NEXT GENERATION HYDRO

Workshop #3

Participant Package

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YUKON DEVELOPMENT CORPORATION

NEXT GENERATION HYDRO powering our future

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YUKON HYDROELECTRIC POWER PLANNING DIRECTIVE CRITERIA

In early 2013, Yukon Government issued the Yukon Hydroelectric Power Planning Directive to Yukon Development Corporation (YDC).

The Directive tasks YDC to plan the development of one or more hydroelectric projects, to ensure together with supporting renewables and to the minimum extent feasible non renewable sources of electrical power, an adequate and affordable supply of reliable and sustainable electrical power in Yukon.

DIRECTIVE CRITERIA 1.0

"Evaluates the expected growth in residential, commercial and industrial demand for electrical power in Yukon."

DIRECTIVE CRITERIA 2.0

"Plans for scalability, so as to allow for the increase of energy supply over time to meet projected demand growth."

DIRECTIVE CRITERIA 3.0

"Assess the project's financial needs and risks, and evaluate options for project financing and financial risk mitigation."

DIRECTIVE CRITERIA 4.0

"Determine the anticipated positive and negative socio-economic and environmental effects of the project, and develop specific means of maximizing its benefits, minimizing its adverse effects and mitigating any unavoidable negative impacts."

DIRECTIVE CRITERIA 5.0

"In respect to the effects have particular regard to the impacts on and opportunities for, the First Nation or First Nations in whose traditional territory the project may be located."

DIRECTIVE CRITERIA 6.0

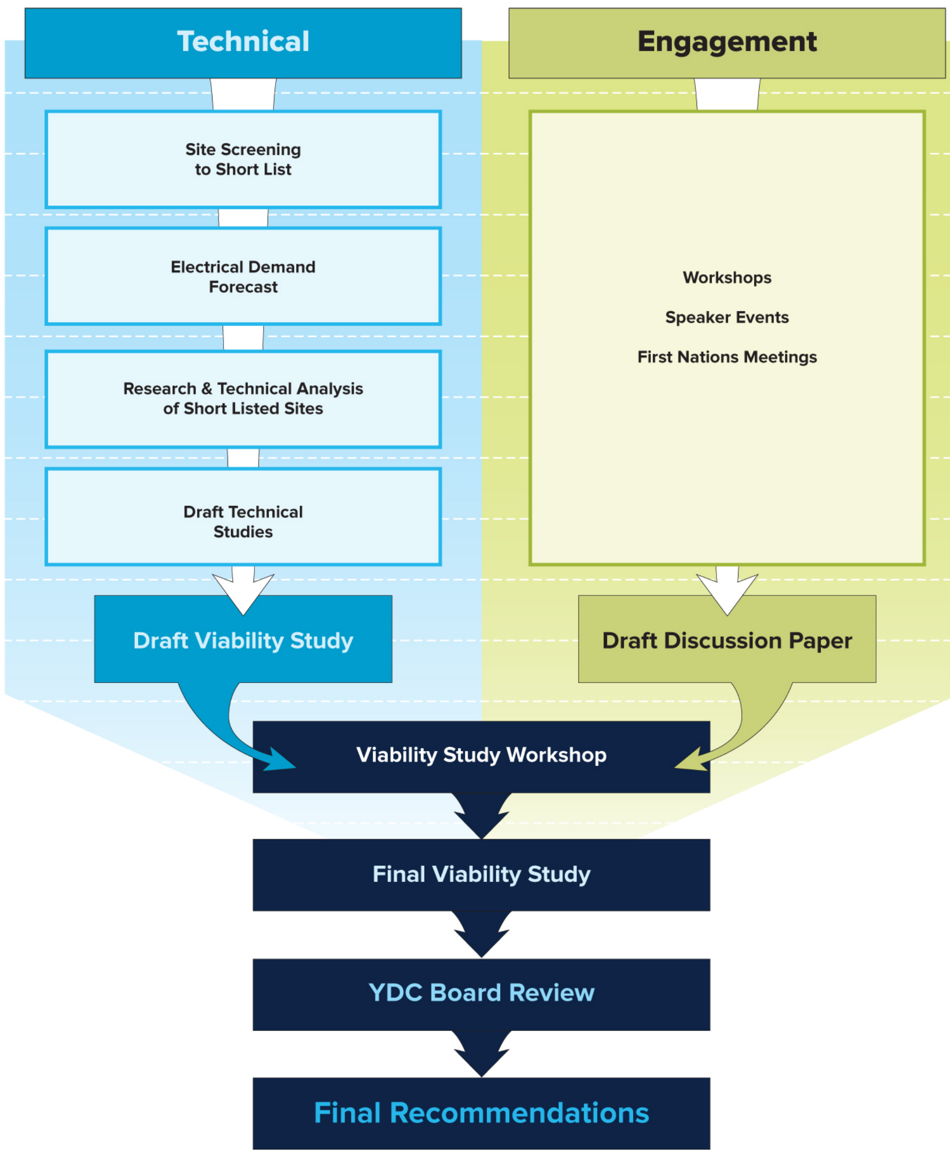
"Engage with First Nations to explore options for project locations as well as opportunities for partnership in project planning and execution."

DIRECTIVE CRITERIA 7.0

"Consider one or more specific possible locations for the project, taking into consideration the above criteria as well as proximity to the existing and expected future customer base."

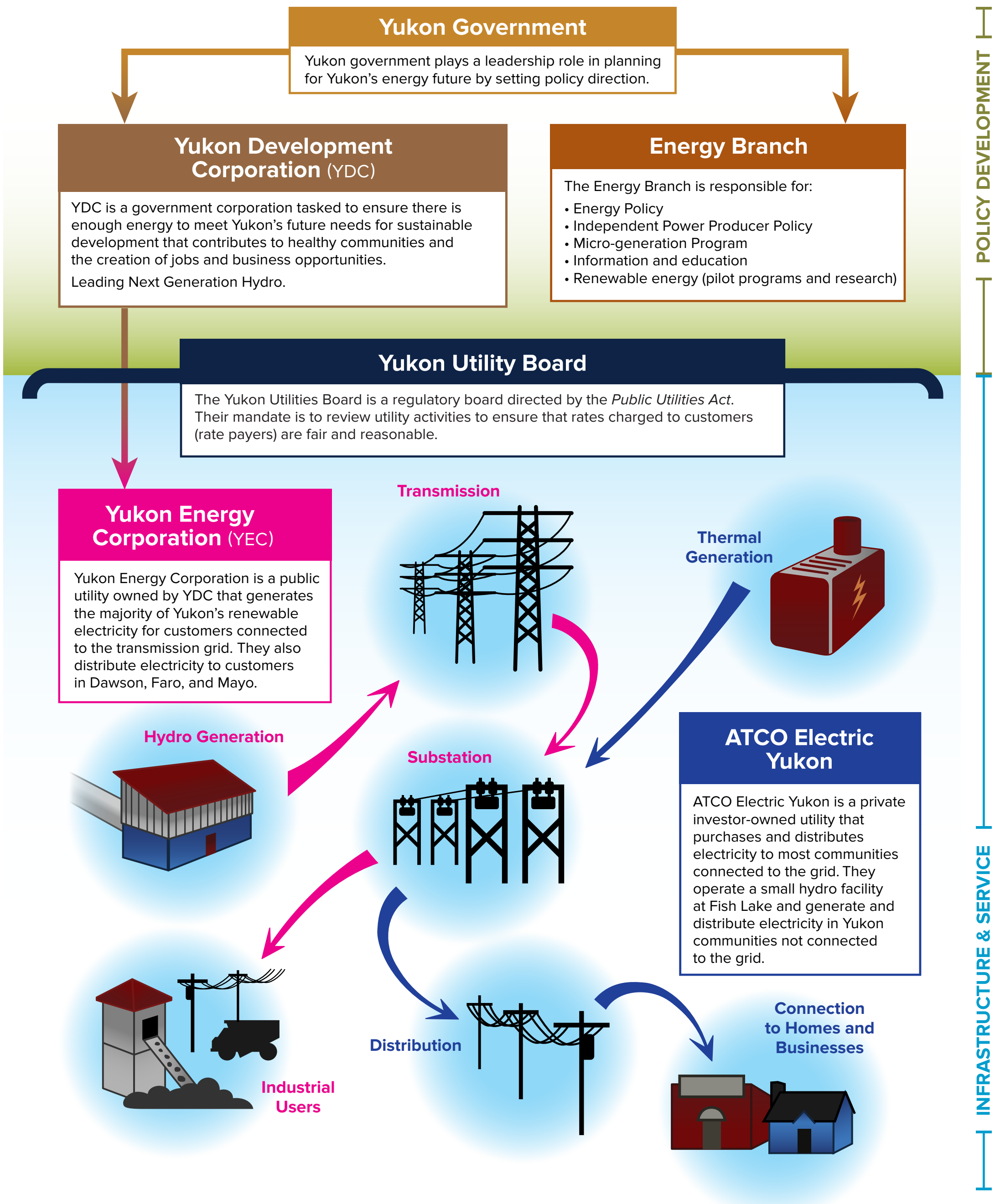
PROJECT PROCESS

Input, comments and feedback will be gathered throughout the course of the year as technical results are shared. Feedback will be compiled in the *Next Generation Hydro Discussion* paper that will be presented to the Yukon Development Corporation (YDC) board together with a summary of all technical work – *the Next Generation Hydro and Transmission Viability Study*. The YDC board will review both documents to develop a recommendation for one or more potential hydro sites.



YUKON'S ENERGY PARTNERS

Several key players have a role in ensuring that Yukon's electricity supply remains abundant, reliable, and cost effective for generations to come. Read more about each key organization and their role in the big picture.



GLOSSARY OF TERMS

Biomass: Energy resources from organic matter, including wood, agriculture waste, and other living material that can be burned to produce electricity and heat.

Capacity (Demand): The supply (or consumption) of electrical power at a given instant in time. Usually measured in watts (W), kilowatts (kW) or megawatts (MW) depending on context. The annual peak demand is a key factor in sizing power lines and generators.

> **Kilowatt (KW)** = 1000 watts
>
> **Megawatt (MW)** = 1000 KW
>
> **Gigwatt Hours (GWh)** = 1000 GW

Climate Change: A change in the average weather that a given region experiences. Climate change on a global scale includes changes to temperature, shifts in wind patterns, and changes to precipitation (from Climate Change Action Plan).

Demand Side Management (DSM): The attempt to reduce overall electrical consumption at customer sites via initiatives, rate structures and or codes/standards. Demand side management, when used during peak demand periods, is useful to delay or avoid upgrading power infrastructure.

Dispatcheable Generation: Refers to sources of electricity that can be dispatched at the request of power grid operators; that is, generating plants that can be turned on or off, or can adjust their power output on demand. Also called "firm" energy.

Distribution Lines: Conductors strung on overhead structures or placed underground that deliver electric power from substations to user sites (e.g. homes, shopping centres, mines).

Electrical Grid or "The Grid": The connected network of transmission lines, substations and distribution lines that brings power from sources (e.g hydro plants, wind turbines, diesel generators) to users (homes, businesses and industrial projects).

Energy: The supply (or consumption) of electrical power over a period of time. Usually measured in kilowatt-hours (kWh) for residential usage or gigawatt-hours (GWh) for regional/territorial usage. The annual energy supply must at least cover the annual energy consumption.

> **Kilowatt hour (kWh)** – amount of energy used or produced in an hour
>
> Example: Energy is power x time (1 MW or 1000 kW x 8760 hours per year = 8.76 GWh)

Example: a 100 watt light bulb 10 hours consumes one kWh of electricity (100 watts x 10 hours = 1000 watts per hour (Wh) or 1 kWh)

Generation: The source of electrical power be it hydro, wind, solar, or thermal (fossil fuel).

Generation Resource: The primary energy source that is converted to electrical power. Common generation resources include hydro, wind, solar, or thermal (e.g. natural gas, coal or diesel).

Geothermal: The use of heat from the earth to generate electricity or provide space heating and cooling.

Hydropower: A form of electrical power generated by converting the kinetic energy of moving water to electricity using a turbine. The capacity of the resource is influenced by the flow and elevation drop (head).

Independent Power Producer (IPP): An energy producer who generates electricity for sale to utilities or consumers such as the general public, businesses or industries.

Intermittent Energy: Any source of energy that is not continuously available due to some factor outside direct control (i.e wind blowing, or sun shinning).

Load: The electrical energy required to power homes, businesses and industrial processes. Sometimes referred to as demand.

Load Profile: A visualization of load (energy demand) over time.

Medium Hydro: A category of hydropower generation that typically has a peak capacity between 10 MW and 100 MW.

Micro Hydro: A category of very small hydropower generation that typically has a peak capacity of less than 100 kW and uses the natural flow of water.

Net Metering: When electricity consumers who own small, renewable energy generators such as wind or solar can receive a credit for a portion of the electricity they generate.

Resource Capacity: The quantity of a particular energy resource. It is usually reported on a site-by-site, regional or territorial basis in both capacity (MW) and energy (GWh) terms

Renewable Energy: Energy that comes from sources renewed on an ongoing basis through natural processes. Examples include sun, wind, wood, flowing water, or relatively warm ground, air or water temperatures (from Climate Change Action Plan).

Run of River Hydro: Is a type of hydroelectric generation where little or no water storage is used.

Small Hydro: A category of hydropower generation that typically has a peak capacity of less than 10 MW and requires some form of weir in the stream or river.

Sustainable Electricity: Is about pursuing innovative business strategies and operating activities that meet the needs of members, stakeholders and the communities in which we operate, while protecting and enhancing the legacy we leave for future generations (from Canadian Electricity Association).

Storage Hydro: Is a type of hydroelectric generation where a storage reservoir is created to store water to accommodate fluctuating river flows.

Sustainable Development: Beneficial socio-economic change that does not undermine the ecological and social systems upon which communities and societies are dependent (Umbrella Final Agreement).

The Public Utilities Act: Among other things defines a public utility as producing, generating, storing, transmitting, selling, delivering or furnishing electricity or gas to or for the public or a corporation for compensation. The act also defines the role of the Yukon Utilities Board (YUB) and the regulation of public utilities via a franchise. There are several Orders in Council that direct the YUB as well. One is the Rate Policy Directive (1995) O.I.C. 1995/090 that ensures ATCO Electric Yukon and Yukon Energy Corporation cannot charge customers different rates and all Yukon residential customers who use 1000 kWh or less per month are charged the same no matter their location in Yukon.

Transmission Lines: Conductors strung on overhead structures (wood pole or lattice steel towers) or placed underground that deliver electric power over long distances from power plants to substations.

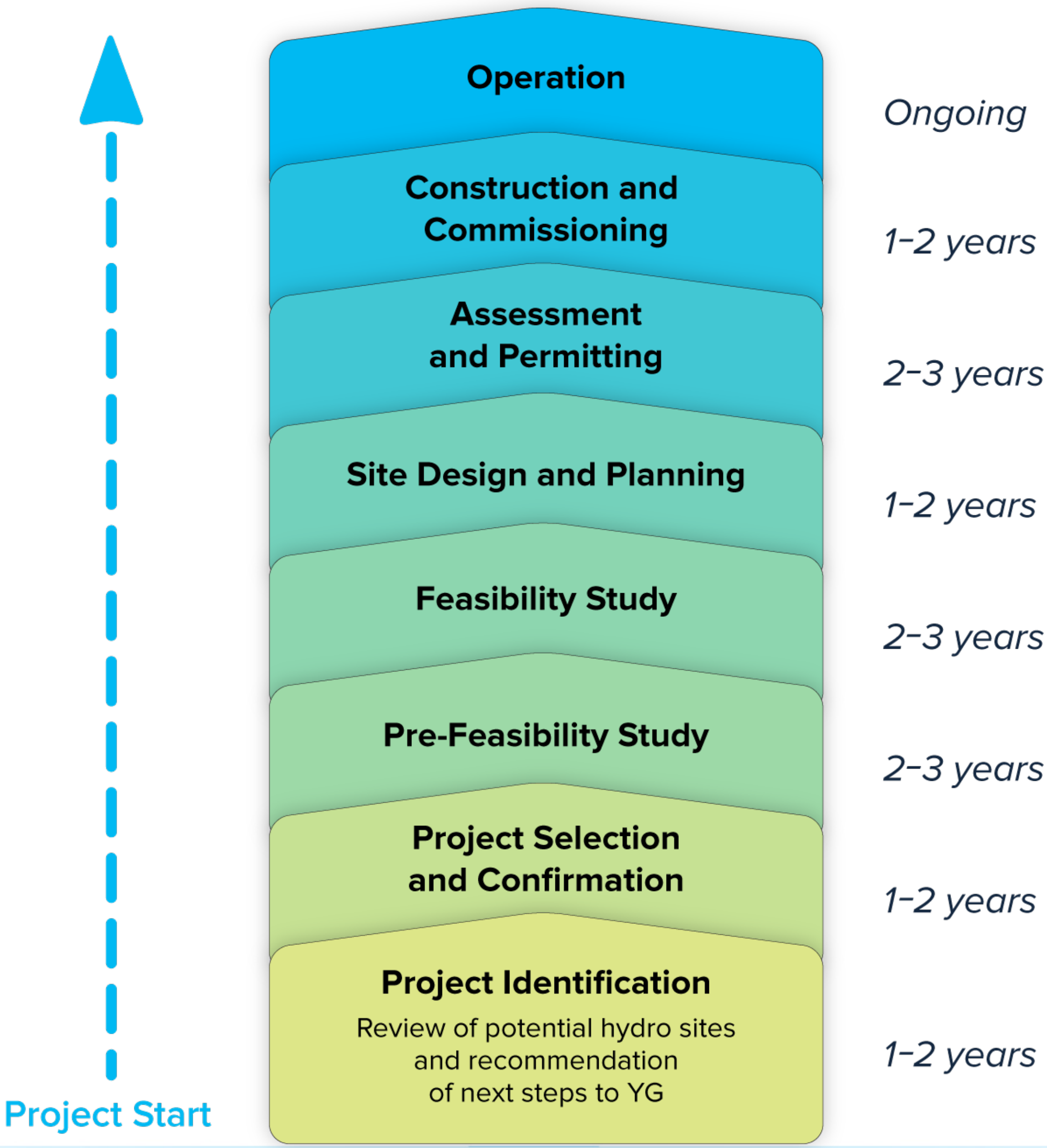
YESAB: Yukon Environmental and Socio-Economic Assessment Board

YESAA: Yukon Environmental and Socio-Economic Assessment Act

Yukon Hydroelectric Power Planning Directive: Yukon government issued ‘The Directive’ to Yukon Development Corporation (YDC) in 2013. It directs YDC to “plan one or more hydroelectric projects, together with supporting renewables and transmission.” The directive has seven criteria for project selection.

HYDRO DEVELOPMENT TIMELINE

A hydro facility is a large undertaking. It can take a minimum of 10-15 years to select, plan and build a hydro project. The chart below shows a typical development timeline for a hydro project. The timeline can shift when considering the development and exploration of several options at the same time.



LEVELIZED COST OF ENERGY (LCOE)

Calculating a cost of energy, or a "Levelized Cost of Energy" (LCOE), provides a consistent means of economically comparing generation projects. The LCOE calculation accounts for both the energy generated, and the total capital and operating costs for a generation facility over its expected lifetime. Levelized Cost of Energy models base the valuation on net present value calculations of the time value of capital costs, operating costs, and energy outputs. For Next Generation Hydro, LCOE has been calculated two ways (Full Utilization LCOE and Forecast Utilization LCOE).

Full Utilization LCOE

The Full Utilization LCOE, expressed in $/MWh, is calculated assuming that a project is built at its maximum size and capacity, that the project generates at its maximum potential, and that all of the generated energy is consumed in a useful manner. This method does not take into account the reality of producing electricity on the Yukon's isolated grid because we cannot sell excess electricity and make use of 100% of the hydro facilities energy in periods of low demand or high supply (e.g. in the summer months).

Forecast Utilization LCOE

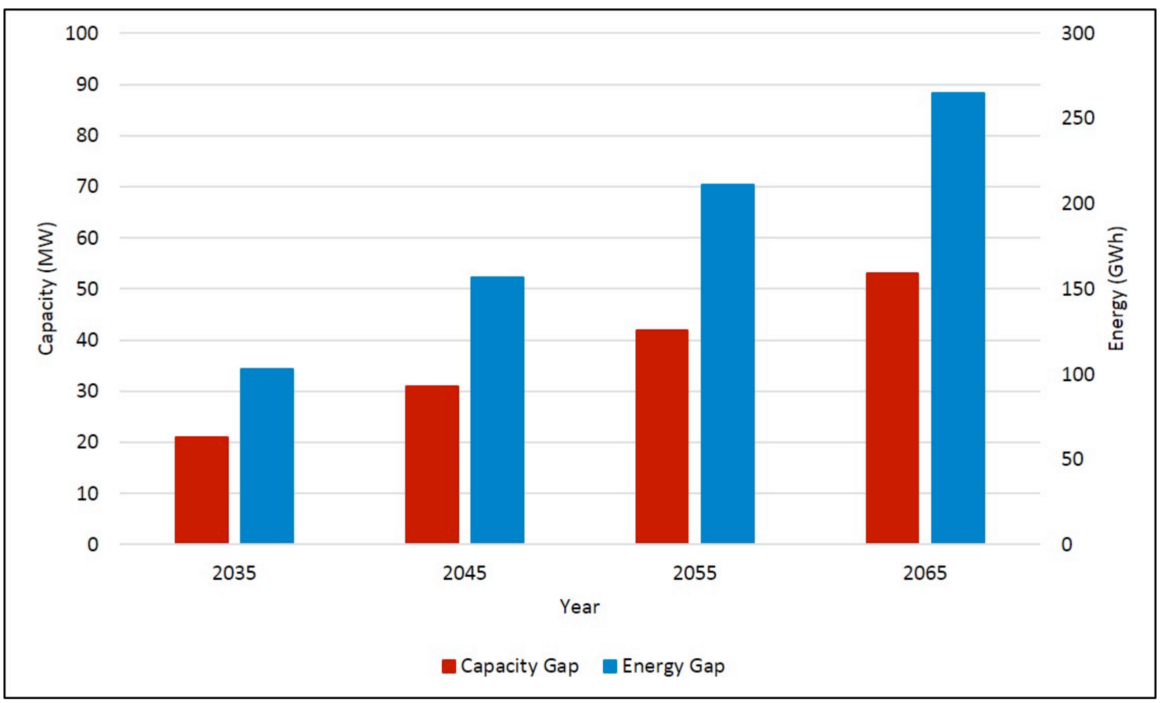
The Forecast Utilization LCOE is more reflective of how a generation asset will be used over time in the Yukon and the costs associated with the Yukon's electricity use. This method does not assume that the project is built to full size immediately, and it also does not assume that the entire energy output is fully consumed. As a result, the Forecast Utilization LCOE is always higher than the Full Utilization LCOE because the cost of the generation asset must be paid for with less energy being produced.

THE YUKON CONTEXT - YUKON'S ELECTRICITY NEEDS 20-50 YEARS FROM TODAY

Challenge #1 – Growing Demand for Electricity

In the Yukon we will need 62% more grid connect electricity in 50 years. According to the baseline scenario from the *Yukon Electrical Energy and Capacity Need Forecast (2035-2065)* Yukon will need up to an additional 265GWh of new electrical energy generation and 53MW of electrical capacity generation by 2065.

This need is expected to be driven by population growth and increases in per capita electricity use. Forecasts were put together blending historical trends and projections including continued population growth and an average number of mines in operation, based on historical figures. Today as a result of the legacy hydro assets (Whitehorse, Aishihik, and Mayo) in the Yukon we have the least expensive electricity rates in the North. Our rates are comparable to major southern cities like Edmonton and Calgary. In 2014 these clean renewable assets provided 99.6% of our energy needs.



From: *Forecasted Baseline energy and Capacity Gap from Yukon Electrical Energy and Capacity Need Forecast (2035-2064)*

Challenge #2 – An Islanded Grid

The Yukon grid is a self-reliant islanded grid. We must rely on our own resources to meet our needs. On an islanded grid, we cannot sell extra electricity or buy from others when we have a shortfall as we have no transmission line connection to our neighbours. This means we must rely on energy sources that can provide dependable capacity when we need it most – in the cold dark winter.

Challenge #3 – Winter Peak Demand

Access to affordable, reliable electricity is crucial for the safety of our citizens and the success of our businesses and communities. We must find a generation solution that can provide electricity we can depend on in our cold dark winters.

We use natural resources such as the sun, wind, water and fossil fuels to produce energy. These sources are available to us in different quantities at different times of the day month and year. For example, river flows in the Yukon are typically weakest in the winter months, as is solar energy when we need it most.

How Does Each Energy Source Compare?

Not all energy sources are created equal and each generation source has benefits, challenges, risks and tradeoffs. We must consider a range of factors.

GWh — Can the generation source provide enough electrical energy to meet our territorial needs 20-50 years from today?

MW — Does the generation source provide dependable capacity when we need it in the coldest darkest months of the year?

$ — What are the costs of the project? How will this affect electricity rates? Is the project economically feasible?

What is the land footprint of the technology? How does it affect fish, wildlife, traditional and cultural land use and other considerations?

Is the energy source renewable or non-renewable?

HOW DOES EACH GENERATION SOURCE COMPARE?

Each energy source was compared to review its ability to meet the forecasted need on a standalone basis and the cost, socio-economic and environmental effects of each technology. The table below summarizes the findings from the *Providing a Context For Next Generation Hydro - Other Solutions to Meet Yukon's Long Term Energy Needs* paper.

	Technical			Economic	Socio-Economic	Environmental	
Resource	**Max. 2065 Energy (GWh)**	**Max. 2065 Installed Capacity (MW)**	**Max. 2065 Firm Capacity (MW)**	**Full Utilization LCOE ($/MWh)**	**Social Impact**	**Land-Use Footprint (ha/MW)**	**Production GHG Emissions[2] ($kgCO_2e/MWh$)**
Wind	65	21	0	157	Potentially Acceptable	36 ± 22	0
Wind + Battery Storage	88	28	0	192	Potentially Acceptable	36 ± 22	0
Solar	13	14	0	192	Potentially Acceptable	0 - 3.5	0
Next Generation Hydro[3]	557	57	57	92	Potentially Acceptable	313 (Range: 187 – 545)	0
Run-of-River Hydro	Unlimited (@23.4GWh / project)	Unlimited (@4.7MW / project)	0.6MW / project	116+	Potentially Acceptable	≈11	0
Small Hydro with Storage	Unlimited (@43.6GWh / project)	Unlimited (@6.5MW / project)	4.2MW / project	126+	Potentially Acceptable	390 (Median)	0
Pumped Storage Hydro	-10* *PS does not produce energy	20	20	183	Potentially Acceptable	145	0
Natural Gas	710	Unlimited	141	229	Potentially Acceptable	0.28-0.42	708

From: *Providing a Context for Next Generation Hydro - Other Solutions to Meet Yukon's Long Term Energy Needs* Paper

The table below describes each individual technology's ability to meet the need as a standalone resource.

Resource	Standalone Resource	Rationale
Wind[4]	No	The integration limit for wind (plus utility battery support) is 28 MW[5] in 2065 (20% of installed capacity), and this is insufficient to meet the Yukon's forecast energy and capacity needs. Must be combined with other generation types.
Solar	No	The integration limit for solar is 14MW in 2065 (10% of installed capacity), and this is insufficient to meet the Yukon's forecast energy and capacity needs. Must be combined with other renewable generation types.
Next Generation Hydro	Yes	Next Generation Hydro provides sufficient dependable winter energy and capacity (57MW expandable up to 90-107MW as required) to meet the Yukon's forecast energy and capacity needs.
Run-of-River Hydro	No	Practical limits on easily developed Run-of-River projects limit the winter energy and capacity economically available from this resource type. On a standalone basis, over 80 Run-of-River projects would be required to meet the winter energy and capacity needs in 2065. Hence, Run-of-River hydro is an expensive source of winter energy and capacity.
Small Hydro with Storage	No	Small Hydro Storage energy shape limits the winter energy and capacity economically available from this resource type. On a standalone basis, approximately 14 projects would be required to meet winter energy and capacity needs in 2065. To reduce the overall costs Small Hydro Storage will likely be combined with other generation types and is preferred over Run-of-River as a source of small hydro winter energy and capacity.
Pumped Storage Hydro	No	This 20MW resource is a net energy consumer; therefore it must be combined with other generation types as part of a generation portfolio.
Natural Gas	Yes	Natural Gas Generation provides sufficient dependable winter energy and capacity.

From: *Providing a Context for Next Generation Hydro - Other Solutions to Meet Yukon's Long Term Energy Needs* Paper

ENERGY SCENARIOS COMPARISONS

The *Putting Next Generation Hydro in Context – Other Solutions to Meet Yukon's Long Term Energy Future* was developed to provide a context for Next Generation Hydro by presenting the impacts and tradeoffs of a variety of alternative supply options.

Scenarios

Seven different energy alternatives were compared and then packaged into four scenarios that reflect how each of the energy sources could work together.

Scenario	Description	Resources Included
Scenario 1 – Natural Gas	Build out natural gas generation	Natural Gas
Scenario 2 – Next Generation Hydro	Build a single Next-Generation Hydro project	Next Generation Hydro
Scenario 3 – Renewables Portfolio (No Pumped Storage)	Build a combination of renewable generation resources (excluding pumped storage hydro) to satisfy energy needs. If required to satisfy residual capacity needs, add natural gas generation.	Wind (with utility scale battery), solar, run-of-river hydro, small hydro with storage and natural gas (capacity only)
Scenario 4 – Renewables Portfolio with Pumped Storage	Build a combination of renewable generation resources including pumped storage hydro to satisfy energy needs. If required to satisfy residual capacity needs, add natural gas generation.	Wind (with utility scale battery), solar, run-of-river hydro, small hydro with storage, pumped storage, and natural gas (capacity only)

From: *Providing a Context For Next Generation Hydro - Other Solutions to Meet Yukon's Long Term Energy Needs*

Scenario 1 – Thermal - Natural Gas Overview

Project Type	Number of Projects	GHG Emissions / Project	GHG Emissions Total	Footprint / Project	Footprint Totals	Energy / Project	Energy Totals	Capacity / Project	Capacity Totals
Existing Hydro	-	-	-	-	-	-	444 GWh	-	92 MW
Natural Gas	12	16,000 tonnes/yr	190,000 tonnes/yr	1.8 ha	22 ha	22 GWh	265 GWh	4.4 MW	53 MW
Totals	12		190,000 tonnes/yr		22 ha		710 GWh		150 MW

Scenario 2 – Next Generation Hydro Overview

Project Type	Number of Projects	GHG Emission / Project	GHG Emissions Total	Footprint / Project	Footprint Totals	Energy / Project	Energy Totals	Capacity / Project	Capacity Totals
Existing Hydro	-	-		-	-	-	444 GWh	-	92 MW
Next Gen Hydro	1	0	0	18,000 ha	18,000 ha	265 GWh	265 GWh	57 MW	57 MW
Totals	1		0		18,000 ha		710 GWh		150 MW

Scenario 3 – Renewables with Battery Storage

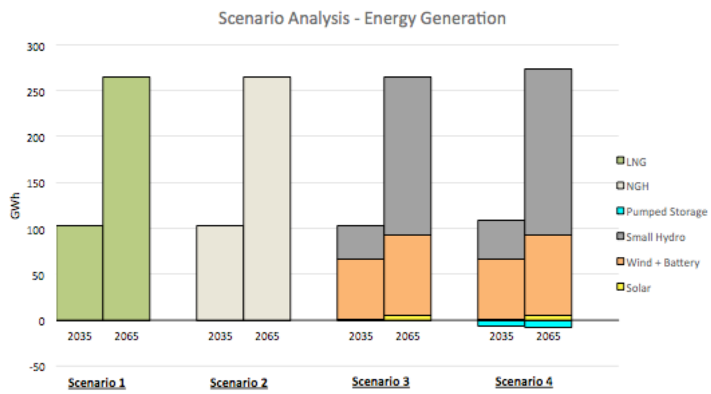
Project Type	Number of Projects	GHG Emissions / Project	GHG Emissions Total	Footprint / Project	Footprint Totals	Energy / Project	Energy Totals	Capacity / Project	Capacity Totals
Existing Hydro	-	-	-	-	-	-	444 GWh	-	92 MW
Wind	4	0	0	300 ha	1200 ha	22 GWh	88 GWh	7.2 MW	29 MW
Solar	5	0	0	0	0	1 GWh	5 GWh	1 MW	5 MW
Small Hydro	11	0	0	2500 ha	27500 ha	16 GWh	176 GWh	6.5 MW	72 MW
Natural Gas	2	≈0	≈0	1.8 ha	3.6 ha	≈0	≈0	4.4 MW	8.8 MW
Totals	22		≈0		29000 ha		710 GWh		207 MW

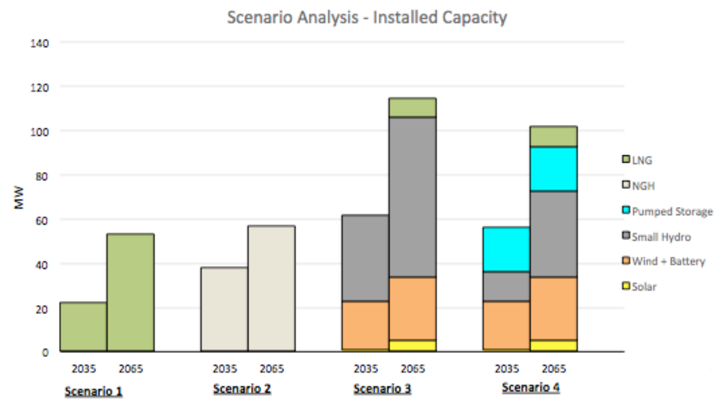
Scenario 4 – Renewables with Pumped Storage

Project Type	Number of Projects	GHG Emissions / Project	GHG Emission Total	Footprint / Project	Footprint Totals	Energy / Project	Energy Totals	Capacity / Project	Capacity Totals
Existing Hydro	-	-		-	-	-	444 GWh	-	92 MW
Wind	4	0	0	300 ha	1200 ha	22 GWh	88 GWh	7.2 MW	29 MW
Solar	5	0	0	0	0	1 GWh	5 GWh	1 MW	5 MW
Small Hydro	6	0	0	2500 ha	15000 ha	30 GWh	180 GWh	6.5 MW	39 MW
Pumped Storage	1	0	0	2900 ha	2900 ha	-8 GWh	-8 GWh	20 MW	20 MW
Natural Gas	2	≈0	≈0	1.8 ha	3.6 ha	≈0	≈0	4.4 MW	8.8 MW
Totals	18		≈0		20000 ha		710 GWh		194 MW

All tables from Putting Next Generation Hydro in Context – Other Solutions to Meet Yukon's Long Term Energy Needs

The graphs are a visual representation of how each energy source in the scenarios contributes to meeting future energy and capacity needs.





From Putting Next Generation Hydro in Context – Other Solutions to Meet Yukon's Long Term Energy Future

Scenario Comparisons

Each portfolio was compared for it's ability to meet the forecasted electricity and capacity gap, its costs, greenhouse gas emissions and land use footprint. The chart below summarizes the tradeoffs between the four scenarios.

	Technical		Economic	Socio-Economic	Environmental	
Scenario	**Meets Yukon Energy Needs?**	**Meets Yukon Capacity Needs?**	**Forecast Utilization LCOE ($/MWh)**	**Social Impact**	**2065 Land-Use Footprint (hectares)[6]**	**2065 GHG Emissions (tonnes CO_2e)**
Scenario 1 – Natural Gas	Yes	Yes	250	Potentially Acceptable	22	190,000
Scenario 2 – Next-Generation Hydro	Yes	Yes	240	Potentially Acceptable	18,000	0
Scenario 3 – Renewables	Yes	Yes (with Natural Gas capacity)	360	Potentially Acceptable	29,000	≈0
Scenario 4 – Renewables with Pumped Storage	Yes	Yes (with Natural Gas capacity)	270	Potentially Acceptable	20,000	≈0

From: *Providing a Context For Next Generation Hydro - Other Solutions to Meet Yukon's Long Term Energy Needs*

TECHNICAL SITE SCREENING PROCESS

The technical team has reviewed, compared and ranked over 200 hydro sites in the Yukon to determine potential suitable sites to meet our electricity needs 20–50 years from now.

Studies from the last 60 years were reviewed and compiled in this process. The methodology below provides an overview of how the sites were short listed.

200 PROJECTS OF INTEREST

PART 1

SCREEN 0 Reconciliation of Known Projects

Duplicate projects and projects with not enough detail of study were eliminated.

SCREEN 1 Fundamental Development Barrier Screen

Projects that had the following characteristics were eliminated:

- Main stem of the Yukon River
- Urban flooding
- Projects in a National Park
- Projects smaller than 10MW
- Incorrect project type (projects that were water diversion only, storage only, or pumped storage)

SCREEN 2 Fundamentally Uneconomic Screen

High-level project costing and energy production assumptions were used to eliminated projects that were fundamentally uneconomic. Any project expected to produce energy at a higher cost than the equivalent thermal generator (18.3¢/kWh) were screened out from further study.

16 PROJECTS OF INTEREST

PART 2

The 16 projects of interest were reviewed according to the four following areas.

AREA 1 Environmental Considerations	AREA 2 Surface / Subsurface Considerations	AREA 3 Constructibility Considerations	AREA 4 Economic Considerations
• Fish Habitat • Aquatic Species at Risk • Terrestrial Species at Risk	• Land Tenure (surface & subsurface) • First Nation Settlement Lands	• Permafrost Classification • Terrain Hazards • Bedrock Faults	• Value of Storage • Ability to Deliver Winter Energy

Based on this analysis short-listed sites were recommended to be reviewed as part of the viability study.

10 SHORT LISTED SITES

PART 3

RESIZING	CASCADING	RECONCILIATION	SCALABILITY
Projects were sized to match the winter energy needs identified in the forecast.	Projects were combined to see how they met the need when put together.	All sites, individual or cascading that did not meet over 95% of the winter energy needs were removed from consideration.	Remaining projects were examined to determine how each site would scale out to meet the forecasted needs over time.

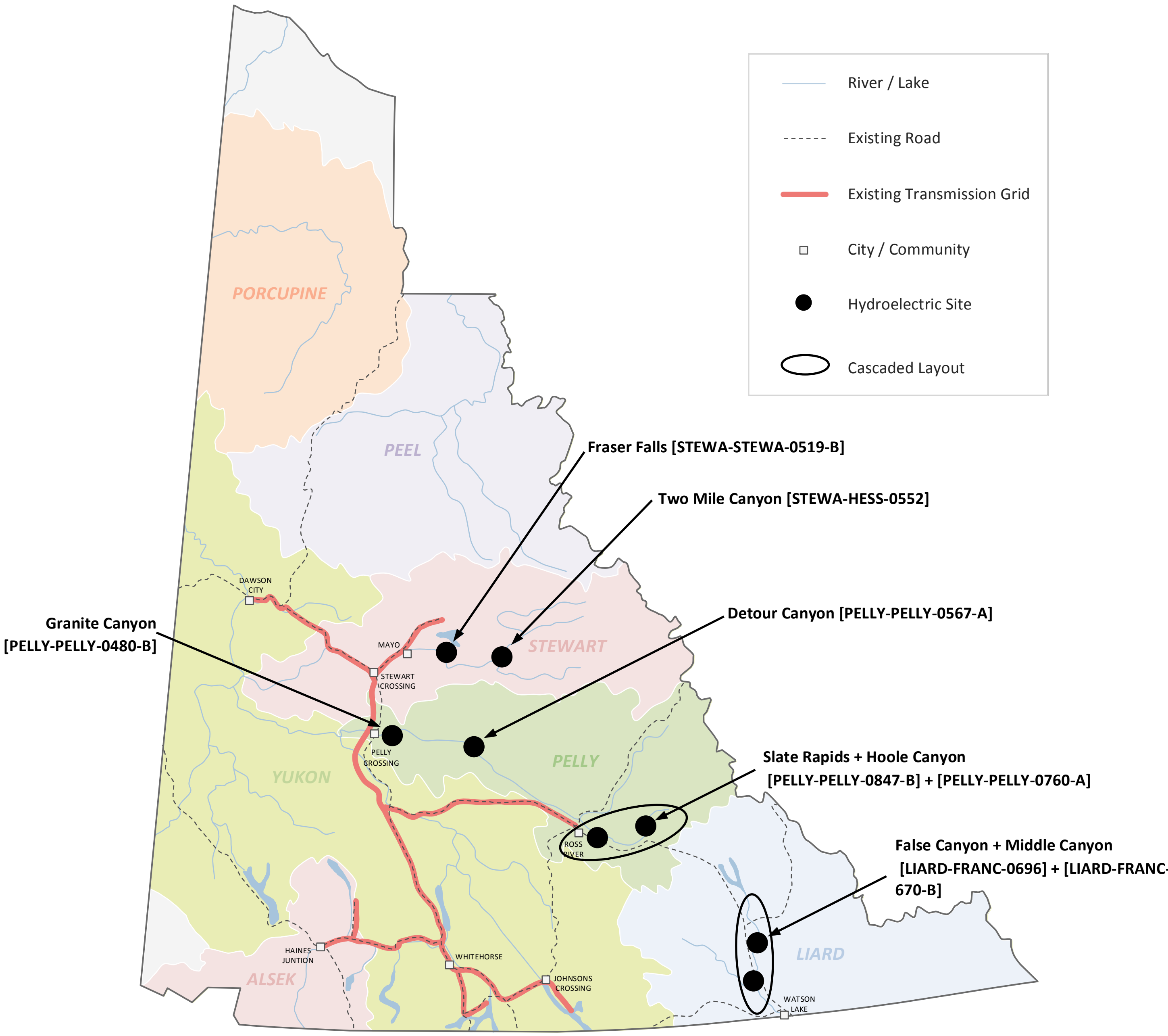
6 PROJECTS OF INTEREST

PART 4

COST	SOCIO ECONOMIC AND ENVIRONMENTAL EFFECTS
Capital costs and Levelalized cost of energy (LCOE) for each remaining site are calculated. High level estimates and site designs are prepared.	The potential positive and negative socio-economic and environmental effects effects of each site are considered.

Six potential remain for consideration in the Next Generation Hydro and Transmission Viability Study.

NEXT GENERATION HYDRO SITES



NEXT GENERATION HYDRO – SITE MATRIX

YUKON DEVELOPMENT CORPORATION

NEXT GENERATION HYDRO powering our future

		MEETING THE NEED			ENVIRONMENTAL EFFECTS							SOCIO ECONOMIC EFFECTS				COST			LAND TENURE OVERLAP						
PROJECT	Nearest Communities	Capacity (MW)	Energy Gap Closure	Max Potential Energy (GWh)	Existing Lake Area (km²)	Incremental Reservoir Footprint (km²)	Total Reservoir Area (km²)	Average Draw-down	Overlapping WKA	Fish and Habitat Impacts	Wildlife and Habitat Impacts	Construction Jobs Created over 3 years	Operations Jobs Created per Year	GDP Generated During Construction ($Million)	GDP Generated During Operations ($Million/year)	Capital Cost ($Million)	Full Utilization LCOE ($/MWh)	Forecast Utilization LCOE ($/MWh)	Category A Lands	Category B Lands	Interim Protected Lands	Other Land Tenure and Dispositions	Special Management or Protected Area	Trapping and Outfitting Concession Lands	Mineral and Metal Mining Resource Areas
DETOUR CANYON	Town of Faro	60	100%	587	0	130	130	7 m	0 known	High	Low	~5,500	~37	~634	~7.3	1,413	110	301	None	~3 ha	~2,300 ha	~6 ha	None	~13,000 ha (trapping) ~13,000 ha (outfitting)	~10,800 ha
FRASER FALLS	Mayo	57	100%	563	0	311	311	3 m	9	High	High	~4,800	~34	~553	~6.7	1,233	100	263	~196 ha	~3,100 ha	None	~900 ha	~7,100 ha	~31,200 ha (trapping) ~31,200 ha (outfitting)	~7,800 ha
GRANITE CANYON	Pelly Crossing	57	100%	588	0	173	173	3 m	3	High	Moderate	~3,300	~28	~380	~5.6	847	68	181	~3,400 ha	~5,400 ha	None	~4,600 ha	None	~17,500 ha (trapping) ~15,000 ha (outfitting)	~35 ha
TWO MILE CANYON	Mayo	54	97%	489	0	101	101	9 m	0 known	High	Low	~3,600	~33	~412	~6.6	919	90	199	None	~2,000 ha	None	~10,300 ha	None	~10,300 ha (trapping) ~10,300 ha (outfitting)	~380 ha
FALSE CANYON + MIDDLE CANYON ROR WITHOUT FARO TO WATSON LAKE	Watson Lake	78	100%	451	109	154	263	5 m	9	Moderate	High	~7,700	~41	~879	~8.3	1,959	196	379	None	None	~1,500 ha	~30,000 ha	None	~26,100 ha (trapping) ~5,000 ha (outfitting)	~3,000 ha
SLATE RAPIDS + HOOLE CANYON ROR WITHOUT FARO TO WATSON LAKE	Faro	107	100%	487	37	154	191	5 m	4	High	Moderate	~11,600	~59	~1,329	~11.7	2,962	269	540	None	None	~4,900 ha	~130 ha	None	~19,100 ha (trapping) ~19,100 ha (outfitting)	~19,100 ha

SITE PROFILE

NOVEMBER 2015

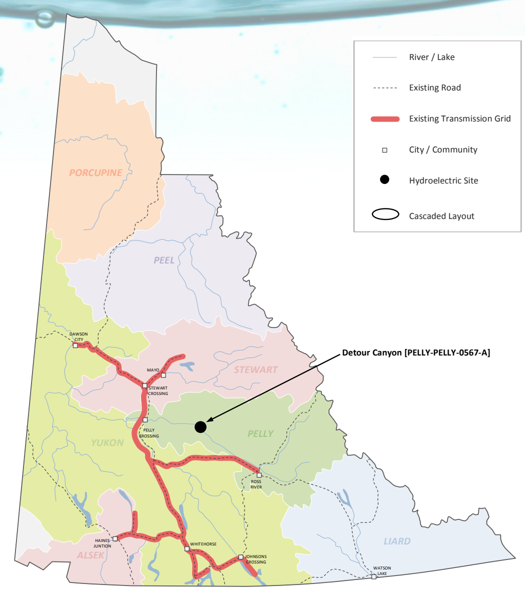
DETOUR CANYON

CAPACITY	ENERGY
60 MW	587 GWh
ENERGY GAP CLOSURE	
100 %	

COMMUNITY		RIVER
Faro		Pelly River
DISTANCE TO TRANSMISSION	NEW ROAD	DAM HEIGHT
83 km	90 km	72 m

PROJECT DESCRIPTION

The **Detour Canyon** project layout includes an approximately 72 m dam with a spillway control structure, a fish ladder, a water intake, conveyance, a 3-unit powerhouse with 2 additional turbine generator bays for post 2065 upgrades, trailrace structures, and diversions to facilitate de-watering of the dam site during construction.



TRADE OFFS

RESERVOIR	
Existing Lake	0 km²
New Flooding	130 km²
Total Reservoir	130 km²
Average Drawdown	7 m

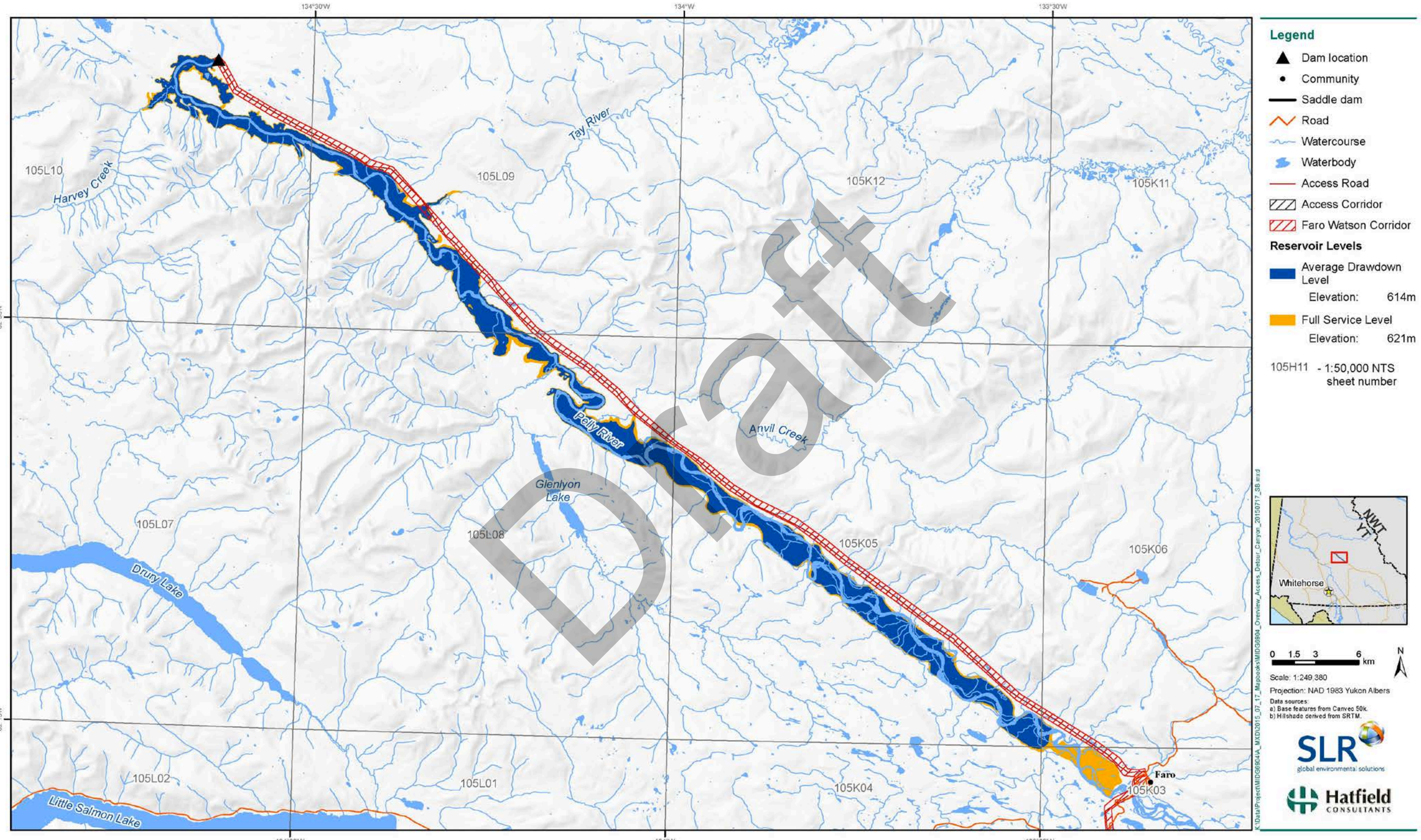
COST	
Capital Cost	$1.413 Billion
Operations and Maintenance	$9.5 Million per year in $2015
Full Utilization LCOE	$100/MWh
Forecasted LCOE	$301/MWh

Costs are preliminary and are based on Class 5 engineering estimates. They are used here to compare the relative costs of each site.

SCALABILITY Detour Canyon

2035	2045	2050	2055	2060
Upstream project operation with 2 turbines		3rd turbine added		

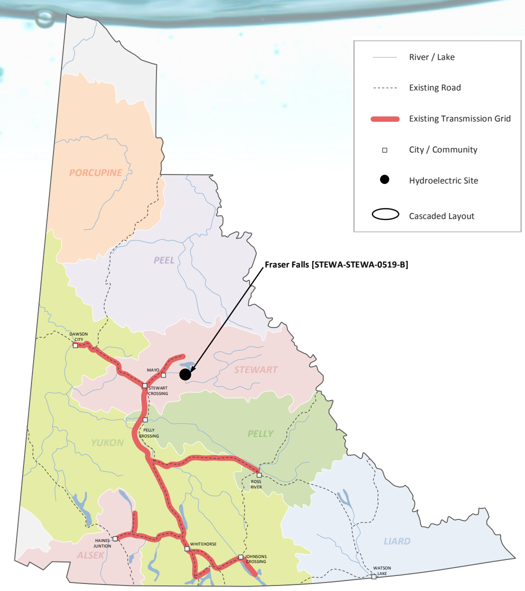
Figure 10: Detour Canyon Priority Site and Reservoir Footprint



FRASER FALLS

CAPACITY	ENERGY
57 MW	563 GWh
ENERGY GAP CLOSURE	
100 %	

COMMUNITY		RIVER
Mayo		Stewart River
DISTANCE TO TRANSMISSION	NEW ROAD	DAM HEIGHT
80 km	40 km	56 m



PROJECT DESCRIPTION

The **Fraser Falls** project layout includes an approximately 56 m dam with a spillway control structure, a fish ladder, a water intake, conveyance, a 3-unit powerhouse with 2 additional turbine and generator bays for post 2065 upgrades, trailrace structures and diversions to facilitate de-watering of the dam site during construction.

TRADE OFFS

RESERVOIR		
	Existing Lake	0 km²
	New Flooding	311 km²
	Total Reservoir	311 km²
	Average Drawdown	3 m

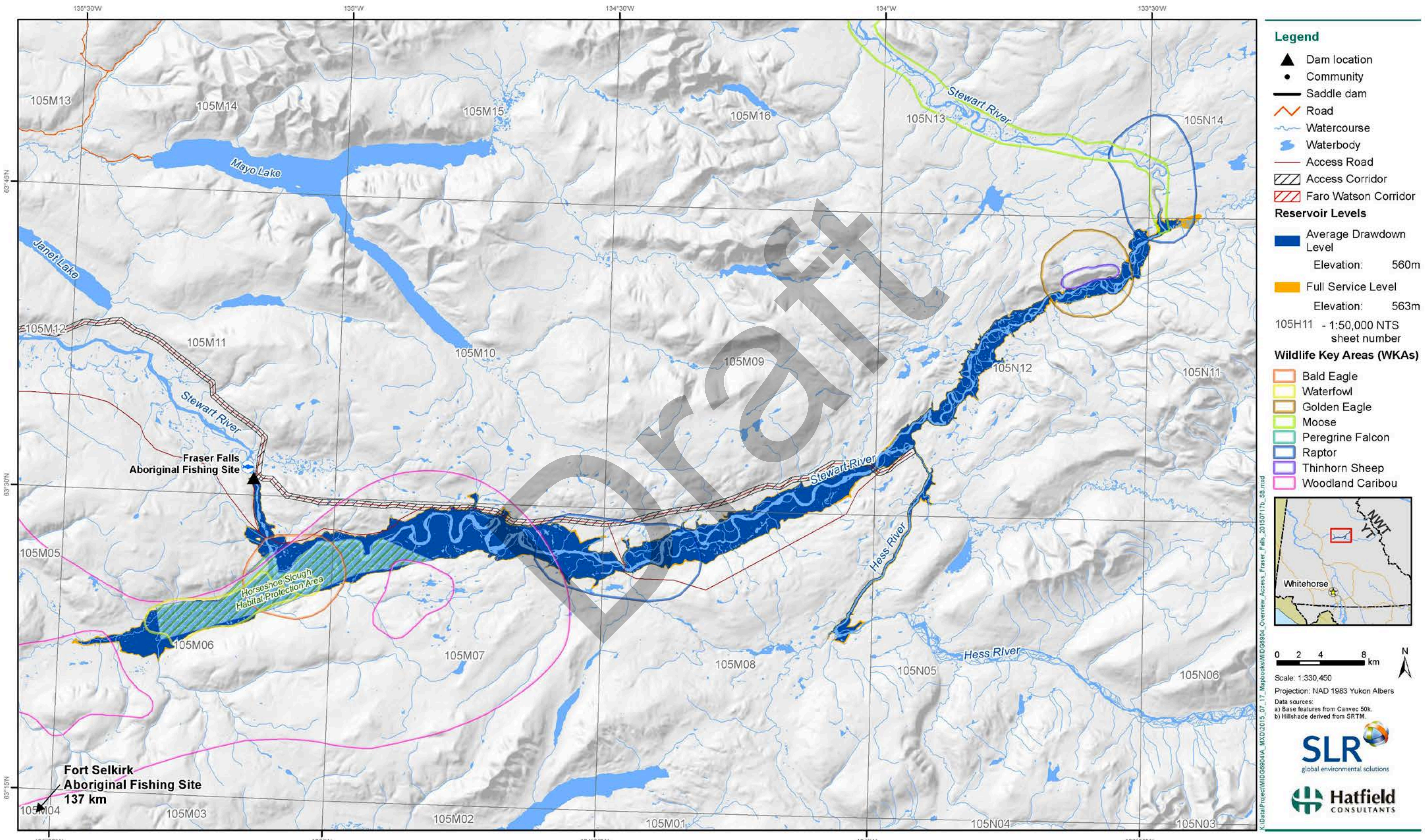
COST		
$	Capital Cost	$1.233 Billion
	Operations and Maintenance	$8.7 Million per year in $2015
	Full Utilization LCOE	$100/MWh
	Forecasted LCOE	$263/MWh

Costs are preliminary and are based on Class 5 engineering estimates. They are used here to compare the relative costs of each site.

SCALABILITY **Fraser Falls**

2035	2045	2050	2055	2060
First 2 turbines installed		3rd turbine added		

Figure 7: Fraser Falls Priority Site and Reservoir Footprint



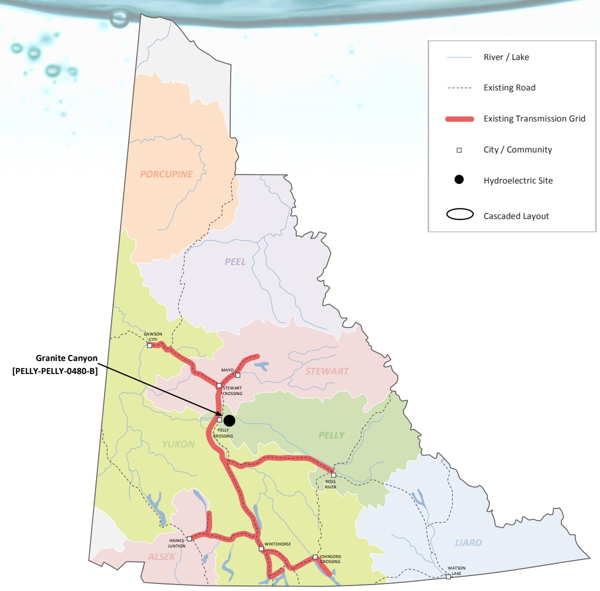
GRANITE CANYON

CAPACITY	ENERGY
57 MW	588 GWh
ENERGY GAP CLOSURE	
100 %	

COMMUNITY		RIVER
Pelly Crossing		MacMillan River + Pelly River
DISTANCE TO TRANSMISSION	NEW ROAD	DAM HEIGHT
15 km	15 km	60 m

PROJECT DESCRIPTION

The **Granite Canyon** project layout includes an approximately 60 m dam with a spillway control structure, a fish ladder, a water intake, conveyance, a 3-unit powerhouse with 2 additional turbines and generator bays for post 2065 upgrades, trailrace structures and diversions to facilitate de-watering of the dam site during construction.



TRADE OFFS

RESERVOIR	
Existing Lake	0 km²
New Flooding	173 km²
Total Reservoir	173 km²
Average Drawdown	3 m

COST	
Capital Cost	$847 Million
Operations and Maintenance	$7.2 Million per year in $2015
Full Utilization LCOE	$68/MWh
Forecasted LCOE	$181/MWh

Costs are preliminary and are based on Class 5 engineering estimates. They are used here to compare the relative costs of each site.

SCALABILITY **Granite Canyon**

2035	2045	2050	2055	2060
First 2 turbines installed		3rd turbine added		

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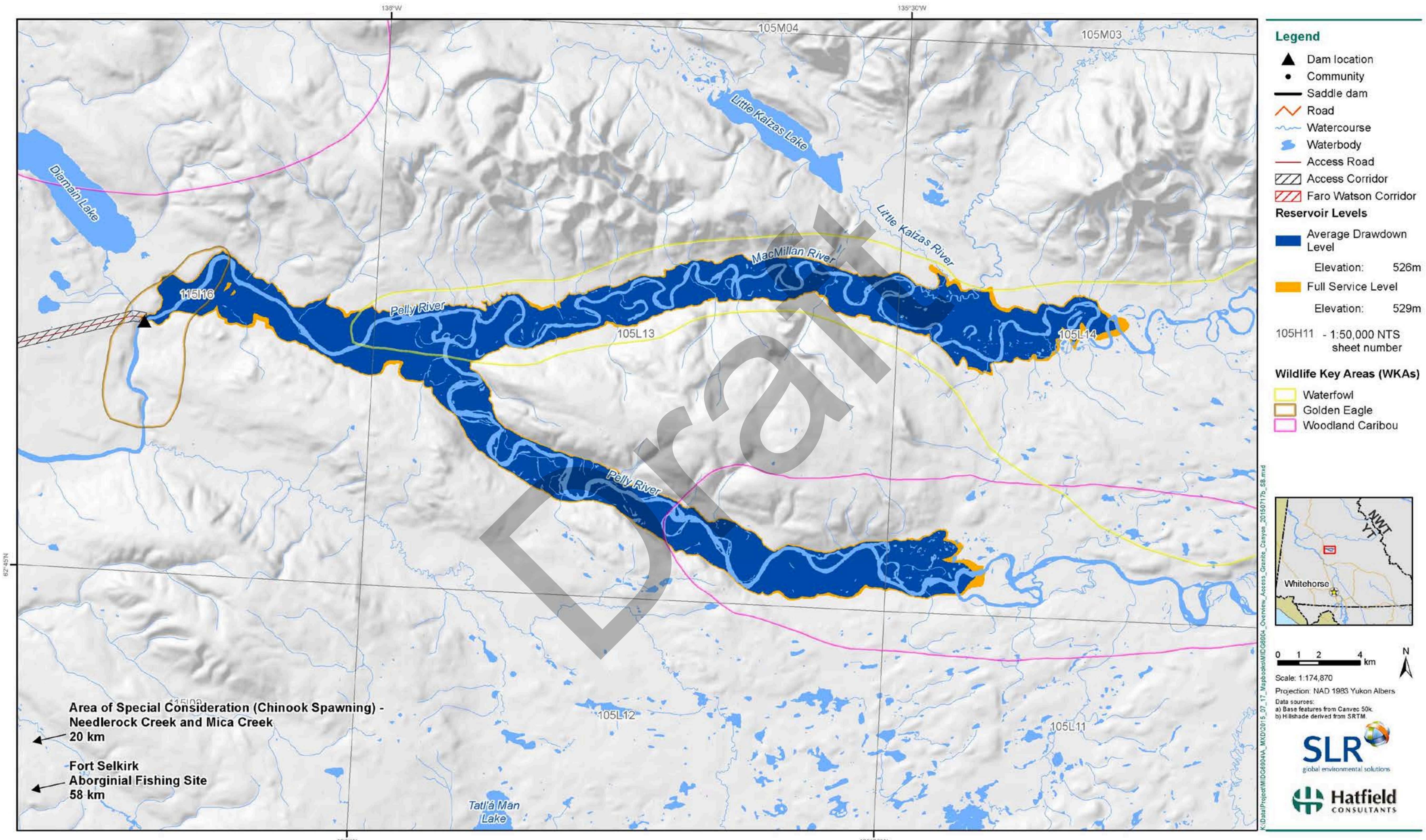
Figure 9: Granite Canyon Priority Site and Reservoir Footprint



SITE PROFILE

NOVEMBER 2015

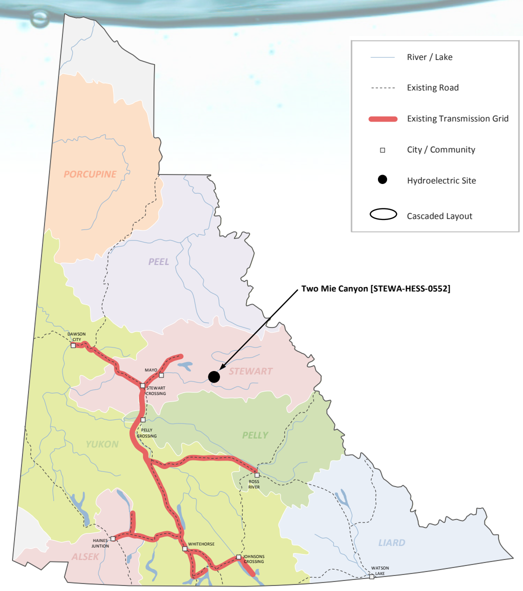
TWO MILE CANYON

CAPACITY	ENERGY
54 MW	489 GWh
ENERGY GAP CLOSURE 97 %	

COMMUNITY		RIVER
Mayo		Hess River
DISTANCE TO TRANSMISSION	NEW ROAD	DAM HEIGHT
113 km	110 km	68 m

PROJECT DESCRIPTION

The **Two Mile Canyon** project includes an approximately 68 m dam with a spillway control structure, a fish ladder, a water intake, conveyance, a 3-unit powerhouse with 2 additional turbine and generator bays for post 2065 upgrades, trailrace structures and diversion tunnels to facilitate de-watering of the dam site during construction.



TRADE OFFS

RESERVOIR	
Existing Lake	0 km²
New Flooding	101 km²
Total Reservoir	101 km²
Average Drawdown	9 m

COST	
Capital Cost	$919 Million
Operations and Maintenance	$8.5 Million per year in $2015
Full Utilization LCOE	$90/MWh
Forecasted LCOE	$199/MWh

Costs are preliminary and are based on Class 5 engineering estimates. They are used here to compare the relative costs of each site.

SCALABILITY Two Mile Canyon

2035 First 2 turbines installed → **2045** 3rd turbine added → **2050** → **2055** → **2060**

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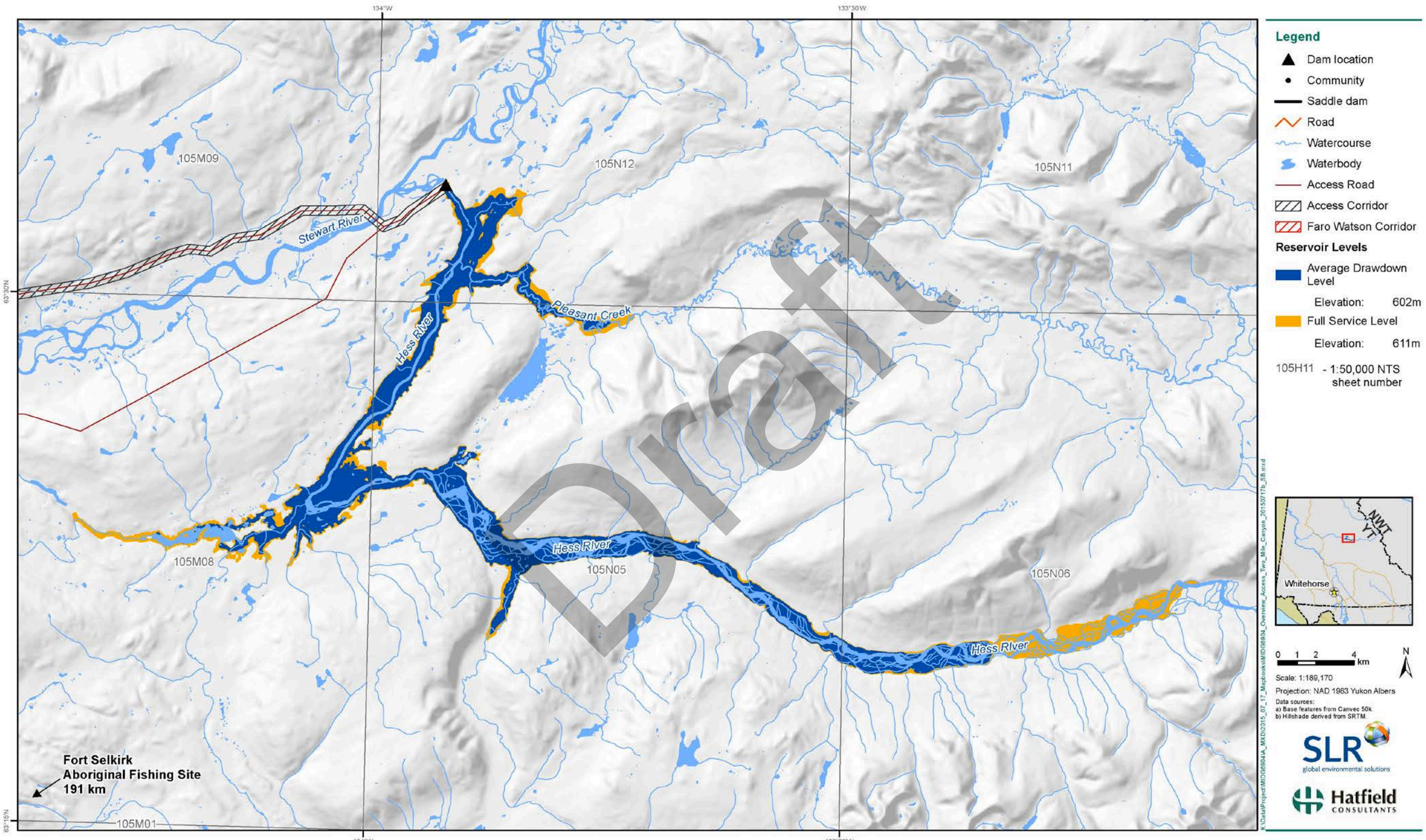
Figure 8: Two Mile Canyon Priority Site and Reservoir Footprint



SITE PROFILE

NOVEMBER 2015

FALSE CANYON + MIDDLE CANYON RUN OF RIVER

CAPACITY	ENERGY
78 MW	451 GWh
ENERGY GAP CLOSURE	
100 %	

COMMUNITY		RIVER
Watson Lake		Frances River
DISTANCE TO TRANSMISSION	NEW ROAD	DAM HEIGHT
10 km with potential future transmission. 310 km to existing transmission.	10 km	65 m

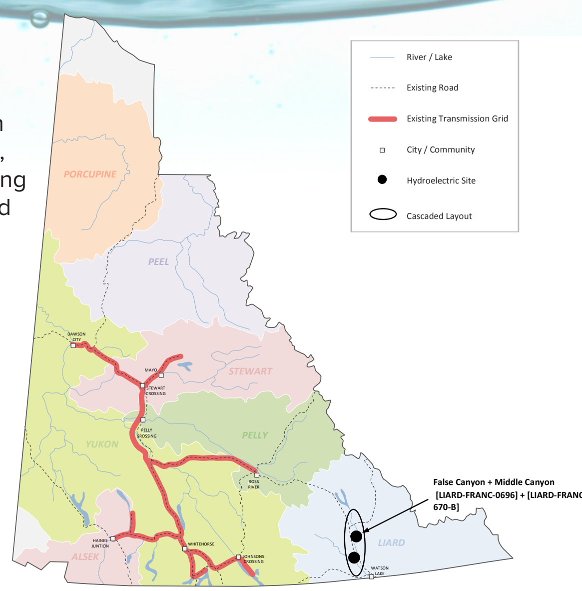
PROJECT DESCRIPTION

False Canyon + Middle Canyon Run of River

is a cascade of two sites with False Canyon located upstream on the Frances River providing water storage and generation, and Middle Canyon Run of River located downstream operating as a run-of-river facility with no water storage (but a headpond needed to create head for generation purposes.)

The **False Canyon** project includes an approximately 65 m dam with a spillway control structure, a fish ladder, a water intake, a conveyance, a 3-unit powerhouse, trailrace structures and diversions to facilitate dewatering of the dam site during construction.

The **Middle Canyon** project includes an approximately 17 m dam, fish ladder, a water intake, conveyance, a 3-unit powerhouse, trailrace structure and diversions to facilitate de-watering of the dam site during construction.



TRADE OFFS

RESERVOIR	
Existing Lake	109 km²
New Flooding	154 km²
Total Reservoir	263 km²
ROR Head Pond	1 km²
Average Drawdown	5 m

COST*	
Capital Cost	$1.959 Billion
Operations and Maintenance	$12.5 Million per year in $2015
Full Utilization LCOE	$196/MWh
Forecasted LCOE	$379/MWh

Costs are preliminary and are based on Class 5 engineering estimates. They are used here to compare the relative costs of each site.
* Costs as calculated without a transmission line between Faro and Watson Lake

SCALABILITY

False Canyon + MIddle Canyon ROR

2035	2045	2050	2055	2060
Upstream project operation with 2 turbines		3rd turbine added		ROR operation

Figure 13: False Canyon Priority Site and Reservoir Footprint

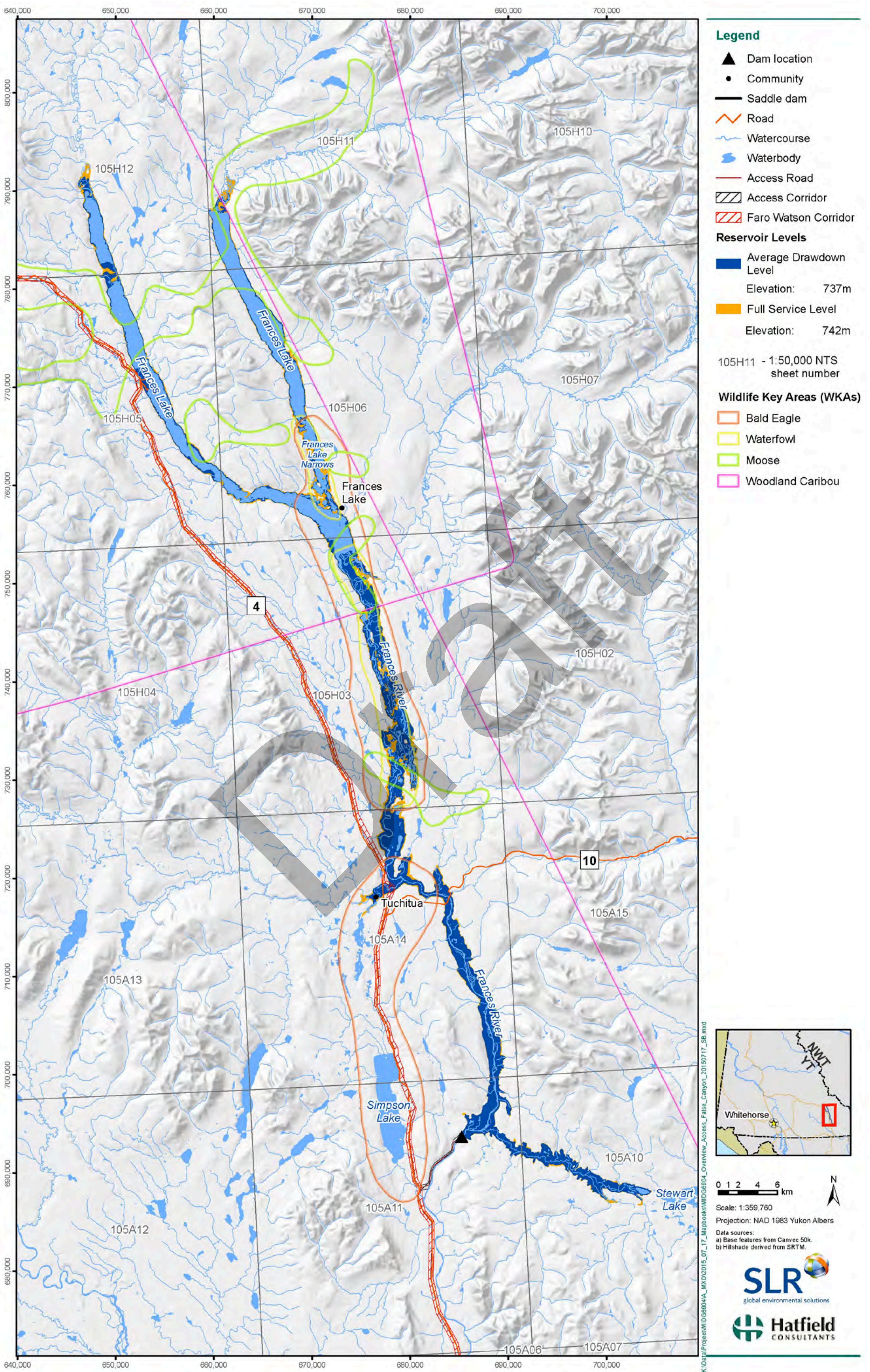


Figure 14: Middle Canyon Run-of-River Priority Site

SITE PROFILE

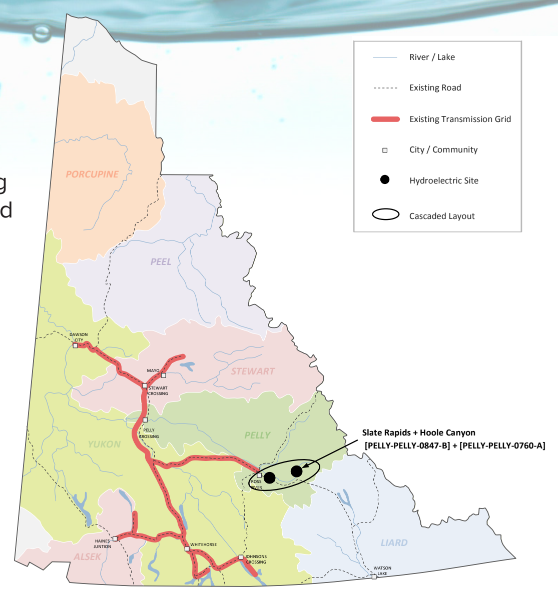
NOVEMBER 2015

SLATE RAPIDS + HOOLE CANYON RUN OF RIVER

CAPACITY	ENERGY
107 MW	487 GWh
ENERGY GAP CLOSURE	
100 %	

COMMUNITY		RIVER
Faro		Pelly River
DISTANCE TO TRANSMISSION	NEW ROAD	DAM HEIGHT
10 km with potential future transmission. 145 km to existing transmission.	10 km	57 m

PROJECT DESCRIPTION



Slate Rapids + Hoole Canyon Run of River

is a cascade of two sites with Slate Rapids located upstream on the Pelly providing water storage and generation, and Hoole Canyon run of river located downstream operating as a run-of-river facility with no water storage (but a headpond needed to create head for generation purposes.)

The **Slate Rapids** project includes an approximately 57 m dam with a spillway control structure, a fish ladder, a water intake, conveyance, a 2-unit powerhouse, trailrace structures and diversions to facilitate dewatering of the dam site during construction.

The **Hoole Canyon** run of river project includes an approximately 71 m weir dam, a fish ladder, a water intake, conveyance, a 2-unit powerhouse, trailrace structures and diversions to facilitate dewatering of the dam site during construction.

TRADE OFFS

RESERVOIR	
Existing Lake	37 km²
New Flooding	154 km²
Total Reservoir	191 km²
ROR Head Pond	23 km²
Average Drawdown	5 m

COST*	
Capital Cost	$2.962 Billion
Operations and Maintenance	$15.9 Million per year in $2015
Full Utilization LCOE	$269/MWh
Forecasted LCOE	$540/MWh

Costs are preliminary and are based on Class 5 engineering estimates. They are used here to compare the relative costs of each site.
* Costs as calculated without a transmission line between Faro and Watson Lake

SCALABILITY

Slate Rapids + Hoole Canyon ROR

2035	2045	2050	2055	2060
Upstream project operation with 2 turbines		ROR operation		

Figure 11: Slate Rapids Priority Site and Reservoir Footprint

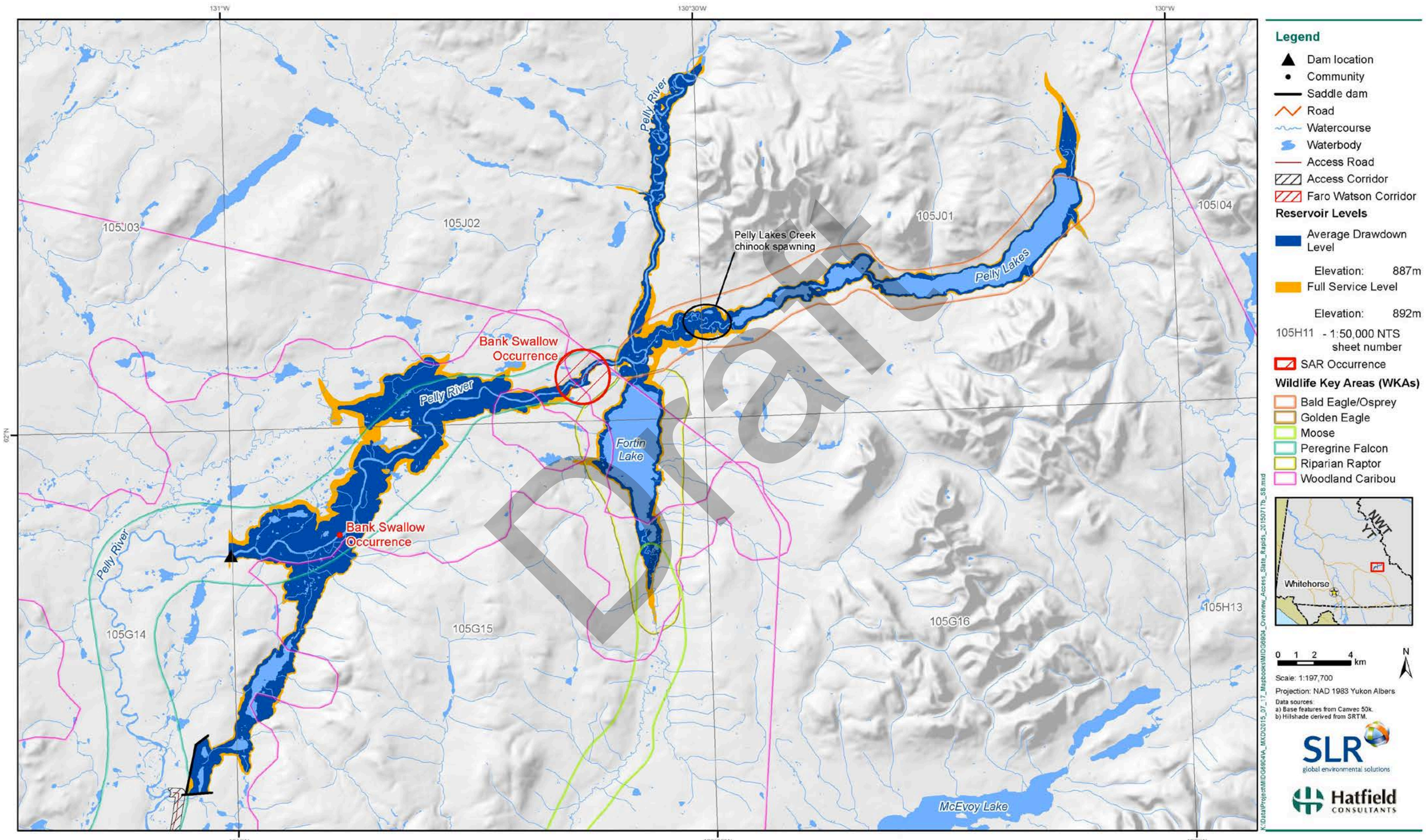


Figure 12: Hoole Canyon Run-of River Priority Site

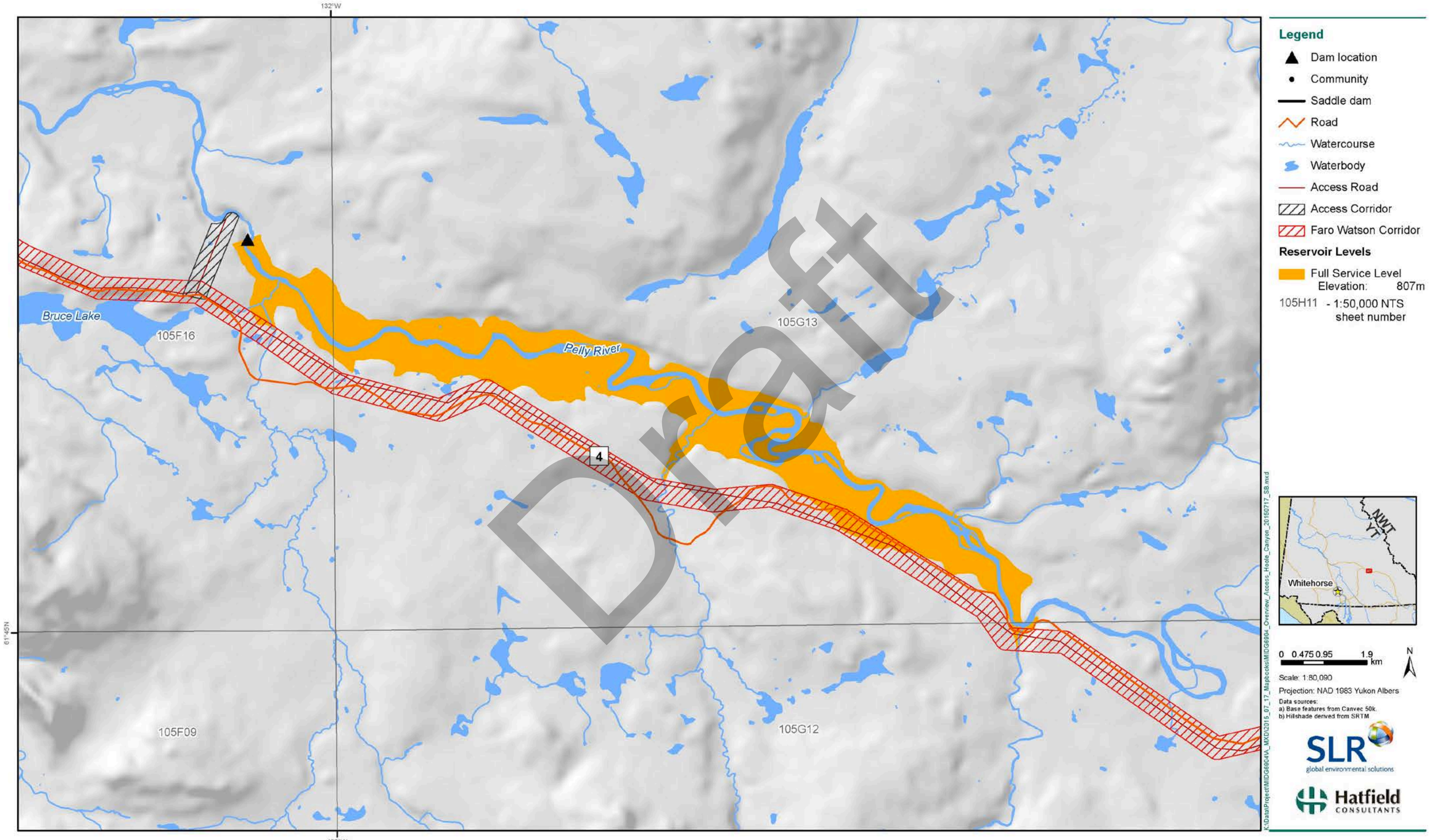


Table 16: Summary of Advantages and Disadvantages

Site Name	Site ID	Key Advantages	Key Disadvantages

Fraser Falls	STEWA-STEWA-0519-B	**Environmental**
		
		• Low fluctuation of reservoir level (3 m over an average year)
		
		Socio-economic
		
		• Economic benefits (i.e., jobs and business activity) are considered substantial in the context of the Yukon economy:
		  o High amount of construction jobs (4,800); moderate amount of operations jobs (34)
		• Low overlap with other Land Tenures and Dispositions (900 ha)
		• High construction GDP (553 million); moderate operations GDP (6.7 million)
		• No displacement of infrastructure
		• Adverse effects on community well-being in local communities is expected to be low
			Environmental
			
			• Overlap with Horseshoe Slough Habitat Protection Area and No-Gold settlement
			• Overlap with chinook, chum salmon and arctic grayling habitat (all three are species of high priority for a National status assessment by COSEWIC). Other fish species will also be affected
			• Overlap with breeding habitat of documented species at risk (woodland caribou, peregrine falcon), and possibly with winter foraging habitat for woodland caribou.
			• Overlap with key nesting habitat for waterfowl and with goose moulting habitat.
			
			Socio-economic
			
			• Overlap with 3,300 ha of Na-Cho Nyäk Dun Settlement Land
			• Overlap with highest area of Renewable Resource Areas (71,800 ha); largest flooded area (311 km^2)
			• Overlap with Non-Renewable Resource Areas (7,800 ha)
			• Overlap with highest area of Traditional Aboriginal Activity use (31,200 ha)
			• Documented Aboriginal fishing sites:
			  o At Fraser Falls and downstream of Fraser Falls (Linklater 2014; DFO 2015b)
			  o Between Fraser Falls and the confluence with the McQuesten River (DFO, 2015b)

Table 16: Summary of Advantages and Disadvantages

Site Name	Site ID	Key Advantages	Key Disadvantages
			• Overlaps known Heritage and Cultural Resource sites. • Project located in area of high archaeological potential.
Two Mile Canyon	STEWA-HESS-0552	**Environmental** • Smallest flooded area (10,300 ha) • Reservoir located outside of mainstem of Stewart River • Relatively lower effects on wildlife and wildlife habitat **Socio-economic** • Economic benefits (i.e., jobs and business activity) are considered substantial in the context of the Yukon economy. o Rated in the mid-range for Construction jobs (3,600) Operations jobs (33); and, o Construction GDP (412 million), Operations GDP (6.6 million) • The Two Mile site is identified in the Na-Cho Nyäk Dun Settlement Agreement as set out for expropriation for hydroelectric or water storage projects with compensation at a maximum of 3% of the construction cost • Relatively low overlap with Renewable Resource Areas (20,700 ha); • Low overlap with Non-Renewable Resource Areas (380 ha)	**Environmental** • Overlap with chinook, chum salmon and arctic grayling habitat. Other fish species will also be affected. • High fluctuation of reservoir level (9 m over an average year) **Socio-economic** • Overlap with 2,000 ha of Na-Cho Nyäk Dun Settlement Land; • Moderate overlap with other Land Tenures and Dispositions (10,300 ha) • Project located in area of high archaeological potential.

Table 16: Summary of Advantages and Disadvantages

Site Name	Site ID	Key Advantages	Key Disadvantages
		• Relatively low overlap with areas used for Traditional Aboriginal Activities (10,300 ha) • Area is part of Na-Cho Nyäk Dun chinook fishery but no documented Aboriginal fishing sites • No displacement of infrastructure • Adverse effects on community well-being in local communities is expected to be low • No overlap known Heritage and Cultural Resource sites	
Granite Canyon	PELLY-PELLY-0480-B	**Environmental** • Low fluctuation of reservoir level (3 m over an average year) **Socio-economic** • The amount of construction jobs (3,300) and operations jobs (2d8) and construction GDP (380 million) and	**Environmental** • Downstream effects on Mica and Needlerock Creek Area of Special Consideration (Yukon Placer Fish Habitat Management System) which support genetically distinct populations of chinook salmon. Other fish species will also be affected • Overlap with chinook, chum salmon and arctic grayling habitat. Other fish species will also be affected. • Overlap with species at risk habitat (trumpeter swan) and potential overlap with wintering habitat of woodland caribou. • Overlap with important nesting habitat for waterfowl. **Socio-economic** • Overlap with 8,800 ha of Selkirk First Nation settlement land (highest amount)

Table 16: Summary of Advantages and Disadvantages

Site Name	Site ID	Key Advantages	Key Disadvantages
		operations GDP (5.6 million) are lowest among the six priority sites, but considered substantial in the context of the Yukon economy. • The Granite Canyon site is identified in the Selkirk First Nation Settlement Agreement as set out for expropriation for hydroelectric or water storage projects with compensation at a maximum of 3% of the construction cost • Low overlap with Non-Renewable Resources Areas (35 ha); • No displacement of infrastructure • Adverse effects on community well-being in local communities is expected to be low	• Moderate overlap with Renewable Resources Area (32,400 ha); moderate flooded area (173 km^2) • Moderate overlap with other Land Tenures and Dispositions (4,600 ha) • Moderate overlap with Traditional Aboriginal Activities (17,600 ha) • Documented Aboriginal fishing site within the reservoir footprint (i.e., at Pelly River near the confluence with Little Kalzas River (DFO 2015b)); • Documented Aboriginal fishing sites downstream: o Fort Selkirk just downstream of the Pelly River outlet (downstream of the project site; Yukon Department of Tourism and Culture 2015a); and o Tatl'á Män Lake at the head of Mica Creek near Pelly Crossing (Downstream of the project site; Yukon Department of Tourism and Culture 2015b). • The Selkirk First Nation regards that the Pelly River upstream of Granite Canyon is of great importance and is culturally significant to them. • Overlaps known Heritage and Cultural Resource sites • Project located in area of high archaeological potential.
Detour Canyon	PELLY-PELLY-0567-B	**Environmental** • Substantially lower effects on wildlife and wildlife habitat	**Environmental** • Downstream effects on Mica and Needlerock Creek Area of Special Consideration (Yukon Placer Fish Habitat Management System) which support genetically distinct populations of chinook salmon. Other fish species will also be affected.

Table 16: Summary of Advantages and Disadvantages

Site Name	Site ID	Key Advantages	Key Disadvantages
		Socio-economic • Economic benefits (i.e., jobs and business activity) are considered substantial in the context of the Yukon economy: o Construction Jobs (5,500) and Operations Jobs (37); o Construction GDP (634 million) and Operations GDP (7.3 million) • Relatively low overlap with Renewable Resource Areas (27,000 ha); relatively low flooded area (130 km^2) • Lowest overlap with other Land Tenures and Dispositions (6 ha) • No displacement of infrastructure • Relatively low overlap with Traditional Aboriginal Activity land use (13,000 ha) • No overlap with known Heritage and Cultural Resource sites • Adverse effects on community well-being in local communities is expected to be low	• Overlap with lower Anvil Creek Area of Ecological and Cultural Special Consideration (Yukon Placer Fish Habitat Management System); • Overlap with chinook, chum salmon and arctic grayling habitat. Other fish species will also be affected • High fluctuation of reservoir level (7 m over an average year) **Socio-economic** • Overlap with 2,300 ha of Liard First Nation/Ross River Dena Council Interim Protected Land • Overlap with 3 ha of Selkirk First Nation Settlement Land • Moderate overlap with Non-Renewable Resource Areas (10,800 ha) • Documented Aboriginal fishing sites downstream: o Fort Selkirk just downstream of the Pelly River outlet (downstream of the project site; Yukon Department of Tourism and Culture 2015a); o Pelly River near the confluence with Little Kalzas River (downstream of the project site; DFO 2015b); and o Tatl'á Män Lake at the head of Mica Creek near Pelly Crossing (Downstream of the project site; Yukon Department of Tourism and Culture 2015b). • Project located in area of high archaeological potential.

Table 16: Summary of Advantages and Disadvantages

Site Name	Site ID	Key Advantages	Key Disadvantages
Slate Rapids + Hoole Canyon ROR	PELLY-PELLY-0847-B PELLY-PELLY-0760-A	**Socio-economic** • Economic benefits (i.e., jobs and business activity) are considered substantial in the context of the Yukon economy: o Highest amount of construction jobs (11,600), highest amount of operations jobs (59) o Highest construction GDP (1,329 million), highest operations GDP (11.7 million)	**Environmental** • Fluctuation of levels of Pelly Lakes and Fortin Lake (effects on shoreline habitat) • Downstream effects on Mica and Needlerock Creek Area of Special Consideration (Yukon Placer Fish Habitat Management System) which support genetically distinct populations of chinook salmon. Other fish species will also be affected • Documented chinook salmon in Pelly Lakes Creek, documented spawning area Pelly lake outlet to 2 km downstream. Effects on spawning reaches, migration, and downstream habitats. Other fish species will also be affected • Overlap with arctic grayling habitat. • Moderate fluctuation of reservoir level (5 m over an average year) • Project is fully within Finlayson caribou herd overwintering range. • Documented bank swallow breeding site; colony-nesting species are at greater risk of local population declines. **Socio-economic** • Overlap with Liard First Nation/Ross River Dena Council Interim Protected Land 4,900 ha • Highest overlap with Non-Renewable Resource areas (19,100 ha); • Moderately high overlap of Renewable Resource Area; • Moderately high overlap with Traditional Aboriginal Activities area (19,100 ha); • Documented Aboriginal fishing sites downstream:

Table 16: Summary of Advantages and Disadvantages

Site Name	Site ID	Key Advantages	Key Disadvantages
		• Low overlap with other Land Tenures and Dispositions (135 ha)	o Fort Selkirk just downstream of the Pelly River outlet (downstream of the project site; Yukon Department of Tourism and Culture 2015a); o Pelly River near the confluence with Little Kalzas River (downstream of the project site; DFO 2015b); and o Tatl'á Män Lake at the head of Mica Creek near Pelly Crossing (Downstream of the project site; Yukon Department of Tourism and Culture 2015b). • Overlaps known Heritage and Cultural Resource sites • Project located in area of high archaeological potential. • Potential displacement of Robert Campbell highway and associated community disruption
False Canyon + Middle Canyon ROR	LIARD-FRANC-0696 + LIARD-FRANC-0670-B	**Environmental** • Effects to fish are limited to non-anadromous fish species and therefore more localized than other priority sites • There is greater potential for moderating effects from Frances Lake complex on mercury accumulation in the reservoir.	**Environmental** • Frances Lake level will be raised by 8 m • Moderate fluctuation of reservoir level (5 m over an average year) • Loss of habitats (spawning, rearing, fluvial) for bull trout (species at risk) • Loss of habitat for arctic grayling. • Documented barn swallow breeding site; colony nesting species at greater risk of local population decline • Overlap with secondary waterfowl staging area and riparian raptor breeding area. • Overlap with caribou WKA (Nahanni herd) and potential encroachment on wintering habitat.

Table 16: Summary of Advantages and Disadvantages

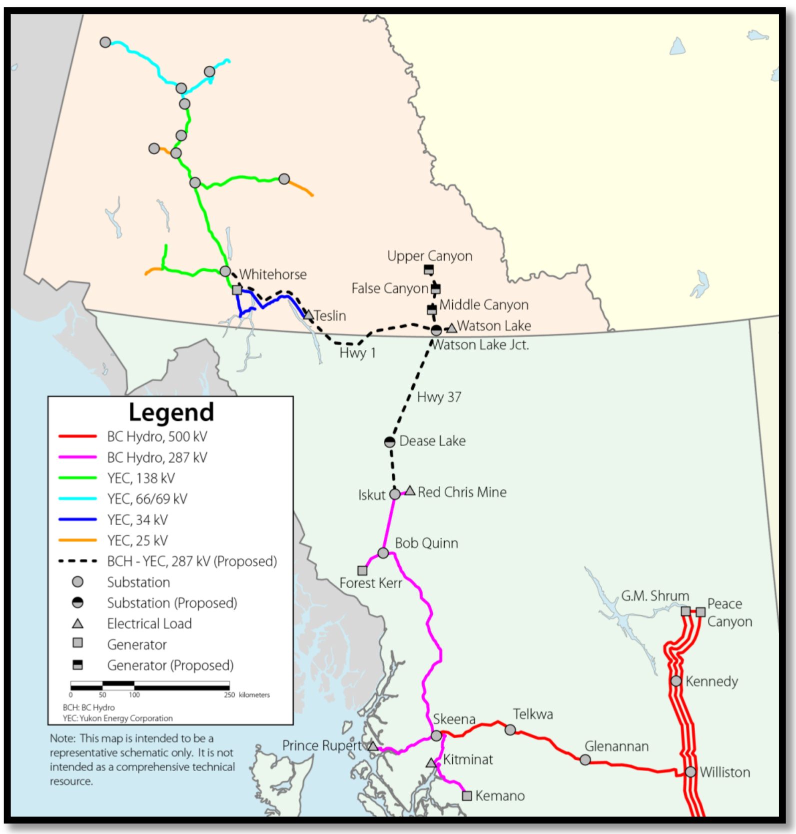
Site Name	Site ID	Key Advantages	Key Disadvantages
		Socio-economic • Economic benefits (i.e., jobs and business activity) are considered substantial in the context of the Yukon economy: o High amount of construction jobs (7,700) o High construction GDP (879 million) o Moderate amount of operations jobs (41) o Moderate amount of operations GDP (8.3 million)	**Socio-economic** • Overlap with 1,500 ha of Liard First Nation/Ross River Dena Council Interim Protected Land • Overlaps with area of potential Traditional Aboriginal Activities • Moderately high overlap with Renewable Resource Areas; second highest flooded area (26,100 ha) • Moderately high overlap with Non-Renewable Resource Areas (3,000) • Highest overlap with other Land Tenures and Dispositions (30,000 ha) • Potential displacement of Robert Campbell Hwy and Nahanni Range Road • Overlaps known Heritage and Cultural Resource sites. Several burial sites are known to exist. • Project located in area of high archaeological potential. • Adverse effects on community well-being in local communities is expected to be low • Adverse effects on community well-being in local communities is expected to be high

TRANSMISSION RESULTS SUMMARY

Connecting the Yukon electrical grid to a neighbouring electrical grid offers several potential benefits. For example, with a transmission line connection, Yukon could purchase energy in times of need, and sell excess energy in times of surplus. As a result, trading with neighbours is a potential source of revenue for the territory and mitigates the risk of being stranded with excess generation supply due to overbuilding for forecast future need.

Unfortunately, connecting the Yukon grid also comes with risks and costs. Namely, any transmission line would be expensive, significant upgrades to the existing Yukon system would likely be required, and trading partners must be willing to purchase at high prices and sell at low prices to generate financial benefits.

The goal of the *Transmission Logistics and Market Assessment* papers was to determine the technical and economic attributes of developing a transmission line to another jurisdiction. The reports studied two potential transmission lines, one to Iskut, BC, and one to Fairbanks, Alaska. A third option connecting to Skagway, Alaska was already studied in a separate report as part of the *Southeast Alaska Economic Corridor Viability Assessment*.



Technical Assessment

The transmission lines required to connect the Yukon to either BC or Alaska are very long and costly to build. In addition, due to the long length the transmission lines also have a relatively low carrying capacity, meaning they are not able to transfer a large amount of electricity. As a result of the high cost of interconnection and low transfer capacity the benefits of constructing must be large to justify the costs.

Interconnection Option	Description	Distance (km)	Capital Cost ($M)	Potential Net Yukon Export[2] Capacity (MW)
#1	287 kV from Whitehorse (Takhini) to Iskut, BC	763	$1,710	64 - 127[3]
#1A	Same as option 1 with Next Generation Hydro sites developed near Watson Lake	763	$1,710	94 - 139[4]
#2	230 kV from Aishihik to Delta Junction	662	$1,325	70 - 80[5]

Table 1 – Transmission Interconnection Options From: Yukon - Transmission Interconnection Assessment

Interconnection Option	Description	Capital Cost per MW of Potential Net Export Capacity ($M)
#1	Whitehorse to Iskut, BC	$13 - $27
#1A	Whitehorse to Iskut, BC (Next Generation Hydro near Watson Lake)	$12 - $18
#2	Aishihik to Delta Junction	$16 - $19

Table 2 – Comparison Of Capital Cost Per Mw Of Net Export Capacity From: Yukon - Transmission Interconnection Assessment

Market Assessment

Based on an analysis of the BC and Alaskan markets for electricity trade with the Yukon, the benefits from trade do not justify the cost of the transmission lines. Given the potential price at which we can import and export energy, the long transmission lines, relatively small Yukon demand, and low carrying capacity the transmission lines to either Alaska or BC are uneconomic.

The table below shows the anticipated export revenue that would be possible given the technical limitations of the proposed transmission lines and the anticipated sale price of electricity and compares it to the cost of building transmission as well as new generation assets needed to produce the power that could be sold.

	(a)	(b1)	(b2)	(a) + (b1) + (b2)
Interconnection Option	Export Revenue (Net of Import Costs) ($M)	New Transmission Costs ($M)	New Generation Costs ($M)	Net Benefits ($M)
YK-BC	214	-1310	-379	-1470
YK-Fairbanks	202	-1015	-379	-1190

Table 3 – Net Benefit Evaluation Of Two Interconnection Scenarios From: Yukon Transmission Value Assessment

To provide a sense of scale, the Yukon would need to export 227MW per hour, 24/7/365 for 60 years to defray the cost of the Iskut, BC transmission line (this would require 6 Whitehorse Rapids facilities to be in operation).

MEETING THE NEED – PUTTING NEXT GENERATION HYDRO IN CONTEXT

	TECHNICAL	ENVIRONMENT		COST	SOCIO-ECONOMIC	BENEFITS	RISKS
GENERATION TYPE	GWh MW Can this technology meet the forecasted gap for 2065 on it's own?	What is the land footprint of this option?	What are the greenhouse gas emissions of this option?	What are the cost implications of this option?	What are the socio-economic considerations of this option?	What are the benefits of this option?	What are the risks of this option?
WIND							
SOLAR							
HYDRO Run of River							
SMALL HYDRO with Storage							
Next Generation **HYDRO**							
Pumped Storage **HYDRO**							
THERMAL LNG							
SCENARIO 3 Mixed Renewables Solution							
SCENARIO 4 Mixed Renewables Solution with Pumped Storage Solution							
TRANMISSION Solution							