

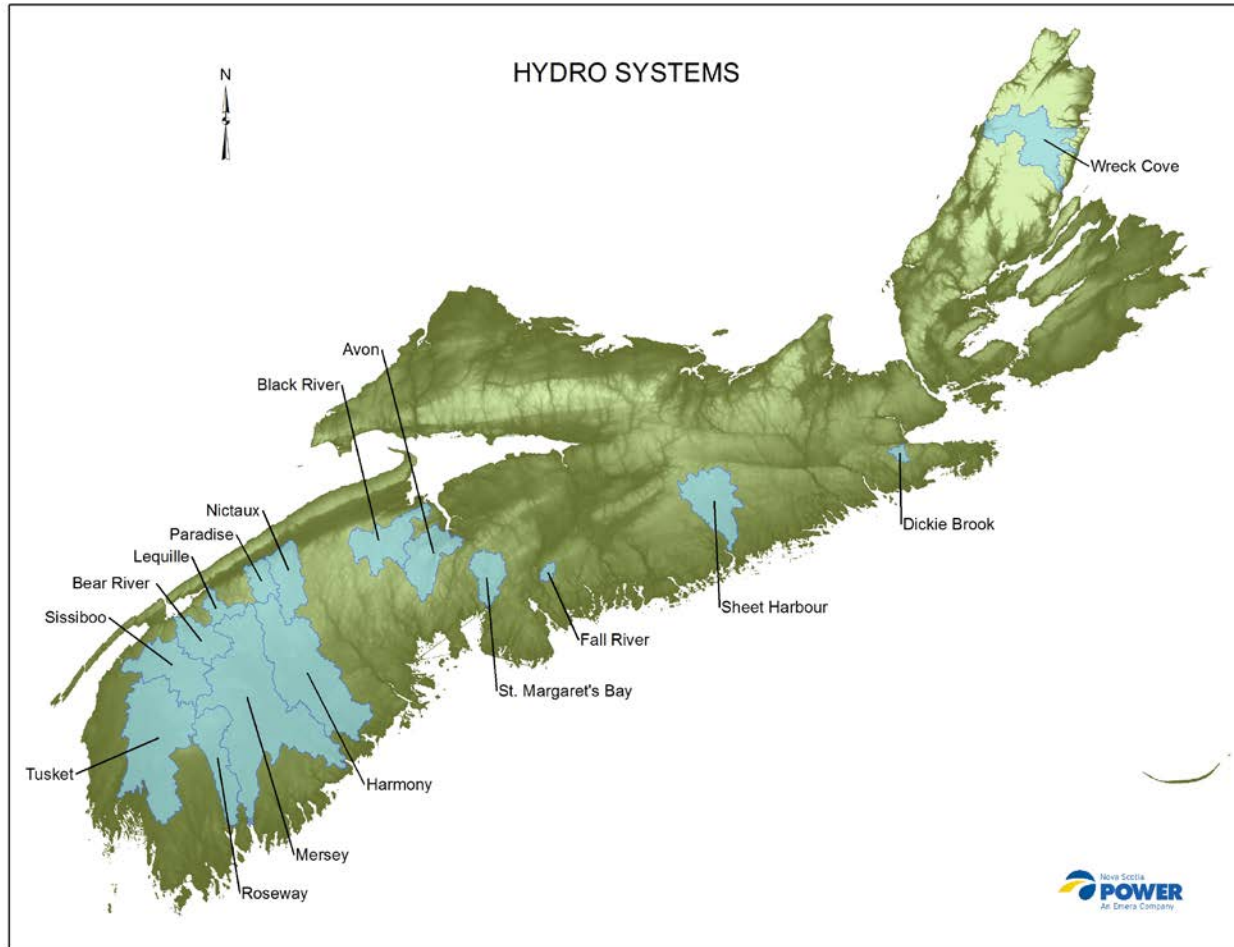
HYDRO ASSET STUDY (HAS)

FEBRUARY 27TH, 2020

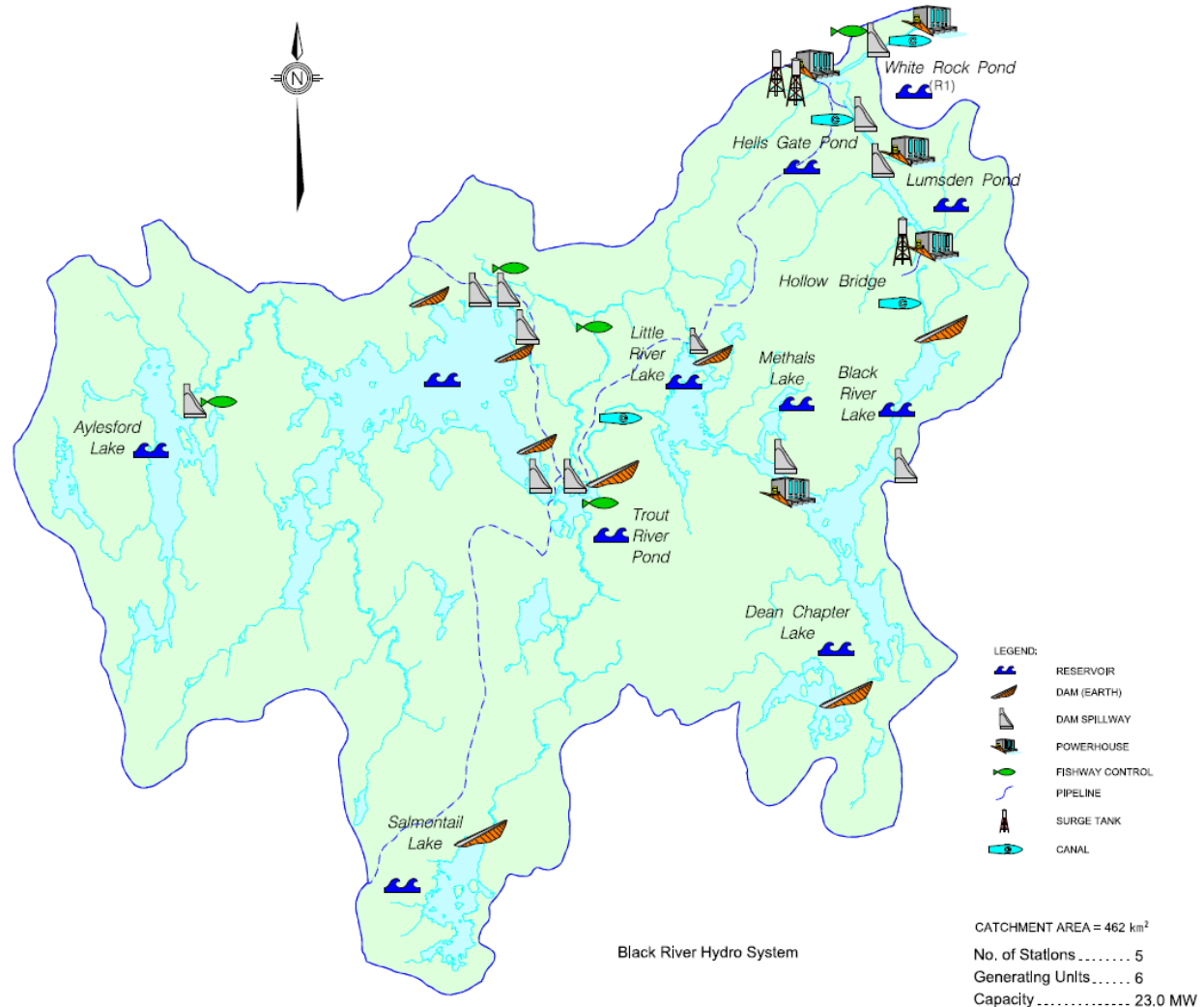
BACKGROUND

- NS Power owns/operates 17 hydro systems, which includes 50 generating units across 31 powerhouses, powered by water contained by over 150 dams
 - Other associated assets include surge tanks, canals, gate structures and fish passages
 - Net winter capacity of 374 MW, annual renewable generation of approx. 1 TWh
 - Original commissioning dates of generating units range from 1922 to 1985
- Hydro Asset Study (HAS) developed out of 2011 Depreciation Study Settlement
 - Final report submitted to NSUARB on December 21st, 2018, in accordance with 2018 ACE Plan Terms of Consensus
 - Intended next steps were for Hydro Asset Study (HAS) to provide input to the next Integrated Resource Plan and Depreciation Study

NS POWER HYDROPOWER



NS POWER HYDROPOWER – BLACK RIVER HYDRO SYSTEM



SUMMARY

- HAS provides the estimated costs to sustain, and to decommission the hydro systems
 - These costs were assumed to span 40 years, and are presented as their net present value (NPV)
 - Sustaining and decommissioning costs are provided to a Class 5 accuracy
 - Sustaining costs presume each hydro system will continue to operate in its present state
 - Sustaining capital developed by NS Power and verified by METSCO Energy Solutions Ltd. (METSCO)
 - Operational costs based on historical values
 - Decommissioning costs account for entire removal of a hydro system, such that each watershed is re-naturalized to resume a natural flow regime, and NS Power has no remaining maintenance, or public safety responsibilities
 - Cost of physical removal, environmental assessment, sediment management developed by Hatch Ltd. (Hatch) and J.B. Yates Consulting Ltd. (Yates), supported by Strum Consulting (Strum)
 - Cost of archaeology developed by Boreas Heritage Consulting Inc (Boreas)

SUMMARY – SUSTAINING CAPITAL

Sustaining Capital

- Developed using NS Power Asset Management Methodology
- Provides a long term (40 year) spend profile for each major asset class, on each hydro system
- Amount and timing of actual spend always dependent on current condition and criticality

Operational Costs

- Based on previous 5 years of costs for items such as maintenance and operations staffing

SUMMARY – SUSTAINING CAPITAL

METSCO Energy Solutions

- Retained to provide independent assessment of NS Power’s hydropower sustaining capital spend profile
- Lead by Thorhallur Hjartarson, P.Eng., M.A.Sc., and Alexander Bakulev, PhD, IAM Certificate in Asset Management, who have extensive experience on similar assignments involving asset risk-based management and system plan developments
- Evaluation framework based on *Subject Specific Guidelines for Asset Management Policy, Strategy and Plant and for Life-Cycle Value Realization*, issued by the Institute of Asset Management (IAM)
- Reviewed 4 key elements of NS Power’s plan: Asset Registry Completeness, Life-Cycle Cost Estimates, Investment Prioritization and Optimization, Other considerations
- Concluded that NS Power’s asset management practices are comparable to similar utilities

SUMMARY - DECOMMISSIONING

Hatch Ltd.

Physical removal, environmental assessment, sediment management

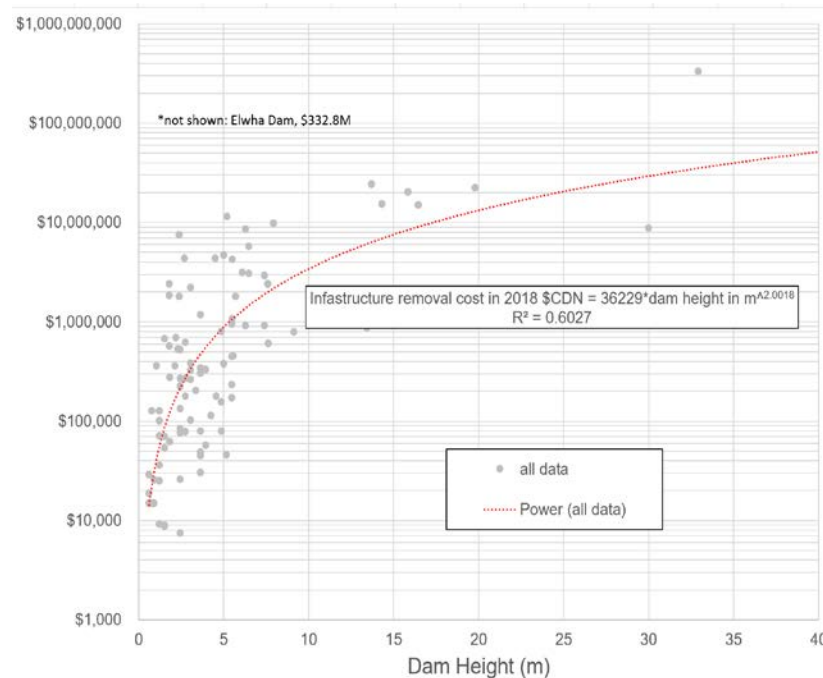
- Hatch is one of the world's largest consultant firms specializing in hydroelectric facilities and dams; and was selected due to its 15 years of experience and leadership in hydropower design.
- Hatch carried out the first large dam decommissioning in Canada and has been involved in other decommissioning and dam assessment projects in Canada, including Mactaquac in New Brunswick and Muskrat Falls in Newfoundland & Labrador.
- Hatch has previously completed work supporting NS Power decommissioning cost and impact estimates
- The two primary consultants involved were C. Richard Donnelly, M.A.Sc., P.Eng. and Trion Clarke, Ph.D. and each has more than 25 years of relevant experience

SUMMARY - DECOMMISSIONING

Hatch Ltd. – Infrastructure Removal

Hatch was retained to provide the complete decommissioning costs of control structures and generation plants for each of NS Power’s 17 hydro systems.

- Infrastructure removal costs were developed using two methods:
 - Five sites had previous comprehensive estimates, completed by Hatch
 - Remaining systems were based on precedent costs of over 100 example cases, where NSPI sites were benchmarked using dam length and dam height



SUMMARY - DECOMMISSIONING

Hatch Ltd. – Sedimentation Costs

Hatch outlined research (Pansic model) indicating that sediment management can be more than 50% greater than the cost of infrastructure removal, and a reliable estimate would require extensive research

- The Pansic model suggests that a typical decommissioning endeavor would be:

Infrastructure Removal	30%
Environmental Engineering	22%
Sediment Management	48%

SUMMARY - DECOMMISSIONING

Hatch Ltd. – Environmental Costs

- Environmental costs were developed using two methods:
 - Four sites had previous comprehensive estimates, completed by Hatch
 - Remaining systems were based on precedent costs from a large literature review, which created a rating matrix
 - Review generated a database of environmental costs based on dam size (height, reservoir area and/or volume) and system features (associated fisheries, stakeholder interest and/or recreational usage, contaminated sediments and/or industrial use, and flood reduction)

Dam Size	Environmental Concerns	Environmental Division Score
Small	Low	4 and below
	Medium	5 – 7
	High	8 – 10
Medium	Low	4 and below
	Medium	5 – 7
	High	8 – 10
Large	Low	4 and below
	Medium	5 – 7
	High	8 – 10

SUMMARY - DECOMMISSIONING

J.B. Yates Consulting Ltd.

- Yates has been involved with assessments, maintenance, improvements and rehabilitation planning for over 40 hydro and thermal generation sites for NS Power, Emera Energy, Minas Basin Pulp and Power, Berwick Electric and Nalcor. Yates has also done similar work for Halifax Water, NSBI and the Department of Transportation and Infrastructure Renewal.
- During the 2010 Depreciation Study, Yates provided costs to decommission NS Power's hydro powerhouses. In 2018 Yates was retained to update these costs to 2018 values
- Separately, Yates provided a report on the cost to decommission the Annapolis Tidal powerhouse, due to the location's unique construction

Strum Consulting

- Strum is a leader in environmental services and assessments in Atlantic Canada including functional wetland assessment, delineation and characterization, alteration permitting and compensation.
- Provided costs specifically for Environmental Permitting, which corroborated Hatch's costs

SUMMARY - DECOMMISSIONING

Boreas Heritage Consulting Ltd.

- Boreas has over 15 years of archaeological consulting experience, including indigenous archaeology and use of technology and geophysics in archaeological investigations.
- Boreas has undertaken archaeological work throughout Atlantic Canada, Alberta and Saskatchewan and has worked for developers, government and industry clients.
- Boreas has supervised and conducted archaeology assessments for some of NS Power's multi-year hydro projects.

SUMMARY - DECOMMISSIONING

Boreas Heritage Consulting Ltd.

Boreas was retained to provide cost estimates for archaeological work related to decommissioning activities

- Boreas created a set of archaeological assumptions founded upon archaeological and planning principles as a result of historical heritage guidelines, standards and best practices throughout Nova Scotia for completing archaeology work during hydro refurbishment or decommissioning activities
- Boreas incorporated all existing documented archaeological site information
- Discussions with NSPI defined areas of impact for decommissioning, including construction and dewatering footprints

SUMMARY

- The report produced two sets of costs, Sustaining and Decommissioning, which are presented below as their 2018 NPV:

System	Sustaining	Decommissioning
Annapolis	\$34,490,000	\$23,920,000
Avon	\$10,190,000	\$46,695,000
Bear River	\$17,880,000	\$124,550,000
Black River	\$47,350,000	\$194,690,000
Dickie Brook	\$5,400,000	\$33,020,000
Fall River	\$3,910,000	\$6,500,000
Harmony		\$5,360,000
Lequille	\$8,330,000	\$10,000,000
Mersey	\$355,730,000	\$213,560,000
Nictaux	\$6,240,000	\$28,190,000
Paradise	\$7,130,000	\$64,190,000
Roseway		\$4,566,000
Sheet Harbour	\$33,440,000	\$55,460,000
Sissiboo	\$16,290,000	\$200,050,000
St. Margaret's Bay	\$23,490,000	\$68,060,000
Tusket	\$23,630,000	\$79,530,000
Wreck Cove	\$160,120,000	\$424,940,000

RESOURCE SCREENING

- NS Power will work with E3 to assess the economic viability of each hydro system via E3's RESOLVE capacity planning model during the Resource Screening phase of the IRP Analysis Plan
- RESOLVE identifies resources portfolios that minimize the sum of investment and operating costs over the IRP horizon period (including end-effects), while meeting energy, capacity and other system constraints
- The Resource Screening phase will test the option of economic retirement of NS Power's hydro systems; the detailed capacity expansion planning simulations will weigh the option of retiring and replacing versus the option of preserving these units
- The screening will consider representative IRP Scenarios to provide meaningful results as to whether certain hydro systems should be considered for retirement during the Portfolio Studies and Operability/Reliability Screening

RESOURCE SCREENING

- The Resource Screening phase will consider:
 - Existing Hydro Resources**
 - Sustaining Capital Investments
 - Decommissioning Costs
 - O&M Costs
 - Hydro System characteristics including:
 - Capacity
 - Energy Production
 - Dispatchability
 - Contribution to Planning and Operating Reserves
 - Replacement Resources**
 - Costs and characteristics from the Supply Side Option Study
- Candidate economic retirements identified during the Resource Screening phase will be considered in the Portfolio Studies and Operability/Reliability Screening; this will assess provision of essential grid services and other system characteristics not modeled in RESOLVE