

**YUKON
ENERGY**



YUKON ENERGY CORPORATION

20-YEAR RESOURCE PLAN: 2006-2025

January, 2006

and

SUPPLEMENTAL MATERIALS

May, 2006

YUKON ENERGY CORPORATION SUBMISSION

20 YEAR RESOURCE PLAN

SUMMARY OF PROPOSED ACTIONS

INTRODUCTION

Yukon Energy's 20 Year Resource Plan Submission addresses major electrical generation and transmission requirements in Yukon during the 2006 to 2025 period, with emphasis on:

- a) near term projects that will require Yukon Energy commitments before the year 2009 with costs of \$3 million or more, and
- b) planning activities that Yukon Energy may be required to carry out in order to start construction on other projects before 2016 to meet the needs of potential major industrial customers or other major potential developments in Yukon.

In response to past commitments, the 20-Year Resource Plan Submission is expected to provide the Yukon Utilities Board (YUB) with the opportunity to review near term generation or transmission projects that Yukon Energy proposes to commit before 2009 with costs of \$3 million or more, including projects based on revised planning criteria now adopted by Yukon Energy. The last Resource Plan, which was submitted for review by the YUB in 1992, covered 1992-2001 and was prepared by Yukon Energy and Yukon Electrical Company Limited (YECL).

The Submission also proposes Yukon Energy planning activities to protect Yukon Energy's ability to start construction on other major generation and transmission projects before 2016 to meet the needs of potential major industrial development opportunities.

This summary reviews the following:

- Resource Planning for Yukon Power Systems (to provide context for this Submission).
- New Capacity Criteria (reviews a key factor affecting proposed actions in this Submission).
- Proposed Near Term Actions (summary of actions proposed for commitment before 2009).
- Proposed Actions Relating to Industrial Development Scenarios and Opportunities (summary of proposed planning activities to protect possible commitments beyond 2009 and before 2016).

RESOURCE PLANNING FOR YUKON POWER SYSTEMS

The distinct and independent power systems in the Yukon are each served by separate source(s) of generation, and include: the Whitehorse Aishihik Faro (WAF) grid; the Mayo Dawson (MD) grid; the diesel community of Watson Lake; and a number of smaller isolated diesel communities (Beaver Creek, Destruction Bay, Pelly Crossing, Swift River and Old Crow).

Yukon Energy's generation on the WAF and MD systems accounts for 112.4 MW of the 127.4 MW of installed and currently rated capacity in Yukon. The YECL generation accounts for the balance, or for 15.0 MW of installed and rated capacity.

Yukon Energy's extensive hydro generation, as well as most of its related transmission facilities, were previously developed in response to major industrial mine developments. Today, these hydro systems are the key factor causing Yukon power costs to be lower than those found in Alaska or the Northwest Territories. Without such hydro facilities, Yukon utilities probably would have relied almost entirely on diesel generation with its associated higher costs.

The Yukon economy, and Yukon's electrical loads and systems have changed substantially since the 1992 Resource Plan review by the YUB. Highlights relevant to the current Resource Plan include:

- Due to closure of the Faro mine, no reopening of the UKHM mine, and no new mines yet having emerged on the WAF and MD systems, there is today a substantial surplus of hydro energy on these grids.
- Yukon Energy's response to these conditions has included greatly increased secondary sales and development of the Mayo Dawson Transmission Line.
- Yukon Energy's three water licences have been renewed.

As the major generator and transmitter of electrical power in the Yukon region, Yukon Energy plans for the capacity and energy requirements of Yukoners, particularly those supplied on the WAF and MD grids.

- **Capacity requirement** planning focuses on the highest or peak megawatt (MW) generation capability (capacity) required on each system during each year, including sufficient generation reserve capability (based on the system's capacity planning criteria) to address unplanned outages.
- **Energy requirement** planning focuses on the number of kilowatt hours (kW.h) of electricity that are required to be generated on each system.

The Resource Plan reviews WAF and MD system capability to supply loads today and into the future under various time horizons, industrial load development scenarios, and resource supply options.

- **Immediate need for new WAF generation capacity:** Forecast load growth, pending retirement (absent substantial Life Extension investment) of three Mirrlees diesel units (11.4 MW) located in YEC's Whitehorse diesel plant, and new capacity criteria adopted by Yukon Energy together create an immediate need for new WAF generation capacity to serve peak winter load requirements in the near term through to 2012.
- **Potential new mines prior to 2009:** Potential new industrial developments prior to 2009 at the Minto and Carmacks Copper mines may also absorb the WAF hydro energy surplus, support transmission extension of the WAF grid from Carmacks to at least Pelly Crossing, and create opportunity to interconnect the WAF and MD grids.
- **Diverse range of other possible industrial development scenarios and opportunities:** Planning activities to proceed with other energy-focused generation projects beyond 2009 and before 2016 are being driven by the potential needs of a diverse range of possible industrial development scenarios and opportunities, including various possible mines and the Alaska Highway Natural Gas Pipeline project.
- **Potential supply resource options for a construction start within the next 10 years:** Supply resource options potentially relevant for a construction start within the next 10 years vary widely depending on the potential industrial developments considered, and include a range of different hydro and diesel generation possibilities as well as transmission, and possibly coal and/or natural gas-fired generation.
- **Balance required:** Readiness and timing to supply new major industrial loads needs to be balanced with understanding of the long predevelopment timelines and considerable costs, uncertainties and risks associated with planning specific power resource options.

Varying levels of technical and costing assessments have been carried out to screen options, including in some instances investigations advanced to the project feasibility stage. The Resource Plan process identifies preferred projects for which YEC can then commit when appropriate to proceed with more detailed project-specific pre-decision planning.

This Submission includes near term projects at different stages of pre-decision planning. No final decision has yet been made to implement these projects. In some instances, environmental approvals have already been secured - in other instances, however, the necessary applications for such approvals have yet to be made. Final design, costing and tendering tend to be a final stage to be carried out prior to final Yukon Energy decisions to proceed with construction/implementation.

NEW CAPACITY CRITERIA

After an extensive review of its system capacity planning criteria, Yukon Energy has adopted new capacity planning criteria. System capacity planning criteria are the sets of rules used to determine how much generation is required on the various Yukon systems and when additions to generation capacity are required.¹

Background on Evolution of Capacity Planning

Planning of a utility system must provide both for system growth and for operation after a component failure. Utility systems across North America vary greatly in size and complexity but the ability of each system to maintain service is compared by using established and recognized criteria.

The criteria used by the Northern Canada Power Commission (NCPC) prior to 1987 were developed to indicate the amount of firm generating capacity required to cover relatively small isolated systems, and were consistent with utility planning standards of that era. NCPC had started with a multiple of small isolated systems, some of which continued, but others had grown to the point where multiple sources were interconnected.

Yukon Energy (and its then manager, YECL), as the operator succeeding NCPC for the Yukon, initially followed the practice of NCPC. It was quickly found that the continuing small isolated installations were reasonably covered by the NCPC criteria but that the larger systems with multiple sources needed more detailed analysis to be secure:

- The small systems were considered to be adequately protected if the generating capacity with the largest single unit out of service was at least 110% of the anticipated peak load.
- For the larger “grid” systems, it became necessary to consider not only the possible loss of a single generator (in the case of WAF, a single “wheel” at Aishihik), but also the likelihood that at least one of the major WAF diesels would be unavailable at the same time. Consequently, the Resource Plan in 1992 introduced recognition of the diesel-related effect on Yukon Energy’s ability to serve any particular WAF load by adding a “10% of installed diesel” reserve on top of the Aishihik hydro reserve.

Under the original NCPC capacity planning criteria and the capacity planning criteria reviewed in the 1992 Resource Plan, the transmission system availability was not taken into consideration.

¹ For the purposes of system planning, all “firm” customer load requirements at the time of system maximum load or peak (e.g., winter peak on WAF) are considered when assessing each system’s capacity planning requirements. Yukon Energy’s policy requires that secondary energy service be interrupted when surplus hydro resources are not available, and therefore no bulk electrical supply capabilities are planned to supply secondary energy service.

In contrast to these earlier Yukon capacity planning criteria, integrated utilities today typically use a statistical approach to evaluate the potential interruption of service for any customer. This is often evaluated as the Loss of Load Expectation (LOLE) and it is measured in hours per year². Most Canadian utilities apply an LOLE range from one to two hours per year as their capacity planning criteria standard. Further, where relevant, certain utilities today have incorporated transmission into this probability assessment when generation reliability is directly and materially affected by transmission.

Certain utilities have also adopted additional tests along with the LOLE criteria. For example, recently the Northwest Territories Power Corporation (NWT Power Corporation) has incorporated into its system capacity planning criteria a second test which is applied in parallel with LOLE criteria to ensure that customers are protected against failure of any single system component.

In summary, throughout various integrated utilities it is apparent that capacity planning criteria have evolved gradually into more defined ratios as systems have grown larger and more complicated. Furthermore, where relevant, transmission reliability is also being addressed today where it directly affects generation reliability.

Recent Yukon Energy Review of Capacity Planning Criteria

Yukon Energy recently completed an extensive review of its capacity planning criteria and, amongst other things, has examined the LOLE approach, testing it against the operating history of its WAF system. This review was undertaken in consultation with reliability experts from the University of Saskatchewan (under the direction of Dr. Roy Billinton³). Dr Billinton and his colleague were retained in late 2004 to review Yukon Energy's then established capacity planning criteria (i.e., the criteria as reviewed in the 1992 Resource Plan), including studying and determining the probabilities inherent in that criteria.

In contrast with statistical approaches such as LOLE, Yukon Energy's capacity criteria reviewed in the 1992 Resource Plan are "deterministic" in that a specific test was adopted for each system as a proxy intended to ensure adequate capacity. Yukon's criteria dealt with the concept of a "reserve" rather than actually assessing the likelihood (or probability) that the generation available will be insufficient to supply the load at any given point in time. Without reference to a specific probability of interruption, the adequacy of Yukon Energy's capacity criteria as reviewed in the 1992 Resource Plan cannot be readily compared today with criteria adopted in other jurisdictions for integrated systems.

² Other terms are also used to describe the probabilistic measures, such as the BC Hydro criteria of Loss of Load Probability (LOLP) or Newfoundland and Labrador Hydro's Loss of Load Hours (LOLH).

³ The same experts advised NWT Power Corporation in the development of the Snare-Yellowknife system planning criteria which criteria received approval from NWT Power Corporation and its regulator in 2004.

The recent work by Dr. Billinton addressed this issue with regard to WAF. It indicated that Yukon Energy's capacity criteria as reviewed in the 1992 Resource Plan provided excellent capacity reliability, based on LOLE, for residential and commercial WAF customers in 1996/97 when the Faro mine was operating. Today, however, in terms of the maximum peak load that can be supported, Dr. Billinton's work indicated that WAF generation is not adequate to supply the peak allowed under that same criteria within any reasonable LOLE reliability standard adopted elsewhere in Canada. The primary reasons for this conclusion are that the WAF system has substantial hydro generation availability that is directly affected by certain transmission, and further that the WAF system also has been trending to an increasing probability of longer outages as it expands (particularly with expansion of residential and commercial loads and major reductions in industrial load).

As a result of this recent review, Yukon Energy has now incorporated the LOLE approach, with recognition of transmission reliability where relevant, into its system planning criteria to better protect all of its firm customers from generation-related outages.

At the same time, Yukon Energy has recognized that the LOLE function is an average that does not indicate how long any particular outage will last, and that any extended outage on WAF or the Mayo Dawson grid during the winter peak could be extremely serious for affected residential and commercial customers. Yukon Energy has addressed this concern by incorporating a second test as part of its capacity planning criteria, known as the N-1 standard⁴ which ensures sufficient system capability to continue to serve firm residential and commercial customers when a failure occurs to the single largest system component. As an example, the biggest loss of generation on WAF today at winter peak would be 30 MW following a failure of the Aishihik transmission line; this loss would be far greater than the loss during winter peak of the biggest generator (which currently is a 15 MW generator at Aishihik).⁵

New Capacity Planning Criteria

The following new capacity planning criteria have been adopted by Yukon Energy:

1. **WAF and MD System-wide capacity planning criteria:** Each grid system (WAF and MD) will be planned not to exceed a Loss of Load Expectation (or LOLE) of 2 hours/year.
2. **Emergency (or "N-1") WAF and MD system capacity planning criteria:** Each grid system

⁴ A test described as "surviving the first failure" or "operating in the N-1 condition where "N" is the normal system complement.

⁵ The largest single unit on the WAF system today is WH 4, one of the hydro units at Whitehorse. However, as Whitehorse has 4 hydro units (WH1 at 5.8 MW, WH2 at 5.8 MW, WH3 at 8.4 MW and WH4 at 20 MW), but only 24 MW of firm flows in winter in drought conditions, a loss of WH4 would only effectively reduce the available capacity by 4 MW (as the other 3 units would still be available); this loss at winter peak would therefore be smaller than the loss of 15 MW via one of the units at Aishihik.

(WAF and MD) will be planned to be able to carry the forecast peak winter loads (excluding major industrial loads) under the largest single contingency (known as "N-1"). The N-1 criterion determines system capacity assuming the loss of the system's single largest generating or transmission-related generation source.

3. **WAF and MD "community" criteria:** For communities on the WAF or MD grids, any location with a load large enough to justify a diesel unit of about 1 MW or more will be considered as a preferred location for new diesel units if that community does not already have back-up from another source (e.g., having an existing diesel unit). The new diesel units would provide grid support, and in times of line failures would provide local generation for the communities where they are located.

For isolated diesel communities no change has been made for the capacity planning criteria (Yukon Energy will maintain the past criteria of being able to meet 110% of the community peak with the largest unit out of service).

PROPOSED NEAR TERM ACTIONS

Four separate major investments are proposed for Yukon Energy generation and transmission commitment before 2009, three with anticipated costs of \$3 million or more. These proposed major projects will address near term requirements and opportunities to 2012 and together will provide over 21 MW of new WAF firm winter capacity by 2012 (i.e., enough new firm capacity to meet WAF capacity shortfalls that would otherwise be expected by 2012 of 18.7 MW under the Base Case forecast and 21.5 MW under the Base Case forecasts plus the Minto and Carmacks Copper mine loads). The four major proposed projects are reviewed below, along with contingency provisions and other proposed actions before 2012:

1. **Aishihik 3rd Turbine Project:** This project, which was initially reviewed in the 1992 YUB Resource Plan hearing, will provide 7 MW of added peaking capability⁶ and about 5.4 GW.h/yr of long-term average hydro energy supply at the existing Aishihik generation station at a capital cost of about \$7 million (2005\$). Under Base Case loads without any new industrial developments, this project is expected to be economic within the planning period to 2025 based solely on its diesel operating cost saving benefits for the WAF grid, including displacement of peaking and then baseload diesel as WAF loads increase. Yukon Territorial Water Board and environmental approvals for the project were received in the new Aishihik Water Licence.
 - a) Accordingly, this project will proceed with final planning activities to enable a final decision during 2007 to start construction for in-service by October 2009.

⁶ Without twinning of the Aishihik Transmission Line, none of this added Aishihik capacity is recognized under the N-1 WAF capacity planning criteria, and only 0.6 MW is recognized under the LOLE WAF capacity planning criteria.

- b) If Marsh Lake Fall/Winter Storage is developed without any additional non-industrial load growth or new industrial loads emerging, the final decision to start construction is proposed to be deferred until late 2009 for in-service in 2011 or 2012.

2. **Marsh Lake Fall/Winter Storage licence revision:** This project, which was not reviewed in the 1992 Resource Plan hearing, will increase the firm winter capacity of the Whitehorse Rapids hydro facility by about 1.6 MW and increase long-term average hydro energy from this facility by about 7.7 GW.h/year at a capital cost of no more than \$1 million.⁷ Yukon Energy will undertake the project planning activities, including consultation and environmental licensing, as required to seek amendment of the Whitehorse Rapids water licence to enable modified operation of Marsh Lake within its current lake levels to enhance fall/winter storage. Basically no new physical works are expected to be required for this project. Project approval is forecast by August 2007 (although provision is made in the event that the new Yukon environmental licencing regime requirements delays completion of the licence amendment to 2008). The effects of the proposed licence amendment are summarized as follows:

- a) **Remain within current lake level limits:** In all cases, the water levels with the amended licence will remain within the lake level limits currently experienced (i.e., the peak controlled level would be below the natural high water levels experienced in the lake).
- b) **Licence amendment changes the “controlled maximum” level:** The proposed amendment would change the licenced “controlled maximum” level that YEC can maintain upwards by about 1 foot; however, during uncontrolled periods of summer and fall (when YEC currently has no control over the lake and it is operating under an entirely natural regime), Marsh Lake has been known to peak at 2 feet above the YEC “controlled maximum” level. The effects of the proposed change are as follows depending on water conditions:
 - i. **Non flood year operation other than a drought:** This project would allow Yukon Energy to reduce the amount of water it releases in non-flood years from August 15 to the end of September, to allow that water to be used instead during the peak winter generation period. No effect is to occur under these conditions in any year prior to August 15, other than under drought conditions (see below).
 - ii. **Flood year operation:** During flood years, there would be no change in the flood levels experienced on Marsh Lake, and no change to operations would be made during August and September until after flood levels subside.
 - iii. **During drought years:** Current licence provisions to help alleviate summer drought levels on Marsh Lake through “early closures” of the Lewes Dam would

⁷ This estimated capital cost is made up of the costs for licencing, any required mitigation works and any potential facility modifications.

remain, and would likely be adapted to alleviate further summer drought conditions to ensure the lake reached the full supply capacity level in each year.

3. **Carmacks-Stewart Transmission Line Project:** This project will fully interconnect the MD and WAF grids as well as facilitate WAF transmission access to potential new mine loads at Minto and Carmacks Copper, providing 5.6 MW of additional firm near term capacity and 15 GW.h/year of additional near term energy for WAF⁸. Development of this project, which is estimated to cost about \$35 million (2005\$), is subject to provision of Yukon Government funding to ensure that there is no net cost to Yukon Energy or Yukon ratepayers beyond what would be required for any other option to provide required capacity and energy. Based on external funding to assure no adverse impact on ratepayers from project development, planning activities will proceed with the Carmacks-Stewart project to enable a decision to proceed with construction early in 2007 for an in-service date in approximately late 2008.

4. **Mirrlees Life Extension Project:** Subject to confirmation of technical feasibility that is expected to be determined within the first quarter of 2006, the Mirrlees Life Extension Project will conclude final planning activities in 2006 in order to provide in-service during 2007 through to 2009 to provide an additional 14 MW of firm WAF winter capacity at a cost of up to \$4.5 million (2005\$).
 - a) **First Mirrlees unit in service by October 2007:** By the summer of 2006 planning work and commitments for construction/implementation will begin on the first Mirrlees unit (5 MW) at a cost of up to \$2.5 million (2005\$)⁹ in order that in-service will occur before October 2007.
 - b) **Other two Mirrlees units by October 2008 and 2009:** Life Extension for the other two Mirrlees units will proceed thereafter for expected in-service in 2008 and 2009, subject to review of the experience gained from Life Extension of the first unit and the possible Yukon Energy consideration of replacing the third Mirrlees unit (4 MW) with a larger capacity new diesel unit (e.g., 8 MW or 11 MW unit).¹⁰

⁸ Added capacity and energy supplied to WAF by this interconnection are subject to MD loads, and will decline as MD loads increase. Reopening of the UKHM mine or other new industrial developments on MD, for example, would reduce MD surplus capacity and hydro energy available to WAF. In contrast, potential additional enhancements at the existing Mayo hydro facility or other new generation opportunities in the MD area could enhance overall WAF/MD power supply in the event of Carmacks-Stewart Transmission line development.

⁹ This cost includes a "teardown" level of overhaul and the common diesel plant upgrade work necessary to undertake the Mirrlees Life Extension Project.

¹⁰ In the event that Mirrlees Life Extension proceeds but the Carmacks-Stewart Transmission Line is not developed in the near term, replacing the third Mirrlees unit with an 11 MW new diesel would more than replace the capacity that otherwise would have been provided by the Carmacks-Stewart Transmission Project.

5. **If Mirrlees Life Extension is not technically feasible, implement diesel replacement/expansion and/or other project options as appropriate:** Without the Mirrlees Life Extension option providing 14 MW of firm capacity, the key near term choice is between the option involving Whitehorse Diesel Replacement/Expansion (capability for three units with combined capacity of up to at least 33 MW) versus the Aishihik 2nd Transmission Line (providing 22 MW under N-1 criteria and about 14.4 MW with LOLE criteria).¹¹

Although the expected capacity shortfall can technically be met with the Aishihik-related option, this is not expected to be the lowest cost option to 2012 under Base Case loads and also this is not the lowest cost long-term option under higher loads including mines. The Aishihik-related option also exposes the WAF grid to near term and growing capacity shortfalls until it is completed.

Accordingly, the Diesel Replacement/Expansion option will be implemented as follows in the event that Mirrlees Life Extension is not technically feasible¹²:

- a) **Base Case Loads: First Diesel Unit (8 to 11 MW) needs to be installed by October 2007:** Yukon Energy will need under these circumstances to proceed with final planning work on this project by summer 2006, including orders for the necessary engine unit (with cancellation provisions) in order that the unit can be installed by October 2007 at a capital cost (2005\$) of up to about \$7.2 million (8 MW) or \$8.8 million (11 MW). This will include updating any common diesel plant systems necessary for connection of a new unit.
 - b) **Other Diesel Units:** Once the first unit is committed, it is expected that up to two additional diesel units (depending on the unit size selected) will be implemented thereafter as required for in-service before 2012.
6. **Ongoing monitoring of existing customer load forecasts and new industrial development opportunities:** In order to facilitate ongoing assessment of generation and transmission options and requirements, Yukon Energy monitoring of annual customer class load trends (peak capacity and seasonal energy) on each grid is required. In addition, Yukon Energy will continue to monitor directly with developers and government specific new industrial

¹¹ In this context, the Aishihik-related option has been examined for possible implementation assuming that it is feasible to commit development of the Aishihik 2nd Transmission Line by 2009 at the latest; under this option, material near term capacity shortfalls would still occur until the Aishihik 2nd Transmission Line was in service.

¹² Diesel Replacement/Enhancement will also be the option pursued as required in the event that other major projects do not proceed as proposed, e.g., the Carmacks-Stewart Transmission Line Project (which is assumed to provide 5.6 MW by late 2008) and/or the Marsh Lake Fall/Winter Storage (which is assumed to provide 1.6 MW by fall 2007 or 2008). In the event that mine loads are connected to WAF without completion of the Carmacks-Stewart Transmission, Yukon Energy will review the feasibility of the Aishihik 2nd Transmission Line project.

development opportunities for grid power service, including assessment of any mine site power contribution to the supply of reliable grid peak capacity.

7. **Other Small Enhancement Projects:** Continued routine utility investment is recommended in assessing and proceeding with projects to enhance existing facilities at a cost less than \$3 million. This includes:
- study of the hydrology of the Southern Lakes, and potentially pursuing small water control structures in this region (new generating stations to manage water plus generate hydro power would, if proposed in the future, exceed \$3 million);
 - continued pursuit of opportunities to cost-effectively rewind or re-runner existing hydro generating units at Whitehorse and Aishihik; and,
 - assessing need and timing for a potential 1 MW diesel unit installation at Carcross/Tagish (likely by YECL).

PROPOSED ACTIONS RELATING TO INDUSTRIAL DEVELOPMENT SCENARIOS AND OPPORTUNITIES

Yukon Energy proposes planning activities as set out below to address a wide range of potential industrial development scenarios beyond the near term, and to protect future opportunities to commit development of additional generation and transmission projects before 2016 in a timely and cost-effective way in the event that one or more of these industrial development scenarios materialize.

Planning activities are organized by industrial development load scenario, identifying proposals as to how to approach each load scenario should it arise. "Pre-commitment" activities are also addressed which encompass planning activities Yukon Energy proposes to carry out prior to any certainty or commitment on the part of potential new industrial loads.

Proposed Activities Regarding Scenario 1: A 10 MW WAF Industrial Scenario

This industrial development scenario (which provides for near term development and operation between 2007 and 2018 of the Minto and Carmacks Copper mines) supports commitment of modest existing hydro enhancements, but does not support commitment of any new hydro site development before 2016 unless mine loads of at least 10 MW are sustained well beyond 2016. Consideration of the smallest hydro site options (1-4 MW) could potentially be supported in the event that 10 MW mine load development extends through to at least 2020. In this context, the following planning activities are recommended in the event these mine loads are seriously being considered for development prior to 2016:

- **WAF hydro system enhancements:** If not already committed pursuant to Chapter 4 near-term recommendations, planning should then proceed to commit the Aishihik 3rd Turbine, the

Marsh Lake Fall/Winter Storage and any other feasible existing hydro enhancements indicated to date by the Aishihik Diversion assessments, the Southern Lakes hydrology work, and existing WAF hydro plant upgrade assessments.

- If not already committed, Aishihik Diversions and Atlin Storage should then be advanced to Level 2 studies, including system-wide water and load dispatch modeling, to quantify the energy benefits under this scenario.
- Ongoing assessment of the Southern Lakes should be completed to identify additional water control or small hydro opportunities to enhance Whitehorse Rapids output.
- **Mayo hydro system enhancements:** If the Carmacks to Stewart transmission line is developed to interconnect the WAF and MD grids, assess and develop as appropriate feasible enhancements at the existing Mayo hydro facility, including enhanced peaking capability.
- **New WAF hydro site development:** If industrial and overall load development commitment is such that both new capacity and baseload diesel generation energy are required through to at least 2020 (and there is no clear indication of more major industrial development scenarios emerging during the 20 year planning period), planning activities should be carried out to enable commitment of a very small hydro site development (1-4 MW, 5-30 GW.h/year)¹³ able to provide new capacity and displace diesel energy.
 - Based on current information, this would indicate that the hydro site at Drury should at that time be advanced to full Level 3 studies that include consideration of variations that maximize capacity.
 - Possible consideration might also be given to Level 2 studies for Squanga as a utility project or IPP, and/or for Morley, as potential alternatives for comparison to Drury.
 - Consideration must include means to mitigate downside risks should industrial loads close prematurely.
 - Actual development in each or these cases will involve investments greater than \$3 million, or long-term contract commitments in excess of \$3 million present value to IPPs, and therefore YUB review will be sought prior to project commitment.
- **Other activities re: DSM:** If loads of this scale and duration develop, further consideration will be given to DSM programming focused primarily on reduction of system peak demand.

Proposed Activities Regarding Scenario 2: A 25 MW WAF Industrial Scenario

If industrial loads are committed on WAF before 2016 for development of more than 10 MW (70 GW.h/year) but less than about 20-25 MW (comparable to the Faro mine) for a period through to at least 2025, planning activities should be carried out to enable commitment before 2016 to develop new hydro site resources to provide approximately 50 GW.h per year to WAF.

¹³ Present estimates of the costs are \$12-\$47 million generation capital cost (2005\$) with potential generation planning costs of \$1.2-\$4.7 million prior to a decision to proceed with construction.

For potential hydro projects, key options to be considered at such time as greater load certainty develops regarding this level and duration of industrial load are as follows:

- **WAF hydro system enhancements:** If not already committed pursuant to Chapter 4 near-term recommendations, planning should proceed to commit the Aishihik 3rd Turbine, the Marsh Lake Fall/Winter Storage and any other feasible existing hydro enhancements indicated to date by the Aishihik Diversion assessments, the Southern Lakes hydrology work, and existing WAF hydro plant upgrade assessments (see proposals for Scenario 1).
- **Mayo hydro system enhancements:** If the Carmacks to Stewart transmission is developed to interconnect the WAF and MD grids, assess and develop as appropriate feasible enhancements at the existing Mayo hydro facility (including any feasible enhanced peaking capability).
- **New hydro site development:** If industrial and overall load development commitment on WAF before 2016 is such that WAF baseload diesel generation energy of more than 10 MW (70 GW.h/year) is then required through to at least 2025, and there is no clear indication of more major industrial development scenarios establishing new WAF industrial loads in excess of about 20 MW (about 125 GW.h/year) emerging during the 20 year planning period and extending beyond 2025, planning activities should then be carried out to enable commitment of a small hydro site development (7-10 MW, about 50 GW.h/year¹⁴) able to provide diesel displacing energy to WAF.
 - New hydro options focused on Yukon-based projects, if available, would be the preference.
 - However, given limited attractive projects in this size range identified in Yukon to date, further Level 1 and 2 activity should be undertaken if timing permits in areas within 50 km of existing 138 kV WAF transmission focused initially on scans of the various inventory studies completed by NCPC or others.
 - Sites in BC, including Moon Lake and Tutshi¹⁵, should have Level 2 studies updated in preparation for this possible load scenario, particularly focusing on the costs and risks associated with interprovincial licencing requirements and water rentals. Level 3 studies should then proceed if warranted.
- **Coal supply possibilities:** In the event that the loads of this scale develop and coal also becomes available from developed Yukon sources, coal generation technology should be reviewed in the event that timing permits to determine the potential for an economic and environmentally sound coal development at sizes below 20 MW, sized as appropriate to fit the industrial loads being developed at that time.

¹⁴ Present estimates of the costs are \$50-\$100 million generation capital cost (2005\$) with potential generation planning costs of \$5-\$10 million prior to a decision to proceed with construction.

¹⁵ No further work should proceed on Surprise Lake so long as the community continues its plans to develop micro-hydro at the site.

- **Other activities re: DSM and wind:** If loads of this scale and duration develop, further consideration will be given to DSM programming focused on both the reduction of system peak demand and energy conservation, and development of new wind generation (if attractive sites near established utility grids can be identified).

Actual development of new hydro sites (or any other new generation site) in each case will involve investments greater than \$3 million, so YUB review will be sought prior to project commitment. In addition, for larger scale developments, planning and feasibility work may exceed the \$3 million level, so there is the potential for YUB review at this earlier stage as well.

Proposed Activities Regarding Scenario 3: A 40 MW WAF Industrial Scenario

If industrial loads are committed on WAF before 2016 of more than about 20-25 MW (150 or more GW.h/year) for a period through to at least 2030, resulting in forecast baseload WAF diesel generation energy of more than about 150 GW.h/year to be required until at least 2030, then planning activities can reasonably proceed to consider commitments before 2016 to develop new hydro site or coal generation resources of 20-30 MW to provide 130-150 GW.h per year of long-term energy (20 or more years) to WAF.

- **Load uncertainties and low probabilities today:** The industrial loads required to reach the above levels at this time involve significant uncertainties and low probabilities.
- **New medium scale hydro site development (20-30 MW, 130-150 GW.h/year):** The development of generation and transmission to serve these loads, based on currently identified potential hydro sites (Primrose and Finlayson), would involve substantial generation capital costs (\$179-\$191 million (2005\$)), excluding transmission, as well as very large planning costs (about \$20 million) prior to a decision to proceed with construction. Such costs are likely at or beyond the limits of YEC's current financial capabilities and involve material costs and risks related to investments in feasibility and planning long before final decisions to proceed can occur or plants brought on-line.
- **Coal supply thermal generation possibilities:** Coal resource options of this scale could involve far less capital than comparable new hydro sites, provided that coal supply as such was otherwise available from developed Yukon sources. The scale at 20 MW (144 GW.h/year¹⁶), however, is still very small for coal thermal technology and would require careful Level 2 and 3 screening and feasibility assessments to confirm its potential feasibility.

For potential generation projects related to the above scales, it is not apparent today that there is sufficient likelihood of this major development scenario arising to justify major investment at this time in planning and

¹⁶ The present estimate of the costs are \$ 61 million thermal plant capital cost (2005\$), excluding transmission or coal resource development costs, with potential generation planning costs of \$6 million or more prior to a decision to proceed with construction.

feasibility studies for medium new hydro or small coal plants. Accordingly, no specific planning activities are recommended at this time.

Coal options for thermal generation must be environmentally sound to be considered. The feasibility of coal generation will depend in part on the cost of employing state of the art technologies to reduce emissions, as well as on the availability of coal supply from developed Yukon sources and the occurrence of very large industrial mine developments that can be connected economically to the grids.

Future decisions with respect to the level of effort and expense in this area will reflect YEC's ongoing assessment of the probabilities of the required loads developing. For projects of this scale, even early planning and feasibility work (at least on hydro sites) will exceed the \$3 million level, in which case YUB review will be sought before proceeding with specific planning commitments of \$3 million or more.

Proposed Activities Regarding Scenario 4: A 120 to 360 MW WAF Pipeline Scenario

The Scenario 4 pipeline loads at this time involves significant uncertainties as regards timing and magnitudes. However, given the implications of this industrial development for all aspects of Yukon power utility activities, and its clear possibility to come into service within the 20-year period for the current Resource Plan, one key activity recommended for the near-term regarding Scenario 4 involves continued active monitoring of this development as well as active planning to identify and assess all potential related material impacts, options and opportunities, including:

- Power supply options for the pipeline for compression (focusing initially on short listing and assessing at Level 1 knowledge large scale hydro site options and related transmission requirements).
- More modest power supply opportunities focused on compressor station "station service" loads.
- Options to use natural gas for power generation to serve cost effectively other incremental industrial loads.

The development of generation and transmission to serve these pipeline loads is likely well beyond the limits of YEC's current financial capabilities, as well as involving material costs and risks related to investments in feasibility and planning long before final decisions to proceed can occur or plants brought on-line. Accordingly, prior to carrying out any planning activities beyond Level 1 assessment of any specific site or technology specific studies, it is proposed that Yukon Energy identify and assess options that would address this constraint, e.g., joint venturing with others, and/or options to secure external government or other financing.

Proposed “Pre-commitment” activities

Prior to any certainty developing regarding any specific industrial scenario that may arise, it is proposed that Yukon Energy remain focused on certain key planning activities to ensure protection of the options to address new load requirements. Yukon Energy proposes the following activities in this regard:

- **Monitoring of Industrial load developments:** Yukon Energy will continue to monitor closely potential load development and related spin-off residential and commercial impacts, including necessary discussions with mineral exploration companies active in Yukon, key officials in Yukon government working with mines and other industrial developments and relevant industry associations. Separately, YEC will maintain ongoing monitoring of potential Alaska Highway pipeline developments and factors that may impact electrical loads in Yukon (including potential for electrical compression).
- **Southern Lakes hydrology assessments:** Continued assessment and studies of the hydrology of the southern lakes area, including identification of potential for water control structures to enhance output of Whitehorse Rapids, as well as potential hydro generation sites.
- **Other existing hydro facility enhancements:** Continued focus on projects to enhance output of existing hydro generation facilities at Aishihik, Whitehorse and in certain cases, Mayo. This includes full Level 3 and 4 studies on the Aishihik 3rd turbine and updating Level 2 studies on Aishihik diversions. Where suitable, activities should be carried out in conjunction with other normal Supply Side Enhancement planning by Yukon Energy, such as re-runnering.
- **Level 1 and 2 assessments to identify preferred 5-30 MW scale Yukon hydro sites:** There is an option to invest in further surveying the potential of other Yukon based hydro generation sites to try to identify good sites in the 5-10 MW range (within about 50 km of existing high voltage transmission) and to advance credible candidates in the 5-30 MW range through Level 2 assessments (including ongoing monitoring of hydrology) in order to identify more clearly preferred sites to develop for possible loads within this range. However, this activity is costly and may require assessment of a number of sites. No activities in this regard are recommended today; however, in the event that at least one large industrial load (such as Red Mountain or Division Mountain) proceeds to advanced licencing and likely commitment stages, it is proposed that this initial work should proceed quickly to determine if the sites identified to date are indeed the best candidates or if there are other Yukon-based sites that should be seriously considered, and to identify specific projects for Level 3 feasibility assessments.
- **Ongoing monitoring of hydrology:** Active hydrology monitoring will proceed where feasible for all hydro sites likely to be serious candidates for future development within the 20 year planning period. The monitoring may be periodic (seasonal flow information, current cost of \$1,000 per year per site) up to a full-time recording station (at a current cost of \$30,000 (initial costs) plus ongoing costs of between \$10,000 to \$15,000 per year).