OEB Staff Interrogatory # 173

Issue:

Issue 29: Are the proposed capital expenditures resulting from the Distribution System Plan appropriate, and have they been adequately planned and paced?

Reference:

Q-01-01
1.2 A reduction in the capital forecast; updated rate base and in-service additions forecasts

Interrogatory:

Hydro One has updated the capital forecast for the years 2018-2022 due to adjustments made to General Plant projects and productivity targets.

Please provide the updated ISD for each General Plant investment that has affected the updated capital forecast and highlight the changes in project scope or explain the productivity change that attributed to the updated capital forecast.

Response:

The attachment to this response includes the following updated ISDs:

- GP-01
- GP-02
- GP-03
- GP-04
- GP-05
- GP-06
- GP-07
- GP-08
- GP-09
- GP-10
- GP-11
- GP-12
- GP-13
- GP-14
- GP-15
- GP-17

- GP-18
- GP-19
- GP-20
- GP-23
- GP-35

Additionally it includes the following newly created ISDs as a result of the updated capital forecast presented in Exhibit Q, Tab 1, Schedule 1:

- GP-36
- GP-37
- GP-38
- GP-39
- GP-40

GP-18 Integrated System Operating Centre

Start Date:	Q1 2015	**Priority:**	High
In-Service Date:	Q3 2020	**Plan Period Cost ($M):**	61.3
Primary Trigger:	Asset Driven – Failure Risk & Capacity		
Secondary Trigger:	Regulatory		

Investment Need:

The Network Operating Divisions ("NOD") Backup Control Centre ("BUCC") facility was placed in-service in 1956, and is the means that regulatory, business and operational requirements are sustained for monitoring and control operations to North American Electricity Reliability Corporation ("NERC") standards, Distribution and Transmission System Code ("DSC") requirements and Hydro One standards respectively. The BUCC facility consists of the building, computer tools and systems that support Operations in the event of a partial or total loss of the primary Ontario Grid Control Centre.

A risk of future extended outages, inability to execute necessary upgrades /replacements and increase capacity to required computer systems and tools, could result in significant disruption to business continuity and Hydro One's ability to meet customer's service level expectations. The facility is currently at capacity in computing space, HVAC, power and due to the age of the structure, among other factors, remedial efforts are either not viable alternatives, cannot be mitigated or are cost prohibitive to execute. In addition, a prolonged activation would impede supporting Operations; i.e., Outage Planning, Operations studies and support due to a lack of back office support space. Current Operations support groups that are fundamental in daily Operations, are unable to occupy the BUCC during any event, and would require current staff at the Richview facility to be relocated, procurement and set up of required computer equipment and would take vital time to implement.

Alternative 1: Status Quo/ Use Offsite Leased Space

Hydro One Network Operating maintains the existing Control Room, and Security Operations maintain existing facilities. A new offsite leased Data Centre facility (to mirror capacity of OGCC data centre based on 20 year lease and initial setup costs) could be provisioned and additional office space would be required and furnished for prolonged activations. This alternative includes additional leased space for the Backup Integrated Telecommunications Management Centre's ("BUITMC") control room and compute needs.

The total cost of this option is estimated to be $78M, of which, the distribution portion will be 50.07%.

This alternative has been rejected as the current BUCC for Network Operating and the Backup ITMC do not meet operational requirements.

- The current facility imposes a high level of risk to both regulatory compliance and, Hydro One's reputation and customers, if any failures are experienced.
- This alternative fails to provide for the Security Operations Centre's ("SOC") need for an adequate primary control centre.
- Even with extensive investment in the existing facilities, this option does not adequately remediate all risk factors (e.g., basement flooding, power capacity constraints, electrical hazards due to proximity to TS).
- This alternative cannot accommodate current or projected growth, requiring further investment in leased facilities in the future.
- This alternative would require the relocation of the existing compute space and critical support infrastructure, currently housed at the BUCC, to a new leased BUITMC.
- This alternative cannot mitigate all known risks due to site conditions, size and location. In the event of a prolonged activation, some existing staff of the Richview facility would be asked to leave to make space for operating activities, and even if this arrangement can be made, there is not sufficient onsite parking, work space, or basic facility infrastructure for the overflow of staff.

Further information relating to the rejection of Alternative 1 is found on pages 22-24 of this Investment Summary Document.

Alternative 2: Build NOD Backup Control Centre and Data Centre exclusively.

This alternative was reviewed in light of the 2013 Toronto rainstorm and ensuing flooding that occurred in the GTA. This event required the ITMC to activate the BUITMC located in Kitchener Ontario. During this event, it was made apparent that a failure in the ITMC function or delays in Backup activation, created an inability to remediate, troubleshoot telecommunication outages, and had a significant impact on Network Operating's ability to monitor and control. Loss of communications had severe impacts on the Control Room's ability to monitor and control field assets and clearly showed that a new NOD Backup Control Centre and Data Centre would not remediate all risks currently identified. This alternative proved that a more robust BUITMC is required.

Due to the importance of the ITMC, the identified need for a new BUITMC and the economies that would be foregone with this alternative, this alternative was removed from further consideration. The estimate for this alternative is $104.8M, of which, the distribution portion will be 50.07%.

Alternative 3: Build Backup Control Centre's for Hydro One Networks and ITMC including shared critical infrastructure, back office support areas and an integrated Data Centre.

This alternative includes Control Rooms, an integrated Data Centre and shared back office support areas for prolonged activation and is considered the minimum requirement to address known operational risks that currently exist. This alternative also includes the purchase of the preferred site. This alternative is estimated at a cost of $124.7M, of which, the distribution portion will be 50.07%.

While this alternative meets Network Operating and the Integrated Telecommunications Management Centre's minimum requirements, it has been rejected as it fails to maximize investment utilization through synergistic lines of business occupancy as well as shared use of critical infrastructure. The incremental cost of the SOC inclusion is $ 6.5M. This also fails to take advantage of operation synergies for operational response to security threats, both physical and cyber.

Alternative 4: Acquire an existing facility that could be retrofitted / utilized to accommodate NOD Backup Control Centre, BUITMC and an integrated Date Centre.

A market assessment was completed that reviewed potential sites against identified requirements for size, location, travel times, power infrastructure, telecommunications and occupancy. This also included an internal assessment of Hydro One owned sites. At the completion of the assessment, it was determined that no suitable site was available in the market or within Hydro One's owned locations. As a result, this alternative was excluded from further consideration.

Retrofitting an existing facility was also considered. In order to suit the environments and critical support infrastructure required for Data Centre reliability, real time 24x7 Control Rooms, Security considerations including dual power supply and telecommunications expansions, extensive investment would be required. At the time of the assessment, no suitable site / facility was available and as such it was removed from further consideration. In addition, the total cost to retrofit was anticipated to be equal to or greater than greenfield construction and as such was removed from further consideration.

Alternative 5: Build ISOC with incremental capacity for a Primary NOD Control Centre, SOC Primary Centre, and BUITMC including an Integrated Data Centre, Shared critical support infrastructure and back office support space.

This option involves building the ISOC as described in alternative 6 and making the necessary arrangements to utilize the ISOC as the Primary Operating Control Centre from Day 1. The OGCC, which is the existing primary operating control centre, will then be converted to be the backup centre.

The additional cost for the building, site and the uplift / upgrades to current mission critical Operating systems and IT architecture to initiate the ISOC as a primary NOD Control Centre, from inception, was determined to be high when weighed against the initial benefits; therefore, this option was rejected. The total cost of this option is estimated to be $141.9M, of which, the distribution portion will be 50.07%.

A strategy to enable a "Dual Control" operational strategy was pursued in an effort to leverage current upgrade investments for their useful life. This alternative does not facilitate the Dual-Control strategy and, without costly upgrades, there will not allow the transition to occur in a more organic nature, representing less cost impacts and less disruption to the Operating functions and staff.

Alternative 6: (Recommended) Initiate Build of the Integrated System Operations Centre (ISOC).

This alternative provides for:

1. a Network Operating Control Centre;
2. a Backup Control Centre for the Integrated Telecommunications Management Centre; and
3. primary facilities for Security Operations.

This Alternative also includes the provision for a shared integrated Data Centre, all critical support infrastructures at the preferred site. This alternative will maximize Operational flexibility for Hydro One Networks and associated lines of business while eliminating the need to duplicate investments in multiple sites, and costly critical support infrastructure (emergency generators, uninterrupted power supplies, telecommunications etc.). The total distribution share of this option is estimated to be $69.3M, and the specific amount for this plan period would be $61.3M.

The ISOC strategy will enable a "Dual Primary" scenario where both Centres can be live as compared to the current live/passive (standby) model. Functionality required to facilitate this strategy is not expected until 2022 and will be implemented within current/future lifecycle schedules for the primary applications (i.e. ORMS, DMS, NMS etc.). This effectively negates the need to prematurely replace, re-architect and implement newer systems prior to their lifecycle expiration while providing the benefits and future flexibility of Primary Control ability.

Further details about the project are included in Appendix A.

A detailed option comparison is included in Appendix B.

Investment Description:

The Integrated System Operations Centre will house multiple lines of business through the provision of dedicated Control Centres: an integrated Data Centre and shared back office areas. This facility will be a hardened facility employing emergency preparedness criterion, industry best practices that meets physical and cyber security standards. This strategy provides flexibility for Hydro One Networks to enable future dual control through a systematic and cost effective approach with planned lifecycle upgrades. These facilities are essential in maintaining adequate redundancy for Operation of the Bulk Electric System, management of the Distribution network and associated customer responsiveness (i.e., outage and storm management). In addition, this will ensure Telecom Communication Network management and adherence to mandated North American Electricity Reliability Corporation (NERC) requirements for Emergency Operating Procedure 008-1 "Loss of Control Centre Functionality". It ensures achievement of reliability and availability targets commensurate with the criticality of these facilities. The ISOC will provide in house security operations, mitigating reliance on third party services and provides needed compute capacity for Security Event Monitoring (SEM).

The ISOC design provides the following:

<u>Facility:</u>

- Provide NOD with a new backup control centre including a control room, back office space and a shared data centre, employing the following strategies; provides the operating flexibility that allows Network Operating to duplicate the current OGCC functionality mitigating the current heightened risk profile with the current BUCC.

- Provides additional training synergies through the use of simulation technologies, allowing use of the facility while not required for backup activation (dual purpose).
- Enables future dual control potential, increasing the readiness and customer response times for any future event that may impact the Ontario Grid Control Centre and NODs ability to manage, monitor, control and dispatch on the distribution system.
- Ensures security requirements, both physical and cyber, including a hardened facility to guard against physical and environmental threats (i.e., tornadoes).
- Provides the ITMC with a new backup operations control centre including a control room, back office and integrated computing facilities mitigating the current risks at the BUITMC and the risks a failure of ITMC Operations poses on Network Operating.
- Provide the Security Event Management centre with needed integrated computing facilities.
- Provide Security Operations with a headquarter location including a control centre, office space, investigative rooms, emergency operations centre (room) and integrated computing facilities.
- Shared and redundant critical support infrastructure.

The total distribution portion cost of the construction build, including contingency and escalation, is estimated to be $51.7M.

Site:

Provides a 16.4 acre site in Orillia Ontario at a cost of $3.0M, and 50.07% of this is the total distribution portion cost. The site was selected based on an extensive Market Assessment in Q1 of 2015. The Orillia site met essential criteria, and included material advantages and associated cost savings in terms of; location, current site development activities completed, forgoing of water detention requirements, improved commute and activation times, and significant municipal development charge savings realized through the Industrial Development Charge Moratorium offered by the City of Orillia.

Architecture and IT design:

The detailed design is expected to be completed by the middle of 2017. The distribution portion of the total engineering and IT consultant costs, for the detailed design, is estimated at $4.9M.

Connectivity and Telecommunication:

Connectivity and SONET at the new ISOC facility allows the ISOC data center to communicate with the OGCC and the rest of the Hydro One telecommunication network. The distribution portion cost to establish this communication connectivity and SONET is estimated to be at $3.6M.

Network Infrastructure:

Lastly, an additional $7.6 million (distribution portion only) has been budgeted for IT infrastructure. This covers the cost associated with connecting each individual workstation console to the ISOC data hall.

Compliance

In order for Hydro One Network Operating to be compliant, there are many requirements, Regulatory Standards and internal Hydro One Standards that must be satisfied. In addition, industry best practices are respected to build on reliability and availability of critical system. The ISOC investment must adhere to; but not limited to the following:

1. North American Energy Reliability Corporation (NERC) –EOP-008 "Loss of Control Centre Functionality" necessitating backup activation to be equal to or less than two hours.
    a. In a related Federal Energy Regulatory Commission (FERC) order (Docket No. RD11-4-000 at 14) FERC signalled its concern that the two hour activation requirement is too long and that "it is imperative that full backup functionality occur as soon as possible after the loss of primary control functionality". FERC also noted that "…it may revisit this transition timeframe". This signalled that the new BUCC facility must take into consideration that activation timelines could be reduced in the future.
    b. NERC and FERC also require the Backup to be "capable of operating for a prolonged period and providing functionality sufficient to maintain compliance with all reliability standards that depend on primary control functionality."
2. Restoration Participant Attachment as required by the IESO administered 'Market Rules' for the Ontario Power System Restoration Plan (OPSRP).
    a. The BUCC is listed as one of the key facilities which comprise Hydro One's contribution to the Ontario Basic Minimum Power System.

3. Required as per EOP-005-2 NPCC-D8 (NPCC Directory 8) and IESO Market Rules & Manuals (Market Rules Chapter 5 – Power System Reliability, Market Manual 7: System Operations, Part 7.8: Ontario Power System Restoration Plan.
4. NERC Critical Infrastructure Protection (CIP) Requirements – ensuring assets are protected logically (electronic security perimeter) and physically (physical security perimeter).
5. Communications: NERC & IESO Market Rules:
   - NERC-COM-001-2;
   - Chapter 2, Appendix 2.2, Section 1.1.4- Technical Requirements: Voice Communication, Monitoring and Control, Workstations and Re-Classification of Facilities;
   - Chapter 2, Appendix 2.2, Section 1.2.3 – Transmitter Submission to the Energy Management System;
   - Chapter 5, Section 12.1.1 – Voice Communications Methods;
   - Chapter 5, Section 12.1.6 & Section 12.2.12 – Alternatives During Loss of Communications;
   - Chapter 5, Section 12.2.3 – Required Voice Communication Facilities;
   - Chapter 5, Section 12.2.4 – Voice Communication Reliability;
   - Chapter 5, Section 12.2.11 - Voice Communication Monitoring and Testing; and
   - Chapter 5, Section 12.3.2 - Required Data Communication Facilities.

<u>Additional Design Criteria</u>

In addition to the above requirements, the following Industry Best Practices have been incorporated into the ISOC design:

- Designed for Dual Hot Centre's with Increased Security
  - Provides additional functionality that improves operational proficiency;
  - Improved system security and redundancy; and
  - Meets minimum provincial anti-terrorism standards (i.e., blast protection).
- Multifunctional Facility / Business Continuity
  - Increased building utilization (multipurpose, real time, simulation and future Dual Control);
  - Operational flexibility and scalability (modular expansion); and
  - Emergency Preparedness criteria – facility separation for common mode failure.
- High Availability / Reliability 99.95%
  - Employing an Uptime Institute guiding principles for a Tier III facility; and
  - Provides for redundancy in computing, communications, cooling and power.

- Emergency Preparedness risk considerations were factored into site selection and facility design, mitigating the current risk the BUCC is exposed to (i.e., not in a flight path, transformer station, etc.).

Risk Mitigation:

- Construction commencement is contingent on the required OEB approvals and if not planned accordingly, could pose project schedule risk. This has been mitigated through a schedule adjustment that will initiate commencement in alignment with OEB schedules.
- Municipal Approvals impose risk to the project schedule however during the current detailed design stage, the municipality has been consulted throughout the process mitigating the risk of future change requests or delay for approvals.
- Site development and environmental risk due to discovery of adverse subsoil conditions. This risk has been mitigated through several borehole assessments of subgrade soil conditions to determine: (a) foreign objects; (b) soil contaminants; and (c) suitability of soil cohesion for adequate foundation strength and no notable issues have been discovered.
- Construction risk due to change requests, lack of performance of proponent and increased costs have been mitigated through plans for Hydro One's and the external designer monitoring on site activities throughout construction ensuring issues are discovered and addressed early and that required contract quality is delivered to schedule.
- Alignment of dependent sub-projects has been identified as a potential risk as a delay in delivery of communication path connectivity to the control network would delay future in-service and commissioning activities. This risk is mitigated through early commencement of this activity to ensure adequate lead times.
- Factors affecting implementation timing and priority are those identified in the Investment need section which speak to the increased reliability risk for backup Operations. These factors have been reviewed and the priority has been set to "high" given the high cost for remedial efforts and the impacts on Operations and Hydro One customers if further failures are experienced.

Result:

The integrated strategy behind the ISOC facility maximizes investment utilization as well as value generated by eliminating the need for additional sites and facilities that would otherwise be required. By building one centralized site to house all stakeholders, economies of scale synergies will be realized. These come in the form of negating the need for multiple

designs, development, sites, facilities (buildings), critical support infrastructure, future maintenance maximizing capital investment, limiting overall rate impacts.

All proposed tenants require critical support infrastructure to meet an availability target commensurate with the criticality of the systems and functions they support (99.95%). The requirements are prescribed by Hydro One internal reliability standards and guided by industry best practices (Uptime Institute Availability "Tier" levels). Critical support infrastructure and IT investment to achieve this objective represent significant investment. With the current ISOC strategy, critical support infrastructure is shared and represents incremental cost to achieve rather than replicating with several installations that would be required to support several sites across Ontario.

- Enhanced monitoring, control and coordinated Customer response (Operating, ITMC, Security and Emergency Preparedness);
- Examples include;
    - Coordinated response for all system vulnerabilities i.e. system events, telecommunication events, cyber events or physical threats through integrated communication within the ISOC facility.
    - Enables future dual active sites, removing activation timelines of backup Operations.
- Share enhanced building protection design and security (physical facility hardening to protect against severe weather or man made threats);
- Share redundant backup generator power supply and other emergency supplies;
- Enhanced site location for improved activation response, elimination of NOD's interim BUCC, adherence to emergency preparedness criteria, dual purpose use for training (negating need for additional training facilities) and other business operations; and
- Enhanced security with centralized operations, improved monitoring and analysis trending for proactive response, and situational awareness for coordinated resolution. An Emergency Operations Centre for Business Continuity and Emergency Preparedness will also be provisioned as part of the Security Operations Centre.

Outcome Summary:

Customer Focus	• Improve the reliability and availability of emergency activation, response and restoration in the event any failure is experienced in the Primary Control Centres. • Reduced rate impacts from a single integrated solution as compared to multiple standalone investments. • Retiring of the current interim NOD BUCC and removal of the risk of costly remedial efforts in the event further failures are experienced.
Operational Effectiveness	• Mitigates the critical risks (infrastructure failures, capacity constraints, location and activation timelines etc.) that exist at the Network Operating Backup Control Centre and the Backup Integrated Telecommunication Management Centre. • Monitoring and control reliability will be sustained under all system contingency scenarios improving Hydro One's compliance risk, customer responsiveness and Operational agility.
Public Policy Responsiveness	• Accommodate all regulatory requirements for physical protection, cyber security and activation timelines responsiveness. (See Appendix A and Compliance section of this document for further details).
Financial Performance	• Reduce the cost impact to Hydro One customers through the realization of economies of scale, mitigating the need to provide multiple sites, buildings and shared critical support infrastructure. • Negate the need to maintain an Interim NOD BUCC and reduce the risk of costly mitigation in the event additional failures are experienced at the main BUCC.

Costs:

Key considerations affecting the final cost of the project consist of the following:

- Availability and Reliability Standards including the need for redundancy in system and building architecture to maintain the existing target of 99.95%. The largest cost element revolves around the Data Center and critical support infrastructure, and the "Tier" or "Redundancy" level can weigh heavily on the investment required. Given the criticality of the Control Centre functions, with leading industry advice, a Tier III level was recommended and designed. This category includes the investment required in the SONET control telecommunications network required to connect the BUCC to field assets for monitoring and control.

- Security Requirements impose additional cost considerations ensuring the facility can withstand both natural and human events i.e. Tornado's, blast protections. Included in this consideration are prescribed regulatory requirements for six sided secure perimeters, cyber security (IT architecture), site access and monitoring of critical assets.
- Costs have been managed through an extensive and thorough assessment with various third party industry experts, internal subject matter experts as it relates to industry best practices, cost saving initiatives (i.e., free cooling), alternative option assessment for independent project elements (site selection, industry comparators), integration of solutions for various business units, functions and needs across Hydro One at a single site. An independent cost consultant has provided costing of the current stage of detail designs.

Variance due to refinement of the IT, Telecom, and construction engineering cost estimates as the engineering design had been finalized.

($ Millions)	**2018**	**2019**	**2020**	**2021**	**2022**	**Plan Period Total**	**Total Project Costs****
Capital* and Minor Fixed Assets	22.0	36.3	3.1	-	-	61.3	69.3
Less Removals	-	-	-	-	-	0.0	0.0
Gross Investment Cost	**22.0**	**36.3**	**3.1**	-	-	**61.3**	**69.3**
Less Capital Contributions	-	-	-	-	-	0.0	0.0
Net Investment Cost	**22.0**	**36.3**	**3.1**	**0**	**0.0**	**61.3**	**69.3**

**Includes overhead at current rates.*
*** Total Project includes amounts spent prior to 2018.*

APPENDIX A – DETAILED PROJECT DESCRIPTION

This investment, formerly known as the Backup Control Centre – New Facility Development, has expanded to include other operational synergistic lines of business that require facilities to perform similar functions (operating, monitoring, control and response functions) that are critical to support Network Operating and to secure Hydro One's assets. An integrated solution was sought to ensure costs are minimized, maximizing the effective utilization of critical infrastructure, office space and the site with the intent to maximize capital investments and reducing customer rate impacts. Below is a description of the Security Operations (SOC), Security Event Monitoring (SEM) and the Integrated Telecommunications Management Centre (ITMC) identified investment need.

The Backup Integrated Telecommunications Management Centre (BUITMC), in-serviced in 1950, requires extensive setup during activation and cannot accommodate back office support staff and regulatory security requirements for access control for critical computing equipment. The current HVAC is not adequate for net new occupancy or equipment and lacks the necessary facilities should a prolonged activation be required. ITMC is a critical element in ensuring that the Network Operations telecommunications network is available and in providing first level support in the event of any communications failure. In the event the ITMC cannot meet its service objectives, and Hydro One experiences an issue with telecommunications paths, Network Operating will be unable to monitor or control the respective field assets. ITMC requires a new Backup Control Centre to alleviate the risk at the current location.

Security Event Monitoring (SEM) is accountable to provide cyber surveillance monitoring services and requires Data Centre capacity, (not a physical tenant) to support primary and backup operations. SEM monitors Network Operating's Compute Network to ensure threats are detected, assessed and remediated so that critical cyber assets are not negatively impacted. Loss of visibility, control or erroneous operations of equipment due to a cyber-vulnerability, poses a serious threat to Hydro One's Operating functions. The risk of cyber related events has increased rapidly due to the relative increase in the amount of IT critical cyber assets employed in Hydro One Networks.

A Security Operations Centre (SOC) and an Emergency Operating Centre are required to provide a primary site for operations, monitoring and coordinated response for physical security threats and are imperative for business continuity. Currently, Security Operations are dispersed across the province and is reliant on third party services. In the event the current vendor cannot meet service obligations, Hydro One will be unable to monitor its critical sites. An integrated security presence at the ISOC will ensure physical threats can be detected,

assessed and appropriate response dispatched. If a physical threat goes undetected, catastrophic impacts can result, in the event critical assets are damaged, which has potential to result in sever impacts to the Transmission and Distribution system networks. In addition, a lack of detection has potential to expose Hydro One to safety and environment risk for staff and the general public.

The current ISOC investment has evolved through a significant collaborative effort with Hydro One Network Operating, ITMC, SEM, Security Operations, industry participants and external subject matter experts. Initiation of this investment was predicated on current asset driven deficiencies / requirements (documented safety hazards, capability constraints, Reliability/Performance Impacts and risks, failures, condition, age, obsolescence, and regulatory and/or Hydro One standards (as described above).

Below is a detailed description of the ISOC investment planning process and execution strategy, which has been developed with the aim to a) fully understand requirements and needs across Hydro One; b) gather leading industry best practices, lessons learned; c) develop detailed programmed space and sizing requirement and asses against industry benchmarks; d) project costing from leading industry experts; e) ensures cost controls and oversight.

Planning Needs Assessment: Phase One

Requests for Proposals (RFP) were issued to conduct a Market scan and a Planning Needs assessment. This provided a detailed assessment of sites available in the market that met a set of specific “essential location requirements” and to provide expertise into the conceptualization and documentation of business needs and requirements of Hydro One Networks, ITMC, SEM and Security operations. The main focus was balancing needs and costs against reliability requirements, industry best practices (including Industry participant’s feedback (New York ISO, New England ISO)) and lastly with lessons learned from the current Primary Ontario Grid Control Centre (OGCC). In addition, business requirements were translated into programmed space requirements based on Hydro One’s experience and at the advice of industry experts. A basis of design was developed, capturing the stated requirements and a cost estimate was provided by an external estimator (for building and support infrastructure) and internal Hydro One engineering groups (for Telecommunications and Dual Power and Power System IT).The final basis of design and cost estimate were utilized to initiate the subsequent Detailed Design Phase.

The sizing of the ISOC is predicated on duplicating the OGCC current functions for Backup Control, including parallel use for training simulation and controller / dispatcher training.

The training facilities at the OGCC are currently at capacity. This effectively reduced the size of the ISOC facility by negating the need to program space for training simulation and instead uses technology to use real-time operating space while not active (in backup mode). In the event the OGCC is rendered inoperable or uninhabitable, the new ISOC facility will be able to continue all day to day functions indefinitely with a limited transition period, expected to be one hour or less.

Security Operations sizing was predicated on defined needs of operators, support staff, an investigation room and an Emergency Operations Centre (which will utilize a shared conference rooms when required).

ITMCs Backup Control Centre duplicated the current Primary Centre exclusively, including Control Room space, Data Centre requirements and provisions a back office support compliment to ensure adequate facilities are available for prolonged activation redundancy and assurance of Operations.

SEMs compute needs were documented, forecasted and the incremental capacity was added to the Data Centre white tile space.

Future growth has been accommodated and captured in the detail design however not all space will be built in the initial ISOC build. Data Centre growth has been included up to and including 2035 due to the sensitivity of the equipment and the risk future construction would pose; however the support infrastructure will be purchased on an as needed basis. Future facility expansion will be enabled for future consideration by way of footings and ensuring construction can be achieved without impacting operations (designing connection points etc.) Future extension of the facility, when required will be included in future OEB rate cases.

Detailed Design: Phase Two

At the completion of the Planning Needs Assessment Phase, a Detailed Design phase commenced with the objective to provide all required documentation, designs and costing to tender the end state solution for construction. During this phase, all drawings, facility programing (space definition), IT architecture etc. will be completed, including site procurement (~$3M), Proof of Concept for IT architecture and a final estimation. This information will be packaged and ready for submission for RFP for the construction phase. It is expected to be completed in 2017.

Pending completion of the Detailed Engineering Design and receipt of required approvals, Hydro one will leverage its internal Supply Chain, an Open Market Construction Tender process in two phases.

Phase One: Request for Pre-Qualification ('RFPQ")

Hydro One will seek to pre-qualify a select number of vendors in an open market process, who demonstrate "required competencies" (e.g., proven large project construction experience, defined safety/environmental programs, change control process controls, demonstrated ability to deliver large construction projects on time and to budget, etc.) related to the construction of the ISOC and acceptance of HONI required market-based Terms and Conditions.

Phase Two: Request for Proposal ("RFP")

Hydro One will release to only the pre-qualified vendors a detailed RFP with a complete set of construction documents. Pre-qualified vendors will be required to review the construction documents, offer input with respect to area's which could result in increased costs if not addressed before construction and provide a "fixed" price proposal to a defined scope of work and schedule, linked to a delivery penalty.

Construction Phase: Phase Three

The successful proponent will commence construction and is planned for Q4 2017.

Post Construction award: Hydro One's external designer will monitor on site activities throughout the construction to ensure any issues are addressed early and that required contract quality is delivered. HONI and designates will participate in interactive Bi-weekly onsite construction process meetings to gauge progress to requirements and address concerns which may impact the process.

The ISOC investment has been identified and assessed as a high priority and was subsequently prioritized and planned due to risk and considerations described below.

Site location risks that will continue to be present as there are no viable remedial alternative to the following risks:

- The current site location, and required travel time, requires maintaining an interim backup facility to perform limited functions in the event the OGCC is rendered inoperable and staff have to transition to the BUCC. The ISOC will eliminate this requirement;

- Structure is landlocked, and no expansion potential exists as the facility is surrounded by a Transformer Station;
- Current emergency preparedness risks will remain:
    - In a flight paths (Pearson International Airport);
    - Between two major highways (Hwy 427 & Hwy 401) in the event of hazardous spills;
    - Gas pipe lines located underneath property;
    - Adjacent to transformer station (electrical, fire and asset failure hazard). In 2011, T7 and T8 transformers at Richview both failed catastrophically, resulting in loss of the station and a major fire. This removed the BUCC from use for an extended period of time;
    - Congested area in the event of wide spread emergencies i.e. Civil unrest, blackout, natural disaster, and commute;
    - Adjacent to public storage facilities.
- Facility risks that could render the Hydro One Networks Control Centre or critical equipment unavailable for an extended period of time, eliminating redundancy of critical monitoring and control of the Distribution system include:
    - Flooding in basement, roof and cable entrances, where computer rooms, power rooms, telecom rooms, switchgear, and SONET communications are currently located;
    - Failures of critical support infrastructure including; the fire panel, HVAC, emergency backup power (generator);
    - Inability for expansion and a high cost for retrofit / maintenance activities;
    - Relocation of the equipment located in the basement of the facility is not viable given the space required on the main floor (Computer rooms, telecommunication gear (SONET), Uninterrupted Power Supply units, switchgear etc.;
    - Competing demands for physical space, power, cooling from multiple tenants; and
    - Electric power system is undersized (Station Service).
- ITMC's current BUITMC has documented the following risk and constraints;
    - Located in a shared space with an inability to expand;
    - Requires extensive setup during activation as the facility cannot accommodate a permanent active installation;
    - Cannot accommodate current back office support requirements;
    - Cannot meet security requirements for access control for critical computing equipment;
    - The current HVAC is not adequate for net new occupancy or equipment;

- Lacks the necessary facilities should a prolonged activation be required; and
- ITMC is a critical element in ensuring that the Network Operations telecommunications network is available and in providing first level support in the event of any communications failure.

Hydro One's Security Operations are currently reliant on an external facility that is owned and operated by a third-party creating corporate and regulatory risks given that Hydro One lacks a contingency site that is capable of monitoring the physical security of its sites and assets. Should the facility or 3rd party services no longer be available to Hydro One due to factors outside of Hydro One's control, Hydro One will not be in a position to monitor the real-time security (including door alarms, motion sensors etc.) of its critical sites, creating both a security and public and employee safety risk. Such an occurrence would also lead to a regulatory non-compliance violation with NERC Standards and possible sanctions, financial penalties and risk to corporate reputation.

APPENDIX B – DETAILED ALTERNATIVE COMPARISON

Detailed Alternative Comparison

Alternative	Description	Cost ($)	Size (Sq.Ft)	Site (Acres)	Cost / Sq.Ft	OM&A**	Benefits / Risks
Alternative One: Status Quo	Maintain existing facilities. (BUCC remediation activities, lease new data hall space and for BUITMC Requirements).	$78M*	18,921	N/A	N/A	N/A	No provision for SOC. BUCC existing location, space, and site constraint risk remains. Significant difficulties for prolonged activation. Includes a leased space for BUITMC, leased Data Centre space for NOD and remedial work to retrofit office space to better accommodate prolonged activation.
Alternative Two	Build NOD BUCC and Data Centre.	$104.8M*	95,420	10+	$1,098	$3.72M	Site, SONET, Dual Power and critical support infrastructure included.
Alternative Three	Build ISOC as BUCC, BUITMC with back office and Data Centre.	$124.7M*	99,716	16.41	$1,251	$4.0M	This includes the preferred site and all critical support infrastructures including but not limited to: SONET, Dual Power, redundant generation, UPS, cooling, shared office and common space. This excludes SOC from inclusion.

Alternative	Description	Cost ($)	Size (Sq.Ft)	Site (Acres)	Cost / Sq.Ft	OM&A**	Benefits / Risks
Alternative Four	Acquire an existing facility for BUCC and BUITMC and integrated Data Centre	Not available. Building specific market scan by Andrew Thompson and Associates (ATA) indicated no suitable site for consideration at time of assessment. Hydro One owned sites were reviewed internally; however also found that no suitable site or facility existed.					
Alternative Five	Build Primary NOD Control Centre, primary SOC, and BUITMC.	$141.9M*	126,200	16.41	$1124	$4.47M	This option assumes that the existing OGCC staff would be moved to the new ISOC and the current OGCC used a Backup. Additional compute / system investment required which is not included in total cost.
Alternative Six	Initiate Build of ISOC with future dual operating capabilities.	$138.4M*	126,200	16.41	$1,096	$4.47M	Provides a NOD BUCC, BUITMC, and Primary SOC including shared integrated Data Centre, and back office support. Current lifecycles for critical applications respected, alleviating addition IT requirements to enable Primary operability. Dual Primary enabled for future implementation.
Ontario Grid Control Centre (data for comparison purposes)		$144.9M	68,000	9.25	$2,131	N/A	Presented in 2016 dollars (originally $118M investment in 2003) Provided for comparison.

*The Distribution portion of this total is 50.07% of the total cost.

**The OM&A cost estimates are the full total cost, and these have not been adjusted to show the distribution portion only.

Data Centre Construction vs. Leased Data Centre

In addition to the above alternatives, a comparison between the option of construction versus a comparable colocation or leased data centre option was conducted by engineering firm Morrison Hershfield, to ensure the most cost effective means of providing needed Data Centre space. This is the largest cost consideration in the overall project total. This assessment was based on a 15 year term based on market prices in the Toronto area. The Toronto area was utilized for this study as it provided a much larger pool of lease options with the required reliability / Tier level standards. The results are shown below which indicated that the co-location/lease option ($122.1M), based on the current design criteria, far exceed the cost of the build option ($73.2M) ($30M in Capital + Incremental annual OMA at $2.5M escalated at 2% per year for 15 years, $43.2M).

	IT/POWER MRC*	**Annual Cost of Rent**
Year 1	$ 341,144.00	$ 4,093,728.00
Year 2	$ 372,529.25	$ 4,470,350.98
Year 3	$ 406,801.94	$ 4,881,623.27
Year 4	$ 444,227.72	$ 5,330,732.61
Year 5	$ 529,725.56	$ 6,356,706.73
Year 6	$ 529,725.56	$ 6,356,706.73
Year 7	$ 578,460.31	$ 6,941,523.75
Year 8	$ 631,678.66	$ 7,580,143.93
Year 9	$ 689,793.10	$ 8,277,517.17
Year 10	$ 753,254.06	$ 9,039,048.75
Year 11	$ 822,553.44	$ 9,870,641.24
Year 12	$ 898,228.35	$ 10,778,740.23
Year 13	$ 980,865.36	$ 11,770,384.33
Year 14	$ 1,071,104.97	$ 12,853,259.69
Year 15	$ 1,169,646.63	$ 14,035,759.58
	Total 15 Year Spend	$122,101,320.25
*MRC = Monthly Recurring Charges include IT load rent, estimated power charges and PUE of 1.6		

Other factors that affected this consideration are; a) no co-location facility provides NERC certified space which would require additional upfront capital cost in year one, b) many facilities have policies that dictate access, upgrade, expansion and security for the facility without renter input which exposed Hydro Ones critical equipment to further risks.

ISOC Breakdown	Est. Cost	Ft2	$ / ft^2	Report Findings of Morrison Hershfield on Build Comparisons
Building Shell Cost	$23M	120,534	$250	Includes shell and basic Mechanical Electrical Power services. This is considered at the bottom of the range of $250/ft2 -$1000/ft2 for hardened facilities of this type, which equals the cost per square foot for SaskPower's most recent facility design. Variance consisted of EF3 Tornado rate vs. EF4 for SaskPower with less office space and did not have Control Room space. Average generic office space range from $150 - 250/sq. ft. dependent on finish and furnishings.
Data Centre Cost	$30M	11,990*	$2502	SaskPower's estimates cost per sq. ft. for data centre space was $3,000 / sq. ft. and it is MH's conclusion that $2502 is within range of similar facilities. A similar telecom project in 2015 with a similar Tier level as HONI was $2575/sq.f.t.
ISOC Total	$138M**	126,200	$1096	This includes Building Shell, Outdoor Yard and Data Centre.

- **Included support galleries (cooling, power distribution).*
- ***Note: The Distribution portion of this total is 50.07% of the total cost.*

Comparisons to Similar Facilities at Other Utilities

Lastly, NOD reviewed a number of utilities investments in facilities and data centre development projects to ascertain the reasonableness of the ISOC scope as compared to the rest of the industry. Below is a table summarizing these findings; which show the ISOC is in line with the cost per square foot for comparable projects.

Industry Comparators	Description/Name	Cost ($M)	Size (Sq. ft.)	Year Built	Adj. Cost to 2016 $ (CPI)	Cost (2016 $) / Sq. ft.
New York Independent System Operator	NYISO Control Center	$59.4M	64,000	2014	$60.82M	$950
American Electric Power	Transmission Operations center	$57.2M	83,500	2007	$65.92M	$789
ISO-New England	Windsor Backup Control Centre	$50.7M	70,000	2014	$51.91M	$742
Pacific Gas & Electric	Distribution Control Center	$52.0M	37,674	2015	$52.57M	$1,395
	Distribution Control Center	$37.05M	24,000	2014	$37.97M	$1,582
	Distribution Control Center	$46.8M	50,000	2016	$46.8M	$936
First Energy	FirstEnergy Tx Control Centre	$58.5M	70,000	2013	$61.16M	$874
BC Transmission Corporation	System Control Modernization Project	$133M	113,022	2008	$148.07M	$1,310
	System Control Centre (building ONLY)	$40M	64,584	2008	$44.53M	$689
	Backup Control Centre (building ONLY)	$30M	48,438	2008	$33.4M	$690
Average Cost :				-	$60.3M	$996
Distribution Portion of ISOC.		$69.3M	63,188	2016	$69.3M	$1,096
Proposed ISOC Cost Comparison		$138.4M	126,200	2016	$138.4M	$1096

Converted from USD to CDN at an exchange of 1 USD to 1.3CDN

Note: The ISOC is comprised of Distribution, Transmission, ITMC and SOC.

Site Assessment

As the table below shows, sites south of Barrie were higher cost and the sites North of Barrie were considerably less expensive. Orillia, given its relative location compared to the Primary Centre, was optimal given the City size, access, lodging, development and emergency services, including the OPP headquarters. Communities further away were ranked lower due to distance, access to emergency services, development and lodging, winter driving hazards and relative site suitability among other factors.

Ranking	Community	# of Sites	Ave. Cost / Acre
1	City of Orillia	4	$114,935 - $181,200
2	Town of Bradford	3	$346,636
3	Town of Collingwood	3	$135,469
4	Town of Midland	6	$90,000
4	Town of Penetanguishene	3	$87,500
5	Town of Alliston (New Tecumseth)	3	$273,900
6	Town of Newmarket	2	$850,000
7	Town of Orangeville	1	$215,000
8	East Gwilliambury	6	$400,000
9	Angus	1	$80,000
10	Innisfill	0	$ -
11	Schomberg (King Township)	1	$475,000
12	Wasaga	0	$ -

Note: An assessment of internal Hydro One TS sites was reviewed against available acreage and emergency preparedness criteria and was determine that there was no existing Hydro One site that could accommodate the proposed facility. This represented a departure for previous assumptions with impacts of land purchase and support infrastructure that must be extended to the preferred site.