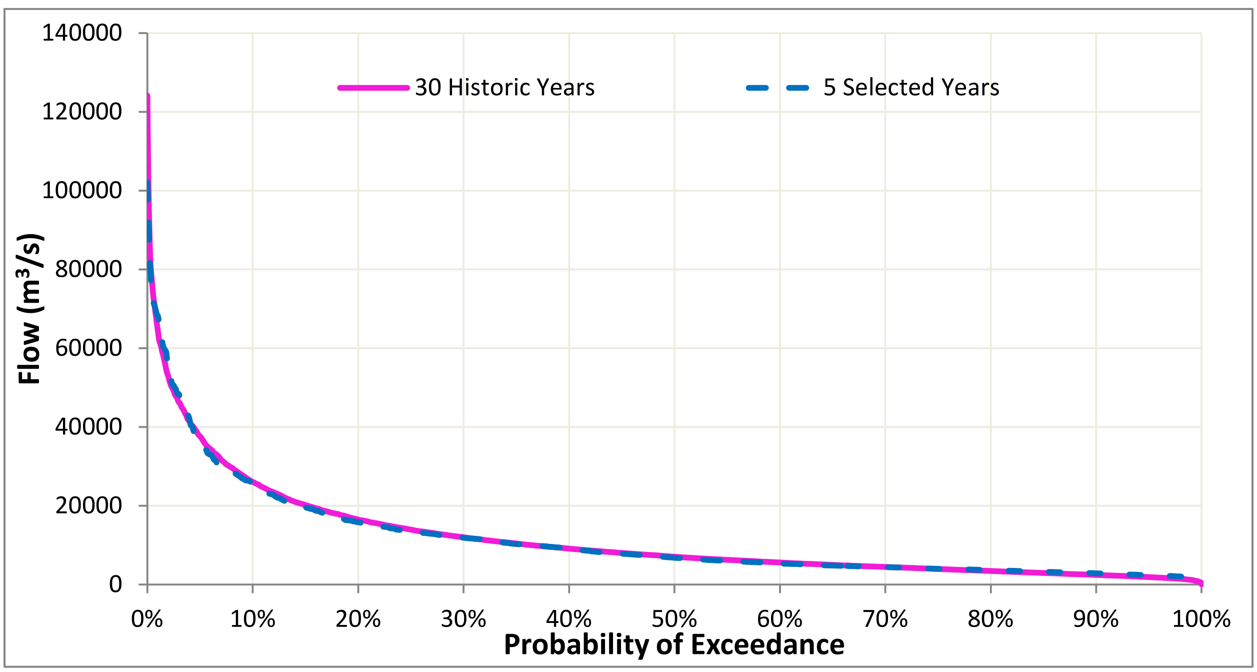


Figure 4.5. Vernon total daily inflow duration curves.

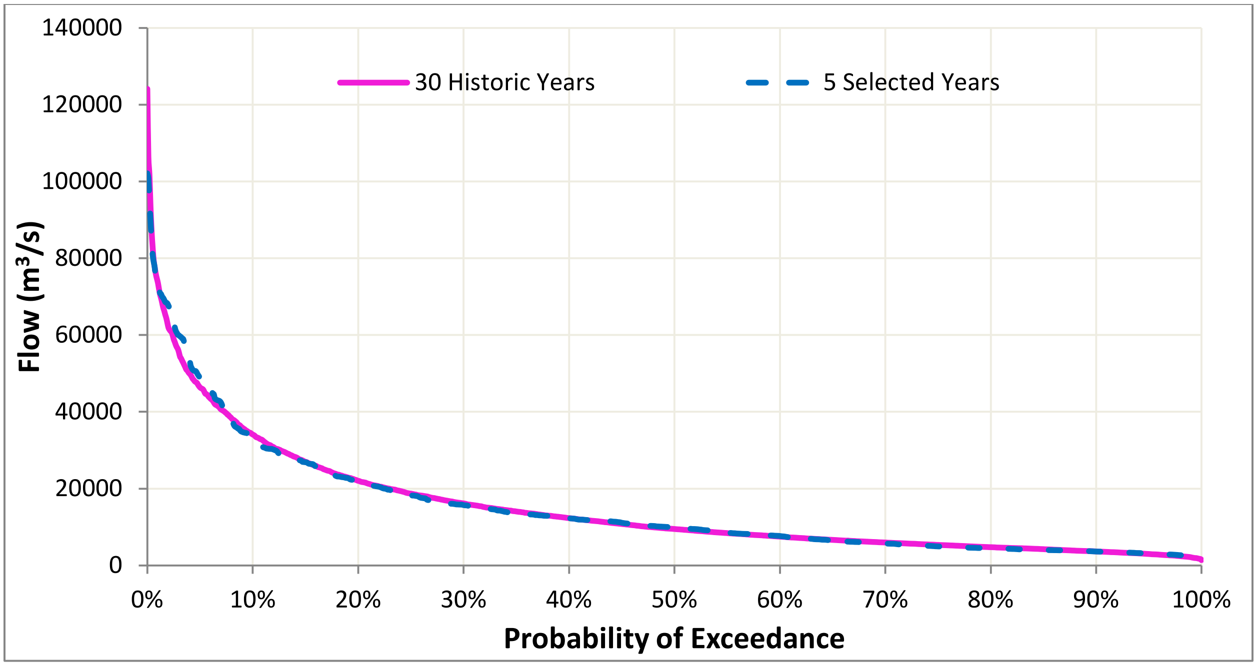


Figure 4.6. Vernon total daily inflow duration curves for spring (March - June).

4.2 Vertical Datum

Several data sources were provided in National Geodetic Vertical Datum of 1929 (NGVD 29) including TransCanada and FirstLight impoundment water surface elevations (WSEs), storage rating curves, and tailwater rating curves. Consequently, the reference datum for elevations in the Vista model is the NGVD 29. The North American Vertical Datum of 1988 (NAVD 88) is the reference datum for elevations in the Hydraulic Model (Study 4) and the resource studies.

For this study, topographic data developed in the Hydraulic model (Study 4) used as input to the Operations model was converted to NGVD 29 was converted to NAVD 88 by adding 0.4 ft to the NAVD 88 elevation data based on the online height conversion tool VERTCON developed by the National Geodetic Survey (NGS, 1994). As an example, a WSE at Wilder impoundment of 384.6 ft NAVD 88 converts to approximately 385.0 ft NGVD 29. Similarly, elevation data resulting from the Operations model were converted to NAVD 88 by subtracting 0.4 ft from the NGVD data before being provided to the resource study groups.

4.3 Model Runs

Vista DSS^{TM} internally uses two modules, LT Vista (Long-Term storage management and generation planning module) and ST Vista (Short-Term generation scheduling module) for each of the hydrologic year runs. The LT Vista run is a weekly time-step run from January of the selected year to the end of May of the next year, a seventeen month period. The LT Vista module provides optimal operation of the five upstream storage reservoirs (Second Connecticut Lake to Comerford, Figure 4.1), thereby minimizing spills during freshets and storing freshet flows for use during dryer months. The module ensures that simulated elevations in the storage reservoirs remain within the defined rule curves and that there is enough water in the storage reservoirs at the end of the selected hydrologic year to meet operational constraints such as minimum flow requirements up until the end of the next year's re-fill period. LT Vista does not consider storage in the headponds in the lower reservoirs (Wilder, Bellows Falls, and Vernon) as they are daily storage projects and so the impacts of annual wet-dry cycle are immaterial to these projects. The module provides weekly water level targets as guidance to ST Vista usage of water in the storage reservoirs.

ST Vista uses hourly time-step and optimizes the system operation, one week at a time, over a one-year horizon. It ensures optimal hourly operation of all storage and daily reservoirs to provide realistic generation and flow release schedules at all projects while adhering to hourly type constraints like ramp rate and flood rules.

5.0 RESULTS

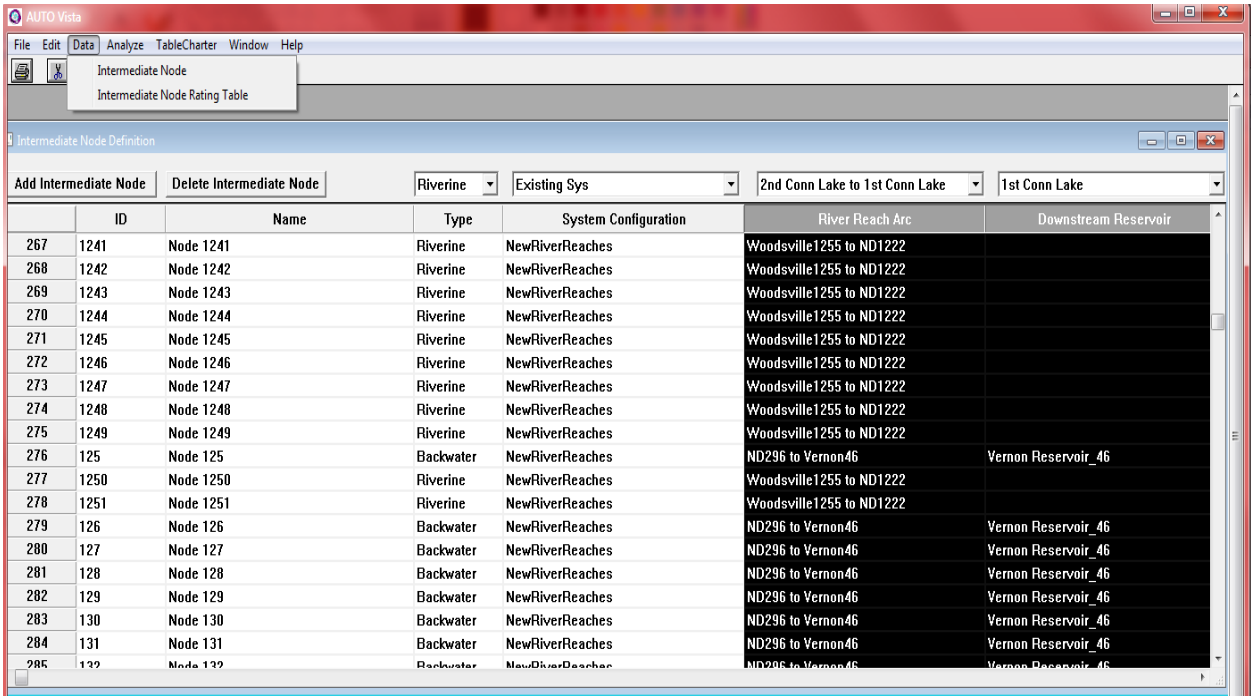
The operations model was used to simulate the routing of river flow and associated impoundment WSEs, and to derive the resulting WSEs, velocities, and flows across the study area and at locations of interest identified in other ILP studies. The results of the hydraulic model on its own, and in conjunction with the operations model, inform other studies, thereby permitting the evaluation of the effects of project operations on aquatic, terrestrial, and geologic resources.

The process for integrating this study with the hydraulic model and other resource studies to interpret project effects was as follows:

1. Short river reaches in the study focus area, with one-hour water travel time determined in Study 4, using the hydraulic model, were defined in the operations model as shown in Figure 4.2 and Figure 4.3.

   The operations model uses the Muskingum Cunge hydrologic routing method to derive outflow at the downstream end of a river reach based on inflow at the upstream end. The method is an approximation of the one-dimensional dynamic wave routing method used in the hydraulic model. The parameters of the Muskingum Cunge model for all river reaches with one-hour water travel time were derived from the time-series of inflow to, and outflow from, the reaches obtained from the hydraulic model.

2. The 1,355 cross sections defined in the hydraulic model within the study area were entered in the Vista database. In order to estimate the flows at the cross sections in the operations model, each cross section was mapped to the appropriate short river reach, previously defined in the model, as shown in Figure 5.1. Additionally, each impoundment cross section is mapped to the respective downstream project headpond.



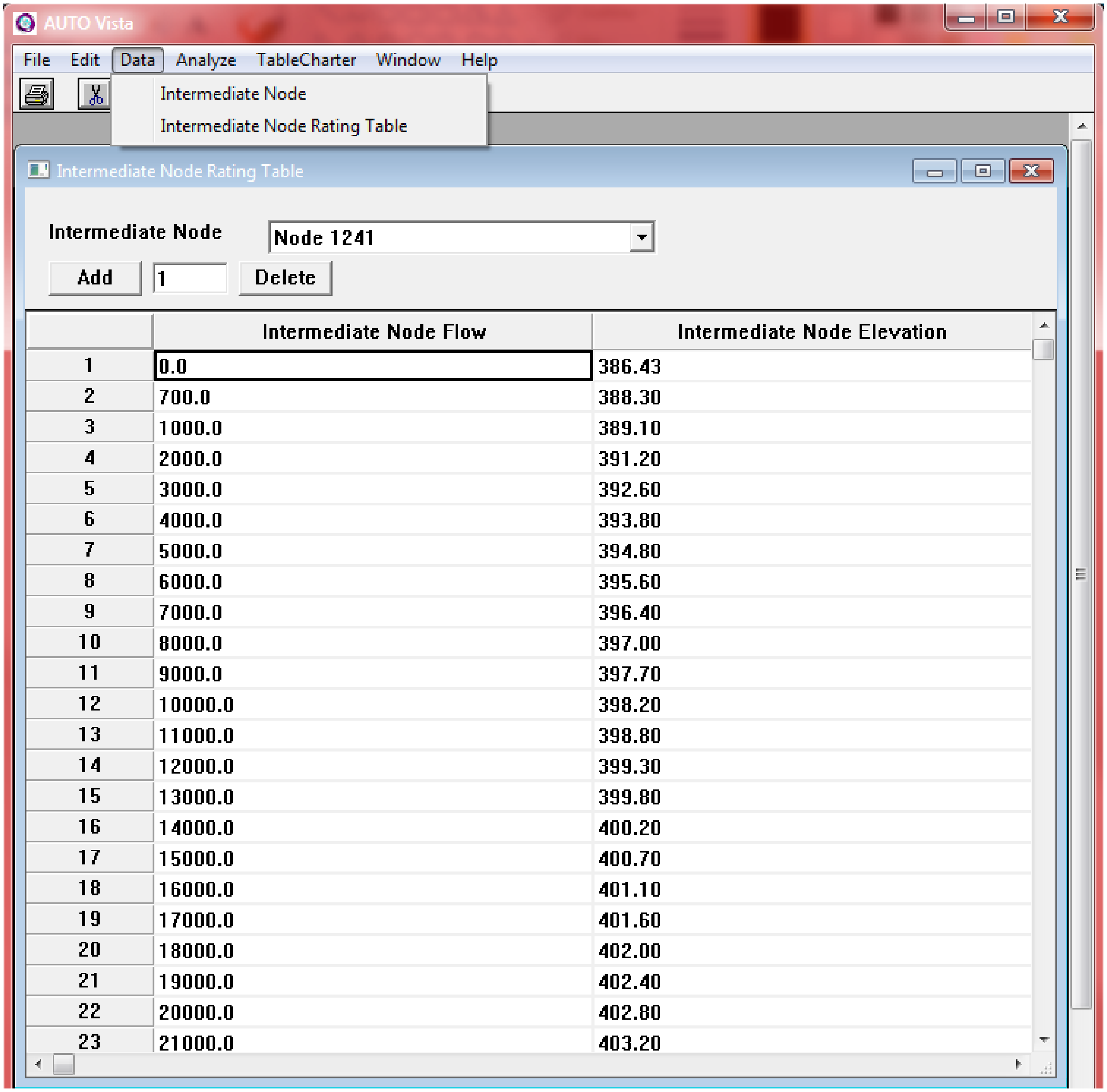
	ID	Name	Type	System Configuration	River Reach Arc	Downstream Reservoir
267	1241	Node 1241	Riverine	NewRiverReaches	Woodsville1255 to ND1222	
268	1242	Node 1242	Riverine	NewRiverReaches	Woodsville1255 to ND1222	
269	1243	Node 1243	Riverine	NewRiverReaches	Woodsville1255 to ND1222	
270	1244	Node 1244	Riverine	NewRiverReaches	Woodsville1255 to ND1222	
271	1245	Node 1245	Riverine	NewRiverReaches	Woodsville1255 to ND1222	
272	1246	Node 1246	Riverine	NewRiverReaches	Woodsville1255 to ND1222	
273	1247	Node 1247	Riverine	NewRiverReaches	Woodsville1255 to ND1222	
274	1248	Node 1248	Riverine	NewRiverReaches	Woodsville1255 to ND1222	
275	1249	Node 1249	Riverine	NewRiverReaches	Woodsville1255 to ND1222	
276	125	Node 125	Backwater	NewRiverReaches	ND296 to Vernon46	Vernon Reservoir_46
277	1250	Node 1250	Riverine	NewRiverReaches	Woodsville1255 to ND1222	
278	1251	Node 1251	Riverine	NewRiverReaches	Woodsville1255 to ND1222	
279	126	Node 126	Backwater	NewRiverReaches	ND296 to Vernon46	Vernon Reservoir_46
280	127	Node 127	Backwater	NewRiverReaches	ND296 to Vernon46	Vernon Reservoir_46
281	128	Node 128	Backwater	NewRiverReaches	ND296 to Vernon46	Vernon Reservoir_46
282	129	Node 129	Backwater	NewRiverReaches	ND296 to Vernon46	Vernon Reservoir_46
283	130	Node 130	Backwater	NewRiverReaches	ND296 to Vernon46	Vernon Reservoir_46
284	131	Node 131	Backwater	NewRiverReaches	ND296 to Vernon46	Vernon Reservoir_46
285	132	Node 132	Backwater	NewRiverReaches	ND296 to Vernon46	Vernon Reservoir_46

Figure 5.1. Hydraulic model nodal cross section definition in the operations model database.

3. In order to estimate water levels in the operations model at econodes of interest, the following relationships derived in the hydraulic model were entered into the Vista database for all the 1,355 cross sections in the hydraulic model:

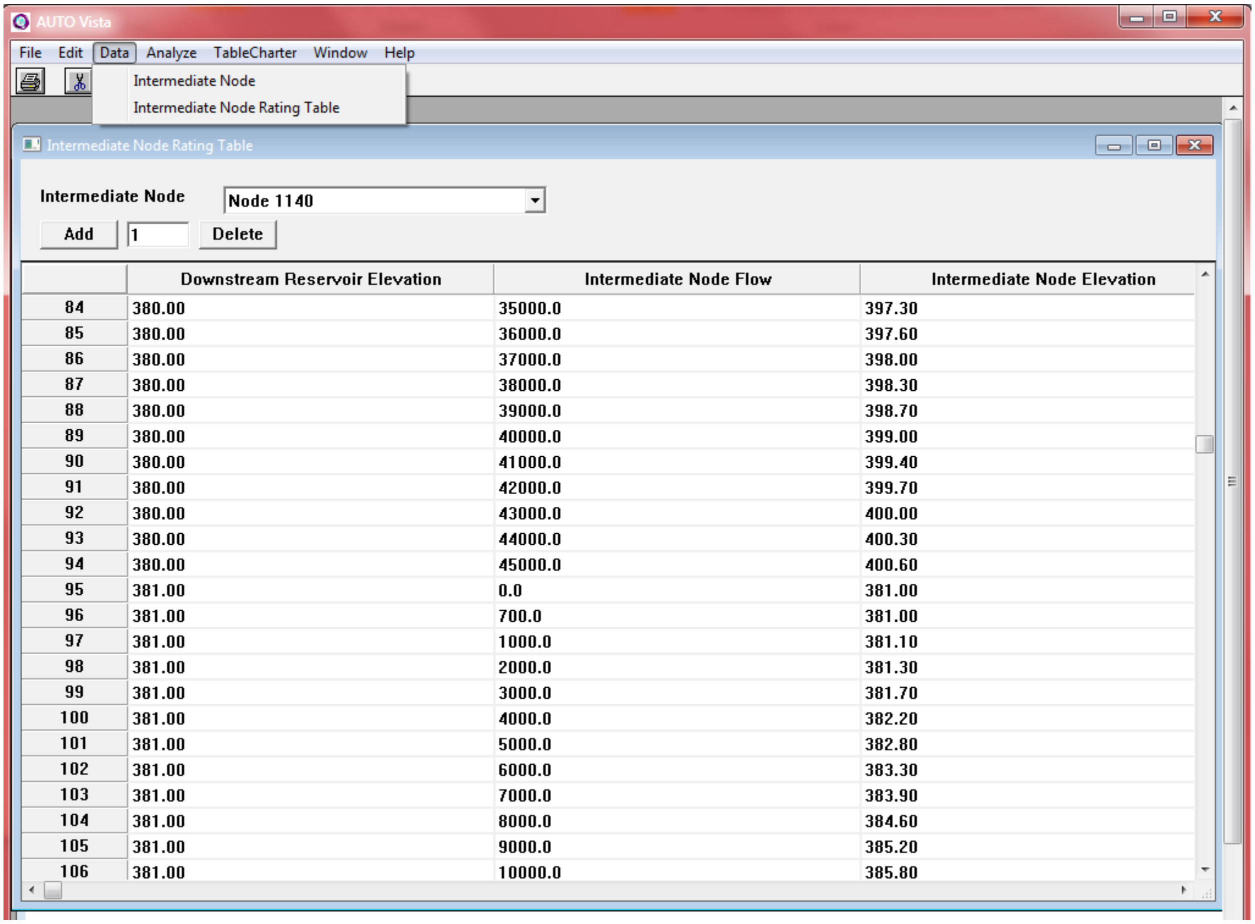
   a. water level as a function of flow rate at the cross section for riverine sections (Figure 5.2); and

   b. water level as a function of flow rate at the cross section, <u>and</u> the water level at the downstream dam for impoundment sections (Figure 5.3).



	Intermediate Node Flow	Intermediate Node Elevation
1	0.0	386.43
2	700.0	388.30
3	1000.0	389.10
4	2000.0	391.20
5	3000.0	392.60
6	4000.0	393.80
7	5000.0	394.80
8	6000.0	395.60
9	7000.0	396.40
10	8000.0	397.00
11	9000.0	397.70
12	10000.0	398.20
13	11000.0	398.80
14	12000.0	399.30
15	13000.0	399.80
16	14000.0	400.20
17	15000.0	400.70
18	16000.0	401.10
19	17000.0	401.60
20	18000.0	402.00
21	19000.0	402.40
22	20000.0	402.80
23	21000.0	403.20

Figure 5.2. Hydraulic model riverine section water level as a function of flow definition in the operations model.



	Downstream Reservoir Elevation	Intermediate Node Flow	Intermediate Node Elevation
84	380.00	35000.0	397.30
85	380.00	36000.0	397.60
86	380.00	37000.0	398.00
87	380.00	38000.0	398.30
88	380.00	39000.0	398.70
89	380.00	40000.0	399.00
90	380.00	41000.0	399.40
91	380.00	42000.0	399.70
92	380.00	43000.0	400.00
93	380.00	44000.0	400.30
94	380.00	45000.0	400.60
95	381.00	0.0	381.00
96	381.00	700.0	381.00
97	381.00	1000.0	381.10
98	381.00	2000.0	381.30
99	381.00	3000.0	381.70
100	381.00	4000.0	382.20
101	381.00	5000.0	382.80
102	381.00	6000.0	383.30
103	381.00	7000.0	383.90
104	381.00	8000.0	384.60
105	381.00	9000.0	385.20
106	381.00	10000.0	385.80

Figure 5.3. Hydraulic model impoundment section water level as a function of flow and downstream dam water level definition in the operations model.

4. Aquatic Habitat Suitability Indices (HSIs) as a function of flow rate, derived from Study 9 - Instream Flow Study (Normandeau, 2016) were entered into the Vista database for econodes of interest as shown in Figure 5.4.

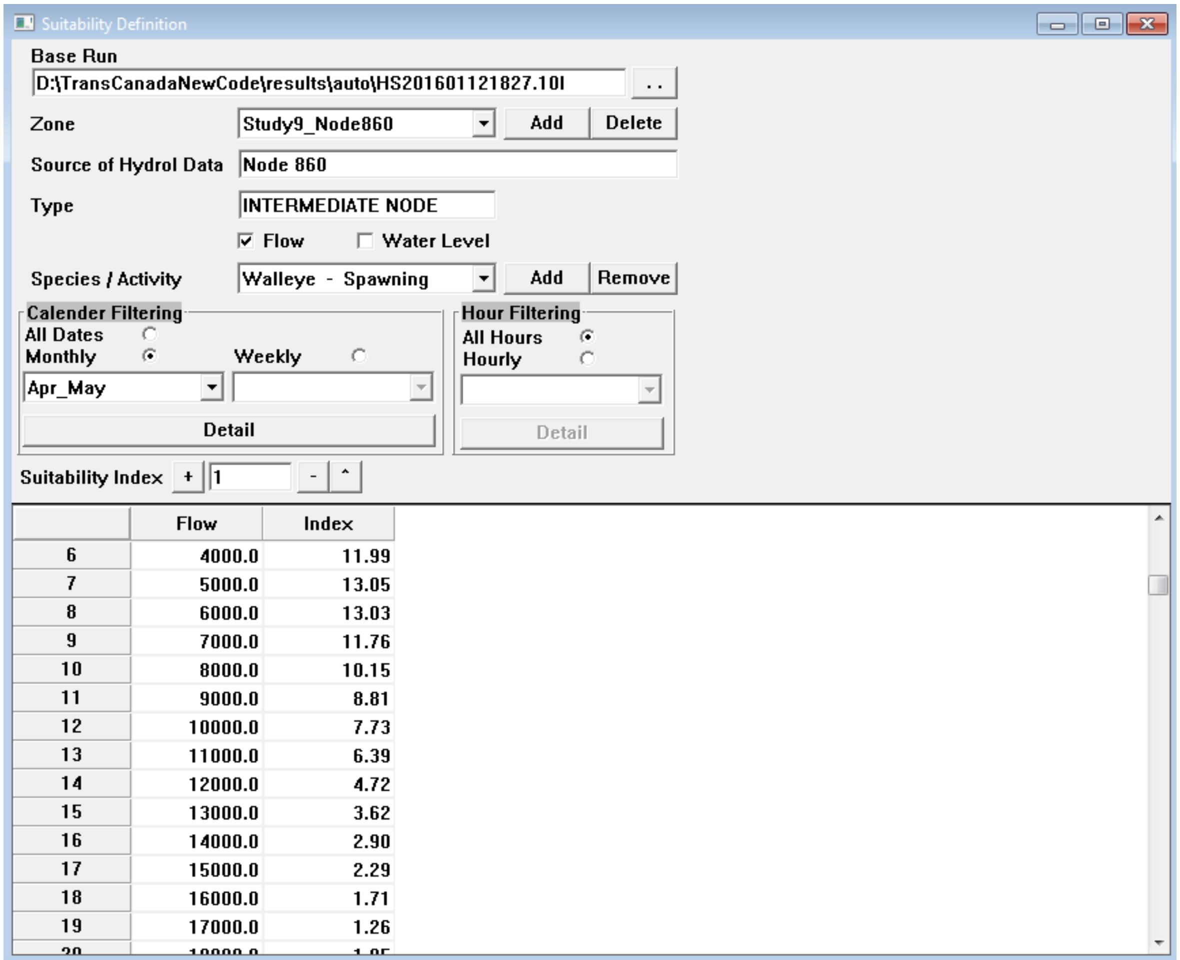


Figure 5.4. Study 9 aquatic habitat suitability index definition in the operations model.

5. The operations model developed a Baseline Case simulating current operations. The results were post-processed based on the above relationships from Study 4 and Study 9 to derive data summarizing the effects at locations of interest to inform the other resource studies.

6. Additional Cases will likely be developed and analyzed representing alternative operations scenarios for the purpose of evaluating the potential effects on a variety of resources (e.g., erosion, fisheries and aquatics, and terrestrial). These alternative operation cases will be based upon stakeholder input and consultation and proposals put forth through working

group discussion of resource study results that examine existing operational impacts.

5.1 Model Validation

A validation process was undertaken to confirm the model's ability to accurately represent operational conditions of the projects. The validation procedure involved comparison of the duration curves of simulated impoundment hourly water surface elevation at the dams with historical hourly water surface elevations. The focus of the validation was placed on recent operations data spanning 2001 to 2011, 2013, and 2014 for the Wilder, Bellows Falls, and Vernon projects. It was based on the years 2000 to 2009, 2013, and 2014 for the Turners Falls project.

Figures 5.5 to 5.8 show comparison of the duration curves of historical and model water surface elevations. The historical values are plotted as dashed lines while the model values are plotted as solid lines. At the top of each figure are comparison plots for individual years. At the bottom of the each figure are comparison plots for combinations of years.

Generating unit sizes have changed at some of the TransCanada projects over the years with the last major change been at Vernon in 2007-2008, when Units 5-8 were replaced. To capture current conditions, the model simulation uses the currently existing units at each project.

As unit sizes affect headpond usage, three different groups of historical data are plotted in comparison with a single combination of the model data for Wilder, Bellows Falls and Vernon (since the model run uses the single current unit configuration) as follows:

- Total record (2001-2014
- Pre-unit change period (2001-2008)
- Post-unit change period (2009-2014)

Similarly, Units 2 and 3 at the Northfield Mountain project underwent generation capacity increases (from 267.9 MW to 291.7 MW each) in 2011 to 2012. Therefore, three different groups (2000-2014, 2000-2009 and 2013-2014) of duration curves are also plotted for historical data in comparison with a single combination of the model data for Turners Falls.

It should be noted that:

a. for the individual year plots, the model curves are generally within the historical year curves; and

b. for the combined year plots, the model curves are quite close to the historic year curves.

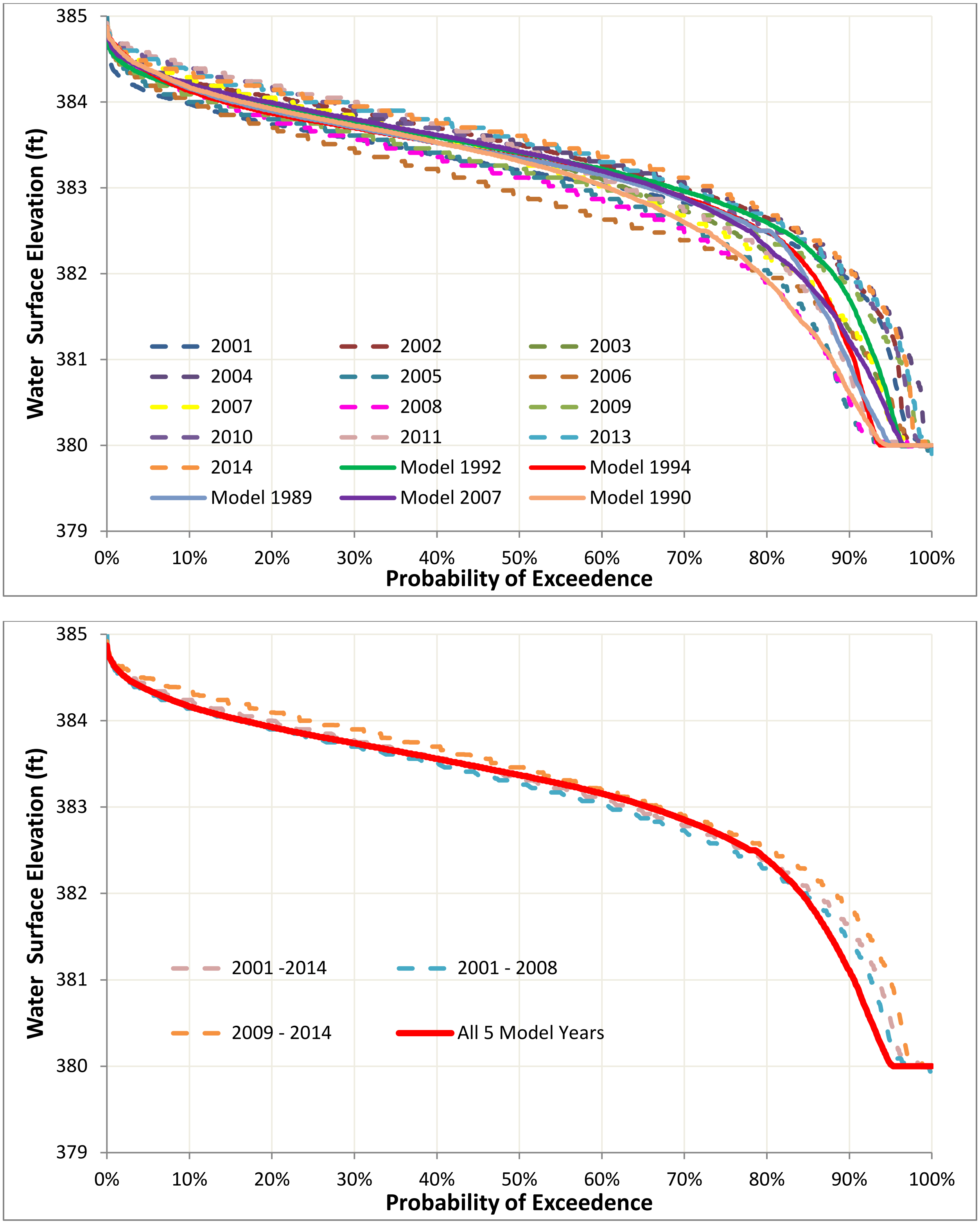
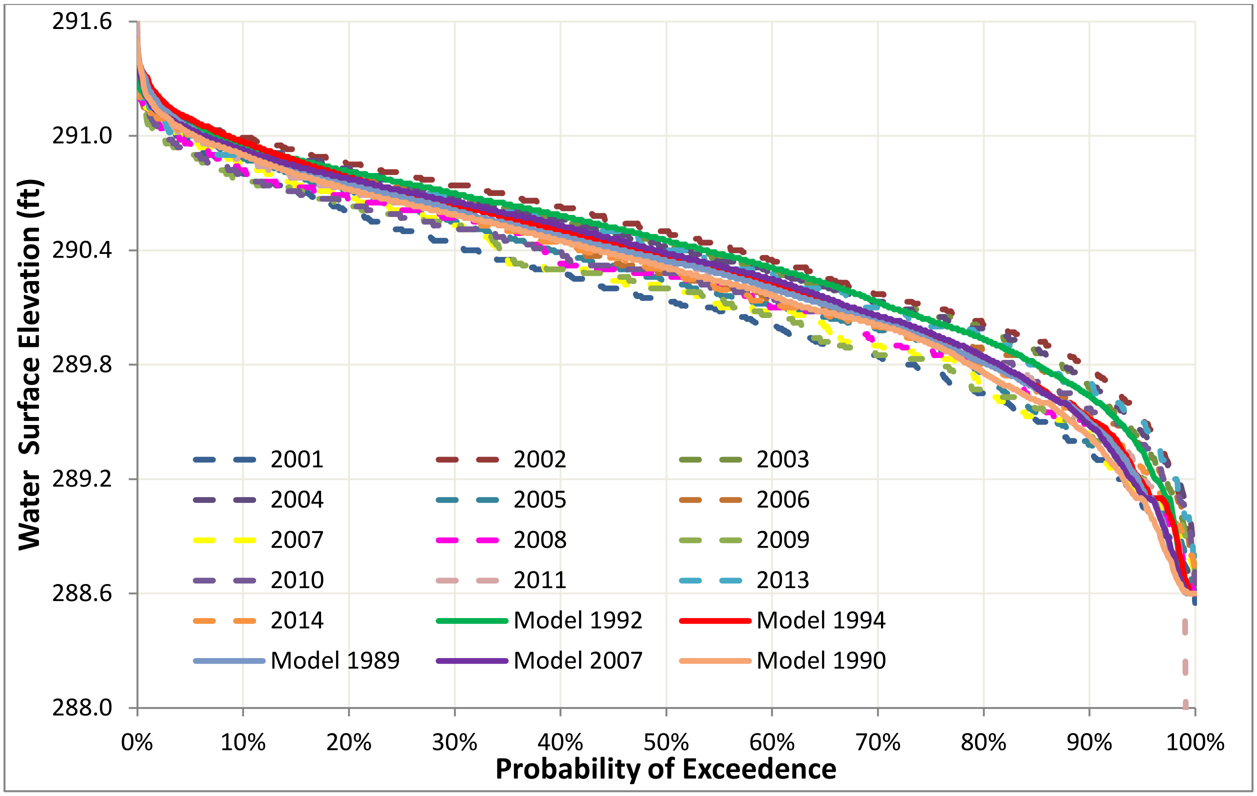


Figure 5.5. Wilder hourly water surface elevation duration curves.



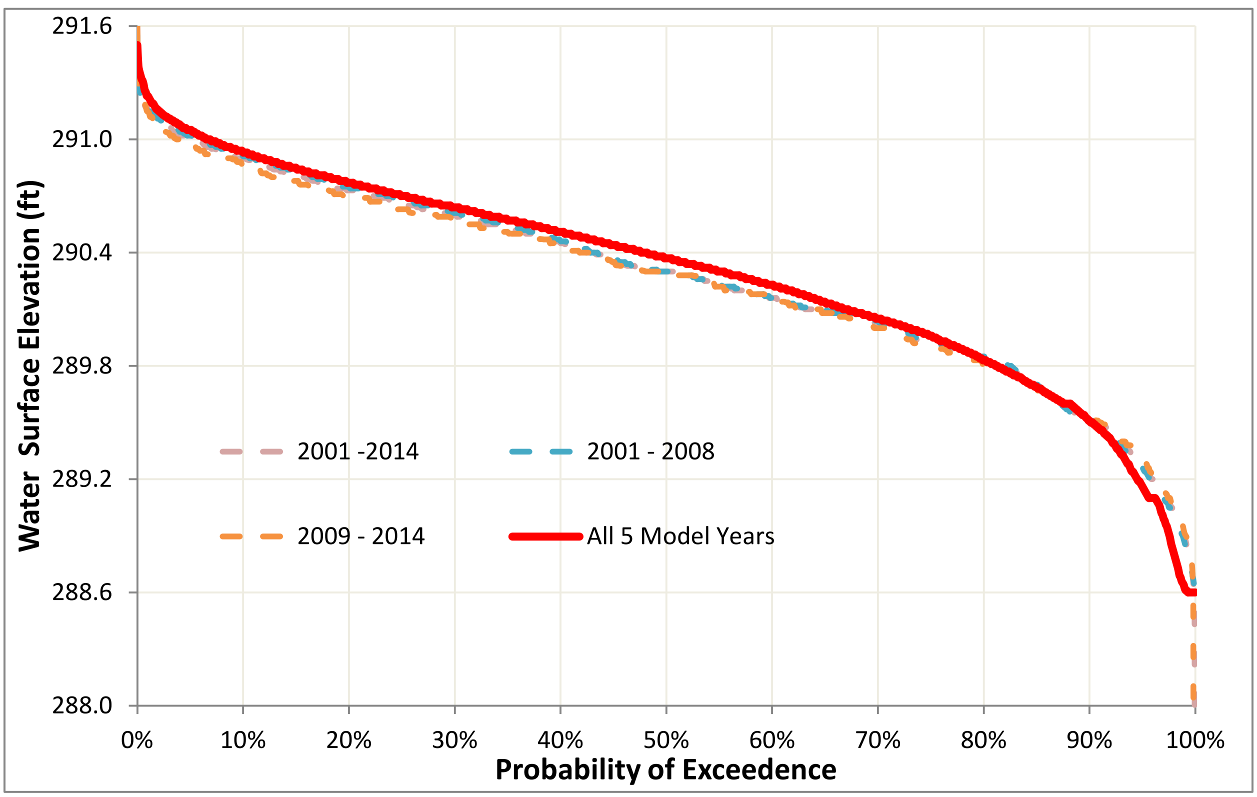
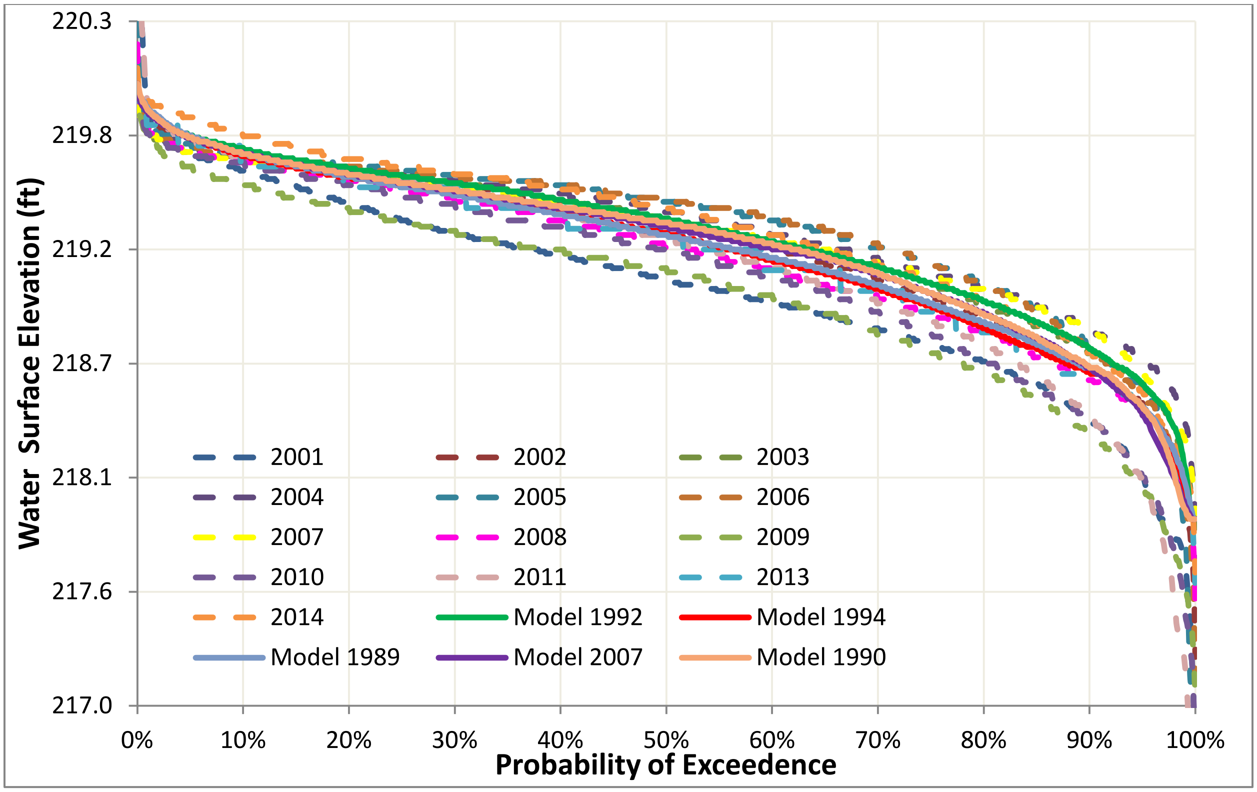


Figure 5.6. Bellows Falls hourly water surface elevation duration curves.



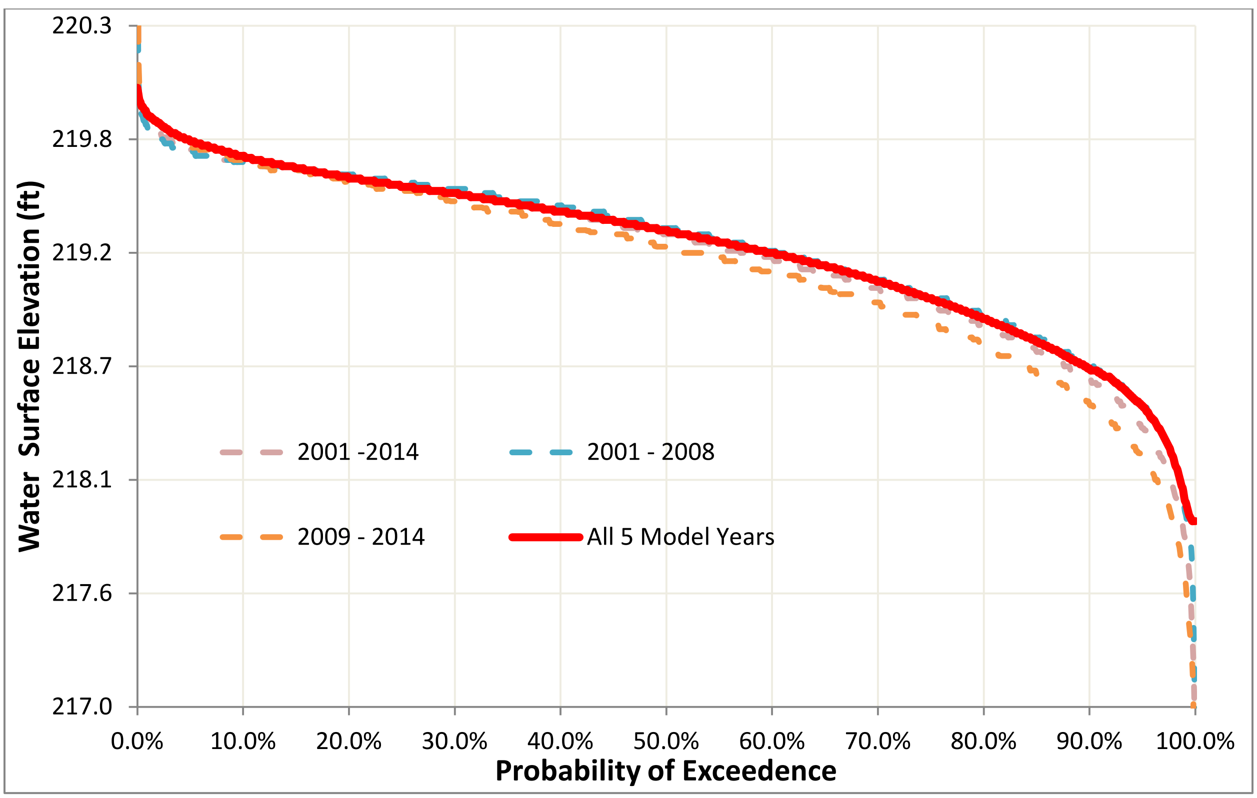
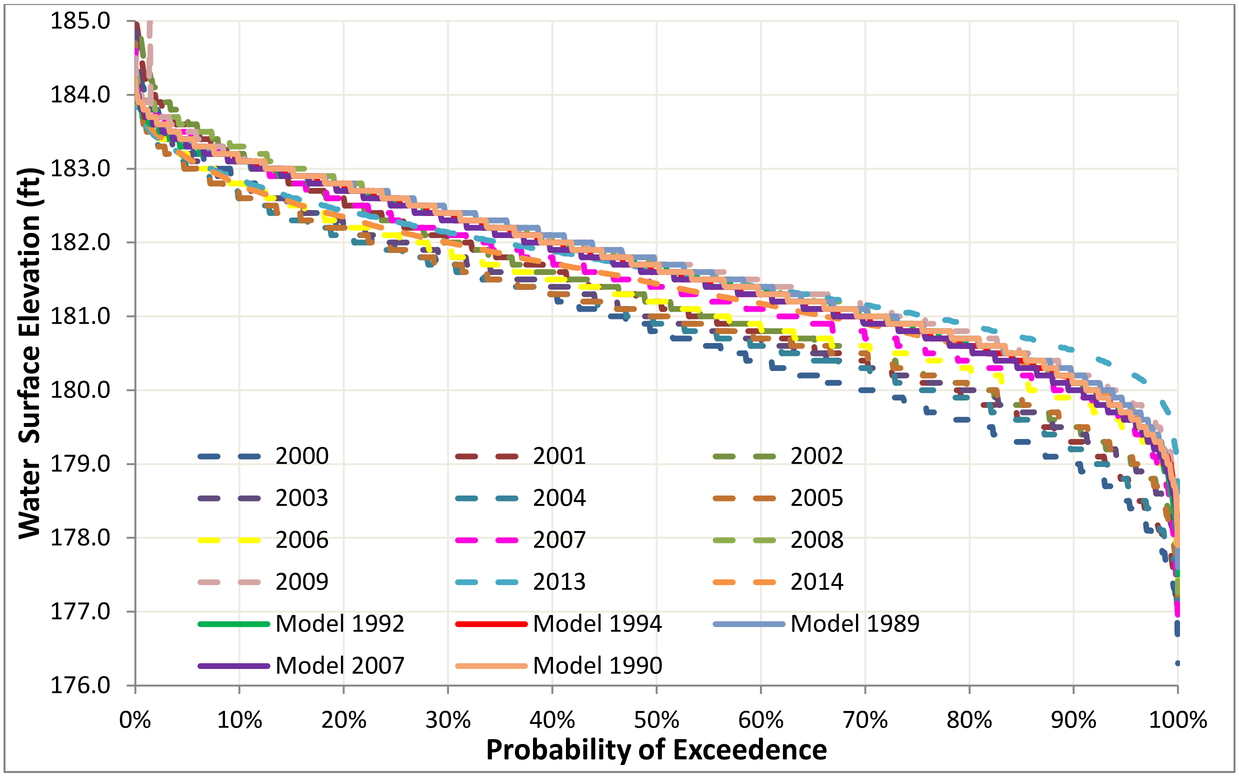


Figure 5.7. Vernon hourly water surface elevation duration curves.



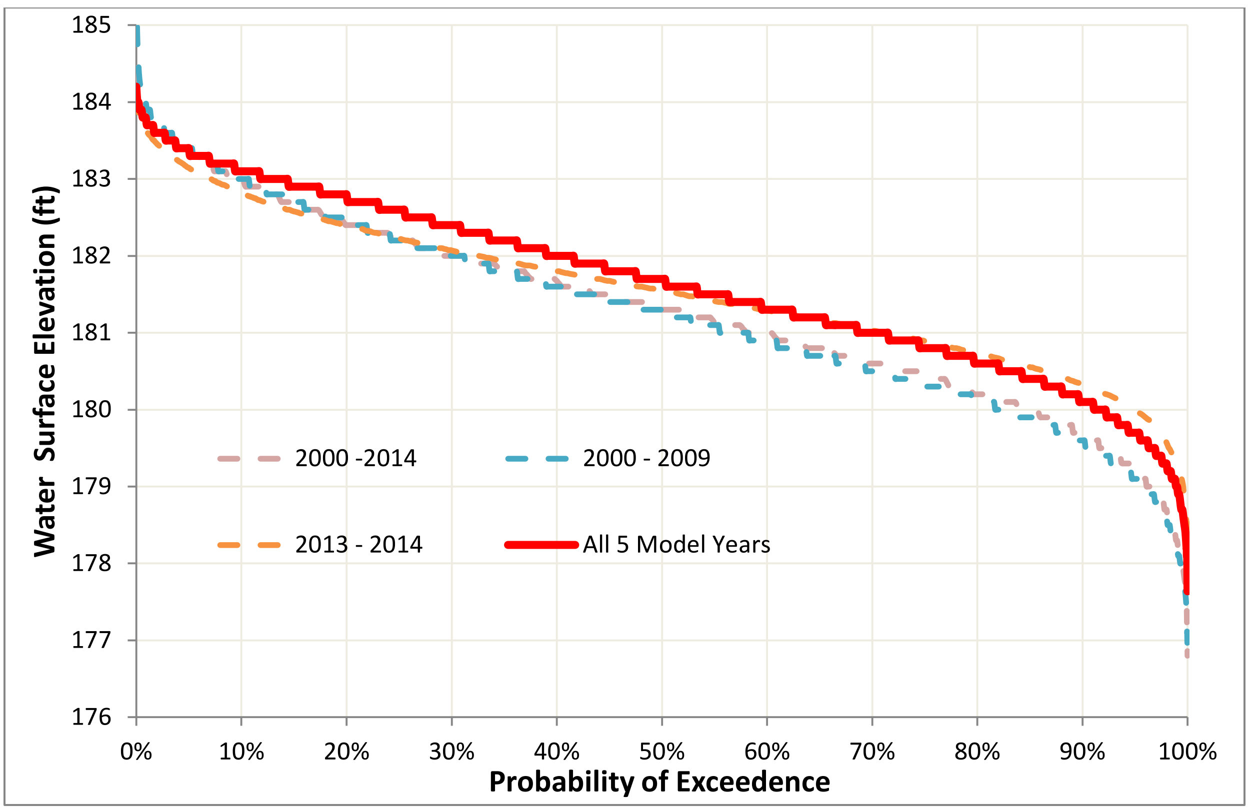


Figure 5.8. Turners Falls hourly water surface elevation duration curves.

6.0 ASSESSMENT OF PROJECT EFFECTS

Requests from resource consultants for operations model data varied based on the specific needs of each resource study, and included WSE data over specific times of year and/or times of day, rates of change of WSEs, and calculations of timing, frequency and/or duration of dewatering or submergence at study-specific locations of interest in relation to study-specific reference elevations.

Table 6.1 provides a summary of the model output provided to resource consultants for resource-specific studies and study reports as of August 1, 2016. Descriptions of study-specific model data used and evaluation of potential project effects are provided in the individual resource study reports.

Table 6.1. Summary of model output provided for resource studies.

Study No.	No. of Econodes	Model Output
2-3	1,252	Modal values and duration curves of daily WSE variation
9	5	Hourly time series and duration curves of life stages habitat indices for 9 species (total of 25 life stages per location)
13	37	Daily time series of number of hours without access and % time without access
14-15	85	Number of days in the time period, and the number of those days in which WSEs were lowered in response to imminent storm events, along with reference elevations
16	34	Hourly time series of WSE
25-26-28-29	48	Maximum, minimum and mean statics and plots of hourly, daily, weekly, monthly and/or seasonal water surface elevation time series along with reference elevations
27	19	Maximum, Minimum, and Mean statistics of weekly WSE and weekly water level fluctuation time series and plots.

7.0 LITERATURE CITED

GEI Consultants, Inc. 2016. ILP Study 4 – Hydraulic Modeling Study Final Report. Prepared for TransCanada Hydro Northeast Inc. June 17, 2016.

Normandeau Associates, Inc. (Normandeau). 2016. ILP Study 9 – Instream Flow Study Interim Report. Prepared for TransCanada Hydro Northeast Inc. March 1, 2016.

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APPENDIX A – Model Constraint Definitions

filed separately in Excel format